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THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY—VOL. IV.

REPORT

ON THE

SCIENTIFIC RESULTS

OF THE

VOYAGE OF H.M.S. CHALLENGER

DURING THE YEARS 1873-76

UNDER THE COMMAND OF

CAPTAIN GEORGE S. NARES, R.N., F.R.S.

AND

CAPTAIN FRANK TOURLE THOMSON, R.N.

PREPARED UNDER THE SUPERINTENDENCE OF

THE LATE

Sir C. WYVILLE THOMSON, Knt., F.R.S., &c.

REGIUS PROFESSOR OF NATURAL HISTORY IN THE UNIVERSITY OF EDINBURGH

DIRECTOR OF THE CIVILIAN SCIENTIFIC STAFF ON BOARD

AND NOW OF

JOHN MURRAY, F.R.S.E.

ONE OF THE NATURALISTS OF THE EXPEDITION

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THE

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ZOOLOGY.

REPORT on the DEEP-SEA MEDUSÆ dredged by H.M.S. Challenger during the years 1873–1876. By Prof. ERNST HÆCKEL.

PREFACE.

THE DEEP-SEA MEDUSÆ form one of the smallest and least important groups of the rich and remarkable deep-sea fauna for whose discovery we are indebted to the voyage of H.M.S. CHALLENGER; the number of the species described does not exceed eighteen, of which half are Craspedotæ and half Acraspedæ. The majority of these eighteen species, however, which represent an equal number of genera, are of great morphological interest, and they, moreover, claim special attention as the first deep-sea inhabitants of this class of animals with which we have become acquainted. I am therefore particularly indebted to Sir Wyville Thomson for most liberally handing over to me for examination the whole of the Medusæ collected by the expedition. To the first large collection of deep-sea Medusæ, sent to me in 1877, I was able to add a few more, which I found incidentally in examining the Radiolaria of the expedition, and in going more minutely over the general collection, during a visit to Edinburgh in 1879. I have especially to thank Mr. John Murray, principal assistant on the civilian staff of the Challenger, for kindly aiding me in this work in every way in his power.

All the eighteen species of deep-sea Medusæ described in this Memoir have already received a brief diagnosis in my System der Medusen published in 1879. Besides these, I had already described two other species, the Æginid, *Æginorhodus rosarius* (System, p. 345, No. 379), and the Cyaneid, *Melusina formosa* (System, p. 535, No. 500).

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Unfortunately, however, the fragments of the only specimens which I obtained of these two beautiful Medusæ, proved on closer examination to be so imperfect and so badly preserved, that I was obliged to give up all idea of their further description and illustration. On the other hand, I gained a special advantage in the description of a few other deep-sea Medusæ, whose single specimens from the Challenger collection were also insufficiently preserved, as I was able to complete it by means of material procured elsewhere. I have to thank Professor Steenstrup and Dr. Lütken for several well-preserved specimens of *Ptychogena pinnulata* and *Pectyllis arctica* from the Zoological Museum of Copenhagen, and my friend Mr. Gregor Buccich for several excellent specimens of *Drymonema victoria* from the island of Lesina in Dalmatia. Three species, of each of which the Challenger collection only contained an imperfect fragment, I took myself living with the tow-net, and thus had an opportunity of examining them minutely; *Pectanthis asteroides* from the Mediterranean, *Cunarcha æginoides* from Lanzarote, one of the Canary Islands, and *Polycolpa forskalii* from the Red Sea. Of the majority of the twelve other species I had, unfortunately, only a single specimen at my disposal, and that was often imperfect; still I hope that, with the assistance of the comparative morphology of the most closely allied Medusæ, I have satisfactorily reconstructed their organisation.

It is by no means certain that all the eighteen deep-sea Medusæ described below are constant inhabitants of the deep sea; the method of capture by the tow-net by which such delicate and fragile organisms are often brought from great depths of the sea is still imperfect, and it is probable that the greater number of Medusæ brought up apparently from the greater depths, really swim in shallower water and are only taken in "hauling in" the net. Those Medusæ, on the other hand, may be regarded with greater probability as permanent and characteristic inhabitants of the deep sea, which have either adapted themselves by special modifications of organisation to such a mode of life, or which give evidence by their primitive structure of a remote phylogenetic origin. As such I consider of the nine Craspedotæ described,—first of all the three Pectyllidæ (*Pectyllis, Pectis*, and *Pectanthis*), and secondly *Cunarcha* and *Æginura*; among the nine Acraspedæ, *Tesserantha*, the two large Periphyllidæ (*Periphylla* and *Periphema*), and the two remarkable Ephyridæ (*Nauphanta* and *Atolla*). It appears, however, from the occasional observations of single naturalists, that other Medusæ species also (especially Charybdeidæ and Rhizostomidæ) inhabit for the most part the bottom of the sea, and pass into considerable depths. We may therefore hope that the following description of the deep-sea Medusæ may be regarded as the first instalment from an interesting region from which we may expect many and important conclusions as to the organisation of the Medusæ.

It will be seen from the systematic survey on p. 141 that altogether eight orders of this class, distinguished by me in my System der Medusen, 1879, are represented among the eighteen deep-sea Medusæ of the Challenger expedition. Of these one species (*Thamnostylus*, Pl. I.) belongs to Order I. Anthomedusæ; one species (*Ptychogena*, Pl. II.) to Order II. Leptomedusæ; three species (*Pectyllis*, *Pectis*, and *Pectanthis*, Pls. III.–VIII.) to Order III. Trachomedusæ; four species (*Cunarcha*, *Polycolpa*, *Pegantha*, *Æginura*, Pls. IX.–XIV.), to Order IV. Narcomedusæ; two species (*Tesserantha* and *Lucernaria*, Pls. XV.–XVII.) to Order V. Stauromedusæ; two species (*Periphylla* and *Periphema*, Pls. XVIII.–XXV.) to Order VI. Peromedusæ; one species (*Charybdea*, Pl. XXVI.) to Order VII. Cubomedusæ; four species (*Nauphanta*, *Atolla*, *Drymonema*, *Leonura*, Pls. XXVII.–XXXII.) to Order VIII. Discomedusæ. Thus thirteen of the thirty-two families which I defined in my System der Medusen, 1879, are represented here (comp. p. 141).

A tabular view of the chorology of these Medusæ is given on p. 142. Their geographical distribution extends throughout the whole of the great oceans; on the whole, there are eight species in the Atlantic-Mediterranean region, and ten species in the Indo-Pacific region. Of the eight former species seven belong to the northern, one to the southern half of the Atlantic Ocean (two of which are also found in the Mediterranean). Of the remaining ten species, two belong to the north half, three to the southern half of the Pacific Ocean, and five to the Antarctic part of the Indian Ocean. One of the latter is also found in the south-western part of the Atlantic.

With regard to the bathymetrical distribution, it will be seen from the table on p. 142 that seven species were taken in depths from 80 to 600 fathoms, six species in depths from 1100 to 1600 fathoms, and five species in depths from 2000 to 2200 fathoms. For reasons already stated, these depths must (partly at least) be considered more or less approximate.

With regard to the figures of the deep-sea Medusæ in the thirty-two plates appended to this Memoir, it is of course impossible, from the imperfect state of preservation of the spirit specimens, to expect that they should be absolutely true to nature. I rather considered it my duty here, as in those figures in my System der Medusen which were drawn from spirit specimens, to take advantage of my knowledge of the forms of the living Medusæ, to reconstruct the most probable approximate image of the living forms. I was greatly assisted in my efforts in this direction by the skilful hand of my lithographer, Mr. Adolf Giltsch. I am also greatly indebted to my friend Dr Reinhold Teuscher for preparing a large number of excellent microscopic sections. This Memoir has been translated into English by Miss Nellie Maclagan, and I thank her for the kind care with which she has executed a difficult task.

The many new morphological facts, furnished by close examination of the deep-sea Medusæ, are not only of special interest in themselves, but are, for the most part, of general interest for deciphering the comparative anatomy of the whole class; this is true, for example, of the Pectyllidæ and Peganthidæ among the Craspedotæ, and of the Periphyllidæ and Ephyridæ, among the Acraspedæ. I therefore considered it convenient to preface the special anatomical description of the eighteen deep-sea Medusæ by a short article on the Organisation of the Medusæ, which serves in a certain measure as a morphological introduction to the former, and at the same time as a preliminary Scheme of a comparative Morphology of the Medusæ.

ERNST HÆCKEL.

JENA, 14*th September* 1881.

THE ORGANISATION OF THE MEDUSÆ.

Sketch of a Comparative Morphology of the Medusæ as an Introduction to the Description of the Deep-sea Medusæ of the Challenger Expedition.

I. GENERAL MORPHOLOGY OF THE MEDUSÆ.

§ 1. Definition of the Medusæ. Medusæ are Cnidariæ or Acalephæ with a gelatinous, radially constructed, concave-convex umbrella, whose vertical axis is the principal axis of the single persona; with swimming muscles on the concave oral side of the umbrella; nerve centres and organs of sense on the peripheric margin of the umbrella; with radial processes (canals or pouches) of the central gastral cavity, and a simple (seldom multiple) oral opening at the oral pole of the principal axis; also with genitalia in the subumbral wall of the gastrovascular system (comp. System der Medusen, 1879, p. 21, &c.). Medusæ are distinguished from the other classes of Acalephæ or Cnidariæ (Polyps, Corals, Siphonophora, Ctenophora) by the following class characters: the mature, completely developed Medusa appears as a single persona (not united in numbers in a colony), which usually swims freely in the water, seldom crawls, still more rarely is fastened to the bottom; (nearly all Medusæ live in the sea, only a few in fresh water). The principal mass of the Medusa body (by volume and weight) forms a concave-convex, watery gelatinous body, the umbrella. This serves as the special swimming organ; a vertical principal axis and two or more horizontal transverse axes (with twice as many radial axes) are always the standard for its pyramidal base form. The convex outer surface of the umbrella (exumbrella) does not generally bear special organs, whilst the concave inner surface (subumbrella) is always overlaid with a muscular plate, which, as the most important organ of motion, deepens and narrows the umbrella cavity by its contraction, and thereby expels the water from it. The most important organs of sensation, the nerve centres, and differentiated organs of sense, and generally the tentacles also, lie on the umbrella margin (where the exumbrella and the subumbrella are contiguous). The organs of nutrition are formed by a radial gastrovascular system which extends over the subumbrella, and is composed of a central principal intestine and a peripheric coronal intestine. The principal intestine (in the centre of the subumbrella) forms a simple gastral cavity, which often projects below like a tube and opens at the oral pole of the principal axis by a simple (seldom multiple) mouth. The coronal intestine (in the periphery of the subumbrella) is composed of four or more radial processes of the central stomach, which sometimes take the form of broad pouches, sometimes of narrow canals. The organs of reproduction are always simple reproductive glands (genitalia) and are always developed in the lower (subumbral) wall of the gastrovascular system, sometimes from its endoderm, sometimes from its ectoderm. Nearly all Medusæ are gonochoristic, only a few hermaphrodite. As regards the phylogeny of the Medusæ, their comparative anatomy and ontogeny points out the class of Polyps as their original ancestral group.

§ 2. Definition of the Polyp. The class of the Polyps, from which the class of Medusæ are phylogenetically derived, and which, therefore, furnishes the key to our morphological knowledge of them, is at the same time the common ancestral group of all Cnidariæ. At present the fresh-water Polyp (Hydra), and the closely allied genera *Clava*, *Coryne*, &c., must be considered their simplest and most primitive representatives. Their developed organism is immediately allied to that of Gastrula (phylogenetically Gastræa), and has the same simple primitive intestine with primitive mouth, whose wall is formed from the two primary germinal layers. The Polyp is chiefly distinguished from the Gastrula by beginning histological differentiation of the two primary germinal layers, and also by the fact that the aboral pole of the principal axis serves as a peduncle for adhesion, whilst a corona of feelers or tentacles is developed round the mouth at its oral pole. This corona of tentacles forms the boundary between the strongly-arched aboral part of the body (cup, "calyx") and the flat or even depressed oral part (oral disk, "peristomium").

§ 3. Medusa and Polyp. The most essential difference between the organisation of the Medusa and the Polyp consists in the formation of the characterstic swimming organ of the former, the umbrella, and of the cathamma or partial fusions between the aboral wall of the cup ("calyx") and the oral disk ("peristomium"), by means of which the peripheric part of the simple gastral cavity is divided into radial pouches or canals, which regularly surround its simple central space. The central gastral cavity of the Medusa does not therefore correspond to the whole simple gastral space of the Polyps (or to the primitive intestine of the Gastræa) but only to the central part of it, whilst on the other hand its peripheric part is homologous with the radial (usually four-rayed) coronal intestine of the Medusa ("pouch corona or canal corona"). The central oral opening is identical in both animal classes, arising from the primitive mouth of the Gastrula, and when it is prolonged in the Polyps into an oral cone or proboscis, the latter corresponds to the freely projecting œsophagus or oral peduncle of many Medusæ. The peristomium of the Polyps (or the slightly concave oral disk) is homologous with the "subumbrella" of the Medusa (or the more strongly depressed lower surface of the umbrella). In the same way the convex outer surface or the dorsal cup-wall (calyx) of the Polyp corresponds to the more depressed dorsal wall or "exumbrella" of the Medusa. The cup-margin of the Polyps (with the insertion of the corona of tentacles) is therefore homologous with the umbrella margin of the Medusa, but in the latter, differentiated organs of sense are developed beside or from the tentacles, whilst this is not the case in the former. As regards histological differentiation, the older and lower Polyp form remains far behind the younger and higher Medusa form. The latter has arisen from the former by adaptation to a swimming mode of life, and has thereby become perfected.

§ 4. Craspedotæ and Acraspedæ (System, p. xxiv. 1, 361). The class of the Medusæ is divided into two different sections or sub-classes, Craspedotæ and Acraspedæ. Both sub-classes form natural principal groups, differing essentially and thoroughly from one another in important conditions of organisation. Although single groups in both sections are so like that they may be confounded together, and, in fact, have often been so, yet the two principal groups differ fundamentally, and have probably arisen quite independently of one another from two different groups of polyps; their most important differences are best seen from the following tables:—

I. Craspedotæ or Hydromedusæ.	II. Acraspedæ or Scyphomedusæ.
A. Gastral space, without gastral filaments or phacelli (Aphacellæ).	A. Gastral space with gastral filaments or phacelli (Phacellotæ).
B. Genitalia ectodermal (sexual products of the outer germinal layer) (Cryptocarpæ).	B. Genitalia endodermal (sexual products of the inner germinal layer) (Phanerocarpæ).
C. Umbrella margin with true velum, without true marginal lobes (Craspedotæ).	C. Umbrella margin without true velum, with true marginal lobes (Acraspedæ).
D. Organs of sense usually simple, without protective plate (Gymnophthalmæ).	D. Organs of sense usually composite, with special protective plate (Steganophthalmæ).
E. Marginal nerve ring double and centralised (Cycloneuræ).	E. Marginal nerve ring simple, usually non-centralised (Toponeuræ).
F. Descent from Hydropolyps, or Polyps without gastral tæniola (Hydromedusæ).	F. Descent from Scyphopolyps, or Polyps with gastral tæniola (Scyphomedusæ).

§ 5. Hydropolyps and Scyphopolyps. The two sections of the class Medusæ correspond to two different sections of the Polyp class, Hydropolyps and Scyphopolyps. The lower more simply constructed Hydropolyps have retained a perfectly simple gastral space with smooth inner surface (primitive intestine or "archigaster" of the *Gastræa*). The higher and more perfect Scyphopolyps are distinguished from the Hydropolyps by four interradial longitudinal swellings or gastral ridges ("tæniola") being developed on the inner surface of the gastral cavity, by which their peripheric part is consequently divided into four broad perradial niches or pouches ("antra gastralia"). The Hydromedusæ or Craspedotæ, as well as the classes of Siphonophoræ, and Ctenophoræ derived from them, are descended from the Hydropolyps (*Hydra*, *Clava*, &c.); the gastral filaments are wanting in all these Cnidariæ. The Scyphomedusæ or Acraspedæ, as well as the class of Corals or Anthozoa are descended from the Scyphopolyps (*Scyphostoma*, *Spongicola*, &c); both these classes have gastral filaments or mesenteric filaments, which have arisen from the tæniola of the Scyphopolyps.

§ 6. Polyphyletic origin of the Medusæ. That the class of Medusæ belongs to the polyphyletic classes of animals is now a phylogenetic hypothesis, which may be brought forward as a probability bordering upon certainty, although, on the one hand, the characteristic structure of the Medusæ appears so uniquely organised that they are most suitably placed as a separate class in the system of the animal kingdom, yet, on the other hand, it by no means follows that they are all derived from a single common ancestral form, which already possessed the form of the Medusæ. It is much more probable that the two sub-classes, or sections of this class, the Craspedotæ and Acraspedæ, are of separate origin, and are descended from groups of Polyps, which have developed into Medusæ, independently of one another. A strong support to this hypothesis is, that the Scyphopolyps, the ancestral form of the Acraspedæ (*Scyphostoma*, *Stephanoscyphus*, &c.), already possess the four important interradial tæniola or gastral longitudinal ridges from which the four characteristic groups of filaments are developed in all Acraspedæ (or Scyphomedusæ). On the other hand, the characteristic groups of filaments are wanting in the Craspedotæ (or Hydromedusæ) as the typical four interradial tæniola are wanting in their ancestral form, the Hydropolyps. Moreover, the reproductive organs originate in the Craspedotæ (as in most Hydropolyps) from the ectoderm and in the Acraspedæ (as in the Scyphopolyps and Corals) from the endoderm. As regards the two sections or sub-classes, the Craspedotæ are more probably of monophyletic origin, the Acraspedæ of polyphyletic.

§ 7. Orders of the Craspedotæ (System, pp. 2, 233, 360). The section of the Craspedotæ or Hydromedusæ is divided into two sub-sections and four orders. The two sub-sections, Leptolinæ and Trachylinæ, are thoroughly and pre-eminently distinguished from one another by the absence or presence of the cordyli or tentacular "auditory clubs." These are modified acoustic tentacles, consisting of a solid axis of chordal endodermal cells, of which the last (distal) contains one or more otolites; their ectodermal epithelium bears stiff auditory bristles. The first sub-section (or Acordyliæ) has no auditory clubs; it has, in fact, either no auditory organs or only "velar auditory vesicles" (marginal vesicles on the velum with ectodermal otolites) which are quite different from the cordyli, and occur in no other group. Moreover in the Leptolinæ, the tentacles are usually hollow, very movable contractile filaments, and their velum is delicate and thin. The second sub-section, the Trachylinæ (or Cordyliotæ), on the other hand, invariably bear true cordyli or auditory clubs with endodermal otolites on the margin of the velum; their tentacles are, moreover, usually solid, tolerably stiff, and slightly contractile filaments, and their velum is thick and compact. The Leptolinæ mostly develop indirectly (by metagenesis), the Trachylinæ mostly directly (by hypogenesis). In both sub-sections there is an order with gastral genitalia (Anthomedusæ, Narcomedusæ), and an order with vascular genitalia (Leptomedusæ, Trachomedusæ). Those differences are clearly shown by the following tables :—

§ 8. Survey of the two sections of Craspedotæ.

Leptolinæ (Acordyliæ). Craspedotæ without auditory clubs or cordyli, with very movable and extensible tentacles, which are usually hollow.	Trachylinæ (Cordyliotæ). Craspedotæ with auditory clubs or cordyli, with stiff and slightly extensible tentacles, which are usually solid.
Order I. Anthomedusæ, Pl. I. (System, p. 3, taf. i.–vii.) Genitalia gastral (reproductive organs originally in the subumbral wall of the stomach), descent from Tubularia polyps.	Order III. Trachomedusæ, Pls. III.–VIII. (System, p. 234, taf. xvi.–xviii.) Genitalia vascular (reproductive organs originally in the subumbral wall of the radial canals), usually without peronia on the umbrella margin, never with peronial canals.
Order II. Leptomedusæ, Pl. II. (System, p. 3, taf. viii.–xv.) Genitalia vascular (reproductive organs originally in the subumbral wall of the radial canals), descent from Campanularia polyps.	Order IV. Narcomedusæ, Pls. IX.–XIV. (System, p. 299, taf. xix.–xx.) Genitalia gastral (reproductive organs originally in the subumbral wall of the stômach), peronia on the umbrella margin, usually with developed peronial canals.

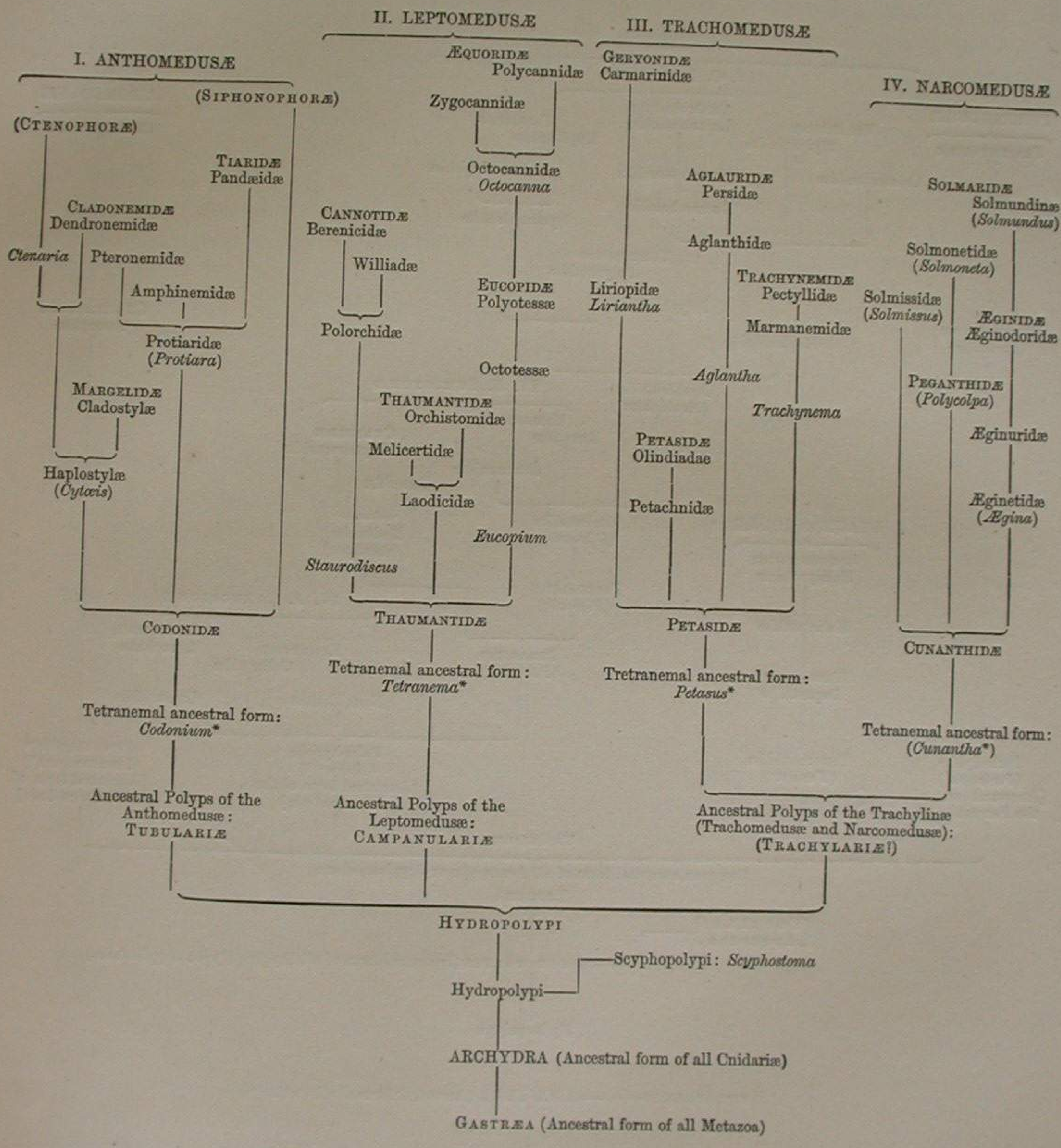
§ 9. Orders of the Acraspedæ (System, pp. 362, 449, 632). The section of the Acraspedæ or Scyphomedusæ is divided into two sub-sections and four orders. The first, older and lower sub-section, the Tesseroniæ (or Tetraperiæ), has a highly arched, usually conical umbrella, and on its subumbral side four large perradial gastral pouches, separated by four interradial septa or cathamma, in whose subumbral wall the genitalia are developed. The second, younger and higher sub-section, the Ephyroniæ (or Octoperiæ) has, on the contrary, a depressed, usually discoid umbrella, and on its subumbral side, a very wide, flat gastral cavity, into which the four original perradial pouches have been merged, and in whose subumbral wall the genitalia are therefore developed; the four interradial septa or cathamma have undergone retrograde formation, and are mostly lost. A further distinction between the two sub-sections lies in the number of their characteristic sense clubs or rhopalia. All Ephyronia or Discomedusæ have eight or more sense clubs (four perradial, four interradial, often several accessory), whilst the Tesseroniæ have only four sense clubs, or none at all. Of the three orders of the Tesseroniæ, the Peromedusæ have four interradial rhopalia, the Cubomedusæ four perradial, and the Stauromedusæ no rhopalia (tentacles instead). These differences are shown by the following tables:—

§ 10. Survey of the two sections of the Acraspedæ.

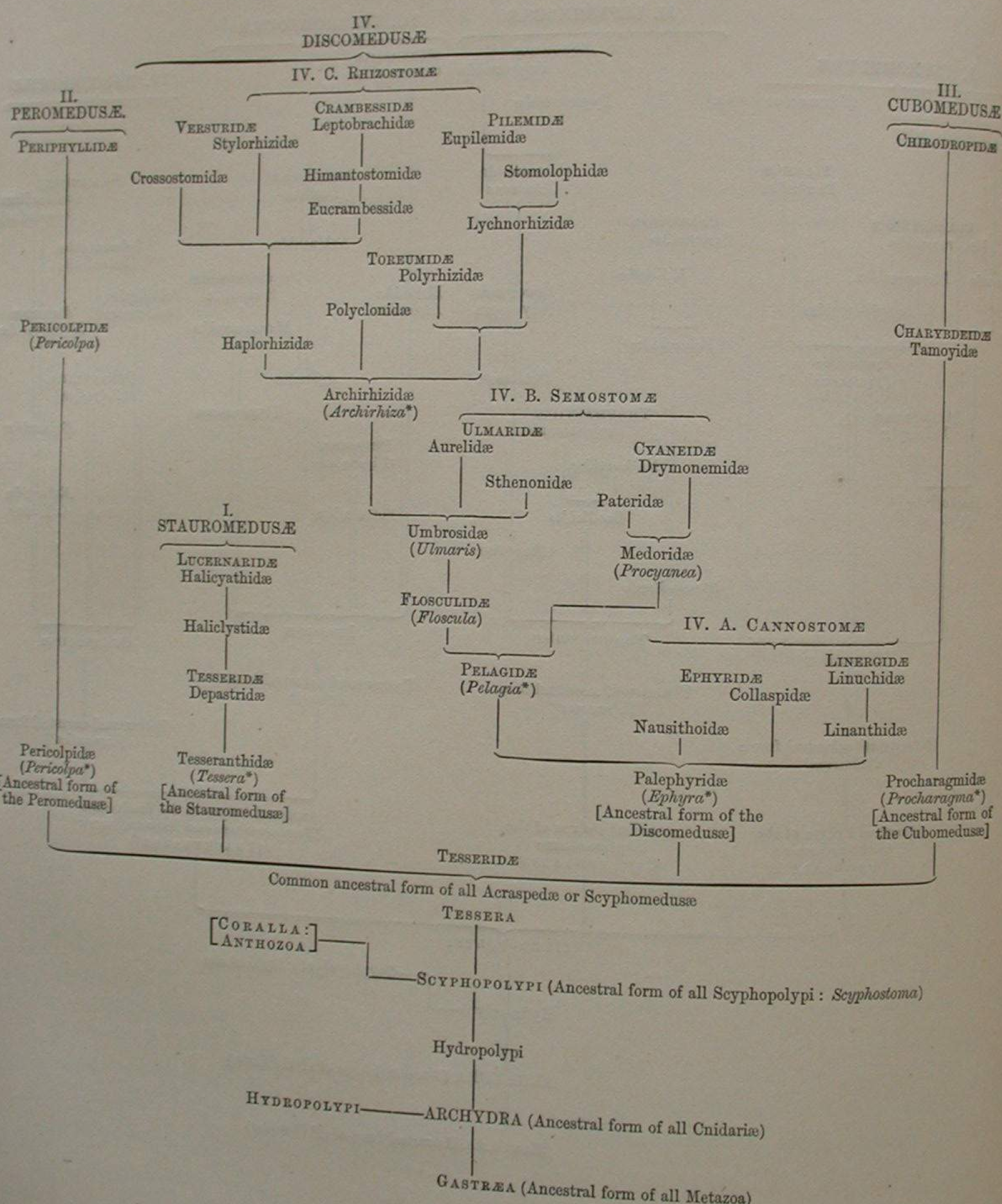
Tesseroniæ (Tetraperiæ).	Ephyroniæ (Octoperiæ).
Acraspedæ without sense clubs, or with four sense clubs (rhopalia). Umbrella usually highly arched, conical; four perradial gastral pouches large, separated by developed cathammal septa.	Acraspedæ with eight or more (up to thirty-two) sense clubs (rhopalia). Umbrella usually depressed, discoid; four perradial pouches small, usually become part of the central stomach, by dissolution of the cathammal septa.
Order I. Stauromedusæ, Pls. XV.–XVII. (System, p. 363, taf. xxi.–xxii.) No rhopalia; simple tentacles instead.	Order IV. Discomedusæ, Pls. XXVII.–XXXII. (System, p. 450, taf. xxvii.–xl.) Eight rhopalia or more, four perradial, and four interradial (sometimes also several accessory).
Order II. Peromedusæ, Pls. XVIII.–XXV. (System, p. 396, taf. xxiii., xxiv.) Four interradial rhopalia and four perradial tentacles between (often eight adradial tentacles in addition).	Sub-Order I. Cannostomæ. Œsophagus simple, without free oral arms. Tentacles usually short and solid.
Order III. Cubomedusæ, Pl. XXVI. (System, p. 423, taf. xxv., xxvi.) Four perradial rhopalia and four interradial tentacles or bunches of tentacles between.	Sub-Order II. Semostomæ. Œsophagus cleft into four large perradial, folded oral arms. Tentacles usually long and hollow.
	Sub-Order III. Rhizostomæ. Œsophagus represented by eight adradial dice-shaped oral arms with numerous funnel openings. Central mouth fused. No tentacles.

§ 11. Polyphyletic origin of the Craspedotæ. The section Craspedotæ or Hydromedusæ is probably a polyphyletic animal group; several different groups of Craspedotæ having arisen independently of one another from several different groups of Hydropolyps. This is corroborated by the fact that all Anthomedusæ are descended from Tubularian Polyps, all Leptomedusæ from Campanularian Polyps. The phyletic divergence of these two groups of polyps is probably very much older than the origin of the two corresponding orders of Medusæ. The Trachylinæ or Cordyliotæ seem to form a third independent group of this section, the Trachomedusæ and Narcomedusæ. But these two orders may also have originated independently of each other. The monophyletic origin of all forms within the four orders of Craspedotæ from a single common ancestral form, though not certain, is still extremely probable (System, p. 359).

§ 12. Hypothetical Ancestral Tree of the Craspedotæ (Polyphyletic).



§ 13. Hypothetical Ancestral Tree of the Acraspedæ (Monophyletic).



§ 14. Monophyletic origin of the Acraspedæ. Whilst the section of the Craspedotæ is probably of polyphyletic origin, and their chief groups have arisen independently of one another, the conditions of relationship among the Acraspedæ or Scyphomedusæ is, on the contrary, so close that the monophyletic origin of these sections may be admitted with the greatest probability. The existing Tessera has even retained a very old primordial form, which has the same significance for the section of the Acraspedæ as Hydra has for the whole tribe of the Cnidaria. The order of Stauromedusæ in which the sense clubs or rhopalia are completely wanting, is developed first of all from Tessera. The two orders of Peromedusæ and Cubomedusæ, spring as two diverging principal branches from the ancestral group of the Stauromedusæ; in the former the four interradial tentacles are transformed into sense clubs or rhopalia; in the latter, on the contrary, it is the four perradial tentacles. The fourth order of Acraspedæ, the extensive group of the Discomedusæ, is distinguished by the fact that all the eight principal tentacles are transformed into rhopalia; it has probably originated from the Stauromedusæ or Cubomedusæ, perhaps rather from the Peromedusæ. The Cannostomæ form the ancestral group among the Discomedusæ; the Semostomæ have probably arisen later from these, and the Rhizostomæ still later from the Semostomæ (System, p. 450).

§ 15. Ontogenesis of the Medusæ. The individual development or ontogenesis, which, according to the biogenetic fundamental law, affords us the surest explanation of the phylogenesis or the original development of the tribe, appears in the Medusæ in two distinct principal forms, as metagenesis and hypogenesis. Metagenesis (or indirect development) includes the alternation of generations of the Medusæ; the Medusa is formed here asexually by gemmation from a sessile polyp; and the ova of the free-swimming Medusæ do not again develop into Medusa, but into the Polyp, which functions as bud-bearing "nurse." On the other hand, hypogenesis (or direct development) of the Medusa consists of the immediate development of the Medusæ from the ova of the Medusæ; the intermediate stage of the Polyp-nurse is wanting. As then the comparative anatomy indubitably shows that the wandering, more highly developed Medusa form is to be derived phylogenetically from the sessile Polyp form, we must consider the metagenesis of the Medusæ as their original or palingenetic mode of development, but their hypogenesis as the modified, shortened, and simplified cenogenetic form of gemmation. It is the metagenesis, not the hypogenesis, which repeats in epitome the method of historical development.

§ 16. Metagenesis or indirect development. The alternation of generations or metagenesis of Medusæ must be considered their original form of generation or primary mode of development,—their palingenesis; it appears in different forms in the two sections of the class. The Craspedotæ originate from Hydropolyps by lateral gemmation, the Acraspedæ from Scyphopolyps by terminal gemmation. These two forms of alternation of generations are not referable to one another, and have arisen independently of one another. Among the Craspedotæ, alternation of generation is the usual form of development of the Leptolinæ (or Acordyliæ), and the Polyp-nurses of the Anthomedusæ are Tubularian Polyps, whilst the Polyp-nurses of the Leptomedusæ are Campanularian Polyps. On the other hand, metagenesis only occurs rarely among the Trachylinæ (or Cordyliotæ) (*Lovenella clausa* is perhaps the Campanularian nurse of a Trachomedusa (?)—System, p. 653). Among the Acraspedæ, ontogenesis of the Tesseroniæ is still unknown. Alternation of generations seems to be the usual form of development in the *Ephyroniæ.* The peculiar form of terminal gemmation, by which the Discomedusa is developed from the Scyphopolyp nurse, is, however, essentially different from the lateral gemmation by which the Craspedotæ are developed from the Hydropolyp nurse.

§ 17. Hypogenesis or direct development. Direct development without alternation of generations, which in one word we call hypogenesis, must not be regarded as the original form of generation in the Medusæ, but as a secondary, shortened and simplified mode of development,—as cenogenesis; it has arisen by lapse of thé alternation of generations. Among the Craspedotæ, nearly all Trachylinæ (Trachomedusæ and Narcomedusæ) develop in this manner, but only a very few Leptolinæ (*e.g.*, the Cannotid *Dipleurosoma*= *Ametrangia*, System, p. 637). Among the Acraspedæ probably many Tesseronia (Stauromedusæ, Peromedusæ, and Cubomedusæ) are similarly developed directly from the ovum; their ontogeny is, however, unknown as yet. Among the Ephyronia (Discomedusæ) hypogenesis is as yet only known to be constant in *Pelagia* (whilst the closely allied *Chrysaora* undergoes metagenesis). *Aurelia* is usually developed with alternation of generations, but in isolated cases without it, directly from the ovum.

§ 18. Medusæ and Acalephæ. Since the alternation of generations with Polpys has been known in the Medusæ, great difficulties have arisen in the classification of the Acalephæ; and the natural class of Medusæ, which can be so easily distinguished from other classes of Cnidariæ, has therefore sometimes been even abandoned by many more recent authors. From the standpoint of the doctrine of evolution, however, these difficulties can be easily solved, and the Medusæ, at the same time reinstated as a class. According to the present extent of our knowledge, it appears most logical, and at the same time, natural to distinguish definitely the following five classes among the Acalephæ:—Class I. Polyps (*Polypi*) includes the common ancestral group of all Cnidariæ; it is divided first of all into two sections, Hydropolyps and Scyphopolyps. To the Hydropolyps (without tæniola) belong (*a*) the hypothetic ancestral form itself *Archydra* (also *Gastræa*, closely related to *Hydra*); (*b*) Hydropolyps without Medusa formation, and with simple genitalia (*Hydra, Clava*); (*c*) Hydropolyps with spore-sacs or medusoid genitalia (Tubulariæ, Campanulariæ); these spore-sacs or medusiform reproductive buds ("sporosacci") are Medusæ, which have undergone retrograde formation, without oral opening and without tentacles and organs of sense. To the Scyphopolyps belong: (*a*) the real ancestral form of the Acraspedæ (*Scyphostoma*); (*b*) the hypothetic ancestral forms of the corals (*Procorallium*); (*c*) Scyphopolyps, which are probably propagated as such without Medusa formation (*Spongicola*, *Stephanoscyphus*). Class II. Corals (*Coralla*, or *Anthozoa*) is phylogenetically derivable from the Scyphopolyps (*Procorallium*), probably a polyphyletic group (having arisen at different times from several different groups of the latter). Class III. Medusæ is most probably polyphyletic; the section of the Craspedotæ has likely arisen from several groups of Hydropolyps (Polyphyletic, § 11), but the section of the Acraspedæ from a single group of Scyphopolyps (Monophyletic, § 14). Class IV. Ctenophora is probably monophyletic, having proceeded from a group of Anthomedusæ (Cladonemidæ) (*Ctenaria*, System, p. 107). Class V. Siphonophora is probably polyphyletic, having proceeded from several forms of Anthomedusæ (Codonidæ, Sarsiadæ, System, pp. 14, 20, &c.). The Siphonophora are polymorphic Medusæ cormi or colonies, whose associated personæ have become differentiated by division of labour, and assumed very different forms.

§ 19. Ectocarp and endocarp Medusæ. As the Craspedotæ are more widely separated by the foregoing distinctions (above all by the absence of the gastral filaments and by the ectodermal genitalia), it is proposed to dissolve the class of Medusæ entirely, and to divide the whole tribe of the Acalephæ or Cnidariæ into two principal groups, of which one (Ectocarpæ) includes the groups just mentioned, the other (Endocarpæ) the Acraspedæ, the Scyphopolyps, and the Corals (with gastral filaments and with endodermal genitalia). This proposition seems entirely justified from a phylogenetic point of view, and we would accept it unconditionally, if we were in a position to carry out a phylogenetic system of the Cnidariæ completely and with certainty. Unfortunately, this is not the case at present. The most probable admission at present is, that the ancestral group of the Acalephæ (the primitive polyps, Archydræ, § 18) were early split up into the two diverging tribes of the ectocarp Hydropolyps (without tæniola) and the endocarp Scyphopolyps (with tæniola). The Craspedotæ (with the later side branches the Ctenophora and Siphonophora) issued from the former, the Acraspedæ and Anthozoa (Corals) from the latter. Only, as, moreover, a polyphyletic origin has now become more probable for the majority of the said classes of Cnidariæ, it seems more accurate for the sharp definition of these classes and their logical arrangement, to abandon at present carrying out a phylogenetic system and to define the said five classes to the extent known:—(1) Polypi, (2) Medusæ, (3) Siphonophora, (4) Ctenophora, (5) Coralla. If, on the other hand, we prefer to take their phylogenetic conditions as the fundamental plan of their systematic classification, it would be carried out according to the following table:—

§ 20. Survey of the two ancestral branches of the Acalephæ.

I. First Ancestral branch of the Acalephæ (without gastral tæniola, with ectodermal genitalia). Acalephæ ectocarpæ (Intæniolæ).	II. Second Ancestral branch of the Acalephæ (with gastral tæniola and endodermal genitalia). Acalephæ endocarpæ (Tæniolatæ).
1. Hydropolyps (common ancestral group of all Acalephæ, and first of all of the Intæniolæ).	5. Scyphopolyps (ancestral group of the tæniolatæ, derived from a branch of the Hydropolyps).
2. Craspedotæ (Hydromedusæ, which have originated from sessile Hydropolyps by adaptation to a free-swimming mode of life).	6. Acraspedæ (Scyphomedusæ, originated from sessile Scyphopolyps by adaptation to a swimming mode of life).
3. Ctenophoræ (an early side branch of the Craspedotæ—Anthomedusæ).	7. Coralla (Anthozoa, the principal group of the sessile Tæniolata, probably sprung from several branches of the Scyphopolyps).
4. Siphonophoræ (swimming colonies of Craspedotæ—Anthomedusæ), with polymorphism of the personæ.	

§ 21. Individuality of the Medusa. The tectological value, or the individual stage of form of the fully developed and mature Medusa is in every case that of an inarticulate transversely axonial (or radiate) persona ("persona inarticulata staur-axonia"). Each Medusa has, therefore, a vertical principal axis (with oral and aboral pole) and two or more horizontal transverse axes, perpendicular to it, with twice as many radii. The number of these radii (usually four) corresponds to the number of the radial sections or parameres which compose the body of the inarticulate persona and which only touch by their axial edges in the vertical principal axis of the body. Those Medusæ which form colonies or cormi, undergo at the same time considerable organo-logical differentiations in consequence of extensive polymorphism of their personæ and become separated from the true Medusæ as a special class: the Siphonophora.

§ 22. Fundamental form of the Medusa. In all Acraspedæ and in the majority of Craspedotæ, the regular pyramid is the geometrical basis-form of the mature body, and the principal axis of the Medusa body (which is vertical in the normal position of the animal) is the axis of the pyramid; its upper (aboral) pole corresponding to the point, whilst its lower (oral) pole, with the oral opening, falls in the middle of the base of the pyramid. The angles of the regular pyramid (at least four) are transected by the primary transverse axes (with twice as many radii of the first order), whilst the middle lines of the lateral surfaces of the pyramid correspond to the indifferent radii of the second order.

§ 23. Primary cardinal number of the Medusa. In all Acraspedæ, and in the majority of Craspedotæ, the original cardinal number of the Cnidariæ (4) is invariably retained (apart from numerous individual exceptions). The geometrical fundamental form of the ordinary quadripartite Medusa is the quadrate pyramid or "quadrangular regular pyramid"; its base forms a square. Only two primary transverse axes exist (the two diagonals of the square), and these cross at right angles.

§ 24. Individual digressions from the primary or typical cardinal number. It is not unusual to find individual abnormalities of the fundamental number (more frequently in many groups or many species, more rarely in others), so that instead of four radii there are six or eight, less commonly other numbers (5, 7, 9, &c.); in single species (*e.g.*, *Aurelia aurita*) this inclination to individual variation of the fundamental number is very great; in some groups (*e.g.*, Cannotidæ, System, taf. ix.) it is constant in many species or genera, so that here of closely allied species or genera, some are quadripartite and others sexpartite. In some other groups (Æquoridæ, Cunanthidæ, Peganthidæ, Solmaridæ) the fundamental number is very large and indefinite; it may mount up to above a hundred (*e.g.*, *Æquorea forskalea*, *Æ. ciliata*, *Mesonema cærulescens*, *M. dubium*, &c.). The fundamental number is more inconstant the higher it rises, and therefore more unequal in the different individuals of a species.

§ 25. Secondary fundamental numbers of Medusæ. Next to the primary fundamental number 4, in the Medusæ only 6, 8, and 12 are prominently significant as secondary fundamental numbers. They become hereditary in many species and groups of species, and thereby acquire a systematic significance. On the other hand, the uneven numbers, 5 and 7, do not appear constantly in any single species of Medusa, but only as individual variations, and so do 9, 10, and 11. As soon as we get beyond the number 12 the fundamental number especially loses all morphological and systematic significance, as it then becomes inconstant and variable, and more so the higher it rises (Æquoridæ, Cunanthidæ, Peganthidæ, Solmaridæ). Moreover, as the fundamental number 8, which often recurs, and is constant in many groups, has arisen by duplication of 4, as the more unusual number 12 from duplication of 6, the most important secondary fundamental number next to the primary 4 really consists of 6; instead of the normal 2 transverse axes of the regular pyramid 3 are formed abnormally, and the hexagonal regular pyramid, therefore, appears instead of the quadrangular.

§ 26. Central and peripheric numbers. In all Medusæ it is only the central part of the body, pre-eminently the stomach, never the peripheric parts, which are the criterion for determining the true fundamental number or homotypical number. The peripheric parts, especially the umbrella margin with its appendages, show higher numbers than the central part in the majority of Medusæ. In most cases these higher numbers of the peripheric parts have arisen either by multiplication from the lower fundamental number of the central part or by regular multiplication according to definite conditions of progression. On the other hand, it rarely happens that the central part is four, and the peripheric part of the umbrella six (*e.g.*, *Polyclonia frondosa*). That the central umbrella usually retains the fundamental number by inheritance, whilst the peripheric part varies in several ways, is explained by the fact that the latter is subject in a higher degree to adaptation. (The fundamental number of all Rhizostomæ, for example, remains 4, with four oral pillars, four genitalia, &c., although they have all eight arms and from eight to twelve sense clubs, as well as a very variable number of marginal lobes.)

§ 27. Radii of the first to the fourth order. The radial structure of the Medusæ (like that of most radiata) is caused by the division of the growth of the central body (originally uniaxial in the gastrula) into different meridian planes. As the growth is more energetic in definite meridian planes, or radial planes (which touch in the common central principal axis), and leads to the development of new organs, the interlying radial planes continue indifferent or opposed, and usually in the middle between these energetic rays of growth. In this way an antithesis arises first of all between radii of Order I. and Order II., which we shall designate shortly "perradii" and "interradii." Special organs very often arise in the middle between the perradii and the interradii, and these then lie in the radii of Order III., the "adradii." Finally, we can distinguish in many cases radii of Order IV., or subradii, which lie in the middle between the eight adradii and the eight principal radii. In the "principal radii" we include the four perradii and the four interradii, whilst, in contrast to these, we term all other possible radii "succursal or secondary radii." Our distinction of these four orders of radii is of great importance, not only for the architecture of the Medusæ, but for the promorphology of most other "radiata"; it allows us to designate, in a single word, the most important conditions of position and relation of the organs with mathematical sharpness and precision. For example, *Ephyra*, the important ancestral form of all Discomedusæ (fig. A), has four perradial oral lobes and limbs of the oral cross (*as*), four interradial genitalia (*s*) and filaments or phacelli (*f*), eight adradial tentacles (*ta*), and sixteen subradial marginal lobes (*l*).

§ 28. Parameres and antimeres. As in all Acraspedæ, and in the majority of the Craspedotæ, 4 is the normal typical fundamental number of the body, the latter consequently consists of four parameres or "radiate parts," which touch in the common vertical principal axis of the body. These four parameres are originally congruent, so that a principal organ comes on each paramere,—an oral lobe, a quadrant of the stomach, a radial canal or a radial pouch, a septum or cathamma between the pouches, a primary tentacle, and so forth. Each paramere has a dipleuric fundamental form (or a strictly "bilaterally symmetrical" form), and therefore again consists of two equally symmetrical halves, the "counterparts" or antimeres. These two antimeres or counterparts comport themselves the same as the symmetrical halves of the body of all higher (dipleuric) animals. We can also distinguish three axes or "euthyna" in each paramere; the longitudinal axis of the paramere coincides with the central principal axis of the whole body; the sagittal axis (or "dorsoventral" axis) of the paramere is the perradius; its lateral axis (or transversal axis) lies tangentially, and touches the two adjacent parameres with its two poles ("right or left pole").

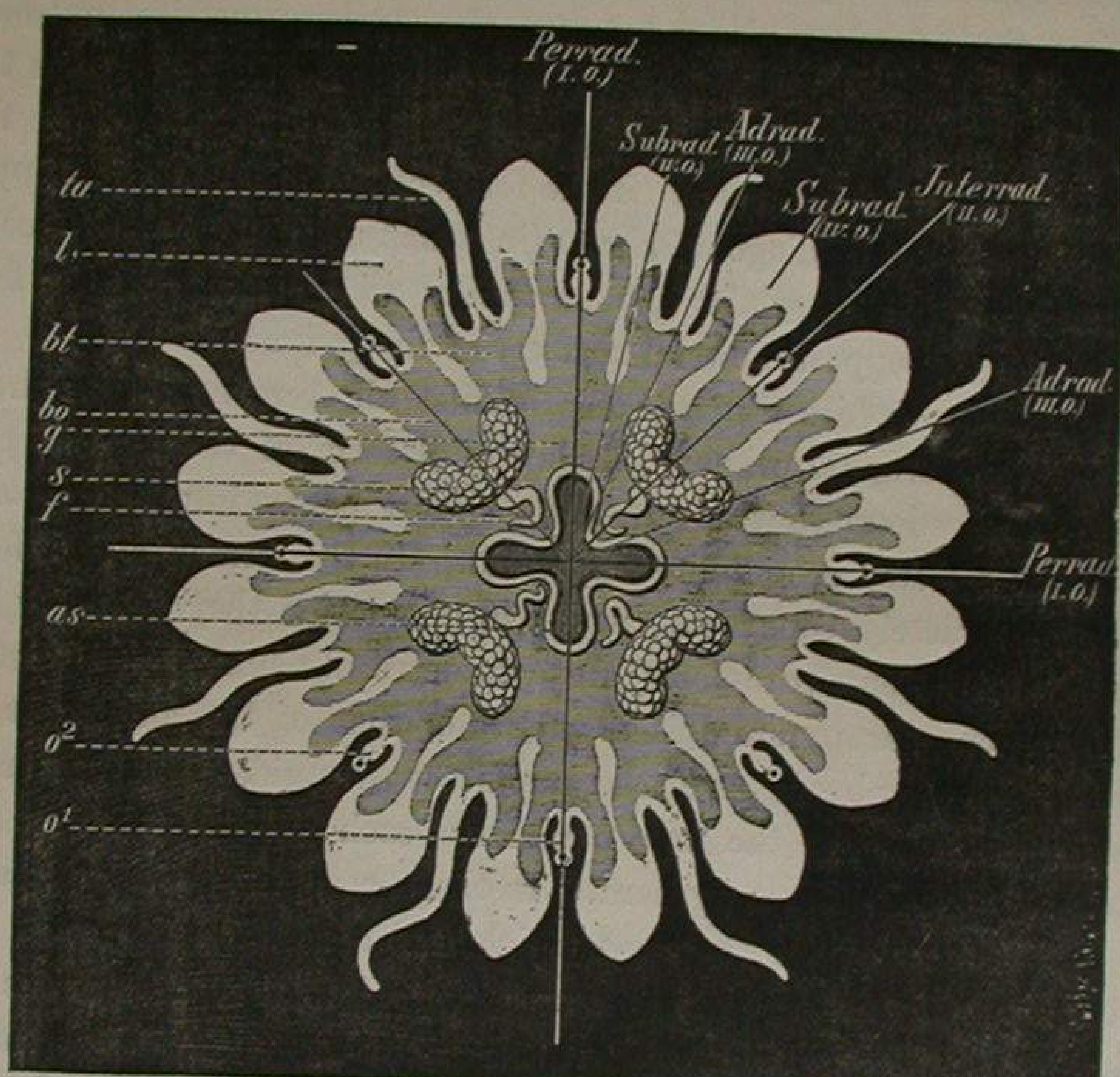


Fig. A. *Zonephyra pelagica* (Discomedusa, Ephyrida).

Subumbral view, giving the four orders of transverse axes (with twice as many radii). The oral cross (*as*) and the four perradial sense clubs (o^1) lie in the four perradii (Order I.). The gastral filaments (*f*), the genitalia (*s*), and the four interradial sense clubs (o^2) lie in the four interradii (Order II.). The eight tentacles (*ta*) and the tentacular coronal pouches (*bt*) lie in the eight adradii (Order III.). The sixteen marginal lobes (*l*) lie in the sixteen subradii (Order IV.). Sixteen bifurcate coronal pouches, eight tentacular (*bt*) and eight rhopalar (*bo*) radiate from the central stomach (*g*).

§ 29. Radial planes or meridian planes. In the Medusæ, as in all regular or symmetrically radially constructed animals, we can distinguish a number of radial or meridian planes, which have a high tectological and promorphological significance, and which are defined by the position of the vertical principal axis and of one of the horizontal transverse axes. As in all Acraspedæ, and in the majority of Craspedotæ, the body has the fundamental form of the quadrate pyramid, we can distinguish in them four principal meridian planes, which are defined by the position of the four perradii and the four interradii, and which stand in definite relation to the four parameres or pairs of antimeres (comp. woodcut, fig. A). The four perradii lie in the two primary meridian planes (or the "radial planes of Order I.") whilst the four interradii lie in the two secondary meridan planes (or the "radial planes of Order II."). Each of the two primary meridian planes is therefore the middle plane (or saggital plane) of each two opposite parameres and at the same time the boundary planes between the two symmetrical antimeres of each paramere. On the other hand, each of the two secondary meridian planes is the boundary plane (or septal plane) of the two adjacent parameres, and at the same time the boundary plane of their two contiguous antimeres. If the four corners of the quadrate pyramid correspond to the four perradii, its diagonal planes (in which each two opposite corners lie) are the primary meridian planes, whilst the secondary meridian planes are formed by the middle lines of each two opposite lateral surfaces of the pyramid.

§ 30. Regular and amphitect pyramids. Whilst all Acraspedæ and the majority of Craspedotæ retain the original primary fundamental form of the regular pyramid, in a large number of Craspedotæ (but in no Acraspedæ) it passes into the secondary fundamental form of the bisected or amphitect pyramid. In the former, all the four parameres of the body are completely congruent, whilst in the latter they are only congruent in pairs, as each two adjacent parameres are symmetrically similar. Whilst the base of the regularly quadrangular pyramid is a quadrate, that of the amphitect quadrangular pyramid represents a rhombus. As in the amphitect pyramid the two primary transverse axes are unequal in size, so, of the four parameres, each two adjacent are symmetrically similar, each two opposite are congruent. In these amphitect Craspedotæ it is usually the unequal development of the tentacles which first causes the alteration of the regular fundamental form. Of the four primary tentacles, the two opposite are much larger or the only ones developed, whilst the other two, alternating with them, are smaller or quite rudimentary (*e.g.*, *Thamnostylus*, Pl. I.; *Discodonium*, System, taf. i. fig. 6; *Ctenaria*, System, taf. vii. figs. 3, 5; *Dissonema*, System, taf. viii. fig. 3; *Dipetasus*, System, taf. xviii. fig. 2; *Æginella*, System, taf. xx. fig. 16). The promorphological conditions of the rhomboid pyramid are entirely the same in these amphitect four Craspedotæ as in the *Ctenophora*. In a few rare cases, the hexagonal amphitect pyramid also appears along with the quadrangular, the same promorphism which distinguishes most corals (*e.g.*, *Dipleurosoma*, System, taf. ix. fig. 9).

§ 31. Dipleuric or zeugite pyramids. The "pair pyramid," or zeugite pyramid, appears much more rarely than the amphitect form, along with the predominating regular pyramid as the geometrical fundamental form of the Medusæ. In such cases the whole Medusa persona has the same promorphological conditions as each one of the four parameres in the ordinary regular Medusa persona. This condition is only found strongly expressed in the Anthomedusa family of the Codonidæ, and characterises there the special subfamily of the Euphysidæ. In it, of the four perradial tentacles, three are rudimentary and transformed into marginal ocelli; the fourth tentacle only is developed, and therefore so much the more strongly. It is simple in *Euphysa* and *Steenstrupia* (System, taf. ii. figs. 8–14), but split into two to three filaments in *Amphicodon* (System, taf. i. figs. 7–9); whilst in the former the fundamental form of the umbrella is only altered a little, in the latter (as also in *Hybocodon*) it is considerably transformed symmetrically,

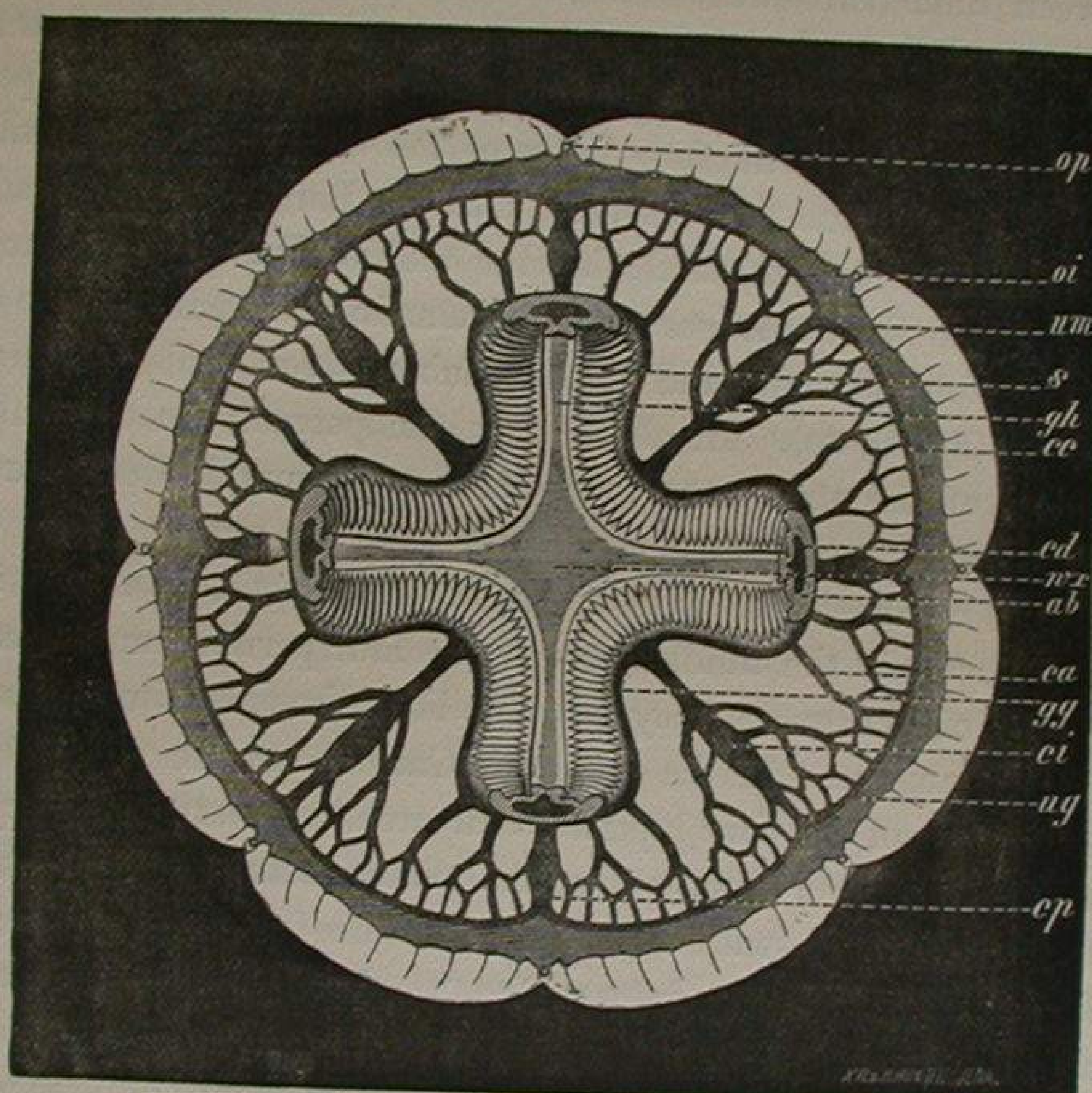


Fig. B. *Cannorhiza connexa* (Discomedusæ, Versuridæ).

Subumbral view of the umbrella. The arm disk with the eight oral arms is removed as the four perradial arm pillars (*ab*), which connect the umbrella disk and the arm disk, are cut through. (*oi*) Inter sense clubs. (*um*) Umbrella margin (turned over inwards). (*s*) Genitalia. (*wx*) Gelatinous cross of the gastrogenital membrane. (*gg*), (*gh*) Peripheric limbs of the gelatinous cross. (*ug*) Peripheric umbrella corona. (*cc*) Coronal canal. (*cd*) Pillar canals. (*ca*) Adradial canals. (*ci*) Interradial canals. (*cp*) Perradial canals.

and distinctly dipleuric or zeugite. The whole umbrella is here bilaterally compressed and divided by a sagittal plane (in which the curved gastral axis lies) into two symmetrical equal halves, a right and a left. The lateral transverse axis is equipolar and shorter than the polar sagittal transverse axis, which has often a tentacle at the one pole, and often has Medusæ buds at its base. The further the tentacle and its group of buds extends up the umbrella at this point, the more distinct the zeugite form becomes.

This fundamental form has become predominant in the Medusoid personæ of the Siphonophora colonies. It appears also in the parasitic *Mnestra*, and is sometimes faintly indicated in some Cubomedusæ (Charybdea).

§ 32. Perradii, or transverse axes of Order I. In the ordinary regularly quadripartite Medusæ, the four perradii or "upper radii" lie in the two transverse axes of the quadrate pyramid perpendicular to each other, in the sagittal middle line of the four parameres, between these two antimeres. In most Craspedotæ the four oral angles, or oral lobes, the four radial canals, the four primary tentacles, and the four genitalia lie in the four perradii (or with dichotomised genitalia in the middle line of the perradii between the halves). In all Acraspedæ the four limbs of the oral cross and of the gastral cross (fig. B, *wx*) correspond to the four perradii, also the four oral lobes and the four oral pillars or primary oral arms (*ab*), and also the middle line of the four lobed primary radial pouches: in the Stauromedusæ and Peromedusæ in addition to these the four tentacles lie in the four perradii, and in the Cubomedusæ and Discomedusæ the four primary sense clubs (fig. B, *op*). In all Medusæ the perradii are originally the zones of the most active life, of the strongest growth, and most complicated differentiation, with preponderating tendency to centrifugal development of the organs.

§ 33. Interradii, or transverse axes of Order II. In the quadripartite Medusæ the four interradii lie exactly in the middle between the four perradii, and, therefore, intersect the latter at an angle of 45 degrees; they therefore lie at the same time in the boundary line, between the four parameres. In the quadrate Craspedotæ the four interradii form the geometrical middle line of the four injected oral archings (between every two perradial oral lobes), and also of the four broad cathammal plates (between every two radial canals); in the octonemal Craspedotæ (with eight tentacles) the four primary tentacles lie in the perradii, the four secondary in the interradii. In all Acraspedæ the four injected oral angles and oral columns lie in the four perradii, also the four fundamental tæniola or gastral ridges, and the four primary gastral filaments (or groups of filaments), and, finally, the four important cathamma (the four primary septal nodes or septal ridges). The interradii, moreover, form the middle line of the four genitalia in most Acraspedæ (fig. B, *s*), and also of the four pair of genitalia in such Acraspedæ in which the latter are divided into two halves. In all Medusæ the interradii are next to the perradii, the zones of the most intense growth and of the most important differentiation, but the tendency to development is predominantly centripetal with them, whilst with the perradii it is centrifugal.

§ 34. Adradii, or transverse axes of Order III. The eight adradii lie in the middle between the four perradii and the four interradii of the quadripartite Medusa; they halve the angles between the former and the latter, and intersect the two at an angle of 22½ degrees. They consequently lie at the same time in the median planes of the eight antimeres. If, on the one hand, we designate the four radii of Orders I. and II.

the principal radii, on account of their prominent morphological significance, radii of Orders III. and IV. belong, on the other hand, to the succursal or secondary radii, which can only claim a subordinate value as compared with the others. In most Craspedotæ the eight adradii are of no special value; they are often without organs, or only bear the eight tentacles of Order III. They are distinguished only in the vesiculated Leptomedusæ (Eucopidæ and Æquoridæ), as the eight typical "velar marginal vesicles" of this group lie in them (fig. C, *ov*, System, taf. xi., xiii.). The eight adradii are of much greater importance in the Acraspedæ. In these the eight hollow marginal "arms" of the Lucernaridæ and the homologous eight oral lobes of the Pericolpidæ lie in the eight adradii, also the eight marginal pouches of the Charybdeidæ and the eight tentacles of the Ephyra.

§ 35. Subradii, or transverse radii of Order IV. The sixteen subradii lie in all quadripartite Medusæ in the middle between the eight adradii on the one side and the eight principal radii (four perradii and four interradii) on the other; thirty-two angles of $11\frac{1}{4}$ degrees remain between the former and the latter. Contrasted with the positive significance of the principal radii, which in all Medusæ mark the active meridian planes of development, and the regular positions of the most important organs, the subradii have, at most, a completely negative value; they mark those meridian planes of the body which of all comport themselves the most passively and indifferently. In most Craspedotæ no special organs lie in them, excepting in some Narcomedusæ, as, for example, in *Æginura* (Pls. XIII., XIV.), where the sixteen internemal pouches (with the genitalia) and at the same time the sixteen auditory clubs of the umbrella margin lie subradially. In the majority of the Acraspedæ, the sixteen subradial planes are distinguished by the absence of all organs. In a few groups of this section only they mark the site of isolated marginal organs. For example, the sixteen marginal lobes of the Periphyllidæ, among the Peromedusæ (Pls. XVIII., XIX.), and of the Ephyridæ, among the Discomedusæ (woodcut, fig. A, *l*) lie subradially. The latter are so far of importance that the marginal lobes of all Discomedusæ have arisen from them: indeed, it is advantageous for the more accurate morphology of this division to distinguish two groups among the sixteen subradial "Ephyra lobes"; the eight Ephyra lobes, enclosed in pairs by the perradii, are corradial, whilst those enclosed in pairs by the interradii are exradial.

§ 36. Umbrella disk and umbrella corona ("discus umbrellæ" and "corona umbrellæ"). In all Medusæ the most important groups of organs of the body are divided in such a way that a certain regularity seems common to them all. We can recognise especially in distinct contrast two principal parts of the body between the central umbrella disk ("discus umbralis") and the peripheric umbrella corona; the former contains the larger and most important part of the vegetative organs, the latter, on the contrary, the preponderating and most important part of the animal organs. The stomach and mouth, as well as the many important organs developed round the mouth (oral lobes, oral arms, &c.),

belong to the central umbrella discus. The peripheric umbrella corona, on the other hand, is characterised by the broad coronal muscle of the subumbrella, and, above all, by the umbrella margin, on which the central nerve system, and also the sense organs and tentacles lie, besides these the velum in the Craspedotæ and the lobe corona in the Acraspedæ.

§ 36. Topographical antitheses. It is indispensable for the clear, and detailed anatomical description of the Medusæ, to avoid the usual, but indefinite and dubious terms, "inner and outer, upper and lower" parts, &c., and instead of those to use definite topographical terms. For this purpose we represent the Medusa in its usual natural position with the vertical principal axis, the convex umbrella surface turning upwards, the concave umbrella surface turned downwards; the umbrella margin forms the boundary between them, in the more limited sense, the free velum margin in the Craspedotæ, the margin of lobes in the Acraspedæ. All the parts lying above this free margin (or the upper convex surface) we term dorsal or exumbral, all lying below it (on the lower, concave surface), ventral or subumbral; the marginal organs lie between the two on the umbrella margin. With regard to the two poles of the vertical principal axis, we term all the central parts which are turned towards its upper pole or apical pole "aboral," and those which are directed towards the lower pole or oral pole "oral." Finally, as regards the two poles of the radii or transverse axes, we name all parts of it which approach the central principal axis "proximal parts," whilst those which turn towards the peripheric margin are "distal" parts.

§ 38. Organic systems. All the different organs which are developed in the Medusæ may be divided into two large organic systems, the neurodermal and the gastrovascular system. The neurodermal system includes preferably the animal organs and apparatus; the umbrella with its exumbral umbrella-covering and subumbral muscular plate, the umbrella margin, with the most important organs of animal life, the central nervous system, the tentacles and the organs of sense. The gastrovascular system, on the other hand, consists principally of the vegetative organs of nutrition and reproduction, of the central principal intestine (with stomach and mouth), and of the peripheric coronal intestine (with pouches and canals), and also of the genitalia or reproductive glands, which are invariably developed in the subumbral wall of the gastrovascular system (sometimes from the ectoderm, sometimes from the endoderm). Taken altogether, the neurodermal system finds its most important site of formation in the peripheric umbrella corona, the gastrovascular system in the central umbrella disk; the former is preferably ectoblastic, the latter endoblastic.

II. GENERAL HISTOLOGY OF THE MEDUSÆ.

§ 39. Primitive germinal layer ("blastoderma"). In all Medusæ as in all other Metazoa, the aggregate cells of the developed body are descendants of the homogeneous, indifferent "segmentation cells," which are formed by repeated division of the fecundated egg cells, and which compose, first of all, the solid multicellular "mulberry germ" ("morula"). As fluid gathers inside this solid spheroidal accumulation of cells, and its homogeneous cells appear on the upper surface, this important hollow sphere, the "germinal vesicle" or "vesicular germ" ("blastosphera" or "blastula"), is originated, whose wall is composed of a single, simple layer of cells. This simple cellular membrane itself is the germinal membrane ("blastoderma") or the "primitive germinal layer." As the hollow sphere then forms a depression at one point of its upper surface, and this depression always deepens, the germinal membrane becomes invaginated, and thus differentiates into the two primary germinal layers composing the "gastrula." As the formation of the gastrula by invagination of the blastula in the Medusæ has been observed in very different groups, we may assume that it happens universally in this class, and supposed exceptions (*e.g.*, *Geryonia*) are founded on erroneous observations.

§ 40. Primary germinal layers ("ectoderma" and "endoderma"). The two primary germinal layers, which first of all arise from the primitive germinal layer, have the same fundamental morphological significance for the Medusæ as for all other Metazoa (gastræa theory). As these two layers regularly recur now in the gastrula of all Metazoa, we may assume that they have been transmitted by inheritance to all the groups from their common ancestral form, the *Gastræa*. According to the fundamental biogenetic law, they therefore appear to be constant in the gastrula of all Medusæ, which first develop by invagination of the blastula. The inner or vegetative germinal layer, the intestinal layer ("endoderma," or "endoblastus"), limits the cavity of the primitive intestine, as a simple nutritive cell layer, whilst the outer or animal germinal layer, the dermal layer ("ectoderma," or "ectoblastus"), covers and protects the former layer from the outside, as simple sensitive cell layer. In Medusæ generally, the cells of the two primary germinal layers (both the inner and the outer) are flagellate, high, cylindrical cells, each of which bears a single, long vibrating flagellum. Whilst the vibrating flagella are constant on the epithelial surface in the majority of the endoderm cells, they are lost in the majority of the ectoderm cells. The two great organic systems of the Medusæ stand in definite relation to the two primary germinal layers, just as they are distributed over the two principal sections of the body, the central umbrella disc, and the peripheric umbrella corona. The more numerous and most important parts of the neurodermal system arise from the ectoderm, those of the gastrovascular system, on the contrary, more usually from the endoderm. During the development of the Medusæ from the gastrula a histological differentiation of the two primary germinal layers appears everywhere, which leads, as in higher animals, to the formation of different tissues, and these tissues are regularly arranged in four strata, which in a certain sense may be considered as "secondary germinal layers."

§ 41. Secondary germinal layers. If we consider the histological differentiation and the structure of layers connected with it, of the organism of the Medusæ as a whole, and if we disregard the close connection of the different "principal layers" and "secondary layers," we can universally distinguish accurately four layers, which follow one another from the exterior, inwards :—(1) the dermal plate or dermal covering ("lamina chrotalis," "chrotoderma"), the layer of cells which covers the whole outer surface of the body in continuous connection and passes into the endoderm at the oral margin; (2) the muscular plate ("lamina muscularis," "myoderma"), the thinner or thicker muscular layer, which proceeds from the ectoderm and is chiefly spread over the concave lower side of the umbrella; (3) the connective plate ("lamina connectiva," "colloderma"), the gelatinous or cartilaginous mass secreted from the endoderm, which as a thicker "gelatinous umbrella" forms, according to volume and weight, the principal mass of the body in all Medusæ, but which is also found as the thinner "supporting lamella" in the subumbrella and the tentacles; (4) the intestinal plate or intestinal epithelium ("lamina gastralis," "gastroderma"), which lines the whole inner upper surface of the umbrella in continuous connection, and passes into the ectoderm at the oral margin. Although the muscular plates are for the most part produced from the ectoderm, and the connective plates, on the other hand, from the endoderm, we must distinctly remember that in isolated cases it is reversed, and muscles are formed from the inner germinal layer and supporting plates from the outer.

§ 42. Two opposite views may be held in histologically judging the organism of the Medusæ. On the one hand, the Medusæ may be considered as diblastic animals, as, in the majority of them, all the tissues which appear between the two primary germinal layers remain in close connection with them, are referable with certainty to one of the two, and only acquire a slight amount of independence. But, on the other hand, we may consider part of the Medusæ (and in a certain sense all of them) as mesodermal (triblastic or tetroblastic animals), as in certain parts of the body (and in some Medusæ to a great extent) independent tissues are really secreted between the outer and the inner germinal layer, and so form a middle germinal layer ("mesoderma"). The following tissues may be pre-eminently regarded as independent mesodermal tissues :—(1) the gelatinous tissue of the umbrella as soon as it contains independent cells; (2) the chordal tissue in the axis of the solid tentacles; (3) the muscular tissue of isolated, especially strongly developed muscles; (4) the nervous tissue in a part of the nerve centres and the organs of sense. In a secondary degree, but less accurately, the following may claim to be termed mesodermal tissues :—(1) the reproductive tissue; (2) part of the urticating tissue (the subepithelial urticating organs); (3) all subepithelial muscles; (4) all subepithelial nervous plexus. The latter, however, want the complete histological independence and the entire separation from the mother-epithelia, already attained by the former. On the whole we find autonomic mesodermal formations chiefly in the higher and larger Acraspedæ, in which both the volume of the body and the organological separation have reached a very high grade, whilst they remain at a much lower stage in the smaller Craspedotæ, which are much lower in this respect. If then isolated organs are found on definite parts of the body, in which the different forms of tissue of the animal's body have attained the same high and independent formation, as in the higher animals, there is nothing to prevent us terming these secreted layers of tissue true "secondary germinal layers" (even though these are only developed locally). The two middle plates, the ectodermal muscular plate, and the endodermal connective plate, may be classed together as mesoderm according to the following diagram.

Diblastic Theory.		Tetroblastic Theory.	Triblastic Theory.
Primitive germinal layer, "Blastoderma."	I. Primary dermal layer, "Ectoderma," *s.a.* ("Ectoblastus").	1. Secondary dermal plate ("Chrotoderma").	External germinal layer, "Ectoderma," *s.st.*
		2. Muscular plate ("Myoderma").	
	II. Primary intestinal layer, "Endoderma," *s.a.* ("Endoblastus").	3. Connective plate ("Colloderma").	Middle germinal layer, "Mesoderma."
		4. Secondary intestinal plate ("Gastroderma").	Inner germinal layer, "Endoderma," *s.st.*

§ 43. Differentiation and teleosis of the tissues. The great and general interest presented by the histological structure of the body of the Medusæ does not only lie in the fact that we can distinguish the origin of the four secondary germinal layers from the two primary, and especially the derivation of the mesoderm from the two primary germinal layers, more certainly and clearly in them than in the higher Metozoa, but also that in them we can more clearly recognise the mechanical causes of these fundamental processes. These mechanical causes, on the one hand, are the physiological division of labour of the cells and the differentiation of the tissues proceeding from it, and, on the other hand, the physiological perfection of the cells and the progressive development or teleosis of the tissues resulting from it. If these processes of development continue to be carried on now by inheritance in the ontogenesis of the Medusæ, the result has been originally brought about in their phylogenesis according to the laws of the theory of selection.

§ 44. Primary and secondary tissues. The importance of the Medusæ for general histology lies chiefly in this, that within this class a long series of histological differentiations and teleoses are developed from the simplest beginnings, step by step before our eyes. Whilst at definite parts of the body (that is in many higher and larger Medusæ) all the four principal forms of the animal tissues are already secreted as independent layers, they appear in other parts of the body (that is, in many smaller and lower Medusæ) still in a dependent form, as mere appendages of a single fundamental tissue, the epithelium. The most different degrees of formation of tissue are represented beside each other in genetic connection, within this long series of perfection and differentiation, so that the most important forms of the higher tissues are to be found here "in statu nascenti." In this respect the Medusæ furnish an excellent argument in favour of the tenet, recently brought forward in the gastræa theory, that there is only one primary tissue, the epithelial tissue, and that all other forms of tissue have arisen secondarily from it. The simplest and phylogenetically oldest form of this primary tissue is the blastoderm of the "blastula," this simple single-layered epithelium, which alone forms the wall of this hollow sphere in the germ of all Medusæ, in the same way as it does in the germ of all other groups of Metazoa. When the two-layered gastrula is formed by invagination of the blastula, the blastoderm (or the simple "primitive germinal layer") of the former is divided into the "primary germinal layers" of the latter, which are likewise simple epithelia. All other formations of tissue (connective, muscular, and nervous tissues) have arisen, both ontogenetically and phylogenetically, from these two epithelia.

§ 45. Epithelial tissue ("tela epithelialis"). The protective tissue or epithelium, which in the gastrula of the Medusæ, as of all Metazoa, is formed first of all by the simple tissue of the multicellular germ, in the mature and developed Medusa, covers firstly, as outer covering ("ectoderm"), the whole upper surface of the body; and secondly, as inner covering ("endoderm"), the whole inner surface of the gastrovascular system. These coverings are everywhere separated from one another by secondary formations of tissues, secreted between them, and only pass uninterruptedly into one another at the oral margin. This oral margin (*am*) is identical with the "primitive oral margin" of the gastrula or the "invagination opening" of the invaginated blastula. The inner covering ("epithelium endodermale") shows far simpler and more uniform conditions of formation in both coverings. However, most of the differentiations recur in it, which appear more expressed and varied in the outer covering ("epithelium ectodermale"), corresponding to its manifold adaptations and relations to the outer world.

§ 46. Outer covering ("epithelium ectodermale" or "chrotale"). The outer covering or chrotal epithelium (which may also be termed "ectoderma" in the more restricted sense) in all Medusæ covers the entire outer upper surface of the umbrella as a connected dermal covering, and only passes into the endodermal epithelium at the umbrella margin (in some Medusæ at the excretory papillæ of the umbrella). Corresponding to the form of the concave-convex umbrella, we distinguish two different principal parts of its ectodermal epithelium, which pass into one another at the umbrella margin, the dorsal and the ventral chrotal epithelium, or the "exumbrella" and "subumbrella." Both are distinguished in the same way as the dorsal and ventral endoderm. The exumbrella or the dorsal ectoderm (also termed "chrotal epithelium of the notumbrella," or shortly "upper ectoderm") covers the whole convex surface of the gelatinous umbrella in the form of a delicate, flat epithelium of very uniform and indifferent character. The cells of this epithelium are usually extremely thin, but very extensible polygonal plates, which lie immediately on the gelatinous body, and are covered on their upper surface by a very delicate cuticule; this often looks dotted or granulated, as at definite distances on it there are thickenings in the form of nodules or small papillæ. Vibrating flagellate cells are wanting for the most part on the dorsal exumbrella, but they are often found on definite limited spaces, especially on and near the umbrella margin; the flagella are then usually very delicate and fine. Pigment cells and urticating cells are more frequently found in the exumbrella, especially in the vicinity of the umbrella margin and in the projecting radial ribs, ridges, nodes, and papillæ with which the convex outer surface of the umbrella is covered in many Medusæ. The subumbrella or ventral ectoderm (also termed the "chrotal epithelium of the coelumbrella," or shortly the "lower ectoderm") covers the entire concave surface of the gelatinous umbrella from the oral margin to the umbrella margin (in the Craspedotæ to the free margin of the velum, in the Acraspedæ to the free margin of the lobe-corona or of the velarium). It shows a much more complicated and varied nature than the dorsal ectoderm. Its cells are usually higher, more cubical, partly covered by a cuticle, partly not covered. Part of the cells bear vibrating flagella at definite points, and feeling bristles at others. In the same way, urticating cells, glandular cells, and also often pigment cells are richly developed in many regions. The differentiation of the ectodermal epithelium is most varied and important at the actual margin of the umbrella, and its appendages, such as the tentacles, marginal lobes, and organs which are developed there. Thus we can often separate a special "subepithelial layer of cells" from the true epithelium (which only covers the free surface). As numbers of thread-cells are often developed, a special "urticating tissue" ("tela urticaria") often arises, which, especially in the Trachomedusæ and Narcomedusæ, forms a thick "urticating ring" and the "umbrella-clasps" ("peronia") running out from it. The firm and thickly accumulated nematocysts there lose their original function of protective weapons, and attain the significance of a supporting dermal skeleton (urticating skeleton, § 71). Another portion of the ventral ectoderm, and, in fact, that portion which covers the subumbral wall of the gastrovascular system in the Craspedotæ, furnishes a subepithelial layer from which the reproductive cells, both male and female, originate in this section of the Medusæ.

§ 47. The inner covering ("epithelium, endodermale," or "gastrale"). The inner covering or gastral epithelium (also termed "endoderma" in the more limited sense), in all

Medusæ, lines the entire extent of the hollow space of the gastrovascular system, consists everywhere of a simple layer of flagellate cells, and passes into the ectodermal epithelium only at the oral margin. Corresponding to the shape of the umbrella enclosing the gastral space, we can also distinguish in this endoderm two different principal parts contiguous at the umbrella margin, the dorsal epithelium, and the ventral epithelium of the gastrovascular system. Both show striking and constant differences. The dorsal endoderm (or the "gastral epithelium of the notumbrella," often also simply termed the "umbral or upper endoderm") lines the concave inner surface of the thick dorsal umbrella, and covers its gelatinous body in the form of a thin, uniform, flat epithelium of very indifferent character (Pl. IV. figs. 6–8, *du*; Pl. IX. figs. 5–7, *du*; Pl. XXV. figs. 8–10, *du*). The ventral endoderm (or the "gastral epithelium of the coelumbrella," often also simply termed the "subumbral or lower endoderm") covers the convex inner surface of the thin ventral umbrella, and is stretched across its subumbral supporting plate in the form of a high differentiated cylindrical epithelium (Pl. V. figs. 6–8, *dw*; Pl. IX. figs. 5–7, *dw*; Pl. XXV. figs. 8–10, *dw*). Its cells are much larger than those of the dorsal endoderm, are often extremely high, and enclose plasma products of various kinds, fat, granules of pigment, crystals, amyloid granules, and other products of a vital change of tissue, but also numerous vacuoles which not unfrequently coalesce. In many places, that is at the œsophagus, one part of these ventral endoderm cells is transformed into glandular cells, and another into urticating cells; epithelial muscular cells and even perhaps sense cells appear to originate from it here in some places. Finally, it is also these ventral endodermal cells which form the reproductive cells in all Acraspedæ; both ova cells and sperm cells proceed from a subepithelial layer of the ventral endoderm. This ventral gastral epithelium is plainly of the highest significance for the aggregate changes of tissue of the Medusæ, whilst the opposite indifferent dorsal endoderm is only of slight importance; these cells are, moreover, "flagellate cells," as in both cases they invariably bear a vibrating flagellum. This flagellum is only missing on the cathammata, those important points at which the dorsal and the ventral endoderm are fused together. Whilst the whole gastral cavity originally shows in the polyps a perfectly simple cup-shaped cavity without radial sections, in the Medusæ it is divided in the course of development into peripheric radial sections, by the fusion of the two walls of the gastral cavity (the dorsal outer wall and ventral inner wall) in definite radia. In this way there originate the important fused plates or cathammata which represent the septa of the radial chambers. Each "cathamma" or "septum," therefore, actually consists of two layers of the gastral endodermal epithelium which have been laid firmly one upon the other, and fused together at those points. These two closely connected layers can sometimes be plainly distinguished (as in many Acraspedæ, Pl. XXV. figs. 8–10), and are sometimes fused into a single simple layer (as in most Craspedotæ). In both cases we designate this simple or double layer of cells as the fused plate, or cathamma plate ("lamina cathammalis," otherwise also "endodermal lamella," and "vascular plate"; comp. under "Cathamma," §§ 100, 101).

§ 48. Connective tissue ("tela connectiva"). The connective tissue (padding tissue or supporting tissue), whose various modifications are included in the idea of the "connectivum"), appears among the Medusæ in two different principal forms, as supporting plates without cells ("fulcra"), and as padding tissue containing cells ("maltha"). The two forms correspond to different phylogenetic stages of development, as the cell-less supporting plate or fulcral plate only represents a simple secretion of the epithelium, which has no independent value as mesoderm; we can only consider as mesoderm the cellular filling tissue or malthar plate, by which cells are produced from the endoderm and are divided by an intersubstance ("secreted tissue"). Both forms are produced in general from the endoderm; though both forms are also produced in a few isolated places from the ectoderm.

§ 49. Supporting tissue or cell-less connective tissue ("fulcrum," "tela fulcralis," "lamina fulcralis"). Under this name we include all forms of the connective tissue which do not contain cells, and are therefore merely structureless or fibrous secretions of the epithelia. They appear in two principal forms, which, however, appear inseparably connected by transitions, as thin elastic membranes and as thick gelatinous masses. The thin elastic supporting membranes are found everywhere in the bodies of the Medusæ as the foundation of the epithelium, and especially of the endoderm, although strongly developed supporting plates often appear also among the ectoderm at definite spots, *e.g.*, in the velum of the Craspedotæ (Pl. VI. figs. 13, 14, *zv*; Pl. IX. fig. 7, *zr*); and in the tentacles of many Acraspedæ. The structureless fulcral lamellæ are generally very thin but very firm; in transverse section, under strong magnifying power, they appear sometimes simple, sometimes doubly contoured, usually strongly refractive. On account of their great elasticity, they are often of physiological importance as antagonists of the muscles (*e.g.*, as extensors of the tentacles and oral styles). This is also the case with the thick cell-less gelatinous tissue, which is only distinguished from the thin elastic supporting membranes by its more extensive, often very apparent volume of development. This forms the principal mass of the gelatinous umbrella (and consequently of the whole body) in the majority of the Craspedotæ, as in this section the collosoma is usually without cells, and appears as a structureless secretion of the endoderm; it also forms the principal body mass in part of the Acraspedæ (*e.g.*, Cubomedusæ, Pelagidæ, Cyaneidæ). The cell-less "fulcral gelatinous tissue," is, moreover, usually (or always?) traversed by numerous elastic fibres, in the same way as the cellular "malthar gelatinous tissue."

§ 50. Padding tissue or cellular connective tissue ("maltha," "rete malthare," "lamina maltharis"). Under this name (for want of a better) we include all the different forms of cellular connective tissue, in contradistinction to the cell-less supporting plate, the fulcral tissue. All the different forms of the "cellular connective tissue" in the higher animals (bones, cartilage, vascular tissue, mucous tissue, &c.), belong to this filling tissue or malthar tissue; in the Medusæ it actually appears only in two essentially different forms, as gelatinous tissue and as chordal tissue. The cellular gelatinous tissue ("tela gelatinosa") is the more important as to extent and distribution. It forms the principal mass of the gelatinous umbrella (and therefore of the whole body) in the majority of the Acraspedæ (namely, in most of the larger forms), whilst it is replaced by the cell-less "fulcral gelatinous tissue" in the majority of the Craspedotæ. The cells of the "malthar gelatinous tissue" are usually scattered sparsely at great distances in the structureless intercellular substance, but sometimes also in greater numbers (namely, near the cathamma) (Pl. XXV. fig. 10). They usually proceed from the endoderm, from whose epithelial layer they have passed into the underlying fulcral layer ("endodermal secreted layer," principally in the umbrella and subumbrella). Similar "ectodermal secreted tissue, "whose cells proceed from the ectoderm (as in the velum of the Pectyllidæ, Pl. V. fig. 7, *x*; Pl. VI. fig. 13, *x*), are more rarely found. The consistency of the gelatinous tissue varies greatly, as on the one hand it may become extremely soft mucous tissue (*e.g.*, the umbrella of the Aurelia), and on the other, a very firm, hard fibrous cartilage (*e.g.*, the cathamma of the Peromedusæ (Pl. XXV. figs. 8, 10). Near these firm fused ridges, the cathammal plates in particular, the gelatinous tissue of many Acraspedæ acquires a nature which so resembles the true "fibrous cartilage" of the vertebrates both in histological structure and physical quality as to be easily confounded with it. In this case the extraordinary firmness of the cellular tissue is chiefly formed by thickening and by the fibrous differentiation of the intercellular substance, whilst the softer or firmer nature of the gelatinous tissue seems usually dependent upon the qualitative and quantitative development of the elastic fibres in it. The latter comport themselves in the cellular gelatinous tissue in the same way as in the cell-less tissue and usually pass from the ectodermal on to the endodermal surface of the gelatinous umbrella (Pl. IX. figs. 5–7, *uf*). They are either simple or branched, usually cylindrical, more rarely flattened like a ribbon (Pl. VI. fig. 19). They are sometimes combined into an elastic network or grouped in branches (Pl. V. fig. 8, *us*). The second principal form of the padding tissue is the characteristic chordal tissue ("tela chordalis"), which greatly resembles the tissue of the "chorda dorsalis" of vertebrates. It is found everywhere in the solid tentacles of the Medusæ, and forms their characteristic firm axis. This is usually cylindrical, and consists of a single row of large, discoid, flat, circular endodermal cells, lying one above the other like the coins in a rouleau of sovereigns (Pl. I. fig. 57; Pl. VI. fig. 17; Pl. XII. fig. 11; Pl. XIII. figs. 5, 6). Each cell is surrounded by a very thick, firm, elastic membrane, and encloses contents as clear as water. The protoplasma of the cell is usually limited to a thin wall-layer, lining the inside of the capsule-shaped membrane, and to a central axial cord, which connects the middle of the proximal and distal wall-layer; the two are sometimes connected by a network of fine threads of protoplasm, traversing the cavity of the cell (Pl. I. fig. 7). The nucleus sometimes lies in the middle of the axial cord, sometimes at the one end. These chordal cells belong to the largest cells of the body of the Medusa; they are often visible to the naked eye, being about 1 mm. broad (p. 38). They sometimes also form a special chordal ring at the umbrella margin (Pl. VIII. fig. 8, *y*). In the short thick tentacles, the chordal cells of the tentacle axis seem sometimes disposed in layers (Pl. IV. figs. 5–8, *yt*; Pl. VI. figs. 12–15, *dt*). The base of the axis is usually still continuously connected with the endoderm of the coronal canal; more rarely it becomes completely separated from it, and, therefore, mesodermal (Pls. IV., VI., XII., &c.). In the gelatinous tissue the small cells retreat entirely against the powerful intercellular substance; the reverse is the case in the chordal tissue.

§ 51. Muscular tissue ("tela muscularis"). The muscles of all Medusæ consist of fine muscular fibrillæ laid parallel, which are connected somewhere with a small lump of protoplasm containing nuclei, and must, therefore, be regarded as filamental processes of muscular cells. The fibrillæ are usually very long and thin, sometimes cylindrical, sometimes flattened like a ribbon; in most longitudinal or radial muscles the fibrillæ are smooth, not striated, but they are more or less plainly striated in the transversal or circular muscles. Both the smooth and the striated muscular cells originate for the most part from the ectoderm. In isolated spots, however, both kinds are also formed from the endoderm (as for example at the œsophagus and the oral arms). With regard to the relation of the muscular cells to their original place of formation, the epithelium, we distinguish two principal forms of the muscular tissue; epithelial muscular cells and mesodermal muscular cells; the latter still lie in the true epithelial layer of the upper surface or immediately below it, whilst the latter have become completely separated from it and form an independent, though thin, mesodermal layer.

§ 52. Epithelial muscular cells ("myoblasti epitheliales," "tela muscularis epithelialis"). The majority of the Medusæ muscles, that is in the section of the Craspedotæ, are composed of smooth or striated fibrillæ, whose muscular cells do not form an independent mesodermal layer, but either belong to the endodermal epithelium itself or to a subepithelial layer lying immediately below it. The fibrillæ of these "epithelial muscular cells" or "neuro-muscular cells" therefore lie immediately under the epithelium from which they proceed, and on the supporting plates on which they are borne. They are usually placed in a parallel layer beside each other, or arranged in several layers one above the other in such a way that they form flat leaves or lamellæ. By further development of the muscles, these "muscular leaves" become arranged in folds, whilst the supporting lamellæ bearing them forms corresponding composite folds by local thickening, as, *e.g.*, in the larger hollow tentacles of the Geryonidæ, and of the Cyaneidæ, &c.; in the velum of some Craspedotæ (Pl. VI. figs. 13, 14). In the smaller and lower Medusæ, the broad coronal muscle forms a simple, smooth, band-shaped plate on the umbrella surface, whilst in many larger and higher Medusæ the supporting plate of the subumbrella is raised in concentric circular folds, which are covered by corresponding folds of the muscular plate (*e.g.*, *Lucernaria*, Pl. XVII. fig. 20; *Periphylla*, Pl. XXII. fig. 22).

§ 53. Mesodermal muscular cells ("myoblasti mesodermales" "tela muscularis mesodermalis"). When the folded epithelial muscular leaves increase in extent and become further developed, their growth is not limited to the formation of folds, but the epithelial or subepithelial muscular cells emerge completely from their point of origin, the epithelium, and form independent "mesodermal muscular cells." As they separate in great quantities from the epithelium and become united to special plates or bundles, they pass inwards in the connective tissue and form perfectly independent mesodermal muscles. Such mesodermal muscles are more commonly found in the system of the longitudinal muscles than of the circular muscles, more rarely and chiefly in the larger species among the Craspedotæ, but more frequently among the Acraspedæ. Thus, for example, in the large Peromedusæ, the powerful deltoid muscles of the subumbrella, the longitudinal muscles, and root muscles of the tentacles, &c. (Pls. XX.–XXIV. *md*, *mk*, &c.), belong to this category. Here the muscles are frequently detached so completely from the epithelium that later on they are separated from it by a special supporting lamella or even a thick gelatinous plate. The external coronal muscles of *Atolla*, which increases to 4 mm. broad by 2 mm. thick, and are composed of many layers of coronal muscular fibres, lying the one above the other, form one of the strongest mesodermal masses of flesh (Pl. XXIX. figs. 4, 7, 8, *mc''*). Among the Craspedotæ, *Pectis* furnishes an example of strong mesodermal muscles in the velum and subumbrella (Pl. V. fig. 7; Pl. VI. figs. 12–14, *m*).

§ 54. Nervous tissue ("tela nervea.") The two essential component parts of nervous tissue, which are distinguished as nerve cells and nerve fibrillæ in the higher animals, are also already differentiated in the Medusæ; the two compose the central as well as the peripheric part of the nervous system, even though their situation and connection in the central nerve ring of the umbrella margin is different from that in the nervous plexus of the subumbrella, and so forth. Both the nerve cells and the nerve fibrillæ, which proceed from and connect them, are, for the most part, products of the ectoderm and have hitherto been considered to be exclusively such. Nerve cells and nerve fibres are found in isolated places in some (and perhaps all) Medusæ, which originate from the endoderm, as on the very movable and sensitive oral parts (oral filaments, oral lobes, oral arms, oral pouches). It is probable that on the gastral inner surface of these oral organs the endoderm forms both muscular cells and nerve cells, among the latter we may perhaps look for specific sense cells (gustatory cells? olfactory cells?). These difficult conditions require much closer investigation. In any case, both this localised and slightly extended ectodermal nervous tissue, and the more important and widely diffused ectodermal nervous tissue are most closely connected with the epithelium from which they are originated. The whole muscular system in the Medusæ preserves more or less its original epithelial character. We can therefore distinguish here, as in the muscular tissue, purely epithelial and subepithelial cells; the former may usually be termed sense cells, the latter ganglion cells. Both are connected by very fine fibrillæ, thread-shaped processes, which are repeatedly branched and combined into network and nerve plexus.

§ 55. Sense cells or epithelial nerve cells ("cellulæ sensillares," "sensoblasti"). Under this title we include all these nerve cells (in the widest sense) which lie in the epithelium itself, and which have fine thread-shaped processes or fibrillæ at their bases, by which they are connected with other cells of the nervous system. These sense cells are sometimes scattered singly in the epithelium between its indifferent covering cells (*e.g.*, on many places in the tentacles and œsophagus), sometimes, as a connected covering, they form a true sensitive epithelium (*e.g.*, on the dorsal nerve ring of the Craspedotæ, and on the margin of the velarium of the Acraspedæ). We can distinguish two principal forms of sense cells, indifferent or neutral, and differentiated or specific sense cells. We call those epithelial sense cells "indifferent," to which we cannot assign a specific function of sense, and which therefore represent the oldest and simplest form of the nervous elements. Provisionally we may consider as such in the Medusæ, all those flagellate cells and bristle cells of the ectoderm which are connected at their base, directly or indirectly, by processes and nerve fibrillæ with other nerve cells, and in which we recognise no specific sensitive function (Pl. XIV. fig. 9). All these neutral sense cells have a fine hair-shaped process on their free upper surface, which is movable in the sensitive flagellate cells (*e.g.*, on the sense epithelium of the nerve ring), but stiff in the bristle cells. We include in the latter the true tactile cells (without nematocysts, with a tactile bristle, "palpocilium") and also the thread cells (with nematocysts and with an urticating bristle, "cnidocilium"). How far the flagellate cells and thread cells of the ectoderm belong to the category of indifferent sense cells depends upon their passing at their base into communicating processes or nerve fibrillæ (comp. below § 79, organs of touch). We may consider as differentiated or specific sense cells such epithelial nerve cells to which from their situation, structure, or connection, we can assign some specific sensitive function. To this category belong—(1) the olfactory cells (or gustatory cells?) on the clavellæ of the Craspedotæ (Pl. II. fig. 8, *q*) and on the protective scales of the rhopalia in the Acraspedæ; (2) the vision cells of the eyes, which are sometimes differentiated into pigment cells and rod cells; (3) the auditory cells of the auditory organs (Pl. VI. fig. 16). The last bear a free, usually long and thin auditory hair, and therefore do not differ in form from the ordinary tactile cells (with a tactile bristle) from which they are also derived phylogenetically; they become "auditory cells" as they are in functional connection with "otolite cells" which contain an otolite, and belong to the ectoderm in one order only (the Leptomedusæ) and in all other orders to the endoderm. In some cases (*e.g.*, in most Leptomedusæ and in the Geryonidæ) the auditory cells become completely separated from the free epithelium to which they originally belonged; they are then transformed into mesodermal interior epithelium, as the open olfactory depressions become detached from the dermal covering and from closed auditory vesicles.

§ 56. Ganglion cells or mesodermal nerve cells ("cellulæ gangliosæ," "neuroblasti"). The ganglion cells bear the same relation to the sense cells as the mesodermal muscular cells do to the epithelial. The ganglion cells are, in fact, subepithelial nerve cells secreted from the epithelium, from which they have originated both ontogenetically and phylogenetically; they are still connected directly or indirectly with this their point of origin by thread-shaped processes, the nerve-fibrillæ (Pl. XIV. fig. 10). All ganglion cells of the Medusæ appear to have two or more processes, and are, therefore, either bipolar (fusiform) or multipolar (stellate) cells. Both forms appear both in the central and in the peripheric nervous system; the bipolar cells, however, preponderating in the central nerve ring, the multipolar ganglion cells in the peripheric nervous plexus; the former therefore lie principally in the umbrella margin, the latter in the subumbrella. The central ganglion cells, moreover, both in the nerve ring and in the organs of sense, show definite conditions of relation and position to the neighbouring organs, especially to the sense cells of the epithelium. In the Craspedotæ, the dorsal (or exumbral) nerve ring covered by the sense epithelium is formed for the most part of parallel lying, circular fibrillæ, and is much poorer in ganglion cells than the ventral (or subumbral) nerve ring which has no sense epithelium and is more motor. In the Acraspedæ the ganglion cells seem rather to be accumulated at the bases of the sense clubs, and to form four or eight ganglia which are sometimes connected by a centralised ring of bundles of fibrillæ (Cubomedusæ), sometimes by a more decentralised plexus of fibrillæ. The peripheric ganglion cells are scattered, sometimes sparsely, sometimes pretty numerously in the nervous plexus, which extends chiefly in the subumbrella in the form of delicate,reticulate plexus of fibrillæ; this subumbral plexus lies between the muscular plate of the subumbrella and the endodermal epithelium, from which the latter has arisen. Both this peripheric nerve plexus and the central nerve ring may already be regarded as mesodermal nerves, as they possess independent cells, secreted from the epithelium.

III. NEURODERMAL SYSTEM OF THE MEDUSÆ.

§ 57. Composition of the neurodermal system. Of the large organic systems composing the body of the Medusæ, the neurodermal system includes the aggregrate animal organs, the apparatus of sensation and motion. This is therefore opposed physiologically to the gastrovascular system, which forms the complex of the vegetative organs. This antithesis is also shown histologically in reference to the two primary germinal layers, as the greater and most important parts of the neurodermal system originate from the ectoderm (or "animal germinal layer"), whilst those of the gastrovascular system originate chiefly from the endoderm (or "vegetative germinal layer"). The apparatus of motion, formed by the umbrella and the wide-spread muscular plates, situated on the concave surface of the umbrella cavity, is by far the more considerable although the less differentiated of the two apparatuses which compose the neurodermal system. The apparatus of sensation is less extensive, but more strongly differentiated; it is situated chiefly on the umbrella margin, and includes the nervous system along with the tentacles and differentiated organs of sense.

§ 58. Umbrella (*u*). The typical and most characteristic principal organ of the Medusæ, which distinguishes them from the ancestrally-allied polyps, is their peculiar swimming organ, the umbrella. From its volume and weight this always forms the principal mass of the body, and consists of a voluminous gelatinous body ("collosoma") which contains a large amount of water, and is sometimes almost as soft as mucus, sometimes almost as hard as cartilage. It is more or less "umbrella-shaped," convex above, arched concavely below. The general form of the umbrella, however, varies greatly. Sometimes its vertical diameter (or "the central principal axis") is greater than the greatest horizontal diameter (or the transverse axis), and the umbrella is thin, conical, bell-shaped, pyramidal, or obelisk-shaped (as in most Anthomedusæ, Stauromedusæ, Peromedusæ, and Cubomedusæ, Pls. XV.–XXVI.). Sometimes, on the contrary, the horizontal diameter is greater than the vertical, and the umbrella, therefore, more discoid, hourglass-shaped, or semi-spheroidal (as in most Leptomedusæ, Trachomedusæ, Narcomedusæ and Discomedusæ (Pls. I.–XIV., XXVII.–XXXII.). The gelatinous body is usually thickest in the middle of the umbrella, and decreases sometimes regularly, sometimes more suddenly towards the umbrella margin. If we take the umbrella and the parts of the gastrovascular system enclosed in it as a whole, we may term the outer convex surface the "outer umbrella" or "exumbrella" (*e*), and the inner concave surface the "inner umbrella" or "subumbrella" (*w*). More accurately speaking, however, the umbrella consists of two distinct gelatinous plates which may be distinguished as the dorsal umbrella ("umbrella dorsalis," or "notumbrella") and the ventral umbrella ("umbrella ventralis," or "coelumbrella"); the former corresponds to the "calyx" or dorsal wall of the polyps, the latter to their "peristomium" or ventral wall. Both walls pass immediately one into the other only at the umbrella margin, and are elsewhere separated by the hollow space of the gastrovascular system, whose bounding surfaces are only fused together at definite points. The exumbrella is the free convex surface of the thick dorsal wall; the subumbrella is the free concave surface of the thin ventral wall.

§ 59. Umbrella dorsalis ("notumbrella," upper or dorsal umbrella). In the more limited sense this part is usually simply termed the "umbrella," as it forms the principal mass of the umbrella, and as its voluminous gelatinous disk is much thicker than the thin gelatinous plate of the ventral umbrella. Its upper convex surface, covered with dorsal ectoderm, is the "exumbrella" (*e*). Its lower concave surface forms the outer or abaxial wall (umbral wall) of the gastrovascular system, and is covered by its flat "dorsal endoderm." The two epithelial layers of the dorsal umbrella, the outer ectodermal layer and the inner endodermal, are separated by the powerful mass of the gelatinous body ("collosoma"). They never run into one another, as they pass immediately at the umbrella margin into the two corresponding epithelial plates of the ventral umbrella. The endodermal epithelium of the dorsal umbrella consists of flagellate cells of an indifferent nature, whilst its ectodermal epithelium often forms thread cells, more rarely also epithelial muscular cells ("exumbral muscles").

§ 60. Exumbrella. The convex outer surface of the dorsal umbrella, which we call shortly the "exumbrella" in many Medusæ, is perfectly smooth, arched equally without any special characteristic, and covered uniformly by the simple ectodermal epithelium. In many other Medusæ, on the contrary, it is distinguished by repeated projections in the form of nodes, ribs, ridges, spicules, &c. These projections are often distinguished by accumulations of thread cells, often also of pigment cells, and therefore serve as weapons of defence of the umbrella. Projecting radial urticating ribs are found among the Craspedotæ that is in many Anthomedusæ, *e.g.*, four perradial in several Codonidæ and Tiaridæ, eight adradial in *Ectopleura* and *Ctenaria* (System, taf. vii. fig. 7), sixteen in *Pectyllis* (Pls. III., IV.), *Pectanthis* (Pls. VII., VIII.), and *Tesserantha* (Pl. XV.). In *Corynetes* the whole exumbrella is overspun with a network of ridges, having projecting urticating papillæ at their points of junction; more commonly the urticating papillæ are scattered equally over it (*e.g.*, *Thamnostylus*, Pl. I.). Among the Acraspedæ, such projecting urticating ribs are of less morphological importance than the deep furrows of the exumbrella, by which the latter is divided into a number of gelatinous plates. Very often there is a deep and distinct circular furrow or coronal furrow, which separates the central umbrella disk from the peripheric umbrella corona. Whilst the former is usually smooth, the latter, on the contrary, is often divided by radial furrows into projecting "gelatinous sockels or pedalia," which serve to bear the tentacles and rhopalia, as *e.g.*, in *Periphylla* (Pls. XVIII., XIX.), *Nauphanta* (Pls. XXVII., XXVIII.), and *Atolla* (Pl. XXIX.). The exumbrella of *Cephea* (System, taf. xxxii.) bears large, conical urticating papillæ.

§ 61. Umbrella ventralis ("coelumbrella," lower umbrella or ventral umbrella).

This part of the umbrella is usually simply termed umbrella in the wider sense, though this name really belongs only to its lower concave surface, which is covered by ectoderm. Its upper, convex surface forms the inner or axial wall (subumbral wall) of the gastrovascular system, and is covered by its high "ventral endoderm." The two epithelial layers of the ventral umbrella, the ectoderm of the concave surface (subumbrella), and the endoderm of the convex surface, only pass into one another at the umbrella margin, and are likewise separated by a thin but firm supporting plate (*zw*). This fulcral lamella of the subumbrella is equivalent to the thick gelatinous body of the dorsal umbrella, though much thinner, and passes immediately into the umbrella margin at the edge of the latter. The endodermal epithelium of the ventral umbrella consists of high flagellate cells, which also often form glandular cells, whilst its ectodermal epithelium (the "subumbrella" in the more restricted sense) originates the most important part of the muscular system of the Medusæ ("subumbral muscles").

§ 62. Subumbrella. The convex inner surface of the ventral umbrella, which we designate shortly as the "subumbrella" (in the more restricted and special sense), is of special importance as bearing the muscular system, which affects the swimming motions of the Medusæ. It is, moreover, distinguished by varied differentiations of the ectodermal epithelium, lining the umbrella cavity enclosed by it. Thus, for example, glandular cells, pigment cells, and thread cells are often found disposed in a certain order on its ectoderm, and in all Craspedotæ it also forms the point of origin of the reproductive glands. Whilst in most of the smaller Medusæ (for example, the Craspedotæ) the subumbrella appears smooth and regularly vaulted, in most of the larger Medusæ (chiefly Acraspedæ) it is folded repeatedly and distinguished by special projections. Among the more important of these are the gelatinous ridges which serve for the wider superficial extension of the subumbral muscular system. They usually run in concentric rings (*e.g.*, on the coronal muscle of the Peromedusæ (Pls. XIX., XXII.), more rarely in radial bunches (*e.g.*, *Drymonema* (Pls. XXX., XXXI.). The mesenteries of many Anthomedusæ, and Trachomedusæ, Stauromedusæ, and Cubomedusæ may be mentioned as special processes of the subumbrella, which project into the umbrella cavity in the form of vertical radial septa; we shall speak of them further on in the "umbrella cavity" along with the various secondary cavities and niches, which penetrate from the umbrella cavity into the subumbrella (§§ 91, 94).

§ 63. Central and peripheric umbrella ("discus centralis" and "corona peripherica"). In all Medusæ a certain morphological and physiological contrast can be recognised more or less distinctly between the central and the peripheric part of the umbrella; the most important part of the vegetative gastrovascular system lies in the former, the most important part of the animal neurodermal system in the latter. We term the central principal section of the umbrella, enclosing the stomach and mouth along with the oral organs, the umbrella disk ("discus umbralis"), the peripheric principal section containing the umbrella margin along with the most important part of the muscular and nervous systems (sense organs and tentacles) the umbrella corona ("corona umbralis"). These two principal sections of the umbrella correspond at the same time to the two principal sections of the gastrovascular system, as the central principal intestine is situated in the umbrella disk, but the peripheric coronal intestine in the umbrella corona. The boundary between the disk and the corona is often sharply defined externally, as an exumbral coronal furrow ("fossa coronaris") is inserted more or less deeply between the two, as in many Narcomedusæ (Pls. IX.–XII.), Peromedusæ (Pl. XVIII.), Cubomedusæ (Pl. XXVI.), and in a few Discomedusæ, very distinctly in many Cannostomæ (Pls. XXVII.–XXIX.). The central umbrella disk is more discoid or lens shaped ("umbrella lens," "lens umbralis") in the depressed Medusæ, but more conical or bell shaped ("umbrella cone" "conus umbralis") in the higher vaulted Medusæ. In the Craspedotæ the peripheric umbrella corona ends in the typical velum of this section, but in the Acraspedæ in the characteristic lobe corona or velarium.

§ 64. Umbrella peduncle and umbrella cupola ("pedunculus umbralis" and "cupola umbrellæ"). In many Medusæ, though only in the minority, the "apex of the umbrella" (the uppermost, aboral and proximal part of the "notumbrella") is not arched and rounded as usual, but prolonged into a projecting apical process or a conical, peduncle-like process. In one order only, the Stauromedusæ, it is developed into a true umbrella peduncle ("pedunculus umbrellæ"), whose aboral end, the "foot plate," serves for adhesion to the bottom of the sea or to foreign bodies (Pls. XVI., XVII.; System, taf. xxi., xxii.). But in many other Medusæ of different orders (namely, of Anthomedusæ and Peromedusæ) in place of an apical peduncle we find a peculiar umbrella cupola or conical apical process ("cupola umbrellæ") at the top of the umbrella. This is the equivalent of the adhering peduncle, and contains, like it, a cæcal axial "apical canal" or "peduncle canal" (*Tesserantha*, Pl. XV. figs. 1–3, *p*). A special morphological interest attaches itself to these parts in that they are heirlooms from the polyp ancestors of the Medusæ, and are homologous with the peduncle and peduncle canal of the polyps, by means of which the latter are fastened to the bottom of the sea.

§ 65. Gastral peduncle and gastral cone ("pedunculus gastralis" and "conus gastralis"). An oral process is often found, though only in the Craspedotæ, on the concave inner surface of the central umbrella disk, in the same way as the umbrella peduncle or the umbrella cupola is developed from it as an aboral process. This oral process first appears as a flat, insignificant, conical elevation in the centre of the endodermal hollow surface of the "notumbrella," and projects, more or less, into the central gastral cavity (System, taf. xi. xiv. xv.). By further growth from this gastral cone, a long cylindrical gelatinous peduncle is developed, which projects far into the umbrella cavity or even beyond the umbrella opening, and which takes the surrounding parts of the "coelumbrella" along with it. The gastral sac lies no longer, as usual, in the bottom of the umbrella cavity, but at the distal end of a free solid gastral peduncle. The radial canals originating in the bottom of the stomach run in the ectodermal outer surface of the cylindrical gastral peduncle (which is often also quadrangularly prismatic, pyramidal, or conical) to the bottom of the umbrella cavity, turn over on to the subumbrella, and run in it to the umbrella margin. The longitudinal muscles which move the gastral peduncle, alternate with its ascending radial canals. The solid gastral peduncle frequently resembles the hollow, and likewise proboscis-shaped œsophagus of the Craspedotæ and has often been confounded with it. The gastral peduncle is never found among the Acraspedæ, but is very frequent in all four orders of the Craspedotæ. It is most strongly developed in a part of the Leptomedusæ (Saphenidæ) and Trachomedusæ

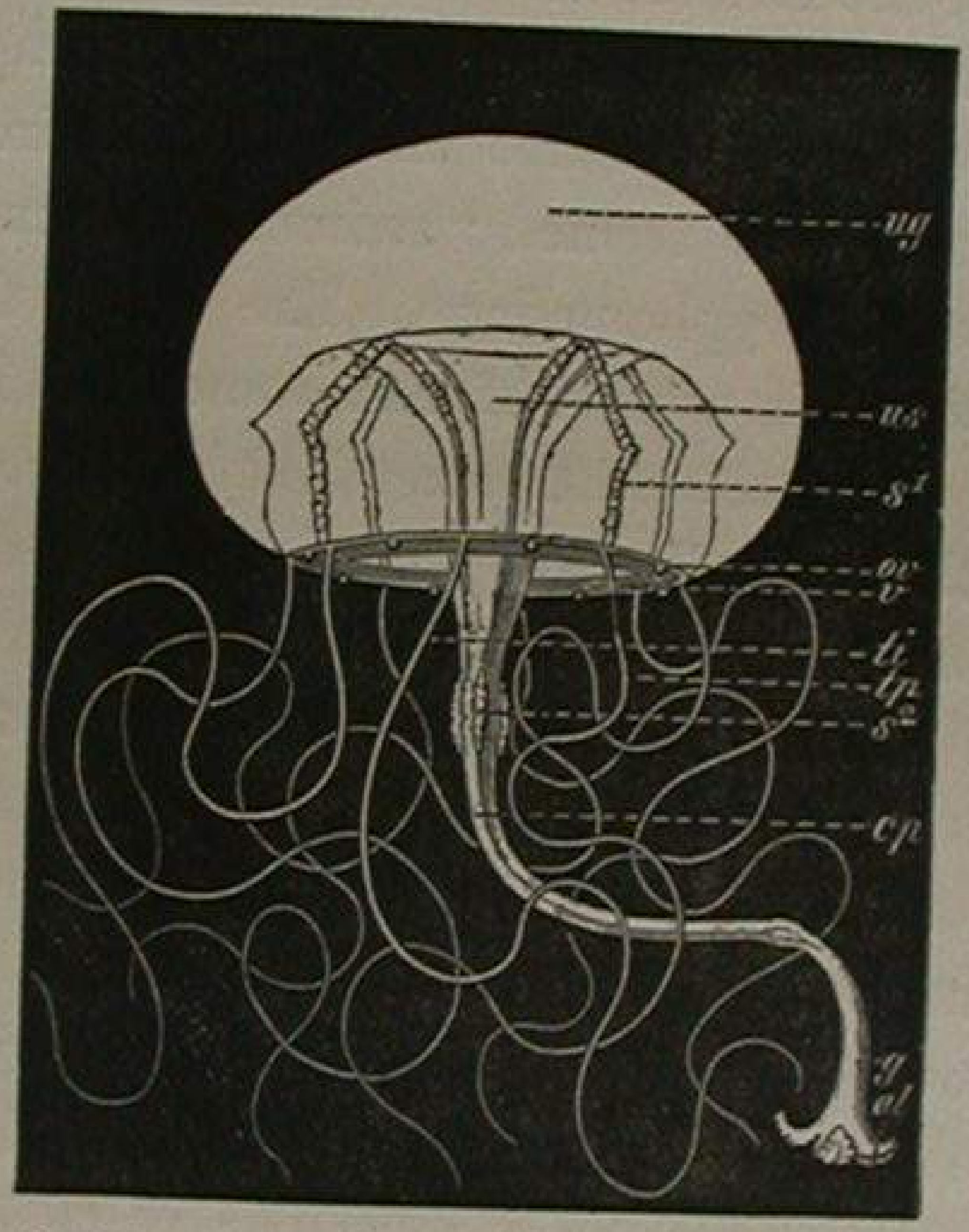


Fig. C. *Octorchis germanica* (Leptomedusæ, Eucopidæ).

Profile view. (*ug*) Gelatinous umbrella. (*us*) Solid gelatinous peduncle of the stomach. (*v*) Velum. (*ov*) Velar marginal vesicles. (*tp*) Perradial tentacles. (*ti*) Interradial tentacles. (s^1) Distal testis (on the subumbrella). (s^2) Proximal testis (on the œsophagus). (*cp*) Perradial canals. (*g*) Stomach. (*al*) Oral lobes.

(Geryonidæ). (Comp. System, taf. iv. xii. xiii. xviii. xx.). In a portion of the Geryonidæ it runs out still further below, past the central part of the umbrella peduncle and forms a pointed cone, projecting freely like a tongue into the hollow space of the stomach, which is fastened below to the gastral peduncle (System, taf. xviii. fig. 5). This tongue-like cone ("conus lingualis," "glossoconus") is perhaps an organ of taste.

§ 66. Umbrella margin ("margo umbrellæ," *um*). The umbrella margin forms the lower or distal boundary line of the umbrella, at which its two walls, the dorsal and the ventral wall, pass into one another; at the same time the exumbral epithelium of the convex dorsal umbrella (*qe*) proceeds directly at this boundary line into the subumbral epithelium of the concave ventral umbrella (*qw*). The umbrella margin is the most important part of the neurodermal system in all Medusæ, both morphologically and physiologically, as in it the most important animal organs—organs of sense, nerves and muscles—attain their highest development. The central part of the nervous system and the tentacles especially are always originally situated in the umbrella margin. The umbrella margin is also of great importance for classification, as it is chiefly on it that the variations of formation appear which lead to the distinction of genera and species. In fact the distinction and nomenclature of the two principal divisions of the Class Medusæ, of the two sections Craspedotæ and Acraspedæ, are taken from the umbrella margin, which presents important and striking diversities in the two sections. The "velum" is characteristic of the former, the "lobe corona" of the latter.

§ 67. Umbrella margin of the Craspedotæ: velum ("diaphragma"). In all Craspedotæ or Hydromedusæ a direct process of the free umbrella margin projects inwards from it; the marginal veil or "velum" (also termed "swimming membrane" or "diaphragma") is wanting in all Acraspedæ or Scyphomedusæ. The velum forms a thin, membranous, broader or narrower ring, which in a state of rest sometimes hangs loose vertically from the umbrella margin, and is sometimes stiffly stretched horizontally and projecting inwards, narrowing the entrance of the umbrella cavity more or less. In the Pectyllidæ (Pls. III.–VIII.) the velum is so broad that it can probably close the entrance into the umbrella cavity when fully extended. In most Narcomedusæ it is very broad, whilst it is very narrow in many Leptomedusæ; in *Obelia* it is rudimentary. We can always distinguish in the velum a free distal margin and a basal proximal margin, inserted at the umbrella margin; likewise a ventral inner surface and a dorsal outer surface. The ventral or subumbral surface of the velum is covered with the ectoderm of the "subumbrella," the dorsal or exumbral surface with the ectoderm of the "exumbrella"; below the latter there lies a thin supporting plate, below the former a muscular plate, composed of circular fibres, which is a direct process of the coronal muscular layer of the subumbrella (comp. Pls. IV.–VI., IX.–XIV.).

§ 68. Collar lobes of the Narcomedusæ. Whilst in most Craspedotæ the velum is stretched at equal breadth all round the umbrella margin, in the order of the Narcomedusæ it undergoes peculiar transformations as the umbrella corona (or "collar"), and is separated by deeper or shallower incisions of the margin into a number of separate "collar lobes" (at least four, *Cunarcha*, Pl. IX.; usually eight or more, Pls. X.–XIV.). These often closely resemble the true marginal lobes of the Acraspedæ, and are usually confounded with them; they differ entirely, however, in origin, structure, and signification. The collar lobes of the Narcomedusæ originate in the tentacles, abandoning their original insertion on the umbrella margin and migrating more or less upwards into the umbrella. They then take with them a process from the urticating ring of the umbrella margin, in the form of a radial (centripetal) urticating streak, which as the "umbrella clasp" ("peronium") keeps up the connection between the ectodermal epithelium of the tentacle and the umbrella margin. The peronia transect the gelatinous body as far as the subumbrella, and at the same time form deeper or shallower indentations at the dorsal bases, which in the Peganthidæ (Pls. X.–XII.) become deep incisions of the umbrella margin. The velum which fills them naturally appears much broader here than at the margin of the underlying collar lobes; it connects the latter in the same way as the velarium of the Cubomedusæ does the true marginal lobes of this order (§ 70).

§ 69. Umbrella margin of the Acraspedæ: lobe corona ("corona lobaris"). Whilst the velum appears in all Craspedotæ or Hydromedusæ as a characteristic process of the umbrella margin, it is generally wanting in all Acraspedæ or Scyphomedusæ. A velum-like mem-

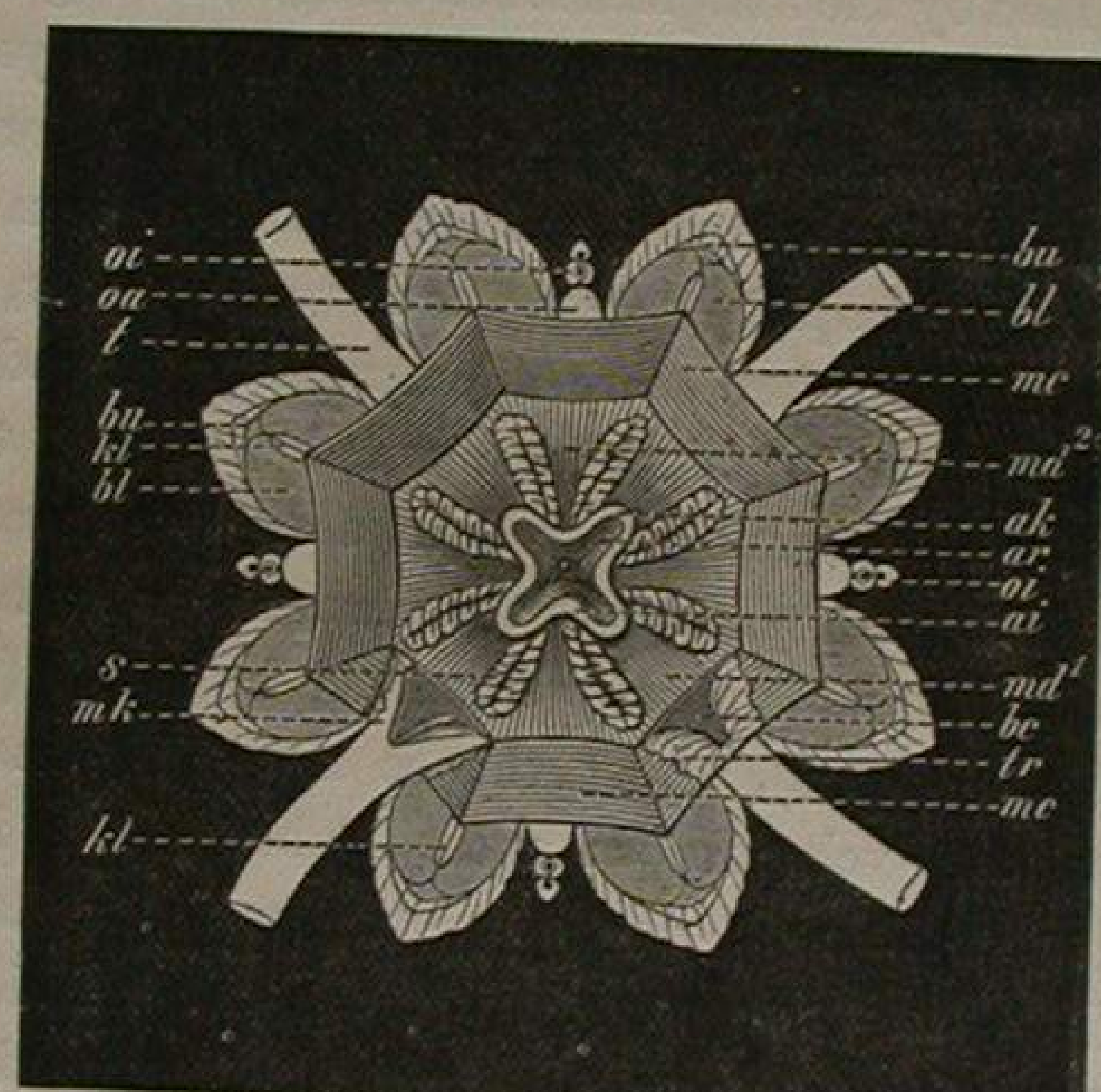


Fig. D. *Pericolpa quadrigata* (Peromedusæ, Pericolpidæ).

Subumbral aspect. (*oi*) Sense clubs (interradial). (*oa*) Ampulla at their bases. (*t*) Tentacles (perradial). (*bl*) Marginal lobes (adradial). (*bu*) Horseshoe-shaped canals of the lobes. (*kl*) Peronia between the two limbs of the canals. (*s*) Genitalia. (*mk*) Root muscles of the tentacles. (*md*[1]) Perradial deltoid muscles. (*md*[2]) Interradial deltoid muscles. (*ak*) Oral ribs. (*ar*) Oral grooves on their inner surface. (*ai*) Oral tæniola. (*ti*) Tentacle roots. (*bc*) Coronal pouches. (*mc*) Coronal muscles.

brane ("velarium"), which in some families of the latter (Charybdeidæ, Aurelidæ) forms a narrower or broader membranous selvage at the umbrella margin (Pl. XXVI. *va*), is perfectly different from the true velum both as to origin and structure. On the other hand, all Acraspedæ have a lobe corona ("corona lobarum"). This is usually wanting in the Craspedotæ, as the gelatinous "collar lobes" which are developed in some groups of the latter (Narcomedusæ, Pls. IX.–XIV.), but are connected by the velum, cannot be compared to the true marginal lobes of the Acraspedæ. The latter may rather be essentially considered as shallow, leaf-shaped "steering tentacles." They have one or two longitudinal muscles on their concave subumbral surface, by whose contraction they can operate like a helm in the motion of swimming. From the ontogeny of the Acraspedæ (*Aurelia*) it is probable that their marginal lobes have really originated phylogenetically from tentacles. A three-cleft *Scyphostoma* tentacle can have given rise in the *Ephyra* formation to a rhopalium and the two "ocular lobes" enclosing it. The number of the lobes varies greatly. In the Acraspedæ there are at least eight adradial marginal lobes (fig. D, Pls. XVI.–XVII.). In place of these, however, we usually find sixteen subradial (Pls. XVIII.–XXVIII.), and their secondary number is often considerably increased (Pls. XXX.–XXXII.).

§ 70. Velarium of the Cubomedusæ. Whilst in most Acraspedæ the marginal lobes project freely at the umbrella margin, alternating with the tentacles and rhopalia, the Craspedotæ are distinguished by the marginal lobes being fused together or connected by a thin intermembrane, like a swimming membrane (Pl. XXXVI.; System, taf. xxv.–xxvi.). In this way a muscular, broad, thin marginal membrane is formed, which strongly resembles the velum of the Craspedotæ, and has hitherto been generally considered homologous with it: it differs completely from the latter, however, both in its origin and its finer construction, and is therefore more appropriately termed velarium. The true velum of the Craspedotæ, and the velarium confounded with it of the Cubomedusæ have arisen quite independently of one another and in a different manner; the two bear a completely different morphological relation to the umbrella margin and to its nerve ring. The velarium of the Cubomedusæ is usually traversed by canals (distal processes of the coronal pouches), (Pl. XXVI. fig. 8), whilst this is never the case in the velum of the Craspedotæ. Moreover, the velarium in most Cubomedusæ is suspended by four perradial "frenula" (or gelatinous ridges of the subumbrella. Comp. above and Pl. XXVI. figs. 2, 8, *vf*). The velarium differs in the two families of the Cubomedusæ, inasmuch as it is composed of eight adradial marginal lobes in the Charybdeidæ, but of sixteen subradial marginal lobes in the Chirodropidæ. The marginal lobes are fused to a velarium in the same way, but not so apparently in many Discomedusæ, such as the Rhizostomæ. It is very broad, for example, in *Drymonema* (Pls. XXX., XXXI.). A narrow circular border of the umbrella margin, which in some Discomedusæ is developed below the corner of tentacles (Aurelidæ, System, taf. xxxiii. fig. 8, *va*) differs both from the velārium and from the true velum of the Craspedotæ.

§ 71. Urticating organs ("nematillæ," "nematophora," "organa urticantia," *n*). In all Medusæ, as in Acalephæ or Cnidaria in general, special organs are formed from the epithelium at definite parts of the body, which are essentially composed of nematocysts ("cnidoblasti"), and are therefore termed urticating organs or "nematillæ." In the Medusæ these are for the most part products of the ectoderm, whilst the endoderm only forms nematillæ in a few places, as for example, on the gastral filaments and in the oral cavity. The urticating organs serve chiefly as weapons of attack and defence (as, for example, the tentacles), but at the same time also as firm supports of the soft body (as, for example, at the umbrella margin). The urticating weapons ("arma urticaria") appear under very varied forms as roundish urticating knobs (in the whole ectodermal surface), closed urticating rings (in the outer wall of the tentacles), narrow urticating streaks or flat urticating pads (at the umbrella margin), conical urticating papillæ (in the exumbrella and subumbrella), composite urticating clubs and urticating batteries (at the end of the tentacles), and so forth. All these urticating weapons consist of epithelial accumulations of numerous urticating cells, which usually lie compacted in the upper surface of the ectoderm, and which throw the urticating threads and fluid from their thread cells, when their freely projecting urticating bristle ("cnidocilium") is touched. They are usually developed in a subepithelial layer, the "interstitial tissue." As soon as the thread cells and their filaments are fully developed in the cnidoblast they become erect, and pass from the subepithelial into the superficial epithelial layer. When this is very thin and flat (*e.g.* in the exumbrella) the thread cells originate in the epithelial cells of the upper surface itself. In many places, principally on the umbrella margin, the thread cells lose their original significance as weapons, accumulate thickly compacted in firm masses, and so assume the function of a supporting skeleton. Such subepithelial urticating skeletons ("sceleta urticaria") attain a high development in the Trachylinæ (Trachomedusæ and Narcomedusæ). They sometimes form a firm urticating ring on the umbrella margin (on the distal margin of the coronal canal (Pls. IX.–XIV. *nc*), sometimes radial urticating streaks, which run centripetally from the urticating ring and rise upwards in the exumbrella. These centripetal urticating streaks serve as firm, elastic support, sometimes for the freely projecting auditory clubs (auditory clasps "otoporpæ," Pls. IX.–XIV. *oo*), sometimes for the dorsally inserted tentacles, whose bases they connect with the umbrella margin (umbrella clasps, "peronia," Pls. IX.–XIV. *en*; comp. § 68). As the cnidoblasts in these supporting shields are accumulated in a number of layers, the one above the other, and lie deep under the epithelial upper surface, the enclosed filaments, which are no longer able to escape, lose their function as armature, whilst the hard nematocysts which assume the supportive function of the firm and elastic cartilaginous tissue become proportionately more strongly developed (Pl. XIV. fig. 12, *en*).

§ 72. Nervous system. In all Medusæ the nervous system stands at a very low stage of development, as it retains the most immediate connection with its place of development, the ectodermal epithelium, and as neither its central nor its peripheric parts have become completely and independently separated. We can usually distinguish in all Medusæ a central and a peripheric section of the nervous system. The circular central part lies either on the umbrella margin or above it on the subumbrella; whilst the peripheric part extends chiefly on the subumbrella in the form of a diffuse nervous plexus. Both in the central and peripheric part we find smaller and larger ganglion cells, mixed with finer and coarser fibrillæ (Pl. XIV. figs. 9, 10). These cells are most closely connected on the one side with the "sense epithelium" of the ectoderm lying below it (namely, at the umbrella margin and the organs of sense), and on the other with the underlying muscular plate (namely, at the subumbrella and the œsophagus). Independent "ganglia" separated into units, or centralised nerve knots, and visible "nerve fibres" consisting of bundles of separate nerve fibrillæ are only developed in a few surfaces (*e.g.*, *Charybdea*, Pl. XXVI.). We ought, however, to observe that the most recent numerous and important researches on these difficult conditions are still too insufficient to allow us to form exhaustive and certain conclusions on the subject. On the one hand we know nothing of the nervous system of several principal groups of the Medusæ (for example, of the two orders of Stauromedusæ and Peromedusæ) ; on the other hand, in the remaining orders, the nervous system has not been examined on important parts of the body, on which from their greater mobility and great sensibility it is probably very highly developed, pre-eminently on the œsophagus and the oral organs. As far as we can judge at present the nervous system of the two sections presents essential differences, as it appears more strongly centralised in the Craspedotæ, more diffuse in the Acraspedæ.

§ 73. Nervous system of the Craspedotæ. In all Craspedotæ, of which the nervous system has been minutely examined up to this time (and among these we find some belonging to all the four orders), its important centre represents a double marginal nerve ring, lying on the proper umbrella margin immediately outside the insertion of the velum. It is covered externally by a ciliated sense epithelium, consisting of small flagellate cells, and is divided by the supporting plate of the velum insertion into two separate rings, an exumbral and a subumbral ring. The dorsal or exumbral nerve ring (Pl. IX. fig. 7, *rc′* ; Pl. XII. fig. 12, *rc′*) is the so-called upper ring (the outer or lower in the normal position of the velum), and seems to be pre-eminently the central organ of sense ; it contains smaller and scantier ganglion cells, also finer fibrillæ, and specially provides for the different organs of sense of the umbrella margin (namely, the auditory clubs and the tentacles). The ventral or subumbral nerve ring (Pl. IX. fig. 7, *rc″* ; Pl. XII. fig. 12, *rc*) is the so-called "lower" ring (the inner or upper ring in the normal position of the velum), and appears to be pre-eminently the motor central organ ; it contains larger and more numerous ganglion cells, as well as several fibrillæ, and provides specially for the muscular system of the velum and the subumbrella. The two nerve rings are immediately connected by numerous fine filaments, which pierce the separating fulcral lamella of the insertion of the velum, and give out numerous filaments which extend like a plexus and are in connection with many peripheric ganglion cells. In many Craspedotæ the nerve ring shows slight swellings, which are perhaps radial ganglia at the points of insertion of the tentacles (especially at the four perradial and four interradial).

§ 74. Nervous system of the Acraspedæ. The structure of the nervous system in the first two orders of the four orders of this section, the Stauromedusæ and Peromedusæ, is next to unknown; the two other orders seem to comport themselves in somewhat different ways. The Cubomedusæ (Charybdeidæ and Chirodropidæ, Pl. XXVI. figs. 25, 26) are distinguished by a strong simple subumbral nerve ring which runs above the umbrella margin at a considerable distance from it. It lies embedded in a groove of the subumbrella, whose muscular plate is interrupted by it, and consists of a clear axial cord, two turbid cords of fibrillæ (an upper and an under) lying on the former and a peculiar overlying nerve epithelium. The nerve ring is swollen at eight places into eight ganglia. The four perradial ganglia are larger and lie higher at the bases of the four highly developed sense clubs; they send out sensible nerves to the sense clubs and motor nerves to the muscular plate of the subumbrella. The four interradial ganglia lie deeper at the basis of the four strong tentacle pedalia, and send out both sensible and motor nerves to the umbrella margin and the tentacles. Wide-spread plexus of fibrillæ, in which numerous multipolar and fusiform ganglion cells are situated, lie in the subumbrella and the velarium, and are connected with the nerve ring and its eight ganglia. The nervous system of the allied Peromedusæ, where we may expect to find the nerve ring in the depth of the exumbral coronal furrow or at the coronal muscle, is probably of the same nature as that of the Cubomedusæ. On the other hand, the nervous system of the Discomedusæ, which has been often examined, varies in its nature in so far that the nerve ring retreats whilst the principal sense clubs (four perradial and four interradial) appear in the foreground as eight separate marginal nerve centres. Each of these eight sense clubs or marginal bodies in the Discomedusæ contains in itself the organs of sense described below, and its base encloses an independent nerve centre, which here, and as in the Cubomedusæ, may be termed the principal ganglion. This consists of a thick pad of nerve fibrillæ and ganglion cells, which are in immediate connection both with the underlying tactile cells of the ectodermal sense epithelium and with the remaining organs of sense of the rhopalium. Other filaments connect it with the nervous plexus of the subumbrella, which extends between the ectodermal epithelium and the muscular plate of the latter, and contains large motor ganglion cells. The bundles of fibrillæ which form immediate connection between the eight principal ganglia of the rhopalia and correspond to the strong nerve ring of the Cubomedusæ may be looked for in the Discomedusæ in the bottom of the umbrella cavity.

§ 75. Organs of sense (" sensillæ "). All Medusæ possess organs of sense on the umbrella margin. The umbrella margin itself is covered for the most part with sense epithelium; it is the mother-ground and place of origin of different sensillæ. These appear in the simplest (and almost universally spread) form as tentacles, which are plainly homologous to the margin tentacles of the polyps from which they have originated phylogenetically. The sensillæ are represented only by tentacles in few groups of Medusæ. In most groups besides tentacles we find differentiated organs of sense on the umbrella margin, which have proceeded partly from undeveloped tentacles, and have partly arisen independently of these. As far as we are able at present to decipher the difficult physiological significance of the different organs of sense, we can distinguish four categories of organs of sense in the Medusæ, according to the specific energy of each, viz. :—1. Organs of touch, mechanical tools for the perception of touch and pressure ; such, above all, are the tentacles with manifold ectodermal cell formations, which appear specially adapted for the perception of mechanical stimulation—viz., tactile bristles, tactile combs, &c. Besides the tentacles, special tactile organs are often found at many places (namely, at the umbrella margin and the margin of the mouth). 2. Organs of smell or organs of taste, chemical sense tools for the perception of the mixture or rarefaction of the sea-water ; these are probably always present (perhaps hidden under the tentacles already mentioned) ; the clavellæ of the Craspedotæ, and the funnel-shaped depressions on the rhopalar protective scale of the Acraspedæ, may be perhaps regarded as special olfactory organs. 3. Organs of vision. Ocelli or pigment eyes, with or without a lens principally and widely extended on the umbrella margin and the basis of the tentacles ; sometimes adapted for thermatic perceptions, sometimes for optical (eyes for warmth, eyes for light). 4. Organs for hearing, appearing in several different forms on the umbrella margin, among which we can distinguish two originally different types, velar auditory vesicles with ectodermal otolites and tentacular auditory clubs with endodermal otolites. All the four kinds of organs of sense may be found united in one and the same " sense tentacle," as is the case with the " sense clubs " or " rhopalia " of many Acraspedæ. As the umbrella margin is the site of the greater number of different sensillæ, in the Medusæ they were usually given the indifferent name of marginal bodies (" corpuscula marginalia "), which only indicated their situation.

§ 76. Tentacles (*t*). The tentacles or feeling filaments are by far the most important organs of the umbrella margin of the Medusæ, as they not only represent the oldest and simplest organs of sense of this class of urticating animals, but at the same time of their limbs. The tentacles are originally placed on the umbrella margin (" marginal filaments "), and are used as feelers as well as sense organs, also as weapons for attack and defence, as sucking-cups for adhesion by suction (Pectyllidæ, Pls. III.–VIII.), as steering organs for swimming, or as manducatory organs for leading the nourishment seized on to the mouth (" filaments of prehension "). Only the small group of the Amaltheidæ among the Craspedotæ, and the large group of the Rhizostomæ among the Acraspedæ are distinguished by complete absence of tentacles ; in them the tentacles have undergone retrograde formation and become lost. As the tentacle corona of the Medusæ corresponds to that of their ancestors, the polyps, the conditions of formation and structure are in general the same in both classes. The tentacles in most Medusæ are placed in a circle on the umbrella margin, just as they are placed on the corresponding peristomial margin or calyx margin in most polyps. In the Medusæ they usually form a single row, and are regularly distributed in it according to number and arrangement (§ 77). More rarely two or more rows of tentacles are placed on the umbrella margin, the one above the other, and are then usually compacted in larger numbers (*Pectyllis*, Pls. III., IV.; *Pectis*, Pls. V., VI.). The tentacles sometimes appeared grouped together in bushes or bundles on the umbrella margin, as in the Lizusidæ and Hippocrenidæ (System, taf. v., vi.), and in *Pectanthis* (Pls. VII., VIII.) among the Craspedotæ; and in the Lucernaridæ (Pls. XVI., XVII.) and the Chirodropidæ (System, taf. xxvi.) among the Acraspedæ. Deviation from the original marginal insertion sometimes takes place, as the tentacles either migrate outwardly on the dorsal surface of the umbrella or inwardly on the ventral surface. Exumbral insertion, on the dorsal surface is found in many Trachomedusæ and most Narcomedusæ (Pls. IX.–XIV.); there the tentacles may be placed far up on the exumbrella, but usually denote their original connection with the umbrella margin by the urticating streaks or umbrella clasps already mentioned ("peronia," § 68; Pls. IX., XIII., XIV., *en*). In the Aurelidæ the tentacles are also inserted dorsally (System, taf. xxxii. fig. 8). The Sthenonidæ and Cyaneidæ are distinguished by subumbral insertion of the tentacles; in the latter they are scattered over nearly the whole subumbrella (*Drymonema*, Pls. XXX., XXXI.).

§ 77. Number and position of the tentacles. Although the tentacles of the Medusæ present the most varied conditions both as to number and position, still by critical comparison we are able to recognise the existence of certain simple primary and original conditions, from which all the others may be secondarily derived. We may conclude from this that most probably four perradial tentacles (at the distal end of the four radial canals) represent the primitive formation for the Craspedotæ, but eight principal tentacles (four perradial and four interradial) for the Acraspedæ. In the section of the Craspedotæ tetranemal forms (with four perradial tentacles) are found in all four orders; *Codonium*, *Cytæis*, &c., among the Anthomedusæ, *Tetranema*, *Eucopium*, &c., among the Leptomedusæ, *Petasus* among the Trachomedusæ, *Cunantha* among the Narcomedusæ (comp. System, p. 359); the two latter may, however, be regarded as already octonemal as in them four interradial cordyli alternate with the four perradial tentacles, the cordyli themselves being merely modified acoustic tentacles (§ 84, comp. Pl. IX.). This is also the case in *Pericolpa*, one of the oldest and simplest forms among the Acraspedæ. The inverted condition is shown in *Charybdea* (Pl. XXVI. where the four sense clubs are placed perradially, but the four tentacles interradially. Both the Charybdeidæ (Cubomedusæ) and the Pericolpidæ (Peromedusæ) are derivable from *Tessera*, the oldest and simplest form among the Stauromedusæ, which may at the same time be considered the hypothetic ancestral form of all Acraspedæ. This has already eight principal tentacles (four perradial and four interradial). In *Pericolpa* only the four interridal tentacles are transformed into sense clubs, in *Charybdea* the four perradial, in *Ephyra* (the ancestral form of the Discomedusæ) all the eight principal tentacles. In the latter, as in the closely allied *Nauphanta* (Pls. XXVII., XXVIII.), eight adradial tentacles (fig. B, *ta*) are developed between the eight principal. In the majority of the Medusæ the number of the tentacles increases with age, as new tentacles are formed later between the original four or eight. This increase takes place according to fixed laws, which vary in the different principal groups. The ontogenetic series in the appearance of the different orders of tentacles, allows us to conclude that there is a corresponding phylogenetic progression. In contrast to the eight principal tentacles (four perradial and four interradial) all the others which appear between them later may be termed succursal. This distinction is important because the eight principal tentacles give rise to numerous transformations and progressive formations. By retrograde formation of two opposite perradial tentacles, dissonemal Medusæ, *e.g.*, *Thamnostylus dinema* (Pl. I.) often arise from tetranemal. Such Medusæ are found among many groups of the Craspedotæ, but not among the Acraspedæ. The remains of the retrograded tentacles usually persist as bulbs of the umbrella margin between the two opposite permanent tentacles. On the other hand, we very rarely find only a single tentacle in the developed Medusæ, the three others having undergone retrograde formation; the Euphysidæ, a small sub-family of the Codonidæ (System, taf. ii.) are mononemal Medusæ. The Amaltheidæ among the Craspedotæ, and the Rhizostomæ among the Acraspedæ, are distinguished by complete loss of all the tentacles.

§ 78. Form and structure of the tentacles. In most Medusæ the tentacles are long, cylindrical filaments, more rarely flattened like a ribbon. They are usually thicker at the base, but pointed conically towards the end, more rarely swollen like a club. They are almost always simple and unbranched; only a single family of the Craspedotæ, the Cladonemidæ, are distinguished by branched or composite tentacles (System, taf. vii.); these are sometimes branched dichotomously, sometimes beset with "secondary filaments" (semi-pinnated) as in the Siphonophora and Ctenophora. The structure of the tentacles is essentially the same in all Medusæ. They are composed of the same four essential layers of tissue (or "secondary germinal layers") as the umbrella itself, namely:—(1) the outer epithelium of the endoderm; (2) the muscular plate underlying it, formed of longitudinal fibres; (3) the structureless, elastic supporting plate; (4) the inner cellular axis of the endoderm. We distinguish two principal forms, solid tentacles and hollow tentacles; both often appear in closely allied Medusæ, sometimes beside one another in one and the same species (Geryonidæ). They are principally to be distinguished by the comportment of the endodermal axis. The solid tentacles are usually stiffer and shorter, less extensible and flexible; they are chiefly found in the Trachylinæ (Trachomedusæ and Narcomedusæ) and also in the oldest forms of the Acraspedæ (Stauromedusæ and Cannostomæ). Their cylindrical endodermal axis usually consists of a single row of discoid chordal cells, lying the one above the other like the coins in a rouleau of sovereigns (Pl. VI. fig. 17; Pl. XIII. figs. 5, 6, &c.; Pl. XV.). They are more rarely arranged in several layers (Pl. IV.

figs. 5–8). The hollow tentacles are generally more flexible and movable, longer and much more extensible, they are chiefly found in the Leptolinæ (Anthomedusæ and Leptomedusæ), and also in the majority of the Acraspedæ. They contain a canal, which represents a peripheric process of the gastrovascular system, and is lined by a single layer of endodermal flagellate cells (Pl. VII. fig. 4; Pl. XVII. figs. 15, 16; Pl. XXI. fig. 21, &c.). In the two forms of tentacles, both solid and hollow, the endodermal axis is covered by a structureless elastic supporting plate, which separates it from the overlying muscular plate, and which at the same time acts as antagonist, or elastic extensor against the contractions of the latter. The muscular plate consists of longitudinal muscular fibrillæ, which are usually still connected with the overlying epithelial muscular cells of the ectoderm. The latter, moreover, contains thread cells and feeling cells very variously arranged, and often also glandular cells and ciliated cells.

§ 79. Organs of feeling (tactile organs, "organa palpantia"). As sensibility to variations of temperature, and reaction against touch and pressure is wide spread among the Medusæ, tactile cells ("cellulæ palpantes") must necessarily be generally present. All indifferent sense cells, all ectodermal cells with hair-shaped processes may probably be considered as such. These tactile hairs may be either flexible and movable ("flagellum") or stiff and immovable (tactile bristle, "palpellum"). Whether all ectodermal flagellate cells are to be regarded as tactile cells is still doubtful, but this view probably holds good for the flagellate cells composing the sense-epithelium above the nerve ring of the umbrella margin and the "marginal corpuscules," and also for the flagellate cells, which in many Medusæ form part of the outer epithelium of the tentacles (sometimes arranged in longitudinal streaks, rings or spirals along the sides of the tentacles, sometimes as a connected covering of the ends of the tentacles). We appear more justified in considering these ectodermal flagellate cells as tactile cells, when we perceive that their bases are directly connected with nerve fibrillæ. This is also the case with the "cells with tactile bristles" of the ectoderm, which bear a stiff, often long, and far projecting tactile hair, a tactile bristle or palpellum. Such cells with tactile bristles are usually widespread in the ectoderm both on the exumbral dorsal, and on the subumbral ventral surface, chiefly, however, on the most sensitive parts, on the umbrella margin and the tentacles, and also on the oral margin and the oral arms. According to this view, the whole urticating cells in the first place, and in the second place the "tactile cells" in the more limited sense, or the palpocells (without nematocysts) belong to this category. The "urticating bristle" ("cnidocilium") of the urticating cells, like the feeling bristle ("palpocilium") of the actual "feeling cells," is a direct process of the protoplasm of the cell, projecting externally freely into the water and as in both cases the latter is connected at the base of the cell with nerve fibrillæ, in both cases the stimulation received by the palpellum can also be communicated by the nerves to other parts (muscles, &c.). The urticating cells (with cnidocilia and nematocysts) and the feeling cells (with palpocilia but without nematocysts) are therefore to be regarded as two different modifications of cells with tactile bristles (with palpella). The distribution of these tactile cells on the sensitive organs of the umbrella and its appendages varies remarkably. For example, in the Trachomedusæ and Narcomedusæ special "tactile combs" are found on the umbrella margin, or comb-shaped rows of tactile bristles, tactile rings on the tentacles, and so forth (System, taf. xvii. figs. 9, 10, &c.).

§ 80. Organs of smell ("organa olfactoria"). The peculiar chemical sensillæ of the Medusæ, which might perhaps be equally or more truly termed organs of taste ("organa gustatoria") belong to this category. It is easily seen from physiological observations and experiments that the Medusæ are very sensitive to change of composition of the salt water, and even to slight rarefaction of it, so that, for example, they sink below as soon as it begins to rain. The organs of chemical perception of sense are not yet known with any certainty, and are probably usually represented by sense cells of the umbrella margin, of the tentacles or of the margin of the mouth. Special organs, which give the impression of sensillæ from their situation and composition, may probably also lay claim to this function, such as the marginal clavellæ among the Craspedotæ and the rhopalar olfactory depressions among the Acraspedæ. The "olfactory clubs" or marginal clubs ("clavelli marginales") are only found in the section of the Craspedotæ and there chiefly in the order of the Leptomedusæ. In my System, 1879 (pp. 118, 123, 143, taf. viii. figs. 7, 12; taf. ix. figs. 3, 8) these clavellæ were termed marginal clubs ("cordyli marginales") as they are found in those Leptomedusæ, in which the auditory vesicles, which they therefore perhaps represent, are wanting (Thaumantidæ, Cannotidæ). They usually (or always ?) want the characteristic "auditory hairs," which are a distinguishing feature of the acoustic organs. The pyriform or club-shaped clavellus (Pl. II. figs. 3, 4, 8), sits with a thin stalk on the umbrella margin, and is, therefore, not to be confounded with the conical disposition of the young tentacles. It contains a cæcal, very narrow "canalis clavellaris," which runs out from the coronal canal and is lined with high cylindrical epithelium (Pl. II. fig. 8, *y*). The latter is separated by a thin fulcral plate (*z*) from the flat epitheluim of the ectoderm (*q*). The clavellæ are found in many Thaumantidæ and Cannotidæ on the umbrella margin, scattered in large numbers (often several hundreds), between the tentacles, and may, therefore, be regarded as sensillæ. This is also applicable to the olfactory depressions ("fossulæ olfactoriæ, *oz*) of the Acraspedæ. These appear in the Discomedusæ as small, cæcal funnel-shaped depressions in the dorsal surface of the rhopalar protective scales (or "funnel plates"), and are lined with a many folded sense-epithelium, furnished with long flagella (comp. under the rhopalia).

§ 81. Organs of vision ("organa optica"). Physiological experiments prove easily and with certainty that all Medusæ are more or less sensible to the influence of light and warmth. From analogy with other animals we are justified in the conclusion that the simplest organs of this sensation are the pigment spots ("ocelli"), chiefly those placed on the umbrella margin. They consist partly of pigment cells, partly of optical sense cells or root cells, which belong to the sense epithelium of the dorsal nerve ring. Whilst these ocelli are originally simple centres for the perception of heat, they are developed later on into true light eyes. As experiments showed, it is principally the swollen bases of the tentacles which bear such pigment eyes, and that chiefly in the order of the Anthomedusæ and in those Leptomedusæ which have no marginal vesicles ("ocellatæ"). Such ocelli are more rarely found in the Trachomedusæ, Narcomedusæ, and Stauromedusæ. On the other hand they are widely spread among the three higher orders of the Acraspedæ and usually found at the base of the sense clubs or rhopalia described below. In many Acraspedæ and a few Craspedotæ (Anthomedusæ) a lens is also found in the pigment body of the eye and in the Cubomedusæ a crystalline lens or retina is developed between the lens and the pigment cup. We also find "composite eyes" in the Cubomedusæ, as, *e.g.*, in *Charybdea*, where each sense club bears two large unpaired and two small paired eyes. Moreover, Medusæ perfectly devoid of colour, which have neither marginal ocelli nor other pigment spots, are sensible to light; in this case it is probably the sense epithellium of the umbrella margin which discharges this function. We therefore find in the class of the Medusæ a long series of different phylogenetic stages of development of optical apparatus, from the simplest beginning up to very composite eyes.

§ 82. Organs of hearing ("organa acustica"). In the majority of Medusæ we find organs of sense on the umbrella margin, which must be indubitably regarded as organs of sense as they possess both otolites ("otolithi") and auditory cells ("otocellæ") bearing bristles. In the minority of the Medusæ, in which the otolites are absent, it is possible (or rather probable) that a lower degree of acoustic functions are exercised by part of the cells bearing tactile bristles ("palpocellæ") already described. As, on the one hand, we know of no definite morphological distinction between such tactile cells, bearing bristles and auditory cells which also bear bristles, and as on the other hand, the latter must be regarded as merely special modifications of the former, it is possible that many apparently indifferent tactile cells are sensible not only to fluctuations of pressure, but also to vibrations of sound. Considering, however, the immense use which the capacity of hearing must be to the free swimming Medusæ (*e.g.*, the perception of the noise of the tempestuous breakers on nearing the coast), it is most probable that a lower or higher degree of sensibility to sound is generally spread in this class. In this case we must consider the cells with tactile bristles, which are found in the Medusæ devoid of otolites, in the whole of the Anthomedusæ, Stauromedusæ, and also in the Ocellatæ (Thaumantidæ and Cannotidæ) must among the Leptomedusæ be regarded as "lower acoustic organs." All other Medusæ, on the contrary, possess "higher acoustic organs" or true "organs of hearing," consisting of auditory cells and otolites; these are found in all the Acraspedæ (with the single exception of the Stauromedusæ) and in the majority of the Craspedotæ, in all Trachomedusæ and Narcomedusæ, and also in the Vesiculatæ (Eucopidæ and Æquoridæ) among the Leptomedusæ. In the Vesiculatæ, however, the organs of hearing have quite a different structure and a different origin from those in the other groups mentioned, the Vesiculatæ have velar auditory vesicles with ectodermal otolites, whilst all the others have tentacular auditory clubs with endodermal otolites. These two types in the structure of the auditory organs differ so entirely that they require a separate description.

§ 83. Velar auditory vesicles (with ectodermal otolites, "vesiculæ velares," also termed "marginal vesicles," "vesiculæ marginales," *ov*). This peculiar form of the audi-

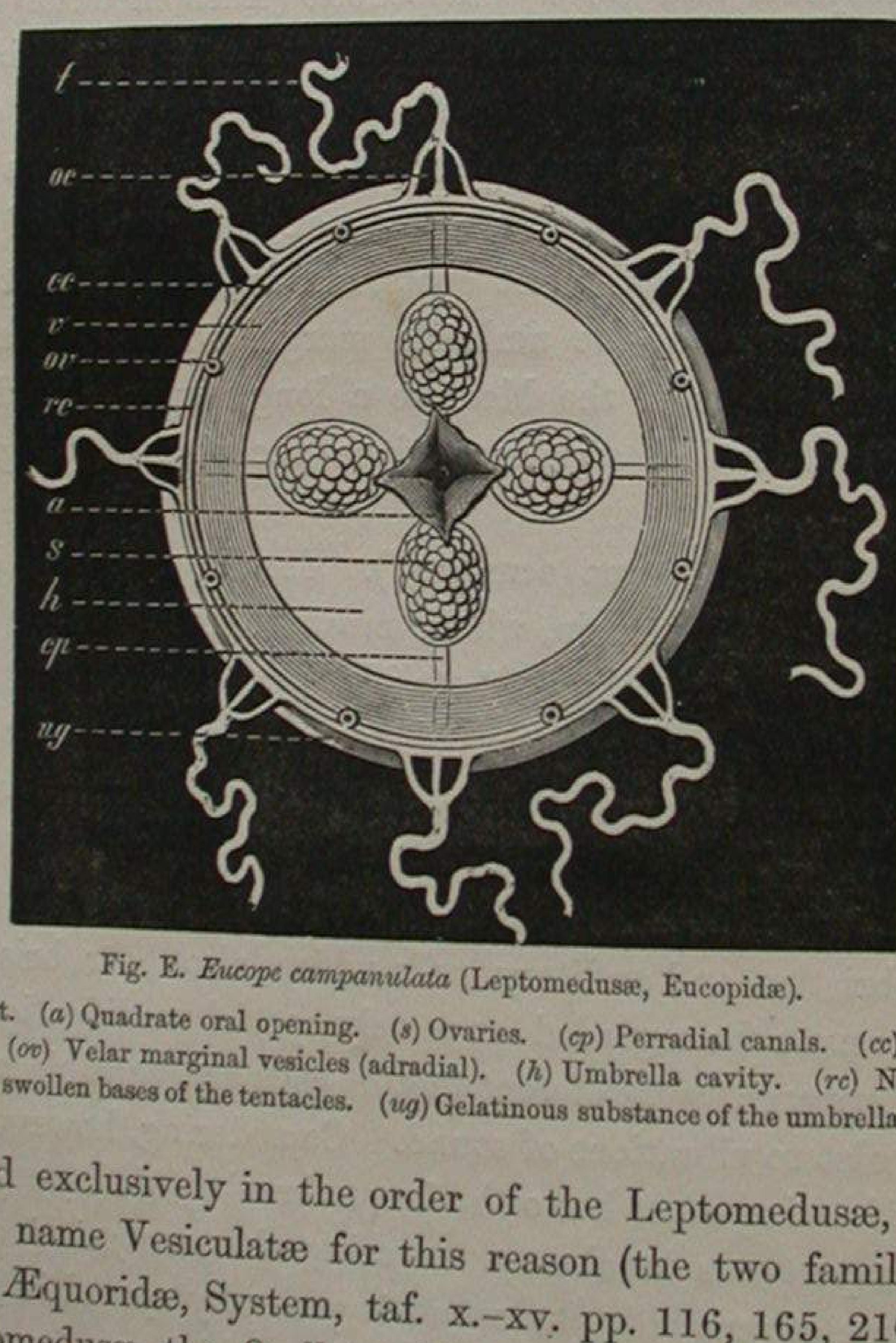


Fig. E. *Eucope campanulata* (Leptomedusæ, Eucopidæ).
Subumbral aspect. (*a*) Quadrate oral opening. (*s*) Ovaries. (*cp*) Perradial canals. (*cc*) Coronal canals. (*v*) Velum. (*ov*) Velar marginal vesicles (adradial). (*h*) Umbrella cavity. (*rc*) Nerve ring. (*oc*) Ocelli at the swollen bases of the tentacles. (*ug*) Gelatinous substance of the umbrella. (*t*) Tentacles.

tory organs is found exclusively in the order of the Leptomedusæ, and there only in a suborder which we name Vesiculatæ for this reason (the two families, rich in forms, of the Eucopidæ and Æquoridæ, System, taf. x.–xv. pp. 116, 165, 210). The other suborder of the Leptomedusæ, the Ocellatæ (the two families of the Thaumanthidæ and Cannotidæ) have neither otolites nor auditory vesicles, but perhaps auditory cells on the subumbral side of the velum. This exception is supported by the fact, that in the simplest cases in the Vesiculatæ (*Mitrocoma*) no closed auditory vesicles are present, but only open depressions in the insertion of the velum, in whose ectoderm auditory cells and otolite cells are developed. These auditory depressions ("fossulæ velares") are probably found in other Leptomedusæ (*Phialis, Tiaropsis, Mitrocomella*, &c.), besides *Mitrocoma* (System, taf. x.). They form small depressions in the subumbral or ventral side of the velum (which is commonly termed the "lower" side but which is the "upper" in the normal position of the horizontally stretched velum). One portion of the subumbral ectoderm cells, which line these depressions, and which are connected with the contiguous ventral nerve ring, forms a calcareous otolite in their interior, another portion of it bears an auditory bristle. As these "auditory depressions" become deeper, enter the dorsal side of the velum vaulted like an arch, and finally become entirely loosed from the ventral side, they are transformed into auditory vesicles ("vesiculæ velares"). These project more or less as conical or roundish vesicles on the dorsal side of the velum, near its insertion on the umbrella margin, become innervated from the subumbral nerve ring, covered externally by the dorsal ectodermal epithelium of the velum and contain a hollow space filled with otolymph (originally sea water); this space is lined with an acoustic epithelium, which originally belongs to the ventral ectodermal epithelium of the velum and consists partly of auditory cells bearing bristles and partly of otolite cells. The auditory hairs of the former surround or lie upon the latter. In the most simple cases, each velar marginal vesicle only contains a single otolite, but in others often a large number of them. The inner (subumbral) sense epithelium and the outer (exumbral) covering epithelium, are separated by a structureless lamella which belongs to the supporting plate of the velum. The number and distribution of these velar auditory vesicles of the Leptomedusæ varies largely; however, there are always originally eight adradial auditory vesicles, which lie exactly in the middle between the four perradial and the four interradial tentacles (fig. *E*). We never find fewer than eight. In most Leptomedusæ their number is considerably increased, often to several hundreds; we may therefore distinguish two groups of the Vesiculatæ, the Octotessæ, and Polyotessæ, the former having invariable eight velar auditory vesicles, the latter having invariably more than eight (System, p. 117, taf. x.–xv.).

§ 84. Auditory clubs or "cordyli" (*ok*), acoustic tentacles with endodermal otolites. This form of the organs of hearing is by far the most common among the Medusæ, and is found in the majority of the class, in the Trachomedusæ and Narcomedusæ among the Craspedotæ, and also among all the Acraspedæ, with the single exception of the Stauromedusæ. The auditory clubs of all these Medusæ are modified, small acoustic tentacles, containing endodermal otolites, and differing therefore entirely in origin and composition from the velar auditory vesicles of the Leptomedusæ (with ectodermal otolites). In the two sections, the auditory clubs have originated, independently of one another, from the tentacles in an analogous manner, from the solid tentacles in the Craspedotæ, from the hollow tentacles in the Acraspedæ. In the former, it is the chordal cells of the solid endoderm axis, which produce the otolites, in the latter it is the endodermal cells forming the epithelium at the distal end of the tentacle canal. The auditory clubs of the Acraspedæ are, moreover, combined in a peculiar way, with other organs of sense (ocelli, olfactory depressions, tactile plates) and with their surroundings, compose the typical sense clubs or rhopalia, which we shall afterwards consider separately. On the other hand the analogous auditory clubs of the Craspedotæ (of the Trachomedusæ and Narcomedusæ) which often closely resemble the others, appear to be more simple formations (Pls. III.–XIV., *ok*). They resemble perfectly simple, solid tentacles, whose axis consists of a row of a few endoderm cells (usually two to four, more rarely five to ten or more), processes of the inner epithelium of the coronal canal. Either only the last of these or several of them (two to four, rarely more) produce in their interior a calcareous concrement, which functions as an otolite. The Trachomedusæ (and a small part of the Narcomedusæ, the Solmaridæ) have only a single round otolite in each auditory club; it is in concentric layers, usually spheroidal, more rarely elliptical, and often coloured red or yellow. Most Narcomedusæ (all, indeed, except the Solmaridæ) possess crystalline otolites of prismatic form (usually several in each auditory club). The acoustic ectoderm epithelium of the auditory clubs is separated from the solid endoderm axis by a thin supporting plate, and bears long stiff auditory hairs; so is the ectoderm of the "auditory pad" or "auditory papilla," which in many Narcomedusæ arises at the base of the auditory club by a swelling of the dorsal nerve ring; the latter always supplies the cordylus. In part of the Narcomedusæ (the Cunanthidæ and Peganthidæ) peculiar, firm urticating streaks are found at the bases of the cordyli which rise from these centripetally into the exumbrella, and are covered with ciliated sense epithelium (auditory clasps, "otoporpæ," Pl. IX. fig. 8, *oo*; Pl. XI. fig. 4, *oo*). Four interradial auditory clubs seem usually present originally; the number often increases largely later on, and may amount to more than a thousand (*e.g.*, *Pegantha magnifica*, System, p. 333).

§ 85. Cordylar auditory vesicles ("vesiculæ cordylares"). Whilst in all Narcomedusæ, and also in the lower and older groups of the Trachomedusæ (Petasidæ, Pectyllidæ, Pls. III.–VIII., Aglauridæ), the auditory clubs stand freely on the umbrella margin, in some of the younger and higher groups of the Trachomedusæ, this is rarely the case, and then only in the young stage. The originally free auditory clubs become enclosed in special "auditory vesicles." In the Marmanemidæ (System, taf. xvii.) this is caused by the ectodermal epithelium of the dorsal nerve ring rising like a wall, in the form of a circular fold, at the base of the free cordylus; its margins grow together above the depression formed, and so transform it into a closed vesicle; the auditory hairs are stretched like harp strings between the inner wall of the vesicle and the upper surface of the cordylus enclosed. Whilst these "auditory vesicles" of the Marmanemidæ lie freely on the umbrella margin, the similarly constructed auditory vesicles of the Geryonidæ lie deeply inserted in the gelatinous body of the umbrella margin. These cordylar auditory vesicles of the Marmanemidæ and Geryonidæ therefore differ entirely both in origin and in finer structure from the "velar auditory vesicles" of the Leptomedusæ (§ 83) with which they were formerly usually confounded.

§ 86. Sense clubs ("rhopalia," *or*). We designate by this name the peculiar, "composite organs of sense," or "marginal bodies" of the Acraspedæ, which are always universal in this section, and only wanting in the lowest and oldest Acraspedæ, the Stauromedusæ. In place of rhopalia the Stauromedusæ have simple tentacles, and it seems undeniable from their whole structure, situation, and distribution that the rhopalia of the Acraspedæ are modified tentacles furnished with several different organs of sense. If we assume that the Tessera, the simplest and oldest among the known Acraspedæ, is the common ancestral form of this section (or at least does not differ essentially from the hypothetic ancestral form), the characteristic position of the sense clubs in three higher orders of the Acraspedæ is explained as follows:—Of the eight principal tentacles of Tessera the four interradial are transformed into rhopalia in the Peromedusæ (Pls. XVIII., XIX.), and the four perradial in the Cubomedusæ (Pl. XXVI.), whilst the four tentacles alternating with them remain unaltered. In the Discomedusæ, on the other hand, all the eight tentacles of Tessera have become sense clubs; in fact the majority of the Ephyroniæ have four perradial and four interradial sense clubs (Pls. XXVII.–XXXII.), and it is only in a few genera that their number increases secondarily from twelve to sixteen, rarely from twenty-four to thirty-two (System, pp. 364, 401, 427, 457). As the sense clubs of the Acraspedæ in this section have originated independently, and as even the four perradial rhopalia of the Cubomedusæ have been formed from "acoustic tentacles" independent of the four interradial sense clubs of the Peromedusæ, the former present no homology with the similar auditory clubs or cordyli of the Craspedotæ, but only a close analogy; they are distinguished from the latter by their more composite structure, and also by their protected position in special rhopalar niches (hence Steganophthalmæ). The rhopalar niches ("antra rhopalaria," Pl. XXX. figs. 2–4, *on*) are ectodermal cavities, which lie in most Acraspedæ on the umbrella margin, but which sometimes change their marginal position later on and migrate either on to the dorsal surface of the exumbrella (Cubomedusæ, Pl. XXVI.) or on to the ventral surface of the subumbrella (*Drymonema*, Pls. XXX., XXXI.). The sense niches or sense sinuses are enclosed on both sides, usually on their ventral or axial surface, by the paired "sense-folds," the axially projecting medial margins of a pair of sense lobes of the umbrella margin (rhopalar lobes); these "plicæ rhopalares" (*of*) are sometimes fused into a plate. On the other hand, the unpaired sense scale or protecting scale ("squama rhopalaris," *os*), originating from the marginal bit of the exumbrella, which originally formed a connecting bridge between the two sense folds, projects on the dorsal or abaxial side of the rhopalar niche as a protecting roof. In the convex dorsal surface of the protective scale, there is usually a cæcal funnel-shaped olfactory depression ("fossula olfactoria," *oz*) whose folded sense-epithelium is furnished with special flagellate cells (olfactory cells). The true sense club, which lies hidden in the niche, corresponds to a short, club-shaped hollow tentacle, whose "sense canal" ends in an otolite sac or "crystal sac" (Pl. XXX. figs. 4–7). The latter consists of a considerable, spheroidal or oval accumulation of crystalline concrements, which have been formed in the endoderm cells of the tentacle canal; it is enclosed in a fulcral sheath covered externally by the ectodermal epithelium, beset with long, stiff, auditory hairs. A peculiar tactile plate (?) whose rod-shaped tactile cells bear long flagella, is usually found at the proximal base of the auditory club on the axial ventral side, whilst on the abaxial dorsal side there is a visible pigment pad which is considered as an eye, and sometimes encloses a lens and sometimes not. These eyes appear to attain their highest development in the Peromedusæ and Cubomedusæ, in them we often find several eyes in each rhopalium, in which a crystalline lens and a retina with a large optic ganglion may be developed (System, pp. 401, 427; taf. xxiii., xxv., &c.,).

§ 87. In all Medusæ the muscular system is composed of two different principal sections, a circular, and a longitudinal system of fibres. Both form a thorough contrast, not only by their local distribution and by the direction of the course of their fibres, but also by their histological nature; the circular or transverse fibres are usually clearly striated, whilst the radial or longitudinal fibres are flat for the most part. By far the largest and most important part of the two systems belong to the subumbrella which functions chiefly as swimming organ. The muscular system of the umbrella margin and the tentacles generally proceeds from the subumbrella. On the other hand, the muscular system of the exumbrella, which is only very partially developed, is by no means important. Both the transverse and the longitudinal fibres are exclusively products of the ectodermal epithelium, with which they are still most closely connected (comp. above, §§ 51–53). Moreover, in some (perhaps all ?) of the Medusæ, weak (usually very unimportant) muscles which originate from the endodermal epithelium of the gastrovascular system appear on certain parts of the body. Certain circular muscles of the œsophagus and the muscles of the gastral filaments belong to these endodermal muscles, which as yet have been but little recognised and investigated. Although the two sections of the class of Medusæ have originated independently of one another, the differentiation of the muscular system show analogous conditions in both cases. In both the circular and the radial system of fibres we can generally distinguish three sections, of which the first occupies the central and proximal part, the second the middle part (the true umbrella in the more restricted sense), and the third the marginal or distal part (along with the marginal appendages).

Survey of the two muscular systems of the subumbrella.

I. System of Circular Muscles (composed of striated fibres, running transversely or circularly).		II. System of Radial Muscles (composed of smooth fibres, running longitudinally or radially).	
1. Proximal part of the circular muscular system.	1. "M. orbiculares," oral circular muscles (circular muscles of the œsophagus and the stomach).	1. Proximal part of the radial muscular system.	1. "M. proboscidales," proboscis muscles (longitudinal muscles of the œsophagus and of the gastral peduncle.
2. Middle part of the circular muscular system.	2. "M. coronares," coronal muscles (coronal pouches, &c.).	2. Middle part of the radial muscular system.	2. "M. codonoides," muscles of the bell (deltoid muscles, &c.).
3. Distal part of the circular muscular system.	3. "M. velares," velar muscles (circular muscles of the velum and the velarium).	3. Distal part of the radial muscular system.	3. "M. marginales," marginal muscles (longitudinal muscles of the tentacles and the marginal lobes.)

§ 88. Circular muscles of the subumbrella ("myosystema circulare"). The circular muscular system of the subumbrella is developed quite analogously in the two sections of the Medusæ class, and consists of transversely-striated muscles, running in horizontal transverse planes (perpendicularly to the principal axis). This system is divided into three different sections,—the proximal circular muscle of the œsophagus and the oral organs ("musculus orbicularis"), middle coronal muscle ("musculus coronaris"), and the distal circular muscle of the velum ("musculus velaris"). The circular oral muscle ("musculus orbicularis," *mo*) forms the proximal part of the circular system, and is generally the weakest of its three sections and also the most irregularly developed in the different groups. It only attains any considerable development in such Medusæ as are distinguished by a strong, movable œsophagus, or by large oral lobes or folded oral arms; for example, among the Craspedotæ, on the folded oral lobes of many Anthomedusæ and Leptomedusæ, on the raised lips, capable of extension into a large sucking-disk, of many Trachomedusæ (Pl. III. fig. 2; Pl. V. figs. 3, 4; Pl. VII., fig. 3, *am*); and on the very contractile and extensible œsophagus of many Narcomedusæ (Pls. IX.–XIV.); among the Acraspedæ on the oral lobes of the Stauromedusæ and Cubomedusæ (Pls. XV., XVII., XXVI.); on the buccal pouches of the Peromedusæ (Pl. XX. figs. 9–11), and on the oral arms of many Discomedusæ (Pls. XXX.–XXXII.). The second and middle section of the circular muscular system, the large coronal muscle ("musculus coronaris," *mc*) is much more important. It must be regarded originally in all Medusæ as the most important swimming muscle, and in most of them, it occupies the greater part of the subumbrella, from the distal margin of the orbicular muscle (or in others of the bell-muscle) to the proximal margin of the velar muscle. Its parallel and thickly compacted circular fibres sometimes run as uninterrupted rings on the whole subumbrella, or are sometimes divided by four, eight, sixteen or more radial septa into an equal number of separate plates. The coronal muscle is divided into four interradial plates in a large number of Craspedotæ; into eight adradial, *e.g.*, in the Cubomedusæ (Pl. XXVI.), into eight principal (four perradial and four interradial) plates in *Pericolpa* (fig. F), into sixteen subradial in the Pectyllidæ (Pls. IV., VIII.); in *Periphylla*, on the other hand, eight of the coronal plates are principal, and eight adradial (Pl. XIX.). Very often (namely, in the larger Acraspedæ) the supporting plate rises below the coronal muscle in the form of simpler or more complex circular folds, so that the muscular system lying above it commands a more extensive

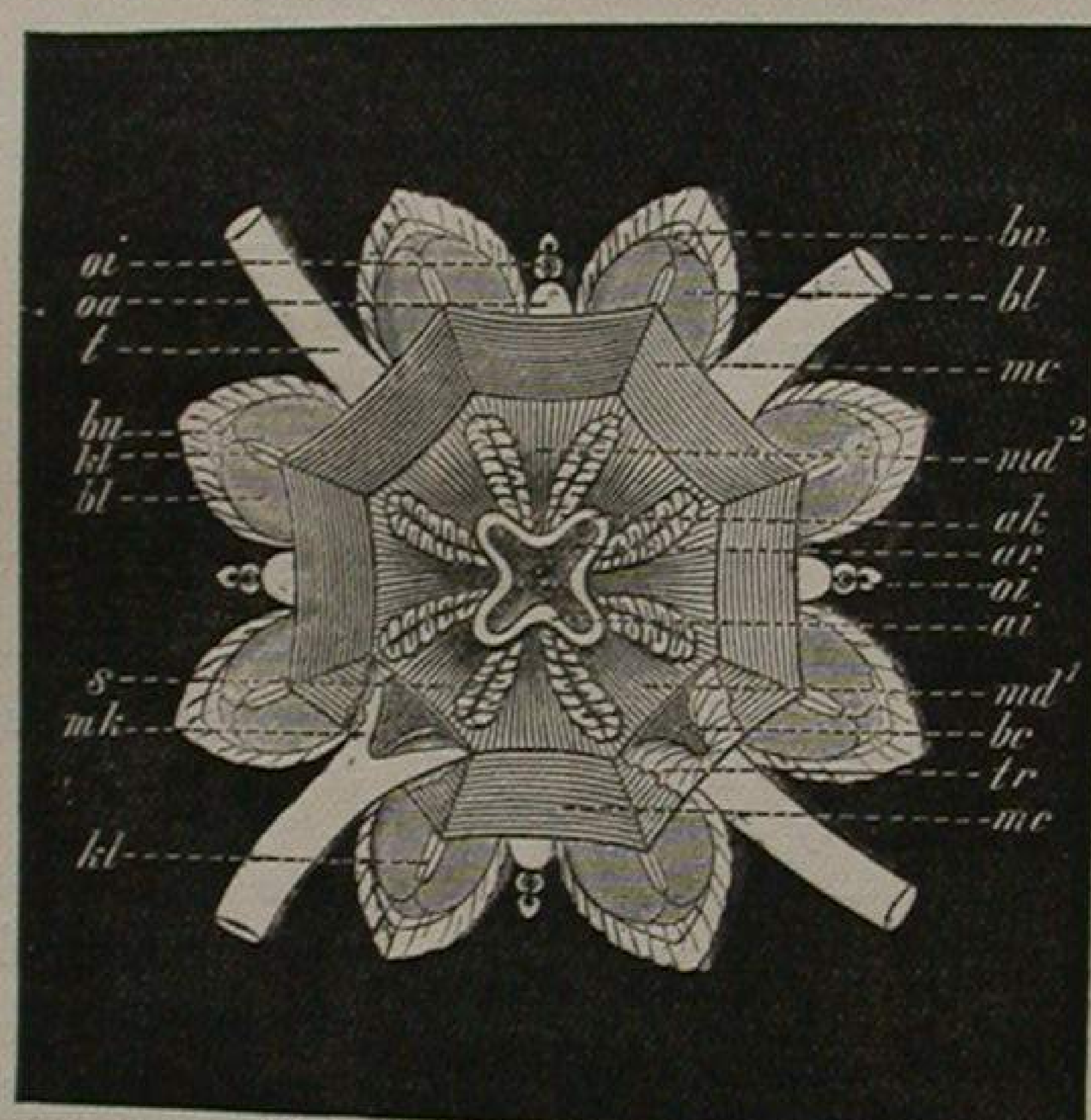


Fig. F. *Pericolpa quadrigata* (Peromedusæ, Pericolpidæ).
Subumbral aspect. (*oi*) Sense clubs (interradial). (*oa*) Ampulla at their bases. (*t*) Tentacles (perradial). (*bl*) Lobe pouches. (*bu*) Horseshoe-shaped canals of the pouches. (*kl*) Peronia between the two limbs of the canal. (*s*) Genitalia. (*mk*) Root-muscles of the tentacles. (*md*¹) Perradial deltoid muscles. (*md*²) Interradial deltoid muscles. (*ak*) Oral ribs. (*ar*) Oral grooves on their inner surface. (*ai*) Oral tæniola. (*tr*) Tentacle roots. (*bc*) Coronal pouches. (*mc*) Coronal muscles.

surface of insertions in a limited space (Pls. XIX.–XXII., *mc*). In most Craspedotæ, the coronal muscle is comparatively broader, and covers the larger part of the subumbrella as connected plates, whilst in most Acraspedæ it is narrower and more limited to their periphery; it is often forcibly thrust back by the deltoid muscles, which extend themselves at its expense (fig. F, *md*). The velar muscle ("musculus velaris") forms the third distal section of the subumbral circular muscular system. In the Craspedotæ it represents the most important element of the velum (Pls. IV.–XIV.) and is separated by the ventral nerve ring from the contiguous distal margin of the coronal muscle. It is represented in the Acraspedæ, by the analogous (but not homologous) coronal muscle of the velarium; it is most strongly developed in the Cubomedusæ (Pl. XXVI., *mv*). Comp. §§ 66–70.

§ 89. Radial muscles of the subumbrella ("myosystema radiale"). Whilst the circular muscular system of the Medusæ is almost invariable composed of transversely striated fibres, the radial muscular system in both sections of this class, is formed for the most part of smooth, not transversely striated, muscular fibres; these run in vertical meridian planes, sometimes more radially, sometimes more longitudinally, parallel to the principal axis. The radial muscular fibres are also divided into three sections analogous to those of the circular muscular fibres; the proximal longitudinal muscles of the œsophagus and of the oral organs, and also of the gastral peduncle ("musculi proboscidales"), the middle bell muscle ("musculus codonoides"), and the distal longitudinal muscles of the umbrella margin ("musculi marginales"). The system of the proboscidal muscles ("musculi proboscidales") forms the proximal part of the radial system; we may include in it, the true longitudinal muscles of the œsophagus and of the different oral organs (oral lobes, oral arms), and also the longitudinal muscles of the gelatinous gastral peduncle (*e.g.*, in the Octorchidæ System, taf. xii., xiii.; Geryonidæ, System, taf. xviii.); in proportion as the gastral peduncle is developed as a movable "proboscis," the four, six, or eight broad longitudinal bands of muscles, which run in its upper surface between the ascending radial canals, become more powerful. Of the longitudinal muscles of the œsophagus itself the four perradial are usually most strongly developed. They run on the four folded oral lobes or the large oral arms which have originated from them, on the abaxial side of their midrib, and radiate, often in bunches, towards their frilled oral margin. In most Medusæ the second and middle section of the radial muscular system, whose separate part we include under the name of bell muscles, is far more important. All the longitudinal muscles of the subumbrella which lie between the base of the "proboscis" and the umbrella margin belong to it. The bell muscle (like the coronal) not unfrequently (namely, in a part of the Narcomedusæ and Stauromedusæ) represents a single, bell-shaped, arched muscular plate, consisting of diverging radial fibres; it is usually divided into a number (four, eight, sixteen, or more) of separate longitudinal muscles. In most Craspedotæ four or eight such longitudinal muscles run on the subumbral surface of the radial canals, but often also four or eight in the middle between these. We consequently find usually four perradial longitudinal bands (*mp*) and four interradial (*mi*) between them, beside often eight adradial, rarely more. They are sometimes simple, unpaired bands, which run exactly in the middle line of the radial canals (*e.g.*, Pectyllidæ, Pls. III.–VIII.), sometimes paired bands, enclosing the two lateral margins of the canals (*e.g.*, Tiaridæ, System, taf. iv. figs. 2, 3). The subumbral radial muscles are most strongly developed in those Craspedotæ which form circumoral buttresses (mesenteries or mesogonia). Many Tiaridæ have four such perradial mesenteries, whilst the Pectyllidæ have eight principal mesenteries (Pl. IV. fig. 3, Pl. VIII. fig. 9, *wr*). They lie as four or eight thin, broad leaves in the principal radial planes, and run in the umbrella cavity, stretching freely from the subumbrella to the œsophagus; their longitudinal muscular fibres ("musculi mesenteriales") pass into the proboscis muscles, at the proximal margin of the mesogonia. Among the Acraspedæ the bell muscle of the Cubomedusæ usually comports itself like that of the Craspedotæ (Pl. XXVI.; System, taf. xxv. xxvi.). The subumbrella of the Tesseronia is on the whole almost cubical; its coronal muscle consists of four broad quadrangular (often almost quadrate or rectangular) muscular plates, which touch at right angles in the interradii. They are divided by four narrow, interradial longitudinal muscles, running along the four cathammal septa, but are halved in the middle by four broader perradial longitudinal muscles; the latter pass below upon four "frenula velarii" (Pl. XXVI. fig. 8, *vf*), above upon the mesenteries which run to the four corners of the stomach (Pl. XXVI. figs. 2, 3; System, taf. xxvi. figs. 2, 3, *gm*). In the remaining Tesseronia (both in the Stauromedusæ and the Peromedusæ) the three strong, broad triangular deltoid muscles (Pls. XV.–XXII. *md*) occupy the place of these narrow, band-shaped longitudinal muscles. The deltoid muscles spring with a broad base at the proximal margin of the coronal muscle (*mc*), and run with converging fibres towards the bottom of the umbrella cavity (fig. F, *md*). The four interradial deltoid muscles (*md*) are usually considerably stronger than the four perradial (*md*); the former are inserted at the four interradial cathammal nodes (*kn*), and often pass out above them as "intergenital muscles" (Pl. XX. fig. 8, *ms*); the latter are inserted at the four perradial palatine nodes (*gk*), and pass from them upon the mesenteries and the corners of the œsophagus. In the Ephyroniæ or Discomedusæ, those parts of the bell muscle appear much less important than in the Tesseroniæ, which is accounted for by the retrograde formation of the four perradial pouches, and by the extension of the broad umbrella corona. The eight deltoid muscles (and especially the four interradial) are pretty strongly developed only in a few Cannostomæ (as in *Atolla*, Pl. XXIX. fig. 3, and *Nauphanta*, Pl. XXVIII. fig. 12), whilst in most Discomedusæ they have undergone retrograde formation. We may therefore regard the four strong pillar muscles of many Semostomæ and Rhizostomæ as developments of the four perradial deltoid muscles; they pass at their proximal end into the four perradial proboscis muscles. The system of the marginal muscles ("musculi marginales") forms the third and distal section of the radial muscular system. Under the term "marginal muscles" we include all the longitudinal or radial muscles which are developed on the umbrella margin outside the circular coronal muscle. They are differentiated in many varied ways. The most important are the muscles of the tentacles and of the marginal lobes. The muscular fibres of the tentacles all run longitudinally in a great variety of arrangements.

§ 90. Muscular system of the exumbrella. Development of the muscular system appears entirely wanting on the upper or exumbral surface of the umbrella, when contrasted with its powerful and universal development on the lower or subumbral surface.

Closer investigation, however, shows that muscles are also developed here in some places, though but feebly, at least in some groups of Medusæ (perhaps in all ?), and then into both transverse and longitudinal cords of fibre. The principal exumbral circular muscles are the feeble zonal muscles ("musculi zonares," *mz*) which are found in some Craspedotæ above the umbrella margin, in others in the circular stricture between the umbrella and the apical process (*e.g.*, *Catablema*, System, taf. iv. fig. 4). They are more strongly developed in some Acraspedæ as, for example, in the visible zonal muscle of the Peromedusæ which divides the smooth umbrella cone from the pedal zone of the umbrella corona and sends out zigzag processes between its pedalia (Pl. XXIII. fig. 34, *mz*; Pl. XXIV. fig. 2, *mz*). Exumbral radial muscles are found in some groups (especially in the Trachomedusæ and Narcomedusæ), developed on the umbrella margin into peronial muscles ("musculi peroniales," Pl. XIII. fig. 7, *ml*; Pl. XIV. fig. 12, *ml*). Other, but feebler, longitudinal muscles appear in both sections here and there on the umbrella apex and on other places of the convex outer umbrella surface. Among the Craspedotæ, four perradial and four interradial longitudinal muscles are found in the peripheric (and sometimes also in the central part) in some Anthomedusæ; and among the Acraspedæ, in the Cubomedusæ. The longitudinal muscular bands of the tæniola and the strong peduncle muscles of the Stauromedusæ, also belong to this system (Pls. XVI., XVII. figs. 13, 14, *m*).

§ 91. Umbrella cavity or swimming cavity ("antrum, caverna umbralis," *h*). The umbrella cavity of the Medusæ is as characteristic for this class of urticating animals as the umbrella itself; it is enclosed above by the lower concave surface of the umbrella ("subumbrella"), whilst it opens freely below through the aperture of the umbrella cavity ("apertura antri"). The subumbral umbrella cavity is more or less vaulted, according as the umbrella is more umbrella shaped or more conical; its vaulted roof, which is lined by the ectoderm of the subumbrella, is, however, always flatter than the outer surface of the umbrella which is covered by the ectoderm of the exumbrella, for the gelatinous wall of peripheric umbrella corona is always thinner than the central umbrella cone. As by each contraction of the swimming Medusæ, the vaulting of the umbrella cavity becomes higher, its opening narrower, and water is ejected through the opening, whilst by each dilatation of the umbrella fresh water enters the flattened and widened umbrella cavity, the latter may be regarded physiologically both as a "swimming cavity" and a "respiratory cavity." The ectodermal epithelium of the subumbrella, which lines the umbrella cavity, is probably adapted for respiratory functions. The opening of the umbrella cavity ("apertura antri") is simple and surrounded by the corona of lobes in the Acraspedæ, whilst in the Craspedotæ it is narrowed by the velum, which projects freely inwards like a diaphragm, from the umbrella margin. In some Craspedotæ the velum is so broad, that it is probably capable of completely closing, for a while, the opening of the umbrella cavity, as in the Pectyllidæ (Pls. III.–VIII.). The central axial space of the subumbrella is occupied more or less by the œsophagus and the different organs of buccal stomach and also often by the genitalia.

§ 92. Niches of the umbrella cavity ("cavernulæ subumbrales"). In many Medusæ special secondary spaces are developed on the subumbral wall of the umbrella cavity, partly by the formation of folds or projections of the subumbrella, partly by the insertion of single organs into pit-like depressions and partly by peculiar conditions of growth of the umbrella margin and the "marginal bodies" lying on it. All these different secondary cavities of the umbrella cavity may be placed together as "niches of the umbrella cavity or subumbral niches" ("cavernulæ subumbrales"). In many Narcomedusæ, namely the Peganthidæ, the cavity of the umbrella corona is divided into a peripheric corona of separate "lobe cavities" ("cavernulæ lobares"), which surround the central umbrella cavity like the altar niches of a round temple (*Pegantha pantheon*, p. 37, Pls. XI., XII.). In *Pectis*, eight adradial "oral funnels or inner buccal pouches" ("cavernulæ buccales") are invaginated from outside into the œsophagus (p. 15, Pls. IV., V. figs. 4, 5, *io*). In many Cubomedusæ and Peromedusæ, namely, the Periphyllidæ, each tentacle is surrounded at its base by a subumbral tentacle funnel ("cavernula tentacularis"), over which the distal margin of the subumbral coronal muscle projects like a roof. In *Periphylla* (Pl. XIX. fig. 6, Pl. XX. fig. 8) it is simple; in *Periphema* (Pl. XXIV. fig. 1) it is divided into secondary funnels by a number of small frenula. In many Cubomedusæ, four perradial triangular subumbral folds pass as "frenula velarii" from the base of the sense niche and the vertical septum of the marginal pouches to the subumbral surface of the horizontal inwardly projecting velarium (Pl. XXVI. figs. 2, 3, 8, *vf*), so that two small velar niches ("cavernulæ velares") are inserted on each side of the velarium. In most Discomedusæ eight (more rarely sixteen) sense niches are formed on the umbrella margin for the reception of the sense clubs or rhopalia ("antra rhopalaria," comp. above, § 86). In some species, *e.g.*, in *Drymonema*, these stretch centripetally far into the subumbrella (Pls. XXX., XXXI., *on*).

§ 93. Coronal cavity of the umbrella and funnel cavity of the umbrella. In some Craspedotæ, or in many Acraspedæ, four or eight vertical folds of the subumbrella, the mesenteries ("mesenteria") are developed in the bottom of the umbrella cavity at the base of the œsophagus, and the upper part of the simple umbrella cavity is thus divided into four or eight separate cavities, the umbrella funnels or funnel cavities ("infundibula," *i*). We therefore term the lower, simple half of the umbrella cavity, which opens freely below at the umbrella margin, the coronal cavity of the umbrella ("antrum coronare"), and the upper quadrilocular or octolocular half as the funnel cavity of the umbrella ("antrum infundibulare"); the former communicate with the latter by four interradial or eight adradial funnel openings ("ostia infundibularia").

§ 94. Funnel cavities and mesenteries ("infundibula and mesenteria"). The four or eight funnel cavities or umbrella funnels ("infundibula," *i*), which compose the umbrella funnel cavity of many Medusæ, are hollow spaces, more or less conical and lined by the ectoderm of the subumbrella; they are always cæcal in the aboral bottom of the umbrella cavity, whilst they open into the coronal cavity of the umbrella by the roundish funnel openings ("ostia infundibularia"). The adjacent funnels are separated by thin vertical septa, the mesenteries ("mesenteria" or "mesogonia," *wr*). In one group only, the Pectyllidæ (Pls. III.–VIII.), there are eight mesenteries present (four perradial and four interradial) between eight adradial funnels. Otherwise there are invariably only four perradial mesenteries between four interradial funnels. The mesenteries or mesogonia are formed by the four perradial oral corners extending, like wings, in the bottom of the umbrella cavity and rising in the form of thin folds of the subumbrella. The further these folds pass towards the outside on the subumbral surface, and the further they pass downwards on the oral corners, the deeper are the intermediate funnel cavities. In the Craspedotæ, the mesenteries are always thin, delicate membranes, which serve chiefly for fixing the œsophagus (*e.g.*, among the Anthomedusæ in *Tiara* and *Turris*, System, taf. iii., iv.; among the Trachomedusæ in *Pectyllis* and *Pectanthus*, Pls. IV., VIII.). In the Acraspedæ, on the other hand, the mesenteries are often hollow, as the central gastral cavity arches into them like pouches, especially in part of the Lucernaridæ ("mesogonial pouches," "bursæ mesenteriales"). The funnel cavities are usually flat and insignificant in the Cubomedusæ (Pl. XXVI.), but very large and deep in the Peromedusæ. In the Periphyllidæ (Pl. XXI. figs. 12, 13, *ib*), they even ascend as far as the point of the umbrella cone, so that they touch the four interradial tæniola, in the centre point of the basal stomach (Pl. XX. fig. 8, *ib*). In such a case, the funnels hollow out the entire length of the four interradial tæniola, so that these solid ridges are transformed into hollow cones. The four interradial funnel cavities are peculiarly modified in the Discomedusæ, where they obtain special importance as "respiratory cavities" or "subgenital cavities."

§ 95. Subgenital cavities ("demnia," otherwise also called "respiratory cavities," "genital cavities," "umbrella cavities of the reproductive organs," "infundibula subgenitalia"). These four peculiar interradial cavities are only found in the order of the Discomedusæ, where they are in part developed and transformed into peculiarly shaped hollow spaces. Fundamentally they are merely subumbral funnel cavities, which have acquired a varied form and function by special adaptation (namely in their relations to the genitalia). Whilst in the three orders of the Tesseroniæ, the four funnels usually rise as slender, hollow cones, corresponding to the conical or pyramidal form of the high, vaulted umbrella, in the Ephyroniæ or Discomedusæ, on the contrary, they extend on the lower surface of the umbrella, in the form of low pouches, in correlation to its flat discoid shape. In this order the subumbral wall of the flat, wide gastral cavity is, at the same time, the place of origin of the reproductive glands, and forms a delicate thin-walled "gastrogenital membrane" (*gg*), in which the four interradial (in the Cannostomæ sometimes eight adradial) reproductive bands are developed. The gelatinous supporting plate of the subumbrella is often thickened round these genitalia in the form of a firm, cartilage-like subgenital ring ("annulus subgenitalis"). If the genital band increases considerably and the delicate gastrogenital membrane round it becomes folded repeatedly, the latter may undergo a double change of position. It either passes below through the firm subgenital ring, which does not extend in an equal degree, into the umbrella cavity, thrusts itself out like a projecting hernia and so forms four pendant external gastrogenital pouches whose cavities are lined by endoderm ("extraversio gonadum,"

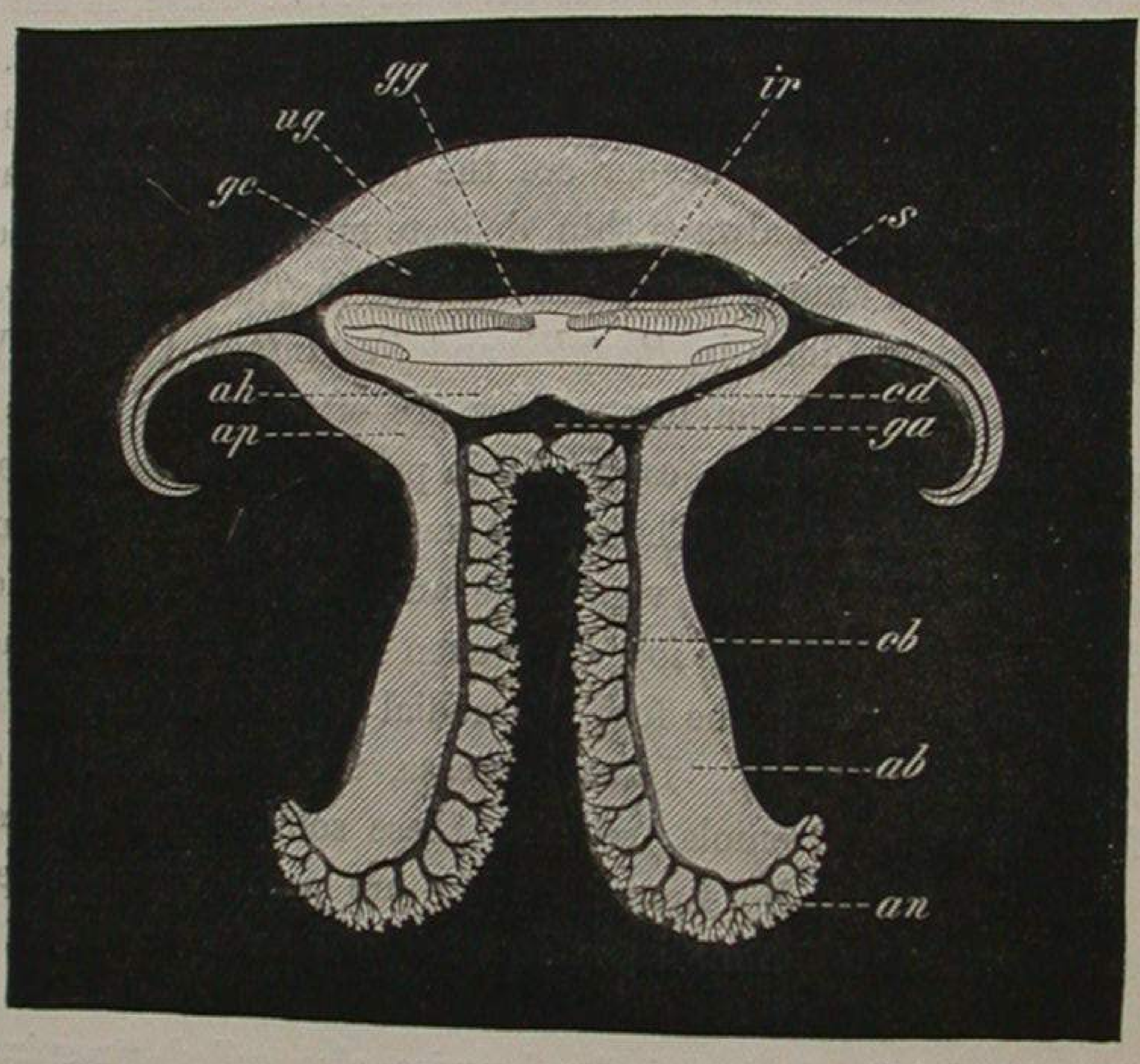


Fig. G. *Cannorhiza connexa* (Discomedusæ, Versuridæ).
Adradial section. (*ug*) Gelatinous umbrella. (*gc*) Central stomach. (*gg*) Bottom of the central stomach (gastrogenital membrane with the genitalia, *s*). (*ir*) Subgenital porticus. (*ah*) Brachiferous plate. (*ap*) Arm pillars. (*cd*) Pillar canals. (*ga*) Buccal stomach. (*ab*) Oral arms (adradial). (*cb*) Brachial canals. (*an*) Funnel frills (sucking mouths).

System, p. 470), as, for example, in the Cyaneidæ (Pls. XXX. XXXI., *gg*) or, reversed, the increasing folded gastrogenital membrane, along with the genitalia attached to it, does not pass through the subgenital ring, but invaginates into the central gastral cavity, like a replaced hernia (as, for example, in the Aurelidæ, System, taf. xxxiii. fig. 7). It then forms four "inner subgenital cavities," lined with the ectoderm of the subumbrella ("introversio gonadum," System, p. 470). These are, however, merely flattened funnel cavities; the "ostium subgenitale," which may be compared to the "hernial opening" ("porta herniæ subgenitalis"), is the narrow opening of the subgenital ring, which leads from the coronal cavity of the umbrella into the four funnel cavities (compare the detailed description in the System der Medusen, 1879, pp. 467–473). Whilst the four subgenital cavities remain separate in most Discomedusæ furnished with them (Tetrademniæ), in part of the Rhizostomæ (Monodemniæ) they are fused in the centre into a single common "subgenital vestibule."

§ 96. Subgenital vestibule ("porticus subgenitalis, syndemnium," *iz*). The peculiar and remarkable hollow space, which we have termed "porticus subgenitalis" (System, 1879, p. 472), is only found in the middle of the subumbrella in two families of the Rhizostomæ, the Versuridæ (System, taf. xl.) and the Crambessidæ (System, taf. xxxviii., xxix.), which we have therefore united into the section of the Monodemniæ. This central subgenital vestibule has arisen from the four interradial, subgenital cavities already described, growing centripetally as far as the middle of the central gastral space, and entering there into immediate communication (Pl. XXXII., and woodcut, fig. G). The delicate gastrogenital membranes (*gz*) which form the thin wall of the invaginated subgenital pouches, touch in the central axis of the gastral cavity and become fused together; these points of fusion are then broken through and the four subgenital cavities, which were originally separated, are consequently fused into one. The cruciform central subgenital vestibule formed in this way (Pl. XXXII, fig. 2, *iz*) is completely lined by the ectoderm of the subumbrella, and only opens to the outside by four interradial portals, the "subgenital ostia" (figs. 1, 7, *ig*). Its upper wall or the vestibule roof ("paries porticus gastralis") is formed by the delicate gastro genital membrane (*gg*) which separates it from the overlying gastral cavity (*gc*) and bears the four genitalia (*s*); its lower wall, or the "vestibule floor," is formed by the peculiar brachiferous disk ("discus brachiferus") from which the eight adradial oral arms of the Rhizostomæ depend, and in the middle of which below we find the suture of the oral cross (Pl. XXXII., figs. 2, 6, 7, *ah*). The two walls are only connected by the four perradial vestibule pillars ("pilastri," *ap*). These are four strong gelatinous columns, placed between the four narrower or wider subgenital openings. The four simple pillar canals (fig. 2, *cd*) which represent the only connection between the upper central stomach (*gc*) and the lower buccal stomach (*ga*) along with the arm canals (*eb*) proceeding from it, run perradially upwards in these columns.

IV. GASTROVASCULAR SYSTEM OF THE MEDUSÆ.

§ 97. Composition of the gastrovascular system. Of the two large organic systems composing the body of the Medusa, the gastrovascular system includes the complex of the vegetative organs, the apparatus for nutrition and reproduction, and is, therefore, physiologically opposed to the neurodermal system, which forms the complex of the animal organs. This antithesis is shown histologically in relation to the two primary germinal layers, as the majority and more important parts of the gastrovascular system originate from the endoderm (or "vegetative germinal layer"), whilst those of the neurodermal system, on the contrary, originate more usually from the ectoderm (or "animal germinal layer"). The apparatus of nutrition, formed by the principal intestine (stomach along with the oral organs) and the radial coronal intestine proceeding from it (vascular corona or pouch corona), is by far the more considerable and widely differentiated of the two apparatuses composing the gastrovascular system. The apparatus of reproduction is much simpler and less differentiated; it consists solely of the sexual glands or genitalia, which are developed in the subumbral wall of the gastrovascular system.

§ 98. Hollow space and walls of the gastrovascular system. The entire gastrovascular system of the Medusæ, in spite of its numerous and important modifications in different groups, shows everywhere one and the same essential type of formation. It appears everywhere as a more highly developed formation of that simple gastral hollow space, which is met with in the lowest polyps (*Hydra*, *Clava*, &c., among the Hydropolyps; *Scyphostoma*, *Spongicola*, &c., among the Scyphopolyps). The primitive, perfectly simple gastral cavity of these oldest polyps is nothing more than the original primitive intestine ("archigaster, archenteron") of the gastræa, which still forms the common ontogenetic base for the intestinal system in the gastrula of all Metazoa; its simple opening is the primitive mouth ("archistoma, blastoporus). We distinguish the two walls of this primitive intestine of the polyps as the aboral calyx wall ("paries calycinalis, calyx") and the oral peristomal wall ("paries peristomalis, peristomium"); the two pass immediately the one into the other at the margin of the calyx ("margo calycinalis"). In the Medusæ, the notumbrella corresponds to the calyx on the one hand and the cœlumbrella to the peristomium on the other; we, therefore, term the calyx wall of the gastral space the dorsal wall ("paries umbralis" or "dorsalis") and the opposite inner or peristomial wall the ventral wall ("paries subumbralis" or "ventralis"). The endodermal epithelium of the former is always formed of small flat flagellate cells, that of the latter of large high flagellate cells (§ 47).

§ 99. Principal intestine and coronal intestine ("axogaster et perogaster"). In all Medusæ the gastrovascular system or intestinal system is divided first of all into two different principal sections, into a central and a peripheric part. For brevity we shall term the former the principal intestine, and the latter the coronal intestine. The central principal intestine ("gaster principalis, axogaster") is simple and undivided, its axis is at the same time the principal axis of the whole body, the umbrella cone (or centre of the gelatinous umbrella disk) lies at its aboral pole, the oral opening, at the oral pole. The peripheric coronal intestine ("gaster coronaris, perogaster"), on the other hand, is always divided by radial septa (or cathamma), into four or more radial cavities (pouches or canals). The ideal, circular or polygonal boundary line between the principal intestine, and the coronal intestine is consequently defined by the proximal ends of the septa or cathamma; the gastral openings ("ostra gastralia," *go*) lie between them. These narrow or wider fissures are the only openings by which the central principal intestine communicates with the divisions of the radially divided coronal intestine.

§ 100. Cathamma or fused parts. (Fusions of the two walls of the umbrella or of the dorsal and ventral umbrella; septa of the gastrovascular system). The only essential difference between the more simple gastrovascular system of the polyps, and the more composite system of the Medusæ derived from them, consists in this, that the peripheric part of the latter is divided by radial septa into a number, four at least, of radial divisions (pouches or canals). These radial pouches and radial canals were formerly erroneously supposed to be collective evaginations of the central gastral cavity, which had grown from its margin into the solid peripheric part of the umbrella. Now we know that these radial hollows have rather arisen from the fusion at definite points (and first of all, at four interradial points) in the periphery of the simple gastral space of its two walls (the umbral dorsal wall and the subumbral ventral wall). These concrescentiæ or cathammata (*k*) form the radial septa of the peripheric gastrovascular system, between which the remains of the originally simple cavity remains open. Corresponding to the origin of these septa or cathamma is a double, narrow, fused layer of endoderm cells, the cathammal plates are found originally in the middle of their solid gelatinous mass.

§ 101. Cathammal plate ("lamina cathammalis," *dk*; endoderm lamella, gastral fused plate, vascular plate). The "endoderm lamella," which on account of its origin and meaning we term cathammal plate, remains intact in all Medusæ in the interior of the cathamma or septa, and keeps up continous connection between the hollow spaces of the gastrovascular system, separated by the septa. The cathammal plate consists originally of a double layer of endoderm cells (Pl. XXV. figs. 8, 10); the outer or abaxial layer (the "umbral endoderm lamella," du^2) belongs to the dorsal epithelium of the coronal intestine, and originally lined the concave inner surface of the notumbrella (figs. 8, 9, *ug*), whilst the inner or axial layer (the "subumbral endoderm lamella," dw^2) belongs genetically to the ventral epithelium of the coronal intestine, and formerly covered the convex outer surface of the cœlumbrella (figs. 8, 10, *zw*). Sometimes (as for example, very distinctly in the firm septal nodes of the Peromedusæ, Pl. XXV. fig. 8, 10), both layers of the cathammal plate remain distinct during the life of the Medusæ, and can even be artificially separated (by suitable pressure) in fine transverse section. This is however not usually the case. Only a single thin layer of cells is generally visible in the connective tissue of the cathamma, as the two endoderm plates, which were originally separate, have become completely fused together. A considerable hardening and thickening of the two connective plates usually takes place in the cathamma on both sides of the endoderm plates, and the soft gelatinous tissue is sometimes even transformed into true firm fibrous cartilage (Pl. XXV. figs. 8, 10, wg^2, zw^2).

§ 102. The three principal forms of the cathamma (*k*). The fusion of the two walls of the gastral space, which give rise to the cathamma or septa, may appear in three principal forms, according as they take place in a point, a line, or a surface. In all three cases the original number of the cathamma amounts to four, and these four primary septa lie interradially (in the middle between the four primary tentacles), whilst the four primary radial cavities separated by them lie perradially (in the same meridian planes as the four primary tentacles). The number of the cathamma may, however, be considerably increased secondarily (corresponding to variations of the homotypical fundamental numbers already mentioned, §§ 23–26). In the most simple case when the concrescence takes place in four points, four septal walls are found ("nodi cathammales," *kn*) as in part of the Stauromedusæ and in all Peromedusæ. The peripheric hollow space of the gastrovascular system then appears as a large coronal sinus ("sinus coronaris"), whose division into four is only indicated by the four small nodes (Pls. XV., XX., XXV.). In the second case, when the fusion takes place in four lines, four septal ridges ("limites cathammales," *kw*) are found as in most Stauromedusæ, all Cubomedusæ, and part of the Discomedusæ (Cannostomæ, and half of the Semostomæ, Pelagidæ, and Cyaneidæ); the peripheric hollow space of the gastrovascular system then forms four radial pouches ("bursæ radiales"), which are separated by the narrow ridges (Pls., XVI., XVII., XXVI.). In the third case, when the fusion takes place in four surfaces, four septal plates ("tabulæ cathammales," *kt*) are formed; as most Craspedotæ, and among the Acraspedæ, in part of the Discomedusæ (in half of the Semostomæ: in the Flosculidæ, and Ulmaridæ, and in all the Rhizostomæ) (Pls. I., II., XXXII.).

§ 103. Cathammal fissures ("antra septalia"). In the order of the Anthomedusæ (and in this only) there appears frequently, if not universally, a partial dissolution of the cathamma, and consequently a local separation of the two fused umbrella walls, by which the peculiar cathammal fissures or septal cavities of these Craspedotæ are originated. In all the cases hitherto observed, they appear as eight adradial cavities, which are completely closed, and contain a gelatinous fluid. They occupy the greater part of the subumbrella, are limited below by the umbrella margin, above by the base of the œsophagus, and are separated from one another by the eight band-shaped longitudinal muscles of the subumbrella, of which four run perradially on the axial side of the four radial canals, and four interradially between the latter (Pls. I. fig. 2, *mi*). The abaxial wall of the cathammal fissures is formed by the thin cell layer of the dorsal endoderm lamella, which lies on the concave inner surface of the notumbrella, whilst its axial wall is formed by the supporting plate of the cœlumbrella, of which the ventral endoderm lamella is lost. The septal cavities are remarkably developed, for example, in *Codonium* and *Sarsia* among the Codonidæ, in *Tiara* and *Catablema* among the Tiaridæ, in *Cytacis* and *Rathkea* among the Margelidæ, &c. They have been hitherto erroneously regarded as cœlome fissures, and placed along with the true body cavity ("cœloma") of the higher animals. Such a cavity does not, however, exist in the Medusæ any more than in other urticating animals. The septal cavities of these Anthomedusæ rather arise from the two fused cathammal plates between the eight principal radial lines becoming parted secondarily, and only remaining fused in these eight lines. From this we see most clearly that the cathammal plates pass continuously into the endoderm layer of the radial canals, where these touch the lateral margins of the septal cavities. On the other hand, the cathammal plates are completely separated from the ectoderm of the umbrella, externally by the gelatinous body of the notumbrella, internally by the supporting plate and muscular plate of the cœlumbrella.

§ 104. Gastrovascular system of the Craspedotæ and Acraspedæ. The two sections of the class Medusæ show differentations, which are perfectly analogous, in the formation of their gastrovascular system, but still present, in spite of all similarity, a constant and therefore very essential difference. In all the Acraspedæ, movable gastral filaments ("filamenta gastralia"), or "internal gastral tentacles," are found on definite places, whilst these are never present in the Craspedotæ. In the Acraspedæ there are at least four of these gastral filaments, which are regularly distributed interradially. They are, however, generally very numerous (usually over a hundred, often over a thousand), and arranged in such a manner as to form four interradial groups of filaments ("phacelli"). The movable filaments of these phacelli are sometimes arrayed in a single row, sometimes in several rows; they are sometimes simple, sometimes branched, and always consist of a solid, cylindrical or band-shaped gelatinous filament (a process of the fulcrum) covered with endodermal epithelium. The phacelli of the Acraspedæ (or "Phacellotæ") are, therefore, of great phylogenetic importance, as indications of them already exist in the polyp nurses of this section. The Scyphopolyps, from which the Acraspedæ are descended, have all four interradial gastral ridges or gastral tæniola on the inner surface of the wall of the stomach, and from these the "filaments" of the "Scyphomedusæ" are developed.

§ 105. Tæniola or gastral ridges ("tæniola gastralia," *ft*). The phylogenetic hypothesis (§ 6) that the two sections of the class Medusæ have arisen independently of one another from two different groups of polyps is fundamentally supported by the fact that the important difference in their gastral formation mentioned above (their being with or without gastral filaments) is already present in the corresponding sections of the class Polypi, from which the Medusæ are descended. The lower Hydropolyps (from which the Craspedotæ or Hydromedusæ) are descended, never possess the four characteristic interradial tæniola of the Scyphopolyps, although similar longitudinal ridges of the inner gastral wall (more irregular in number, form and position) are also found in some Craspedotæ (Tubulariæ, &c). On the other hand, the higher Scyphopolyps from which the Acraspedæ (or Scyphopolyps) are descended, are all originally distinguished by the presence of the four interradial tæniola (also called "gastral walls, mesenteric swellings, longitudinal ridges, longitudinal walls, longitudinal swellings of the inner gastral wall"). These longitudinal gastral ridges (which are also universal among the corals as the so-called mesenteric filaments or mesenteric bands, more properly "gastral bands"), appear originally in the Scyphopolyps as four interradial rib-like thickenings of the gelatinous supporting plate or fulcral lamella; they project from the inner surface of the gastral wall freely into the gastral cavity, and in this way divide its peripheric hollow space into four perradial niches or grooves (Pl. XV. figs. 2, 3, 7, 8, *ft*; Pl. XVII. figs. 13, 14, *ft*). They usually contain a longitudinal muscle (Pl. XVII. fig. 13, *m*) and are always covered by endodermal epithelium.

§ 106. Dorsal and ventral tæniola ("tæniola notumbralia" and "cœlumbralia"). As the tæniola or gastral ridges of the Scyphopolyps are developed over the whole extent of their gastral surface and originally (in *Scyphostoma*, *Spongicola*, &c.,) run from the aboral to the oral pole, from the foot plate of the peduncle to the margin of the mouth, we must divide them into two principal sections, a notumbral part and a cœlumbral part; these two pass into one another at the peristom margin or calyx margin of the Scyphopolyps (corresponding to the umbrella margin of the Scyphomedusæ). The notumbral or dorsal tæniolum reaches from the aboral base or point of the cone to the peristomial margin or umbrella margin, and is a ridge-like thickening of the calyx or "notumbrella" (covered with dorsal endoderm). The cœlumbral or ventral tæniolum reaches from the peristomial margin to the umbrella margin, and is a ridge-like thickening of the "cœlumbrella" covered with ventral endoderm. The cathamma or septa of the Acraspedæ (*k*) are formed at the points where the two portions of the tæniola, the dorsal and the ventral ridges, come in contact and become fused.

§ 107. Gastral filaments (mesenteric filaments, internal gastral tentacles, *f*). The characteristic "gastral filaments" of the Acraspedæ, which are universally present in them and totally wanting in the Craspedotæ, are originally papillæ or excrescences of the tæniola. We immediately perceive from such Acraspedæ, in which the tæniola persist in their original form (especially Stauromedusæ) that the filaments are originally parts of the tæniola (*Tesserantha*, Pl. XV.; *Lucernaria*, Pl. XVI., XVII). This is also the case in the strobilation of the Discomedusæ, where the separate parts of the four strobila tæniola are immediately transformed into the four primary filaments of the Ephyrula

Medusa which detaches itself from the strobila (fig. A, *fp.*). Corresponding to this origin, each filament consists of a solid (sometimes cylindrical, sometimes flattened) gelatinous filament or fulcral papilla, which is simply a papillose or digital excrescence of the supporting plate of the tæniolum. The endodermal epithelium of the latter passes directly on to the filament and consists partly of flagellate cells, partly of glandular cells (calyx cells) to which thread cells and (perhaps universally ?) delicate muscular epithelial cells are often added (comp. Pl. XXII. figs. 23–26). The movable gastral filaments of the Medusæ are usually simple, more rarely branched dichotomously or even pinnated (Pl. XXVI. fig. F, *f*).

108. Phacelli, or groups of filaments. It is only in the simplest and oldest genera of the Acraspedæ (*Tessera*, System, taf. xxi.; *Ephyra*, taf. xxvii.) that the filamental

Fig. H. *Procharagma prototypus* (Cubomedusæ, Charybdeidæ).

Horizontal transverse section below the stomach, whose subumbral wall (*gc*) is completely visible, in the middle, the oral opening (*a*) with the four perradial oral lobes (*al*). The gastral filaments (*f*) are placed upon the four interradial pyloric valves (*gy*). (*gw*) Subumbral wall of the two gastral pouches (*bp*). (*s*) Genitalia. (*ug*) Gelatinous substance of the umbrella.

products of the tæniola are limited to the simple gastral filaments (lying immediately on the four interradial cathammal nodes), and also in the young larvæ of other Acraspedæ, *e.g.*, in the Ephyra larvæ of *Aurelia*, there are at first only four such simple filaments (fig. A, *fp.*). In all other Acraspedæ numerous filaments are present, which form separate "groups of filaments" or phacelli. There are always originally only four interradial phacelli (fig. D, *f*); these have arisen by division of the four originally simple filaments, or by repeated production of filaments from the tæniola. Instead of the four interradial, there are often eight adradial phacelli, which have arisen by bifurcation of the former, and are, therefore, more accurately, four pairs of phacelli. These are usually united in pairs at the proximal end, whilst they diverge at the distal end. The distal division of the eight phacelli is strongest in the Periphyllidæ, where the four tæniola are hollowed to their aboral ends by the four endodermal conical funnel cavities of the subumbrella (Pls. XXI., XXII.). The phacelli sometimes form straight lines, sometimes arches more or less waved and have often a complicated course as in Periphyllidæ (Pls. XXI., XXII). The tæniola may form phacelli in all the three chambers of the principal intestine; in most Acraspedæ the formation of them is limited to the central stomach. In the Peromedusæ and in some Stauromedusæ, they are

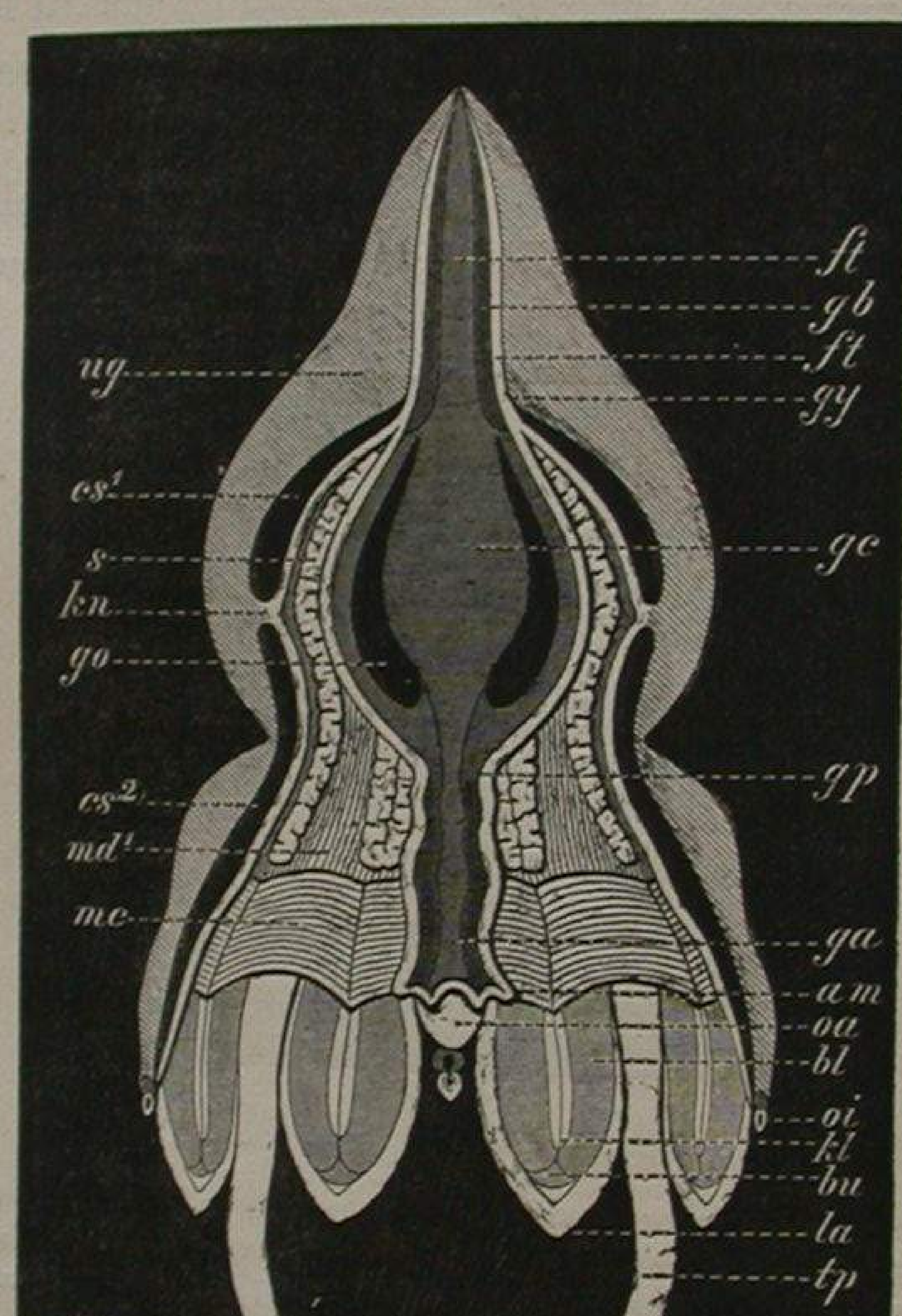


Fig. I. *Pericolpa quadrigata* (Peromedusæ, Pericolpidæ).
Interradial section. (*ug*) Gelatinous umbrella. (*cs*) Coronal sinus (*cs'* proximal part, *cs*² distal part). (*s*) Genitalia. (*kn*) Cathammal nodes. (*go*) Gastral openings. (*md'*) Deltoid muscles. (*mc*) Coronal muscle. (*ft*) Tæniola. (*gb*) Niches of the basal stomach between the tæniola. (*gy*) Pylorus. (*gc*) Central stomach. (*gp*) Palatine opening. (*ga*) Buccal stomach (œsophagus). (*am*) Oral margin. (*oi*) Sense clubs (interradial). (*oa*) Ampullæ at their base. (*bu*) Horseshoe-shaped canal of the marginal lobes (*la*). (*kl*) Peronia between the two limbs of the canal (*bl*). (*tp*) Tentacles (perradial).

strongly developed in the basal stomach, in the Cubomedusæ and Peromedusæ in the buccal stomach: their terminal processes are the barbous filaments of the Peromedusæ (Pl. XX. figs. 9–11, *af*). In the Discomedusæ, the phacelli assume a definite topographical (and perhaps also physiological) relation to the reproductive glands; they lie there on the inner surface of the subumbral gastral wall, on the inner or axial margin of the frill-shaped, folded genitalia, whose winding course they follow.

§ 109. The three chambers of the principal intestine ("gaster principalis"). The central principal intestine of the Medusæ is rarely perfectly simple, it is usually divided more or less distinctly into two or three sections or chambers, lying one above the other in the principal axis of the body. The lowest of these is the œsophagus or buccal stomach ("gaster buccalis," fig. I, *ga*), which contains the oral opening at the oral pole of the principal axis. The middle chamber is the principal cavity or central stomach ("gaster centralis," *gc*). The third or uppermost section is the peduncle tube or basal stomach ("gaster basalis," *gb*), which ends cæcally at the aboral pole of the principal axis. The central stomach communicates with the basal stomach, below by the palatine opening ("porta palatina," *gp*), above by the pyloric opening ("porta pylorica," *gy*); besides these there are usually gastral openings ("ostia gastralis," *go*), in the lateral walls of the central stomach, by which the latter communicates with the radial chambers of the coronal intestine. All the three stomachs are well developed in many Medusæ of both sections (namely Anthomedusæ and Peromedusæ); the uppermost (basal) stomach has, however, usually undergone retrograde formation. In the majority of Medusæ, the buccal stomach is the longest, the central stomach the broadest of the three chambers, whilst the basal stomach is the smallest or has disappeared. All the three chambers can be already distinguished in many polyps (both Hydropolyps and Scyphopolyps). The buccal stomach of the Medusæ corresponds to the freely projecting proboscis ("tubus oralis") of the polyps, the central stomach to their peculiar "calyx stomach" ("cavitas calycina"), and the basal stomach to their peduncle tube ("tubus peduncularis").

§ 110. Buccal stomach or œsophagus ("gaster buccalis," also termed "tubus oralis, proboscis, manubrium," *ga*). The buccal stomach or œsophagus (*ga*) is the first and lowest of the three chambers of the principal intestine. It is evolved from the "œsophagus" or "proboscis" of the polyps, and shows extraordinary diversity of size, form, and differentiation. It originally bears the oral opening (*aa*) at the oral pole of its vertical axis, whilst it opens at the aboral pole of the axis into the central stomach (*gc*) by the palatine opening (*gp*); the latter is sometimes sharply defined, sometimes indistinct. The palatine opening is usually found in the middle of the subumbrella, so that the œsophagus hangs freely from the latter into the umbrella cavity. In the majority of the Medusæ, the œsophagus is the longest, but not the broadest of the three gastral chambers. It is developed exceptionally strongly in the Anthomedusæ, Trachomedusæ, Peromedusæ, and Discomedusæ, whilst in the other orders it is usually weak or often quite rudimentary. The œsophagus rarely forms a simple cylinder without radial division (as in the Codonidæ, System, taf. i., ii.; and in many Narcomedusæ, System, taf. xix. xx.). In the majority of Craspedotæ, and in all Acraspedæ, the œsophagus is prominently quadrilocular, as the four perradial buccal ribs ("costæ orales," *ab*) have a tendency to centrifugal growth, project towards the outside, and become prolonged into the midribs of the oral lobes, whilst the four intermediate buccal columns ("columnæ orales," *ac*) have a tendency to centripetal growth, project inwardly, and end below in the archings of the oral margin.

§ 111. Oral opening ("actinostoma, apertura oris, osculum," *aa*). In all Medusæ, the mouth is originally a simple, usually quadrate or cruciform opening at the lower end of the buccal stomach. Its margin, however, rarely continues perfectly simple, different organs being commonly developed from it, of which the four perradial oral lobes and the oral arms, which have arisen from their prolongation, are by far the most usual and the most important (§ 113). The terminal oral opening itself in the Medusæ usually shows the same characteristic cross figure as the transverse section of the œsophagus, the typical oral cross ("stomostaurus"), with four limbs projecting perradially and four intermediate angles projecting interradially (Pl. I. figs. 2, 4; Pl. XV. figs. 5, 6, &c.). The perfectly constant position of this oral cross is very important for the orientation of the transverse axes. The free oral margin or the margins of the oral arms are usually strongly armed with thread cells, which are often placed in special regularly distributed groups (Pl. I. fig. 4). As the gelatinous supporting plate below these groups of thread cells is arched conically or hemispheroidally, oral urticating papillæ or urticating knobs are formed (oral papillæ, "papillæ orales," *e.g.*, in *Pelagia*). If these grow in length, they become developed into the tentacle-like, cylindrical movable filaments, which serve, like the true (marginal) tentacles, both for feeling and for seizing upon prey. The structure of these oral tentacles or oral fingers ("digitella") completely resembles that of the inner "gastral tentacles," or gastral tentacles (§ 107) with which they were formerly often confounded ("oral filaments"). But the epithelium, which covers the solid gelatinous axis of the two analogous organs, belongs to the endoderm in the gastral filaments and to the ectoderm in the oral digitella. In many Semostomæ (*e.g.* *Aurelia*) and in all Rhizostomæ, a large number of digitella beset the margins of the oral arms. The oral styles ("stomostyli") are apparently similar, but essentially different organisms. They are developed principally in the Anthomedusæ, where they characterise the families of the Margelidæ and Dendronemidæ (System, p. 70, taf. v.–vii.). In structure they completely resemble the solid marginal tentacles, and consist of a cylindrical axis, formed of a single row of endodermal chordal cells (Pl. I. fig. 5, *d*); these are separated by a firm, elastic supporting plate (*z*), from a thin muscular plate (*m*), whose longitudinal fibres are connected with the ectodermal epithelium (*q*); the free distal end bears a spheroidal urticating knob (*m*). There are originally only four simple oral styles present at the four perradial oral angles (*Cytæis*, *Lizusa*, System, taf. v.–vii.). The œsophagus is sometimes prolonged secondarily into a long pendant proboscis, so that the oral styles, which were originally terminal, are found at its base (*Thamnostylus*, Pl. I. fig. 1; *Limnorea*, *Nemoposis*, System, pp. 86, 92, taf. v.).

§ 112. Buccal pouches and oral columns ("bursæ buccales" et "columnæ orales"). In some Medusæ of both sections, the thin, extensible walls of the œsophagus are extended into large evaginations, which project centrifrugally to the outside (into the umbrella cavity), and may be compared from their form and function to the buccal pouches of many mammalia (*bb*). We term the thicker parts of the oral wall, which project inwardly centripetally between them, the oral columns (*ac*). The buccal pouches are most strongly developed among the Acraspedæ in the Peromedusæ, where they form four powerful perradial archings outward of the large buccal stomach and appear inflated hemispheroidally or even spheroidally (as in *Periphylla*, Pls. XVIII.–XXV., *bb*). Each single inflated buccal pouch is sometimes more voluminous here than the whole central stomach. The four thick intermediate, interradial oral columns (*ac*) project internally with their axial surfaces extended like wings, in such a way, that the adradial side spaces of the four buccal pouches form special niches or wing pouches behind these oral wings (*ad*, comp. also System, p. 405, taf. xxiv. fig. 14). Among the Craspedotæ the buccal pouches are most strongly developed in the Trachomedusæ, whose œsophagus is often highly extensible. *Pectis* (Pl. V. figs. 2–5; Pl. VI. fig. 11) has sixteen subradial buccal pouches, which are developed in pairs from four perradial and four interradial evaginations of the œsophagus, and are separated by eight adradial subumbral oral funnels (Pl. V. fig. 5, *io*). Other Trachomedusæ have eight adradial buccal pouches (formed by the division of four perradial).

§ 113. Oral lobes and oral arms ("lobi orales," *al*; "brachia oralia," *ab*). In the majority of Medusæ the oral margin is not simple, but its four perradial corners are prolonged into four leaf-shaped oral lobes or oral arms, between which four interradial oral sinus or oral incisions ("sinus orales") project internally. The four oral lobes have usually the shape of a thin oral leaf, whose delicate margins are folded more or less, often very daintily, whilst a strong midrib projects in the middle (as distal end of the perradial oral corner). The supporting plate of this midrib is often thickened gelatinously, shaped like a groove, concave outside and convex inside. The axial inner side of the oral lobes is always covered by endoderm, its abaxial outer side by ectoderm (comp. in the System, 1879, the oral lobes of the Anthomedusæ, taf. iii., iv.; of the Leptomedusæ, taf. viii., x., xi., xiii.; of the Trachomedusæ, taf. xvi., xviii.; of the Narcomedusæ, taf. xix., xx.; of the Stauromedusæ, taf. xxi., xxii.; of the Peromedusæ, taf. xxiii., xxiv.; of the Cubomedusæ, taf. xix., xx.; of the Discomedusæ, taf. xxvii., xxx., xxxii., xxxiii.). The oral lobes are termed "oral arms," if the four perradial oral lobes are very large, and the intermediate oral sinus so deep that they divide the œsophagus almost, or completely into four parts. These oral arms attain an extraordinary development in the order of the Discomedusæ, in the sub-order of the Semostomæ, namely, in the "pennon-mouthed" Pelagidæ (System, taf. xxxi.), and Cyaneidæ (System, taf. xxx.). In most Cyaneidæ they resemble delicate curtains with numerous folds, which are frequently larger than the whole umbrella, and are therefore termed "oral curtains" (Pls. XXX., XXXI.).

§ 114. Quadripartite mouth of the Rhizostomæ. The third and last sub-order of the

Discomedusæ, the rich group of the Rhizostomæ (System, 1879, pp. 464, 560, taf. xxxiv.–xl.) is distinguished by an extremely peculiar development of the mouth, unique of its kind in the whole animal kingdom. This has arisen phylogenetically from the second sub-order, the Semostomæ (*loc. cit.*, taf. xxx.–xxxiii.), as the latter is derived from the Cannostomæ, *loc. cit.*, taf. xxvii.–xxix.). This plainly points out the ontogeny of the Rhizostomæ, which are Cannostomæ in their earliest stage, then become Semostomæ, and are finally transformed into Rhizostomæ. The simple quadrangular œsophagus of the Cannostomæ first shows four delicate, frilled oral lobes at the oral margin (Ephyridæ,

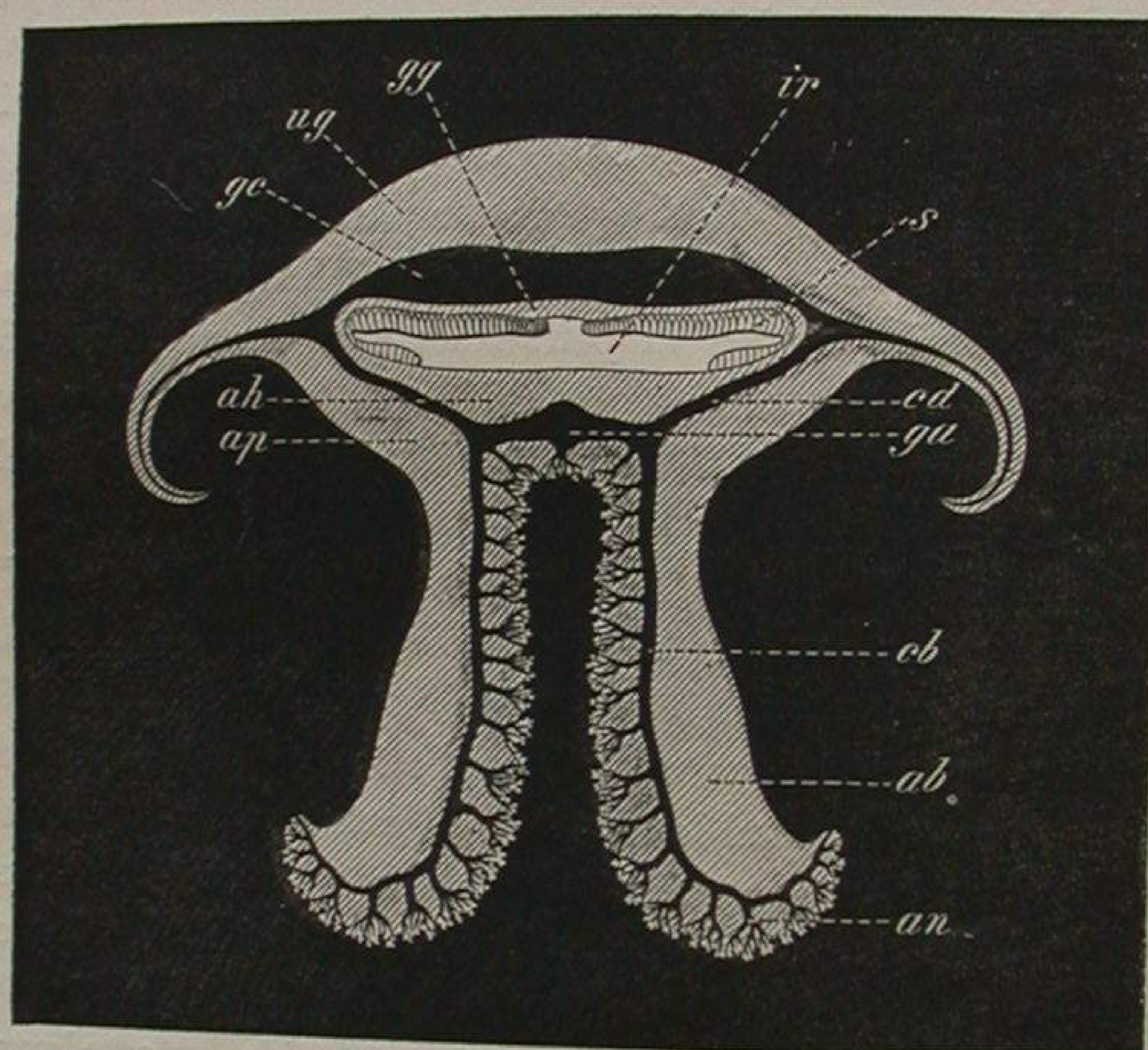


Fig. K. *Cannorhiza connexa* (Discomedusæ, Versuridæ).

Adradial section. (*ug*) Gelatinous umbrella. (*gc*) Central stomach. (*gg*) Bottom of the central stomach (gastrogenital membrane with the genitalia, *s*). (*ir*) Subgenital porticus. (*ah*) Brachiferous plate. (*ap*) Arm Pillars. (*cd*) Pillar canals. (*ga*) Buccal stomach. (*ab*) Oral arms (adradial). (*cb*) Branchial canals. (*am*) Funnel frills (sucking mouths).

System, taf. xxvii.; Flosculidæ, taf. xxvii.). As these increase considerably in size, and the intermediate four interradial oral sinuses take the form of deep incisions, they are transformed into four strong, perradial oral arms, which are developed in most Ulmaridæ into long oral pennons (System, taf. xxxi.–xxxiii.). In one Ulmarid (*Aurosa*, System, taf. xxxiii. figs. 7, 8), the four perradial oral arms are bifurcated at the distal end into two lobes. In this way, the eight adradial oral arms are formed, which are present in all Rhizostomæ, and which are only connected in pairs at their bases; where they are usually connected with four strong perradial oral pillars (*ap*). Whilst the thin leaf-like margin of the arms are strongly frilled, their thick midrib is deepened into a groove on the concave endodermal side (oral grooves, "sulci orales," *az*). The separate folds of the strongly frilled oral margins are laid against one another in such a way that the opposite and contiguous endodermal surfaces of the groove-shaped folds become fused at the points of junction, and transformed into short canals. They open freely on the outside by a funnel at the distal end, towards the inside into the perradial oral groove by a fissure. By fusion of its margins, this oral groove is transformed into a canal (brachial canal). Finally, as the central oral opening becomes fused between the bases of the four oral pillars, and closed by a cruciform "oral suture" (Pl. XXXII. fig. K), they are physiologically represented by the numerous "frill funnels" (funnel mouths or sucking mouths). This polystome of the Rhizostomæ, therefore, finally rests upon the division into many parts of the originally simple mouth; the central part becomes fused whilst it is replaced by numerous peripheric oral funnels. The fusion of the oral frills is therefore dependent upon endodermal concrescence or the formation of cathamma, as in the septa between the subumbral radial divisions of the coronal intestine. The endodermal cathammal plate (§ 101) is persistent in both cases. The funnel frills of the Rhizostomæ, whose freer oral margin is usually thickly beset with countless digitellæ, may produce varied appendages. Thus, urticating clubs are formed by annular fusion ("concrescentia annularis"), (*e.g.*, *Cassiopea*, *Cotylorhiza*, System, taf. xxxvii.), whilst the urticating scourges are formed by fissure-shaped fusion ("concrescentia longitudinales"), ("*e.g.*, *Cephea*, *Lychnorhiza*, System, taf. xxxiv.).

§ 115. Palate or palatine opening ("palatum, porta palatina," *gp*). This is the name applied to the circular constriction by means of which the œsophagus in most Medusæ is more or less clearly separated from the central stomach. In many cases it is insignificant or almost obliterated, whilst in others it appears distinctly as a slender neck (comp. in the System, for example, the Anthomedusæ, taf. iii., iv., vii.; the Leptomedusæ, taf. x., xii., xiii.; the Trachomedusæ, taf. xvi., xviii.; the Narcomedusæ, taf. xix., xx.; the Stauromedusæ, taf. xxi., xxii.; the Peromedusæ, taf. xxiii., xxiv.; the Cubomedusæ, taf. xxv., xxvi.; the Discomedusæ, taf. xxvii., xxviii., xxx., xxxi., &c.). The palatine opening is usually the narrowest part of the principal intestine, and in many cases appears capable of closing voluntarily, so as to debar the water from passing in from the buccal to the central stomach. The form of the palatine opening is usually distinctly cruciform; the four perradial limbs of this "palatine cross" forming the upper terminal portion of the "oral cross," project centrifugally towards the outside, their concave abaxial ends being often depressed into a groove, (palatine groves "sulci palatini,") *gs*, Pl. XX. fig. 11). They are sometimes supported by a strong, node-like thickening of the fulcral lamella (palatine nodes, "nodi palatini," *gk*, Pl. XX. figs. 9, 10) The four interradial palatine lips ("labia palatina" *gl*), which project centripetally inwards, lie between the palatine nodes (System, taf. x. fig. 6; taf. xxiv. fig. 14; taf. xxviii. fig. 5, taf. xxxi. fig. 3); the gelatinous fulcral plate of the latter is often as strongly thickened as that of the former, and frequently becomes as hard as cartilage, especially in the larger Acraspedæ. In many Cyaneidæ it forms a thick palatine ring as hard as cartilage (" annulus palatinus," Pl. XXX. figs. 30, 31, *aw*). The Cubomedusæ *Chirodropus* is distinguished by the development of its palatine lips, into four interradial palatine valves (" valvulæ palatinæ," System, p. 429, taf. xxvi. figs. 3, 4, *k*); they resemble the semilunar valves of the human heart in form, have their concave side turned to the central stomach, which they can close completely and so prevent any communication with the œsophagus.

§ 116. Central stomach or central cavity (" gaster centralis, cavitas centralis, *gc*). The second and middle chamber of the three chambers of the axial principal stomach, the central stomach, is homologous in the free-swimming Medusa, with the central calyx cavity, or the true stomach of the sessile polyps. It is separated from the buccal stomach above by the palatine opening (" palatum "), from the basal stomach, below by the pyloric opening (" pylorus "). In the side walls of the central stomach there are four perradial (rarely more) openings (" ostia gastralia ") by which it communicates with the surrounding pouches or canals of the coronal intestine. The general form and relative size of the central stomach varies most remarkably, and is often difficult to define. It usually forms the widest and broadest of the three chambers of the principal intestine, whilst the buccal stomach is the longest. The central stomach is sometimes entirely enclosed in the gelatinous substance of the umbrella, sometimes not; in the former instance its horizontal axis is usually considerably larger than its vertical, in the latter instance it is usually the reverse. We can therefore generally distinguish two principal forms of the central stomach, which are, however, connected by numerous intermediate forms and cannot be sharply defined,—the high obelisk stomach, and the flat lens stomach. The high obelisk stomach (" gaster centralis obeliscus ") has usually the form of an obelisk or a truncated quadrate pyramid (Pls. XV.–XXIV.); the palatum forms its lower base, the pylorus its upper base, the four perradial gastral ostia correspond to the four angles of the obelisk, the four interradial side walls of the central stomach or the obelisk plates (" tabulæ obelisci," *gz*) to the four sides. The vertical axis of the obelisk stomach is usually larger than the horizontal diameter. It usually hangs freely in the umbrella cavity and is often fastened to a shorter or longer " gastral peduncle " (" pedunculus gastralis," *us*, see above); this is the case in the majority of the Anthomedusæ (System, taf. iii., iv., vii.), of the Leptomedusæ (System, taf. xi.–xv.), and of the Trachomedusæ (System, taf. xvi.–xviii.), also among the Acraspedæ in most Tesseroniæ, in the Stauromedusæ as well as the Peromedusæ and Cubomedusæ (System, taf. xxi.–xxvi.). In many cases four perradial mesenteric folds or mesogonia serve to fasten the freely hanging obelisk stomach to the subumbrella; the Pectyllidæ are distinguished by eight such mesogonia (four perradial and four interradial) (Pls. III.–VIII.). The second principal form of the central stomach, the flat lens stomach (" gaster centralis lenticula ") only predominates in two orders, in the Narcomedusæ among the Craspedotæ (System, taf. xix., xx.), and in the Discomedusæ among the Acraspedæ (System, taf. xxvii.–xl.). The horizontal axis of the central stomach is usually much larger than the vertical, and the lenticular flat central stomach does not project at all, or only slightly into the subumbral umbrella cavity; its peripheric margin is cut away like a lens. As the basal stomach, and, consequently, the pylorus, are wanting, the flat upper wall or cover of the stomach is

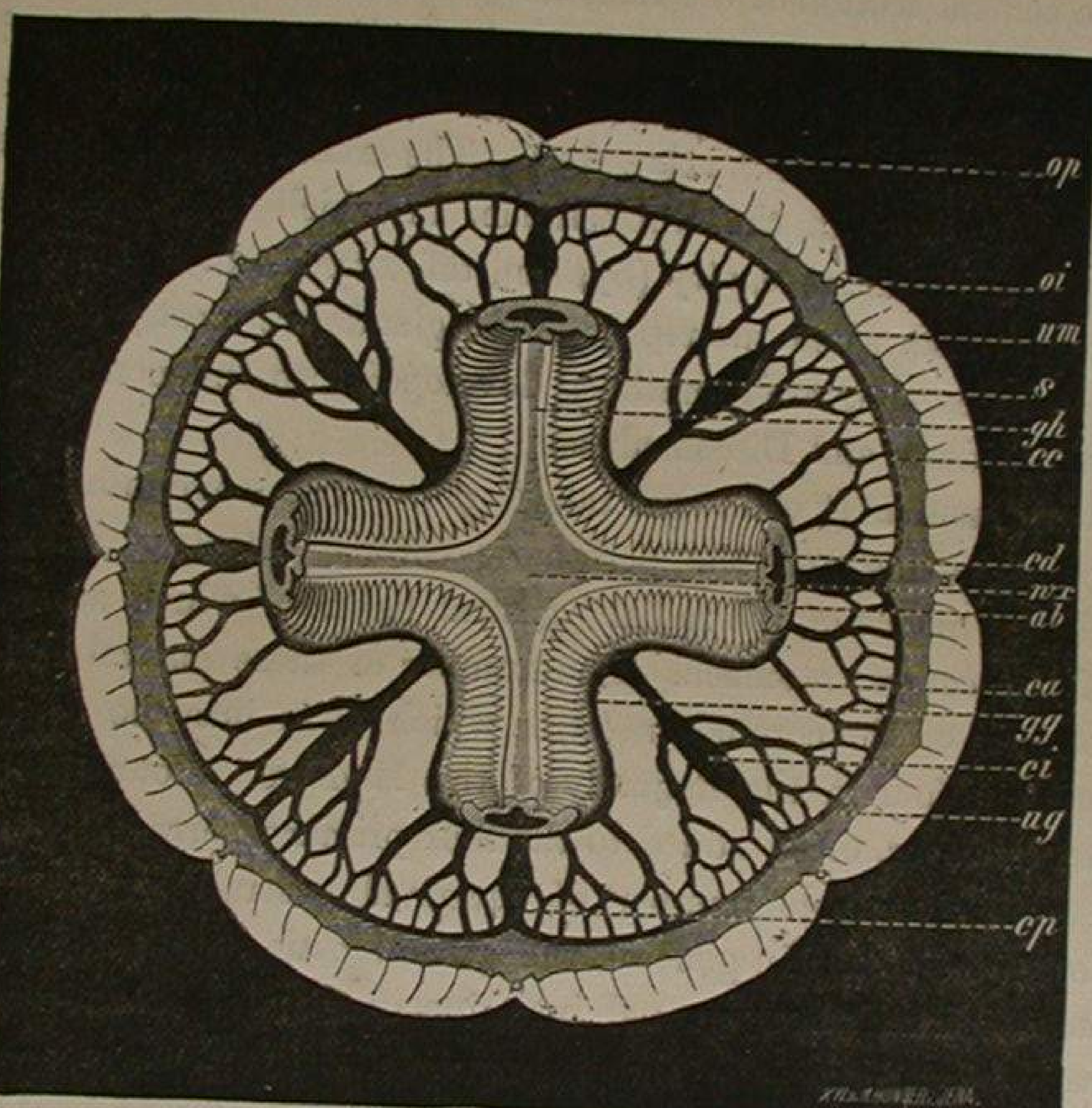


Fig. L. *Cannorhiza connexa* (Discomedusæ, Versuridæ).

Subumbral view of the umbrella. The arm disk with the eight oral arms is removed, as the four perradial arm pillars (*ab*), which connect the umbrella disk and the arm disk, are cut through. (*oi*) Interradial sense clubs. (*um*) Umbrella margin (turned over inwards). (*s*) Genitalia. *wx*) Gelatinous cross of the gastrogenital membrane. (*gg*), (*gh*) Peripheric limbs of the gelatinous cross. (*ug*) Peripheric umbrella corona. (*cc*) Coronal canal. (*cd*) Pillar canals. (*ca*) Adradial canals. (*ci*) Interradial canals. (*cp*) Perradial canals.

formed immediately by the discoid gelatinous substance of the umbrella; the lower wall or bottom of the stomach is supported by a thick gelatinous plate of the subumbrella, and communicates in the middle through the palatum with the œsophagus (Pls. XXVI.–XXXI.).

§ 117. Cruciate chambers and cruciate columns ("cameræ cruciatæ" et "columnæ cruciatæ"). In many Medusæ of different groups the quadrate central stomach assumes a more or less distinct cruciate form, as four perradial archings outwards alternate with four interradial archings inwards in the same fashion as in the oral cross and the palatine cross (Pl. XXXII. figs. 3, 4). We therefore term the four perradial limbs of the central gastral cross, the cruciate chambers, and the four interradial gelatinous pieces of the umbrella, projecting centripetally between them, the cruciate columns. The latter correspond morphologically to the interradial centre of the obelisk plates, and at the same time to the central section of the tæniola. The cruciate form of the central stomach is prominently developed in many Anthomedusæ (System, taf. iv., figs. 7, 9), the Leptomedusa (System, taf. viii. fig. 6), Stauromedusæ (System, taf. xxi., xxii.), and Discomedusæ (System, taf. xxviii., xxix., &c.). The cruciate chambers are most strongly developed in the sub-order of the Rhizostomæ, in which they are often considerably larger than the central cruciate cavity (System, taf. xxxvii.–xl.). The cruciate chambers attain special importance, when the reproductive glands are mostly or entirely developed in them; in such cases they are sometimes developed into independent genital pouches as in many Anthomedusæ and Discomedusæ.

§ 118. Gastral fissures ("ostia gastralia," *go*). The communication between the central principal intestine and the peripheric coronal intestine in all Medusæ takes place exclusively by means of the radial "gastral fissures," which are usually limited to the side-wall of the central stomach. The number of these gastral ostia corresponds to that of the chambers of the coronal intestine which open into the central stomach, and therefore amounts to four in the majority of the Medusæ. Four secondary interradial gastral ostia are, however, often added to the four primary perradial, and sometimes also a larger and usually variable number of succursal gastral fissures. The latter vary extremely in form and size. In general, the gastral ostia naturally form large and wide fissures in those Medusæ, whose coronal intestine consists of broad pouches and narrow septa, therefore in most Acraspedæ, and, for example, in the Tesseroniæ, the Cannostomæ, and in the Typhlocannæ among the Semostomæ (Pls. XV.–XXXI.). On the other hand the gastral ostia form small and narrow holes in those Medusæ, whose coronal intestine is composed of narrow canals with broad septa; therefore in most Craspedotæ, both in the Cyclocannæ and Rhizostomæ, among the Discomedusæ (Pls. I.–VIII., XXXII.). According to their position, the gastral openings sometimes lie vertically, sometimes obliquely, sometimes horizontally. Most Tesseroniæ are distinguished by very large, wide gastral ostia; they lie vertically or subvertically in most Peromedusæ, and in one part of the Stauromedusæ (Pls. XVI.–XXV.), whilst they are horizontal or sub-horizontal in most Cubomedusæ (Pl. XXVI.), and in another part of the Stauromedusæ; in all cases the margins of the gastral ostia are entirely or for the most part edged with phacelli (Pl. XVII. fig. 21). Sometimes, namely in the Cubomedusæ, there are valves by which the gastral ostia can be closed. The small Narcomedusæ group of the Solmonetidæ, in which the entire coronal intestine is obliterated, is distinguished by the entire want of the gastral ostia (*Solmaris* and *Solmoneta*, System, taf. xix. figs. 10–12; taf. xx. figs. 7–10). In consequence of this retrograde formation in *Solmaris*, the whole gastrovascular system is reduced to a simple, lenticular, central stomach.

§ 119. Pylorus or gastral opening ("porta pylorica," *gy*). In most Medusæ in which the basal stomach is developed, the latter appears more or less sharply defined from the central stomach by a circular constriction. We term this the gastral opening or pylorus; it comports itself above in the same way as the palatine opening does above, but is wanting, of course, in all Medusæ in which the basal stomach has undergone retrograde formation. In the Anthomedusæ, the only Craspedotæ which have a basal stomach or apical canal, the pyloric opening is a simple, circular stricture, and only of special interest in the Cladonemidæ, as it perhaps corresponds to the "funnel opening" which separates the ectodermal "œsophageal stomach" from the endodermal "funnel cavity" in the Ctenophoræ (*Ctenaria*, System, p. 107, taf. vii.). The pylorus, like the basal stomach, is usually wanting among the Acraspedæ, in the Discomedusæ or Ephyroniæ, whilst it is usually very pronounced in the Tesseroniæ. In the Stauromedusæ the plyoric stricture is sometimes obliterated, sometimes deeply inserted (taf. xv. figs. 2, 3, *AB*). In the Peromedusæ it is sharply defined by the proximal margin of the coronal sinus (Pl. XXI. figs. 12, 13, *CD*). Special "pyloric valves" ("valvulæ pyloricæ") which project inwardly from the four interradial angles of the quadrate stricture and from the bottom of the four small pyloric pouches ("bursæ pyloricæ," *by*), are often developed in the Cubomedusæ and in the Cannostomæ.

§ 120. Basal stomach or basal tube ("gaster basalis," vel "tubus cupolaris," also termed "peduncle canal, peduncle tube, apical canal, or cone canal," *gb*). The basal stomach is the third and uppermost of the three principal chambers of the central principal intestine; it is separated by the pylorus from the central stomach, and corresponds to the peduncle tube or peduncle canal of the stalked polyps. It is lost in the majority of Medusæ, and only preserved by inheritance in a few groups. We only find it among the Craspedotæ in part of the Anthomedusæ, where it appears as a simple, narrow canal, which traverses the apical process of the umbrella cone, ending cæcally in the point of the latter; the stomach of the germinating Anthomedusæ was originally connected by this peduncle canal with the stomach of the nursing Tubularia polyp (comp. System, p. 5, taf. i., ii., iv., vii.); in many Cladonemidæ it is inlarged into a spacious apical cavity ("cavitas cupolaris"), which is sometimes occupied by the young brood (*Pteronema*, *Eleutheria*). The enlarged pyriform apical cavity of the Cladonemidæ is of great interest as it probably corresponds to the funnel cavity of the Ctenophoræ (System, pp. 99, 107, taf. vii., *Ctenaria*). Among the Acraspedæ the basal stomach is usually entirely wanting in the depressed Discomedusæ or Ephyroniæ, whilst it is constant and usually highly developed in the three other orders, the highly arched Tesseroniæ. It appears in the Stauromedusæ (in the Tesseridæ, Pl. XV., and Lucernaridæ, Pl. XVI., XVII.) as a shorter or longer quadrilateral canal which traverses the apical process or peduncle of the umbrella, and terminates cæcally at its aboral end. The four interradial tæniola (*ft*) divide the peduncle canal into four perradial semicanals (peduncular grooves or niches of the basal stomach, "semicanales basales," *gn.*, Pl. XVI. fig. 13). In some Lucernaridæ these become four separate peduncular canals ("canales basales"), as the four interradial tæniola met in the axis of the stomach where they are fused into a central column ("columella"). In the Peromedusæ, the basal stomach is always highly developed, is sharply defined from the central stomach by the pyloric ring (which corresponds to the upper margin of the "coronal sinus"), and is divided by the projecting tæniola into four niches or semicanals. The division into four of the conical basal stomach is more strikingly defined if the four tæniola are transformed into hollow cones by the subumbral funnel cavities, which in *Periphylla* penetrate to the point of the cone (Pl. XXI. figs. 12–18, *ib.*). In the Cubomedusæ the basal stomach is sometimes fused with the central stomach, sometimes separated from it by a pyloric stricture, in which case it forms a very flat, low, quadrate cavity; its four interradial angles are sometimes extended into four low, triangular pyloric pouches ("bursæ pyloricæ, *by*), which are separated from the central stomach by four projecting pyloric valves (System, p. 430).

§ 121. The two principal forms of the coronal intestine ("gaster coronaris," "perogaster"). Under the term "coronal intestine," we include the whole peripheric gastrovascular system of the Medusæ, which surrounds the central principal intestine like a garland, and only communicates with it by the gastral openings. Although it has essentially the same formation in both sections of the class, we may assume that it has been developed independently in both sections. The fusion of the two walls of the peripheric gastral space, by which the radial chambers of the coronal intestine originate, shows an essential difference in the two sections. In the Craspedotæ, which are descended from Hydropolyps (without tæniola), the concave inner surface of the not-umbrella or dorsal umbrella, is fused almost throughout its entire extent with the convex outer surface of the cœlumbrella or ventral umbrella, in such way that the cathamma originally represent four broad plates, between which only four narrow radial canals remain over; these are connected in a supplementary manner by a secondary coronal canal. In the Acraspedæ, on the other hand, which are descended from the Scyphopolyps (with the four characteristic tæniola), these gastral ridges are the starting-point of the concresence; at four interradial points the dorsal point of the four tæniola (on the notumbrella) is fused with their ventral part (on the cœlumbrella) in such a way that the cathamma originally represent four small nodes or narrow ridges, between which the four broad radial pouches remain free; these communicate at the peripheric umbrella margin below the four nodes, by a primary coronal canal, the distal remains of the simple gastral space. Although these two essentially different principal forms of the coronal intestine in the two sections probably express a comprehensive primary difference in its conformation, modifications of it are present in both sections, which make it possible to confound the formations derived from them. The Narcomedusæ, especially, approach the Acraspedæ strikingly, the Cubomedusæ the Craspedotæ. In spite of this, the two groups are genetically entirely different, and it is therefore quite to the purpose to consider the two principal forms of the coronal intestine separately; we designate the former, the vascular corona, the latter the pouch corona.

§. 122. Vascular corona of the Craspedotæ ("corona canalium"). In the majority of the Craspedotæ one and the same form of the coronal intestine is maintained, the vascular corona, which must be regarded as the typical and original form for this section.

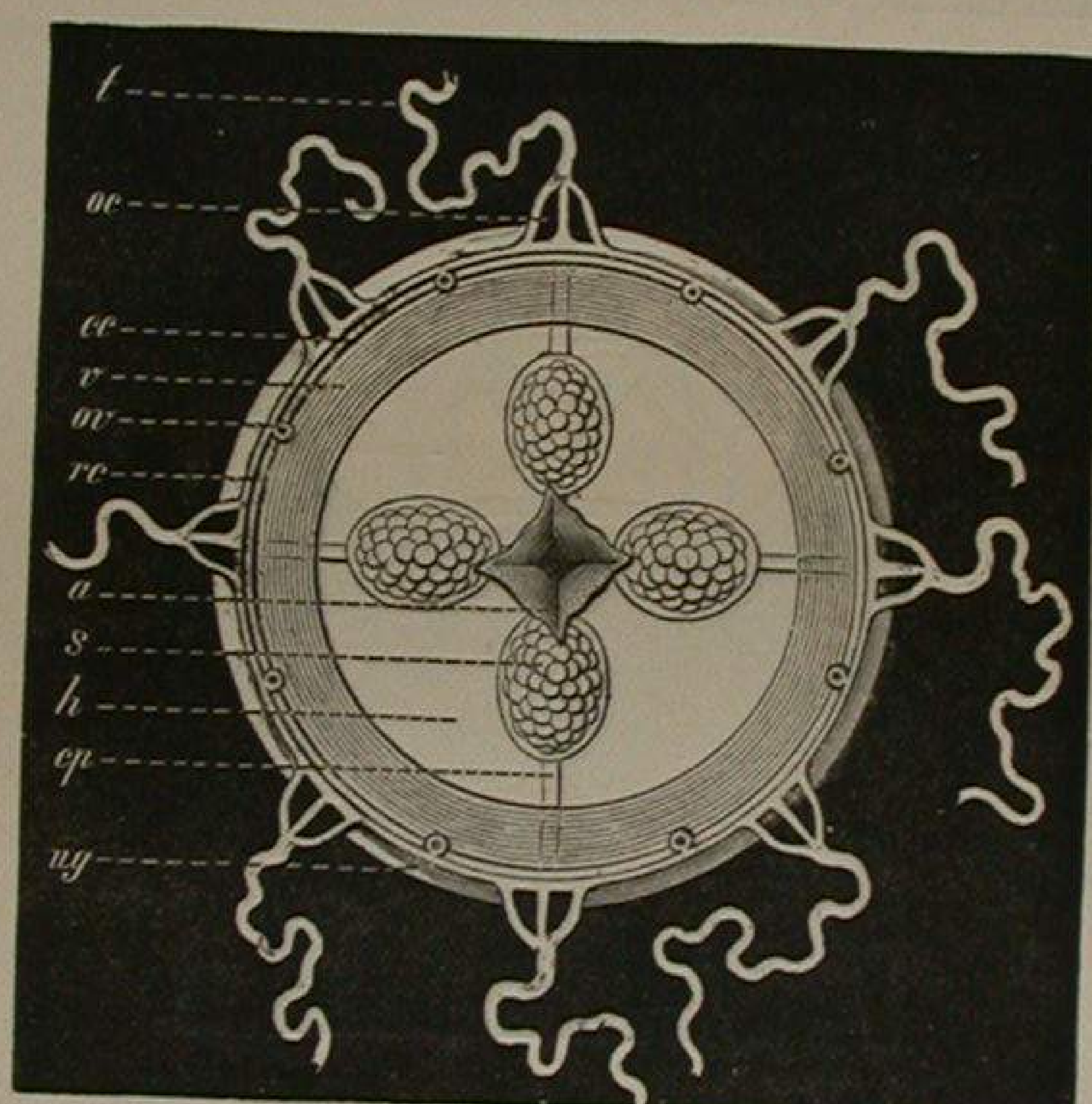


Fig. M. *Eucope campanulata* (Leptomedusæ, Eucopidæ).

Subumbral aspect. (*a*) Quadrate oral opening. (*s*) Ovaries. (*cp*) Perradial canals. (*cc*) Coronal canals (*v*) Velum. (*ov*) Velar marginal vesicels, (adradial). (*h*) Umbrella cavity. (*rc*) nerve ring. (*oc*) Ocelli at the swollen bases of the tentacles. (*ug*) Gelatinous substance of the umbrella. (*t*) Tentacles.

It is composed of four narrow, perradial canals (fig. M *cp*) which run out from the four angles of the central stomach, and pass through the subumbrella to the umbrella margin, where they are united by a coronal canal (*cc*) (comp. Pls. I. II.) The typical quadrilocular vascular corona of their Hydropolyps has arisen from the simple gastral space of their predecessors the Hydropolyps, by their two walls (calyx wall and peristom wall) being laid together and fused in such a way that only four narrow radial canals remain open between them. The broad concrescentic surfaces between the four perradial canals still contain in the developed Craspedotæ the important (originally double) layer of endoderm cells which authenticate their origin (cathammal plate, § 101). The marginal coronal canal (*cc*), which connects the four radial canals at the umbrella margin, does not appear to be the marginal part of the originally simple gastral space (of the Hydropolyps) which remains open, but to have arisen from the distal ends of the radial canals which remain open, being connected by marginal processes (hence the secondary coronal canal). This typical primitive form of the coronal intestine of the Craspedotæ is subject to varied modifications, of which some (Narcomedusæ) are so like the pouch corona of the Acraspedæ that they may be confounded with it (" convergent selection ").

§ 123. Radial canals (" canales radiales," *cr*). In the majority of Craspedotæ we only find four perradial canals, which open into the coronal canal at the insertion of the

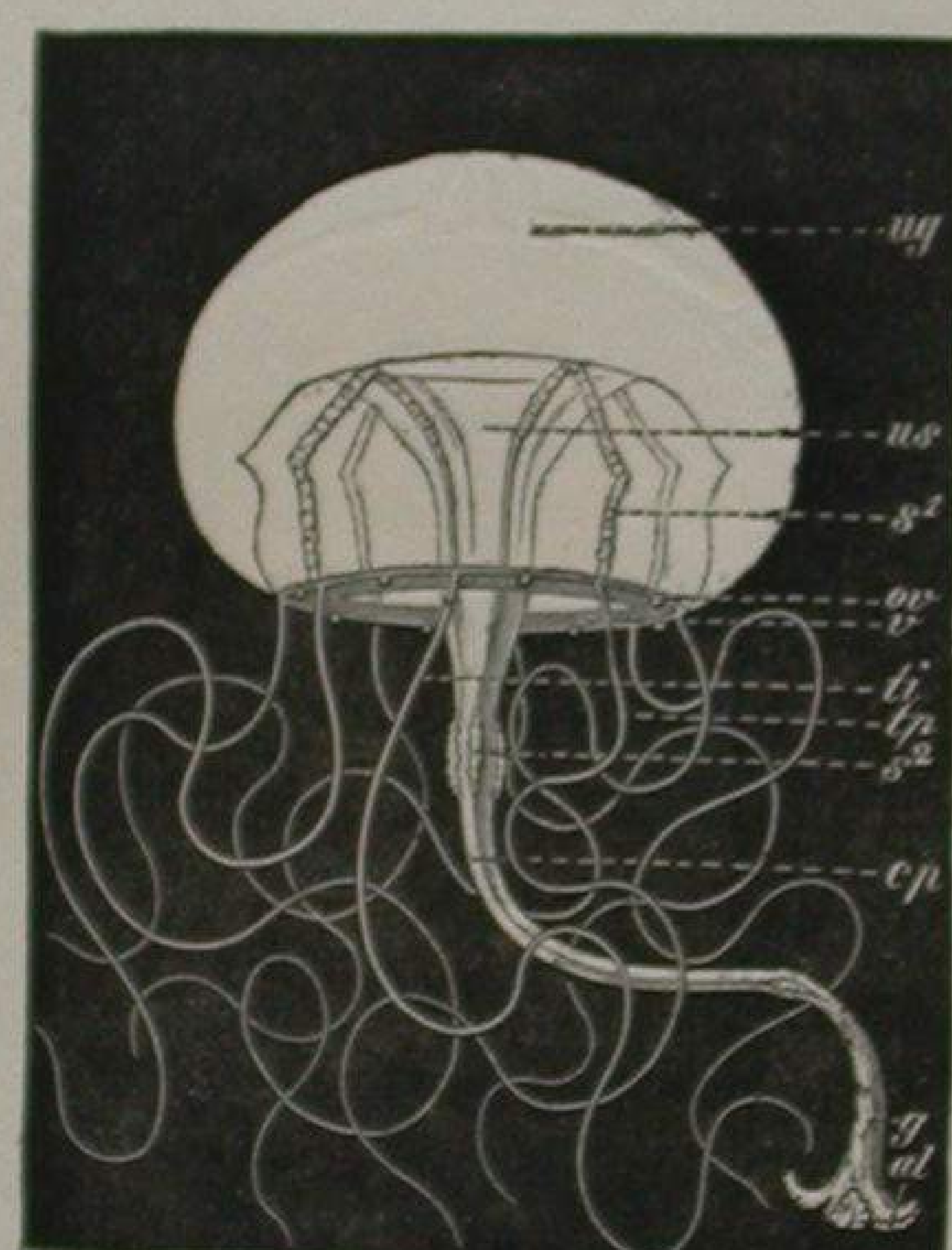


Fig. N. *Octorchis germanica* (Leptomedusæ, Eucopidæ).
Profile view. (*ug*) Gelatinous umbrella. (*us*) Solid gelatinous peduncle of the stomach. (*v*) Velum. (*ov*) Velar marginal vesicles. (*tp*) Perradial tentacles. (*ti*) Interradial tentacles. (s^1) Distal testis (on the subumbrella). (s^2) Proximal testis (on the œsophagus). (*cp*) Perradial canals. (*g*) Stomach. (*al*) Oral lobes.

four primary tentacles. They are usually very narrow and cylindrical, more rarely flattened like a ribbon (in some Tiaridæ, Geryonidæ, Narcomedusæ). There are rarely six canals instead of four (in part of the Cannotidæ and Geryonidæ, System, taf. ix. figs. 6–9; taf. xviii. figs. 7, 8). In some families eight canals are constant, as four interradial secondary canals are developed supplementarily in the middle between the four perradial (Pls. III.–VIII.; Melicertidæ, Octocannidæ, Trachynemidæ, Aglauridæ, System, taf. viii., xvi., xvii.). On the other hand we rarely find eight adradial canals, which have arisen from basal bifurcation of the four perradial (*Ctenaria*, *Cladonema*, *Dendronema*, System, taf. vii.). In the Æquoridæ the number of the radial canals rises from 8 to from

50–60, sometimes to from 100–200 and more, and is at the same time very inconstant (System, taf. xiv., xv.). Their number is likewise variable and inconstant in the Narcomedusæ, where it never rises beyond 32 and usually amounts to between 11 and 20 (System, taf. xix., xx.). Whilst the radial canals of most Craspedotæ, are quite simple and unbranched, the three sub-families of the Cannotidæ, are distinguished by their being repeatedly ramified; the radial canals of the Polyorchidæ are beset with cæcal side branches, and consequently appear pinnated (*Ptychogena*, Pl. II.); in the Berencidæ both the simple or ramified side branches of the radial canal, and their direct process open into the coronal canal; in the Williadæ the radial canals are bifurcated as in the Cladonemidæ and Zygocannidæ; the bifurcations may also be repeatedly dichotomised (System, taf. ix.). In those Craspedotæ where a solid gelatinous gastral peduncle is developed in the centre of the subumbrella, each radial canal is divided into two sections, an ascending peduncle canal, and a descending subumbral canal; the peduncle canal leads from the bottom of the stomach at the oral end of the gastral peduncle to the base of the latter (in the bottom of the subumbrella); the subumbral canal from the last-named point to the coronal canal (fig. N).

§ 124. Coronal canal of the Craspedotæ (" canalis circularis," *cc*). In all Craspedotæ the radial canals are originally connected at the umbrella margin by a coronal canal (" canalis circularis "). Its ontogenesis shows that it does not arise from the primary gastral space remaining open at its peripheric margin, but by secondary anastomotic formation of the radial canals. Whilst the latter are formed by the two endodermal surfaces of the simple gastral space of the polyps becoming fused into four broad interradial cathammal plates, the connective coronal canals at the distal end of the open radial canals are formed by the separation of their two epithelial layers (dorsal and ventral endoderm) at the distal margin of the endodermal cathammal plates. The marginal coronal canal of the Craspedotæ, is therefore formed in the same way as the secondary coronal canal of the Cycloperiæ among the Discomedusæ, whilst the primary coronal canal (or better, " coronal sinus ") of the other Acraspedæ has quite a different formation (comp. § 126, 123). The tentacle canals, which pass into the hollow tentacles, run out in a distal direction from the simple coronal canal of the Craspedotæ. The " centripetal canals " which run out from the coronal canal towards the middle of the subumbrella, where they end cæcally (§ 135), are sometimes developed in a proximal direction.

§ 125. Festoon canal and radial pouches of the Narcomedusæ. The order of the Narcomedusæ is distinguished by a peculiar condition of formation of the coronal intestine, apparently completely different from that of the other Craspedotæ. Broad cæcal pouches apparently proceed from the central stomachs, which are not connected by a coronal canal, and resemble those of the Typhloperiæ among the Discomedusæ. More minute comparative investigation however shows that they cannot properly be compared with the latter, but that the typical fundamental form of the coronal intestine is the same here as in all other Craspedotæ, *i.e.*, four narrow perradial canals communicating by a coronal canal at the umbrella margin. This original formation only undergoes peculiar modifications, which appear to be influenced pre-eminently by the centripetal migration of the tentacles on to the exumbrella (comp. System, 1879, taf. xix., xx. pp. 302–306). Whilst in other Craspedotæ the tentacles usually retain their original position on the umbrella margin, in the Narcomedusæ they migrate from there up to the dorsal surface of the exumbrella, towards the apex, taking with them, from their original insertion, part of the umbrella margin, whose urticating ring is transformed into a centripetal umbrella clasp ("peronium"), (§ 68, Pls. IX.–XIV., *en*). The original marginal coronal canal, which lies on the inner side of the marginal urticating ring, follows the centripetal processes of the latter, which forms the peronium in the exumbrella and edges the two lateral margins of the peronium in the form of a double peronial canal ("canalis peronialis," *ck*, Pls. IX.–XIV.). The two parallel double canals (which are only separated by the peronium) open at the dorsal point of insertion of the tentacle, into the distal end of the true radial canal, which is expanded like a pouch (*Cunantha*, *Cunina*, System, taf. xix. figs. 1, 3). Whilst many Cunanthidæ (the Cunoctanthidæ) show this most simple condition and are therefore connected immediately with certain Trachomedusæ (Geryonidæ), in other Cunanthidæ (Cunoctonidæ) the distal part of each radial canal bifurcates into two cæcal pouches diverging distally, and these internemal lobe pouches therefore lie in pairs between each two peronia and peronial canals (*Cunarcha*, Pl. IX. figs. 2–4, *Cunoctona*, System, taf. xx. figs. 1–6). In the closely allied Æginidæ the simple proximal part of the widened radial canals has undergone retrograde formation or become merged into the periphery of the stomach, whilst the two lobe pouches which have arisen from their distal part are developed into independent internemal gastral pouches, opening immediately into the periphery of the stomach (*Æginura*, Pls. XIII., XIV.; *Ægina*, System, taf. xx.). The double peronial canals, which open into the stomach between each two pair of pouches, seem at first to be simple radial canals, connected by a simple coronal canal at the umbrella margin; this apparently simple coronal canal, however, really consists of four or eight separate marginal canals ("canales marginales," *cm*); these are completely separated by the distal ends of the peronia, and each marginal canal, along with the inverted halves of the two contiguous peronial double canals, forms a horseshoe-shaped arch canal. An arch canal opens by two separate ostia between each two peronia into the gastral cavity. The entire coronal canal, when formed as in the Æginidæ of four or eight separate canals, is called the festoon canal ("canalis festivus," *cf*, Pls. XIII., XIV.). The Peganthidæ (Pls. X.–XII.) present another modification. The radial canals are merged in the central stomach or have undergone retrograde formation, so that the festoon canal (or the modified coronal canal) opens immediately into the stomach and with twice the number of openings than the number of arches composing the festoon canal; each arch opens by two gastral ostia (*go*). In the family of the Solmaridæ the festoon canal is completely obliterated; the radial canals may also be completely obliterated here (Solmonetidæ), whilst in other Solmaridæ, the pernemal gastral pouches remain (Solmissidæ), sometimes the internemal gastral pouches (Solmundinæ, System, taf. xix. xx. p. 346).

§ 126. Pouch corona of the Acraspedæ (" corona bursarum "). In contrast to the canal corona of the Craspedotæ, an essentially different form must be regarded as the typical and original arrangement for the section of the Acraspedæ, *i.e.*, the pouch corona composed of four wide, perradial pouches, which begin at the circumference of the central stomach, and run in the subumbrella towards the umbrella margin where they are united by a coronal canal. This typical quadripartite pouch corona of the Scyphomedusæ, has been developed from the simple gastral space of their ancestors the Scyphopolyps by the four interradial tæniola of the latter being laid together and fused at four points (of equal height), or in four streaks, by their upper dorsal parts and lower ventral parts. In this way four small interradial nodes or narrow ridges are originated (Pl. XV. figs. 2, 3, *kn*; Pl. XVI. figs. 2, 3, *ks*), which form incomplete septa between four wide perradial pouches (*bp*). The small fused nodes or the four narrow fused ridges in the mature Acraspedæ still contain a double layer (or a layer become simple by fusion) of endoderm cells, which indicates this origin as a cathammal plate (§ 101, Pl. XXV. fig. 8). The marginal coronal canal which connects the four broad pouches at the umbrella margin below the four narrow septa, appears to be the marginal part of the originally simple gastral space of the Scyphopolyps, which has remained open (therefore a "primary coronal canal"). This typical primitive form of the coronal intestine of the Acraspedæ is subject to varied modifications, of which some (Flosculidæ) are so like the canal corona of the Craspedotæ that they may be confounded with it (" convergent selection ").

§ 127. Radial pouches (" bursæ radiales," *bs*). The constant number of four of the perradial pouches of the Acraspedæ is very remarkable when contrasted with the frequent variations of the number of four shown by the Craspedotæ. The four perradial pouches are orignally (phylogenetically) present, though they are often lost at an early stage. They correspond to the four flat gastral pouches of the Scyphostoma, which are constantly separated by four interradial tæniola. Frequent individual exceptions (especially individuals with six or eight radial pouches) are of no importance, as they do not transmit their peculiarity. The two sub-sections of the Acraspedæ, the Tesseroniæ and Ephyroniæ, are, however, in general strikingly distinguished, as in the Tesseroniæ (Pls. XV., XXVI.), the four primary radial pouches always remain very large, and with the coronal sinus belonging to them form the permanent principal component part of the coronal intestine, whilst in the Ephyroniæ (Pls. XXVII.-XXXII.) they have usually undergone retrograde formation or become merged by fusion into the central stomach; they appear, however, to be of no great importance, and to have retreated towards the peripheric pouch corona. The latter, which consists of at least eight, but usually of sixteen radial coronal pouches, always forms the principal component part of the coronal intestine in the Ephyroniæ, whilst in the Tesseroniæ it has retreated completely against the inner quadrilocular pouch corona. Important differences, are, however, connected with the further organisation of the two sub-sections. It is therefore practical to consider the radial pouches of the Tesseroniæ and Ephyroniæ separately.

§ 128. The four perradial pouches of the Tesseroniæ. In all the three orders of the Tesseroniæ, the Stauromedusæ, Peromedusæ, and Cubomedusæ, the four primary perradial pouches (*bp*) form, from their circumference and extent, by far the most important part of the coronal intestine, whilst, on the other hand, the marginal pouch corona has retired against its periphery (System, pp. 363–449, taf. xxi.–xxvi.). As in all Tesseroniæ, the umbrella is highly vaulted, and its fundamental form represents a high quadrate pyramid (usually truncated above), the four broad pouches occupy its four lateral surfaces, whilst the intermediate four interradial septa correspond to the four angles of the regular pyramid. Each quadrangular pouch communicates at the upper or proximal margin by a fissure-shaped gastral ostium (*go*) with the central stomach, at the lower or distal margin by two or more fissures with the marginal pouches; its two lateral margins are formed by the septa or cathamma, and their ideal (interradial) prolongations. All the four perradial pouches communicate below the four cathamma, by four interradial fissures, which taken together represent an ideal primary coronal canal, the coronal sinus ("sinus coronaris," § 134). Of the two flat, quadrangular walls of each perradial pouch, the outer (abaxial) is formed by the inner (concave) endodermal surface of the notumbrella, whilst the inner (axial) is formed by the endodermal surface of the cœlumbrella. Whilst all Tesseroniæ agree without exception in these essential general conditions of structure, many important modifications are found in detail which are referable on the one hand to the different extent of the cathamma, and on the other to the different position of the gastral ostia. In one portion of the Stauromedusæ, and in all Peromedusæ, the gastral ostia form narrow longitudinal fissures of the central stomach, standing more or less vertically, whilst in another portion of the Stauromedusæ, and in all Cubomedusæ, they form broad transverse fissures, standing more or less horizontally; the special anatomical relation of the proximal part of the pouch to the central stomach, therefore, differs considerably. As regards the four interradial septa of the four pouches or the four primary cathamma, in one portion of the Stauromedusæ (Tesseridæ), and in all Peromedusæ, they form small, but very firm nodes, as hard as cartilage ("nodi cathammales," Pl. XV. figs. 2–6, *kn*; Pls. XX.–XXIV., *kn*); whilst in the other portion of the Stauromedusæ (Lucernaridæ), and in all Cubomedusæ, they form long, narrow ridges ("limites cathammales," Pls. XVI., XVII., *ks*). The Peromedusæ are, moreover, distinguished from all other Tesseroniæ by the union of the four perradial pouches above the four septal nodes, into a powerful upper coronal sinus, which encircles the central stomach, and reaches with its upper (closed) margin up to the pyloric ring (Periphyllidæ, Pls. XX., XXI., *co″*; comp. § 134).

§ 129. The four perradial pouches of the Ephyroniæ. In the second and younger sub-section of the Acraspedæ, the Ephyroniæ, the coronal intestine strikes out a direction of formation which contrasts thoroughly with, and differs essentially from that presented by the first and older sub-section, the Tesseroniæ. Whilst the four primary radial pouches of the coronal intestine in the Tesseroniæ are always very large, and form its principal component part, in the Ephyroniæ they appear to be wanting, or only to exist as small rudiments: up till now they have been completely overlooked in the Ephyroniæ or Discomedusæ, and not taken into account by any author on Medusæ. The two deep-sea Cannostomæ, *Nauphanta* (Pls. XXVII., XXVIII.) and *Atolla* (Pl. XXIX.), are of great importance for comprehending their formation; from their size they show the primitive formation more clearly than the known small *Nausithoe*, in which the four septal nodes are certainly also present but are very small, and have hitherto been invariably overlooked. In all the Cannostomæ named (and probably in all Discomedusæ of this sub-order) four interradial septal nodes (*kn*, Pl. XXVII. fig. 3; Pl. XXVIII. figs. 14, 15; Pl. XXIX. figs. 3, 6) are found in the upper part of the coronal intestine. They correspond completely, in situation and significance, to those of the Tesseridæ (Pl. XV. figs. 2–6, *kn*), and the Periphyllidæ (Pls. XX.–XXIV., *kn*). In *Atolla* (Pl. XXIX.) these important four interradial cathammal nodes are triangular and strongly flattened, whilst in *Nauphanta* (Pls. XXVII., XXVIII.), and also in *Nausithoe*, they are very small, and have as yet been taken no notice of. In their transverse sections, however, they show distinctly the important cathammal plate or endodermal lamella (*rk*), the fused plate between the gelatinous body of the notumbrella and the supporting plate of the cœlumbrella (Pl. XXV. fig. 8, *dk*). The ventral wall of the cœlumbrella and the dorsal wall of the notumbrella are fused by means of these four interradial fused nodes; between these four perradial transverse fissures remain, which represent the four rudimentary, very much shortened radial pouches, and whose proximal margin is at the same time to be regarded as a "gastral ostium" (*go*). If we suppose these nodes prolonged interradially downwards in the form of narrow septal ridges, the underlying coronal canal or coronal sinus (*cs*) will be thereby divided into four broad, long, radial pouches, resembling those of the Lucernaridæ (Pls. XVI., XVII., *bp*). In the two other sub-orders of the Discomedusæ, the Semostomæ and Rhizostomæ, the four primary septal nodes, which were originally present, appear to have undergone retrograde formation, and become lost, whilst the Cannostomæ have kept them faithfully up to the present day; the Cannostomæ—which in many respects still resemble the Tesseroniæ—being the ancestral form of the Discomedusæ, from which the Semostomæ have been developed later (and the Rhizostomæ still later from the Semostomæ). In the Ephyrula larva of the latter, the four primary gastral filaments, probably indicate the spot formerly occupied by the predecessors of the septal nodes. The four cruciate pouches of the central stomach already described, may perhaps be considered as partly or wholly the remains of the original four radial pouches of the coronal intestine, and the centripetal septal ridges between them, as remains of the cathammal plates.

§ 130. The marginal pouches of the Tesseroniæ. It is only in the Tesseridæ, the first and oldest family of the Tesseroniæ, that the peripheric coronal intestine is formed exclusively of the four large perradial pouches and the marginal coronal canal or coronal sinus, which connects the latter below the four interradial septa (*Tesserantha*, Pl. XV. figs. 2–6 ; *Tessera*, System, Pl. XXI.). In all other Tesseroniæ, other pouches are found at the distal margin of the four perradial pouches, which are developed as peripheric archings outwards of the latter and compose the corona of marginal pouches. In the Lucernaridæ they are represented by four pair of arm pouches which pass into the eight adradial arms or marginal lobes, from whose distal end they send out a tentacle canal into each tentacle (Pls. XVI., XVII.). The Charybdeidæ, in which the eight adradial marginal pouches are separated alternately by the four interradial septa and the four perradial "frenula velarii" (Pl. XXVI.), comport themselves quite in the same way. In the Chirodropidæ the number of radial pouches is doubled, as each of the eight adradial marginal pouches is split up into two subradial lobe pouches (System, p. 446, taf. xxvi.). In most Cubomedusæ, moreover (with the exception of the lowest forms, the Procharagmidæ) numerous simple or branched velar canals run out from the distal margin of the lobe pouches, extend in the velarium (the broad marginal membrane connecting the marginal lobes) and end cæcally with anastomosis (Pl. XXVI. fig. 8, *cv*). The conditions differ somewhat in the Peromedusæ, as in the Pericolpidæ, first of all (System, taf. xxiii.) eight principal coronal pouches (four perradial and four interradial) run out from the distal margin of the coronal sinus. Their subumbral walls form the eight coronal plates of the coronal muscle. Each of the eight coronal pouches is split up into a medial principal canal, and two distal lobe canals. The medial canal passes into the tentacle in the four perradial coronal pouches, into the sense clubs in the four interradial; whilst, on the other hand, the two lobe canals of each coronal pouch (*bl*) provide for the halves of each two adjacent canals turned to each other, at whose distal end they communicate by a horseshoe-shaped canal (*bw*) with the opposite canals of the other halves (Pl. XXII. fig. 22 ; Pl. XXIII. fig. 29). The Periphyllidæ are only distinguished from the Pericolpidæ by having three tentacles with two intercalary subradial marginal lobes in the place of each simple perradial tentacle (Pls. XVIII.–XXV.). As the whole lobe canals of the Peromedusa are connected below by U-shaped horseshoe canals (*bn*) at the distal end of the marginal lobes, a waved connected festoon canal of peculiar formation is developed in all Peromedusæ at the outermost margin of the lobed umbrella (Pl. XX. figs. 8, 22).

§ 131. The marginal pouches of the Ephyroniæ. Whilst in the Tesseroniæ the marginal pouches always appear as merely subordinate appendages on the distal margin of the four perradial pouches (or of the large coronal sinus formed by junction of the latter), in the Ephyroniæ or Discomedusæ they form the principal component part of the coronal intestine. They differentiate here in a great variety of ways. The more the four primary perradial pouches in the Discomedusæ become subsidary, the more extensive are the numerous and voluminous marginal pouches which take their place; in spite of this, the latter must be regarded here as originally distal processes of the former. It is important to distinguish the original from the later formations among the manifold and protean differentiations undergone by the corona of marginal pouches in the different groups of Discomedusæ. We consider the simple eight principal radial pouches (four perradial and four interradial) which appear universally in the Ephyra larva of the Ephyroniæ, and then pass into the eight typical sense clubs or rhopalia (and which are therefore called sense pouches, ocular pouches, or rhopalar pouches (" bursæ rhopalares," *br*) as the primitive marginal pouches of this order. They correspond to the eight coronal pouches of the Pericolpidæ (among the Peromedusæ), of which four likewise lie perradially and four interradially, the former passing into the tentacles, the latter into the rhopalia (woodcut, fig. O, p. xcvi.). Eight adradial alternating tentacle pouches, which pass into the eight typical tentacles of this order (Pls. XXVII., XXVIII., *bf*), are, however, immediately added to these eight principal rhopalar pouches. The characteristic corona of marginal pouches in most Ephyroniæ, therefore consists of sixteen coronal pouches ("bursæ coronares," *bc*), of which the eight principal rhopalar pouches are, however, phylogenetically older than the eight adradial tentacle pouches. All the sixteen pouches are separated by sixteen narrow septa or fused streaks; these sixteen subradial cathammal ridges correspond to the sixteen subradial peronia of the Periphyllidæ. The sixteen coronal pouches of the Discomedusæ do not, however, communicate like those of the Periphyllidæ by a marginal festoon canal (below the distal ends of the cathammal ridges), but remain originally completely separate and end cæcally. Many Ephyridæ still show this original condition, as the eight large or principal pouches end cæcally in the eight sense clubs, the eight smaller adradial pouches at the bases of the eight tentacles. The varied peripheric pouch formations of the Discomedusæ may all be derived from this primary condition as secondary modifications and more recent developments.

§ 132. Typhloperiæ, or Ephyroniæ without annular canal. According to the preceding view, the peripheric pouch corona of the Discomedusæ consists originally in all Acraspedæ of this order (as in all their Ephyrula larvæ at the present time) of sixteen simple, cæcal coronal pouches, separated by sixteen narrow subradial cathammal ridges, and from which the eight principal pouches (four perradial, four interradial) pass into the rhopalia, and the eight adradial into the tentacles. As regards the further differentiation of this originally simple pouch corona, there are two different types in this order so rich in forms; the older, conservative type, we shall term for brevity, the Typhloperiæ, the young and more progressive type the Cycloperiæ; the latter is distinguished by the acquisition of a second circular canal, which is still wanting in the former. Of the

Discomedusæ, the group of the Typhloperiæ, or Ephyroniæ, without coronal canal, includes first all the Cannostomæ (Ephyridæ, Linergidæ) and, secondly, half of the Semostomæ (Pelagidæ, Cyaneidæ). In these the sixteen coronal pouches always continue completely isolated, whether they remain simple or become repeatedly branched. The tentacles remain simple and unbranched in the Ephyridæ (System, taf. xxvii., xxviii.) and Pelagidæ (System, taf. xxxi.) each coronal pouch is, however, usually bifurcated into two lobe pouches, which provide for the inverted halves of each two neighbouring canals; the two simple cæcal lobe canals of each lobe therefore belong to two different adjacent marginal lobes and remain completely separated by the (subradial) peronium. Consequently, there are usually thirty-two cæcal lobe pouches present, but this number may be increased considerably by later division and the formation of secondary lobes. The Lineragidæ (System, taf. xxix.) and Cyaneidæ (System, taf. xxx.), on the other hand, are distinguished by distal ramification of the lobe pouches. Each lobe pouch sends out numerous bifurcate or dendritic canals from their periphery; these comport themselves like the "dendritic velar canals" of the Cubomedusæ (Pl. XXVI.), never form anastomoses, and end everywhere with cæcal branches at the periphery of the lobes (Pls. XXX., XXXI.).

§ 133. Cycloperiæ, or Ephyroniæ with annular canal. Whilst in the Typhloperiæ, described above, the sixteen original coronal pouches and their distal ramifications remain entirely separate, the second half of the Discomedusæ is distinguished by the development of a connecting coronal canal between the coronal pouches. Of the three sub-orders of the Discomedusæ, the Cycloperiæ or Ephyroniæ, with coronal canal, includes, first the half of the Semostomæ (Flosculidæ, Ulmaridæ), and, secondly, the whole of the Rhizostomæ. It is clear from the ontogeny of the Cycloperiæ that they are derived phylogenetically from the Typhloperiæ, and that their characteristic annular canal ("canalis annularis," *ck*) has been developed secondarily, as a circular, peripheric anastomosis between the originally separate, cæcal coronal pouches. The Ephyrula larva of the Cycloperiæ is so like that of the Typhloperiæ that they may be confounded together, and is also furnished with sixteen simple, cæcal, coronal pouches. In the course of their metamorphosis, these pouches in the Cycloperiæ form lateral processes which grow towards those of the neighbouring coronal pouches with which they enter into open anastomosis. In this way the secondary annular canal of the Cycloperiæ ("canalis annularis") is formed; it is analogous to, (not homologous with) the secondary circular canal ("canalis circularis") of the Craspedotæ, but different from the coronal canal or primary ring-canal of the Acraspedæ ("canalis coronaris"). The latter lies at the proximal side of the coronal pouches (between them and the four septal nodes), whilst the former lies on the distal side of the coronal pouches. Another important peculiarity of the Cycloperiæ stands in direct correlation to the development of their annular canals; the sixteen broad coronal pouches of the Typhloperiæ are transformed in all Cycloperiæ into sixteen narrow coronal canals, as the sixteen narrow subradial septal ridges between the pouches ("limites cathammales") are extended into sixteen broad septal plates ("tabulæ cathammales"). This originates a special form of the coronal intestine, which resembles the common form of the Craspedotæ so strongly that the two may be confounded, but which has arisen quite independently, and also differs essentially in its relation to the principal intestine. Moreover, the narrow "radial canals" of the Craspedotæ spring immediately from the central stomach, whilst the similar "coronal canals" of the Cycloperiæ spring originally from the distal margin of a coronal sinus, lying at the distal side of four cathammal nodes. Otherwise, both the further differentiation of the radial canals and their circular canals and their relation to the adjacent orders of the umbrella margin show the greatest similarity in both sections. The oldest family among the Cycloperiæ, the Flosculidæ (System, taf. xxxii.) show simple radial canals which are not branched inside the annular canal (as in the majority of the Craspedotæ). All the remaining Cycloperiæ (the Ulmaridæ and all Rhizostomæ) have branched radial canals, which branch inside the annular canal (as in the Cannotidæ among the Craspedotæ). In both cases peripheric canals of the annular canal run from it, outside it, into the tentacles, rhopalia, marginal lobes, &c. (§ 135).

§ 134. Coronal sinus of the Acraspedæ ("sinus coronaris, canalis coronaris"). The coronal sinus of the Acraspedæ (*cs*) already mentioned forms a very important arrangement, which has hitherto never been properly taken into account. It must not be confounded with the annular canal described above, but must be considered as an original and typical peculiarity of this section. Originally, it is a perfectly simple, cylindrical or flattened ring in the coronal part of the subumbrella, and is formed by the entire peripheric section of the coronal intestine, lying outside the distal margin of the four interradial cathammal nodes (*kn*) or ridges (*ks*), as in *Tesserantha* (Pl. XV. figs. 2–6, *cs*) and in *Tessera* (System, taf. xxi., *cs*), the closely allied ancestral form of all Acraspedæ. Although its ontogeny is still unknown, we may assume with certainty as regards its phylogeny, that it does not represent a secondary marginal communication of the four broad perradial pouches, but rather the marginal portions of the originally simple Scyphostoma stomach which has remained open, and lies outside the four interradial cathamma (*k*). As the latter are originally merely small fused nodes (as in the Tesseridæ and Peromedusæ), the intermediate perradial pouches at first merely form narrow horizontal fissures. As soon, however, as the nodes become elongated concrescentic ridges (as in the Lucernaridæ and Cubomedusæ) the insignificant horizontal fissures extend simultaneously into pouches of considerable size, at the cost of the broad coronal sinus, which is for the most part absorbed into them. The broad coronal sinus is thus reduced into a narrow coronal canal which keeps up the communication between the four large perradial pouches below the distal margin of their septal ridges (Pl. XVI. figs. 2, 3, 12, *cc*; Pl. XXVI.). The coronal sinus is most widely extended, and at the same time undergoes a very striking modification in the Peromedusæ, probably in direct correlation with the powerful extension of the four subumbral funnel cavities (*ci*) which here grow centripetally up as far as the pylorus (*gy*). The coronal sinus extends correspondingly upwards to the pylorus, and is divided into an upper and a lower part. The upper coronal sinus (fig. O, *cs'*) lies above the four small interradial septal nodes (*kn*), and may probably be really considered as a peripheric section of the central stomach (*gc*), whilst the lower coronal sinus (fig. O, *cs*) lies below the septal nodes and probably alone

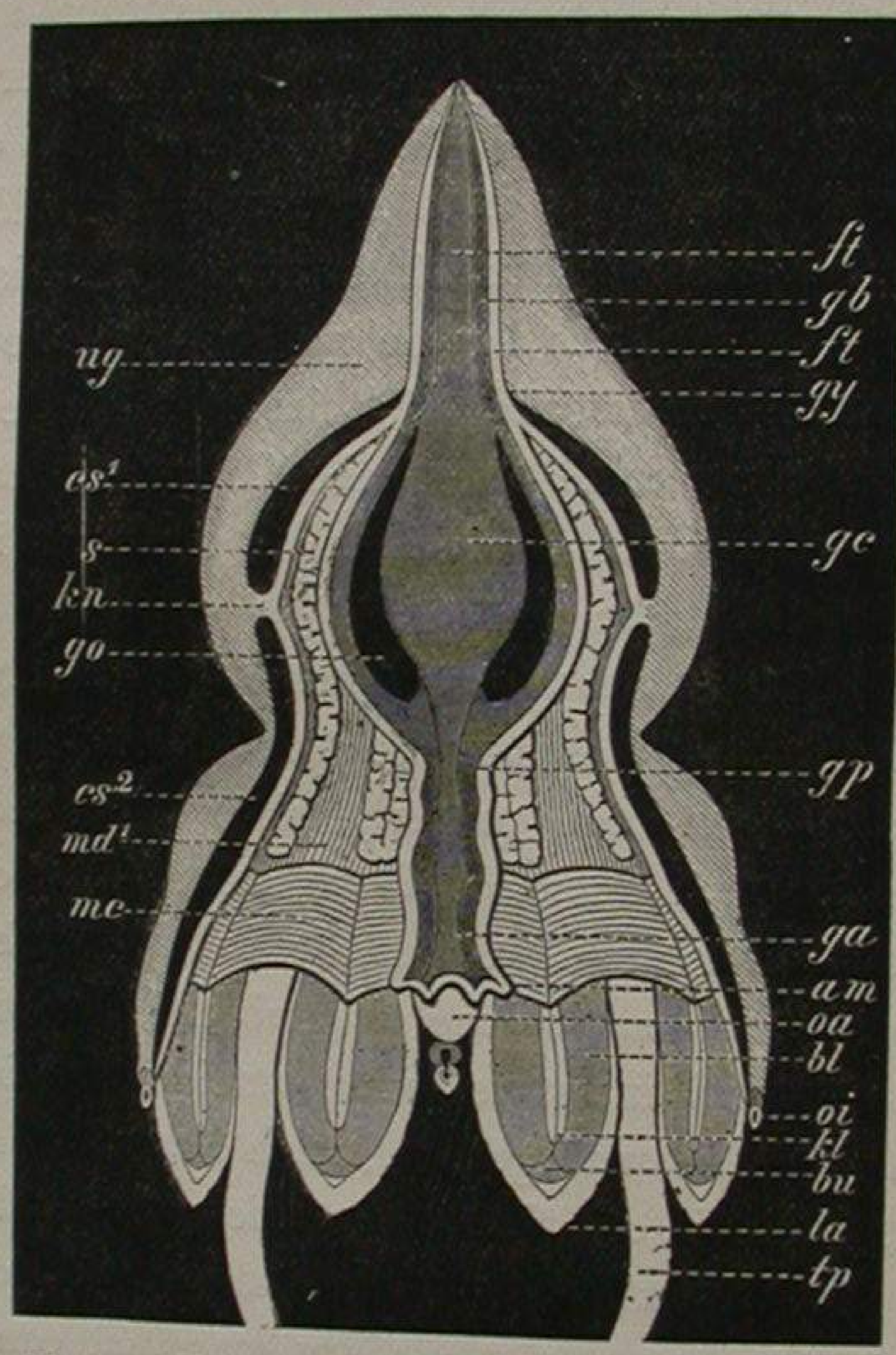


Fig. O. *Pericopla quadrigata* (Peromedusæ, Pericolpa).

Interradial section. (*ug*) Gelatinous umbrella. (*cs*) Coronal sinus (*cs'*) proximal part, (*cs²*) distal part, (*s*) Genitalia. (*kn*) Cathammal nodes. (*go*) Gastral openings. (*md*) Deltoid muscles. (*mc*) Coronal muscle. (*ft*) Tæniola. (*gb*) Niches of the basal stomach between the tæniola. (*gy*) Pylorus. (*gc*) Central stomach. (*gp*) Palatine opening. (*ga*) Buccal stomach (œsophagus). (*am*) Oral margin. (*oi*) Sense clubs (interradial). (*oa*) Ampullæ at their base. (*bu*) Horseshoe-shaped canal of the marginal lobes (*la*). (*kl*) Peronia between the two limbs of the canal (*bl*). (*tp*) Tentacles (perradial).

corresponds to the true primary coronal canal of the other Tesseroniæ. If this view be correct, the true gastral ostia (and at the same time the four perradial pouches) are represented by the horizontal cleft spaces between the four nodes, whilst the vertical fissures in the wall of the central stomach, which we have described as gastral ostia (fig. *O, go*) must be regarded as four cruciate pouches of the central stomach. It is possible, however, that the upper coronal sinus (*cs'*) has arisen from the secondary confluence of the four large perradial pouches, of whose long septa the distal part only remains (in the form of four small nodes). Among the Ephyroniæ (or Discomedusæ), the Cannostomæ only show similar conditions; *Nausithoe* and *Nauphanta* (Pls. XXVII., XXVIII.), and also *Collaspis* and *Atolla* (Pl. XXIX.) have preserved the coronal sinus (*cs*) along with the four primary cathamma (*k*) and their four intermediate perradial fissures up to the present time. In the other Ephyroniæ (Semostomæ and Rhizostomæ), the four cathamma are dissolved and have disappeared; the coronal sinus is consequently merged in the central stomach of which it forms the peripheric part.

§ 135. Peripheric processes of the gastrovascular system. In many lower Medusæ of both sections, the formation of the gastrovascular system is limited to the essential portions of the principal intestine and the peripheric coronal intestine already described. In the majority of Medusæ, however, there are additional, accessory processes of the vascular system, which serve for the nutrition of the peripheric organs. Such pre-eminently are the nutritive canals of the marginal organs, the tentacles and the organs of sense: they run out partly immediately from the distal ends of the radial canals or pouches, partly from the marginal coronal canal, connecting the latter among the Craspedotæ; besides these, special centripetal canals are sometimes developed, which grow out from the annular canal towards the middle of the subumbrella, and serve for the nutrition of the latter. They are found almost exclusively in the order of the Trachomedusæ, and are usually simple with cæcal proximal ends: *e.g.*, as in *Pectis* among the Pectyllidæ (Pl. V. fig. 2; Pl. VI. figs. 11, 20), in *Olindias* among the Petasidæ, and in part of the Geryonidæ (System, taf. xv. figs. 9, 10; taf. xviii. figs. 5, 8). The Cannotid *Spirocodon* is distinguished by dendritic ramification of the centripetal canals (System, p. 636, No. 588). The most remarkable of these peripheric processes of the vascular system among the Acraspedæ are those which pass into the marginal lobes or the velarium formed by their fusion. The velar canals of the Cubomedusæ (Pl. XXVI. fig. 8), the lobe canals of the Discomedusæ belong to this category. In the Typhloperiæ (§ 132), as in the Cubomedusæ, the latter never form anastomoses, whilst in the Cycloperiæ (§ 133) they form by repeated anastomoses a vascular network, varied in form, which often occupies not only the marginal lobes but a large part of the subumbrella (Pl. XXXII. fig. B, § 117). Finally, there are noticeable irregular gelatinous canals, sometimes simple, sometimes branched ("canales endocollares") which in the larger and older Discomedusæ grow out extensively from the coronal intestine into the gelatinous substance of the body (*e.g.*, *Chrysaora*, *Cyanea*, *Pilema*, *Crambessa*).

§ 136. Peripheric openings of the gastrovascular system. In the majority of all Medusæ the central mouth forms the only opening of the gastrovascular system. In single Medusæ of both sections, however, there are also small peripheric openings, which are in every case of a secondary nature. The most important of these are found on the umbrella margin, and may be generally termed marginal pores ("pori marginales").

Among the Craspedotæ the so-called excretory papillæ or subumbral papillæ (also termed marginal funnels or excretory funnels, "papillæ excretoriæ" or "subumbrales") belong to this category. These peculiar excretory organs of the umbrella margin are found exclusively in the order of the Leptomedusæ, among which, however, they are tolerably wide spread. They are small funnel-shaped or conical warts, which project in different numbers, on the distal margin of the subumbrella between the margin of insertion of the velum and the circular canal: they contain an evagination of the circular canal and open by a small aperture into the umbrella cavity (System, p. 119, taf. xi. fig. 13, *ex*; taf. xiii. fig. 5, *q*). Their number in many Eucopidæ (*e.g.*, *Octorchis*) and Æquoridæ (*e.g.*, *Polycanna*) is very considerable but indefinite. The flagellate cells of the endoderm in the subumbral papillæ are directed externally towards the marginal pore, so that the latter must be regarded as an "excretory opening" or "anus." Among the Acraspedæ, similar marginal axial openings have been long known in *Aurelia*, where they lie at the distal end of the eight adradial canals, where the latter open into the coronal canal; the ejection of fluid by these canals can be easily observed directly in the eight adradial marginal pores. These pores also occur in other Ulmaridæ. As, however, they are small and easily overlooked, it is possible that they are much more widespread than we are aware of at present. In some Medusæ, the tentacles seem also to have an opening at the distal end.

§ 137. Reproductive organs ("gonades, genitalia, sexualia," *s*). In all Medusæ the reproductive organs show very simple, homologous, and uniform conditions of formation, inasmuch as they everywhere consist essentially of reproductive glands ("gonades"), and are universally developed in the subumbral wall of the gastrovascular system. The two sexes show no essential difference, as the male spermaria develop in the same places, and in the same way as the female ovaries. On the other hand, there is an essential and thorough distinction between the two sections of the class Medusæ, inasmuch as the subepithelial layer of cells, which, as sexual epithelium or germinal epithelium, furnishes the two kinds of sexual cells, the spermatozoa, and the ova, belongs to the ectoderm in the Craspedotæ, to the endoderm in the Acraspedæ. In the former, the mature reproductive elements are therefore emptied immediately outside into the ectodermal umbrella cavity, whilst in the latter they first pass into the endodermal hollow space of the gastrovascular system, from which they are ejected by the mouth. The Craspedotæ are therefore Ectocarpæ, like the Hydropolyps, Siphonophoræ, and Ctenophoræ, whilst the Acraspedæ are Endocarpæ, like the Scyphopolyps and Corals (§ 19).

§ 138. Gonochorism and Hermaphroditism. Nearly all known Medusæ are of separate sexes, gonochoristic, only a very few are hermaphrodite. The Pelagic *Chrysaora* certainly belongs to the latter (System, p. 503, taf. xxxi.). Here, whilst the four interradial genitalia produce ova, roundish spermaria or testes-like sacs are simultaneously formed in very irregular number on the most varied parts of the sumbumbral wall of the gastro-vascular system, both in the genitalia, and on the oral arms, and also on different parts of the principal intestine, and of the coronal intestine, and even in the peripheric coronal pouches. *Chrysaora* is usually purely male in youth, hermaphrodite later on, and purely female when mature; it seems, however, also to furnish purely gonochoristic specimens, which during their whole lifetime form purely male or purely female sexual cells. Hermaphroditism similar to that of *Chrysaora* seems also to exist in the closely allied Linergidæ; the peculiar, regularly distributed subumbral vesicles of these Cannostomæ appear to develop spermatozoa, whilst their genitalia only produce ova (System, p. 493, taf. xxix.). Among the Craspedotæ part of the Narcomedusæ appear to be hermaphrodite; these and some other (probable) cases of hermaphroditism are not known with sufficient certainty. The sperm cells of the Medusæ are universally fine flagellate cells, not strikingly distinguishable from those of other Acalephæ. The egg cells are usually naked and amœboid in the Craspedotæ (Pl. I. fig. 8) but usually enclosed in fulcral capsules in the Acraspedæ (Pl. XX. fig. 7); in some Acraspedæ they contain a visible food-yolk and then come to more than 1 mm. in size (Pl. XXV. fig. 4).

§ 139. Genitalia of the Craspedotæ. The reproductive glands are developed in all Craspedotæ (in thorough and important contrast to the Acraspedæ) from the ectoderm of the subumbral wall of the gastrovascular system, and when mature, are emptied immediately into the umbrella cavity. They are sometimes formed more in the central part of the gastrovascular system, sometimes more in the peripheric part; in the first case we call them gastral genitalia, in the second case, vascular genitalia. Gastral genitalia in the subumbral wall of the central stomach, and the œsophagus proceeding from it, are found in the two orders of the Anthomedusæ (Pl. I.), and the Narcomedusæ (Pls. X.–XII.), whilst on the other hand, the two orders of the Leptomedusæ (Pl. II.), and the Trachomedusæ (Pls. III.–VIII.) have vascular genitalia in the subumbral walls of the peripheric radial canals. There are, however, isolated exceptions in both groups; the central gastral genitalia sometimes grow centripetally and extend from the stomach also on to the peripheric canals (*e.g.*, *Nemopsis* among the Anthomedusæ, System, taf. v. figs. 6–9); in many they even pass mostly or entirely on to the gastral pouches of this order, which originate from the proximal part of the radial canals (Pls. IX., XIII., XIV.). In other cases the reverse occurs, and the peripheric vascular genitalia extend upon the central stomach (*e.g.*, *Staurostoma*, *Staurophora*, *Orchistoma* among the Leptomedusæ, System, taf. viii. fig. 6; taf. xv. figs. 3–5). If we consider the Craspedotæ to be a monophyletic group of animals, the gastral production of the genitalia may probably be regarded in general as the older and original condition from which the vascular production of the reproductive glands has been developed later, or we may assume that the subumbral wall of the entire gastrovascular system originally produced sexual cells, and that these productions were distributed later on the principal intestine and coronal intestine. If on the contrary (and with more probability) we consider the Craspedotæ as a polyphyletic group, the vascular genitalia and the gastral genitalia may have arisen in the different orders, independently of one another.

§ 140. Gastral genitalia of the Craspedotæ. The simplest and most primitive condition of the genital formation is shown in the section of the Craspedotæ in such genera as have only a simple reproductive organ, a circular genitalium in the subumbral gastral wall, having the mouth placed in the middle. This condition is shown by the Codonidæ among the Anthomedusæ, and also by isolated genera among the Anthomedusæ. The Codonidæ (System, p. 10, taf. i., ii.) are distinguished by a long thin œsophagus, extending in a vertical direction, in whose wall the reproductive cells are regularly developed, so that the genital ring keeps the form of a cylindrical tube. In contrast to this formation the Narcomedusæ have a flat, broad, gastral sac, extending in a horizontal direction, so that the genital ring in its subumbral wall likewise appears flat and broad (*Polycolpa*, Pl. X. fig. 1). Whilst in many Narcomedusæ, the central genital ring remains quite simple, in others, it extends centripetally on to the peripheric radial pouches, and in many it is finally limited to the radial pouches. It is divided into the same number or double the number of separate genital pouches, which originally appeared as radial canals (comp. the System der Medusen, pp. 312, 327, 335, 347, taf. xix., xx.). In *Æginura* (Pls. XIII., XIV.), the genitalia are formed by sixteen internemal gastral pouches, in *Pegantha* (Pl. XIII. fig. 3) by a corona of separate sacs, which evaginate separately into the periphery of the stomach and hang down in the separate subumbral lobe cavities of the umbrella corona (Pl. XI. fig. 3). In most Anthomedusæ the originally simple genital ring (in the Codonidæ) is divided in the same way, in four or eight radial pieces. The radial division first takes place by the four interradial areæ remaining free from sexual production, whilst four perradial genitalia lie in the four angles of the stomach (System, taf. iii. figs. 1, 2; taf. iv. 1, &c.). Each of these may, however, be re-divided into two halves, which are separated by the perradial longitudinal muscle of the angles of the stomach (*Thamnostylus*, Pl. I.; System, taf. iv., figs. 3, 10). Finally, these eight adradial reproductive glands may be placed near each other and fused in the four interradia in such a way that the inverted limbs of each two adjacent genitalia, originally separate, are connected into a single gland; so that, finally, there are four interradial genitalia in the side walls of the stomach (System, taf. v. figs. 1, 3; taf. vi. fig. 3, 15, &c.). We have, therefore, apparently the same condition as in many Acraspedæ; only in the latter, the interradial position of the four bow-shaped genitalia is a primary appearance, whilst in the Craspedotæ it is secondary (or rather tertiary).

§ 141. Vascular genitalia of the Craspedotæ. In antithesis to the gastral genitalia of the Anthomedusæ and Narcomedusæ, we find in the Leptomedusæ and Trachomedusæ the reproductive glands are usually limited to the subumbral wall of the radial canals, of which they sometimes occupy the entire length, sometimes only a part of it (proximal, middle or distal part). As in most Craspedotæ the number of the radial canals amounts to four, they are usually also four perradial genitalia (Pl. II.). This primitive number is doubled in those Craspedotæ in which four secondary interradial canals have arisen between the four primary perradial (Melicertidæ, Octocannidæ, Aglauridæ, Pectyllidæ, Pls. III.–VIII.; System, taf. viii. fig. 10; taf. xvi., xvii.). In the Æquoridæ, where the number of the radial canals multiplies indefinitely (20–80 and over), the number of the genitalia fastened to them increases correspondingly (System, taf. xiv., xv.). In the simplest case, each reproductive gland forms a simple, ridge-shaped thickening in the subumbral wall of each radial canal. In many Craspedotæ, however, this ridge is divided into two lateral halves, between which the median line of each wall remains free from the sexual products. The two paired halves of these reproductive ridges lie further asunder in proportion to the developement of a longitudinal radial muscle in this median line (Pl. VIII. fig. 9). They sometimes hang down in the umbrella cavity as two parallel folds (*e.g.*, Æquoridæ), sometimes extend like leaves in the surface of the subumbral wall (Geryonidæ). The canal usually forms a cæcal evagination into the genital ridge on the subumbral wall of the radial canal, whether it remains simple, or is divided into two paired halves, so that it assumes the form of a pendant vesicle, sac, or tube (Pls. III.–VIII.). Further complications in its formation also arise when the genital band is arranged in folds; the depressions between the separate folds may also become so deep that it is divided into numerous separate vesicles (*e.g.*, *Olindias*, System, taf. xv. fig. 11). The Octorchidæ, a sub-family of the Eucopidæ, are distinguished by each of the four genitalia, being divided into two pieces lying far apart; the proximal part lies on the ascending radial canal of the umbrella peduncle (fig. N, s^2), the distal part on the descending radial canal of the subumbrella (fig. N s', p. 190); here eight genitalia also come on four radial canals.

§ 142. Genitalia of the Acraspedæ. The reproductive glands in all Acraspedæ (in constant and typical contrast to the Craspedotæ) are developed from the endoderm of the gastrovascular system. The sexual products in process of development first appear from the subepithelial germinal layer, in the depth of the gelatinous mesoderm, and are there enclosed in special fulcral capsules (Pl. XXV. fig. 7, *zz*). When mature, they break through these chorion sheaths, and fall freely into the gastral space from which they are emptied out through the oral opening. In the Acraspedæ, as in the Craspedotæ, the formation of the reproductive cells takes place sometimes more in the central part of the gastrovascular system, sometimes more in the peripheric part. Whilst in the Craspedotæ, the central gastral genitalia appear to be the primary formation, and the peripheric vascular genitalia to be derived secondarily from them, in the Acraspedæ, the development of formation is probably reversed. It is precisely the older and more simply constructed Tesseroniæ (the Stauromedusæ, Peromedusæ, and Cubomedusæ), that have bursal genitalia, which are developed in the subumbral wall of the four wide radial pouches, or of the wide peripheric coronal connecting them; in the younger and more highly developed Ephyroniæ (the Discomedusæ), the genitalia pass more and more centripetally from the subumbral wall of the radial pouches or peripheric coronal sinus, or to the subumbral wall of the broad, flat central stomach, so that they here appear again as gastral genitalia. Another still more important distinction between the two sections consists in the fact that in the Craspedotæ the four radial pieces of the reproductive apparatus lie originally perradially, whilst on the contrary, in the Acraspedæ they lie originally interradially. Whilst in the Ephyroniæ, among the Acraspedæ, there are usually four interradial glands (more rarely divided into eight pieces), in the Tesseroniæ, on the contrary, there are usually eight separate pieces, which, however, always belong in pairs to the four interradial genitalia.

§ 143. Bursal genitalia of the Acraspedæ (Tesseroniæ). In all Tesseroniæ the central stomach remains free from the sexual productions, and the reproductive glands are exclusively, or for the most part, developed in the subumbral wall of the four

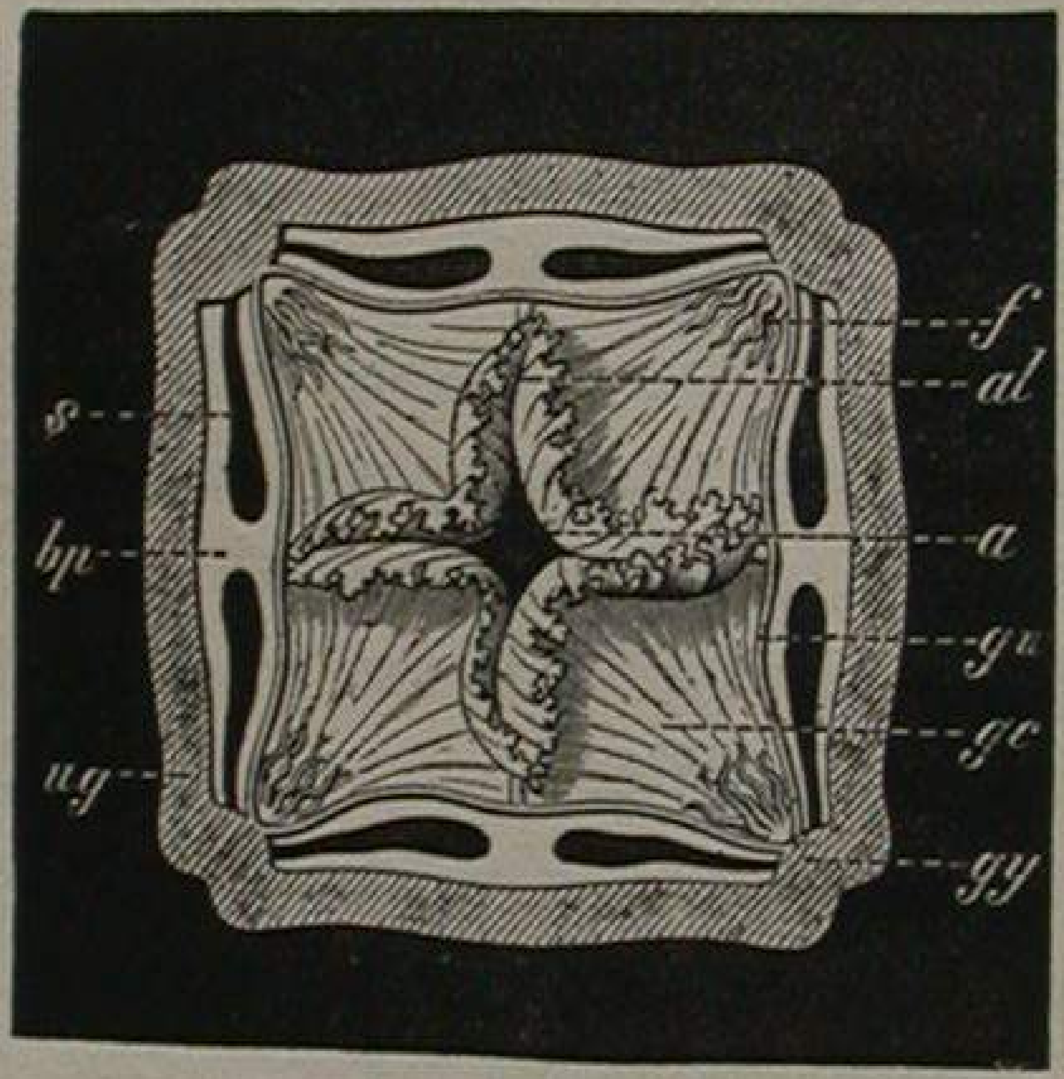


Fig. P. *Procharagma prototypus* (Cubomedusæ, Charybdeidæ).

Horizontal transverse section below the stomach, whose subumbral wall (*gc*) is completely visible, in the middle, the oral opening (*a*) with the four perradial oral lobes (*al*). The gastral filaments (*f*) are placed upon the four interradial pyloric valves (*gy*). (*gw*) Subumbral wall of the two gastral pouches (*bp*). (*s*) Genitalia. (*ug*) Gelatinous substance of the umbrella.

perradial pouches. In the most simple case, four interradial horseshoe-shaped glands are formed, which include the four interradial cathammal nodes (*kn*) or the proximal ends of the four narrow septal ridges (*ks*) in the concavity of their U-shaped proximal ends, whilst the two limbs of each arch project into the two adjacent perradial pouches (Pl. XV. figs. 2–6). The oldest and simplest of all Acraspedæ, the Tesseridæ (System, taf. xxxi.), and some of the closely allied Lucernaridæ (*Halicythus*), show this most simple and apparently original condition. In all other Tesseroniæ (and also in most Lucernaridæ and in all Peromedusæ and Cubomedusæ) each of the four interradial genitalia is divided into two separate halves, as the convex proximal ends of the horseshoe-shaped gland (which encloses the cathammal nodes) have undergone retrograde formation and disappeared, so that only the two limbs remain. These lie on the two sides of the interradial cathammal septum belonging to them, but in two different perradial pouches, so that each pouch contains the inverted halves of two adjacent pairs of genitalia. In the Lucernaridæ (Pls. XVI.–XVII.) and in the Peromedusæ (Pls. XVIII.–XXV.) the eight reproductive glands, which are connected in pairs, lie as leaf-shaped swellings in the subumbral wall of the four perradial pouches themselves. In the Cubomedusæ (Pl. XXVI.), on the other hand, they are only connected with the four perradial pouches by a narrow marginal insertion (immediately next to the fused streak of the cathamma but on its subumbral side), and otherwise project as eight free genital leaves into the hollow space of the pouches, of which they occupy the larger part (fig. P, *s* ; System, taf. xxi.–xxvi.). In the different Tesseroniæ we find many stages of development in the structure of the genitalia. In the simplest case, in the Tesseridæ, the sexual glands are merely simple ridges or pads, originated by wheel-shaped thickenings of the endoderm of the subumbral wall (like the most simple vascular genitalia of the Craspedotæ) ; a corresponding ridge of the fulcral lamella serves as supporting frame ("sterigma") for the subepithelial germinal cells. Further (in part of the Peromedusæ), more or less complicated folds are formed, which rise above the subumbral wall and project freely into the space of the pouches ; the supporting frame of the fulcral plate ("sterigma") likewise rises higher and attains greater development (Pls. XXIII. fig. 38, 39 ; Pls. XXV. fig. 5–7). In the Cubomedusæ the sterigma is developed into a broad, thin leaf, which is only connected with the supporting plate of the subumbrella at the base of insertion (near the cathammal ridge), and bears sexual cells on both its free surfaces (axial as well as abaxial) ; its freer margin is sometimes lobed or branched dendritically (*Chirodropus*, System, taf. xxvi.). The reproductive glands attain their most complicated structure in the Lucernaridæ (System, p. 386). Each of the eight reproductive leaves is here divided into numerous, separate follicles, each containing a genital sinus with excretory passage, and each follicle is sometimes again composed of a number of smaller sacs (Pl. XVII. figs. 17–19).

§ 144. Gastral genitalia of the Acraspedæ (Ephyroniæ). Whilst in all Tesseroniæ the subumbral wall of the four perradial pouches is the place of origin of the reproductive glands, in the Ephyroniæ or Discomedusæ it has migrated centripetally from the pouch wall to the subumbral wall of the central stomach. This centripetal change of locality must therefore be phylogenetically considered as secondary, since the younger and more highly developed Ephyroniæ are clearly derivable from the older and more simply constructed Tesseroniæ, and since the lowest and oldest grades of development of the former present points of connection with the latter. In some Cannostomæ (especially some Ephyridæ) in which the four primary interradial cathammal nodes are still preserved, we still find four interradial horseshoe-shaped genitalia, which enclose the nodes by their concave proximal arches and whose distal diverging limbs still lie in the subumbral wall of the coronal sinus or of the four perradial pouches (System, pp. 467, 480, 492 ; taf. xxvii., xxviii., xxix.). The pairs of limbs are here often divided into separate halves, as the connecting proximal arch has become lost (*Nauphanta*, Pl. XXVII., XXVIII.; *Atolla*, Pl. XXIX.). Whilst the first and oldest order of the Discomedusæ, the Cannostomæ, still present more or less the original genital conditions of the Tesseroniæ, these have disappeared entirely in the other Discomedusæ, in all Semostomæ and Rhizostomæ. As here the four primary cathammal nodes are resorbed, and both the four perradial pouches, separated by them and the coronal sinus are consequently merged in the flat central

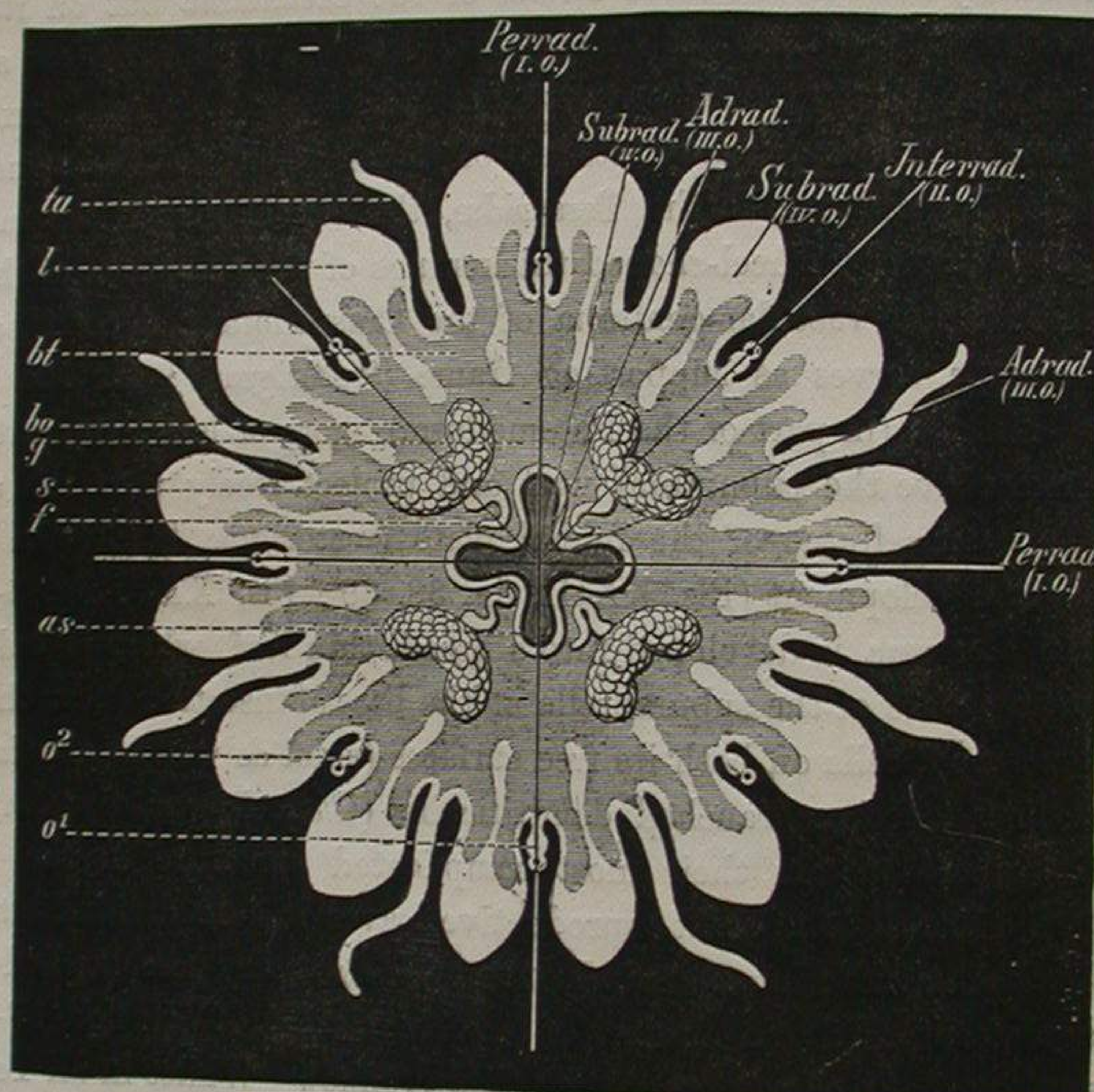


Fig. Q. *Zonephyra pelagica* (Discomedusa, Ephyrida).

Subumbral view, giving the four orders of transverse axes (with twice as many radii). The oral cross (*as*) and the four perradial sense clubs (o^1) lie in the four perradii (Order I.). The gastral filaments (*f*), the genitalia (*s*), and the four interradial sense clubs (o^2) lie in the four interradii (Order II.). The eight tentacles (*ta*) and the tentacular coronal pouches (*bt*) lie in the eight adradii (Order III.). The sixteen marginal lobes (*l*) lie in the sixteen subradii (Order IV.). Sixteen bifurcate coronal pouches, eight tentacular (*bt*) and eight rhopalar (*bo*) radiate from the central stomach (*g*).

stomach, four simple interradial genitalia usually lie in the subumbral wall of the central stomach, lying nearer its centre in proportion as the Ephyroniæ character is more highly developed and the peripheric umbrella corona becomes extended at the cost of the central umbrella disk. The delicate, thin gastrogenital membrane (*gg*) on whose endodermal inner surface the four genitalia are situated, is certainly simply termed the bottom of the stomach or subumbral wall of the central stomach; but it must always be borne in mind that it is only its axial or proximal part which really deserves this name, whilst its abaxial or distal part rather corresponds originally to the subumbral wall of the coronal sinus and the four perradial pouches at its proximal margin, which have become merged in the central stomach in consequence of the dissolution and resorption of the four interradial cathamma. The delicate gastrogenital membrane is frequently (namely, in the Pelagidæ and Cyaneidæ) evaginated downwards out of the gastral cavity (like a hernia), and forms four pendent gastrogenital pouches, in the bottom of which the four frill-shaped genital bands lie ("extraversio gonadum," Pls. XXX., XXXI.; System, p. 470, taf. xxx.). In most Rhizostomæ, on the contrary (and also in the Aurelidæ), the thin gastrovascular membrane invaginates inwards into the gastral cavity (like a replaced hernia "intraversio gonadum," System, p. 470, taf. xxxiv.–xl.). If the four invaginated inner gastrogenital pouches approach each other in the centre so that they touch, they may become fused together and enter into communication by breach of the fused walls. In this way there arises the remarkable formation, which has been already described, of the "subgenital vestibule," of which the roof is formed by the cruciate gastrogenital membrane, the floor by the brachial disk (comp. above § 96, p. lxxvii., woodcut, figs. G and H, and Pl. XXXII.; also in the System, pp. 471–473, taf. xxxviii.–xl.). These and other modifications of the gastrogenital formation of the Ephyroniæ have already been described comparatively in the System der Medusen (1879, pp. 467–473). They are all derivable from the four simple horseshoe-shaped genitalia, which we find in the subumbral wall of the periphery of the stomach (or of the coronal sinus) in *Ephyra*, the oldest and simplest form of the Discomedusæ (fig. Q). In this and other morphological respects, *Ephyra* remains one of the most important types among all Medusæ.

DESCRIPTION OF THE SPECIES.

CLASS I. CRASPEDOTÆ, Gegenbaur, 1856.

CRYPTOCARPÆ, Eschscholz, 1829. GYMNOPHTHALMÆ, Forbes, 1848.
HYDROMEDUSÆ, Carus, 1863. APHACELLÆ, Hæckel, 1878.

Medusæ without gastral filaments or phacellæ; with ectodermal genitalia (or sexual products formed from the external germinal layer); with a true velum (always without a velarium); without true marginal lobes of the umbrella; with double centralised nerve-ring. Phylogenetic descent (probably universal) and ontogenetic descent (now established for the majority) derived from hydroid-polyps without gastral filaments or from hydrostomæ. Ontogenesis chiefly alternation of generations, often with metamorphosis. The sexual craspedote generation is formed by lateral gemmation from the asexual hydrostoma generation.

Order I. ANTHOMEDUSÆ, Hæckel, 1877.

Craspedotæ without marginal vesicles and otolites, with ocelli at the bases of the tentacles. Genitalia in the external or oral wall of the stomach. Number of the radial canals almost always four, very rarely six or eight. Ontogenesis chiefly alternation of generations, often with metamorphosis. The trophosome of the asexual generation is a hydroid-polyp of the order Tubulariæ.

Family, MARGELIDÆ, Hæckel, 1877.

MARGELIDÆ, Hæckel, System der Medusen, 1879, p. 68, taf. v., vi.

Anthomedusæ with four or more simple or branched oral styles, with four or eight separate genital sacs in the wall of the stomach, with four narrow simple radial canals, and with simple unbranched tentacles, which are sometimes distributed equally, sometimes grouped in four or eight bundles.

Sub-family, THAMNOSTOMIDÆ, Hæckel, 1867.

Margelidæ with branched or compound oral styles, and tentacles equally distributed, not grouped in bundles.

Thamnostylus,[1] Hæckel, 1879.

Margelidæ with branched or compound oral styles and only two opposite perradial tentacles.

[1] θάμνος, bush; στῦλος, style.

The genus *Thamnostylus* with the single species *Thamnostylus dinema* (Pl. I.) is the only deep-sea Anthomedusa which I found among the collections of the Challenger expedition. It belongs to the family of the Margelidæ, to the sub-family of the Thamnostomidæ, and is the only dissonematous genus of this sub-family, with only two developed opposite marginal tentacles (like *Cubogaster* among the Cytaeidæ).

The genus *Thamnostylus* is distinguished by the remarkable development of the oral organs; the long central œsophagus, which projects below far out of the central stomach, and the four strong numerously branched oral styles which spring from its basis are much larger in proportion to the rest of the body in *Thamnostylus* than in the other Margelidæ. In other respects *Thamnostylus dinema* appears at the first glance a very abnormal and peculiarly formed Anthomedusa. Closer consideration and comparison with other Craspedotæ shows, however, that its structure is not special or peculiar to itself. We rather find in it a peculiar combination of striking characters, which appear otherwise combined in other Anthomedusæ. The Margelidæ *Limnorea triedra* and *Favonia octonema* described by Péron (1809) appear to come nearest to it (Péron, Tableau des Méduses, No. 8, Annales du Museum d'Hist. Nat., tom. xiv. p. 329). Leseur has given a very good figure of both (in pl. iii. of his Recueil des Planches inédites des Méduses, figs. 3, 5), which clearly shows a near relation to *Thamnostylus* and *Nemopsis*. Here the œsophagus also projects out of the umbrella cavity, and is surrounded by a bush of blood red much-branched oral styles which spring from its basis. On the ground of these figures (which have been copied by Blainville (1834) and Milne-Edwards (1849), L. Agassiz has placed *Limnorea* and *Favonia* among the Rhizostomata. (Compare my System der Medusen, 1879, p. 87, and also the figure of *Nemopsis heteronema*, p. 93, taf. v. figs. 6-9).

Thamnostylus dinema, Hæckel (Pl. I.).

Thamnostylus dinema, Hæckel, 1879, System der Medusen, p. 85, No. 95.

Umbrella hemispherical, twice as broad as high. Stomach quadrangularly pyramidal, reaching almost to the plane of the velum. Genitalia four egg-shaped swellings in the wall of the stomach; œsophagus quadrangularly prismatic, twice as long as the stomach, projecting far out of the umbrella cavity; four oral styles a little shorter than the œsophagus, springing from its basis, 6 to 8 times dichotomised; two opposite long, strong tentacles, several times longer than the breadth of the umbrella. Horizontal diameter of the umbrella, 16 mm.; vertical diameter, 8 mm.

Habitat.—Antarctic Ocean, south from the Kerguelen Islands. Station 153. Lat. 65° 42′ S., long. 79° 49′ E. Depth, 120 fathoms.

The form of the umbrella is almost hemispherical, half as high as its greatest breadth somewhat above the umbrella margin. The gelatinous substance thick, gradually and regularly thinning out towards the margin. The exumbrella (or the external convex surface of the umbrella) has a finely punctured appearance, as small round, stinging papillæ are scattered equally over it (fig. 1). The subumbrella (or the inner concave surface of the umbrella) shows a strong annular muscular system, and eight narrow radial or longitudinal muscles, of which four perradial (*mp*) accompany the four radial canals, and four interradial run in the middle between the radial canals (*mi*). Their proximal ends pass into the longitudinal muscles of the stomach and the œsophagus. The velum projects from the umbrella margin towards the interior as a somewhat broad muscular membrane, and narrows the entrance to the umbrella cavity considerably. The umbrella cavity itself is flat and limited in size as the central third of it is occupied by the large gastral pyramid with the reproductive sacs.

The umbrella margin is thickened into a roll, and pigmented red. At the points where the four perradial canals open into the marginal circular canal, the rim of the umbrella margin swells into four thick ocellar-bulbs with dark red pigment. Of these the two opposite are without tentacles, whilst the two others, alternating with the former, bear very long and strong tentacles (fig. 1). These are several times longer than the diameter of the umbrella, cylindrical, thickened like a club at the base, and beset with rings of thread-cells along the entire length.

Gastrovascular system. The central part consists of the quadrangularly pyramidal central stomach, in whose wall the reproductive sacs lie; and of the projecting œsophagus, double the length of the central stomach, from whose basis spring the four multibranched bunches of the oral styles. The peripheric part of the gastrovascular system consists of the four perradial canals which spring from the basis of the central stomach and open into the circular canal at the umbrella margin ; a canal passes from the latter into each of the two tentacles, and traverses its whole length. These two tentacle canals, as well as the four radial canals and the circular canal uniting them, are rather narrow and ribbon-shaped, and show nothing special. On the other hand, the central part of the alimentary apparatus has a somewhat complicated construction.

The central stomach (figs. 1–3, *gc*) has the form of a quadrangular pyramid whose height is nearly equal to the diagonal of its basis, and whose truncated end, which has a downward direction, is the starting-point of the long œsophagus and of the four tree-like oral styles. The quadrate basis of the quadrangular stomach pyramid occupies the central third of the subumbrella, and is formed by the lower surface of the gelatinous umbrella; the four radial canals open into the central cavity at the four angles of the square, and pass thence in the form of semi-cylindrical grooves to the four perradial corners of the gastral pyramid. The thickened wall of these grooves forms the midrib of the four leaf-shaped genitalia or pinnated "reproductive leaves."

Genitalia. Each reproductive leaf forms an egg-shaped swelling, with the rounded basis turned upwards and the truncated point turned down. As four to five deep transverse grooves on both sides of the midrib divide the genitalium into the same number of lobes, it assumes the form of a delicate pinnated leaf. Its five to six pairs of pinnules become longer from the top to the bottom and are delicately notched at the edges like many fern-fronds (fig. 6). Numerous large and small ova appear lying very closely together on the upper surface of the single pinnated leaves. The ova are large, naked amœboid cells, of irregular roundish or polyhedral outline, which enclose a large clear germinal vesicle. In this nucleus a dark germinal spot of considerable size (nucleolus) is visible which contains a distinct nucleolinus (fig. 8). The four reproductive leaves occupy the greater part of the thickened wall of the central stomach, so that only four narrow interradial areæ of its external surface are free from them (fig. 3). More minute investigation, however, shows that only the perradial midrib and the aboral basal parts of the reproductive leaves are integrate portions of the wall of the stomach itself, from the ectoderm of whose angles they are developed. On the other hand, the oral points of the genitalia and the larger part of their lateral margins are free, and only lie superficially on the external wall of the stomach. Between the colourless ova, as in the remaining parts of the wall of the stomach and of the umbrella margin, there are numerous fine granules of the same blood-red pigment (insoluble in spirit of wine) which causes the red colour of the oral styles and of the stinging capsules of the tentacles.

The oral styles ("stomostyli," figs. 1–5). In this species, as in several other Margelidæ (*Hippocrene*, *Nemopsis*, *Rathkea*, *Limnorea*, &c.), the characteristic oral styles form extremely delicate multi-branched bunches, distinguished by their blood-red colour. These branches are, however, more numerously and more strongly developed here in proportion to the rest of the body than in all the other Margelidæ. When fully extended (as it appears in the particular specimen before us) they occupy a space exceeding that of the whole umbrella. The four perradial strong stems of the oral styles are nearly as thick as the swollen basal pieces of the tentacles and spring from the truncated point of the central stomach round about the basis of the long œsophagus almost at the height of the plane of the velum (fig. 1). Each of the four strong stems divides directly into two thick principal branches, which again bifurcate after a short course. These branches appear to dichotomise at least six or eight times (sometimes oftener), so that the aggregate number of the terminal branches amounts to more than a thousand. The calibre of the branches becomes smaller with each new bifurcation, so that the four basal principal stems are at least six to eight times as thick as their terminal branchlets. Each of the latter ends with a spherical stinging knob, which is composed of numerous longitudinally extended, radially placed thread cells, and bears long fine cnidocils (fig. 5 *n*). The minute structure of the oral styles and their branches is the same as in other Margelidæ. Their principal mass forms an endodermal cellular axis, consisting of a single row of flat coin-shaped endoderm cells placed in series like a rouleau of money. Their nuclei, surrounded by an area of protoplasm, lie in their centre (fig. 5 *d*), and distinctly form a connected axial cord in the centre of the whole column of cells (which in the solid oral styles of other Margelidæ, as in the similar tentacles of the Narcomedusæ and many hydroids, were erroneously considered by former observers to be a "central canal"). This solid endodermal cellular axis is surrounded by a thin, but firm and very elastic, strongly refringent, supporting lamella, by whose elasticity the extension of the contracted oral styles is effected on the cessation of the contraction of the muscle (figs. 5–7, *z*). The muscles, which in a great measure shorten and at the same time thicken the oral styles by their contraction, form a thin lamella, composed of longitudinal, parallel fibres. This muscular plate, here as in the tentacles, is a product of the ectoderm, whilst the elastic lamella is secreted by the endoderm. The ectoderm covering of the oral styles consists of flat epithelial cells which partly form flagellate capsules, partly stinging capsules, and also contain numerous granules of blood-red pigment. The stinging cells of the end knobs are not pigmented.

The œsophagus or "gullet," which may also be termed "proboscis," and which springs from the oral opening of the central gastral pyramid in the centre between the four stems of the oral styles, is two or three times as long as the gastral pyramid, and projects far beyond the velar opening of the umbrella cavity. It is quadrangularly prismatic, of equal thickness in the two upper thirds, whilst the lowest third is swollen into an egg-shaped pharynx without muscles. The latter is divided from the lowest part of the œsophagus, which bears the quadratic oral opening, by a circular constriction ("strictura palatina") (fig. 4). The thickened oral edge bears a circle of stinging knobs (figs. 4, *an*). The four perradial corners of the œsophagus project strongly, whilst the concave lateral surfaces lie in folds.

Order II. LEPTOMEDUSÆ, Hæckel, 1866.

Craspedota partly without, partly with marginal vesicles, these, when present, developed from the insertion of the velum, with ectodermal otolite cells. Ocelli at the bases of the tentacles sometimes present, sometimes wanting. Genitalia always in the course of the radial canals. Number of the radial canals varying, sometimes four, six, or eight, sometimes very large, sixteen, thirty-two, eighty, or even several hundred. Velum thin and delicate. Ontogenesis, usually alternation of generations, often with metamorphosis. The trophosome of the asexual generation is a hydroid-polyp of the order Campanulariæ.

Family, Cannotidæ, Hæckel, 1877.

Cannotidæ, Hæckel, System der Medusen, 1879, p. 140, taf. ix.

Leptomedusæ without marginal vesicles, with four or six radial canals, which are branched, forked, or pinnated, in whose course the genitalia lie.

Sub-family, POLYORCHIDÆ, A. Agass., 1862.

Cannotidæ with four or six radial canals, which are pinnated, or furnished with cæcal side branches which do not reach into the circular canal.

Ptychogena,[1] A. Agass., 1865.

Cannotidæ with four pinnated radial canals, whose alternating pinnated branches bear several leaf-shaped cleft, indented or compound genitalia. Stomach a flat, wide pouch, without special oral lobes.

The genus *Ptychogena* was established by A. Agassiz, in 1865, for the North American deep-sea form, *Ptychogena lactea* (North American Acalephæ, p. 137, fig. 220). A second somewhat different deep-sea species from the North-Atlantic Ocean (*Ptychogena pinnulata*) is here described, and completes Agassiz's short definition. *Ptychogena* is the connecting link between the apparently very different genera *Gonynema* and *Staurophora*. Whilst the stomach is a long tube in *Gonynema*, and is entirely rudimentary in *Staurophora*, in *Ptychogena* it forms a flat, wide-opened quadrate pouch, whose four corners pass conically contracted without definite limits into the four radial canals; and whilst in *Gonynema* the pinnated branches of the genitalia are entirely limited to the radial canals, but in *Staurophora* run centripetally to the centrum of the cross of these canals, they are developed in an intermediate degree in *Ptychogena*. They there occupy only the proximal half of the radial canal, but pass from it some distance upon the wall of the stomach. Both North Atlantic species of *Ptychogena* appear to be true deep-sea Medusæ. A. Agassiz writes of it as follows (*loc. cit.*, p. 139):—

"This Medusa, like *Tima*, swims at a considerable depth below the surface. The action of the light and increase of temperature of the surface is sufficient to kill them in the course of half an hour; the moment they are brought to the surface the spherosome loses its transparency, the genital organs become dull, and the Medusa is soon completely decomposed. This action is much more rapid than anything I have noticed even in Ctenophoræ, *Mertensia* being the only genus in which the decomposing effects of light and heat are at all equal to what is produced here. This Jellyfish must be a deep-water species, as they have only been found during a single fall, and then only for a few days, when they seemed quite abundant."

These remarks most probably are applicable to *Ptychogena pinnulata* as well as *Ptychogena lactea*. The example of the former in the Challenger collection was found at a depth of 1250 fathoms.

[1] Πτυχή, turning; γονή, reproductive organs.

Ptychogena pinnulata, Hæckel (Pl. II.).

Ptychogena pinnulata, Hæckel, 1879, System der Medusen, p. 148, No. 150.

Umbrella depressed, three to four times as broad as high. Stomach quadrangular, very flat and wide, one-third of the diameter of the umbrella, with slightly-raised oral margin, which is prolonged at the corners into four short lobes. Genitalia, four broad, almost circular, pinnated leaves, which occupy the proximal half of the radial canals, at whose conically-enlarged origin they pass into the wall of the stomach, each leaf with twenty to thirty pairs of alternating pinnated branches, which are not divided, and which bear leaf-shaped, deeply-notched reproductive lobes at the lower free margin. Two to three hundred long tentacles with numerous marginal clubs between. Horizontal diameter of the umbrella, 50–60 mm.; vertical diameter, 20–30 mm.

Habitat.—North Atlantic Ocean. I was able to investigate several well-preserved specimens in spirit of this North Atlantic species from the Copenhagen Zoological Museum, which had been found by Captain Moberg between Ireland and Iceland (lat. 59° 7′ N., long. 13° 32′ W. from Greenwich). A fragment of a Cannotid, which I discovered in a jar of the Challenger collection, from Station 50 (May 21, 1873), in the same jar as *Pectyllis arctica* (dredged near Halifax from a depth of 1250 fathoms, lat. 42° 8′ N., long. 63° 39′ W.), appears identical with these specimens. Although this decomposed fragment hardly included the quadrant of a disc, it was still sufficient to identify it completely with these Copenhagen specimens from which the following description and drawing are taken.

Ptychogena pinnulata shows, on the whole, the same formation of the umbrella as the closely-related *Ptychogena lactea* (*loc. cit.*). The umbrella is depressed, projecting somewhat more strongly in the centre. The horizontal breadth at the opening of the umbrella cavity is from two to three times as great as the vertical height. The gelatinous substance of the umbrella is tolerably firm, but thin, and diminishes in thickness rather rapidly from the centre towards the margin; in the centre its thickness amounts to 5 or 6 mm. The exumbrella is smooth, without special distinct characters.

The umbrella margin is thickly beset with two rows of appendages, an outer row of long tentacles, and an inner row of short marginal clubs (figs. 3, 4). The number of tentacles or marginal filaments amounts to from 200 to 300; in one specimen I counted 320. There are usually from 70 to 80 upon each quadrant. They lie thickly pressed together. The swollen basis or tentacle bulb is 1·8 mm. long, 0·6 mm. broad, and has the form of a half-oval leaf lying in the meridian plane. The abaxial margin is strongly arched, rising gradually from the basis, and then falling off rapidly. The axial margin is straight or sinuated a little concavely. The marginal filament itself is very thin, and in the spirit specimens before me nearly as long as the diameter of the umbrella; in the living animal probably three or four times as long. The marginal clubs, or tactile clubs (figs. 3, 4, *ok*), lie on the inner side of the tentacles between their insertion and the basis of the velum. In some places they alternate with the tentacles, but are usually irregularly distributed. Their number appears very variable. In one of the three specimens before me there are very few (20 to 30), in the second above 100, and in the third over 200. The opaque marginal clubs appear chalk-white in reflected light, black in transmitted light. They are pyriform, gradually enlarging from a narrow stalked base about one-third to one-half as long as the basal bulbs of the marginal filaments, 0·6 to 0·8, at the most 1 mm. long and 0·3 mm. broad. Treated with acid, they show a narrow canal (fig. 8). The velum (*v*) is rather broad, but very thin and delicate, and with many folds. The system of circular muscles of the subumbrella is moderately developed, and shows no special peculiarities. The umbrella cavity is very shallow, its upper half filled up in a great measure by the stomach and the four genitalia.

The wide oral opening leads into a short, shallow gastral sac, whose four basal corners are extended into four conical funnels. These pass into the four radial canals, which are pinnated in their proximal half and bear the genitalia (figs. 1, 2). The narrow radial canals open at the umbrella margin into an annular canal, which sends branches into the tentacles and marginal clubs (fig. 8).

The oral opening (figs. 1, 2 in the centre) is quadrate, very wide, with irregularly frilled borders, extending at the four perradial corners into four short wavy oral lobes (fig. 2, *al*). The thin transparent wall of the quadrangularly prismatic gastral tube hangs down nearly to the middle of the umbrella cavity; its lower free oral margin is much thinner. A perradial cross (fig. 2, *g*) whose four limbs are 0·5 mm. broad and 8 mm. long, appears very plainly in the fundus of the stomach on the gastral surface of the gelatinous umbrella. This cross is formed by four very narrow ciliated grooves which are centripetal processes of the umbrella wall of the four radial canals. In one of the three examples the four limbs of the cross meet in the aboral centre-point of the subumbrella, so that the quadrate ground of the stomach is divided into four congruent equally limbed triangles (fig. 2). In the other two examples the points of the two opposite triangles are truncated and rest (at one specimen at the length of 2 mm. in the other at 6 mm.) in such a way that opposite points of the two other alternating triangles remain at about the same distance from each other (fig. 7). The geometrical form of the ciliated cross is here plainly amphitect, whilst it is completely regular in the first specimen (fig. 2).

The four perradial corners of the fundus of the stomach are prolonged into four conical funnels (fig. 2, *ck*) whose ends extend to the middle of the genitalia and occupy the proximal half of the radial canals. The latter are very broad in the proximal half, and, on the other hand, very narrow in the distal half below the genitalia. In the middle of its course each radial canal gives out a number of alternating pinnated branches, twenty to thirty on each side, at right angles at the two edges (fig. 5). These branches are longest in the middle (up to 10 mm.), and gradually decrease in size towards the ends of the radial canal; they are very short at both ends. The genitalia proceed from their lower wall. The four genital glands (figs. 5, 6) seen from the subumbrellar surface have the shape of broad elliptical or almost circular leaves, occupying the centre of the radial canals from which they hang freely into the umbrella cavity (figs. 1, 2). On closer inspection it is shown that each gland forms a delicately-pinnated leaf, whose 20 to 30 pairs of pinnated branches are lamellæ placed perpendicularly (*s*). The upper edge of each lamella is connected with a transverse pinnated branch of the radial vessel, whose lower (subumbral) wall forms a fold; the lower free edge of each lamella is serrated or rather, split up into a number of finger-shaped points. The number of these points is greatest (10 to 15) in the broadest lamellæ in the middle of each gland, smallest in the narrowest lamellæ at the two ends of the genitalia. Each lamella is therefore, in itself the half of a pinnated leaf, whose straight upper edge has grown to the transverse branch of the radial canal, whilst the divided lower edge projects freely into the umbrella cavity.

Order III. TRACHOMEDUSÆ, Hæckel, 1866.

Craspedotæ with auditory clubs, which sometimes stand freely on the umbrella margin, and are sometimes enclosed in auditory vesicles, with endodermal otolite cells. Ocelli at the basis of the tentacles usually wanting. Genitalia always in the course of the radial canals. Number of the radial canals, sometimes four, sometimes six, sometimes eight, never more; between these there are often centripetal blind canals. The velum is firm and broad. Ontogenesis, so far as we yet know, hypogenesis (or direct development without alternation of generations) usually accompanied by metamorphosis.

Family, TRACHYNEMIDÆ, Gegenbaur, 1856.

TRACHYNEMIDÆ, Hæckel, System der Medusen, 1879, p. 255, taf. xvii.

Trachomedusæ with eight radial canals, along whose course the eight genitalia lie; with long tube-like stomach without ventral peduncle; with auditory clubs, which are seldom free but usually enclosed in auditory vesicles lying on the umbrella margin.

Sub-family, PECTYLLIDÆ, Hæckel, 1877.

Trachynemida with sucking cups on the tentacles, with radial mesogonia or broad mesenterial bands.

Pectyllis,[1] Hæckel, 1879.

Trachynemidæ with eight genitalia in the course of the eight radial canals, without centripetal canals. The genitalia are cut in two by eight radial mesogonia or leaf-shaped mesenterial bands, and connected with the bases of the stomach. Oral cavity without oral funnels, and without side pouches. Tentacles with sucking-cups very numerous and placed closely one over the other in several rows on the umbrella margin. Numerous (8 or 16 ?) auditory clubs.

The genus *Pectyllis*, with the two following genera *Pectis* and *Pectanthis*, form the special small group of the Pectyllidæ, which I placed in the System der Medusen (1879, p. 265) as a sub-family in the family of the Trachynemidæ. The Pectyllidæ are, however, so strongly distinguished by several striking peculiarities from the remaining Trachynemidæ, the Marmanemidæ, that it is better to separate them as a special family. The Pectyllidæ agree with the Marmanemidæ in having eight radial canals and eight genitalia hanging from them, in the form of the depressed umbrella, and in the absence of a gelatinous gastral peduncle; on the other hand, they are distinguished from them by two peculiar characteristics which are wanting in the other Trachomedusæ, in having eight mesogonia and numerous sucking-tentacles furnished with terminal sucking-cups. The auditory clubs of the umbrella margin are free as in the Aglauridæ, not enclosed in "marginal vesicles" as in the Marmanemidæ. The peculiar "mesogonia," or genital mesenteries, are thin, membranous, vertically-placed leaves, which extend in the radial plane between the central œsophagus on the one side and the eight sac-shaped reproductive glands on the other, are inserted in the middle line of the latter, and sometimes pass along the radial canals almost to the umbrella margin. The upper part of the umbrella cavity is, therefore, divided into eight radial sections ("infundibula subumbralia"). The peculiar sucking tentacles of the Pectyllidæ are hollow or solid, very elastic and contractile threads, which bear a powerful sucking-cup at the free end, and are used for adhering by suction. Part of them resemble the "ambulacral-feet" of the echinoderms in form and in the mode of motion. The sucking tentacles are very numerous in all three genera of the Pectyllidæ, sometimes closely packed together in several rows, one above the other, on the margin of the umbrella; sometimes grouped more or less distinctly in separate bunches; in all of them we can distinguish sixteen (or 32 to 64) bunches more or less divided by marginal incisions, so that the umbrella margin appears almost lobed. A further peculiarity of the Pectyllidæ is the extremely broad, powerful velum, which apparently, in all three genera, can be extended till, like a sphincter, it completely closes the umbrella cavity; they surpass all other Craspedotæ in this extreme development of the velum. The Pectyllidæ are finally distinguished by a peculiar formation of the

[1] Πηκτύλλις, *Pectyllis*, derivative of *Pectis*.

circular canal, namely the glandular folds or tufts of its endoderm lining, which project from its lower edge into the lumen of the vessel. As all the three genera of the Pectyllidæ which have been observed as yet (each only with one species) are typical deep-sea Medusæ, it is probable that the special peculiarities above mentioned are partially or entirely the result of adaptation to life at great depths of the sea. At any rate they are of sufficient importance to justify the separation of the Pectyllidæ from the Marmanemidæ as a special family. Among the three genera of the Pectyllidæ, *Pectanthis* is distinguished by the sucking tentacles being grouped in sixteen separate bunches, whilst in the other two genera they are closely crowded together along the edge of the umbrella margin. *Pectis* is characterised by having blind centripetal canals which are wanting in *Pectyllis* and *Pectanthis*.

Pectyllis arctica, Hæckel (Pls. III., IV.).

Pectyllis arctica, Hæckel, 1879, System der Medusen, p. 266, No. 287.

Umbrella nearly hemispherical, about 1½ times as broad as high. Exumbrella with sixteen projecting radial ribs, alternating with sixteen deep radial grooves. Stomach quadrangular prismatic, about as long as the radius of the umbrella. The margin of the mouth fleshy and thickened, quadrate, with four perradial pointed lobes and four interradial strong longitudinal muscles. Eight egg-shaped genitalia in the proximal half of the radial canal, divided in two by broad radial mesogonia. Border of the umbrella thickened, thickly beset with several rows of sucking-cups, which are divided into sixteen larger and forty-eight smaller groups (16 to 20 sucking-cups in each group). Between these are placed sixteen longer and thirty-two shorter tentacles, and numerous (?) (8 to 16) auditory clubs. Horizontal diameter of the umbrella, 18–24 mm.; vertical diameter, 12–16 mm.

Habitat.—Arctic part of the North Atlantic Ocean.

I had an opportunity of examining several well-preserved spirit-specimens of this species from the Copenhagen Zoological Museum, which were collected by Olrik in 1868 on the west coast of Greenland. A specimen from Station 50 of the Challenger list (dredged 21st of May 1873, near Halifax, at a depth of 1250 fathoms; lat. 42° 8′ N., long. 63° 39′ W.) is identical with them. The Pectyllid described by Allman in 1878 as *Ptychogastria polaris* (Nare's Narrative of a Voyage to the Polar Sea, vol. i. p. 299) appears closely related to this species. I saw an incomplete specimen of this in 1879, in the British Museum.

The umbrella (Pl. III. figs. 1, 2; Pl. IV. figs. 3, 4) is nearly hemispherical, so that the transverse diameter across the opening of the umbrella cavity is nearly twice as great as the vertical axis (fig. 1). The former measures 18–24 mm., the latter 12–16 mm. The gelatinous substance of the umbrella is thin but firm, and appears to be nearly of the same thickness throughout its whole extent (fig. 3). The exumbrella or the outer convex surface of the umbrella is divided by sixteen rim-like radial ribs whose distal ends project lobe-like on the margin of the umbrella, into sixteen deepened radial areæ or grooves (Pl. III. figs. 1, 2); eight of the sixteen radial ribs correspond with the underlying genitalia and mesogonia (four perradial and four interradial). The eight principal ribs unite above in the centre of the exumbrella into an eight-rayed star, while the eight remaining adradial ribs which alternate with these do not reach the top of the umbrella. Each two ribs are united at the distal end by a two-limbed clamp; whose intercostal centre turns inwards and downwards (figs. 1, 2). This arching inwards forms the boundary between each two of the sixteen flat marginal lobes, and lies in the ideal prolongation of the sixteen intercostal radial grooves of the exumbrella (" sulci exumbrales "). These form the deepest part of the concave grooves between each two ribs. They are only sharply defined in the middle zone of the exumbrella, and obliterated below and above. A very delicate radial rib runs in the exumbrella between each groove and each rib (fig. 1).

The umbrella margin (" margo umbralis," figs. 1, 2, 4, 10, &c.) is considerably thickened, and even at a superficial view appears divided, more or less clearly, into sixteen flat, slightly convex, projecting lobes, each of whose central points forms the distal end of a radial exumbral rib. The entire margin of the umbrella is continuously beset with numerous tentacles (above a thousand), which are placed one over the other in several rows, and are transformed into short-stalked sucking-cups. Isolated auditory clubs (8 or 16 ?) are placed between them. A very broad velum projects inwards from the ring of cnidæ of the umbrella margin.

The number of marginal tentacles amounts to 1000 or 1200; all bear a terminal sucking-cup. Only a small number of them appear in the form of longer or shorter filaments; in the greater number the filaments part of the tentacle is so much reduced, and the terminal sucking-cup so strongly developed, that they appear as short-stalked or even unstalked suckers (" acetabula "). The distribution of these appendages is very regular and peculiar. Each of the sixteen marginal lobes bears a principal group, composed of three larger sucking-cups and three triangular sucking-plates alternating with them, and in each sucking-plate we can distinguish sixteen to twenty sucking-cups of different sizes (comp. figs. 1, 2, 4, 10). Sixteen very large sucking-cups of the first size are the keystones of the arches, at the end of the sixteen exumbral ribs (fig. 7, *xa*; fig. 10, A). Thirty-two sucking-cups of the second size lie somewhat depressed between them (fig. 8, *xb*; fig. 10, B). Between these two series placed still deeper and with longer stalks there are forty-eight sucking-cups of the third size (fig. 5, *xc*; fig. 10, C). Finally, under these, closely crowded together in a triangular group, are numerous smaller sucking-cups with longer stalks, their number increasing towards the insertion of the velum, while their size diminishes (fig. 6, *xd*). Each of these so-formed " sucking-plates" has a great resemblance to the sucking-plates at the end of the two long prehensile arms of the ten-armed Cephalopods (*Sepia*, &c.). It was not so easy, unfortunately, to determine the number of the longer tentacles with a small sucking-cup at the end, as most of these had been torn away. It appears, however, that sixteen longer tentacles (hardly as long as the radius of the umbrella) are inserted under the sixteen uppermost sucking-cups of the first size, and thirty-two shorter tentacles between them below the sucking-cups of the second size (figs. 1, 2). The structure of these tentacular formations is the same everywhere. The principal mass forms a strong, solid axis of large chordal cells (or clear vesicle-like endoderm-cells, *yt*). This is covered by a thin but firm and very elastic fulcral plate, and above this a thin layer of longitudinal muscular fibres. The external epithelium of the ectoderm covering the latter is rich in cnidæ, which are usually accumulated on the abaxial side of the tentacle basis in the form of a thick cushion of cnidæ (figs. 6, *n*; 8, *n*). The sucking-cup at the truncated end of the tentacles is likewise furnished on its enlarged margin with a thick ring of cnidæ, and has a strong muscular plate on its concave surface (fig. 7, *xa*). The mode in which these sucking-cups are very regularly and delicately distributed on the margin of the umbrella will be best understood by comparison of figs. 1 and 2 in Plate III., figs. 4 and 10 in Plate IV. and of the sections of the umbrella margin in figs. 5–8 (comp. the explanation of Pls. III. and IV.). The velum (figs. 2, 3,*v*; 4,*v*), is very broad and powerful, and appears capable of completely closing the umbrella cavity. The internal axial half, whose free margin surrounds the narrow entrance to the umbrella cavity, is much thinner than the strong external or abaxial half; the two halves are divided by a deep annular fold projecting into the umbrella cavity (figs. 3, 4). The muscles of the velum form numerous delicate circular folds. The subumbrella has also very strong circular muscles forming numerous ring-like folds on the whole lower surface of the umbrella. The umbrella cavity is divided (as in *Pectanthis asteroides*) into eight deep funnel-like sections, as eight broad, vertical septa (four perradial and four interradial) stretch across from the eight radial canals and genitalia to the base of the stomach (mesogonia, fig. 3, *wa*).

The central mouth leads into a tube-shaped quadrangular stomach, from whose basis in the bottom of the umbrella eight radial canals pass out (four perradial and four interradial). These bear the sac-shaped genitalia in their proximal half, which are fastened to the subumbrella by the leaf-shaped mesogonia just mentioned. The stomach is a very thick-walled tube with strong muscles, has the form of a quadrate pyramid, is fixed by the narrow basis in the centre of the subumbrella, and hangs down in it nearly to the middle of the height of the umbrella cavity (fig. 3, *gp*). At the quadrate oral opening the four perradial corners of the pyramid (*ak*) pass into four triangular oral lobes (*al*) whose axial internal surface is divided by a (perradial) longitudinal groove into two lips (fig. 2). An interradial thickening of the longitudinal muscle appears sharply defined between each two oral lobes (figs. 2–11). The interradial oral edges which are divided in two by the longitudinal muscles are turned over outside (like the brim of a hat). The very powerful muscles of the mouth and of the stomach lie in numerous folds projecting internally (figs. 2, 12).

The eight narrow radial canals (fig. 3, *cr*) which run at equal distances from the fundus of the stomach (fig. 3, *go*) to the periphery, are there opened into a narrow annular canal (fig. 3, *cc*; figs. 5–8, *cc*). In the transverse section these walls show numerous thick folds and tufts (*dp*), which proceed from the distal margin of the canal, and project freely into its lumen. As usual, the outer or umbral wall of the annular canal, which lies close to the marginal portion of the gelatinous substance of the umbrella (*n*), is covered by a flat, tabular epithelium (*dn*), whilst, on the other hand, the remaining portion or the subumbral wall is covered by high, cylindrical epithelium (*dw*). The latter also lines the tufts or folds of the lower wall of the canal. At their basal end (which is turned from the lumen of the canal), the very high cylindrical cells of the tufts contain granules of black pigment, enclosing a nucleus. These pigmented tufts (which resemble the intestinal tufts of the vertebrata) have probably secretive or excretive functions. (Comp. Pl. IV. figs. 5–8, and explanation.)

The eight genitalia or reproductive glands (figs. 2–3, *sc*) hang in the proximal halves of the eight radial canals, as visible sacculations from it (four perradial and four interradial). These appear as wide, fluted, thick-walled, egg-shaped, or fusiform sacs. A radial mesogonium (or genital mesentery) rises in the middle of the subumbral wall of each sac, as a thick vertical fold of the subumbrella, which passes from the basis of the stomach to the umbrella margin (fig. 3, *wr*). These eight mesogonia attach the corners of the stomach, halve the eight genitalia, and divide the space of the umbrella cavity into the eight above-mentioned umbrella funnels, or the peripheric niches of the umbrella cavity.

Pectis,[1] Hæckel, 1879.

Trachynemidæ with eight genitalia in the course of the eight radial canals, between which blind centripetal canals run from the annular canal. Genitalia connected with the basis of the stomach by eight radial mesogonia or leaf-shaped mesenterial bands. Oral cavity with eight invaginated oral funnels, and sixteen evaginated side pouches. Tentacles with sucking-cups very numerous, closely crowded together in several rows above each other on the umbrella margin. Numerous (8 or 16 ?) auditory clubs.

The genus *Pectis* is strikingly distinguished from both other genera of Pectyllidæ by its blind centripetal canals, which run out in large numbers from the annular canal (as in *Olindias* among Petasidæ, *Glossoconus* and *Glossocodon* among the Liriopidæ, *Carmaris*

[1] Πηκτίς, hardened, stiffened.

and *Carmarina* among the Carmarinidæ). The sucking-tentacles beset the whole umbrella margin, closely crowded in several rows over each other, as in *Pectyllis*, not in separate bunches as in *Pectanthis*. The radial mesogonia are much less strongly developed than in the two other genera. The structure of the œsophagus, with its eight curious adradial, ectodermal, oral funnel cavities, and the eight pair of endodermal side pouches alternating with them, is quite peculiar, and, as far as I know, does not exist in any other Craspedota.

Pectis antarctica, Hæckel (Pls. V., VI.).

Pectis antarctica, Hæckel, 1879, System der Medusen, p. 266, No. 288.

Umbrella almost hemispherical; about $1\frac{1}{2}$ times as broad as high. Exumbrella finely radially ribbed, with thirty-two more prominent ribs towards the margin. Stomach quadrangularly prismatic, nearly as long as the radius of the umbrella. Oral cavity with eight pairs of hemispherical side pouches. Oral margin fleshy and thickened, quadrate, with four radial oral tentacles. Eight genitalia, egg-shaped sacs having folds, in the proximal half of the radial canals, connected with the base of the stomach by eight narrow radial mesogonia. 11 to 13 blind radial canals (3 larger and 8 to 10 smaller) between each two radial canals. Umbrella margin, thickened into a roll; thickly beset with numerous rows of sucking-cups (about a thousand), forming thirty-two connected groups. Between these numerous (8 to 16 ?) free auditory clubs. Horizontal diameter of the umbrella, 36 mm.; vertical diameter, 24 mm.

Habitat.—Antarctic portion of the Indian Ocean, S.S.E. from Kerguelen Island. Lat. 60° 52′ S., long. 80° 20′ E. Depth, 1260 fathoms. Station 152. 11th February 1874. From this habitat I had only one single specimen for examination, but it was complete and well preserved.

The umbrella showed, in a perfectly uninjured state, the peculiar natural shape represented in figs. 1 and 2, Plate V.; fig. 11, Plate VI. A deep exumbral circular furrow runs externally round the umbrella, about half-way up its height, dividing it into an upper, nearly hemispherical, umbrella cone, and a lower, shallow, funnel-shaped, umbrella margin. The largest transverse diameter of the umbrella (at the opening of the umbrella-cavity) amounted to 36–40 mm., and was nearly double that of the largest vertical diameter (in the axis of the umbrella).

The exumbrella (or the external, convex surface of the umbrella) is traversed throughout by a very large number of fine radial ribs, amounting in the periphery of the umbrella to 500 to 600 (Pl. V. fig. 1; Pl. VI. fig. 20). Besides these there are also thirty-two more prominent radial ribs, running the whole length, and thirty-two less prominent "costæ exumbrales" (fig. 20, *cs*) alternating with them.

The gelatinous substance of the umbrella (fig. 2, *ug*) is nearly of equal thickness in the upper aboral half of the umbrella, and nearly as thick on the radial section as the genitalia fixed on its subumbral side. It is very much thickened in the centre of the apex, and projects into the fundus of the gastral cavity in the form of a short, conical, gelatinous appendage (fig. 2, *nk*). On the other hand, the gelatinous substance is much thinner in the lower oral half, hardly one-fourth or one-fifth as thick as in the upper half, from which it is sharply divided (half-way up the height of the umbrella) by the exumbral circular furrow. An enormous number of sinous elastic fibres, running from the exumbral to the subumbral wall, traverse the gelatinous substance of the umbrella, to which they give a considerable degree of firmness; they are placed together in dainty pyramids (fig. 8, *uf*), whose points touch the exumbrella (*e*), and their bases the subumbrella (*w*); these pyramids form regular longitudinal series, corresponding to the exumbral radial ribs.

The umbrella margin ("margo umbralis," figs. 1, 11, 12, 20) is not so visibly lobed in this genus of the Pectyllidæ as in the two others, but rather appears to be of equal thickness all over, and closely beset with an enormous number of short sucking-tentacles placed in several rows above each other. Closer consideration, however, shows that this garniture of the umbrella margin is by no means equally distributed, but rather arranged in eight larger and thirty-two smaller groups. These, however, hang closely together, and are not separated by depressions as in *Pectyllis* and *Pectanthis*. A similar lobed formation of the umbrella margin also exists fundamentally in *Pectis*, though it is not so apparent externally as in the other two genera. Each of the thirty-two small groups of tentacles (fig. 20, *td*) consists of from 30 to 40 solid tentacular appendages. Of these the 16 to 20 upper (proximal) are short-stalked, pyriform, or club-shaped sucking-cups, the 12 to 16 lower (distal) on the contrary are somewhat longer tentacles, partly with a terminal sucking-cup, partly apparently forming feelers. These "tactile tentacles" without sucking-cup (fig. 17) were mostly torn away, the longest barely above 1 mm. in length. They are probably much longer in the living animal (as in *Pectyllis arctica*, Pl. III. fig. 1). The numerous sucking-cups form 6 to 8 alternating rows placed one above the other on the umbrella margin; in each of the thirty-two small groups, which have an almost rhomboidal outline, they are placed in 5 to 6 diagonal rows, each with 4 to 5 tentacles (fig. 20). The size of the sucking-cups, which enclose a visible conical ectodermal sucking cavity, decreases gradually from above downwards (fig. 12). A larger sucking-cup is placed above somewhat further on the umbrella margin (fig. 20, *st*). All the tentacles of this genus are solid; their endodermal axis consists of large clear chordal cells which are sometimes placed in a discoid row one behind the other (fig. 17, *dt*), sometimes more numerous and in a more complete arrangement beside each other (fig. 15, *dt*). This vesicular axial tissue is covered by very powerful internal annular muscles, which thicken at the end into a strong annular swelling; single bundles of external longitudinal muscles, very much thickened at the exumbral side of the tentacles, extend out above these annular muscles; they run out below the sucking-cups into eight to twelve radial cords, which converge towards the centre of the sucking-cup (figs. 9, 10).

The auditory clubs (probably eight or sixteen) lie on the axial side of the umbrella margin, under the insertion of the velum, inside the lowest row of tentacles. After most careful search, I was only able to discover two or three of them, very small, and of the same construction as in the Aglauridæ. The thin endodermal axis of the auditory club (fig. 16) consists of a few chordal cells (*d*), of which the last is expanded like a vesicle, and contains a large spheroidal otolith with concentric layers (*ol*). The ectodermal cells of the epithelium of the club bear very long and fine auditory hairs (*oh*).

The velum (figs. 11–14) is thicker in *Pectis* than in any Craspedote hitherto known, and is distinguished by a very unusual development of the muscular system. The breadth of the velum is so great that when fully extended it can probably close the entire umbrella cavity like a sphincter. The external abaxial half of the velum contiguous to the umbrella margin, is nearly as thick as the tentacles, and three to six times as thick as the internal axial half, from which it is divided by a deep circular furrow (fig. 11, right half). If we draw the free projecting internal margin of the velum carefully towards the inside, we can bring it so near the centre as to make it probable that the umbrella cavity can be completely closed by the velum being drawn over it, as in the foregoing species. The following layers (from above to below in the natural position of the horizontal extended velum) can be distinguished in horizontal sections through the velum :—(1) the ventral or subumbral epithelium of the velum (*vw*), containing dark-brown pigment similar to that of the subumbral epithelium; (2) a considerably thick layer of clear vesicular connective tissue (*x*); (3) the muscular plate of the velum which projects into this connective tissue in the form of numerous highly-developed circular folds, each fold sending out numerous secondary folds or shoots into the clear plate of connective substance (*x*), so that it appears delicately pinnated in the transverse section (fig. 13, *mv*); (4) a thin but firm elastic supporting lamella, which sends out processes into the muscular folds (*zv*); (5) the dorsal or exumbral epithelium of the velum (*ve*). The epithelial cells of the exumbral epithelium of the velum are much smaller and flatter than those of the subumbral.

The ectodermal epithelium of the lower surface of the umbrella or the subumbrella consists of cells of dark brown pigment, from which the milk-white walls of the canals are sharply thrown out. The underlying annular system of the subumbrella forms numerous compact circular folds. In *Pectis* the umbrella cavity is simple, without subumbral funnel cavities, as the eight radial "mesogonia" or "genital mesenteries" so strongly developed in *Pectyllis* and *Pectanthis* are by no means so complete here. They are merely indicated by eight narrow subumbral folds, running from the basis of the eight genitalia to the basis of the stomach (fig. 2, *wr*).

The gastrovascular system in *Pectis* has, on the whole, the same plan as that of

Pectyllis, but is easily distinguished by the blind centripetal canals running from the circular canal, and also by the peculiar side pouches in the periphery of the mouth, and the oral funnels alternating with these (Pl. V. figs. 2–5; Pl. VI. fig. 11). The central œsophagus hangs down from the fundus of the umbrella cavity till past the middle of it in the shape of a quadrangular tube beset above the oral opening with eight pairs of side pouches. The eight radial canals running out from the basis of the stomach unite at the umbrella margin into a circular canal, from which run numerous short blind centripetal canals (Pl. VI. fig. 11).

The quadrate oral opening (figs. 3, 4, *al*; fig. 11 in the middle) is surrounded by a very muscular protuberant oral margin, whose surface has strong folds of the circular muscle (fig. 3, *mc*). These folds are divided into four interradial groups by four perradial longitudinal muscles, ending in the four short heart-shaped oral lobes (fig. 3, *al*). Above this muscular oral margin (which is probably very ductile, and adapted for adhesion by suction) appears a very prominent circle of sixteen side pouches ("bursæ buccales," figs. 2–5, *bb*). These form hemispherical, or, more properly, semi-oval evaginations of the gastral wall, and hang together in pairs in such a way that eight pairs appear as oral bifurcated terminal shoots of the eight gastral grooves (*gs*); of these longitudinal grooves of internal wall of the stomach, which proceed above in the fundus of the gastral cavity (figs. 3, 4, *cr*). Each two pairs of side pouches are divided by a peg-shaped oral funnel (infundibulum orale, figs. 2, 4, 5, 10). These conical adradial oral funnels are quite peculiar invaginations of the gastral wall, in a certain measure "internal side pouches" unknown to me in any other Medusa. Their conical cavity, which is cœcal at the point, is lined by the ectoderm, and opens into the umbrella cavity, whilst these "external side pouches" (*bb*) are lined by the endoderm, and open into the oral cavity. Such "external side pouches" are unknown to me in any other Craspedota, but they occur in the Periphyllidæ among the Acraspeda (compare below). The ectodermal external wall of the external side pouches is coloured with violet-brown pigment, and has a broad milk-white dentated longitudinal striation in the middle. The endodermal covering of the oral funnels is coloured milk-white, and sharply contrasted with the dark violet periphery of the oral cavity. The upper part of the gastral cavity into which the gelatinous sphere of the umbrella (fig. 2, *ubr*) projects, appears eight-rayed in the transverse section (fig. 6), as eight adradial longitudinal folds running from the eight oral cavities project inwardly between the eight concave gastral groups into the lumen of the central cavity (*g*). Compare the perradial longitudinal section (fig. 4).

The eight radial canals (figs. 11, 20, *cr*) which run from the basis of the stomach to the umbrella margin, and there open into the circular canal, as well as the circular canal itself (*ce*), and the blind centripetal canals proceeding from it, are not cylindrical tubes, but flattened band-like vessels which are sharply distinguished by their milk-white colour from the dark violet subumbrella. In transverse section (fig. 12, *ce*) the circular canal shows a high circular fold projecting nearly half-way into the lumen at its lower marginal edge, which touches the basis of the velum (*yc*); the high cylindrical partly-pigmented epithelium of this fold has probably a glandular nature like the similar folds and tufts in the annular canal of *Pectyllis*.

Pectis is specially distinguished by the blind centripetal canals proceeding from the annular canal, as these are wanting in the closely-related genera *Pectyllis* and *Pectanthis*, although they are indicated in the latter by the eight adradial projections of the circular canal, which alternate with the eight radial canals (Pl. VII. figs. 11, 20, *ce*). On the whole, the centripetal canals of *Pectis* comport themselves like those of *Olindias* among the Petasidæ, and of *Glossoconus* and *Carmarina* among the Geryonidæ, but they are shorter and broader, and have the form of a pointed equilateral triangle (fig. 20, *ce*). Their aggregate number amounts to 80 to 100, as 11 to 13 centripetal canals lie between each two radial canals, with the starting-point of their broad basis touching the circular canal. Although their number and arrangement is not perfectly regular, the (primary) adradial centripetal canal (in the middle between each two traversing radial canals) is always the largest. Then follow the (secondary) centripetal canals, which lie in the middle between the former and the latter, whilst the remaining canals are considerably smaller and irregularly distributed (comp. Pl. VI. figs. 11 and 20; Pl. V. fig. 2).

The eight genitalia (Pl. V. fig. 2, *bs*; Pl. VI. fig. 11) in *Pectis* as in *Pectyllis* (Pl. IV. fig. 3) are wide, folded, thick-walled pouches, which occupy the proximal half of the radial canals and communicate with the lumen of the eight radial canals by a wide fissure. The eight mesogonia or "genital mesenteries," which connect the genitalia with the aboral half of the œsophagus, as broad radial lamellæ in *Pectyllis* and *Pectanthis*, are rudimentary in *Pectis* (fig. 2, *wr*). In the only specimen examined (a female) the wide cavity of the reproductive pouch was empty for the most part, and only contained a few ova.

Pectanthis,[1] Hæckel, 1879.

Trachynemidæ with eight genitalia in the course of the eight radial canals, without centripetal canals. Genitalia halved by eight radial mesogonia or leaf-shaped mesenterial bands, and connected with the base of the stomach. Oral cavity without oral funnels and without side pouches. Tentacles with sucking-cups very numerous, divided into sixteen separate bunches, each two bunches between two radial canals; sixteen subradial auditory clubs, one in the middle of each bunch of tentacles.

The genus *Pectanthis* is distinguished from the two other known Pectyllidæ from

[1] Πηκτις, firm, compact; ἄνθος, a flower.

the numerous tentacles being divided into sixteen isolated subradial bunches, so that each bunch lies in the middle between a radial canal and an intercanalar adradial rib of the exumbrella. A free auditory club is placed in the centre of each bunch upon a projection on the lower side of the umbrella margin. The margin of the umbrella appears distinctly divided by sixteen incisions (four perradial, four interradial, and four adradial), into sixteen projecting lobes, each bearing a bunch of tentacles with an auditory club. The eight mesogonia by which the umbrella cavity is divided into eight funnels are strongly developed, as in *Pectyllis*, and the numerous cæcal centripetal canals between the radial canals, by which *Pectis* is distinguished, are also wanting as in *Pectyllis*.

Pectanthis asteroides, Hæckel (Pls. VII., VIII.).

Pectanthis asteroides, Hæckel, System der Medusen, p. 267, No. 289.

Umbrella depressed to a hemisphere; two to four times as broad as high. Exumbrella with sixteen radial ribs. Stomach quadrangularly prismatic; nearly as long as the radius of the umbrella. Mouth four-lobed, extensible into an octagonal sucking-disk. Eight egg-shaped genitalia in the proximal half of the radial canal, encircling the basis of the stomach in the form of an eight-rayed star, and halved by long radial mesogonia. Umbrella margin swollen, thickened, with sixteen intercostal protuberances or marginal lobes, each bearing a subradial auditory club and a pencil-shaped tuft of twelve to sixteen tentacles. Tentacles hollow, of unequal length, the longest equal to the radius of the umbrella, generally with a sucking-disk at the end. Horizontal diameter, 5 mm.; vertical diameter, 2 mm.

Habitat.—The Mediterranean. I myself caught a living specimen of this deep-sea Trachomedusa with the tow-net in the Adriatic Sea on April 15, 1878, at a depth of 200 fathoms, some miles distant from Pola. The following description and the figures on Plates VII. and VIII. are prepared from this specimen (a mature male), which was examined alive. I also found a small specimen of the same species, which did not admit of any minute investigation, but still furnished proof of its identity in a bottom specimen from the Challenger collection from Station 4, at the entrance of the Straits of Gibraltar. Lat. 36° 25′ N., long. 8° 12′ W. 16th January 1873. Depth, 600 fathoms.

In the example which I observed alive in Pola, the umbrella in a contracted condition had an almost hemispherical bell shape. In a dilated condition, on the other hand, it appeared distinctly depressed, so that the largest horizontal diameter was three to four times greater than the largest vertical diameter. The former measured 4–5 mm., the latter 1–2 mm.

The exumbrella or the external convex surface of the umbrella is divided by sixteen projecting radial-ribs into sixteen deepened radial areæ or depressions, which project like lobes on the umbrella margin (Pl. VII. fig. 12). Of the sixteen radial ribs ("costæ exumbrales"), four perradial and four interradial (in the middle between the former) lie above the mesogonia. These eight principal ribs are distinguished by thin streaks of purple-red pigment, which pass into eight large red ocellar spots at the umbrella margin, but are wanting in the eight other alternating adradial ribs. All sixteen ribs are tipped with nematocysts, which appear yellowish-white by reflected light and black by transmitted light. These spots of pigment form a broad band in the periphery of the exumbrella above the margin of the umbrella, and are divided from it by a colourless streak. The eight red ocellar egg-shaped spots before mentioned are placed at the distal ends of the eight red pigmented ribs; they may, perhaps, be considered as true ocelli, though they do not appear to contain a lens (comp. Pl. VII. fig. 1). Besides these, there are also sixteen large crescent-shaped golden-yellow spots at the marginal end of the ribs of the exumbrella. The sixteen concave intercostal radial depressions of the exumbrella alternating with these increase in breadth and depth towards the umbrella margin, and are traversed in the middle by a deep-radial furrow ("sulcus exumbralis"). A pedunculated subradial auditory club lies at the end of these radial depressions (Pl. VIII. fig. 8, *ok*) in the middle of the projecting marginal lobe, and of the bunch of tentacles borne by it.

The peculiar peripheric umbrella margin ("margo umbralis," Pl. VIII. fig. 8) is considerably thickened, and armed with a connected urticating ring (*nc*), consisting of a thick accumulation of thread-cells. The sixteen protuberances or flat lobes are rounded like an arch, and when looked at from above (and also at their subumbral surface) show a cord of cilia pigmented black immediately inside the urticating ring. This ciliated cord is sinous, and forms from eight to ten projecting vessels on each lobe (fig. 8, *xp*). In the arching inwards of the umbrella margin between each two lobes, at the distal end therefore of each exumbral rib, the black ciliated cord becomes a tongue-shaped projection, showing a funnel-like depression, which may perhaps be an organ of smell (fig. 8, *xo*). A small free auditory club rises on the outer edge of each of the sixteen marginal lobes enclosing a spheroid or elliptic otolite in the free end (in the last endodermal cell, fig. 8, *ok*). The auditory club lies nearer the lower margin of the umbrella, inwards from the insertion of the tentacles. More minute investigation was unfortunately impossible.

The tentacles, which amount to 200 to 260, are divided into sixteen pencil-shaped bunches, each two bunches between each two radial canals. In the transverse section the tentacles are hollow (fig. 4), capable of great extension, movable and contractile, furnished with a sucking-disk at the end, and are very similar to the ambulacral feet of the Echinodermata. The Medusæ attach themselves by these sucking-disks to the vertical walls of the glass vessel, and climb up them like an Asterias or a Sea-urchin (figs. 6, 10). The living specimen which I observed at Pola assumed moreover the peculiar attitude represented in Plate VIII. fig. 7. The Medusa lies on its back, extends a portion of the sucking-feet stiffly out round it, and attaches itself to the bottom of the glass, whilst the other portion of the sucking-feet play freely in the water, as if feeling and fishing for prey; the mouth, therefore, stretches vertically from the opening of the velum, which is contracted like a funnel, and also moves as if groping in different directions. The tentacles, when extended, are almost as long as the radius of the umbrella; when contracted they are much shorter; in the centre they are thickened like a spindle, and become thinner at either end. A more minute investigation of the tentacles shows that we can distinguish two different forms. The larger number have a sucking-disk, which is pigmented red at the end, and are used for crawling and adhesion by suction; the smaller numbers are simply pointed at the end, without sucking-disk, and are used as feelers, usually extended round and upwards, and moving like worms (figs. 6–10).

The velum (fig. 3, *vn*; fig. 7) is very thick, broad, and powerful. The plate of its circular muscles is arranged in numerous circular folds projecting from the subumbral surface, which, by interference, produce an iridescence. It is probable that in *Pectanthis* (as in *Pectis* and *Pectyllis*) the velum can be extended so as to entirely close the umbrella cavity like a sphincter. The circular muscles of the subumbrella form projecting circular folds similar to those of the velum, but are arranged in sixteen arcades corresponding to the sixteen exumbral ribs and to the sections of the umbrella margin between every second lobe (fig. 9, *wn*). The subumbral exoderm is distinguished by scattered nematocysts (fig. 9, *wn*). The umbrella cavity is divided, as in *Pectyllis arctica*, into eight separate compartments, or funnel cavities, as the eight broad leaf-shaped mesogonia (fig. 9, *wr*) are stretched between the radial canals and the basis of the stomach (see below).

The central four-lobed oral opening leads into a tube-shaped four-sided stomach, from whose basis eight radial canals (four perradial and four interradial) run out in the bottom of the umbrella cavity. These bear the eight genitalia as sack-shaped evaginations in their proximal half, and are united in the umbrella margin by a circular canal which sends out branches into the tentacles. The central œsophagus (fig. 9, *gb*) hangs down in the middle of the umbrella cavity as a muscular tube of a gold-yellow colour, and prismatic quadrate form. The four interradial lateral surfaces are slightly depressed into a groove between the four rounded perradial bodies. The œsophagus is nearly as long as the radius of the umbrella when extended, much shorter when contracted. The oral opening is divided by four shallow grooves into four short blunt oral lobes (*al*) armed with an accumulation of nemocysts. The mouth can project out of the umbrella cavity through the opening of the velum, and extend externally in the form of a very thin flat octagonal sucking-disk (fig. 3, *am*).

In a more extended condition the extremely thin oral disk extends almost to the margin, and shows eight small triangular lappets (four perradial and four interradial, fig. 3, *am*) at the margin of the mouth. Eight narrow radial canals run from the periphery of the bottom of the stomach; these are united at the umbrella margin into a circular canal, and the eight genitalia placed in their proximal third.

The eight genitalia (four perradial and four interradial) are egg-shaped, thick-walled sacs, pigmented red, and with the side walls touching each other; they surround the basis of the stomach like an eight-rayed star (fig. 2, *s*; fig. 9, *s*). The sacs are half as long as the œsophagus, occupying the upper half of the umbrella cavity, and contain a large evagination of the radial canal (fig. 5, *sc*). A radial genital mesentery or mesogonium, a vertical radial fold with brown stains of the subumbrella, is inserted in the middle of the subumbral wall of each genitalium; this begins at the basis of the stomach and runs along the subumbral median line of the radial canals to the margin of the umbrella (fig. 9, *wr*). These eight mesogonial leaves fasten the edges of the stomach, halve the eight genitalia, and divide the space of the umbrella cavity into the eight peripheric niches (or imperfect funnel cavities) above mentioned. The transverse section of each genitalium shows that they actually consist of two completely separated halves, between which the basis of insertion of the mesogonial fold (*wr*) is intersected as a dividing septum. The living specimen examined by me in Pola was a male. The two sperm-sacs of each genitalium (*sm*) were divided by a strong fulcral plate (*z*) from the high cylindrical epithelium of the endoderm (*d*), and lay immediately under the endodermal epithelium, to which they owe their origin.

Order IV. NARCOMEDUSÆ, Hæckel, 1877.

Craspedotæ with auditory clubs, which always stand freely on the umbrella margin, with endodermal otolite cells. Ocelli at the basis of the tentacles usually wanting. Tentacles inserted dorsally, connected with the distant umbrella margin by peronia which divide it into a number of collar lobes. Genitalia originally in the lower or oral wall of the stomach, from which they often extend peripherically into the radial gastral pouches. Radial canals sometimes wanting, sometimes present, in which case they extend in the form of flat, radial, gastral pouches. Annular canal sometimes obliterated, but always divided by the radial peronia into a number of arched canals bordering the margin of the collar lobes. Number of the radial parts (tentacles, lobes, and pouches) indefinite and varying, rarely four, usually eight or more up to thirty-two. Ontogenesis, as far as we know, usually hypogenesis, often accompanied by metamorphosis.

Family CUNANTHIDÆ, Hæckel, 1877.

CUNANTHIDÆ, Hæckel, System der Medusen, 1879, p. 310, taf. xix. figs. 1–3, taf. xx. figs. 1–6.

Narcomedusæ with broad pouch-shaped radial canals or pernemal gastral pouches, which are sometimes simple, sometimes split each into two cæcal lobe pouches, but are always connected with the circular canal by double peronial canals, with otoporpæ (or clasps of the cordyli) at the basis of the auditory clubs.

Sub-family, CUNOCTONIDÆ, Hæckel, 1877.

Cunanthidæ, whose radial pouches bifurcate each into two cæcal lobe pouches.

Cunarcha,[1] Hæckel, 1879.

Cunanthidæ, with four perradial tentacles, inserted in the bifurcation of four perradial gastral pouches, which at the distal part are continued into four lobe pouches.

The genus *Cunarcha* is one of the simplest and oldest of all forms of the Narcomedusæ, and is immediately connected with *Cunantha*, the hypothetic originating genus of this order; like the latter it has only four tentacles and four alternating collar lobes, but is distinguished from it by the four perradial gastral pouches being continued at the distal end into two cæcal lobe pouches; eight cæcal lobe pouches, therefore, lie in pairs between the four tentacles in the periphery of the umbrella collar. This genus forms thereby a very interesting phylogenetic transition between *Cunantha* and *Ægina*. By retrograde formation of the otoporpæ and the proximal part of the radial pouches it would be transformed into *Ægina*. The presence of lobe pouches is common to *Cunarcha*, and to the genera *Cunoctona* and *Cunissa;* they compose the special sub-family of the Cunoctonidæ, whilst the other sub-family of the Cunanthidæ, the Cunoctanthidæ, have simple radial pouches without lobe pouches (*Cunantha, Cunoctantha, Cunina*), System, p. 314.

Cunarcha æginoides, Hæckel (Pl. IX.).

Cunarcha æginoides, Hæckel, 1879, System der Medusen, p. 315, No. 329.

Umbrella cap-shaped, one and a half times as broad as high. Lens of the umbrella biconvex. Umbrella collar with four broad, oval lobes, as long as the radius of the lens. Mouth with long conical œsophagus; four gastral pouches very broad and short, deeply

[1] *Cunarcha*. Oldest form of Cunoctonidæ.

cleft into eight distal lobe pouches occupying the greater part of the collar lobes; four perradial tentacles longer than the diameter of the umbrella; twelve auditory clubs (three on each lobe), the middle auditory club twice as large as the two lateral. Horizontal diameter, 4 mm.; vertical diameter, 2 mm.

Habitat.—West Coast of Africa. I first observed a living specimen of these species off Lanzerote, one of the Canary Islands, in December 1866, and the figures of Plate IX. and the following description are taken from this specimen. Later I found a specimen in a glycerine preparation of the Challenger expedition, containing the beautiful Phæodaria *Cœlodendrum*, south of the Azores, west from the Canary Islands, lat. 32° 41′ N., long. 30° 6′ W. Depth, 1675 fathoms. This glycerine specimen from the Challenger collection was very imperfectly preserved, but sufficiently preserved to settle its identity with the living specimen found at the Canaries. It is, however, possible (or probable) that this Medusa does not belong to such a great depth, but was captured in shallower water in drawing up the lead.

The umbrella (Pl. IX. figs. 1–3) has the form of a flat cap, and is nearly once and a half as broad as high. When the broad velum hangs loose, the aggregate height of the umbrella (including the velum) nearly equals the greatest breadth (in the middle of the height). The umbrella is divided into two distinct anatomical portions, the upper "umbrella lens" and the lower "umbrella collar," by a deep horizontal circular furrow of the exumbrella, the coronal furrow (fig. 3, *ec*). The central umbrella lens or umbrella disk (fig. 3, *w*) is simply formed by the gelatinous body of the umbrella, and has the form of a thick biconvex lens with a rounded edge; its upper surface is covered with the flat exodermal epithelium of the exumbrella, and is somewhat more strongly vaulted than the lower gastral surface, which is covered by the endodermal epithelium of the stomach. The two surfaces are connected by numerous fine, sinuous elastic fibres which traverse the gelatinous substance perpendicularly (fig. 6, *uf*; fig. 7, *uf*). The consistence of the gelatinous substance is considerable, resembling that of a soft gelatinous cartilage. The umbrella collar ("umbrella edge" or shortly "collar"), as we shall term the portion of the umbrella lying underneath the insertion of the tentacles, has a very complicate structure as contrasted with the simple lens lying above it. It consists of a corona of four lobes arising from deep radial indentations or incisions of the umbrella margin, the peronial furrows. And these, again, are caused by the four tentacles having left their original position on the umbrella margin and having emigrated a little way into the exumbrella. I consider this peculiar centripetal change of position of the tentacles into the exumbrella, which is probably connected with their partial development into feelers, as the first "true cause" of the manifold and varying transformations, which the umbrella margin and the adjacent organs undergo in all Narcomedusæ. Originally the tentacles were placed immediately on the margin of the umbrella as in the other Craspedotæ. When they passed upwards into the external surface of the umbrella, they took with them an urticating streak of the urticating ring of the margin, and this urticating streak becomes the umbrella clasp or "mantel clasp" ("peronium") (figs. 3, 4, *en*). This contains the basis of the tentacles in continuous connection with the urticating ring of the umbrella margin, and so gives rise to a radial furrow, more or less deep, of the umbrella collar which cuts through its gelatinous substance, but leaves the subumbrella intact. Transverse sections show that the peronia are tolerably thick, solid, clasp-like cords, consisting of a peculiar modification of urticating tissue; numerous strata of large spheroidal nematocysts lie closely accumulated one above the other. The distal end of the umbrella clasp is in continuous connection with the urticating ring of the umbrella margin (fig. 4, *nc*), whilst its proximal end is inserted at the spot where the tentacle (*t*) runs out from its conical root (*tr*). The exumbral surface of each peronium lies freely in the depth of the peronial furrow (between each two collar lobes), whilst its subumbral surface is covered by the longitudinal muscle (fig. 5, *mp*) which rises from the margin of the umbrella to the bases of the tentacle. Both lateral margins of the peronium touch the adjacent peronial canals (*ck*).

The four collar lobes ("lobi collares," fig. 4), which are separated by the four peronia, are of a broad uniform shape; their broad proximal basis falls in the coronal furrow of the exumbrella, whilst their distal point forms the usually projecting part of the umbrella margin (figs. 2, 3). Its distal external margin, which bears three auditory clubs on each lobe, is joined to the velum; the lateral margins are limited by the peronia. The lobe pouches (with the sexual products) lie in the concave internal or axial surface of the collar lobes, whilst the external or abaxial half is vaulted convexly. The thin gelatinous plate of the lobes is considerably thickened in the middle, and a sharp edge of the exumbrella projects like a rib in the interradial middle line (figs. 1, 4, *er*).

As in all Narcomedusæ, the peculiar umbrella margin in *Cunarcha æginoides* is strongly indented in consequence of the dorsal change of position of the tentacles, and supported by a strong urticating ring (fig. 4, *nc*; fig. 7, *nc*). This consists, like the peronia, of thickly accumulated nematocysts, and is covered with a ciliated sensitive epithelium. The proximal margin of the urticating ring touches the annular canal (*cc*), its distal margin rarely touches the velum (*v*). The two thin nerve rings (fig. 7, *rc′* dorsal or exumbral, *rc″* ventral or subumbral nerve ring) which are separated from one another by the supporting lamellæ of the velum, lie on the two edges of the urticating ring. The radial section (fig. 7) shows the more special anatomical and histological conditions of the umbrella margin. (Comp. the explanation.) The umbrella margin of *Cunarcha æginoides* has sixteen tentacular organs, namely, four long strong perradial tentacles, four interradial large auditory clubs, and eight adradial smaller auditory clubs.

The four perradial tentacles, which are common to *Cunarcha* and the nearly related *Cunantha*, remain permanent only in these two genera, whilst in all remaining Cunanthidæ this original number either increases or only amounts to four in the first early stage. As in all other Narcomedusæ, the tentacles are solid and fastened in the gelatinous substance of the umbrella by a peculiar "tentacle root." At the point of insertion of the tentacle where the "root" runs into the gelatinous substance, both tentacle and root are in continuous connection with the proximal end of the peronium, whose distal end passes into the urticating ring of the umbrella margin. The muscle and the nerve of the clasp, which maintain direct communication between the nerve ring of the umbrella margin and the tentacles, run on the axial side of the peronium. We may therefore say that the solid dorsally inserted tentacles are composed of three essential parts, which join at the point of insertion, viz., (1) the tentacle filament or the free projecting part; (2) the tentacle root, which is enclosed as a support in the gelatinous substance; and (3) the peronium which maintains the connection with the umbrella margin. The tentacle filament, or the free projecting part of the tentacle (figs. 4, 6 *l*), shows precisely the same structure which we have already described in the solid tentacles of the Pectyllidæ. The endodermal axis, which originates from the endoderm of the circular canal, forms a cylindrical column and consists of a single row of large, clear, discoid chordal cells, lying one above the other like the coins in a rouleau of sovereigns. The conical or carrot-shaped tentacle root (figs. 4, 6, *lr*), a direct process of the endodermal axis, projecting more or less into the gelatinous substance of the umbrella, consists of similar cells. The point of it has a centripetal direction and lies with its lower (umbral) side on the upper (exumbral) side of the gastral pouch, which it likewise serves to support firmly. A structureless septum divides it from the gelatinous substance covering it, and from the adjacent endoderm of the vascular system. The exodermal epithelium of the free tentacle filament, which consists partly of thread cells, partly of sense cells, does not run from its insertion at the root, but passes continuously into the urticating epithelium of the peronium. The urticating cells, which contain nematocysts, are tolerably equally distributed; so are the sense cells, which partly bear cilia or feeling bristles. At the club-shaped swollen distal end of the tentacles, the spheroidal thread cells are more thickly accumulated, and the cilia of the sensitive epithelium considerably prolonged so as to form a thick bunch (fig. 3). The part of the insertion of the tentacle, where filament, root and peronium join, is surrounded as with a collar by a thick semi-circular urticating swelling (figs. 2, 4, 6, *n*).

The twelve auditory clubs of this species, as in all Narcomedusæ, must be regarded as "modified acoustic tentacles" (System der Medusen, p. 307). The four interradial (primary) auditory clubs which lie on the point of the four coronal lobes, are from two to three times as large as the eight adradial (secondary) (fig. 4, *ok*). The free projecting lithocyst is club-shaped, and sits with a thinner short stalk upon a flat roundish "auditory pad" (figs. 4, 6, 7, 8). The solid axis of each auditory club consists of three to four short, broad, discoid endodermal chordal cells, of which the proximal is the smallest, and continuously connected with the endodermal epithelium of the annular canal. The distal end cell of the axis, on the other hand, is very large, and encloses a prismatic crystalline otolite (fig. 8, *ol*). The sense-epithelium forming the exodermal covering of the auditory clubs is composed of very long, fine auditory cilia, which diverge radially and so form a bundle in whose axis the club is placed (figs. 7, 8, *oh*). An auditory clasp, also termed a "marginal mantel clasp" or "centripetal urticating streak" ("otoporpa," fig. 4, *oo;* fig. 8, *oo*), runs from the basis of each auditory club. It is a broad thickened streak of the exodermal epithelium, consisting of a thick accumulation of thread cells and covered with ciliated sense cells. The longitudinal axis of the auditory clasp is a centripetal prolongation (sometimes straight, sometimes broken) of the longitudinal axis of the auditory clubs; both lie in the same meridian plane. The auditory clasps of *Cunarcha æginoides* are of the same nature as those of *Cunoctantha polygonia* (System, p. 317, taf. xix. fig. 2). They are shorter and stumpier than in most other Cunathidæ, almost triangularly club-shaped, gradually broadened from the thin distal end (at the marginal urticating ring) towards the broad proximal end, and ending there in a thick crescent-shaped urticating swelling similar to that at the insertion of the tentacle (figs. 4, 8, *op*). Like the three auditory clubs of each collar lobe, the auditory clasps belonging to them are very unequal in size, the medial (interradial) two to three times as long and broad as the two lateral (adradial); whilst the latter only project slightly above the proximal margin of the annular canal, the former extends till between the two lobe pouches of each lobe (figs. 2, 3, 4, *op*).

In *Cunarcha æginoides*, as in all other Narcomedusæ, the peculiar "subumbrella" is limited to the concave ventral side of the peripheric umbrella collar, whilst the entire ventral surface of the central umbrella lens is occupied by the broad gastral disk. The circular coronal muscle of the subumbrella consequently forms a broad muscular ring, which only lines the concave surface of the four collar lobes; its upper or proximal line of limitation touches the coronal furrow and the periphery of the stomach, whilst its lower or distal margin is divided from the strong velum by the urticating ring and nerve ring of the actual umbrella margin.

The velum is of considerable breadth, thick and compact, considerably broader at the four perradial peronial indentations of the umbrella margin than at the four interradial points of the collar lobes (fig. 1, 3, *v*); it is sometimes extended tensely horizontally, and in that case it narrows the entrance to the umbrella cavity so much that only a narrow opening for the passage of the œsophagus remains; sometimes it projects downwards like a funnel (fig. 3, *v*), and sometimes it hangs loosely and vertically from the umbrella margin like a compact multifold curtain. Like the four-lobed umbrella collar, the broad velum as well as its distal process, present a very different appearance according as they are dilated or contracted, and this is also the same with the umbrella cavity, of which they form the wall (comp. figs. 1, 3, 6). The latter usually appears as a narrow annular hollow space, whose internal (axial) wall is formed by the conical basal half of the œsophagus, and its external (abaxial) wall formed above by the umbrella collar, below by the velum. The upper (proximal) margin touches the peripheric margin of the gastral cavity, and corresponds to the exumbral coronal furrow, whilst the lower (distal) margin forms the opening of the umbrella cavity.

The gastrovascular system (figs. 1, 4) is divided in *Cunantha æginoides*, as in all other Narcomedusæ, into two essential and very distinct principal parts—into the central stomach with œsophagus, and the peripheric corona of pouches with a circular canal; the former is fastened to the ventral side of the central umbrella lens, the latter to that of the peripheric umbrella collar. The central stomach (*gc*) is a flat circular pouch, whose horizontal covering or upper aboral wall is formed by the lower, slightly convex, depressed surface of the central gelatinous lens of the umbrella. The bottom or lower wall of the central stomach, on the contrary, is only a narrow ring, whose thick muscular wall extends downwards like a cone, and becomes a long strong œsophagus (fig. 3, *gt*). This œsophagus is very mobile and contractile, nearly as long as the horizontal diameter of the umbrella, the upper half conically funnel-shaped, the lower half nearly quadrangularly prismatic; it ends below in a narrow oral opening, which sometimes seems quadratic, sometimes circular (fig. 3, *na*). Like the whole lower wall of the stomach, the proboscis-like œsophagus is capable of great extension and contraction.

The peripheric corona of pouches which runs from the periphery of the basis of the stomach (towards the inside of the coronal furrow) begins with four broad perradial gastral pouches, lying crosswise (figs. 2, 4, *bg*), whose upper (adumbral) wall is supported in its perradial middle line by the stiff tentacle root lying on it (*tr*). The breadth of the four gastral radial pouches increases remarkably towards the outside, and surpasses the length considerably; after a short course they bifurcate into two semi-oval cæcal pointed lobe pouches (figs. 2, 4, *bl*). These fill the largest part of the subumbral wall of the collar lobes, and at the same time represent the genitalia, as the ova are developed from the exodermal epithelium of their subumbral wall (fig. 4, *so*). Only a few (two to four) large ripe ova lie in each lobe pouch, among numerous others very small and undeveloped. A double clasp canal or peronial canal (fig. 4, *ck*) runs out between the two lobe pouches of each perradial gastral pouch from the middle of the distal end of the latter. This double canal consists of two narrow parallel tubes, which are separated by the deep furrow of the peronium or umbrella clasp. The two parallel canals diverge on the umbrella margin, at the distal end of the peronium, turn almost rectangularly in contrary directions, and run along the distal margin of the umbrella lobe, in whose centre they unite with the half of the corresponding neighbouring canal running towards them. In this way there is formed a peculiar annular canal shaped like a garland or a festoon, whose arches border the periphery of the umbrella lobes, and whose inverted corner corresponds with the insertion of the tentacle. In proportion, as the arches of the lobe collar in the Cunanthidæ becomes rounded, the shorter is the double canal, which connects the free-arched margin of the annular canal with the radial gastral pouch, and the longer at the same time the festoon canal, as we may suitably term the annular canal, with its bow-shaped archings inwards. However isolated this formation of the vascular system in the Cunanthidæ may appear at first sight, it may easily be referred back to that of some of the closely allied Trachomedusæ (especially the Geryonidæ). In these Geryonidæ, in which the flat "genital layers," or pouch-like broadened radial canals only reach to the annular canal, we only require to insert the indentation of the umbrella margin deeper into the opening place of the annular canal, and to represent the umbrella clasps as running straight through to the basis of the tentacles, in order to have the formation of the Cunanthidæ. The annular canal of the Geryonidæ (and of the remaining Craspedotæ) consequently corresponds to the entire "festoon canal" of the Cunanthidæ, which is composed of the double peronial canals and the peripheric "marginal canal" (lying on the marginal urticating ring), which connects them. On the other hand, the four broad perradial "gastral pouches" of *Cunantha* and *Cunarcha* correspond to the four typical "radial canals" of the Craspedotæ, which are also sometimes extended like a ribbon (as, for example, *Liriope* and *Glossocodon*). The two lateral wings of the last, in which the sexual products develop, may also be compared to the two sexual "lobe pouches" of *Cunarcha* (comp. my System der Medusen, 1879, pp. 304, 306, taf. xix. fig. 2; taf. xx. figs. 1, 2). The paired lobe pouches of *Cunarcha* and *Cunoctantha* (*l.c.*, taf. xx. figs. 1, 2) are at the same time nothing else than the "internemal gastral pouches" of the Æginidæ (*l.c.*, taf. xx. fig. 11). *Cunarcha* therefore appears to be a very interesting phylogenetic intermediate form between *Cunantha* and *Ægina*, immediately connecting these two tetranemal parent genera of the Cunanthidæ and Æginidæ with each other. (Comp. the tabular "Uebersicht über die Homologien der Radial-Canäle einiger tetranemalen Trachomedusæ and Narcomedusæ" in my System der Medusen, 1879, p. 336.)

Family, PEGANTHIDÆ, Hæckel, 1877.

PEGANTHIDÆ, Hæckel, System der Medusen, 1879, p. 323; taf. xix. figs. 4–7; taf. xx. figs. 14, 15.

Narcomedusæ without radial canals and without gastral pouches in the subumbrella, but with a festoon canal (or a circular canal formed by a circle of separate lobe canals), with otoporpæ or auditory clasps at the basis of the auditory clubs.

Sub-family, POLYXENIDÆ, Hæckel, 1877.

Peganthidæ with a single circular genitalium, forming a simple or lobed girdle in the subumbral wall of the stomach.

Polycolpa,[1] Hæckel, 1879.

Peganthidæ with a simple reproductive girdle forming a broad ring in the lower wall of the stomach (with genital cæca in the lobe cavities). Numerous (10 to 30) collar lobes, and the same number of tentacles alternating with them.

Polycolpa is the simplest, and phylogenetically the oldest genus in the family Peganthidæ, that peculiar group of Narcomedusæ which are distinguished by the complete want of the radial canals, and by the formation of a bow-shaped festoon canal. Whilst the most closely related Cunanthidæ have still several true radial canals (in the form of broad pernemal "gastral pouches"), these disappear completely in the Peganthidæ, inasmuch as the strong tentacles by their dorsal change of position occupy the whole of the umbrella margin up to the periphery of the stomach, where they are inserted. The original radial canal (the "gastral pouch") as well as the peronial double canal, undergo retrograde formation; both become lost. The annular canal, however, is divided into the same number of isolated vessels as there are lobes of the umbrella collar. Each horseshoe-shaped lobe-canal or bow canal edges the margin of its lobe, and opens at base of the latter immediately into the gastral cavity (beside the insertion of the tentacles) by two separate mouths. The whole gastrovascular system in the Peganthidæ therefore consists only of the flat lens-shaped gastral sac and the circle of isolated lobe canals, each opening with two mouths into the periphery of the stomach. Of the four genera of the Peganthidæ, which are all closely related, *Polycolpa* appears to be the simplest and oldest form, as it has the primitive formation of the genitalia. The simple genital girdle forms a broad undivided ring in the lower or subumbral wall of the stomach. It does not send out cæcal or pouch-like processes into the separate lobe cavities as in the closely related genus *Polyxenia* and in the genera *Pegasia* and *Pegantha*, derived from the latter.

Polycolpa forskalii, Hæckel (Pl. X.).

Polycolpa forskalii, Hæckel, 1879, System der Medusen, p. 328, No. 350.

Umbrella flat and discoid; two to three times as broad as high. Twenty-five lobes, nearly pentagonal; none as long as broad. Genital girdle very broad, occupying nearly the whole lower wall of the stomach. Twenty-five tentacles, three times as long as the radius of the umbrella; 130 to 170 auditory clubs (5 to 7 on each lobe). Horizontal diameter, 20 to 30 mm.; vertical diameter, 8 to 10 mm.

Habitat.—The Indian and Pacific Oceans. I myself observed a living (female) specimen of this species in the Red Sea. It was taken in the tow-net at a depth of above 60 fathoms, and the figures in Plate X. are drawn from it. I recognised, as I

[1] Πολύκολπα, with many curves (at the umbrella margin).

believe, the same species in an incomplete fragment found by the Challenger expedition near Mindanao, one of the Philippine Islands, at a depth of 82 fathoms. Station 201. Lat. 7° 3′, long. 121° 48′ E. 26th October 1874.

I name this species in honour of the meritorious Swedish naturalist, Peter Forskal, who not only gave the most trustworthy description of Medusæ in the last century, and was the first to describe the Medusæ of the Red Sea, but also (in 1775) made the first (and hitherto best!) description and drawing of a Peganthid (*Polyxenia mollicina*).

The umbrella (Pl. X. figs. 1-3) is depressed, discoid, nearly two to three times as broad as high, and divided, as in all Peganthidæ, by a deep horizontal coronal furrow (fig. 3, *ec*), into an upper half, the massive umbrella lens, and a lower half, the lobed umbrella collar. The thick umbrella lens ("umbrella disk" or "gelatinous mantel") consists of a planoconvex or biconvex gelatinous mass of a cartilaginous or even caoutchouc-like consistency. The solidity of the gelatinous disk, connected with a high amount of elasticity, attains its maximum among the Craspedotæ in this family. The cause of this extreme solidity are the innumerable branched, net-like, anastomosed, elastic fibres which run crosswise through the gelatinous substance from the external to the internal surface of the umbrella. The vertical thickness of the umbrella lens is one-third as great as its greatest horizontal diameter. The exumbrella is flat, without any special distinguishing character (fig. 2). The umbrella collar, which is sharply divided from the umbrella lens lying above it by the deep circular constriction, consists of a circle of twenty-five thick gelatinous lobes, and of the broad velum, which not only completely fills the interspaces between the lobes or the pernemal incurvatures of the subumbrella, and connects them like a swimming membrane, but also projects inwards a considerable way about the external margin of the lobes. The limits of the umbrella collar and the umbrella lens is marked by a circular line, in which the tentacles are inserted, and in which the openings of the festoon canal in the periphery of the stomach lie. (Comp. figs. 2, 3, 6.)

The umbrella lobes—or more accurately "the gelatinous lobes of the umbrella collar"—consist of a process of the gelatinous substance of the lens, which becomes thinner towards the exterior in the direction of the margin of the lobes. Although the thickness of the gelatinous substance in the lobes is not nearly so great as that of the central lens, it is still considerable, and the lobes have great solidity. It is therefore difficult to flatten out the marginal lobes, which are strongly rolled inwards both in the living and the dead animal. The circle of rolled-up lobes makes the umbrella here (and still more in other Peganthidæ) look like the flower of the turncap lily (*Lilium martagon*). The outline of the collar lobes is sometimes more rectangular, sometimes more pentagonal, according to the state of contraction (figs. 1, 2, 6). The lateral margins, as well as the point, is always strongly curved inwards; its exumbral external surface is, therefore, strongly curved both in a radial (longitudinal) and a tangential (transverse) direction.

The subumbral internal surface is strongly concave, corresponding to this external vaulting, and forms a protecting cavity, which is only open in a radial direction towards the umbrella cavity. We shall designate these cavities, which are essentially niches or secondary cavities of the umbrella cavity, and surround it like the altar niches of a circular temple (Pantheon), the lobe cavities; in most other Peganthidæ (as in the following species *Pegantha pantheon*) they serve for the reception and protection of the genital sacs, which branch out from the gastral genital ring. The central umbrella cavity itself (fig. 3, *h*), which is very flat and low as in all Peganthidæ, is limited above by the subumbral gastral wall and the genitalia lying in it, whilst it opens wide below (fig. 1).

The subumbrella is represented in the central part as far as the lower surface of the umbrella lens by the muscular subumbral gastral wall, as this extends to the borders of the lens and collar. In the peripheric part, on the other hand, at the lower surface of the umbrella collar, the subumbrella forms a circle of isolated muscular plates lining the inner concave surface of the lobes. The muscular ring of the subumbrella appears lobed in the lower part, from the proper margin of the umbrella (with the nerve ring and urticating ring), being deeply indented between every second lobe. The velum completely occupies the interspaces between the lobes to the umbrella margin like a swimming membrane, and moreover projects internally a little further than the connecting annular margin towards the axis of the umbrella cavity. The velum is very thick and compact, laid in many folds, and, like the lobes, almost always found more or less rolled up. Concentric annular folds predominate in the inner or axial part of the velum, whilst radial folds predominate in the outer or abaxial part, which runs in between the folds in the form of a triangular tip (figs. 6, 8, *v*). The subumbrella is so deeply indented between each two lobes that the triangular tips of the velum rise between them as far as their base and the insertion of the tentacles (figs. 2, 6). The structure of the subumbrella and of the velum is the same as in the next following species (comp. Pl. XII. fig. 12).

As the proper umbrella margin (in a morphological sense) is not determined by the free axial margin of the velum (the limit between exumbrella and subumbrella), but rather by the marginal urticating ring and the double nerve ring lying on it, the true umbrella margin appears deeply indented in *Polycolpa forskalii*, as in all Peganthidæ. It forms a continuous margin of the collar lobes and, at the same time, the frontier line between these and the velum (fig. 6, *nc*). The festoon canal lies on the inner margin of the urticating ring (fig. 6, *cf*) which accompanies it all along. The more minute structure of the umbrella margin is the same as in the following species (comp. Pl. XII. fig. 12). Of tentacular organs the umbrella margin bears twenty-five tentacles and a large number of auditory clubs (five to seven on each lobe).

The tentacles, whose number in all Peganthidæ equals that of the collar lobes, alternate regularly with the latter, and are inserted at the bases of every two lobes in the coronal furrow of the exumbrella (figs. 1–3, 6). The twenty-five tentacles of our *Polycolpa forskalii* are $1\frac{1}{2}$ to 2 times as long as the diameter of the umbrella, and are sometimes curved upwards like a crown (as in *Pegantha pantheon*, Pl. XI. fig. 1), sometimes turned downwards under the umbrella (Pl. X. fig. 2); they are cylindrical, cartilage-like filaments, somewhat thickened at the bases, becoming gradually pointed finely towards the end, and combining a high amount of stiffness and firmness with considerable elasticity. The solid chordal axis resembles the chorda dorsalis of the vertebrata, and consists of large, clear, thick-walled endoderm cells, which have a firm elastic membrane, transparent contents, and a large nucleus. The chordal axis of each filament forms a single row or column of such coin-shaped chordal cells (comp. Pl. XII. figs. 10, 11). Its exodermal epithelium contains numerous spheroid nematocysts, especially in the abaxial side of the filament. The clear conical tentacle root is also composed of thicker chordal cells, it penetrates radially (centripetally) some way from the insertion of the tentacles into the gelatinous substance of the disk, and often lies, bent like a hook, with its lower oral side on the periphery of the stomach (Pl. X. fig. 3, *tr*; fig. 7). A net of branched protoplasmic filaments radiating from the layer surrounding the nucleus is visible in each chordal cell of the root (fig. 7). The endodermal supporting plate, which encloses the chordal axis of the tentacles like a tube, also surrounds the root up to the point, which, on the other hand, the layer of longitudinal muscular filaments (lying outside the endodermal supporting plate) does not. "Umbrella clasps" or peronia, which appear so strongly developed in *Cunarcha* and *Æginura*, are only rudimentary in *Polycolpa* and *Pegantha* as in most Peganthidæ. As the deep indentations of the umbrella margin extend between each two lobes almost to the base of the tentacle, the peronia are naturally so much shortened that they almost disappear. By their retrograde formation the insertion of the tentacle remains in continuous direct connection with the urticating ring as it passes immediately into the former at the base of the lobes. The interlobar points of the velum, therefore, also extend to the tentacle root between each two lobes (fig. 6).

Polycolpa forskalii has 130 to 170 auditory clubs, 5 to 7 on each of the twenty-five lobes (fig. 6). One of them is placed on the point of the lobe, the others (in pairs opposite each other) on its lower lateral margin. Their structure is the same as those previously described in *Cunarcha*. Here, however, each of the 3 to 4 endodermal axial cells usually contains an otolite (fig. 8, *ol*). The otoporpæ or "auditory clasps" at their bases (fig. 8, *oo*) are club-shaped urticating streaks of the exumbrella covered with ciliated sense-epithelium with larger and smaller nematocysts (fig. 8, *n*). Their other functions are the same as in *Pegantha pantheon* (comp. Pl. XI. fig. 4).

The gastrovascular system (figs. 1, 3, 6, 8) has the special formation, peculiar to all Peganthidæ, which distinguishes this family of the Medusæ from all the rest. It consists of two principal sections, the central stomach and the peripheric festoon canal (fig.

6, *cf;* fig. 8, *cf*). The latter runs like a garland along the margin of the lobes and opens throughout between every two tentacles with a double mouth in the periphery of the stomach. The stomach is a completely flat, circular, or polygonal pouch, occupying the entire lower surface of the umbrella lens (fig. 3, *gc*). Corresponding to the latter, the upper wall or cover of the stomach forms a flat or only slightly convex, rarely concave, circular surface, whose periphery presents in certain conditions of contraction a regular polygon; each of its projecting corners corresponds to a tentacle insertion, each side of the base to the base of a collar lobe. The projecting corners sometimes form triangular pouches with the ends directed towards the insertion of the tentacle (last rudiments of radial pouches). The lower wall or bottom of the gastral pouch is a circular or regularly polygonal thick, muscular plate, covered with endoderm above and exoderm below. The oral opening, which is extended into a short cylindrical œsophagus hanging freely down, is in the centre (fig. 3, *at*). The thickened oral margin is simple, not split up into oral lobes. The muscular plate appear considerably swollen at the oral margin (longitudinal section, fig. 5, *m*). Numerous gland cells (*gd*) are scattered between the high cylinder cells of the gastral endoderm (*dg*), they are 2 to 3 times as broad as the latter, have twice as large a nucleus, and are distinguished by the turbid, granular nature of the protoplasm. As in all Narcomedusæ, the muscular wall of the stomach is capable of considerable contraction and dilatation.

The peculiar festoon canal (" canalis festivus," fig. 6, *cf;* fig. 8, *cf*) which attains its highest development in the Peganthidæ and the complete want of radial canals connected with it, suffices alone to characterise this family and to distinguish it from all other Medusæ. Phylogenetically this peculiar condition is simply derived from that of the Cunanthidæ, and from the fact that the stomach stretches by peripheric growth as far as the insertion of the tentacles (or to the limit of the umbrella lens and the umbrella collar), and so includes the broad pouch-shaped radial canals. The deep sinuses which are found in the Cunanthidæ between each two radial pouches are in some measure obliterated in the Peganthidæ. Hence the " triangular points " of the periphery of the stomach, which in some Peganthidæ run out to the insertion of the tentacles (already described by Eschscholtz in *Polyxenia* as " long three-sided processes of the stomach "), must, in fact, be considered the last rudimentary remains of radial canals. While in the Cunanthidæ the latter still serve to connect the stomach with the radial canal, in Peganthidæ the triangular points open into the periphery of the stomach in as many places as there are insertions of the tentacles between each two collar lobes. The circular canal has, therefore, the same disposition as in the nearly related Cunanthidæ; it runs along the velar margin of the collar lobes immediately under the urticating ring of the true umbrella margin; it is, however, interrupted at the basis of each two adjacent lobes by the insertion of the tentacle, and opens into the stomach beside the latter. The state of the case may be expressed thus : the annular canal of the Peganthidæ is divided into many (10 to 20) bow-like or semicircular lobe canals, running on the margin of the gelatinous lobes inside from the insertion of the velum, and opening at the bases of the lobes into the periphery of the stomach. The circular canal is, however, in no way reduced but forms a spacious tube, whose lumen in the larger species is often a millimeter in diameter and allows the introduction of a probe. Its endoderm is usually thickened and laid in folds, in some species even rising into numerous tufts or papillæ (like intestinal tufts). No such folds are recognisable in the transverse section of the festoon canal in our *Polycolpa forskalii*, whilst in the species immediately following a low annular fold is clearly present at the distal margin of the canal as in *Pectis* (comp. Pl. VI. fig. 12, *yc*, and Pl. XI. fig. 12, *yc*).

The reproductive glands in *Polycolpa forskalii* appear in their simplest form as a broad circular girdle, occupying the largest part of the lower subumbral gastral wall (fig. 1, *sf*; fig. 3, *sf*). In the living female specimen observed by me in the Red Sea, this girdle was of a beautiful sky-blue colour, so were the tentacles and the urticating ring of the umbrella margin; the points of the tentacles were dark-blue. The subumbral convex external surface of the reproductive girdle is tolerably smooth, and only traversed by insignificant and incomplete radial folds (fig. 1, *sf*). A thick compressed mass of small egg-cells, between which isolated large ova are scattered, appears in the radial transverse section (fig. 3, *sf*; fig. 4), between the high gastral endodermal epithelium of the ova (fig. 4, *dg*) and the flat subumbral exodermal epithelium (fig. 4, *qg*).

Sub-family, Pegasidæ, Hæckel.

Peganthidæ, with a circle of several separate genitalia, forming dilatations of the subumbral gastral wall and lying apart in the lobe cavities of the umbrella collar.

Pegantha,[1] Hæckel, 1879.

Peganthidæ, whose gastral reproductive girdle is divided into a circle of separate vesicle-shaped genital sacs, equal in number to the tentacles and alternating with them (a simple or multi-lobed cæcum in each lobe cavity). Numerous (10 to 30) collar lobes, and the same number of alternating tentacles.

The genus *Pegantha* represents the most complete and phylogenetically the youngest genus of the remarkable family of the Peganthidæ, in which the family type reaches its highest development. Whilst in the preceding genus *Polycolpa*, the ancestral genus of the family, the genitalium appears as a simple girdle in the lower wall of the stomach, which, in *Polycenia* and *Pegasia* develops into a peripheric circle of lobes, in

[1] Πηγή, a spring; ἄνθη, a flower.

Pegantha the girdle is divided into a circle of completely separate perigastral genital sacs, one of each hanging freely in every lobe cavity of the umbrella collar (comp. System der Medusen, 1879, p. 327, pl. xix. figs. 4–7).

Pegantha pantheon, Hæckel (Pls. XI., XII.).

Pegantha pantheon, Hæckel, 1879, System der Medusen, p. 332, No. 359.

Umbrella crown-shaped, twice as broad as high, eighteen egg-shaped lobes, one-half as long as broad. In each lobe cavity a simple genitalium in the form of a broad roundish delicately-twisted leaf, eighteen tentacles twice as long as the radius of the umbrella, 400 to 450 auditory clubs (23 to 25 at each lobe). Horizontal diameter, 20 mm.; vertical diameter, 10 mm.

Habitat.—The South Pacific Ocean, near Mindanao, Philippine Islands. I found the extremely well preserved (male) specimen of this species, from which the figures in Plates XI. and XII. are taken, in the same bottle of the Challenger collection which contained the fragment of the preceding species. Station 201. Lat. 7° 3′ N., long. 121° 48′ E. 26th October 1874. Depth, 82 fathoms.

The umbrella (Pl. XI. fig. 1; Pl. XII. figs. 7–9) is shaped like a diadem or crown; is nearly twice as broad (20 mm.) as high (10 mm.), and divided by a deep horizontal coronal furrow into a massive upper half, the umbrella lens, and a lobed lower half, the umbrella collar. The massive upper part or umbrella lens consists, as in the previous species, of a tolerably firm biconvex gelatinous lens, of which the horizontal diameter is twice as great as the thickness (fig. 7, *ug*).

The exumbrella is distinguished by branched strongly-projecting ribs, between which deep radial furrows traverse the external upper surface (figs. 1–8). The ribs of the umbrella lens, which increase in thickness from the centre towards the periphery, are distributed so that a thicker principal rib runs in the middle of each collar lobe from which several thinner secondary ribs branch out laterally.

The umbrella collar consists of a circle of eighteen oval umbrella lobes (figs. 7, 8). These "gelatinous lobes of the umbrella collar" were closely pressed together in the specimen examined, and were so strongly rolled inwards, and of such a cartilaginous consistency that they could only be opened out flat under strong pressure (fig. 8, right half). They then appear of a broad oval, once and a half as long as broad. The convex external surface of each lobe (fig. 2) is strongly vaulted and traversed by five projecting longitudinal ribs of which the centre rib is considerably thicker than the lateral. The concave inner surface of each lobe (fig. 3) encloses a roomy lobe cavity, in which hangs a genital sac with folds. These eighteen lobe cavities (fig. 3, *hl*) form a circle of niches or secondary cavities round the central umbrella cavity, and surround it like the altar-niches of a circular temple (Pantheon). The central umbrella cavity itself is flat and low, opening wide below, whilst it is limited above by the subumbral gastral wall (comp. figs. 1, 7, 9).

The subumbrella, with its annular muscular layer is divided, as in the previous species, into two very different parts, limited by the circle of genitalia (fig. 9). The central part of the subumbrella, which corresponds in extent to the lower surface of the umbrella lens, is formed by the lower, folded, very muscular gastral wall, and appears pierced in the middle by the œsophagus (fig. 7). The peripheric part, on the other hand, is composed of the circle of isolated muscular plates which line the inner concave surface of the eighteen collar lobes. The velum completely fills the narrow interspaces of these lobes, and, moreover, projects freely a little way further over the points of the lobes like a connected circular edge (fig. 1, *ve*, right half *v*). Vertical sections of the firm velum (fig. 12, left) show that the upper (subumbral or ventral) epithelium of the velum (*vw*) is three times as high and as thick as the lower (exumbral or dorsal) epithelium (*vw*). A strong circular muscular layer lies on the former (*mv*), and a thick elastic supporting plate on the latter (*zv*).

As in the other Peganthidæ, the peculiar umbrella margin (characterised by the urticating ring and nerve ring) is deeply indented, and covers the selvage of the collar lobes like a connected edge. In *Pegantha pantheon* it forms eighteen deep curves reaching as far as the insertion of the tentacles (figs. 2, 3, 8, 12). In the radial transverse section of the umbrella margin (Pl. XII. fig. 12) the urticating ring (*na*) appears covered by dense epithelium with long cilia. The dorsal nerve ring (*rc′*) is divided from the ventral nerve ring (*rc″*) by the supporting lamella of the velum (*zv*); both lie immediately outside (abaxially) the insertion of the velum (comp. the explanation of fig. 12). The distal margin of the broad festoon canal (*cf*) touches the velum immediately. Of tentacular organs, the umbrella margin bears eighteen tentacles and numerous (over 400) free auditory clubs.

The eighteen strong tentacles, which alternate with the eighteen collar lobes and are inserted at their basis in the coronal furrow, were generally curved upwards in the specimen examined, as often happens in the Narcomedusæ (fig. 1). They are cylindrical, somewhat thicker towards the base, thinner towards the point, and nearly as long as the diameter of the umbrella. The endodermal axis is composed of a single row of coin-shaped chordal cells (a millimeter broad), in which the nuclei form a central chain (fig. 11). A visible layer of longitudinal muscular fibres (*m*) lies outside the strong supporting plate (fig. 10, *z*). The spheroidal nematocysts (*n*) in the exodermal epithelium are chiefly accumulated in the abaxial side of the tentacles, most thickly at the point. A thick, almost closed, urticating ring, which has only a break internally on the axial side (figs. 2, 3, *nb*) is placed at the insertion of the tentacles. Inside this the tentacles run into the pointed conical roots (*tr*) which pass centripetally into the gelatinous substance of the umbrella.

The auditory clubs in *Pegantha pantheon* are very numerous, 400 to 450, 20 to 25 upon each of the collar lobes (figs. 1, 2). They are regularly distributed along the bow-shaped umbrella margin, and run inwards immediately into the auditory clasps. The otoporpæ or auditory clasps (figs. 2, 4, *oo*) are all equal in length, nearly three times as long as the auditory clubs; their axis converges more or less towards the middle point of the lobe base (fig. 2). Their inner end is thickened and rounded like a club; their exodermal epithelium contains many larger and smaller thread-cells. The auditory clubs themselves are larger than in most other Narcomedusæ, and contain an axis of three to five, usually four, large endodermal cells, each enclosing a crystal. The proximal otolite (at the thin end of the auditory club) is the smallest, the distal otolite (in the club-shaped rounded end) the largest, and between these one or two medium-sized crystals (in the middle endodermal cells). The auditory club is surrounded by a stiff bunch of auditory hairs (*oh*), which run out from the auditory pad (*op*). After treatment with acetic acid and carmine, a nucleus coloured red (perhaps the original cell nucleus enclosed by the formation of the otolite) was visible in the centre of the otolite (fig. 12, *ol*). The manner in which the auditory clubs and their auditory clasps are disposed upon the umbrella margin, and their relations to the adjacent organs will be best understood by a comparative study of figs. 2 and 4 in Plate XI. and figs. 7 and 12 in Plate XII. In fig. 12 especially it is clear how the auditory club rises on a thin stalk from the conical auditory pad (*op*) of the urticating ring (*nc*), and how the fulcral lamella (*z*) between the two nerve rings (*nc*) passes through to the base of the auditory club, and thence into its supporting plate.

The gastrovascular system (Pl. XI. figs. 1, 3; Pl. XII. figs. 7, 9, 12) is, on the whole, the same as that already described in *Polycolpa forskalii* (comp. above, p. 34, and Pl. XI. figs. 1, 3, 6, 8). The stomach also forms a wide, flat, circular pouch, occupying the whole lower side of the umbrella lens (fig. 7, *gc*). Whilst the slightly convex lower surface of the latter forms the cover of the gastral cavity, its bottom is formed by the very muscular and extensible central part of the subumbrella, which is laid in a large number of radial folds (fig. 9). A short, wide œsophagus hangs down in the middle of the folds, its ample oral opening showing a swollen, thickened oral margin (fig. 7, *qg*). The peripheric part of the gastrovascular system is formed by the festoon canal, which is composed, in this species, of eighteen separate lobe canals (comp. above, p. 35). The latter run on the inner side of the urticating ring along the margin of the oval collar lobes, and open at their bases immediately into the periphery of the gastral cavity (fig. 3, *go*). The two openings take in between them the stalk of the genital sacs, which hangs in the relative lobe cavity (fig. 3, *oc*). The ribbon-shaped flattened canals are nearly one-eighth as broad as the greatest breadth of the lobes. Their subumbral endodermal epithelium (fig. 12, *dw*) is composed, as usual, of very high narrow cylindrical cells, whilst that of their umbral wall (*dw*) consists of many flat, flagellate cells. A low endodermal fold, like that in *Pectis* (Pl. VI. fig. 12, *yc*), but less strongly developed, rises at the distal margin of the festoon canal, projecting freely into its lumen (Pl. XII. fig. 12, *yc*).

In contrast to the preceding *Polycolpa*, in which the reproductive glands appear in their simplest form as a circular closed girdle in the lower wall of the stomach, *Pegantha* shows us the most widely differentiated and highly developed form of the genitalia. Here the originally simple and connected genital girdle is divided into a circle of separate reproductive sacs, hanging freely in the periphery of the gastral cavity. Each lobe cavity of the umbrella collar receives one genital pouch, which is surrounded and protected by the concave subumbral surface of the collar lobes (Pl. XI. fig. 3; Pl. XII. figs. 7, 9). The genera of the Peganthidæ, *Polyxenia* and *Pegasia* represent connective intermediate forms between the two extremes *Polycolpa* and *Pegantha*, so that we have here the division of the simple subgastral reproductive girdle into a circle of separate pouches, shown in four different phylogenetic stages (comp. my System der Medusen, 1879, pp. 327–332). The cavities of the isolated reproductive sacs of *Pegantha pantheon* (fig. 5, *sc*) communicate with the periphery of the gastral cavity (figs. 7, 9, *sc*). Each of the eighteen genitalia has the shape of a thick roundish leaf, with the two edges turned towards the edges of the collar lobes, whilst the upper surface is delicately twisted or folded (fig. 3, *s*). The transverse section (figs. 5, 6) shows that the gastral endodermal epithelium of the sac cavity (*sd*) is composed of high cylindrical cells, and divided by a strong supporting plate from the mass of the spermatozoa (*sm*). On the other hand, the latter is in continuous connection with the gastral ectodermal epithelium of the subumbrella, from which it originates. Under stronger magnifying power, we find the same condition here which Hertwig described (1878) in *Cunina lativentris*. The superficial ectodermal layer of cells (figs. 5, 6, *sw*), which forms the subumbral cover of the testes, sends out supporting fibres containing nuclei (*zs*) into the subepithelial layer of cells lying beneath it. The larger cells of this layer (*sm*) usually lie inwards, touch the endodermal fulcral plate (*z*), and must be regarded as "mother cells of the spermatozoa," whilst the smaller cells, which usually lie outwards, form spermatozoa already ripe (fig. 6, *sz*).

Family, ÆGINIDÆ, Gegenbaur, 1856.

ÆGINIDÆ, Hæckel, System der Medusen, 1879, p. 334, taf. xix. fig. 8, 9; taf. xx. fig. 11–16.

Narcomedusæ with a marginal canal communicating immediately with the stomach by double peronial canals, with internemal gastral pouches (which have arisen from the distal lobe pouches of radial canals through retrograde formation), without otoporpæ or auditory clasps at the basis of the auditory clubs.

Sub-family, ÆGINURIDÆ, Hæckel, 1879.

Æginidæ with eight peronial double canals (four perradial and four interradial).

Æginura,[1] Hæckel, 1879.

Æginidæ having eight peronial double canals and eight tentacles (four perradial and four interradial), and also sixteen internemal reproductive pouches, alternating in pairs with the eight tentacles.

The genus *Æginura* shows twice as many tentacles and reproductive pouches as the well-known primitive genus of the Æginidæ, *Ægina*. The *Æginura myosura*, which I am about to describe, is the only species of this genus, and also the only species of Æginidæ of the Challenger collection, of which I can give a satisfactory account. A second species of this family, much larger, and of more complicated structure, which I placed in my System, 1879, as *Æginorhodus rosarius* (p. 345), proved on closer examination too much destroyed and badly preserved for any satisfactory description. I am even dubious if the diagnosis of the species taken from this fragment be correct.

Æginura myosura, Hæckel (Pls. XIII., XIV.).

Æginura myosura, Hæckel, System der Medusen, 1879, p. 343, taf. xix. figs. 8, 9.

Umbrella cap-shaped, twice as broad as high. Mouth quadrate or four-lobed, with cylindrical œsophagus half as long as the radius of the umbrella. Sixteen almost rectangular reproductive pouches, the two medial of each quadrant smaller than the two lateral. Eight tentacles alternately different; the four perradial larger, and inserted higher than the four interradial; the former nearly double the length of the radius of the umbrella, the latter the same length. Horizontal diameter, 30 mm.; vertical diameter, 15 mm.

Habitat.—Indian Ocean, south of Australia. I found a male specimen of this species somewhat damaged, but still pretty well preserved, in a bottle of the Challenger collection, containing numerous Phæodaria (*Aulosphera, Cœlodendrum*, &c.) from Station 159. Lat. 47° 25′ S., long. 130° 32′ E. 10th March 1874. Depth (apparently) 2150 fathoms. In the System der Medusen (p. 343), "Weber" was given by an oversight instead of "Challenger."

The umbrella (Pl. XIII. figs. 1, 2; Pl. XIV. fig. 11) has the shape of a flat cap or biretta; the upper surface flattened nearly horizontally (slightly depressed in the middle), whilst the side walls stand almost vertically (slightly widened below). The

[1] *Æginura, nomen proprium.*

largest horizontal diameter near the umbrella margin amounted to 30 mm., double the vertical height of the umbrella (15 mm.). As the umbrella margin in the specimen examined was strongly contracted, the height in the living animal must be proportionately greater (20 mm. or more). The umbrella, seen from the upper or lower surface, appears distinctly octagonal, as the eight principal radia (with peronia and tentacles) project more strongly outwards than the eight interlying side walls (fig. 2), so that the umbrella of the dead Medusa has really the shape of a short, regularly octagonal prism. The gelatinous substance of the umbrella is tolerably soft (as in all true Æginidæ), not so firm as in the Cunanthidæ and Peganthidæ, though there, as here, it is traversed by numerous elastic fibres. The gelatinous umbrella is very thick throughout the flattened apical surface (equal to one-third of the height of the umbrella) but very thin (and decreasing proportionately below) on the thin lateral walls (fig. 11, *ug*).

The exumbrella is flat, without any special characteristic, and only traversed by eight shallow peronial furrows (fig. 7, *es*); these run vertically from the insertion of the tentacles to the umbrella margin, and are connected by thin "peronial plates" with the peronia or "umbrella clasps" lying beneath them (*em*). The eight peronial plates ("laminæ peroniales," figs. 7, *em*; 12, *em*) consist of a double layer of the exodermal flat epithelium of the exumbrella, and originate from the two gelatinous walls of the umbrella, which limit the open peronial groove laterally in the Cunanthidæ (Pl. IX. fig. 5, *es*), but lie above the grooves with their edges fused together in the Æginidæ. The peronium in the Æginidæ is therefore completely enclosed by the gelatinous substance of the umbrella on the abaxial side, and by the subumbrella on the axial side, whilst in the Cunanthidæ the abaxial side of the peronium lies free at the bottom of the open peronial groove (Pl. IX. fig. 5, *en*). In *Æginura* the distal end of the peronium joins that of the peronial plate under the umbrella margin; both pass continuously into the marginal urticating ring (Pl. XIII. figs. 1, 2, 4, *nc*; Pl. XIV. fig. 11, *nc*).

The umbrella cavity and the subumbrella lining it do not present in *Æginura*, any more than in the other Æginidæ, any of the striking peculiarities which distinguish the two families of the Narcomedusæ, the Cunanthidæ, and Peganthidæ; the conditions do not differ essentially from those usual in the Craspedotæ. Hence it comes that the umbrella collar is not divided into separate lobes by deep peronial incisions, and the margin of the umbrella is therefore almost entire. The peculiar lobe cavities of the Cunanthidæ (Pl. IX. fig. 6, *nl*) and the Peganthidæ (Pl. XII. fig. 7, *nl*) are consequently wanting. In *Æginura* the umbrella cavity is more a simple cylindrical, or almost octagonal, hollow space, with the œsophagus hanging in its axis, whose horizontal roof is formed by the subumbral bottom of the stomach (Pl. XIV. fig. 11, *gw*), whilst it opens wide below, and is limited laterally by the vertical side walls of the subumbrella. The latter has an unbroken broad layer of circular muscular fibres, which is divided by the eight peronia into eight quadrangular plates, but not cut through by it (comp. figs. 7, 11, 12, *mw*).

The velum (*v*) in *Æginura*, as in the other Æginidæ, is tolerably broad and strong, though not so thick and muscular as in the Cunanthidæ and Peganthidæ. Nor does it form the peculiar lateral points which project vertically into the deep peronial incisions of the umbrella margin, between each two collar lobes, as in the last-named families. As the collar lobes in the Æginidæ are not divided, but united below as far as the umbrella margin by the peronial plates, the velum is nearly of equal thickness throughout, and only slightly broader at the eight principal points where the peronia rise out from the eight corners of the umbrella margin (Pl. XIII. figs. 2, *v*; 4, *v*).

The umbrella margin (fig. 2) appears regularly octagonal from the slight curvings above mentioned at the principal points where the distal ends of the peronia and peronial plates run out from the urticating ring of the umbrella margin. Its cylindrical urticating ring is limited inside by the velum, outside by the distal margin of the exumbrella, above by the annular canal, and below by the double nerve ring. The sixteen subradial auditory clubs are placed on the abaxial external surface of the urticating ring, between the lower margin of the gelatinous umbrella and the upper margin of the velum, whilst the eight tentacles are inserted much further up on the exumbrella, at the height of the covering of the stomach.

The sixteen auditory clubs ("cordyli," Pl. XIII. figs. 1–3, *ok*) are placed strictly subradially, *i.e.*, they lie in the sixteen radial meridian planes, exactly in the middle between the eight adradial planes of third order, and the eight principal planes, in which the four interradial tentacles (second order) and the four perradial tentacles (first order) are placed. The auditory clubs are placed upon a hemispherical auditory pad (fig. 3, *op*), a wart-like swelling of the urticating ring, which apparently conceals a "ganglion acusticum;" at least the ganglion cells of the dorsal nerve ring are much more thickly accumulated there (fig. 10), and are connected immediately by numerous fine nervous fibrillæ, with the high cylindrical sense cells covering the auditory pad. A thick bunch of very long, fine auditory hairs radiate from the pad (fig. 3, *oh*). The auditory club, which is very thin at the base and considerably enlarged at the distal end, is placed in the axis of the conical bunch. Its endodermal axis consists of 5–6 chordal cells, of which the 2–3 proximal are very small and without otolites, but the 3–4 distal very large, and enclose otolites. The largest otolite in the terminal endoderm cell is sometimes nearly half as long as the whole auditory club. The ectodermal covering of the latter is divided from the endodermal axis by a delicate fulcral lamella (*z*), and consists of flat sense cells (fig. 3, *q*).

The eight tentacles are inserted high up on the exumbral surface, far from the umbrella margin, and only connected immediately with it by the eight long, strong peronia. A conical tentacle root (fig. 11, *br*) runs inwards from the point of insertion (at the proximal end of the peronial furrow), horizontally and centripetally, into the gelatinous substance of the umbrella, whilst the peronium (*em*) goes downward almost at a right angle to the umbrella margin. All eight tentacles have the same form and structure; the four primary perradial tentacles are, however, twice as long as the four secondary interradial, the former are also inserted somewhat higher, and the clasps of the latter are consequently somewhat shorter. The four perradial tentacles are somewhat longer than the largest diameter of the umbrella, the four interradial only about half so long. The free cylindrical tentacle filament (fig. 5, longitudinal section; fig. 6, seen from the outside) is more than a millimeter thick at the base, decreases towards the point like an awl, and is shaped like a mouse's tail ("myosura"). The solid axis resembles a rouleau of coin, and consists of a single row of discoid chordal cells whose nuclei lie in the centre, one behind the other (fig. 5, *ym*; comp. also Pl. XII. figs. 10, 11). The elastic structureless supporting plate enclosing this column of chordal cells (*z*), is covered by a layer of longitudinal muscular fibres (fig. 6, *mt*), above and outside which lies the single layered epithelium of the ectoderm (*d*). The spheroidal nematocysts (*m*) in the exoderm lie thickly together on the dorsal (abaxial) side of the tentacles, and form a raised urticating band (fig. 6, *m*), whilst they are only scantily distributed and of smaller size on the other sides of the tentacles.

The peronia or "umbrella clasps," which serve to connect the base of the tentacle with the urticating ring of the umbrella margin, are eight thick urticating streaks, gradually increasing in breadth from the top to the bottom (figs. 1, 2, 4, *en*). They appear egg-shaped in transverse section (figs. 7, *en*; 12, *en*), and under higher magnifying power they prove to be composed of the peculiar "peronial tissue" or "urticating skeletal tissue," which is the most important element in the urticating ring, and in the peronia and otoporpæ of the Narcomedusæ. This tissue (fig. 12, *en*) consists of compacted exodermal thread cells, varying greatly in shape and size. The roundish thread cells containing nematocysts enclose a long urticating thread, wound thickly and spirally; they have very thick walls, and are partly much larger (three to four times as large) than the ordinary largest nematocysts of the tentacles. These nematocysts are plainly incapable of throwing out their threads, but only serve with their thickened wall as firm "supporting cells." The inner axial side of the peronia is then closed on the exodermal epithelium of the subumbrella (figs. 7, 12, *qw*); also on the peronial canals, touching them laterally (*cts*) by a thick supporting plate, whilst its outer abaxial side touches the gelatinous substance of the umbrella (*wg*).

The tentacle roots (fig. 11, *tr*) are, as usual, conical, being a centripetal prolongation of the tentacle axis, consisting of a few large chordal cells of the endoderm, and having their points directed centripetally. They are covered by a structureless supporting plate, but have no exodermal epithelium. Their dorsal and their lateral surfaces are enclosed in the gelatinous substance of the umbrella, whilst their ventral surface lies immediately on the cover of the stomach (or the dorsal gastral wall), which it serves at the same time to support.

In *Æginura*, as in the other true Æginidæ, the gastrovascular system (Pl. XIII. figs. 1, 2, 4, 7; Pl. XIV. figs. 8, 11, 12) consists of two different principal parts, corresponding to the two principal parts of the umbrella, and separated by its coronal furrow (*ec*). The central gastral cavity with the œsophagus and oral opening lies on the subumbral side of the central lens of the umbrella, whilst on the subumbral side of the peripheric corona of the umbrella there is a circle composed of sixteen internemal reproductive pouches and eight peronial double canals, connected with the umbrella margin by an octagonal marginal canal, along with which it forms the "festoon canal." The central gastral cavity is flat and wide and regularly octagonal in outline (corresponding to the eight tentacle roots and peronial furrows). The cover of the stomach or the upper umbral wall is formed by the flat or slightly convex gastral surface of the gelatinous umbrella lens, into which the adjacent tentacle roots (*tr*) project centripetally as eight supporting edges. The bottom of the stomach or the lower subumbral wall, consists of a thick layer of circular muscular fibres, immediately connected on their lower surface with the ectodermal epithelium of the subumbrella (*w*), but separated on their upper surface by a thick supporting plate (*z*) from the high endodermal epithelium of the stomach. A cylindrical œsophagus (*gt*) hangs from the middle; it is nearly half as long as the whole radius of the umbrella, probably considerably longer in the living animal. The œsophagus is nearly as broad as long, and quadrangularly prismatic towards the lower end, where the four interradial longitudinal furrows appear, which divide the four broad bordering oral lobes (fig. 8).

The coronal intestine, which projects from the periphery of the central principal intestine, is composed of a circle of sixteen reproductive pouches, alternating in pairs with eight peronial double canals, and arises from the octagonal marginal canal along with which it forms the festoon canal. This festoon canal ("canalis festivus") is homologous with the festoon canal already described in *Cunarcha*, *Polycolpa*, and *Pegantha*, and really consists of eight internemal "lobe canals," which edge the margin of the eight quadrangular collar lobes of the corona of the umbrella. In *Æginura*, however, the lateral margins of these "collar lobes" are fused into the eight peronial furrows (*es*), so that each lobe canal is divided into a horizontal middle part (an octant of the marginal canal) and two vertical side limbs (the two inverted halves of two peronial double canals). At first sight a simple "circular canal" appears to exist upon the umbrella margin (Pl. XIII. figs. 1, 2, 4), which is connected with the stomach by the eight simple broad "radial canals" (as in many Craspedotæ, such as the Pectyllidæ, Pls. III.–VIII.). In the transverse sections (figs. 7, 12), however, we see at once and indubitably that the eight broad, apparently simple "radial canals" consist of two isolated "peronial canals" (*ck*) fully separated by the peronium. Each of the two adjacent peronial canals or clasp-canals open independently above (beside the insertion of the tentacles) into the periphery of the stomach, whilst it turns almost at right angles into the corresponding pieces of the marginal canal. The marginal canal ("canalis marginalis," *cm*) which runs along the proximal side of the urticating ring, is not however the usual marginal "circular canal" of the Medusæ margin, but consists of eight completely distinct pieces, separated from each other by the distal ends of the peronia. Each of these independent "octants of the marginal canal" runs at the two ends into a peronial canal, the two branches thus forming a horseshoe-shaped "lobe canal." Each lobe canal opens with two separate mouths into the gastral cavity beside the base of insertion of each two tentacles. The two peronial canals of each double canal and their two gastral openings (at both sides of a tentacle) therefore belong to two different "lobe canals." The eight lobe canals form collectively the eight-lobed "festoon canal," and this is phylogentically only a peculiar modification of the primarily simple "circular" canal, caused by the dorsal change of position of the tentacles and the formation of peronia connected with it.

The sixteen subradial reproductive pouches of *Æginura* show essentially the same formation already described by Mertens in *Æginopsis laurentii* (1838, *loc. cit.* Pl. VI.). They are quadrangular, almost rectangular, and distributed in such a way that a large and a small pouch is placed on each of the eight collar lobes (Pl. XIII. fig. 1, 2). The pouches, consequently, lie in internemal pairs, a pair between each two tentacles and peronia. It appears, however, on closer inspection that, as in *Æginopsis laurentii*, all the sixteen pouches actually belong to four primary groups. Two smaller pouches are placed on both sides of the four larger perradial tentacles, and two larger pouches on both sides of the four smaller interradial tentacles. If the whole umbrella be divided into four quadrants, whose middle lines form the four perradial peronia and the border lines the four interradial peronia, a group of pouches consisting of two small medial pouches and two large lateral pouches falls in each of the quadrants. The same condition is shown, if we suppose each of the eight lobe pouches of *Cunarcha* already described (Pl. IX. figs. 2–4, *bl*) divided by a centripetal incision of their distal margin into two pouches of unequal size, and the four proximal (perradial gastral pouches), formed by the bifurcation of the eight lobe pouches, to have undergone retrograde formation. It is then clear that each group of four associated reproductive pouches belonging together in *Æginura*, is simply the double bifurcated distal part of a perradial gastral pouch, whose undivided proximal part has undergone retrograde formation (or become part of the central stomach).

In fact, it is only by such morphological comparison that we can understand phylogenetically the remarkable and varied conditions of vascular formation in the Æginidæ. The peculiar, apparently isolated, gastrovascular system of the Æginidæ, is, therefore, naturally derived from that of the Cunoctonidæ, from those Cunanthidæ (*Cunarcha, Cunoctona, Cunissa*) in which each radial canal (or each "pernemal gastral pouch") is cleft at the distal margin into two cæcal lobe pouches. If these paired lobe pouches become larger, and the undivided proximal piece of the pernemal gastral pouch undergoes retrograde formation at the same time, the former originate the characteristic internemal gastral pouches of the Æginidæ, which were primarily placed in pairs between every two tentacles (as in the tetranemal *Ægina*, System, 1879, p. 337, taf. xx.). The two pouches which have a tentacle between them are therefore the distal halves belonging to a former pernemal gastral pouch, *i.e.*, of a radial canal at the end of which each tentacle was originally placed. But the two pouches lying between every two primary tentacles are opposite distal halves of two adjacent radial canals. This view is justified by the fact, that in all the older and simpler forms of the Æginidæ two gastral pouches are always placed between every two tentacles. In our *Æginura* (as in *Æginopsis*) each of the eight lobe pouches is divided a second time. The peculiar formation of the festoon canals of the Æginidæ can only be explained in this way. It shows essentially the same conditions as in the Cunanthidæ. Here as there, the originally simple circular canal is divided into the same number of separate arches or "lobe canals" as there are umbrella lobes, and each lobe canal opens with two mouths beside the base of two neighbouring canals. But whilst in the Cunanthidæ the opening of the lobe canal is found in the middle of the distal margin, in the Æginidæ it occurs immediately in the periphery of the stomach. In the former the undivided proximal part or principal part of the radial canals (or of the pernemal gastral pouches) has entirely disappeared, and the internemal lobe pouches only are left (as remains of the divided distal part). The inverted halves of every two adjacent lobe canals are also connected with a "double canal" or double "peronial canal." In the Æginidæ, as the proximal half of the umbrella margin has retrograded, and the distal half become proportionally more strongly developed, the double canal appears very much prolonged, and has the deceptive appearance of "a simple radial canal opening into the periphery of the stomach between every two internemal gastral pouches." Thus very simple and clear homologies exist between formations apparently very different, as I have already shown in my System der Medusen, 1879, pp. 305, 306, &c.

The specimen of *Æginura myosura* was a male, and its sixteen testes (the sixteen "internemal gastral pouches") contained masses of ripe spermatoza. They did not however, fill up the cavity of the pouches, but were placed on the outside of its subumbral wall. In transverse sections the internal side of the subumbral wall showed the same high cylindrical epithelium as that of the peronial canals (figs. 7, 12), whilst the endodermal epithelium of the opposite umbral wall consisted, in both cases, of a thin layer of flat plate cells covering the gelatinous substance of the umbrella. The spermarium, on the contrary, lies like a thick plate immediately under the exoderm epithelium of the subumbrella from which it originates, and is divided from the high cylindrical epithelium of the endoderm by a distinct supporting plate. In *Æginura* as in Pegantha (p. 34, Pl. XI. figs. 5, 6), the subumbral ectoderm sends out supporting fibres containing nuclei into the spermarium which lies under it, and is derived from it. Here, therefore, as in all Craspedotæ, the sexual products originate from the ectoderm, whilst the reverse is the case in the Acraspedotæ, where, in both sexes, they are formed by the endoderm. The ripe spermatozoa and the ripe ova are therefore thrown outside immediately in the Craspedotæ or "Cryptocarpæ," whilst in the Acraspedæ or "Phanerocarpæ" they first pass into the gastrovascular system, and are then ejected by the oral opening; the former are therefore properly "Ectocarpæ," the latter "Entocarpæ" (Hertwig, 1879). When Eschscholtz, the meritorious founder of the system of the Medusæ, 1829, distinguished the two principal divisions of this class as "Cryptocarpæ" and "Phanerocarpæ" according to the different formation of their reproductive organs, he expressed prophetically an important difference, whose peculiar character was first more accurately recognised fifty years later.

Class II. ACRASPEDÆ, Gegenbaur, 1856.

Phanerocarpæ, Eschscholtz, 1829. Steganophtalmæ, Forbes, 1848.
Scyphomedusæ, Ray-Lankester, 1877. Phacellotæ, Hæckel, 1878.

Medusæ with gastral filaments or phacellæ; with endodermal genitalia (or sexual products from the internal germinal layer); without true velum (often with velarium); with true marginal lobes of the umbrella; without double centralised nerve ring. Phylogenetic descent (probably universal) and ontogenetic descent (at present still in the majority) derived from scyphopolyps with gastral filaments or from scyphostoma. Ontogenesis usually alternation of generations (in the form of strobilogenesis) often connected with metamorphosis. The sexual acraspede generation is formed by terminal gemmation from the asexual scyphostoma generation.

Order V. STAUROMEDUSÆ, Hæckel, 1877.

Acraspedæ without sense clubs, with simple tentacles or marginal anchors (adhesive tentacle rudiments). Originally eight principal tentacles (sometimes rudimentary).

Besides these eight principal tentacles there are often small secondary tentacles (usually in bunches upon eight adradial marginal lobes). Stomach having four wide perradial gastral pouches, which are separated by four narrow interradial septa or fused selvages, and connected on the umbrella margin by a circular sinus. Genitalia, four interradial horseshoe-shaped swellings or four pair of adradial swellings, which are developed in the subumbral wall of the gastral pouches from their endoderm, and project wholly or partially into their cavity.

Family, TESSERIDÆ, Hæckel, 1877.

TESSERIDÆ, Hæckel, System der Medusen, 1879, p. 371, taf. xxi.

Stauromedusæ with simple, undivided umbrella margin, without hollow marginal lobes or "arms." Eight principal tentacles (four perradial and four interradial) always present, not transformed into marginal anchors or sense clubs; besides these, sometimes numerous secondary tentacles. Coronal muscle of the umbrella margin circular, not divided into eight isolated marginal muscles. Either an apical process or an umbrella peduncle on the apex of the umbrella.

Sub-family, TESSERANTHIDÆ, Hæckel, 1879.

Free-swimming Tesseridæ, without a stalk, but with an apical process on the cone of the umbrella; with simple solid tentacles without terminal urticating knob.

Tesserantha,[1] Hæckel, 1879.

Tesseridæ, without peduncle, with an apical process and with sixteen simple solid tentacles without terminal urticating knob (four perradial, four interradial and eight adradial). The genus *Tesserantha* is one of the simplest and oldest Medusæ forms of that important family the Tesseridæ, which are to be regarded as the general ancestral group of all Acraspedæ. This primitive Acraspeda form is essentially merely a Scyphostoma with sixteen tentacles which, in adapting itself to a free-swimming mode of life, changed its oral disc into a subumbrella, and its basal peduncle into an apical process, divided the peripheric gastral space into four radial pouches by four interradial fused knobs, and became sexually mature in this form. *Tesserantha* is distinguished from the octonemal closely related *Tessera* by the addition of eight new adradial tentacles (of the third order) to the eight principal tentacles (four perradial and four interradial). Moreover, whilst in *Tessera* only four simple gastral filaments run out from the four septal knobs, as terminal free processes of the four interradial tæniola, the septal knobs in *Tesserantha* are beset with a double row of filaments throughout the greater part of their length (the proximal basal part alone excepted). In this and other respects, namely in the formation of four perradial mesogonial folds and four interradial funnel cavities alternating with these, *Tesserantha* comes nearer *Depastrella*, and therefore forms an interesting transition gradation between *Tessera* and *Depastrella*. At present there is only one known species of this genus, the deep-sea Medusa described below.

[1] *Tesserantha*, four-sided flower.

Tesserantha connectens, Hæckel (Pl. XV.).

Tesserantha connectens, Hæckel, 1879, System der Medusen, p. 375, No. 402.

Umbrella helmet-shaped, one and a half times as high as broad, with conical apical process and peduncle canal on the top. Exumbrella with eight longer and eight shorter exumbral urticating ribs. Four double rows of gastral filaments along the four interradial tæniola inside the central stomach. Œsophagus quadrangularly prismatic, half as long as the height of the umbrella. Oral opening with four short, frilled, oral lobes. Eight simple horse-shoe-shaped genitalia enclosing the small septal nodes in the concavity of the arch. The eight principal tentacles (four perradial, four interradial) of equal length, nearly as long as the height of the umbrella; the eight secondary (adradial) tentacles only half as long. Horizonal diameter of the umbrella, 6 mm.; vertical diameter, 9 mm.

Habitat.—South-east part of the Pacific Ocean, not far from the island of Juan Fernandez, lat. 33° 31′ S., long. 74° 43′ W.; Station 299. 14th December 1875. Depth, 2160 fathoms.

The umbrella (figs. 1–3) is highly vaulted, bell or helmet-shaped, rather constricted beneath at the opening, just above the umbrella margin, and furnished above with a pointed, conical, apical process which is nearly a third as long as the whole height of the umbrella. It is about half as large again as the greatest horizontal diameter of the umbrella above the umbrella margin. The exumbrella is distinguished by eight projecting, strong, urticating ribs, four perradial and four interradial (figs. 1, *er*; 6, *er*). These are sharp corners of the outer surface of the umbrella, almost triangular in transverse section, which are armed with a broad streak of pigment cells and thread cells, and stretch uninterruptedly from the point of the umbrella cone to the eight ocelli of the umbrella margin, from which they pass on to the dorsal surface of the eight principal tentacles. Eight secondary incomplete longitudinal ribs alternate with the eight principal complete longitudinal ribs of the exumbrella; these are much narrower and shorter and only run from the bases of insertion of the eight adradial tentacles to half the height of the umbrella (fig. 1, *er*).

The umbrella margin is somewhat contracted by a circular marginal stricture, and is beset with sixteen tentacles, between which the gelatinous substance of the umbrella projects a little in the form of short, roundish, solid, gelatinous lobes (figs. 1, 4, *l*). The eight principal tentacles (four perradial and four interradial) are nearly as long as the height of the umbrella, whilst the eight adradial or secondary tentacles alternating with them, are only half as long. These also want the black roundish eye-spot ("ocellus," fig. 1, *oc*) which is found at the base of the eight principal tentacles. These ocelli consist of accumulations of black grains of pigment in the ectoderm of the tentacle basis. All the sixteen tentacles are solid cylindrical filaments, gradually becoming thinner towards the pointed distal end. Their structure resembles that of the oral styles of the Margelidæ (p. 1, Pl. I. fig. 5) and of the solid tentacles of the Peganthidæ (p. 30, figs. 10, 11, &c.) already described. Each tentacle, therefore, consists of four different layers: (1) a solid cylindrical endodermal axis, formed of a single row of clear coin-shaped chordal cells; (2) a thin but firm and very elastic fulcral plate; (3) a thin muscular plate composed of parallel longitudinal fibres; (4) an exodermal epithelium, bearing partly thread cells, partly pigment cells. The latter contain grains of blackish pigment, and are chiefly found on the abaxial or dorsal side of the tentacle, where they form a black longitudinal streak which represents the direct process of the ocelli and the exumbral ribs of pigment. The tentacles, with their basal ocelli, are the only organs of sense found in the *Tesserantha*, as in all Stauromedusæ; special auditory clubs, like those of the other Acraspedæ, are not present.

The deep cavity of the umbrella (subumbrella) consists of a lower simple cavity of the corona of the umbrella, whose vertical axis is occupied by the œsophagus (fig. 2, *at*), and of an upper quadrilocular part divided by four mesenteries into four conical funnel cavities (fig. 6, *ii*). These mesenteries or mesogonia (fig. 2, *wr*) are four thin perradial membranes, which stretch vertically between the four perradial angles of the base of the stomach and the middle line of the four radial pouches. They serve principally to attach the œsophagus, are cut out like a crescent at the lower free edge, and pass immediately into the tissue of the subumbrella at the upper, rather thinned, basal margin. The mesenteries must be regarded essentially as folds of the subumbrella, whose structure they share. We find them again in a similar form in the Charybdeidæ, Tiaridæ, and Pectyllidæ (Pl. IV. fig. 3, *wr*; Pl. VIII. fig. 9, *wr*). The four interradial funnel cavities ("infundibula subumbralia," fig. 6, *ii*), which are divided by the four mesenteric folds, are conical sacs, opening below into the umbrella cavity, but projecting more or less with their cæcal point into the central gastral cavity; their aboral extension could not be exactly defined; they perhaps extend as far as the tæniola are set with filaments, to the beginning of the basal stomach.

The muscles of the subumbrella are formed by two different systems, which are found more or less modified in all Acraspedæ; a distal system of circular muscular fibres and a proximal system of radial muscular fibres. The first form the typical coronal muscle ("musculus coronarius," figs. 2–4, *mc*), a broad octagonal ring on the umbrella margin, whose eight angles are defined by the bases of the eight adradial tentacles. The system of radial or longitudinal muscles is composed of eight triangular deltoid muscles, whose broad base rests on the proximal margin of the coronal muscle. The four perradial deltoid muscles (figs. 3, 4, *md'*) are narrower and longer, and pass above into the mesenteric folds. The four interradial deltoid muscles (figs. 3, 4, *md''*) are broader and shorter, and their truncated point is inserted at the four septal nodes (*kn*).

In *Tesserantha*, as in all Acraspedæ, the "gastrovascular" system consists of two principal parts, the central principal intestine and the peripheric coronal intestine. The central part or the axial principal intestine ("gaster principalis") communicates with the peripheric coronal intestine by the four perradial openings ("ostia gastralia"), and is divided into three different sections, the basal, the central, and the oral stomach. The aboral basal stomach or peduncle canal ("gaster basalis," *gb*), which may also be called the "apical canal," is a narrow, almost cylindrical, hollow space occupying the entire cone of the umbrella, in whose point it ends cæcally above, whilst below it opens by the pylorus (*gy*) into the central stomach. Four longitudinal gelatinous selvages, the important interradial tæniola, project from the inner surface into its hollow space, and, as in the closely-allied Lucernaridæ, traverse the entire length of the hollow basal umbrella peduncle (figs. 2, 3, 8, *ft*). The peripheric part of the basal stomach is thus divided into four perradial grooves (figs. 3, 8, *gb*).

The central stomach ("gaster centralis," *gc*) has, on the whole, a spheroidal or almost quadrangularly pyramidal form, which, however, is complicated by the four interradial exodermal funnel cavities (*ii*) sinking down into it from above. The distal processes of the four tæniola, each of which bears two rows of gastral filaments (*ft*) inside in the central stomach, run as projecting selvages on the endodermal gastral surface of the funnel cavities. The central stomach opens above by the "porta pylorica" (*gy*) into the basal stomach, below in the centre by the "porta palatina" (*gp*) into the oral stomach, and round by the four cleft-shaped gastral openings into the coronal intestine. The gastral openings (fig. 6, *go*) are narrow, almost horizontal clefts, divided from one another by the four interradial septal nodes ("nodi cathammales," *kn*), these important points of fusion at which the umbral and the subumbral wall of the gastral space have grown together. That this is really a fused plate is plain from the fact that an endodermal layer of epithelium—"endodermal lamella" or cathammal plate—runs in the middle through the cartilaginous-like gelatinous mass of the septal node.

The oral stomach or œsophagus ("proboscis," *ga*) is formed of a quadrangularly prismatic tube, nearly equal in length to the breadth of the umbrella (figs. 1, 2, *at*). It is four times as long as broad, and has four projecting perradial angles which run into the four mesenteries above, whilst the external surface is depressed like a groove between them (fig. 6, *a*). The oral opening is surrounded by an undulating oral margin crowded with thread cells, and runs out into four short perradial lobes (fig. 4 in the middle).

The peripheric coronal intestine ("gaster coronaris"), which in most Acraspedæ is divided into from four to sixteen radial pouches or canals, forms a simple wide coronal sinus ("sinus coronaris," *cs*) in *Tesserantha* as in *Periphylla*. It occupies the whole space between the septal nodes and the umbrella margin (figs. 2, 3, 5, *cs*). The broad gastral openings only may, therefore, be considered as homologous with the four radial pouches (*bp*); in fact, the four short septal nodes which divide the gastral openings correspond to the four longer septa or interradial selvages, which separate the four broad radial pouches in the Lucernaridæ (comp. Pls. XVI., XVII.).

The four reproductive glands (figs. 2, 3, 4, 6, *o*) in *Tesserantha*, as in *Tessera* and *Depastrum* (= *Carduella*) form four horseshoe-shaped swellings in the subumbral wall of the coronal sinus. Their central arch encloses the four septal nodes with its concave distal margin, whilst its concave proximal margin projects above into the central gastral cavity, and appears fimbriated with the lowest distal group of the gastral filaments. The two limbs of the U-shaped reproductive arches run upwards, diverging slightly into the subumbral wall of the coronal intestine, and their limbs, which are curved outwards, touch the proximal margin of the coronal muscle. In *Tesserantha*, as in *Tessera*, a thickened gelatinous selvage of the fulcral plate of the subumbrella appears to project into the hollow space of the coronal sinus, in the entire extent of the reproductive swelling, and the sexual cells appear to be developed from the endodermal epithelium of the sinus on the axial side of these genital selvages. The spirit specimen (a female) which I examined did not admit a closer investigation of its finer structure. Slight transverse folds are visible on the endodermal upper surface of the genitalia (figs. 3, 4, *s*).

Family, LUCERNARIDÆ, Johnston, 1847.

LUCERNARIDÆ, Hæckel, System der Medusen, 1879, p. 379, taf. xxii.

Stauromedusæ, with lobed or incised umbrella margin, divided by eight concave arches (four perradial and four interradial) into eight hollow adradial lobes or arms; a brush-shaped bunch of hollow knobed tentacles at the end of each arm; eight principal tentacles (four perradial and four interradial) either transformed into adhesive marginal anchors or wanting (having undergone retrograde metamorphosis, or lapsed). Coronal muscle of the umbrella margin divided into eight isolated marginal muscles. A peduncle for adhesion at the apex of the umbrella.

Sub-family, HALICLYSTIDÆ, Hæckel (ELEUTHEROCARPIDÆ, Clark).

Lucernaridæ without mesogonial pouches in the subumbral wall of the four radial pouches.

Lucernaria,[1] O. F. Müller, 1776.

Lucernaridæ without mesogonial pouches in the subumbral wall of the four radial pouches, and without marginal anchors or marginal papillæ (*Lucernaridæ eleutherocarpæ inauriculata*). Peduncle one chambered with four separate tæniola.

[1] *Lucernaria*, like a candle; from *Lucerna*, a candle.

The genus *Lucernaria*, the oldest known form among the Stauromedusæ, was founded by O. F. Müller, more than a hundred years ago, for the large and widely distributed Acraspeda of the North Atlantic Ocean, which he named *Lucernaria quadricornis* (Prodom. Zool. Dan., 1776, p. 227). This notable and well-known form alone can therefore be taken as the typical species by which to define the character of the genus *Lucernaria*. Later authors, such as Keferstein, Leuckart, Taschenberg, and others, have, for the most part, placed all other later known Lucernaridæ in this genus. However, for reasons given in the System der Medusen (1879, pp. 380, 387), I considered the division of the true Lucernaridæ into four genera justified, and therefore limit the genus *Lucernaria* to the forms without mesogonial pouches and without marginal anchors (*Eleutherocarpidæ inauriculata*). The genus *Lucernaria* is distinguished from the closely allied genus *Haliclystus* (which is very minutely described by Clark in his monograph on *Haliclystus auricula*, 1878) by the absence of marginal anchors or marginal papillæ, and from the two other genera of the family (*Halicyathus* and *Craterolophus*) by the absence of the peculiar "mesogonial pouches or mesenteric pouches," which in the latter penetrate from the stomach into the subumbral wall of the four perradial gastral pouches. The species described below (from 3240 feet deep) is the first deep-sea Lucernarid, as all the other species of this family hitherto described, are littoral, or only found at moderate depths (from 20 to 50 feet at most). This species is, moreover, distinguished in several ways and by many peculiarities (especially by the slight development of the eight arms and the complicated structure of the genitalia) from the four other hitherto known species of this genus, so that it is perhaps better to constitute it the representative of a special genus, *Lucernosa*.

Lucernaria bathyphila, Hæckel (Pls. XVI., XVII.).

Lucernaria bathyphila, Hæckel, 1880, System der Medusen, p. 640, No. 597.
Lucernosa bathyphila, Hæckel, 1880 (*in litteris*).

Umbrella bell-shaped, when extended, nearly as broad as high. Peduncle almost rudimentary, conical, one-chambered, hardly one-sixth so long as the cavity of the umbrella, with four strong, linear, interradial, longitudinal muscles. Eight arms united in pairs. The four perradial arches of the umbrella margin three times as broad and deep as the four interradial arches; each arm with 80 to 120 tentacles; eight genitalia, very broad, separated by a broad interspace from the base of the peduncle as well as from the end of the arm, each genitalium composed of numerous (above 200) separate sacs, which again consist of a large number of isolated follicles. Horizontal diameter of the umbrella, 50–60 mm.; vertical diameter, 60–80 mm.

Habitat.—The North Atlantic Ocean, between the Faröe Islands and the Shetland Islands. Lat. 60° 3′ N., long. 5° 51′ W. Depth, 540 fathoms (John Murray). This species, the first Lucernarid from the deep-sea, was not taken during the Challenger expedition, but was part of the spoil of a subsidiary cruise in H.M.S. "Knight Errant," organised by Sir Wyville Thomson in the summer of 1880, with the view of verifying some of the Challenger results. I am obliged to him for giving me an opportunity of including this species in the list of Challenger Deep-sea Medusæ, as in many respects it has a peculiar interest as a link between the preceding *Tesserantha* and the following *Periphylla*.

The umbrella (Pl. XVI. figs. 1–8) is of a roundish bell shape, or almost pyriform, only a little longer than broad, and adhering by a very short peduncle at the aboral pole. The whole length (or height) (including the peduncle) of the spirit specimen examined came to 60 mm., the greatest breadth (in the middle of the height) to 50 mm. As, however, the specimen was strongly contracted, the height in the living animal would come to at least 70–80 mm., and the breadth to 55–60. This species, as well as the two closely allied species, *Lucernaria quadricornis*, and *L. pyramidalis* belong to the largest species of the family Lucernaridæ; the latter has a much shorter stem but a smaller cup.

The peduncle ("pedunculus," *p*), by which the bell-shaped cup fixes itself to the bottom of the sea, is rudimentary and slightly developed in *Lucernaria bathyphila*, as in all other species of the family. It rather resembles the "apical process or conical process" of the Tesseridæ, from which it is probably derived (System der Medusen, 1879, p. 365, taf. xxi., xxii.). Its length amounts, at most, to one-sixth of the whole length of the body, but cannot be sharply defined, as the thicker oral end of the club-shaped peduncle passes gradually, without distinct boundary, into the cup. The thinner aboral end is truncated, and has a small roundish disc on the surface of the point of adhesion (fig. 8). This plate has numerous adhesive cells ("colletocystæ") in its thickened exoderm, it lies in irregular folds, and is divided by four deep interradial furrows into four perradial swollen lobes (fig. 8). Each furrow passes a little way into the exumbrella of the peduncle, so that it also appears four lobed in a transverse section above the disc (fig. 13). The four interradial, longitudinal furrows of the exumbrella of the peduncle have four corresponding gastral tæniola in its inner wall (figs. 1, 2, 21, *ft*); these are the important longitudinal, gelatinous selvages, already found in *Scyphostoma*, which traverse the entire length of the peduncle, and pass immediately below into the four interradial septa of the gastral pouches (fig. 12, *ks*). In the horizontal section these tæniola appear almost egg-shaped, compressed laterally, and only connected (as by a peduncle) by a very thin gelatinous plate (fig. 14, *ft*) with the wall of the umbrella peduncle, from which they project centripetally inwards. The gastral hollow space of the peduncle is thus divided into four perradial peduncle grooves (fig. 13, *cp*) which communicate by narrower clefts with the central basal stomach (*gb*), and form a regular maltese cross seen in transverse section. The peduncle in our species is, however, one-chambered, as in all species of the genus *Lucernaria* (in the stricter sense). (System der

Medusen, 1879, p. 389). The four strong tæniola contain a well-developed, longitudinal muscle (figs. 13, *m*; 14, *m*); this is enclosed in a voluminous gelatinous sheath (*ft*), which is considerably thicker on the axial side than on the abaxial side, and which internally forms numerous dendritically branched folds. The muscular plate of the peduncle (*m*) is extended on these folds of the gelatinous supporting plate; it encloses a central axial cord of exoderm cells (*q*) lying in the axis of the tæniolum; there are the "epithelial muscular cells" of the exumbrella which have immigrated centripetally from its outer surface into the gelatinous selvage. The delicate figure shown by each tæniolum in its oval transverse section (fig. 14) consists, from its axis towards its periphery, of the following layers:—(1) The central cell-cord of the ectodermal epithelial muscular cells (*q*); (2) the folded muscular plate arising from it (*m*); (3) the fulcral lamella (*z*) with its dendritic supporting folds, and the thick gelatinous sheath surrounding it (*ft*); (4) the endodermal covering of the gastral epithelium (*d*).

The cup ("calyx"), or the peculiar "umbrella" of our *Lucernaria* (after removing the stalk) is almost oval, broadest in the middle, gradually passing into the conical peduncle above, and slightly contracted below towards the umbrella margin and the eight arms (figs. 1–3). As in all Stauromedusæ, the umbrella consists of two thin walls, an external convex umbrella and an inner concave subumbrella. The two walls enclose the hollow space of the gastrovascular system, pass into each other at the umbrella margin, and are otherwise only connected with each other by the four interradial septa ("lines of fusion, or cathammal selvages," *ks*). The two walls consist in section chiefly of a thin but firm gelatinous plate (fulcral lamella, *z*); its inner side is covered by gastral endoderm (*d*), its outer side by dermal exoderm (*q*). The external convex surface of the umbrella or the true exumbrella (*e*) is smooth, without special characteristics, and only traversed by four slight interradial longitudinal furrows (the distal processes of the peduncle furrow). The gelatinous substance under the exumbrella is not thick but very firm, and traversed by numerous elastic fibres which run from the outer to the inner surface of the gelatinous plate (fig. 13, *uf*); they are also equally numerous in the thin gelatinous plate of the subumbrella (fig. 18, *uf*). The ectodermal epithelium of both the exumbrella and the subumbrella is armed with scattered urticating organs (comp. my System der Medusen, 1879, p. 382).

The antrum or umbrella cavity ("necto-calyx") (*h*), which is lined by the ectoderm of the subumbrella (*qw*), is divided in our species, as in all Lucernaridæ, into two parts, the lower (distal), simple, coronal umbrella cavity, and the upper (proximal), quadrilocular, funnel umbrella cavity. The coronal umbrella cavity (fig. 5, *hc*, "antrum coronarium") is perfectly simple, cylindrical, or almost cubic, and occupies the entire lower half of the body; the eight deltoid muscles, and the distal halves of the genitalia lie in its subumbrellar wall. The funnel umbrella cavity ("antrum infundibulare," *i*) is divided from the coronal umbrella cavity by the oral boundary-line E F (figs. 2, 3), and is composed of four interradial pit-like depressions (figs. 6, 7, *ii*) separated from one another by four perradial vertical folds of the subumbrella (fig. 3, *wr*). These are Clark's "circumoral buttresses;" they extend in the form of four free mesenteric lamellæ from the four perradial angles of the œsophagus to the middle of the subumbral wall of the radial pouches, and are best described as reproductive folds or genital mesenteries ("mesogonies"). The four depressions lined with the ectoderm of the subumbrella are the funnel cavities ("infundibula," figs. 2, 6, *ii*). The cæcal ends of these conical or trigonal pyramidal hollow spaces penetrate from the coronal cavity of the umbrella deep into the central gastral cavity, and have occasioned many misapprehensions. Clark calls them "circumoral pouches," Taschenberg "genital pouches," Kling "pyramidal spaces," and Hertwig "intergenital pouches." As these funnel cavities are only lined by the ectoderm and have no connection with the gastrovascular system, but belong much more to the system of the subumbral umbrella cavity, they cannot be termed "pouches" but merely "cavities." They recur in the same way in many other Acraspedæ as "subgenital cavities." In our *Lucernaria* they penetrate so deep into the central gastral cavity as to divide its oral half into four perradial peripheric niches, or "central chambers." The conical funnel cavities between the latter are separated from them by the gastral filaments, and pass directly above into the solid tæniola (fig. 21, *ft*).

The muscular plate of the subumbrella lies immediately under the ectodermal epithelium, from which it is secreted, and consists of a marginal octomeral coronal muscle and of eight separate radial muscles. The coronal muscle ("musculus coronarius"), or circular muscle of the umbrella margin, is homologous with the simple marginal circular muscle of the Tesseridæ and with the large octomeral coronal muscle of the Pericolpidæ, which in the Periphyllidæ is divided into sixteen muscular areæ. The coronal muscle in the eight-armed Lucernaridæ, as in the closely-allied eight-lobed Pericolpidæ, consists of eight separate areæ, the eight "marginal muscles," of which four longer (figs. 2, 3, 12, *mm'*) lie in perradial octants, four shorter (*mm''*) in four interradial octants; as, however, the eight arms (or marginal lobes) are adradrial, each coronal muscular area (or each marginal muscle) applies to the two halves of each two adjacent arms turned to each other. It extends on their external or abaxial side, and that of the tentacles running out from them. The separate bundle of muscles, which here pass into the tentacles, therefore extend them and make them arch outwards ("extensores"). If, on the other hand, all the eight marginal muscles contract simultaneously, they narrow the umbrella opening like the simple circular muscle of the Tesseridæ. The coronal muscle is, moreover, in all Lucernaridæ much narrower than in the Pericolpidæ, and has the form not of a broad band, but of a thick cord. In our species this cord shows six to eight deep parallel furrows, divided from each other by the same number of circular folds (fig 20 in radial transverse section). The height of these folds increases from above downwards (from the proximal to the distal margin of the marginal muscle).

Each fold is formed by an elevation of the supporting lamella (z), which again forms secondary folds, and therefore appears dendritically branched in transverse section. The circular fibres of the muscular plate (m) cover this system of folds connectedly; and are covered in their turn by the ectodermal epithelial cells of the subumbrella (qw) from which they are secreted. The eight longitudinal deltoid muscles (figs. 2, 3, 4, 12, md) work antagonistically to the eight circular marginal muscles. In the deltoid muscles of our species the four perradial (md') are very weak but very broad, whilst on the other hand the four interradial (md'') are much narrower, but proportionately more strongly developed. These appear to be the direct processes of the strong tæniola muscles, they run along the entire length of the septa of the pouches (fig. 12, *tr.s*), and split up below at the distal end of the latter, into two strong limbs (fig. 12, md''') each of which bears a bunch of tentacles.

The umbrella margin has eight shallow concave depressions or "marginal sinuses," between which, as in all Lucernaridæ and Pericolpidæ, lie eight adradial marginal lobes. These eight adradial hollow marginal appendages, which have hitherto been generally termed "arms" in the Lucernaridæ and erroneously considered a special peculiarity of this family, are, in fact, from their situation, structure, and signification, merely the eight adradial marginal lobes of the closely allied Pericolpidæ and as such homologous to the eight sense lobes (or "eye lobes") of the Periphyllidæ. The essential difference from the Pericolpidæ, which is strikingly displayed by the Lucernaridæ, is that each of the marginal lobes or "arms" bears a brush-shaped bunch of numerous small, hollow knobbed tentacles at their points. Morphologically considered, these tentacles belong to the category of accessory or secondary tentacles, and are merely long-stalked urticating knobs. On the other hand the four principal tentacles of Tessera (four primary perradial and four secondary interradial) have disappeared in the genera *Lucernaria* and *Craterolophus*, whilst in *Haliclystus* and *Halicyathus* they are transformed into adhesive "marginal anchors." In our species the eight arms are very small, and less developed than in most other Lucernaridæ; they project only slightly from the umbrella margin as broad triangular points and are placed together in pairs, so that the four perradial sinuses of the umbrella margin are three times as large as the four interradial (figs. 1–4). Each short arm or marginal lobe bears a bunch of from 80–120 tentacles.

All the tentacles (Pl. XXII. figs. 15, 16) are completely fused together at their basal halves, so that only their distal halves are free and movable (fig. 15). They are cylindrical, 2–3 mm. long, when contracted (probably twice as long when extended), and nearly $\frac{1}{2}$ mm. thick. As in all true Lucernaridæ, they are hollow, thick-walled little tubes, whose cæcal and somewhat thinner distal end bears a thicker urticating knob. This stalked urticating knob in our species is developed into a strong sucking-cup, with a depressed sucking-pit in the middle (fig. 16, x). The hollow cylindrical epithelium of the ectoderm (q) is four to six times as high in the sucking-cup as on the tentacle stalk, and has a peculiar construction, which however could not be more minutely investigated as the tentacles were not sufficiently well preserved. The ectodermal cells in the central sucking-pit are much flatter, and without nematocysts (fig. 16, *x*). The muscular plate, consisting of strong longitudinal fibres (*m*), lies immediately under the ectoderm (*q*). Then comes a thick gelatinous supporting plate, which acts as elastic extensor against the pull of the longitudinal muscular fibres, and re-extends the contracted tentacles, shortened by the latter. In the sucking-cup the gelatinous fulcral lamella forms a peculiar thick cap (fig. 163′), which encloses the cæcal end of the tentacle canal and is sharply divided by a distinct boundary line (z'') from the thinner gelatinous plate of the peduncle (z'''). The endoderm (*d*) forming the epithelium of the tentacle canal (*ct*), consists of high, dark-brown pigmented cylindrical cells, having numerous unicellular glands distributed among them. The cæcal distal end of the tentacle canal shows a very peculiar condition unknown to me in any other Lucernarid. The end of the canal is closed by a conical wedge, which completely fills the distal end of the lumen of the tube and is enclosed by endoderm. This axial wedge of the sucking-cup (fig. 16, *y*) dyes a much more intense dark red with carmine than any other part of the tentacle. It contrasts sharply with the yellow-brown endodermal cells enclosing it, and seems composed of roundish corpuscles, thickly pressed together, which refract light strongly and look like nematocysts. This axial wedge of the sucking-cup perhaps serves as a firm support during its adhesion.

The formation of the gastrovascular system (Pl. XVI. figs. 2–7; Pl. XVII. figs. 13–16) does not differ essentially in our *Lucernaria* from that known in other species of this genus; it lies between the simpler formation of the Tesseridæ (Pl. XV.) and the more developed formation of the Periphyllidæ (Pls. XVIII.–XXII.). As in the Tesseridæ it is divided into a central principal intestine (" gaster principalis "), and a peripheric coronal intestine (" gaster coronalis "), communicating by four perradial gastral openings (*go*). The principal intestine consists of three parts, viz., the aboral basal stomach in the peduncle, the central stomach, and the freely projecting buccal stomach or œsophagus. The central stomach is separated from the basal stomach by the pyloric opening (" pylorus "), and from the buccal stomach by the palatine opening (" palatum "). The basal stomach (" gaster basalis," *gb*) is the peduncle canal already mentioned; it passes through the entire length of the peduncle, and ends cæcally in its oral basis, whilst it opens at the oral peduncle end by the pylorus (*gy*) into the central stomach. The basal stomach originally presented a simple cylindrical or quadrangularly prismatic hollow space, corresponding to the " apical canal " of the Tesseridæ. As the four interradial tæniola (*ft*) project from the wall of the peduncle into the stomach, they divide its periphery into the four perradial peduncle grooves or half canals already described (fig. 13, *cp*). In this way the basal stomach acquires in transverse section the characteristic regular cross shown in fig. 13, Plate XVII. The central stomach (" gaste centralis ") has usually a conical or quadrangularly pyramidal shape, and opens with the truncated aboral end into the peduncle stomach by the pyloric opening ("pylorus," *gy*) and with the quadratic, strongly constricted oral basis into the buccal stomach by the palatine opening ("palatum," *gp*). Four perradial clefts, the gastral openings ("ostia gastralia," figs. 2, 3, *gp*; fig. 21, *go*) lead from the central stomach into the four radial pouches. As the four conical interradial funnel cavities (*ii*) already described project arch-like between the four gastral openings into the central stomach, the formation of the latter becomes rather complicated. Both margins of the cleft-shaped gastral openings are edged nearly their whole length by a row of fine gastral filaments (fig. 21, *f*); these are only wanting on the lower (oral) fourth of the gastral openings where their margin forms the cartilaginous-like thickened groove of the palate (fig. 21, *gs*). The rows of filaments or phacelli run above to the point of the funnel cavities, but do not pass on to the solid tæniola. In comparison with other Lucernaridæ, and with the considerable size of our species, its filaments appear slightly developed, very fine and rather short; they are limited here to the lateral margin of the gastral openings, whilst in other species they often extend distally far on to the lateral margins of the genitalia, or proximally on the basal tæniola. Like the filaments, the œsophagus or "buccal stomach" seems only slightly developed in *Lucernaria bathyphila* (proboscis, figs. 2–4, *ga*). It forms a low, fleshy, membraneous border, quadrate in outline, which only projects slightly from the palatine opening into the umbrella cavity. The thickened glandular margins of the oral opening are only slightly frilled (fig. 9). The four perradial angles of the œsophagus pass at the palatine opening, into the four subumbral mesogonial folds (*wz*).

The peripheric coronal intestine ("gaster coronaris"), which only communicates by the four perradial gastral openings with the central stomach, in *Lucernaria bathyphila* is formed (owing to the slight development of the eight arms) almost exclusively by the four voluminous radial pouches ("bursæ radiales," *bp*) which Clark termed "quadrant chambers," Keferstein "broad pouch-shaped radial vessels," Taschenberg "radial canals," Kling "radial chambers," and Hertwig "radial chambers or radial pouches." These present four flat pouch-like hollow spaces extending between the umbrella and subumbrella to the umbrella margin. They are only divided by four interradial "septal selvages," or "lines of fusion," linear septa in which the umbrella is fused with the subumbrella ("septa cathammalia," *ks*). As this fusion does not, however, extend as far as the umbrella margin, the four pouches communicate there below the distal end of the septa, by four interradial circular openings, so that a circular communication, a sort of "circular canal," is formed on the umbrella margin (fig. 12, *cc*). The proximal half of the four radial pouches opens by the gastral openings into the central stomach; whilst eight lobe pouches or "arm pouches" ("bursæ lobares") run from its distal margin into the eight arms. The end of each lobe pouch again sends out a tentacle canal into each tentacle (figs. 15–16, *ct*). As the eight arms or marginal lobes in our species project only slightly above the umbrella margin, their lobe pouches (*bl*) never reach an independent development. The development is consequently proportionably greater of the four radial pouches, whose length is nearly two-thirds that of the whole length of the umbrella, and only partially occupied by the conspicuous genitalia, lying in their subumbral wall (comp. figs. 2–7, *bp*).

The genitalia (Pl. XVI. figs. 2–7, *s*, figs. 10, 11; Pl. XVII. figs. 17–19, 21). The specimen examined was a mature female, and showed most distinctly that the ova in the Lucernaridæ (as in all Stauromedusæ) are developed from the endoderm of and in the subumbral wall of the radial pouches, then fall into their cavity, reach the central stomach through the gastral openings, and are finally expelled through the mouth; all parts of the gastrovascular system of the uninjured Medusa contained when opened numerous, loose, ripe ova. The ovaries (figs. 2, 3, *sf*) form eight broad plates occupying the greater part of the subumbral wall of the four perradial gastral pouches, and are distributed in pairs in such a manner that the two genitalia separated by an interradial septum, form a connected pair. The two ovaries lying in one and the same radial points, therefore form two different pairs (comp. my System der Medusen, 1879, p. 386). The interradial interval between each two reproductive leaves is considerably smaller than the perradial interval; their distance from the distal margin of the four radial pouches is also much less than from the proximal margin (comp. figs. 2, 3, *sf*). Their outline is semi-oval or almost lanceolate, and broadened in the distal third.

The structure of the ovaries in *Lucernaria bathyphila* is very peculiar, and more complicated than in all other Stauromedusæ hitherto known. Even with the naked eye the upper surface of the eight reproductive glands appears granular as if paved, and a slight magnifying power (fig. 21, *sk*) shows that each genitalium is composed of a large number (nearly 200–250) of entirely separate sacs. These have an irregular roundish or polygonal outline, averaging 1 mm. in diameter (the smallest rather under $\frac{1}{2}$ mm., the largest rather above $1\frac{1}{2}$ mm.). Whilst in all other Lucernaridæ hitherto known these reproductive sacs ("sacculi genitalis," *sk*) represent simple glands with a single hollow space and excretory passage, in our deep-sea species they are lobed glands composed of several separate lobes or follicles, each having its own cavity and its own excretory passage. Each separate sac (fig. 10, seen from the surface, fig. 18, in perpendicular longitudinal section) is therefore usually composed of from thirty to fifty follicles (*sb*). Each separate follicle (fig. 11 from the surface, fig. 19 in longitudinal section) contains a "sinulus" (*sc*) or secondary cavity, which opens by a "ductulus" or secondary excretory passage (*sl*) into the "sinus genitalis," or principal cavity of the sac (fig. 18, *sc*); the last opening by its ductus or principal excretory passage (*sl*) into the radial pouch (*sa*). The ova (fig. 19, *so*), which are developed from the endodermal epithelium of the follicle, pass first from its sinulus (*sc*) into its ductulus (*sl*), thence into the sinus of the sacculus (fig. 18, *sc*), and from the sacculus by the ductus (*sl*) into the radial pouch. The ovary of

Lucernaria bathyphila, therefore, furnishes the first example in the order of Stauromedusæ of a complicated reproductive gland with lobed sacs and branched hollow spaces; and this, and other peculiarities already mentioned of our deep-sea species, justify its being raised to the type of a separate species, *Lucernosa.* Both the separate sacs and the follicles of which they are composed are enclosed in a thin structureless "membrana propria," a direct process of the gelatinous fulcral plate of the subumbrella. The sacs (figs. 17, 18, *sk*) project freely from the subumbral wall of the radial pouches, on whose endodermal surface they are placed, into the hollow space of the pouches; their free abaxial surface is covered by the ciliated endodermal pouch epithelium, whilst their fixed axial surface is divided from the ectodermal pouch epithelium (*qw*) by the thick gelatinous plate of the subumbrella (figs. 17, 18, *ug*). There is, therefore, no doubt that the ova are developed from the endodermal cells of the sacs, which has no connection with the subumbral ectoderm.

Order VI. PEROMEDUSÆ, Hæckel, 1877.

Acraspedæ with four interradial rhopalia, containing an auditory club with an endodermal otolite sac and one or more eyes, four perradial tentacles or twelve tentacles (four perradial and eight adradial), eight adradial or sixteen subradial marginal lobes. Stomach surrounded by a subumbral coronal sinus, whose division into four radial gastral pouches is only indicated by four small interradial septal nodes; eight or sixteen coronal pouches on the distal margin of the coronal sinus; two lateral lobe pouches from each coronal pouch, and in the middle between the lobe pouches, a pouch for the tentacle or the rhopalium. Genitalia, eight adradial horseshoe-shaped swellings which lie in the subumbral wall of the coronal sinus, are developed from its endoderm and partly project into its cavity.

Family, PERIPHYLLIDÆ, Hæckel, 1877.

PERIPHYLLIDÆ, Hæckel, System der Medusen, 1879, p. 415, plate xxiv.

Peromedusæ with twelve tentacles (four perradial and eight adradial), with four interradial rhopalia and sixteen subradial marginal lobes (eight tentacular and eight ocular). Exumbrella with sixteen pedalia, and a coronal muscle with sixteen coronal areæ (four perradial, four interradial and eight adradial), a coronal pouch between each pedalium and each coronal area. Marginal festoon canal formed of thirty-two lobe pouches.

Sub-family, PERIPHEMIDÆ, Hæckel, 1880.

Periphyllidæ whose four interradial funnel cavities are not limited to the central stomach but also traverse the basal stomach, wholly or partially.

Periphylla,[1] Steenstrup, 1837.

Periphyllidæ with four perradial buccal pouches of the œsophagus and four perradial completely separated niches of the basal stomach. Between these niches, the four subumbral funnel cavities (or the four hollow interradial tæniola of the basal stomach) form hollow cones, which are beset along their whole length by two rows of gastral filaments and touch each other above in the point of the cone.

The genus *Periphylla*, as well as the following closely allied genus *Periphema*, was only presented in the Challenger collection by a single specimen. However, its large size and its excellent state of preservation enabled me to examine it more minutely and thoroughly than I had ever been able to examine any other *Peromedusa*. So that the following description of *Periphylla mirabilis* with the six plates (XVIII.–XXIII.) may be accepted as a firm foundation for the anatomical knowledge of the whole order of Peromedusæ. This conspicuous and remarkable group of Acraspeda was, till lately, almost unknown. On the one hand, it keeps in many ways the primitive formation of the Stauromedusæ, and is more closely connected both with the Tesseridæ and the Lucernaridæ than the two orders of Cubomedusæ and Discomedusæ, especially with regard to the remarkable formation of the central gastrovascular system. On the other hand, it is raised so far above the other three orders of Acraspedæ by the peculiar complication of its anatomical structure, and specially by complicated formation of the pouches, that in many respects it may be called the most highly developed of all Medusæ. At any rate, we must consider them as an independent principal group, as a special "order" of Acraspedæ, which have no direct connection with the Cubomedusæ and Discomedusæ, but must be rather regarded as a peculiarly developed branch of the Stauromedusæ. All that was known of the wonderful Peromedusæ up to the year 1879 was limited to the imperfect description of three different species of the genus *Periphylla*. But two of these figures showed only the empty umbrella of the dead animal without any internal organs—*Charybdea periphylla*, Péron and Lesueur (1809); and *Charybdea bicolor*, Quoy and Gaimard (1833). The description of the third species, *Dodecabostrycha dubia*, Brandt (1838), is partly good, partly very erroneous and incomplete, and remained to be completely unintelligible. Detailed examination of several well-preserved specimens of the stately *Periphylla hyacinthina* and some other smaller species made by me on the genera *Pericolpa*, *Pericrypta*, and *Peripalma* first enabled me, in 1879, to describe more minutely the hitherto unknown organisation of the Peromedusæ, and to place them as an independent order of the class (in the System der Medusen, pp. 396–422, Pls. XXIII., XXIV.). The anatomical description given there will, however, be enlarged and completed in many points by the following more

[1] Περιφύλλα=set round with leaves.

detailed anatomy of *Periphylla mirabilis*. This species, as well as the following species, *Periphema regina* belong to the family of the Periphyllidæ, these large and highly organised Peromedusæ which have twelve tentacles, sixteen marginal lobes, and thirty-two lobe pouches. Contrasted with these stand the older and more simply constructed Pericolpidæ, which are more closely connected with the Lucernaridæ, and have only four perradial tentacles, besides eight marginal lobes, and sixteen lobe pouches. Each perradial tentacle of the Pericolpidæ is represented in the Periphyllidæ by three tentacles, and two marginal lobes inserted between them. All Peromedusæ have invariably only four interradial rhopalia, and this alone distinguishes them from all other Medusæ. Our *Periphylla mirabilis* is distinguished from all other species of the genus by the eight strong barbous filaments of the margin of the mouth, and may therefore be regarded as the representative of a distinct genus—*Periphenga mirabilis* (περιφέγγα, radiating).

Periphylla mirabilis, Hæckel (Pls. XVIII.–XXIII.).

Periphenga mirabilis, Hæckel, 1879, System der Medusen, p. 422, No. 424.

Umbrella conical, about one-fourth higher than broad. Pedal zone of the exumbrella somewhat higher than the lobe zone, both together nearly three-fourths as high as the cone zone. Marginal lobes oval, pointed; their distal wings triangular, half as high as their proximal gelatinous swelling. The eight tentacle lobes projecting less than the eight rhopalia lobes on the umbrella margin. Tentacles twice as long as the height of the umbrella, one-third as broad as the marginal lobes at their basis. Œsophagus cubical, one-third as high as the umbrella, reaching only to the coronal muscle, with eight adradial, long, feathered, barbous filaments at the margin of the mouth. Horizontal diameter, 120 mm.; vertical diameter, 160 mm.

Habitat.—South Pacific Ocean, near the east coast of New Zealand. Lat. 40° 28′ S., long. 177° 43′ E. Station 168. The single specimen captured, a mature male, was taken July 8, 1874, at a depth of 1100 fathoms. It was admirably preserved in spirit, was quite perfect; and was, on the whole, of a pale violet colour. The inner or endodermal surface of the gelatinous umbrella was overlaid with dark, violet-brown pigment, which was easily rubbed off, and consisted of small roundish granules in the endodermal cells of the abaxial wall of the gastral space. The tentacles appeared coloured darker violet, the genitalia reddish-yellow. After lying some years in spirit, the colours become fainter.

The umbrella (Pl. XVIII. fig. 1; Pl. XIX. fig. 6; Pl. XX. fig. 8; Pl. XXI. figs. 12–20) of *Periphylla mirabilis*, as of most other Peromedusæ, is high-arched, conical, pointed above, and widened like a funnel below, or almost helmet-shaped. The height (or vertical diameter) of the umbrella—including the marginal lobes, excluding the tentacles—amounted in the uninjured specimen to 16 centimetres; therefore, one-fourth more than the breadth at the opening of the umbrella, 12 centimetres being the largest horizontal diameter. Almost in the middle of its height,—8½ cm. from the umbrella cone, 7½ cm. from the umbrella margin, the umbrella is deeply constricted by a horizontal circular furrow, the coronal furrow ("fossa coronaris," *ec*). The umbrella cone or "cone zone" ("zona conaris") is a perfectly simple smooth cone, pointed above and widening symmetrically below; its firm, gelatinous substance is of nearly equal thickness throughout, about 8 mm.; in the coronal furrow (*ec*) its thickness suddenly diminishes to 2–3 mm. (fig. 35). The external surface of the cone is flat throughout without any ornament. The corona of the umbrella, on the contrary, is subdivided by a lower horizontal circular furrow into two zones, the upper pedal zone and the lower lobe zone.

The pedal zone ("zona pedalis") is divided by sixteen deep longitudinal furrows into the same number of projecting wedge-like gelatinous socles, the pedalia. Of these the four interradial are considerably smaller (25 mm. high, 12 mm. broad above, and only 8 mm. below), and bear below the four sense clubs and their ocular lobes ("pedalia ocularia"). The twelve remaining gelatinous socles ("pedalia tentacularia") bear the tentacles and their lobes below, and are much larger (35 mm. high, 13 mm. broad above, 17 mm. below). Between each two interradial ocular pedalia (fig. 19, *ni*) there are three larger tentacular pedalia, the central one (*up*) lying perradially, the two lateral (*ua*) adradially, (comp. figs. 18 and 19). The firm gelatinous substance of the umbrella is 10–12 mm. in thickness in the upper part of the pedalia, whilst in their lower part it is diminished to 3–5 mm. Each pedal is limited on the upper convex margin by a crescentic area ("areola semilunaris") (fig. 34, *xs*), which is divided by 8–10 small shallow longitudinal furrows into the same number of smaller swellings ("gyruli"); they end above in the bottom of the large coronal furrow, and contain pointed processes of the exumbral zonal muscle (fig. 34).

The exumbrella of the corona of the umbrella in our *Periphylla*, as probably in all Peromedusæ, is distinguished, not only by the longitudinal and transverse furrows already mentioned, which penetrate more or less deeply and are connected with important internal anatomical and ontogenetic conditions of organisation, but also by special exumbral muscles. In the deep coronal furrow between the umbrella cone and umbrella corona ("fossa coronaris," *ec*) there is a ring-shaped external zonal muscle ("musculus zonaris," *mz*), with sixteen exumbral points projecting from its distal margin; these are triangular, having the point directed downwards and correspond to the radii of the marginal lobes; they consequently lie subradially, and their distal end passes below in the furrow, between the two pedalia in whose prolongation the lobe clasp (fig. 34, *mz*) is placed. Both the zonal muscle itself and the muscular points proceeding from it are composed of strong annular fibres.

The true umbrella margin (in the wide sense) ("margo umbralis," *um*; Pl. XVIII. fig. 1; Pl. XIX. fig. 6; Pl. XX. fig. 8; Pl. XXII. fig. 22) is formed by the lobe zone of the umbrella corona already mentioned, and consists of the following important organs:—four interradial sense clubs, twelve tentacles (four perradial and eight adradial), and sixteen subradial marginal lobes, inserted between the former and the latter. These organs in all Peromedusæ, show very peculiar and complicated conditions of structure, which thoroughly distinguish them from both the Stauromedusæ and the Cubomedusæ. Notwithstanding, these structures are phylogenetically derived from those of the Stauromedusæ and then from those of the Pericolpidæ (comp. my System, 1879, taf. xxiii.). The four perradial tentacles and their four interradial sense clubs have arisen from the eight principal tentacles of the Tesseridæ, and are therefore homologous with the "marginal anchors" of the Lucernaridæ; on the other hand the eight adradial tentacles with the alternating marginal lobes of the Pericolpidæ, are homologous with the hollow arms of the Lucernaridæ. The umbrella margin of the Periphyllidæ has plainly arisen in this way from that of the Pericolpidæ, as instead of each perradial tentacle, there are three tentacles with two additional marginal lobes between them. The number of tentacles rises in this way from four to twelve, and the number of the marginal lobes from eight to sixteen. The original number of the four sense clubs remains invariable in all Peromedusæ, and is typical of the whole order.

The sixteen marginal lobes ("lobi marginales," Pl. XVIII. fig. 1; Pl. XXII. fig. 22; Pl. XXIII. figs. 29–32) of the corona of the umbrella are, on the whole, egg-shaped, lie subradially in the meridian plane of the fourth order, and are divided into four pair of ocular lobes (*lo*), and four pair of alternating tentacular lobes (*lt*). The two ocular lobes ("lobi oculares") of each umbrella quadrant lie exradially, as the interradial eye is set between them. The marginal incision between them up to the eye is 17 mm. deep, half as deep as the incision between each ocular lobe and the neighbouring tentacular lobe. The two ocular lobes of each pair therefore compose a broadly oval, ocular principal lobe, whose free margin is divided into two secondary lobes (fig. 1). Each ocular secondary lobe is divided by a deep longitudinal furrow into two halves, an adocular and an exocular. The exocular or external half, which touches the adradial tentacle, is wing-shaped and thinned, and runs into a delicate membranous selvage in the margin of the lobe ("patagium," *lp*). The inner or adocular half, which touches the interradial eye, is strongly thickened, so that in conjunction with that of the adjacent secondary lobe, it forms a thick swelling, projecting convexly outwards, in direct prolongation of the ocular pedalium (*ur*). Each ocular principal lobe therefore appears like a broad oval leaf, which has a midrib 1 cm. broad, side-wings 3 cm. broad, and is 4 cm. long in all (in the middle line). The two tentacular lobes ("lobi tentaculares") of each quadrant of the umbrella lie coradially, as they enclose the perradial tentacle beween them and are divided externally from the ocular lobes by the adradial tentacle. Each of the two tentacle lobes represents a longish oval leaf 4 cm. long and 2 cm. broad, divided by a deep subradial longitudinal furrow into two lateral swellings; this furrow forms the direct process of the coradial furrow, which separates the adradial pedalia of the furrow zone from the perradial. Each of the two swellings of each tentacular lobe is almost linear. A very thin, folded, wing-shaped membranous selvage ("patagium," *lp*), 5–8 mm. broad, also runs round the margin of this lobe; it is broadest at the point and narrowest at the base (fig. 1, 22, &c.).

The fused clasp of the marginal lobes ("loboporpa, cathamma lobare," *kl*; Pl. XXII. fig. 22; Pl. XXIII. fig. 29). The exumbral longitudinal furrow of each lobe, which divides its two gelatinous swellings and passes above into the "sulcus interpedalis," has a corresponding fused clasp (*kl*) in the interior of the lobe. This is a rectilinear gelatinous selvage of cartilaginous hardness, firmness, and elasticity. It springs with a broad basis (fig. 29, *kl*) from the proximal margin of the coronal muscle, and reaches the border of the middle and distal third of the lobe, where it becomes thicker and ends (fig. 22, *kl″*). Its peculiar structure is shown in Plate XXV. fig. 10, under a higher magnifying power. The clasp is formed by the umbral or abaxial endodermal epithelium (fig. 10, *dw*) and the subumbral or axial endodermal epithelium (fig. 10, dw_2) becoming fused into sixteen subradial straight lines in the peripheric part of the circular sinus, by which the latter is divided in the region of the coronal muscle into sixteen coronal pouches (*bc*). The fused clasp of the marginal lobes completely divides the two adjacent coronal pouches, but only partially divides the lobe pouches proceeding from them (Pl. XXV. fig. 10, *bl*), which are bent into each other like a horse-shoe at the thickened distal end of the clasp (*bu*, figs. 22, 29). Both the thicker gelatinous plate of the umbrella (Pl. XXV. fig. 10, *ug*) and the thinner gelatinous plate of the subumbrella (*zw*) undergo considerable induration and peculiar histological change in the region of the fusion of the two layers of endodermal epithelium. The soft gelatinous substance becomes a firm fibrous cartilage with numerous roundish cells separated by a fibrillar intersubstance. The fibrous cords of the intercellular substance cross each other in all directions, as they do in the analogous cathamma of the nodes of the septa (Pl. XXV. fig. 4, *kn*).

The sixteen tentacles (Pl. XXVIII. fig. 1; Pl. XIX. figs. 6, 7; Pl. XXI. fig. 21; Pl. XXII. fig. 22) are strong, hollow cylindrical tubes, which gradually decrease conically towards the distal point. All the twelve tentacles (four perradial, eight adradial) are of equal size. They are from 30–40 cm. long, consequently twice the height of the umbrella; they are possibly 50–60 cm. long in the living animal. The tentacles are 8 mm. thick at their enlarged conical bases; 3 cm. below the insertion they are 5 mm. thick; 5 cm. below only 3 mm., and so gradually decrease towards the point which runs out almost to a thread. The smooth upper surface of the cylindrical tube appears repeatedly constricted by numerous annular folds, which are only interrupted by the longitudinal muscles (figs. 1, 6, 7). The spacious cavity of the tentacles is enclosed by a thin but very firm leather-like wall.

The tentacle wall is formed of four layers (Pl. XXI. fig. 21):—(1) the endodermal epithelium (*d′*) of the canal (*ct*); (2) the supporting plate (*z*); (3) the muscular plate (*m*); (4) the ectodermal epithelium of the outer surface (*q*). The finer structure of the wall is very peculiar, but could not be diagnosed satisfactorily from the only spirit-specimen examined. The ectodermal epithelium (*q*) contains numerous nematocysts. The muscular plate (*m*) appears thinned away on both lateral surfaces of the tentacles, but on the other hand thickened so remarkably on the inner and outer side that it projects in the form of two strong band-shaped longitudinal muscles. The external or axial longitudinal muscle springs from the pedalia, and usually occupies only the proximal third or fourth of the length of the tentacle. The inner or axial longitudinal muscle runs through the entire length of the tentacle, and is split up above into two conical root muscles (*mk*, figs. 22, 29). These invaginate the distal margin of the corresponding coronal pouch, divide it into an external velar pouch and an internal avelar pouch, diverge into the "funnel of the tentacle" (*it*), formed in this way between the velar and avelar pouches and run as the proximal margin of the coronal muscle, where they are inserted (comp. below). If the internal longitudinal muscle is strongly contracted, the tentacle appears rolled up spirally and laid in deep transverse folds (*d*). A structureless thin, but very firm, supporting plate ("lamina fulcralis," fig. 21, *z*) lies under the muscular plate (*m*) and under the supporting plate, the endodermal epithelium of the tentacle canal (*d*). The nature of the latter is very remarkable; it consists of large vesicular cells, and rises in the shape of a thick spongy cord (fig. 21, *d''*) on the abaxial side of the canal wall. This cord consists of an accumulation of very large vesicular cells, and fills like marrow nearly the half of the lumen of the tube (*ct*). It would require to be more minutely investigated in living and well-preserved animals. So would another most peculiar arrangement of the ten-tentacles; a strong, double-valved aperture lying inside the base of the tentacle immediately at the point where the tentacle roots diverge (Pl. XXII. fig. 22, *yk*). The elastic fulcral lamella is swollen there into a thick gelatinous plate containing cells, and forms two horizontal vent-valves lying above one another, by means of which the cavity of the tentacle can be completely closed. Even by strong pressure from within the tentacle cavity it was impossible to overcome the antagonism of the double valve. The cavity of the vent-hole (fig. 22, *cx*) between the distal (*yk''*) and the proximal valve (*yk'*) is nearly as high as broad.

The marginal sense clubs ("rhopalia") of *Periphylla* (Pl. XVIII. figs. 1–5; Pl. XXII. fig. 22, *or*; Pl. XXIII. 31, 32, *or*) have been already described by me in *Periphylla hyacinthina* in my System der Medusen (1879, taf. xxiii. figs. 9–12). They appear to have essentially the same formation in *Periphylla mirabilis*, and represent very composite organs of sense connected among the forms hitherto known, with the rhopalia of the Cubomedusæ on the one side and with those of the Nausithoidae on the other. As in all Peromedusæ there are only four interradial rhopalia, which lie in the radii of the septal nodes and the tæniola. They were, unfortunately, very badly preserved in the spirit-specimen examined; a complete and correct insight into their very complicated minute structure could only have been obtained by examination and special preparation of fresh rhopalia.

With the naked eye they can be recognised as white granules in the incision between the two ocular marginal lobes. Each rhopalium consists of a conical basal part, the sense knob, of a large sense vesicle on the axial side of the knob, and of a sense fold or protective scale which is placed at the distal end of the sense knob and surrounds the auditory club as well as the eye (comp. Pl. XVIII. fig. 2, seen from the inside, axial side; fig. 3, seen from outside, abaxial side; fig. 4, seen in profile; fig. 5, seen half from the inside, half in profile). The sense knob corresponds to the basal part of the greatly shortened and thickened tentacle, from which the whole sense club is phylogenetically derived. It projects between the bases of its two constituent sense lobes, is usually conical in shape, and bears the large spheroidal or oval sense vesicle ("ampulla rhopalaris," *oa*), a cæcal arching outwards of the sense pouch (*bo*) on its inner or axial side. Just under the ampulla the sense knob is constricted like a neck and surrounded by the large, darkly pigmented sense collar (*op*). The latter forms an ectodermal swelling, with a thick accumulation of brown or dark pigment and has quite the shape of a high coat collar, which closes round the neck of the sense knob on the abaxial (external or dorsal) side, whilst it falls obliquely on the axial (inner or ventral) side, and passes into two lateral symmetrically-placed lapels (figs. 2, 3, *op*). The two lapels of the sense collar are divided from one another by a deep, broad furrow, which is only bridged over below at the distal margin of the collar by a narrow cross bar of pigment. An unpaired axial eye with lens (*oc'*) and pigment cup appears to lie in the depth of the furrow between the end arms and the pear-shaped auditory club (*ok*), the distal end of the acoustic tentacle rises on a thin stalk immediately below it. The auditory club is white, and consists of an axis of endoderm cells, the last of which forms a large spheroidal otolite sac, closely filled with numerous small prismatic crystals (*ol*). The ectodermal covering of the auditory club bears auditory hairs which project freely into the niche of the auditory scale (*os*). The latter forms a protective scale, oval or triangular in shape, arched convexly outwards, concavely inwards, so that it surrounds the auditory club as a protection from the abaxial (external) and distal (lower) side. Two eyes containing a planconvex or biconvex lens in the midst of a cup of brown or black pigment (?) appear placed inside the niche of the scale (*on*) on the abaxial side of the auditory club (between the otolite sac and the sense collar). All these conditions could, unfortunately, only be indistinctly and incompletely recognised in the poorly-preserved spirit-specimen, so that it was only by aid of comparison with the sense clubs of some other *Periphylla* that I was able to draw out figures 2–5 reproduced in Plate XVIII., which can only claim to be approximately or even remotely correct. It may, however, be safely asserted that the sense clubs of *Periphylla* are modified interradial tentacles, which function simultaneously as acoustic and as optical organs of sense; in some respects they appear allied more with the sense clubs of *Charybdea*, in other respects with those of *Nausithoe*. In our species there are probably three small eyes furnished with pigment, lens and nerves above the auditory club; of these the unpaired (lower) eye looks inwards, the two paired (upper) eyes outwards.

The nervous system of *Periphylla*, like that of all the Peromedusæ, is at present unknown, and, unfortunately, in spite of repeated efforts, I was unable to make it out from the single spirit-specimen examined. It requires fresh researches on living and specially-prepared material. But considering the high stage of differentiation and perfection to which the formation both of the muscular system and of the sense organs of our highly developed Medusa has attained, we may assume that the nervous system is also fully developed. This supposition is further justifiable from the fact that the closely-allied Cubomedusæ have a highly developed nervous system with centralised nerve ring, and that the organs of sense show many analogies in the two orders. A nerve ring probably runs in the coronal furrow as an important central organ, in immediate connection with the four interradial sense clubs. A second nerve ring perhaps exists at the margin of the coronal muscle, and possibly a third at the oral margin or the palatine ring. From the large size of this Medusa, these important conditions might be explained by examination of more perfectly preserved *Periphylla* treated with osmium and other such reagents.

The subumbral umbrella cavity ("antrum," Pl. XIX. fig. 6; Pl. XX. fig. 8; Pl. XXI. figs. 12–19) in our *Periphylla*, as in all Peromedusæ, is divided into two distinct sections, the distal simple coronal cavity and the proximal quadrilocular funnel cavity, the palatine ring forming the boundary of the two. The distal (lower or oral) coronal cavity of the umbrella ("antrum coronare," fig. 19, *hc*) is simple, shaped on the whole like a hemisphere or truncated cone, and enclosed round by the corona of the umbrella; it is 7 cm. in height by 12 cm. in diameter, opens below to the outside by the opening of the umbrella and contains the œsophagus in its centre. The upper boundary of the coronal cavity against the funnel cavity is formed by the palatine ring ("annulus palatinus," *wp*). I give this name to the important subumbral boundary ring between the œsophagus and the coronal sinus, in whose plane the four perradial palatine nodes are inserted into the wall of the sinus. Four wide horizontal openings, the funnel openings ("ostia infundibularia," fig. 18, *if*), leading from the coronal opening of the umbrella into the four interradial funnel cavities (*ii*), are placed between the four palatine nodes.

The funnel cavities ("infundibula") are conical ectodermal invaginations of the subumbrella into the central stomach. They correspond completely to the "funnel cavities" of the Lucernaridæ, but are much more strongly developed, and play a much more important part. Whilst in *Pericolpa* and *Peripalma* they only reach the boundary of the central stomach and basal stomach (as far as the pyloric ring), in *Pericrypta* and *Periphylla* they completely hollow out the conical tæniola and also pass above into the basal stomach as far as its conical point, where the cæcal ends of their cones touch in the subumbral centre of the umbrella cone. Each infundibulum represents a sub-regular cone 3 cm. high and 4 cm. in diameter at the base, and is divided by the horizontal boundary line of the pyloric opening (*gy*, figs. 12, 13), into two distinct sections of equal height, a lower distal half, and an upper proximal half. The lower or distal half of the funnel (or the "central funnel," fig. 16, 17, *ic*) lies in the outer surface of the central stomach (*gc*); its inner or axial wall is formed by the obelisk plates (*yz*) of the central stomach, its outer or abaxial wall by the subumbral wall of the coronal sinus (*cs*). The upper or proximal half of the funnel (or of the "basal funnel," fig. 14, *ib*) is encircled by the four niches of the basal stomach (*gn*), and is only joined to the inner wall of the gelatinous umbrella at the interradial line (fig. 14, *ug*). The four funnel cavities of the Peromedusæ are homologous with those of the Stauromedusæ and the Cubomedusæ, and may also be comparable to the subgenital cavities of the Discomedusæ, the respiratory cavities of older authors on the medusæ. In fact, they may serve both as means of respiration and locomotion, as they are emptied by each systole of the umbrella and filled with fresh water by each diastole; their wall is firm, but very thin.

The inner concave umbrella wall or subumbrella, shows a highly developed system of strong swimming muscles, evolved from the more simple muscles, which I distinguished in the Stauromedusæ as the distal coronal muscle and the proximal bell muscle (comp. my System der Medusæ, 1879, pp. 366, 382, 399, 456, taf. xxi. xxx., &c.). The coronal muscle ("musculus coronaris," *mc*) is improved into a powerful broad band, and more strongly developed than in all other Acraspedæ. It consists of powerful leaves of the circular muscle, whose thick supporting plate rises above the subumbral surface in the form of 10 to 12 strong circular folds; the height of these circular folds (mc_2) decreases from above to below, their breadth increases (Pl. XIX. fig. 6; Pl. XXI. fig. 8; Pl. XXII. fig. 22, *mc*). The upper or proximal margin of the coronal muscle (figs. 8, 22, mc_1) forms a simple circular line, corresponding with the distal margin of the large circular sinus. The lower or distal margin of the coronal muscle (figs. 8, 22, mc_4) forms sixteen triangular, subradially projecting points which run as far as the middle of the marginal lobes. The whole coronal muscle is therefore divided by sixteen selvages into sixteen quadrangular areæ, the coronal plates ("tabulæ coronares"). The four interradial ("ocular") are somewhat narrower than the remaining twelve ("tentacular"). They are divided by the lobe clasps ("loboporpæ," *kl*), the longitudinal fused selvages, which divides each marginal lobe into two halves (comp. pp. 66, 67); they serve at the same time as firm cartilage-like selvages for the insertion of the circular muscular fibres. Each quadrangular coronal plate corresponds, therefore, to the adjacent halves of two marginal lobes, and connects them most closely. Four of the muscular areæ correspond at the same time to the four interradial sense clubs, whilst the twelve others correspond to the tentacles. The two lateral margins of each muscular area (formed by the lobe clasps) are straight, and converge upwards; the lower or distal margin is the larger, and sinuated concavely; the upper or proximal margin is convex, and touches alternately the basis of the deltoid muscles and the distal end of the genitalia.

Whilst the large coronal muscle with its circular fibres contracts the distal part of the subumbrella, the muscle of the swimming bell ("musculus codonoides") with its longitudinal fibres answers for the proximal half of the subumbrella. The most important longitudinal muscles of this system are the eight strong deltoid muscles ("musculi deltoides," *md* ; Pl. XIX. fig. 6 ; Pl. XX. fig. 8). They are very powerful, equilaterally triangular, and touch the proximal margin of the coronal muscle with their broad bases, whilst their truncated point is directed upwards and their longitudinal fibres consequently diverge centripetally. The four weaker perradial deltoid muscles (*md'*) are inserted by their truncated point at the distal end of the gastral openings, in the subumbral wall of the four cartilaginous palatine nodes (*gk*). The four stronger interradial deltoid muscles (*md''*), on the other hand, are longer, and inserted further up on the subumbral wall of the four septal nodes (*kn*) in the middle of the length of each pair of genitalia between the two halves. Between these, the deltoid muscle also forms, above the septal node, a thin band-shaped prolongation, which runs centripetally as far as the pylorus ("musculus intergenitalis," fig. 8, *ms*). Besides these, a stronger longitudinal muscle, which I will call "musculus congenitalis" (fig. 8, *mn*), runs into the subumbrella on the two lateral margins of each of the four gastral openings, between them and the limiting genital bands. It springs with a broader base from the inverted lateral margin of the perradial deltoid muscle, runs, gradually becoming narrower, up above between the gastral ostium and the limbs of the genitalia, and is inserted above with its narrow end in the pyloric ring (fig. 8, *gy*). Finally, a narrower and very much weaker longitudinal muscle, which may be termed "musculus axogenitalis," runs in the middle of the eight genitalia, and, in fact, on the midrib between the two limbs of each genitalium (fig. 38, *mx*). On the whole, therefore, the system of the muscle of the swimming bell ("musculus codonoides") is divided into four stronger interradial and four weaker perradial areæ ; the four interradial deltoid muscles, the four intergenital muscles and the eight axogenital muscles belong to the former; the four perradial deltoid muscles, and the eight congenital muscles to the latter.

Although the circular system of the distal coronal muscle, and the longitudinal system of the proximal swimming bell muscle, form by far the most important part of the subumbral muscular system, it is represented by weaker muscles in other parts of the subumbrella. The circular fibres already mentioned, in the wall of the basal funnel cavities, belong to it on the one hand, and the longitudinal fibres on the concave axial side of the marginal lobes, which we shall briefly term "lobe muscles" ("musculi lobares," *mh*), on the other. Each of the sixteen marginal lobes has in its thin subumbral wall a pair of such longitudinal muscular bands, which run to both sides of the medial (subradial) lobe clasps (*lk*), and clearly correspond to the well-known stronger lobe muscles of the Discomedusæ.

The gastro-vascular system of *Periphylla mirabilis* (Pl. XX. figs. 8–11 ; Pl. XXI. figs. 12–20 ; Pl. XXII. fig. 22 ; Pl. XXIII. figs. 29–31) is distinguished from that of all

Peromedusæ by many very peculiar and complicated arrangements, which can only be completely understood after long and minute study. The only gastrovascular system among the forms of the Medusæ systems hitherto known, which offers more detailed points of comparison, is that of the Lucernaridæ, and in *Periphylla*, as in the Lucernaridæ, it is derived from that of Tesseridæ (comp. the general anatomical representation of the Stauromedusæ in my System, 1879, pp. 363–395, taf. xxi., xxii.). But whilst the essential condition of the central gastrovascular system in those Stauromedusæ resembles that of the Peromedusæ, in the Peromedusæ it differs in detail in very important and peculiar complications, and especially in the formation of the peripheric part. Generally speaking, we can distinguish in all Peromedusæ two principal sections of the gastrovascular system, the central principal intestine ("gaster principalis") and the peripheric coronal intestine ("gaster coronaris"); they are only connected by four narrow, cleft-shaped, perradial gastral openings, and are otherwise completely separate.

The central principal intestine ("gaster principalis") occupies the entire length of the axial space of the body and extends from the umbrella cone to the oral margin. It is divided by two circular constrictions or horizontal strictures into three principal sections —basal stomach (*gb*), central stomach (*gc*), and buccal stomach (*ga*). The upper or aboral circular stricture between the basal and the central stomachs, I term the pyloric opening or pylorus ("porta pylorica," *gy*); the lower or oral circular stricture, between the central and the buccal stomachs, the palatine opening or palatum ("porta palatina," *gp*). In order to gain a general correct idea of the complicated conditions of form of these three sections of the principal intestine, it is convenient to refer them to simple mathematical figures; the basal stomach is a cone (or more properly a quadrate pyramid), the central stomach an obelisk (or a truncated, regular quadrangular pyramid), the buccal stomach a cube (or a four-sided prism). The central stomach communicates with the peripheric circular sinus of the coronal intestine by four lanceolate perradial openings ("ostia gastralia").

The buccal stomach (eventually also termed proboscis or œsophagus, "gaster buccalis, tubus oralis, proboscis" Pl. XIX. fig. 6 in the centre; Pl. XX. fig. 11; Pl. XXI. fig. 19) forms the lowest oral third of the axial principal intestine, is dice-shaped on the whole, and hangs perfectly freely in the centre of the coronal hollow of the umbrella, as it is only fastened above to the subumbrella by the four perradial palatine nodes (*gk*). The length of the edge of the cube amounts to nearly 5 cm.; Plate XX. shows it apart in its natural size, fig. 9 the interradial external view, fig. 10 the perradial external view, and fig. 11 the perradial transverse section. The lower (oral) wall of the cube occupies the quadrate oral opening (*oa*), and the upper (aboral) wall the palatine opening (*gp*); the four perradial vertical lateral surfaces of the cube are formed by the buccal pouches (*bb*), the four interradial edges between them by the buccal columns (*ac*).

The oral opening ("osculum," *aa*), is shown from below in the middle of fig. 6 of

Plate XIX.; it forms a quadrangle with rounded angles. The delicate, thin membranous margin of the mouth (oral margin) is contracted inside like a narrow velum, and appears swollen and thickened at the four interradial angles by the crescentic oral ends of the buccal columns which are concave inside. Each of the latter bears two thin oral filaments two cm. long at the end of the horns of the crescent ("barbulæ, filamenta oralia," figs. 9–11, *af*). These may probably be considered as the last oral branches of the limbs of the tæniola (see below). They are thickened conically at the base, and run out to the point in a very thin long filament (or in a pencil-shaped bunch of filaments); they are amply furnished with large bean-shaped nematocysts, whose urticating threads are twisted spirally and armed with bristles.

The oral cavity ("cavitas buccalis") is divided by the four interradial buccal columns into four perradial peripheric buccal pouches (*bb*), which only communicate with the central cavity of the mouth (*ax*) by four narrow œsophageal clefts. The four oral columns ("columnæ buccales," *ac*, figs. 9–11, 19) are nearly rectangular ridges or plates, 5 cm. high and 2–3 cm. broad, projecting inwards in the interradial meridian plane into the oral cavity. They are supported by a visible layer of gelatinous substance, several millimetres thick, which is thickest at the two lateral margins and in the middle of each plate, so that each plate is also traversed on its gastral surface by a pair of shallow, parallel, longitudinal grooves (transverse section, fig. 19, *ac*). The lateral parts of the buccal columns project like wings on the two sides of the groove (adradial oral wings, "alæ buccales," *ad*). In this respect they resemble the tæniola of the *Scyphostoma*, and, in fact, I consider them homologous with the peristome part of the latter. In *Periphylla mirabilis*, moreover, they are much less strongly developed than in the following species:—*Periphylla regina* (Pl. XXIV. fig. 3) and *Periphylla hyacinthina* (System, 1879, taf. xxiv. fig. 14). The four perradial egg-shaped buccal pouches ("bursæ buccales," *bb*, figs. 9–11, 19) project arching out externally between the buccal columns. The central spaces only of each buccal pouch opens freely into the oral cavity, their peripheric spaces have dilatations or horns which are covered for the most part by projections of the enclosing wall. Each buccal pouch is therefore divided by the projecting wings of the buccal columns into the open central space, and the lateral horns or wing pouches ("ventriculi laterales, bursæ alares," *bd*) covered by the buccal columns. Each side pouch passes above into a larger and deeper aboral corner horn, below into a smaller and shallower oral corner horn; the former ends cæcally in the upper thickened end of the wing of the buccal column (fig. 11, *ad*). The corner horns are not so depressed in this species as in the following one. The four perradial buccal clefts ("fissuræ buccales," *ae*), by which the four buccal pouches communicate with the central space of the oral cavity, are narrowed in the middle. The buccal pouches are inflated ovally out from them (figs. 9, 10, *bb*). The perradial wall of the buccal pouches is very much thinned, and is traversed by parallel longitudinal streaks, which are divided by fine transverse streaks into darker cubes (oral glands, fig. 10, *ag*). This wall becomes considerably thickened above, and then passes directly into the four perradial palatine nodes (*gk*), by which the buccal stomach is fixed to the subumbrella.

The palate or palatine opening ("palatum, porta palatina," *gp*; Pl. XX. fig. 11; Pl. XXI. figs. 12, 13, 18, *gp*) forms the important opening for communication between the buccal stomach (*ga*) and central stomach (*gc*); it can probably be completely closed by muscular contraction in the living *Periphylla*. Properly speaking, it consists of the wide central palatine opening and the four perradial palatine grooves surrounding it. The central palatine opening ("porta palatina", *gp*) is quadrate, its interradial lateral margins are formed by the upper, swollen and thickened, aboral margins of the buccal columns (*ac*), which here pass immediately into the lower delicate oral margins of the thin obelisk plates (*gz*). Its perradial corners, on the other hand, communicate by a narrow cleft (perhaps capable of closing) with the four palatine grooves which represent in some measure four secondary openings of the central principal opening (figs. 8, 11, 18, *gs*). These four perradial palatine grooves ("sulci palatini," *gs*) lead from the oral cavity immediately towards the outside into the coronal sinus, and form, at the same time the dilated distal ends of the cleft-shaped gastral openings (*go*). They are imbedded in the cartilaginous mass of the four palatine nodes ("nodi palatini," *gk*). It appears that the palatine grooves remain open even when the principal opening is completely closed, and then by contact of the two lips of their fissure can be transformed into short closed canals (of about 3 mm. in diameter).

The central stomach ("gaster centralis, obelisk stomach," *gc*; Pl. XX. fig. 8; Pl. XXI. figs. 11–18), the middle of the three divisions of the axial principal intestine, is somewhat smaller than the buccal stomach, and has, on the whole, the form of an obelisk or a truncated regularly quadrilateral pyramid (figs. 12, 13, *gc*). We can distinguish geometrically two bases and four lateral surfaces. The lower (oral) base is formed by the palatine opening described above ("palatum," *gp*), by which the central stomach opens into the buccal stomach. The upper (aboral) basis, on the other hand, occupies the quadratic pyloric opening ("pylorus" *gy*), by which the central stomach communicates with the basal stomach. The four interradial lateral surfaces of the obelisk-shaped central stomach form four trapezoid, or almost rectangular thin lamellæ, which on account of their special importance I have termed (once for all, to prevent confusion) the four obelisk plates of the central stomach ("tabulæ obelisci," *gz*). The thin wall of these quadrangular plates, which are placed more or less vertically, belongs properly to the subumbrella, and is formed by a delicate but firm gelatinous plate or supporting lamella, whose inner or axial surface is covered by gastral endoderm and its outer or abaxial surface by the subumbral ectoderm of the funnel cavities, and a thin layer of muscle belonging to it. The upper or aboral margin of each obelisk plate is formed by a quadrant of the pyloric stricture (*gy*), the lower or aboral margin by a quadrant of the palatine stricture (*gp*), whilst the two lateral or longitudinal margins are beset with a row of gastral filaments (*fc*), and form the lateral boundary margin of a gastral opening (*go*). The four gastral openings or perradial clefts of the central stomach ("ostia gastralia," *go*), are four wide, long cleft openings, by which the central stomach communicates in its whole length with the coronal sinus, and whose middle line corresponds to the four perradial borders of the obelisk or, what is the same thing, to the ideal boundary line, at which each of the two obelisk plates touch. The gastral openings have a narrow lanceolate shape, and are broadest in the middle (6–8 mm.) and 36–40 mm. long (figs. 8, *go*; 12, *go*). The upper or aboral pointed end of each gastral opening touches the perradial point of the pyloric stricture (*gy*); on the other hand, the lower or oral end touches the perradial point of the palatine opening (*gp*), and is intersected here in the form of a peculiar groove, the palatine groove already described, which is embedded in the firm palatine nodes. The border of gastral filaments (*fg*) ends somewhat above the palatine groove.

The pylorus, or pyloric opening, is the name which I have given to the quadrate opening, by which the central stomach communicates with the basal stomach ("pylorus, porta pylorica," *gy*; figs. 8, 12, 13; *gy*, fig. 15). The four perradial angles of this quadrate form the aboral end of the four gastral ostia (*go*). The four interradial lateral lines of the quadrate, 3 cm. in length, form the upper (aboral) boundary lines of the obelisk plates, in which they touch the axial walls of the basal funnel cavities. As each of the two adjacent basal funnels touch each other by their lower ends at the pyloric opening, two gastral filaments (fig. 15, *b*) are placed in each corner of the pyloric quadrate. It is only in the four pyloric corners (fig. 15, *gy*) that the wall of the pyloric opening touches the gelatinous wall of the umbrella (*ug*), from which it is otherwise completely separated by the four interradial subumbral funnel cavities (*ii*).

The basal stomach ("gaster basalis," peduncle stomach, *gb*; Pl. XX. fig. 8; Pl. XXI. fig. 14) forms the upper or aboral third of the axial principal intestine, and has the form of a regular hollow cone, whose base is the pylorus, and whose point is the cone of the umbrella. As, however, it encloses the four interradial conical funnel cavities, it really has the geometrical fundamental form of a quadrilateral regular pyramid. This is 4 cm. high, whilst the length of its edges amounts to 5 cm. and the lateral length of its quadrate base to 3 cm. The point of the pyramid is prolonged into a narrow cæcal tube, which traverses the aboral cone of the gelatinous umbrella, and whose point nearly touches the external surface of the latter. This canal of the umbrella peduncle (fig. 8, *cb*) is here closed cæcally, and does not open by an aperture into the upper surface, as appears at first sight. The cavity of the narrow spindle-shaped peduncle canal is lined with dark-brown pigment, and therefore stands out conspicuously in the clear gelatinous mass (fig. 1, in the point above). As the four interradial conical subumbral funnel cavities (*ib*) already described traverse the whole length of the basal stomach and meet above in its point, the periphery of its conical hollow space is divided into four perradial grooves, the basal pouches, or niches of the basal stomach ("bursæ basales," *gn*). They are broadest in the middle, lanceolate above and below (figs. 8, 12, *gn*). They communicate with the simple central space of the basal stomach by four narrower longitudinal clefts, and correspond to the four peduncle chambers of *Lucernaria* (Pls. XVI., XVII., *gn*). The transverse section is therefore the same in both cases, and shows the form of a Maltese cross; but with this difference, that in *Lucernaria* (Pl. XVII. fig. 13) as in *Pericolpa* and *Peripalma* the four interradial tæniola are solid selvages, whilst in *Periphylla* (Pl. XXI. fig. 14) as in *Periphema* and *Pericrypta* they are hollow cones. Two diverging phacelli (or longitudinal rows of gastral filaments) beset the entire length of the hollow cone, and diverge from each other below at the pylorus, in such a way that the two phacelli of each two adjacent cones which are turned to each other meet in the four perradial angles of the pylorus. From thence they diverge further upon the margin of the gastral openings.

The tæniola ("tæniola gastralia," gastral longitudinal selvages, *ft*). The axial principal intestine of *Periphylla*, whose three divisions have been already described, has apparently an extremely complicated character, which separates it in a striking manner from other Medusæ. A clear, simple explanation of this may, however, be gained by comparing this axial intestine with the more simple principal intestine of the Lucernaridæ and Tesseridæ. If we abstract the secondary differentiations, and only bring forward the primary principal conditions, we are able to refer all these formations to the simple, common ancestral form, to the primary intestine of the scyphopolyps, *Scyphostoma* (comp. my System der Medusen, pp. 364, 367, 384, 403, &c.). The four endodermal interradial tæniola are already developed from this primary intestine, divide the periphery into four perradial niches or pouches, and traverse the whole length of the gastral wall, from the aboral peduncle base to the oral margin. These then characterise pre-eminently the section of the Acraspedæ, and develop the peculiar typical "gastral filaments." In their common parent form, *Tessera* as in *Scyphostoma*, we can distinguish two sections in each tæniolum, the umbral at the umbrella wall and the subumbral at the peristome wall; the two touch at the umbrella margin. From beginning to end, from the aboral central point to the oral margin, the interradial tæniola and their products show a steady tendency to centripetal growth, whilst on the contrary the perradial pouches between them show the same tendency to centripetal growth. In our *Periphylla* (1) the four funnels of the basal stomach and their rows of filaments, (2) the obelisk plates of the central stomach with rows of filaments, (3) the buccal columns of the buccal stomach with their wings and oral filaments belong to the centripetal system of the four interradial tæniola. On the other hand, (1) the four niches of the basal stomach, (2) the gastral openings of the central stomach leading into the peripheric coronal intestine, (3) the buccal pouches and wing pouches of the buccal stomach belong to the centrifugal system of the four perradial pouches. The correctness of this view is proved directly by the distribution of the eight phacelli or rows of filaments, of which each two come on one tæniolum, and are placed in some measure on two diverging limbs of the tæniola.

The phacelli or the longitudinal rows of the gastral filaments (Pl. XX. fig. 8; Pl. XXI. figs. 14–18; Pl. XXII. figs. 23–28) are extremely powerfully developed both in *Periphylla mirabilis* and in the following *Periphema regina* (Pl. XXIV. fig. 1). The number of filaments amounts to several thousand, and their length to 30 or even 40 mm. They are apparently distributed over the whole extent of the basal and central stomach that they form eight continuous longitudinal rows or "phacelli," which run divergingly from the conical basal stomach. Closer inspection, however, shows that the two phacelli of each pair originate as diverging limbs, from a simple interradial phacellus deep in the bottom of the basal stomach. They there form a simple row of short filaments, which stand freely on the interradial tæniola and project into the basal gastral cavity. This simple phacellus soon divides into two limbs, which diverge only slightly at first but more strongly afterwards. At the pylorus they diverge so strongly that they touch the meeting limbs of the adjacent tæniola in the four perradial angles of the pylorus. They then run along the margin of the gastral openings (*go*) nearly to the upper margin of the palatine groove. Each perradial gastral opening is bordered on both sides of the margin by a row of long gastral filaments, which project freely into the central gastral cavity. These filaments are generally 1–2 cm. long.; many of them, however, 3–4 cm. long; their breadth varies between $\frac{1}{4}$ and 1 mm., but often amounts to $1\frac{1}{2}$–2 mm. They are sometimes more cylindrical in shape, sometimes flattened like a ribbon, often tongue-shaped at the end (Pl. XXII. fig. 23; transverse section figs. 24, 25). The structure of these gastral filaments is the same as usual (fig. 26). A gelatinous supporting plate (*z*), enclosing scattered cells, is covered with an endodermal epithelium, which contains three kinds of cells, (1) narrow, high, cylindrical flagellate cells (*fe*); (2) flask-shaped glandular cells with turbid contents, consisting partly of finely granular protoplasm, partly of large, strongly-refractive corpuscles (*fd*); (3) thread-shaped epithelial muscular cells containing nuclei (*fm*). These endodermal muscular cells, hitherto sought for in vain, exist, I believe, isolated here in the large contractile and very mobile gastral filaments (fig. 28).

The peripheric coronal intestine ("gaster coronaris") includes the entire peripheric part of the gastrovascular system (as opposed to the axial principal intestine) and occupies the whole subumbrella from the pylorus to the umbrella margin. It is divided into two principal sections, which are separated by the upper or proximal margin of the coronal muscle. The upper or proximal section itself fills the large coronal sinus, whilst the lower or distal section forms the peripheric corona of pouches. This consists of sixteen quadrangular coronal pouches, which correspond to the coronal plates of the coronal muscle. Three pouches, two lateral lobe pouches, and a middle pouch passing into a tentacle or a sense club, run out from the distal margin of each coronal pouch. The peripheric coronal intestine is only connected openly with the axial principal intestine at four points, viz., at the four perradial gastral openings (*go*).

The remarkable, enormously large circular sinus, or coronal sinus ("sinus coronaris," or "canalis coronaris,") *cs;* Pl. XX. fig. 8, *cs;* Pl. XXI. figs. 12–18, *cs*) is that part of the gastrovascular system which specially distinguishes the Peromedusæ from all other Medusæ, and which does not recur in the same form and to the same extent in any other group of Medusæ. It forms a colossal annular pouch which is placed more or less subvertically, and in *Periphylla mirabilis* is 30 mm. high, so that it fills the half of the whole height of the umbrella. In the circular sinus we distinguish an upper or proximal and a lower or distal margin, and an inner or axial and an outer or abaxial wall. The upper margin and the outer wall of the circular sinus are without any opening; on the other hand, it communicates at the lower margin by sixteen horizontal clefts, with the sixteen coronal pouches, and at the inner wall by the four vertical gastral openings with the central stomach. The lower or distal margin (fig. 15, *cs*) coincides with the proximal margin of the coronal muscle (*mc*), and has, consequently, sixteen subradial projecting corners (Pl. XIX. fig. 6). The aboral or proximal margin (fig. 15, *cs*), is a simple circular ring of the subumbrella, which coincides with the plane of the pylorus; the hollow space of the coronal sinus is here completely closed, and does not communicate with the surrounding circular pylorus; the proximal margin of the circular sinus (fig. 15, *cs*) is completely separated from the pyloric opening (*gy*) by the four interradial funnel cavities (*ii*) (which touch here), and only touches the pyloric opening externally in the four perradial pyloric corners (gy_4). The external, umbral, or abaxial wall is formed by the smooth concave inner surface of the gelatinous umbrella, and is covered by dark pigment, which is deposited in the form of black-brown balls in the endoderm cells of the umbral wall. The inner, subumbral or axial wall of the circular sinus is formed by the subumbrella, which here assumes very complicated conditions in consequence of the strong development of the four funnel cavities. Considered more closely, this axial wall is divided into an upper broader, and a lower narrower section, which is bounded by the subumbral palatine ring or the insertion of the four perradial palatine nodes (*gk*) at the subumbrella. The upper or proximal section of the axial wall, above the palatine nodes, is pierced in its entire length by the four perradial gastral openings, these important clefts already described, by which the hollow space of the central stomach opens into the coronal sinus (*go*). The lower or distal section of the axial wall, on the contrary, is perfectly simple, without openings; the deltoid muscles (*md*) lie on its subumbral surface. Moreover, the four pair of genitalia (fig. 20, *sm*) lie in the four quadrants of the axial wall of the coronal sinus, which are separated by the four gastral ostia. The colossal hollow space of the coronal sinus forms a powerful closed pouch; apart from the four septal nodes which I shall next describe, it is perfectly simple, and, moreover, so wide that I could easily introduce three of my fingers, and so realise its full extent. The powerful volume of its contents is probably subject to important modifications according to the state of contraction of its muscular and very extensible subumbral wall.

The inner or axial wall of the coronal sinus is firmly connected with its external or abaxial wall at four interradial points. These points lie exactly in the radii of the four sense clubs, in the middle third of the height of the sinus, a little above the middle (figs. 8, 12, 13, *kn*). They are the important septal nodes or fused nodes ("nodi septales, nodi cathammales," *kn*; Pl. XX. fig. 8, *kn*; Pl. XXI. fig. 17, *kn*; Pl. XXIII. fig. 33; Pl. XXV. fig. 8); they correspond to the interradial septa of the Lucernaridæ and Cubomedusæ, which divide the length of their radial pouches. Each of the septal nodes forms a gelatinous cube, tiny but firm as cartilage, of from 2–3 mm. in diameter. Under strong magnifying power, the transverse section (Pl. XXV. fig. 8) shows that the umbral gelatinous substance of the thick abaxial wall (*wg*) is firmly fused here with the gelatinous supporting plate of the subumbral axial wall (*zw*). Between the two walls, however, in the tangential median plane of each node, there is a double layer of endoderm cells, the important cathammal plate ("vascular plate or endodermal lamella," *dk*). The higher cylindrical cells of the axial cell layer (dw_2) form the direct continuation of the subumbral endodermal epithelium of the inner sinus wall (*dw*); in the same way the flatter cells of the abaxial cell layer (du_2) pass immediately into the umbral endodermal epithelium of the external sinus wall (*du*), and contain the black-brown round pigment granules by which the wall is characterised. We cannot, therefore, doubt that the nodes are really formed by fusion of the two vascular walls. The gelatinous substance on both sides of the double gastral lamella was so much hardened that it notched the knife in making sections. Under stronger magnifying power (Pl. XXV. fig. 8) it showed here the same striking induration and histological modification of the gelatinous tissue, already described in the periphery of the lobe clasps, the transition into hard fibrous cartilage (comp. above p. 67, and Pl. XXV. fig. 10).

If we suppose that the four septal nodes, prolonged centripetally to the pylorus and developed into four selvages, connect the axial and abaxial wall of the coronal sinus in its entire proximal half, the sinus would thereby be divided into four wide perradial pouches, corresponding to those of the Lucernaridæ and Charybdeidæ; and as in these the four radial pouches here communicate below by a circular canal, viz., by the simple distal half of the circular sinus, below the septal nodes. We may therefore say the ideal horizontal circular line, in which the four interradial septal nodes lie, form the boundary line between an upper and a lower coronal sinus, both of which are in open communication between the four nodes. The upper or proximal coronal sinus (cs_4) corresponds to four wide perradial pouches, whose septa are reduced to nodes, and which communicate by the gastral openings with the central stomach. The lower or distal coronal sinus (cs_2) corresponds to a very much widened coronal canal which connects the four radial pouches at the umbrella margin (as in the Lucernaridæ and Charybdeidæ). The correctness of this morphological view is also justified by comparison with the important common parent group of the Tesseridæ (System, p. 369, taf. xxi.).

The large coronal sinus is divided by the upper or proximal margin of the coronal muscle from the marginal pouch corona, which forms the principal section of the peripheric coronal intestine ("corona bursarum," Pl. XXI. figs. 12, 13, 19, 20; Pl. XXII. fig. 22; Pl. XXIII. figs. 29–32; Pl. XXIV. fig. 1). This corona is composed of the sixteen coronal pouches and the canals which run from them into the four sense clubs, the twelve tentacles, and the sixteen marginal lobes. The sixteen coronal pouches ("bursæ coronares," *bc*) into which the lower or distal margin of the circular sinus opens (at the proximal margin of the large coronal muscle), correspond in number, shape, and size to the sixteen coronal plates or the separate trapezoid muscular areæ of the large coronal muscle (*mc*). They are shallow quadrangular pouches, whose inner or axial wall is formed by the folded muscular area itself, its outer or abaxial wall by the smooth internal surface of the gelatinous umbrella on whose external surface there is a pedalium corresponding to each coronal pouch. The upper or proximal margin is formed by the horizontal narrow cleft, by which it communicates with the coronal sinus; it corresponds to the subumbral boundary line between the coronal muscle and deltoid muscle. The two lateral (or radial) margins are formed by the lobe clasps (*kl*), by which each coronal pouch is divided all its length from the two neighbouring pouches. As each lobe clasp cuts a marginal lobe all its length into two halves, each coronal pouch belongs to the adjacent halves of two lobes and sends out an evagination, the lobe pouch ("bursa lobaris," or lobe canal, "canalis lobaris," fig. 22, *bl*; fig. 29, *bl*) into each of these halves. As the lobe clasp (*kl*) only halves the upper or proximal part of the lobe and leaves the lower or distal part free, both pouches of each lobe are in open communication below the clasp. They consequently form a horseshoe-shaped canal, whose two parallel limbs are directed centripetally and only separated by the septum of the lobe clasp (horseshoe canal, "bursæ hipposideri," fig. 22, *bw*; fig. 29, *bu*). Its proximal openings are in two adjacent coronal pouches. If we fill one of the two lobe pouches of a coronal pouch with air, the air passes through the U-shaped canal into the adjacent coronal pouch (fig. 22, *bu*). In this way there actually arises in all Peromedusæ a connective circular canal at the umbrella margin, which in some measure resembles the festoon canal of the Narcomedusæ, runs along the margin of all the lobes, and puts all the coronal pouches into peripheric communication. In the Pericolpidæ, this wide festoon canal or marginal canal ("canalis marginalis," *cm*) is composed of eight coronal pouches and sixteen lobe pouches, whilst in the Periphyllidæ it is composed of sixteen coronal pouches and thirty-two lobe pouches (comp. my System der Medusen, taf. xxiii. xxiv.).

As the four interradial areæ of the coronal muscle corresponding to the sense clubs are considerably narrower than the twelve remaining areæ corresponding to the tentacles, the same of course holds good of the coronal pouches whose subumbral wall forms the folded muscular areæ. In the middle of the lower or distal margin of each coronal pouch, just where its two lobe pouches opens into it, a canal also runs out from it between the two lobe pouches which leads into the tentacle inserted in the coronal pouch. The four interradial sense canals ("bursæ sensillares," *bo*) which provide for the four sense clubs, are short and simple, and swell into a spheroidal vesicle ("ampulla rhopalaris," *oa*; Pl. XIX. figs. 2–3; Pl. XXII. fig. 22; Pl. XXIII. figs. 31, 32, *oa*) at the basis of each sense club (on the axial side). The formation of the twelve tentacle canals (of which four are perradial and eight adradial) is more complicated. At the tentacle basis, below the two tentacle roots, these canals can be closed by the peculiar double valvular vent-hole already described (comp. p. 68, and Pl. XXII. fig. 22, *yk'*, *cx*).

These complicated anatomical conditions of the peripheric pouch corona are more difficult to understand, inasmuch as each of the twelve tentacular coronal pouches (but not the four ocular coronal pouches) are divided into two pouches by an imperfect tangential septum (Pl. XXII. fig. 22; Pl. XXIII. fig. 29). These two pouches, the inner or axial velar pouch (*bc'*), and the outer or abaxial avelar pouch (*bc'''*), communicate by a longitudinal cleft in the middle of the septum which divides them ("fissura septalis," *bc''*). This peculiar complication arises from each tentacle sending out above at its insertion (between two marginal lobes) two diverging centripetal muscles, the root muscles of the tentacles (*mk*) already described. These invaginate the lower or distal margin of the coronal pouch in such a way that each tentacle root is surrounded by a conical ectodermal hollow space, the funnel cavity of the tentacle root (*it*). The cæcal end of this funnel cavity extends to the upper or proximal margin of the coronal muscle where the point of the tentacle root is inserted. The septal fissure, by which the axial velar pouch communicates with the abaxial avelar pouch, remains between the two bifurcate diverging tentacle roots (*mk*). The "septum velare" (*wm*), which itself is hollow and separates the two pouches, has consequently a very complicated formation. It is formed by two parallel lamellæ of the velar fold, which only pass into one another above at the proximal margin of the coronal pouches and at the two margins of the septal fissure. The space between the two lamellæ, the funnel cavity of the coronal pouch ("infundibulum coronare," *ic*) is lined by the ectoderm of the subumbrella, and divided into a distal simple "funnel cavity of the tentacle base," and two diverging cæcal horns running proximally from it, the two "funnel cavities of the tentacle roots" (*it*). The muscular wall of the delicate membranes which separate these cavities forms part of the invaginated coronal muscle, and is laid in delicate folds, as is best seen from the figure of the partially-opened coronal muscle in Plate XXIV. fig. 1.

Genitalia ("sexualia," *s*; Pl. XIX. fig. 6; Pl. XX. fig. 8; Pl. XXI. figs. 17 18; Pl. XXII. figs. 38–40). The single specimen examined of *Periphylla mirabilis* was a mature male, whose testes had shed most of the spermatozoa. The testes ("spermaria," *sm*) form eight horseshoe-shaped or U-shaped glands, which lie adradially in the subumbral wall of the coronal sinus. The convex arch of each horseshoe is turned distally, and nearly touches the proximal margin of the coronal muscle (*mc*), whilst the two parallel limbs of the horseshoe are directed proximally (or centripetally), and their points nearly touch the pyloric stricture (*gy*). The eight U-shaped reproductive glands therefore extend in an adradial direction through nearly the entire height of the coronal sinus (*os*), and only leave a small part of the upper (proximal) margin and the lower (distal) margin of its subumbral wall free. The eight genitalia are connected in pairs, in such a way that a pair lies between each two perradial gastral openings (*go*). The two genitalia of each pair are divided by the intergenital longitudinal muscle (*ms*) in the upper (proximal) half, by the septal nodes (*kn*) in the middle, and by the interradial deltoid muscle (*md*) in the lower (distal) half. The four pairs, on the other hand, are divided by the four gastral openings (*go*) in the upper half, and by the four perradial deltoid muscles (*md*) in the lower half. The lower half only lies freely in the coronal cavity of the umbrella (*hc*), whilst the upper half is concealed deep in the funnel cavity (*ie*). The four limbs of each pair run nearly parallel in the upper half (in the funnel cavity), whilst the two genitalia of each pair diverge distally (in the coronal cavity of the umbrella), as they diverge parallel to the two limbs of the interradial deltoid muscle. The two limbs of each genitalium converge, however, at their distal end, and are connected there by the cords of the horseshoe, whose convex outer margin nearly touches the inner margin of the coronal muscle (comp. Pl. XX. fig. 8, and Pl. XXV. fig. 1). The two limbs of the horseshoe-shaped genital band are broadest below (1 cm.), and gradually narrow as they run up (0·5 cm.) towards the proximal points of the two limbs (Pl. XXIII. fig. 38). The limbs are of equal length in *Periphylla mirabilis*, whilst in *Periphylla hyacinthina* the lateral limb (next the gastral opening) is much shorter than the medial limb (next the septal nodes). (Comp. my System, Pl. XXII. figs. 13, 16.)

Structure of the spermaria (Pl. XXIII. figs. 38–48). Each of the eight horseshoe-shaped genitalia shows a projecting, nearly adradial, selvage, the genital rib ("costa genitalis, sterigma," *st*) between its two limbs. It consists of a firm selvage-like thickening of the fulcral plate of the subumbrella and of the weak axogenital longitudinal muscle (*mx*) lying on it. Gelatinous transverse selvages run, as in a pinnated leaf, from both sides of this midrib, and serve to support the separate pouch-shaped transverse folds of the genitalium (fig. 38). More minute examination shows that the testis represents a broad U-shaped arched band having many transverse folds along its whole length. The convex lateral margin of the U-shaped band is fastened to the subumbral wall of the ring sinus, whilst the concave, medial margin projects slightly into the canal space of the ring sinus. The separate pouch-shaped, arched-out, transverse folds of the genital band, amounting to about 50 to 60 in each genitalium, are of a narrow, oval or conical shape, and bear the same relation to the midrib that the pinnæ do in a pinnate leaf. Numerous secondary folds lie in each transverse fold. The interspaces between these folds perhaps develop into special genital sinuses with excretory passages opening into the pouch space and from there into the ring sinus, which probably comport themselves as in the complicated forms of the Lucernaridæ. The complicated structure of this many-folded genital band, is, however, as in the Lucernaridæ, very difficult to make out. In the single specimen of *Periphylla mirabilis* before me, the ripe pouches of the testes were already flattened for the most part, and the spermatozoa emptied into the coronal sinus. The small follicles of the testes which, closely placed together, compose the folded genital band, are placed in 3–4 layers, the one above the other, and have an irregular roundish polyhedric shape, and measure 6, 1· 0, 5· in diameter. Each single follicle (fig. 40) is surrounded and separated from the others by a thin fulcral lamella containing nuclei (*zs*). In transverse section, under stronger magnifying power, we see that the larger mother-cells of the spermatozoa (*sd*), which arise from the endodermal epithelium of the sinus wall, line the wall of the follicle, whilst the centre is filled by the ripe spermatozoa (Pl. XXIII. fig. 40 *sz*).

Periphema,[1] Hæckel, 1877.

Periphyllidæ, with four perradial buccal pouches of the œsophagus and four perradial niches of the basal stomach, united in its aboral basis. Between the niches, the four subumbral funnel cavities (or the four hollow interradial tæniola of the basal stomach) form hollow cones, which are beset with two rows of gastral filaments, but are free from them above each end, separated below the point of the cone.

I established the genus *Periphema* in 1877 (in the Prodromus Systematis Medusarum) for a large Periphyllid, of which there were, unfortunately, only broken and incomplete fragments of a single, very large specimen in the Challenger collection. I was, however, able by careful examination of these fragments, and with the help of other Periphyllidæ examined by me (viz., by comparison with the large, perfectly preserved specimen of *Periphylla mirabilis*), to compose a complete quadrant of the Medusa from the fragments, from which the figure in Plate XXIV. is drawn in its natural size. The reconstruction was more difficult, as the enormously developed proboscis or buccal stomach (fig. 3) was completely torn away from the pylorus and broken in pieces, and there were also distracting abnormal deformities—clearly in consequence of an earlier but completely healed injury—on the only remaining quadrant of the subumbrella (fig. 1), which I have of course left out in the figure. Apart from these, our *Periphylla regina* seems very closely allied to the preceding *Periphylla mirabilis*, and I therefore included it without hesitation in this genus in my System (1879, p. 421). However, I now consider it more appropriate to separate it generically from *Periphylla regina* under the

[1] Περιφημος = greatly renowned.

name of *Periphema regina*, as I had already done in the Prodromus (1877). Whilst in the true *Periphylla* (*P. mirabilis, P. hyacinthina*, &c.) the four large interradial conical funnel cavities of the subumbrella traverse the whole length of the central and basal stomach, and meet with their points in the centre of the umbrella cone, in *Periphema regina* they stop short a little way below the subumbrella, so that the four points of the conical funnel cavities remain separated by a basal hollow space, which has the geometrical basis of a quadrate pyramid, and fills the point of the cone. The four perradial niches of the basal stomach are consequently connected at their aboral ends by this conical cavity, whilst they are completely separated in the true *Periphylla*.

Periphema regina, Hæckel (Pls. XXIV., XXV.).

Periphema regina, Hæckel, 1877, Prodrom. System. Medus., No. 389.
Periphylla regina, Hæckel, 1879, System der Medusen, p. 421, No. 423.

Umbrella bell-shaped, nearly as high as broad. Pedal zone of the exumbrella rather narrower than the lobe zone, both together nearly as high as the cone zone. Marginal lobes, oval, rounded obtusely, their distal wings nearly semicircular, about half as high as their proximal gelatinous swelling. The eight tentacle lobes project further on the umbrella margin than the eight rhopalia lobes. Tentacles very thick, nearly as long as the height of the umbrella, one-third as broad at their base as the marginal lobes. Œsophagus cubical, very large and very thick-walled, nearly half as high and half as broad as the umbrella, the oral margin in the plane of the umbrella margin, without barbous filaments. Horizontal diameter, 180–200 mm.; vertical diameter, 180–200 mm.

Habitat.—The Antarctic Ocean, south-west of the Kerguelen Islands. Lat. 62° 26′ S., long. 95° 44′ E. Station 156. The large specimen, to which the fragments examined belonged, was a mature female, and was taken from a depth of 1975 fathoms, 26th February 1874. The colour of the broken fragments, otherwise well preserved in spirit, was reddish, the ovaries were brownish-yellow and the endodermal epithelium of the abaxial wall of the coronal sinus—or the inner surface of gelatinous umbrella—from dark red-brown to black-brown.

The umbrella (Pl. XXIV. figs. 1, 2) of *Periphema regina*, as far as could be made out from the fragments to hand, is bell-shaped, considerably more depressed than in *Periphylla mirabilis*. Its apex is flatly truncated, and nearly equal in height to the diameter of the bell opening, 18–20 cm. The exumbrella is divided by a broad, deep coronal furrow (fig. 2, *ec*), nearly in the middle of the height, into an upper umbrella cone, and a lower umbrella corona. The umbrella cone is smooth, flattened above, and almost hemispheroidal. The coronal furrow is very broad, and the gelatinous substance of it very much thinned. It is divided by sixteen subradial longitudinal furrows (which pass below into the lobe clasps) into sixteen broad, crescentic areæ ("areolæ semilunares," fig. 2, *ec*). A vane-like-shaped process of the exumbral zonal muscle (*mz*) lies between the crescentic folds at the end of each longitudinal furrow. The umbrella corona may be subdivided into an upper pedal girdle and a lower lobe girdle. The pedal girdle ("zona pedalis") is, however, much less strongly developed than in most other Periphyllidæ, and hardly 2 cm. high. The pedalia are slightly vaulted and comparatively small. The lobe girdle of the umbrella corona (figs. 1, 2, "zona lobaris") is more strongly developed in *Periphylla regina* and differently shaped from that of *Periphylla mirabilis.* The sixteen subradial marginal lobes are much larger compared to the pedalia, and are rounded, not pointed. The difference in size between the four pair of ocular lobes, and the four pair of tentacle lobes alternating with them is considerably greater. Neither the two gelatinous swellings lying in each marginal lobe nor the inter-furrow are so thick as in *Periphylla mirabilis;* the lobe clasp ("loboporpa," fig. 2, *kl*), which lies at the bottom of this furrow, and supports the septum between the two halves of the pouch, is much feebler, but shows the same structure in transverse section, fig. 10, comp. above, p. 71), on the other hand, the thin delicate wings ("patagia," *lp*), which form the selvage of the lobe margin, are much broader and longer in our species than in the foregoing. If we measure from the circular line of the exumbrella, indicated by the insertion of the tentacles between the marginal lobes, the tentacle lobes are 50 mm. long (without wings, 35 mm.), and the ocular lobes only 45 mm. (without wings, 30 mm). The tentacle lobes are more than 30 mm. broad in the middle, the ocular lobes a little over 20 mm. (figs. 1, 2).

The four interradial sense clubs in this species appear to be very small and almost rudimentary (fig. 2, *o*); in the fragment to hand, however, there was only one preserved, and it did not allow of closer investigation. Only half of the twelve tentacles were preserved (figs. 1, 4). They are on the whole of the same nature as in the preceding species (comp. above, p. 67), but are considerably shorter and thicker. Their length is nearly equal to the height of the umbrella (18–20 cm.), whilst in *Periphylla mirabilis* it is twice as great. The longitudinal muscle appears to be less strongly developed. The thickness of the hollow tentacles at the conically swollen base amounts to 10 mm. They then thin away into a cone and run out below into a fine point (fig. 2, *t*). The peculiar insertion of the tentacle by two root muscles (*mk*) inside a tentacle funnel (*it*), and the remarkable formation of the double-valved vent-hole at its base, is the same here as has been already described in *Periphylla mirabilis* (comp. Pl. XXII. fig. 22, and Pl. XXV. fig. 1).

The inner concave umbrella wall (subumbrella, Pl. XXIV. fig. 1) in *Periphema regina* shows on the whole the same conditions already (p. 71) described in detail in *Periphylla mirabilis.* The muscular system is, however, much more strongly developed in the former, and the separate muscles show more prominently. The eight longitudinal deltoid muscles ("musculi deltoidei") are yellowish-white, very stout, firm glistening bands, and appear remarkably powerful. The strongest is the interradial deltoid muscle (fig. 1, *md′*), an equilateral triangle, 36 mm. in height, 32 mm. at base, whose truncated point reaches as far as the middle of the genitalia, and is there inserted at the interradial septal node (*kn*). The muscular fibres which diverge radially from its point towards the base are nearly equally powerful throughout. The narrow "musculus intergenitalis" (*ms*) above, between the two genitalia of each pair, is formed by a weaker process of this deltoid muscle. The perradial deltoid muscle (*md'*) is weaker than the interradial; it forms an equilateral triangle 20 mm. in height, 25 mm. at base, whose truncated point reaches as far as the oral end of the gastral opening (*go*), and is inserted there below the palatine groove (*gs*) at the perradial palatine node (*gk*). The lateral muscular fibres (*md'''*) are much more strongly developed in this muscle than in the median muscles. A band-shaped "musculus congenitalis" (*mp*) springs from each side of the perradial deltoid muscle; it lies coradially between the outer margin of each genitalium (*s*) and the gastral opening (*go*), and extends to the upper end of the latter. This band-shaped congenital muscle is 10 mm. broad below, 5 mm. broad above; its length amounts to 60 mm. Its fibres which run parallel, and only converge slightly above, spring from the lateral margin of the perradial deltoid muscles, and are inserted above at the pyloric opening (*gy*).

The broad coronal muscle (fig. 1, *mc*) shows essentially the same condition as that already described in *Periphylla mirabilis* (p. 71). Its proximal margin (*mc*) serves as a basis of origin for the deltoid muscles. Its subumbral surface is elevated into 10 to 12 circular folds (mc_2) with deep furrows sunk between them (mc_3). The coronal muscle is also divided by the sixteen subradial lobe clasps into sixteen coronal areæ. These are 25 mm. high in the middle (between each two marginal lobes), but 30 mm. high laterally in the middle of each marginal lobe. The four ocular muscular areæ (25 mm. broad) are only a little smaller than the twelve tentacular coronal areæ (30 mm. broad). The intermediate lobe clasps are much weaker than in the preceding species, but show the same structure in transverse section (fibrous cartilage, Pl. XXV. figs. 9, 10). The formation of the lower or distal margin of the coronal muscle (Pl. XXIV. fig. 1, mc_4) is peculiarly differentiated. Whilst in *Periphylla mirabilis* it is quite smooth, projects internally like an umbrella roof over the insertion of the tentacles, and forms a simple tentacle funnel (*it*), in *Periphema regina* it is fringed and divided into numerous fine folded lobes or "frenula." On each of the sixteen muscular areæ there are nearly twenty such frenula, 2–3 mm. long, which connect the distal margin of the muscle with the subumbral surface of the marginal lobe lying below it. An equal number of subumbral funnel-shaped depressions are deeply inserted between these frenula in the thickened distal margin ("infundibula subcoronaria").

Both parts of the umbrella cavity, the lower simple coronal umbrella cavity and the upper quadrilocular funnel umbrella cavity, comport themselves the same on the whole in *Periphema regina* as in *Periphylla mirabilis*. The simple coronal umbrella cavity forms a circular hollow space, whose subumbral external wall forms the umbrella corona with the coronal muscle and the deltoid muscle lying above it. The wide hollow space of the coronal umbrella cavity is filled, for the most part, by the powerful buccal stomach, whose oral margin extends to its opening. The quadrilocular funnel umbrella cavity (which is sharply defined by the four palatine nodes (*gk*) from the simple umbrella coronal cavity) shows however an essential variation in our species. Whilst in *Periphylla mirabilis* the four conical interradial umbrella funnels traverse the whole length of the central and the basal stomach, and meet above in the central point of the umbrella cone, in *Periphema regina* they stop some little way below the cone; the four points of the funnels are here inserted separately at four interradial points of the umbral wall of the flattened basal stomach, which are at 4 cm. distance from each other. This occasions a perfectly different formation of the basal stomach, which chiefly justifies the foundation of the genus *Periphema*.

Apart from the differentiated formation of the basal stomach, the gastrovascular system of *Periphema regina* shows essentially the conditions already described in detail in *Periphylla mirabilis.* Only the special formation of single parts and their comparative sizes show unimportant differentiations. Of the three chief sections of the axial principal intestine, the buccal stomach is the largest, being 8 mm. high, whilst the height of the central stomach and of the basal stomach only amounts to 5 cm.

The buccal stomach or œsophagus (fig. 3) is extremely fleshy and thick walled. The four quadrants of the œsophagus were found as four isolated fragments, still partially connected with the pieces broken off from the central stomach, in the bottle containing the incomplete remains of our species. One such quadrant is represented in natural size in fig. 3. Each quadrant contains a complete buccal pouch (*bb*), and the enclosing half of the oral column touching it (*ee*). From the beast having been torn during its capture, the œsophagus was quartered through the interradial meridian planes. The reconstructed form of the buccal stomach is on the whole that of a cube of 7 cm. to the side; more closely considered, it forms rather an octagonal prism with alternating broad and narrow lateral surfaces; the former are formed by the buccal pouches, the latter by the oral columns. The oral columns ("columnæ buccales," fig. 3, *ac*), are remarkably strong, and supported by a powerful, fleshy, gelatinous swelling. The adradial wings of the oral columns ("alæ buccales," *ad*) appear extremely fleshy, and laid internally in strong longitudinal folds, whilst their interradial middle plate is thinner, very much extended and diminished in size, towards the oral margin. The wings project internally considerably above the lateral parts of the buccal pouches, so that they are arched out on both sides into spacious wing pouches. The buccal pouches ("bursæ buccales," *bb*), when inflated would be almost hemispheroidal: their wall is supported by a thin, elastic but firm, gelatinous plate, which is broadened below and rounded obtusely at the oral margin. The distal ends of the eight adradial wings therefore project most below at the oral margin (*am*), without running out into barbous filaments as in the preceding species. The unusual strength of this large proboscis indicates a predatory mode of life.

The central stomach appears capable of being completely shut off from the buccal stomach, as the palatine opening (*gp*) is narrowed by strongly-projecting palatine swellings, and both the four perradial palatine nodes (*gk*) and the contiguous lateral parts of the palatine grooves are also considerably thickened. On the other hand, the four obelisk plates of the central stomach are very delicate and thin walled (torn for the most part). The four perradial angles of the quadrate pyloric opening coincide with the four proximal ends of the four cleft-shaped gastral openings.

The basal stomach (*gb*) shows an essentially different formation from that of the preceding species. In the latter the four perradial peripheric niches surrounding its conical axial space are completely separate from each other, whilst the four interradial funnel cavities of the subumbrella run above as far as the point of the conical basal stomach and meet there in the centre of the umbrella cone. In *Periphema regina*, on the other hand, the interradial funnel cavities end 2 cm. below the basal centre point of the basal stomach. The latter consequently forms a quadratic undivided depression in the bottom of the flatter vaulting of the cone with the funnel cavities and their phacelli springing from its four angles. The distance of these four points (the lateral length of the quadrant) amounts to 4 cm. The shattered condition of the fragments before me, did not allow of the complete reconstruction of the basal stomach. The central part of the umbrella cone with its four funnel points was, however, preserved, and showed clearly that the four perradial niches of the basal stomach communicate freely. This peculiarity distinguishes *Periphema* generically from *Periphylla*.

The phacelli or longitudinal rows of gastral filaments in *Periphema regina* are extremely large and more strongly developed than in any other Medusa known to me. They consist of several thousand strong and very long filaments, placed in several rows along the gastral tæniola (not in a single row as in the preceding species). The filaments are longest in the middle of the phacelli, up to 80 mm. long and 1 mm. thick. They become shorter and thinner towards both ends, and are then mostly only 10–20 mm. long and hardly 0·5–0·2 mm. thick. Their special formation and distribution is the same as in the previous species. Two diverging phacelli run from the cone point of each of the four interradial funnels, extending on the lateral margins of the gastral openings as far as the pylorus, and ending 1 cm. above the palatine groove (fig. 1). The filaments are sometimes cylindrical, sometimes flattened like a ribbon, often thickened into knots and tongue-shaped at the end. The nature and disposition of these glands is the same as in the preceding species. The lumen both of the central and the basal stomach is occupied for the most part by this mass of filaments.

The peripheric coronal intestine in *Periphema regina* shows the same formation as that already described in detail in *Periphylla mirabilis* (p. 78). The colossal coronal sinus (*cs*) which only communicates with the central stomach by the four perradial gastral openings, is divided a little above the middle into four quadrants by the four interradial septal nodes (fig. 1, *kn*). These "cathammal nodes" are only a few millimeters large, but consist of very firm fibrous cartilage (comp. above, pp. 67, 80; and Pl. XXV. fig. 8). The peripheric pouch corona, into which the coronal sinus opens at its lower margin by sixteen tranverse clefts (at the upper margin of the coronal muscle), is divided by the sixteen subradial lobe clasps into sixteen coronal pouches; and each of these is subdivided by the invagination of the tentacle funnel into an inner and an outer coronal pouch (axial velar pouch and abaxial avelar pouch). Besides these, each coronal pouch gives out two lobe pouches below, which compose the marginal "festoon canal"; and whilst each of the four interradial coronal pouches sends an ocular pouch to the sense club, each of the twelve remaining coronal pouches sends out a wide tentacle canal into each tentacle (comp. above, p. 81, and the explanation of Pl. XXV. fig. 1).

Genitalia (Pl. XXIV. fig. 1, *sf*). The fragment before me belonged to a mature female, but only one pair of the four pairs of reproductive glands was preserved. The two ovaries of this pair showed the situation and form represented in the middle of fig. 1. They lay between the gastral openings in the subumbral wall of the coronal sinus, whose upper and lower margin they almost touch with both ends. Both ovaries of the pair lie almost parallel beside each other in the upper half, and are only separated by the narrow intergenital muscle (5 mm. broad). On the other hand they diverge strongly in the lower half, as there the triangular interradial deltoid muscle (*md'*) is inserted between them. The distance between the lower ends amounts to 50 mm. Each of the eight ovaries forms a narrow horseshoe-shaped arched genital band, whose convex distal arch nearly touches the upper margin of the coronal muscle (*mc'*) below, whilst the two parallel limbs, which lie close together, almost reach above to the pylorus (*gy*). The thickened supporting plate of the subumbrella forms a projecting midrib ("sterigma, costa genitalis," *st*) in the middle between the two limbs. The genital band is raised on both sides into a series of folds, which project internally into the umbrella cavity and externally into the coronal sinus (figs. 5, 6). The number of these broad folds, which are subdivided like a fan into smaller folds (figs. 5, 6), amounts from 40 to 50 in each ovary (20 to 25 in each limb). They are 4–6 mm. long, 2–4 mm. broad, and closely packed with spheroidal ova. The smallest ova lie at the basal margin of insertion of the folds, the largest at the freely projecting margin, which is turned towards the "costa genitalis" (*st*). At the basis of the folds we see clearly that the smallest and youngest ova originate immediately from the endoderm cells which line the subumbral wall of the coronal sinus. As soon as the ova grow to a certain size, each ovum becomes enclosed in a gelatinous fulcral sheath (fig. 7, *yz*), a superficial abaxial growth of the supporting plate of the subumbrella (*wz*). In transverse sections, through the genital folds, we see the ova, enclosed in these fulcral capsules, lying in rows beside one another (fig. 7). The extension and strength of the fulcral capsule increases proportionately with that of the ovum enclosed. The ripest ovum of *Periphema regina* reaches the extraordinary size of a millimeter and more. The ova consist for the most part of an opaque food yolk, composed of spheroidal yolk granules of equal size (0·01 mm. diameter), thickly compacted (fig. 4, *yd*). Each ripe ovum is also enclosed (inside the fulcral sheath) by a thick structureless (?) chorion (fig. 4, *yc*), showing a projecting micropyle at one spot (fig. 4, *ym*). It has the form of a short bottle neck, and resembles the micropyle known in the eggs of our freshwater mussels (*Naïadacea*). Below the micropyle we can distinguish with the naked eye a white spot ("cicatricula") on the yellow yolk, in which the large spheroidal germinal vesicle is enclosed ("nucleus," *yn*). It contains a visibly dark, germinal spot ("nucleolus," *yf*), and this again contains a large double contoured germinal point ("nucleolinus," fig. 4, *yp*).

Order VIII. CUBOMEDUSÆ, Hæckel, 1877.

Acraspedæ with four perradial sense clubs, containing an auditory club with endodermal otolite sac and one or more eyes; four interradial tentacles or bunches of tentacles. Stomach with four wide perradial quadrangular pouches separated by four long, narrow interradial septa or fused selvages. Genitalia four pair of leaf-shaped swellings, which are fastened by one margin along the four interradial septa, are developed from the subumbral endoderm of the gastral pouches, and project freely into their hollow space.

Family CHARYBDEIDÆ, Gegenbaur, 1856.

CHARYBDEIDÆ, Hæckel, System der Medusen, 1879, p. 433, taf. xxv.

Cubomedusæ with four simple, interradial tentacles and four perradial sense clubs; without marginal lobes in the velarium, but with eight adradial marginal pouches; without pouch arms in the four broad perradial pouches.

Sub-family, TAMOYIDÆ, Hæckel, 1877.

Charybdeidæ with velar canals, and with four perradial frenula of the velarium.

Charybdea,[1] Péron and Lesueur, 1809.

Charybdeidæ with four simple interradial tentacles, having pedalia; with suspended velarium (with velar canal and four perradial frenula). Stomach flat and low, without

[1] Χάρυβδις = an eddy, a gulf, rapacious.

broad mesenteries; central stomach and basal stomach fused, without distinct pyloric stricture. Four horizontal groups of filaments, simple or double, bush-shaped or brush-shaped, limited to the interradial corners of the bottom of the stomach.

The genus *Charybdea*, the oldest known genus of this family and order, was founded by Péron in 1809, with the following indefinite diagnosis :—"La concavité de l'estomac se confondant avec celle de l'ombrelle; rebord garni de faux bras, ou plutôt de faux tentacles" (Tableau des Meduses, &c., Annal. Mus. H. N., vol. xxiv. p. 332). Péron united in this genus two entirely different Acraspeda, both of which he knew only very superficially and incompletely—the Mediterranean *Charybdea marsupialis* and the æquatorial Atlantic *Charybdea periphylla*. The latter was first seperated by Steenstrup and raised to be the representative of the genus *Periphylla*. On the other hand, the genus *Charybdea* was retained by almost all new authors for the known *Charybdea marsupalis* of the Mediterranean, which had already been described and figured by Plancus in 1739, as "urtica soluta marsupium referens," and of which Milne-Edwards had given a very full (though for the most part mistaken) description in 1833. Quite recently (1879) Claus gave a very detailed histological monograph of this type of the genus *Charybdea*. I was myself able to examine several new species of this genus, and to re-describe its character more minutely. In the sense which I have retained here, those Charybdeidæ which have a suspended velarium (with canals and frenula) belong to the *Charybdea*. *Charybdea* is distinguished from the genus most nearly related (*Tamoya*) by the flat, low pouch-shaped stomach, the narrow mesenteric folds, and, specially, by the formation of the gastral filaments. These are distributed horizontally in the four perradial corners of the bottom of the stomach, as four simple or double pencil-shaped or brush-shaped groups of filaments, whilst in *Tamoya* they extend as four vertical bands in the interradial lateral lines of the large depending gastral sac. The deep-sea species described below is, on the whole, nearly related to the Mediterranean *Charybdea marsupialis*, which is only half the size, but is distinguished from it by the broader velum, containing twice as many velar canals, which are also much more richly dendritic. Moreover, the sculpture of the exumbrella is different. The histological conditions have been described in great detail by Claus in his monograph on *Charybdea marsupialis*; we shall therefore confine ourselves to a short account of the organological peculiarities, giving special prominence to the specific differences shown between *Charybdea murrayana* and *Charybdea marsupialis*. There may perhaps be sufficient to justify this species being taken as the representative of a separate genus: *Charybdusa*. I have named this species in honour of my friend John Murray, first assistant in the Challenger Commission.

Charybdea murrayana, Hæckel (Pl. XXVI.).

Charybdea murrayana, Hæckel, 1879, System der Medusen, p. 442, No. 436.
Charybdusa murrayana, Hæckel, 1877, Prodrom. System Medus., No. 408.

Umbrella bell-shaped, almost cubical, rather higher than broad, depressed above, somewhat widened below; lateral surfaces almost quadratic. Stomach quite flat with four short oral lobes, four tuft-shaped phacelli, composed of bunches of large brush-shaped filaments. The vertical distance of the heart-shaped sense niches from the umbrella margin half as great as the horizontal distance of the pedal bases. Velarium, broad with twelve dendritic velar canals in each quadrant. Pedalia, a longish oval, one-third as long as the height of the umbrella. Tentacles cylindrical, longer than the height of the umbrella. Horizontal diameter of the umbrella, 50 mm.; vertical diameter, 60 mm.

Habitat.—West Coast of Africa, not far from Sierra Leone. Lat. 30° 10′ N., long. 14° 51′ W. Depth, 200 fathoms. Station 348. There were two well-preserved female specimens, taken 9th April 1876.

The umbrella (Pl. XXVI. figs. 1, 6) is, on the whole, nearly cubical, as in most Cubomedusæ. The vertical diameter (60 mm.) is however rather greater than the largest horizontal diameter (50 mm.); four rounded, interradial "corner pillars" (corresponding to the tentacles) project more or less strongly at the four vertical lateral corners of the cube, whilst the four perradial lateral walls (corresponding to the pouches) recede between the pillars and seem more depressed. As they do not lie quite vertically but diverge a little below, the umbrella has really the shape of a truncated, regular quadrilateral pyramid. Its upper apical surface is slightly depressed and circumscribed like a cap, by a horizontal coronal furrow.

The exumbrella, as in most Cubomedusæ, is divided by longitudinal furrows into a number of areæ, projecting convexly between the furrows. We can generally distinguish sixteen such exumbral furrows, viz., firstly, eight subradial furrows (fig. 1, *ea*), which separate the four broader perradial lateral walls from the four narrower corner pillars; secondly, four perradial furrows, which divide the four depressed lateral walls in two and extend downwards from the ocular crypt to the velarium (fig. 1, *ep*); and thirdly, four interradial furrows, which halve the four projecting corner pillars (*ei*). The last-named furrows are the deepest, so that the two halves of each pillar project in the form of semi-cylindrical swellings. The four pedalia, which bear the tentacles, run out below from the pillars. The four perradial sense clubs, alternate regularly with the pedalia, and lie high above the umbrella margin in a special cavity of the exumbrella, the sense niche ("crypta rhopalaris," *eo*). The external heart-shaped entrance to this deeply hollowed crypt is partly covered by the scale of the rhopalium ("squama rhopalaris"), a protective scale of the exumbrella, projecting above the opening like a roof. The exumbrella appears finely granulated, as numerous urticating warts or round groups of thread cells are scattered freely over it. The gelatinous substance of the umbrella shows a considerable degree of firmness, in spite of its being very thin and without any cellular elements. The gelatinous substance varies in thickness in different places, according to the different longitudinal furrows of the exumbrella and the subumbrella, being thinnest along the interradial furrows (in the middle of the corner pillars) and thickest at the two sides of the pillars, and above in the cap-shaped apical cover of the umbrella (figs. 1-3, *ug*).

The subumbrella or nectocalyx is nearly cubical. The four corners of the cube are interradial and formed by the narrow septa of the broad gastral pouches, or by the "fused streaks" by which the subumbrella is connected with the umbrella. The muscular layer of the subumbrella is thus divided into four rectangular muscular plates, which are placed nearly vertically to each other in the interradial "fused streaks"; they correspond to the four lateral surfaces of the cube, and form the axial wall of the four radial pouches (fig. 3, *mw*). The circular fibres of each muscular plate are, however, interrupted in its perradial middle line by a band-shaped, longitudinal muscle, which extends from the ocular niche, upwards to the mesogonia and downwards to the frenulum (fig. 3, *mp*). The broad coronal muscle is therefore actually divided here into eight quadrangular coronal areæ as in *Pericolpa* (System, taf. xxiii.). Whilst, however in *Pericolpa*, these areæ lie in the principal radii (four perradial and four interradial), in *Charybdea* they are placed adradially.

The umbrella margin (figs. 1, 5, 8), in a wider sense, bears four perradial sense clubs and four interradial tentacles. These marginal organs are connected by a remarkable nerve ring of peculiar structure. Below this nerve ring, however, the umbrella margin passes into a broad velarium, a thin marginal membrane resembling the velum of the Craspedotæ, but, however, essentially different. As regards the eight marginal organs they are undeniably derived phylogenetically from the eight principal tentacles of *Tessera* and *Tesserantha* (Pl. XV.); the four sense-clubs from the four perradial principal tentacles, and the four tentacles from the four interradial. In this respect the condition is exactly inverted in the Cubomedusæ, as in the Peromedusæ (specially in the Pericolpidæ). In the Discomedusæ all the eight principal tentacles are transformed into rhopalia.

The velarium or marginal membrane (figs. 2, 5, 8, *va*), represents a membranous, annular distal process of the umbrella margin. It has hitherto been simply termed velum, and placed beside the similarly termed velum of the Craspedotæ. These two formations are, however, only analogous, not homologous; they have originated independently of each other, and their structure though similar is in no way identical, that is, their relation to the nerve ring is essentially different. As in all *Charybdea* belonging to the sub-family of the Tamoyidæ, the velarium is traversed by special canals, and is fastened in a very peculiar fashion to the subumbrella by the four perradial frenula (suspensors or supporting folds, figs. 2, 8, *vf*). These frenula are muscular, vertical, gelatinous folds, formed by a visible, perradial thickening of the gelatinous supporting plate, and stretching from the sense depression to the free margin of the velum. They keep the velarium suspended horizontally, and can raise it still higher by contraction of their longitudinal muscles. The velarium is divided by the four perradial frenula on the one hand and the four interradial pedalia on the other, into eight adradial octants or "velar lobes." These are homologous in position and morphological importance, with the eight free marginal lobes of the *Pericolpa*, and the eight arms of the Lucernaridæ (comp. *Lucernaria*, Pls. XVII., XVII., and also my System, taf. xxii., xxiii.). Hence we see that the velarium of the Cubomedusæ corresponds to a corona of eight fused adradial marginal lobes.

The umbrella cavity (figs. 2–6) is almost cubical, corresponding to the subumbrella. Its four vertical sides are formed by the subumbral walls of the four radial pouches, the upper surface by the subumbral gastral walls; the lower surface is occupied by the umbrella-opening, which is strongly contracted by the projecting velarium. The stomach hangs down in the axial space of the umbrella cavity; its peripheric space is divided above into four small interradial funnel cavities ("infundibula"). These are formed in the upper (proximal) part of the umbrella cavity in such a way that they stretch across the four perradial mesogonia (which we shall describe below) from the four corners of the stomach to the middle of the four radial pouches. The frenula of the velarium correspond to these proximal suspensors in the lower distal part; four corresponding niches are sunk as velar funnels between the frenula. The horizontal diameter of the umbrella disk is consequently smallest in the four centripetal projecting perradial lines, largest in the centrifugal projecting interradial lines (along the cathammal septa); the former correspond to the lateral lines of the quadrate, the latter to the diagonal lines.

The pedalia, or gelatinous sockels (figs. 1–5, *wi*), are four peculiarly-shaped interradial gelatinous appendages of the umbrella margin. They bear the tentacles at the distal end, and are sharply defined from them. Gegenbaur terms the sockels of the *Charybdea* "marginal leaves," Fritz Müller "processes of the corner swellings," and Claus "umbrella lobes." Claus compares them erroneously with the marginal lobes of the other Acraspeda. But these true marginal lobes never lie in the principal radia of the first and second order (perradial and interradial), but always between them. On the other hand, the peculiar pedalia of the Cubomedusæ always lie interradially, and can only be compared to the pedalia in the Peromedusæ, which bear both tentacles and sense clubs (comp. above, p. 65). In our *Charybdea murrayana* (figs. 1–5, *wi*) the pedalia are cuneiform or trilaterally prismatic in the upper third, compressed laterally in the two lower thirds, and shaped like a thin longish oval leaf, nearly a third as long as the height of the umbrella; its axial edge is curved concavely, its abaxial edge convexly, whilst its lateral surfaces appear bent unsymmetrically. The tentacle springs from its truncated distal end; the thicker proximal end is cut out concavely, and inserted at the lower part of the corner, swelling above the umbrella margin in such a manner that a small axial cavity, or pedal funnel ("infundibulum pedale," fig. 3, *it*), remains between the two.

The four tentacles are strong, cylindrical, hollow filaments, 4 mm. thick, thickened like a club at the basis (to 6 mm.), and longer than the height of the umbrella (probably several times as long in the uninjured animal). In the longitudinal and transverse sections, their thick wall shows the same peculiar and complicated structure, fully described by Claus in *Charybdea marsupialis.*

The four perradial sense clubs or marginal bodies ("rhopalia") lie above the umbrella margin, in the ectodermal sense niches ("crypta rhopalaria or ocularia") already mentioned. The structure of these highly-developed organs of sense in *Charybdea murrayana* is the same as in the Mediterranean *Charybdea marsupialis*, where they were first investigated by Gegenbaur in 1836, and recently and minutely by Claus in 1878. They have a very complex structure, and essentially resemble those of the Peromedusæ and Discomedusæ, as they contain both optical and acoustic organs; their finer structure, however, varies in several respects, and in some ways very peculiar. Each sense club is fastened by a thin peduncle into the sense niche of the exumbrella, and is partly covered externally by the protective scale, which projects like a roof over the exodermal aperture of the rhopalar niche. It contains a large otolite sac containing numerous crystalline endodermal otolites in its club-shaped swollen terminal part. The six eyes, two larger unpaired in the perradial middle line, and four smaller paired on the two sides of the unpaired, lie above the otolite sac; each unpaired eye consists of a pigment cup, a thick lens, and a powerful corpus vitreum lying between them; the lens is wanting in the smaller paired eyes. A very large ganglion opticum of a highly developed structure forms the nerve centre of the optical apparatus.

The nervous system has the same high centralisation as in the other Cubomedusæ, and corresponding to their highly developed organs of sense, it shows itself in a more complete and more centralised form, than in the other Acraspeda; in this respect it attains the highest stage of formation among all Acraspeda. The central nervous system, which was discovered in *Tamoya* by Fritz Müller (1859), consists of a complete nerve ring and of eight ganglia, the four larger perradial being placed at the basis of the sense clubs, and the four interradial at the basis of the tentacle pedalia; from the perradial ganglia sense nerves go out to the organs of sense and motor nerves to the longitudinal muscles, while motor nerves go out to the tentacles from the interradial ganglia. The former always lie considerably higher than the latter, so that the nerve ring rises in a vaulted arch from the rhopalar niche to the basis of the pedalia. The whole nerve ring (figs. 2–8, *rc*) therefore forms four depressed arches. Their highest part lies perradially, their lowest part interradially. The nerve ring lies embedded in a groove of the subumbrella, interrupting its muscular plate, and consists of a clear axial cord and two more turbid fibrillar cords (an upper and an under) lying on it with the peculiar nerve epithelium lying above them. Extensive plexuses of fibrillæ with large multipolar and spindle-shaped ganglion cells run out thence and spread chiefly on the subumbrella. The finer structure of the nervous system and the organs of sense have been recently described in detail by Claus in *Charybdea marsupialis* (1879, *loc. cit.*). His endeavour to compare the condition of this structure of the Cubomedusæ with that of the Craspedota, is, however, untenable, as the two have arisen independently of one another, and are, therefore, not homologous. The nerve ring of the Cubomedusæ also corresponds only to the lower (subumbral) nerve ring of the Craspedotæ, whilst the upper (exumbral) ring of the former is entirely wanting. On the other hand, the central nervous system of the Peromedusæ is probably essentially closely allied to that of the Cubomedusæ.

The gastrovascular system (figs. 1–10) resembles that of the Stauromedusæ in the simplicity of its formation (*Tesserantha*, Pl. XV.; *Lucernaria*, Pls. XVI., XVII.). The principal stomach or axial intestine is connected by four horizontal perradial gastral openings with four wide quadrangular radial pouches, which are divided in their entire length by four narrow interradial septal selvages, and communicate by a narrow circular canal at the distal end of the selvages. The axial principal intestine, or the stomach in the wider sense ("gaster principalis"), really consists in most Cubomedusæ of the same three sections as in the Stauromedusæ and Peromedusæ, viz., an aboral basal stomach, a middle central stomach, and an oral buccal stomach; the pyloric opening ("pylorus," *gy*) also forms in this case the boundary between the basal and the central stomach and the palatine opening ("palatum," *gp*), that between the central and the buccal stomach. In *Charybdea*, however, as in many other Charybdeidæ, the pyloric opening is very wide and the pyloric stricture very slightly developed, so that, taken together, the basal and the central stomach seem to form a single, simple, somewhat flat, quadratic chamber.

The buccal stomach or œsophagus ("gaster buccalis," *ga*)—the "oral funnel" of Fritz Müller, "oral peduncle" of Claus—is comparatively small in our species, and forms a flat quadrate pyramid. Its truncated point is formed by the narrow palatine opening (fig. 9, *gp*), its angles by the four perradial strong oral ribs, thickened selvages of the gelatinous plate, which gives consistence to the whole stomach. The oral ends of these buccal ribs project considerably at the quadrate oral opening, and cause the formation of the four lanceolate or oval "oral lobes." A deep perradial groove runs on the axial endodermal surface of these frilled triangular oral lobes; it bends with a sharp turn towards the outside at the palatine opening, and runs, enclosed in the mesogonial fold, on the inner surface of the subumbral wall of the central stomach as far as the middle line of the radial pouch (figs. 4, 6, *gs*). The thickened oral rib itself, which at the same time forms the midrib of the leaf-shaped many-folded oral lobe, runs at the palate immediately into the low mesogonial fold. The folded oral tubes, which were strongly contracted in our spirit specimen and appear thickly frilled at the margins, are probably capable of greater expansion in the living animal.

The central stomach in this *Charybdea*, as in most Charybdeidæ, is joined to the basal stomach, as the pyloric stricture between the two is not developed and only faintly indicated by the slightly projecting pyloric valves. These two divisions of the stomach therefore compose a wide, but very flat pouch, or a low chamber, quadratic in outline. Its bottom or lower wall represents the thin quadrate plate, which at the same time forms the fundus of the cubic umbrella cavity. This muscular plate is pierced in the middle of the palatine opening, from whose four perradial corners the gastral grooves already mentioned (figs. 4, 6, *gs*), run to the middle of the four gastral openings. The horizontal cover of the low gastral chamber or its upper wall is formed by the smooth endodermal surface of the cap-shaped umbrella apex (figs. 2, 3, *gu*). The four interradial corners are occupied by the four pyloric valves, the narrow "bow-shaped fused lines" (Claus), which are placed perpendicularly at the proximal ends of the long septal selvages. On the other hand, the four perradial side walls of the chamber between the selvages are represented by the four gastral openings (fig. 6, *go*), four narrow horizontal clefts, which lead from the stomach into the four radial pouches. We find here a complicated arrangement of valves, by means of which the stomach can be completely shut off for a time from the radial pouches, These four perradial "pouch-valves" alternate with the interradial pyloric valves (*gy*). Above each pyloric valve the stomach forms a peculiar evagination in the form of a low triangular pouch, and the phacelli or dendritic bunches of gastral filaments (*b*) are placed in this pyloric pouch.

The gastral filaments (fig. 7, *f*), are much more strongly developed in *Charybdea murrayana* than in the closely-allied *Charybdea marsupialis;* in each of the four interradial corners of the stomach they form a visible phacellus or bush, composed of ten to twelve larger and several smaller branches. The stems of these branches are connected below at the root, where they rise from the aboral surface of the subumbral pyloric valve, and so actually represent the principal branches of a single, very short, powerful stem, a primary interradial primitive filament. The lower (distal) half of each branch consists of a strong, simple, or bifurcate stem, the upper (proximal) half of a pencil-shaped bunch of numerous branches, which are partly simple, partly dichotomised (figs. 9, 10). The solid axis of the filaments is formed by a thick cylindrical or flat ribbon-like gelatinous filament (a process of the supporting plate of the subumbrella); its endodermal epithelium is mostly composed of gland cells, having many flagellate cells at the base and urticating cells at the point.

The four broad quadrangular radial pouches (figs. 2–6, *bp*), occupy the greater part of the subumbrella, and are only separated from each other by four narrow interradial septal selvages (*ks*). These correspond to the septal nodes of the Tesseridæ and Peromedusæ, and to the septal selvages of the Lucernaridæ; and, like the latter, have arisen by fusion of the umbral and subumbral wall of the primitive stomach of the Scyphostoma, ("cathamma," *k*). The remains of the gastral epithelium are therefore visible in the transverse section of the selvages, in the form of the "endodermal lamella, cathammal plate, or vascular plate" (fig. 10, *kp*), which separates the thicker gelatinous disc of the umbrella (*ug*), from the thinner supporting lamella of the subumbrella (*zw*). We can even distinctly distinguish two layers of cells in the gastral plate, of which the outer belongs to the umbral endoderm, the inner to the subumbral endoderm. A leaf-shaped genitalium, which projects freely into the contiguous radial pouch, is fastened along the entire length of the septal selvages on each side of its subumbral part (fig. 10, *s*).

Four margins and two walls can be distinguished in each radial pouch. Whilst the two lateral margins of the quadrangular pouch are formed by the interradial septal selvages, its lower (or distal) margin is the proximal velar margin and its upper (or proximal) margin is the gastral opening. The latter can be completely closed by the perradial pouch-valve; this is formed by a horizontal fold of the subumbrella, which rises at the upper margin of the pouch and projects as a thickened gelatinous plate freely into the cavity of the basal stomach. The external or abaxial wall of the radial pouches is formed by the smooth endodermal surface of the gelatinous umbrella, its inner or axial wall by the delicate subumbrella. The latter is thin-walled and very extensible, and consists from within to without of the usual four layers:—(1) The endodermal epithelium with high, glandular, cylindrical cells (fig. 10, *dw*); (2) the thin but firm supporting plate or gelatinous lamella (*zw*); (3) the muscular plate (*mw*); and (4) the exodermal epithelium (*qw*). Although pretty firm, the subumbral wall is so thin that it stretches, like a delicate veil, above the pouches, and allows all the organs lying in them to shine clearly through. A narrow band-shaped longitudinal muscle (fig. 3, *mp*) runs in its perradial middle line. This muscle passes above into the "mesogonium," or upper supensory, below into the "frenulum velarii," or lower supensory. The latter divides the distal section of each of the radial pouches into two broad adradial lobe pouches.

The eight lobe pouches or marginal pouches ("bursæ lobares," or "marginales," figs. 2, 3 8, *bm*) are caused by a perradial septum, which, running from each rhopalar niche to the upper velar margin, divides the distal part of each radial pouch into two halves. This septum is merely the abaxial margin of the frenula itself in which the umbral and subumbral walls of the pouch are fused together. Each of the marginal pouches thus formed is rectangular, nearly twice as broad as high. Dendritic, cæcal, velar canals run from their lower or distal margin into the "velarium" (fig. 8, *cv*). These lie entirely in the thickened supporting lamella of the velarium, and are flattened like a ribbon; their endodermal epithelium, like that of the radial pouches, is flat and clear on the umbral side, high and glandular on the subumbral. Their ramification is delicately dendritic and is weaker towards the perradius, stronger towards the interradius. There are forty-eight velar canals on the whole, so that twelve of them come on each quadrant. The largest velar canal lies nearest the interradial pedal and shows 6 to 8 pairs of side branches, partly simple, partly cleft. On the other hand, the number and size of the irregular side branches increases at intervals towards the frenulum (fig. 8). The velar canals lie freely in the gelatinous fulcral lamella of the velarium and are not connected by a cathammal plate; they are therefore secondary formations, which have subsequently grown with the solid supporting plate of the velarium from the distal margin of the lobe pouches.

The four perradial rhopalar canals (or ocular vessels) arise by a funnel-shaped basis from the middle line of the radial pouches above the velar frenula, and pass, narrowed, immediately into the peduncle of the sense club, in whose free head part they end in an ampulla-shaped expansion. The four tentacle canals (or the pedal canals leading into the tentacles) arise at the four interradial angles of the umbrella by a double root, as each tentacle receives a root canal from the distal corner of each quadrangular radial pouch. Each pouch therefore gives out two root canals for two adjacent tentacles. The junction of the two root canals takes place immediately below the distal end of the septum. The tentacle canal proceeding from it traverses the entire length of tentacle, and is comparatively very narrow, owing to the thickness of the tentacle wall. A kind of marginal circular canal is formed by the communication of the radial pouches, which is produced at their distal margin by the root canals.

The genitalia (Pl. XXVI. figs. 2, 6, 10, *s*) form eight broad, thin, semi-oval leaves which are fastened in pairs along the four interradial septal selvages, and project freely from these into the four radial pouches; they occupy the greater part of their hollow space so that the two reproductive leaves of each pouch touch each other or even overlap with their free margins in its middle (fig. 2, *s*). Claus sees in this formation "a very peculiar arrangement" (1879, Zoologie, p. 289). The difference presented between the reproductive glands of the Cubomedusæ, and those of the other Acraspeda, is, in fact, only insignificant; and the former may easily be referred back to the latter. Most Lucernaridæ show the same conditions in the broader anatomical sense, as in these two genitalia come upon each of the four broad radial pouches. These, however, do not belong to the said pouches, but rather to the interradial septum, which separates each two pouches. The two genitalia, which belong to two adjacent pouches and are separated by a septum, form one pair, and in *Halicyathus*, as in *Tesserantha* (Pl. XV.), are connected into a horse-shoe by a convex arch at the proximal end of the septum. In the remaining Lucernaridæ (Pls. XVI., XVII.) this U-shaped connective arch has undergone retrograde formation, so that eight separate adradial reproductive leaves lie beside each other, and this holds good for the Peromedusæ and Cubomedusæ. In all cases, likewise, the reproductive elements are formed from the subumbral endoderm of the radial pouches (fig. 10, *rw*). Then the reproductive leaves are fastened to the septum in such a way that they touch the umbral wall immediately; but as they are completely separated from it by the cathammal plate of the septum (*ks*), they belong genetically to the subumbral wall. Each reproductive leaf is really a thin fold of this subumbral wall, inasmuch as the gelatinous supporting lamella of the latter forms a leaf-shaped process ("sterigma," fig. 10, *zs*), which is covered on both sides by the subumbral endodermal epithelium. The reproductive elements, which fall freely when ripe into the pouch, are developed from the subumbral endodermal epithelium on both sides of the sterigma. They originate from the subepithelial endoderm cells, which cover both surfaces of the fulcral process. The latter corresponds to the sterigma or fulcral frame in the genitalia of the Peromedusæ (p. 83), and formed in both female specimens before me a broad, fibrous, axial plate (fig. 10, *zs*), thickly covered with later and earlier egg cells (*so*). The reproductive leaves are covered on both free surfaces by the connected cylindrical epithelium of the endoderm (fig. 10, *pd*). The ripe reproductive elements pass from the radial pouches into the stomachs through the gastral openings, and are expelled through the mouth.

Order VIII. DISCOMEDUSÆ, Hæckel, 1866.

Acraspeda with eight to sixteen or more sense clubs (always four perradial and four interradial, besides these occasionally several accessory clubs); in each sense club an auditory club with an endodermal otolite sac and often an eye at the same time. Marginal lobes always eight pair of primary (Ephyra lobes) and frequently numerous accessory (velar lobes) besides. Tentacles sometimes present, sometimes wanting. Stomach surrounded by a corona of radial processes (8 to 16 to 32 or more; sometimes broad radial pouches, sometimes narrow radial canals. Genitalia four interradial folded swellings in the subumbral gastral wall, developed from its endoderm (rarely divided into eight adradial swellings); sometimes invaginated in the form of a pouch towards the inside in the central gastral cavity, sometimes evaginated hernia-like towards the outside in the umbrella cavity. Umbrella depressed and discoid. The general fundamental form of all Discomedusæ is the octomeral Ephyra.

First Sub-order of the Discomedusæ, CANNOSTOMÆ, Hæckel, 1879.

Discomedusæ with undivided proboscis or oral tube, a simple, quadrangularly prismatic œsophagus, without oral arms; with simple or quadrangular central oral opening, and with short, solid marginal tentacles.

Family, Ephyridæ, Hæckel, 1877.

Ephyridæ, Hæckel, System der Medusen, 1879, taf. xvii., xviii., p. 450.

Cannostomæ with broad radial pouches, without terminal branched canals. Discomedusæ with simple, quadrangular œsophagus, without oral arms; with simple oral opening, usually sixteen broad radial pouches (eight ocular and eight tentacular), more rarely 32 to 64. Usually eight sense clubs (four perradial and four interradial), more rarely 16 to 32. Alternating with these an equal number of short, solid tentacles. Usually 16 (rarely 32 to 64) marginal lobes, with or without simple lobe pouches, always without branched lobe canals; four interradial or eight adradial genitalia in the subumbral gastral wall.

Sub-family, Nausithoidæ, Hæckel, 1879.

Ephyridæ with eight sense clubs and eight adradial tentacles, with sixteen marginal lobes and eight separate adradial genitalia.

Nauphanta,[1] Hæckel, 1879.

Ephyrid with eight sense clubs and eight tentacles, with sixteen marginal lobes and thirty-two lobe pouches (sixteen ocular and sixteen tentacular). Central stomach opened by four perradial gastral openings into a ring sinus, from whose distal margin run out sixteen coronal pouches; eight separate adradial genitalia, equally distributed, not grouped in pairs.

The genus *Nauphanta* is, as yet, represented only by the remarkable deep-sea Medusa described below. It is most closely allied to the Mediterranean *Nausithoë* among all Medusæ hitherto known, but is distinguished from it by peculiar conditions of structure. The sculpture of the exumbrella with its deeply insected coronal furrow between the central disc and the peripheric corona, and with the very prominent pedalia (polyhedric gelatinous swellings between the radial furrows) reminds us strikingly of the Periphyllidæ and Collaspidæ; in other respects it appears to be a very old intermediate form connecting among Peromedusæ, Cubomedusæ, and Discomedusæ; as it is closely related morphologically to all these groups, it indicates the common descent of the Ephyroniæ and Tesseroniæ. *Nauphanta* takes the highest place among the three genera of the Nausithoidæ, and represents the most highly developed form among the octomeral Ephyridæ. In many respects it approaches the following polymeral Collaspidæ. It agrees with the closely-allied *Zonephyra* and *Pelagia* in having thirty-two lobe pouches, whilst it differs from them both in the formation of the reproductive organs. These comport themselves the same as in *Nausithoë*, and form eight roundish adradial sacs, similar in form and at equal distance from each other. The two specimens before me, a male and a female, are perfectly mature. The ovaries are eight tuberous, scutiform plates, whose endodermal upper surface is covered with very large ova. Instead of these plates the spermaria form numerous digitate spermatic sacs. The developed pedalia of the corona of the exumbrella remind us of the Peromedusæ (*Periphylla*) on the one hand,

[1] Ναυφάντη, the name of a ship in Aristophanes.

and of the Collaspida (*Atolla*) on the other. Like *Atolla, Nauphanta* is a true deep-sea form of high phylogenetic antiquity.

Nauphanta challengeri, Hæckel (Pls. XXVI., XXVII.).

Nauphanta challengeri, Hæckel, 1879, System der Medusen, p. 487, No. 452.

Umbrella cap-shaped, with a horizontal apical surface, and vertical side-wall, one and a half times as broad as high. Exumbrella with a deep coronal furrow and sixteen deep radial furrows. Umbrella corona with sixteen pedalia (eight smaller rhopalar and eight stronger tentacular); sixteen marginal lobes oval, nearly twice as long as broad, with a deeper peronial furrow, about one-fourth as long as the radius of the umbrella. Tentacles cylindrical, pointed, about as long as the radius of the umbrella. Genitalia eight oval, adradial, kidney-shaped swellings, twice as long as broad; their proximal halves somewhat broader than their intervals, their distal halves covered by the coronal muscle. Horizontal diameter, 12 mm.; vertical diameter, 8 mm.

Habitat.—The South Atlantic Ocean, not far from the island of Tristan da Cunha. Lat. 32° 24′ S., long. 13° 5′ W. Depth, 1425 fathoms. Station 335. Both specimens examined (a male and a female) are well preserved, and were taken on 16th March 1876. The transverse and longitudinal sections figured are taken from the two halves of the halved female specimen.

The umbrella (Pl. XXVII. fig. 1; Pl. XXVIII. figs. 12–14) of *Nauphanta challengeri* has the form of a cap or biretta, and is considerably more vaulted than in most other Discomedusæ. Its special conformation, and especially the peculiar sculpture of the exumbrella, reminds us in many respects of the Cubomedusæ and Peromedusæ, with which the oldest ancestral forms of the Discomedusæ are clearly very closely allied. Whilst the upper flattened apical surface appears almost horizontal, the steep, vertical side walls stand almost vertical. The umbrella is constricted between the first or second third of its height by a deep horizontal coronal furrow ("fossa coronalis," *ec*), and is thereby divided into an upper (central) umbrella disc, and a lower (peripheric) umbrella corona. The umbrella disc ("discus umbrellæ"), which is depressed above like a cup in the middle, forms the horizontal cover of the flat discoid basal stomach (*gb*); the umbrella corona ("corona umbrellæ") encloses the corona of the radial pouches, and bears below at the margin the corona of the tentacles, and rhopalia, and the marginal lobes alternating with them.

The exumbrella (figs. 1, 13) is distinguished by the horizontal coronal furrow (*ec*), and also by deep, radial, or longitudinal furrows, which, as in *Periphylla* (Pls. XIX., XX.), divide the external surface of the umbrella into convex, projecting, gelatinous swellings. We can distinguish on the whole sixteen deep, subradial, longitudinal furrows, and sixteen shallower, alternating with them. The latter traverse nearly the whole exumbrella and touch both the umbrella disc and the umbrella corona, whilst the deeper subradial furrows are confined to the umbrella corona. Of the sixteen shallow, longitudinal furrows, four are perradial, four interradial, and eight adradial. They are placed at equal distances in the central umbrella disc, and divide its peripheric, thickened half into sixteen equal, subradial disc-swellings, whilst its thinner central half remains without furrows, and is, at the same time, considerably thinned away (figs. 1, 13, 14). In the peripheric umbrella corona, on the other hand, they are only distinctly impressed in the distal part of the sixteen coronal swellings. The deeper sixteen subradial longitudinal furrows, which traverse the entire corona of the umbrella, lie between the sixteen coronal swellings, and are placed in pairs in such a way that the umbrella corona is divided into eight narrower and eight broader gelatinous sockels or pedalia; the former bear the eight rhopalia, the latter the eight tentacles (figs. 1, 13). Each of the sixteen gelatinous sockels consists of a thicker, undivided proximal part and a thinner distal part, halved by a shallow, radial furrow; the former contains a coronal pouch, the latter a pair of lobe pouches. The eight narrower, principal ocular sockels ("pedalia rhopalaria"), four perradial (*up*), and four interradial (*wi*), are distinguished by their side lines being sinuated concavely, and their narrower proximal part being only half as long as the bifurcate distal part. The eight broader adradial tentacular sockels ("pedalia tentacularia," *ww*), on the contrary, show convexly projecting side lines, and their broader proximal part is nearly twice as long as the deeply inserted distal part (figs. 1, 13). The ends of the bifurcate halves are rounded obtusely in all sixteen pedalia, and sharply defined from the marginal selvage of the marginal lobes ("patagium," *lp*).

The subumbrella (figs. 12, 13) is divided into three sections by the broad coronal muscle (*mc*), by whose two margins they are separated from one another. Its inner or upper intracoronal third reaches from the insertion of the stomach (relatively from the four pyloric valves or interradial septal nodes) as far as the inner or proximal margin of the coronal muscle (*mc*), and contains both the proximal halves of the eight adradial genitalia (*s*), and the narrow longitudinal deltoid muscles alternating with them; of these muscles, as in *Atolla* (Pl. XXIX.), the four interradial (fig. 12, *md*) are much stronger and broader than the four perradial (fig. 12, *md*). The middle or coronal third of the subumbrella is occupied solely by the broad coronal muscle ("musculus coronalis," figs. 12, 14, *mc*). This comports itself precisely as in *Periphylla*, and is divided by the sixteen fused clasps of the marginal lobes (fig. 12, *kl*) into sixteen quadrangular coronal areæ. Of these the eight adradial (tentacular) are considerably broader than the eight principal (rhopalar); the former cover, at the same time, the distal halves of the genitalia on their axial side. The external or lower extracoronal third of the subumbrella extends from the outer or distal margin of the coronal muscle (mc_1) to the actual margin of the umbrella, and is occupied by the corona of lobes. In it we can distinguish sixteen pairs of longitudinal lobe muscles, a pair for each marginal lobe.

From the umbrella being so much vaulted, the umbrella cavity (*w*) is more spacious and higher than in most other Discomedusæ. It is nearly cylindrical in form, as its subumbral side walls rise nearly perpendicular (fig. 14). But as the eight genitalia project like arches towards the inside, it is rather octangularly prismatic. Its upper base is occupied by the subumbral bottom of the stomach (*gw*), its lower bases by the wide opening of the umbrella, surrounded by the corona or marginal lobes. The axial middle space of the proximal half is filled by the pendant œsophagus. The subumbral gastral wall forms four narrow mesenteric folds or mesogonia in a radial direction above, and projects further between them in an interradial direction, so as to form four flat, interradial funnel cavities (fig. 3, *ii*); these are covered over by the four flat pyloric valves (fig. 2, *gi*), which bear the phacellæ (fig. 2, *f*). The special formation of this part is very similar to that of many Cubomedusæ (Charybdeidæ).

In *Nauphanta*, as in Ephyra, the common ancestral form of all Discomedusæ, and in most genera of the family Ephyridæ (all Palephyridæ and Nausithoidea), the umbrella margin (Pl. XXVII. fig. 1; Pl. XXVIII. figs. 12–14) is regularly composed of the following marginal organs:—Eight rhopalia (four perradial and four interradial), eight adradial tentacles alternating with these, and sixteen subradial marginal lobes, inserted between the rhopalia and the tentacles. The number of the sixteen marginal organs, which alternate with the sixteen subradial marginal lobes, is therefore the same here as in *Tesserantha* (Pl. XV.) and *Periphylla* (Pl. XVIII. &c.). Whilst, however, in the Stauromedusa *Tesserantha* all the sixteen marginal organs remain simple tentacles, and in the Peromedusa *Periphylla* the four interradial tentacles are transformed into rhopalia, in our Ephyrida only the eight adradial tentacles appear to be permanent; the eight principal tentacles (four perradial and four interradial) are transformed into the characteristic sense clubs, as in all other Discomedusæ.

The eight sense clubs or rhopalia (figs. 12, 13, *cr*; fig. 20) resemble most strongly those of the most closely allied *Nausithoë*, among all known forms of these organs, though they also agree in many and most important points with those of *Periphylla* (Pl. XVIII.). They are distinguished from those of most other Discomedusæ by their broad, succinct shape. The eight sense clubs lie hidden between each pair of marginal lobes in four perradial and four interradial deep incisions of the umbrella margin, which alternate with the deep tentacular incisions (figs. 12–14). Each rhopalium has, on the whole, the form of a broad tongue-shaped leaf, and is nearly one and a half times as long as broad. In the normal position of the vertical umbrella margin, its free distal end is directed upwards in such a way that the convex abaxial surface looks freely outwards, the concave axial surface freely inwards towards the umbrella cavity. Of the four sense organs which are united in each rhopalium, the olfactory depression lies on the convex external side of the basal part, the eye opposite on its concave internal side, the tactile plate below the eye, and the free auditory club hidden in the spacious auditory niche (fig. 20, *on*). The olfactory depression or olfactory funnel ("infundibulum olfactorium," *oz*) forms a flat conical depression in the convex exumbral side of the thickened basal part; its endodermal epithelium is laid in delicate folds, and consists of rod-shaped sense cells (olfactory cells?). Opposite it, on the concave subumbral side, there is a broad black brown pigmented pad (fig. 20, *op*), in whose centre the unpaired axial eye lies embedded, as in *Nausithoë;* this seems to contain a concave-convex lens in the middle of a darker pigmented knob (*oc*). Below the knob a narrow dark pigmented band runs out, which projects more strongly convexly, bears a variously shaped epithelium with long tactile hairs, and probably represents a tactile plate (*op*). The auditory club (*ok*) rises on a thin stalk outside this plate (on its abaxial side); it hangs freely down in the concave rhopalar niche (*on*), and is surrounded protectively towards the outside by the broad concavo-convex protective scale or auditory scale (*os*); the blunt lower margin of the latter is folded over above towards the inside. The solid auditory club, whose ectodermal epithelium bears long auditory hairs, encloses a spheroidal or subspheroidal otolite (fig. 20, *ol*; fig. 21) in its free swollen distal end. This otolite is crystalline, and transparent and shows many irregular, polygonal, slightly convex facets, as well as a sharply projecting granulation on its upper surface. Several smaller otolites seem added to the larger one at the proximal end.

The eight tentacles (*t*), which alternate with the eight rhopalia, and therefore lie adradially, spring further above in deeper incisions of the umbrella margin. They are nearly as long as the height of the umbrella, cylindrical, pointed like an awl at the distal end, and swollen to a cone at the proximal basis. A short canal (a branch of the eight adradial coronal pouches) runs some way into the basal part of the tentacles which otherwise are solid. Their principal mass forms a soft, elastic, chordal axis, composed of large vesicular endoderm cells. The ectodermal covering consists partly of thread cells, partly of tactile cells, and partly of epithelial muscular cells. The long muscular fibres of the latter run longitudinally and form a strong longitudinal muscle on the axial side of the tentacles.

The sixteen marginal lobes (*lm*) lie subradially, in the middle between the eight adradial tentacles and the eight alternating rhopalia. They are obliquely oval, with unequal sides, as their tentacular margin is nearly twice as long as their rhopalar margin. Each marginal lobe is considerably thickened in its proximal half, by the inverted bifurcate branches of each two adjacent pedalia, whilst its distal half is formed by a very delicate, thin-membraned, almost triangular patagium (*lp*).

The gastrovascular system (Pl. XXVII. figs. 2–10; Pl. XXVIII. figs. 12–15) of *Nauphanta* appears at first sight very simply formed, and not essentially different from that of *Ephyrula*, the known common germinal form of the Discomedusæ. On closer investigation, however, it shows several very remarkable and important conditions of formation not to be found at the present day in the majority of Discomedusæ, and which may be considered extremely old peculiarities inherited from the common ancestral form of the Acraspedæ. In this way *Nauphanta* comes nearer the Tesseroniæ than the other Ephyroniæ, and connects these two sub-sections of the Acraspedæ in a most interesting fashion; above all, it is remarkable in one respect, that the four important interradial septal nodes or cathamma which separate the four broad perradial gastral pouches and which have disappeared entirely in most Discomedusæ, still exist here. The reproductive glands lie in the subumbral wall of the coronal intestine below the septal nodes (much further, therefore, towards the exterior than in most other Discomedusæ) But in the peculiar nature of the central principal intestine, and also in that of the peripheric coronal intestine, we find manifold peculiarities which recall the Tesseroniæ more than the Ephyroniæ, and which must be regarded as very ancient heirlooms from the common ancestral form of the two sections.

The axial principal intestine ("gaster principalis," figs. 2–7) appears at first sight to consist, as in the other Discomedusæ, of two principal sections, of the upper (aboral) central stomach and the lower (oral) buccal stomach; the former is covered by the umbrella disk, and is itself flatly discoid; the latter is more funnel-shaped, and hangs freely down in the umbrella cavity. The buccal stomach is, however, constricted in the middle; this stricture probably corresponds to the palatine opening ("porta palatina," *gp*), in which case we can probably still distinguish here all the three gastral chambers of this section of Medusæ. The boundary between the two principal sections is formed by the horizontal cathammal plane, in which the four septal nodes or cathamma (*kn*) are placed; these may be considered the pyloric opening ("porta pylorica," *gy*). Otherwise the three gastral chambers have an extremely simple formation. If the foregoing supposition be correct, the buccal stomach or œsophagus ("proboscis") is limited to the oral half lying below the palatine opening (*gp*), which has the form of a truncated quadrangular pyramid. The base of the latter is formed by the quadrate oral opening, from whose four corners the four perradial short triangular oral lobes project (figs. 12, 14, *al*). It only extends as far as the proximal margin of the coronal muscle; consequently the œsophagus only occupies the upper half of the umbrella cavity. Above the palatine opening (*gp*), the stomach is again dilated in the form of a flat funnel, corresponding to the true central stomach (*gc*). This funnel opens above immediately into the flat basal stomach (*gb*), and appears only separated from it by the four interradial pyloric valves ("vavulæ pyloricæ," *gi*). These are four flat tongue-like projections, which stand out centripetally from the four septal nodes in the base of the stomach, and bear the gastral filaments at their upper free end (fig. 14, *f*); they completely correspond to the stronger pyloric valves of many Cubomedusæ (p. 98). The ideal horizontal plane, in which they lie, corresponds to the pylorus of the Tesseroniæ, and therefore actually forms the lower boundary surface of the basal stomach, whose upper surface is formed by the horizontal, almost level, endodermal surface of the central gelatinous disc of the umbrella (fig. 14, *ng*).

The four septal nodes ("nodi cathammales," fig. 3, *kn*; fig. 14, *kn*) are four interradial, small but firm nodules, hard as cartilage, in which the subumbral gastral wall is firmly fused with the umbral. Four broad horizontal clefts remain between the nodes, the four perradial gastral openings, by which the central stomach communicates with the peripheric coronal intestine. These important conditions of organisation correspond clearly to those of the Tesseroniæ. The four important interradial cathammal nodes especially, as well as the ring sinus lying beneath them, are homologous with those of the Peromedusæ; whilst on the other hand the condition of the four interradial tongue-shaped pyloric valves shows a special homology with many Cubomedusæ. In most other Discomedusæ (certainly in all *Semostomæ* and *Rhizostomæ*) these Tesseronia-like formations have disappeared, as the septal nodes and the pyloric valves have undergone retrograde formation.

The gastral filaments (Pl. XXVIII. fig. 18) are not very numerous, but comparatively large and thick. They are four arched interradial phacellæ, whose convex margin corresponds to the free margin of the tongue-shaped pyloric valve (*gi*). Each crescentic phacella consists of a single row of from twenty to twenty-four gastral filaments, placed closely near each other. They are cylindrical, and decrease in length from the middle of the phacella towards the two ends, the longest one nearly one-third as long as the radius of the umbrella.

The peripheric coronal intestine ("gaster coronaris") extends from the horizontal cathammal plane of the four septal nodes (which lies a little above the exumbral coronal furrow), to the umbrella margin and consists of the following three coronal or horizontal sections: A, a proximal or upper corona of four perradial gastral pouches; B, a middle corona of sixteen coronal pouches; and C, a distant or lower corona of thirty-two marginal lobe pouches. On closer examination we can even distinguish five different sections of the coronal intestine, as there is also a special coronal sinus (*cs*) between the four perradial principal pouches and the sixteen coronal pouches, and below it an intercalary corona of eight pouches (fig. 4). Compare the transverse section (figs. 2–10) and the longitudinal section (figs. 14, 15).

The four broad radial pouches, or perradial gastral pouches (fig. 4), which belong to all Tesseronia, are undeniably also present here, or are at least represented by the four gastral openings or broad cleft spaces between the four interradial septal nodes (*kn*). We may also include with these the circular hollow space below the septal nodes, between them and the proximal margin of the coronal pouches, unless we prefer to compare this hollow space to a special coronal sinus (*cs*, fig. 14), like that of the Peromedusæ ("sinus coronaris," p. 79, Pl. XXI., *cs*). In fact the conditions here are the same as in all those Tesseroniæ, whose interradial septa or cathammata are merely small short nodes, not long selvages.

The sixteen coronal pouches ("bursæ coronares") which form the middle zone of the coronal intestine, go out from the distal margin of the coronal sinus; they are alternately broader and narrower, and are divided from each other by the sixteen subradial septal selvages, which form the proximal processes of the sixteen subradial lobe clasps (figs. 4–15, *kl*). Their inner or axial wall forms below the sixteen coronal areæ of the coronal muscle, its outer or abaxial wall the sixteen pedalia of the umbrella. Each coronal pouch divides below (at the distal margin of the coronal muscle) into three cæcal terminal branches, of which the two lateral enter the inverted halves of the two adjacent marginal lobes, whilst the middle passes either into a rhopalium or into a tentacle. The eight narrower ocular pouches (*bo*) (four perradial and four interradial) extend to the eight rhopalia, in whose ampullæ their middle terminal branch ends cæcally. The eight broader tentacle pouches (*bt*) are much wider, and contain the distal halves of the genitalia, which are fastened to their subumbral wall; their middle terminal branch passes into the basal part of the tentacles; they project a considerable way into the umbrella cavity (figs. 5, 6). Of the eight ocular pouches, the four perradial are somewhat longer than the four interradial, as they spring from the coronal sinus rather higher up than the latter. This explains how in the transverse section of the umbrella only eight radial pouches appear immediately below the simple coronal sinus (fig. 4). The four narrow, perradial ocular pouches (bo_1) alternate with four very broad wide pouches (br_2) which contain the upper proximal ends of a pair of genitalia; rather further down they divide into three pouches, a middle interradial ocular pouch and two lateral adradial tentacular pouches (fig. 5). This comportment of the coronal pouches is best seen by comparative consideration of the longitudinal section (figs. 14, 15) and the transverse section (figs. 3–8). It is also worthy of remark that the subumbral endoderm of the ocular pouches rises into high papillæ and folds, corresponding to the sterigma of the tentacular pouches (figs. 4–8).

The thirty-two lobe pouches ("bursæ lobares," *bl*) fill in pairs the proximal half of the sixteen marginal lobes, whilst the delicate thin-membraned distal half of the lobes remains free (figs. 12, 14, *bl*). The two pouches of each lobe are separated by the subradial lobe clasp (*kl*) and belong to two different adjacent coronal pouches, an ocular and a tentacular. As the rhopalia lie considerably deeper than the insertions of the tentacles, the sixteen ocular lobe pouches are much shorter than the sixteen tentacular lobe pouches. The distal ends of both lie, however, in the same horizontal plane. The peripheric corona of pouches in *Nauphanta*, therefore, shows essentially the same conditions of formation as in *Pelagia*.

The genitalia (Pl. XXVII. figs. 4–8, *s*; Pl. XXVIII. figs. 12–16, *s*) in both sexes form eight separate bean-shaped glands, lying regularly distributed internally on the subumbral wall of the coronal intestine, above the eight tentacles. More minute investigation, however, shows that they are associated in pairs, as in the Cubomedusæ and Peromedusæ. Consequently, there are really four interradial pairs of genitalia present, which originally stood in immediate relation to the four septal nodes. We see clearly, especially from transverse sections, through the proximal halves of the ovaries, a little above the coronal muscle, that the eight genitalia really form four interradial pairs which have been developed from the four interradial septal nodes. Each pair of genitalia lies in a broad interradial pouch (*br'*), where the four interradial ocular pouches are still united with their two tentacular pouches (fig. 4); and rather further down, the sterigma of the two associated genitalia are curved and rolled inwards in such a way that their convex, lobed upper surfaces are turned towards one another. The two reproductive glands of each pair consequently correspond to arched halves of the four interradial genitalia of *Tesserantha*. The form both of the ovaries and the spermaria in *Nauphanta* is bean-shaped or kidney-shaped, concave on the axial side, convex on the abaxial. They extend above into the coronal sinus, near the septal nodes with the uppermost parts of their truncated proximal half, whilst they almost touch the distal margin of the coronal muscle and the tentacle basis, with the lowermost part of their thinner distal half. The two halves are separated externally from each other by the proximal margin of the coronal muscle (figs. 12, 14, *mc*), which stretches like a veil above the lower half. At a superficial view, it seems as if the genitalia lay in the subumbral wall of the coronal intestine, and from thence form projecting pouches in the umbrella cavity. Comparison of longitudinal and transverse sections shows, however, that for the most part, they lie freely in the hollow space of the tentacular coronal pouches and are only connected with their subumbral wall at a node-like point, which we shall call the genital root (figs. 4–11, 15, st_1). The fulcral frame ("sterigma"), bearing the endodermal germinal epithelium, runs out at this root from the gelatinous supporting lamella of the subumbrella.

The sterigma (*st*) or the fulcral frame of the genitalia runs out from the root as a short, thick cone; it immediately extends in the shape of a thin, strong, arched shield, having many folds, and bearing numerous irregularly-formed hollow papillæ on its convex upper surfaee. This fulcral frame of the genitalium then appears branched dendritically both in the transverse and the longitudinal sections (4–11, fig. 15), it corresponds to the pinnated genital rib of the Peromedusæ ("sterigma," p. 83, Pl. XXIII. fig. 38). The node-like root of the sterigma is crescentic, cut out concavely at the upper or proximal margin. At the same time, it is hollowed out by a cæcal arching outwards of the coronal pouch, in such a way that in the transverse section (fig. 6) it seems to begin with two separate radical branches, which are the two horns of the crescent (*st''*). The shape of the sterigma is, therefore, really very complicated (figs. 2–15). The cartilaginous connective tissue, which forms the fibrous stroma of the sterigma, has numerous cells, especially towards the endodermal upper surface. As the sterigma is only connected with the subumbrella at its thin root, it otherwise projects freely into the hollow space of the coronal intestine, extending into the coronal sinus with the proximal half, and into the eight tentacular coronal pouches with the distal half. The sterigma is covered on its convex outer surface by the usual endoderm of the subumbral wall of the coronal intestine. On the concave inner surface, which encloses a genital sinus with repeated archings-out, this endoderm is transformed into germinal epithelium, which forms reproductive elements.

The germinal epithelium of the endoderm (fig. 16, *ds*), which forms large egg cells in the female, and spermatic follicles nearly twice the size in the male, is found exclusively on the concave inner surface of the shell-shaped, bent-in fulcral shield, as lining of the genital sinus enclosed by the shield. The sinus has a very complicated form, as the scutiform sterigma is turned over concavely, not only at its abaxial (outer), but also at its lateral surfaces, so that it is repeatedly arched outwards. The folded-over, concave, axial half is, moreover, fused for the most part with the convex abaxial half in such a manner that only a narrow passage leads from the hollow space of the coronal intestine into that of the genital sinus. This narrow passage is the "apertura sinus genitalis" (*sa*); it is difficult to find, and appears both in *Nauphanta* and in *Atolla* to lie turned towards the two genitalia belonging to an interradial pair, at the interradial side of the sterigmal root. This aperture was the more difficult to find in the two preserved spirit specimens, as the hollow space of the sinus was almost entirely filled with coagulated slime (?), and the epithelium in great part destroyed. Both the ripe egg cells and the ripe balls of spermatozoa pass from the germinal epithelium into the gelatinous plate of the sterigma, and are enclosed here in thin-walled fulcral capsules. These burst later on, and the ripe reproductive elements probably do the same, then fall directly into the hollow space of the coronal intestine of the genital sinus, through whose aperture they are emptied into the coronal intestine, from thence by the gastral openings into the stomach and then outside through the mouth.

Sub-family, Collaspidæ, Hæckel, 1879.

Ephyridæ, with 16 to 18 sense clubs, and the same number of tentacles, with 32 to 64 marginal lobes, and 8 separate genitalia.

Atolla,[1] Hæckel, 1879.

Ephyrida, with 16 to 32 rudimentary sense clubs, and the same number of tentacles, with 32 to 64 marginal lobes, and 64 to 128 lobe pouches. Central stomach opened by four perradial gastral openings into a coronal sinus, from whose distal

[1] *Atolla* = an island surrounded by coral reefs.

margin run out 16 to 32 broad tentacular coronal pouches, and the same number of alternating rudimentary ocular canals; 8 separate adradial genitalia, grouped in pairs, not distributed at equal distances.

The genus *Atolla*, like the preceding *Nauphanta*, is one of the most remarkable and morphologically interesting deep-sea Medusa brought to light by the Challenger expedition. Both are very ancient remains of an extinct ancestral group of Discomedusæ, which clearly indicate the close connection of this order with the Cubomedusæ and Peromedusæ. *Atolla* has a near relation in *Collapsis*, which is also an Antarctic deep-sea Medusa, and which I have described in my System der Medusen (1879, p. 489, taf. xxviii.). These two compose a special small group of deep-sea Cannostomæ, which I include provisionally as a sub-family of the Ephyridæ, but which it would be as well to separate in future as an independent family of the Collaspidæ. These two genera must be essentially looked upon as Ephyridæ, which are distinguished by their colossal size and peculiar complications in the formation of the umbrella corona, and the coronal intestine. The central umbrella disc, which is separated by a deep coronal furrow from the surrounding umbrella corona, has, on the whole, the same formation as in the Nausithoidæ, especially *Nauphanta*. The wide, but short, quadrangular œsophagus, cruciform in transverse section, is surrounded by eight genitalia, which in *Atolla* (as in *Nausicaa*) are grouped in pairs, whilst in *Collapsis* (as in *Nausithoë* or *Nauphanta*) they are adradially distributed at equal distances. The formation of the peripheric umbrella corona differs entirely, as it is distinguished both by the increased number of the marginal organs, and by special modifications of the structure. Whilst in all other Ephyridæ, Nausithoidæ, as well as Palephyridæ, the number of the sense clubs, tentacles, and pairs of lobes invariably amounts to eight, in the Collaspidæ it rises from sixteen to thirty-two, and seems to vary in the same way as it does in most polynemal Narcomedusæ. These remarkable Discomedusæ are altogether so like the polynemal Narcomedusæ that at first I took them for gigantic forms of the latter. Another peculiarity of the Collaspidæ consists in the extraordinary development of their coronal muscle. This is divided into two different, sharply defined wings, an inner or abaxial, which is delicate and thin like a velum, and an outer or abaxial, which is disproportionately thick and divided into from sixteen to thirty-two areæ. Immediately below it, at the basis of each short tentacle, there are two thick spindle-shaped radical muscles, like those in the Peromedusæ. The Collaspidæ also resemble the Peromedusæ strikingly in the sculpture of the exumbrella, as its coronal part is divided by deep furrows into thick polyhedral gelatinous pieces or pedalia. One half of these pedalia sustain the sense clubs, the other half support the tentacles. The sense clubs and the pouches belonging to them are small and scantily developed in *Collapsis*, and quite rudimentary in *Atolla*. This retrograde formation of the higher organs of sense is probably a consequence of adaptation to life in great depths of the sea. The formation of the coronal intestine is also very interesting and important, since it forms a wide coronal sinus in its proximal part, as in the Peromedusæ. This sinus, as in *Nauphanta*, communicates at its distal margin with the marginal corona of pouches, and at its proximal margin by four perradial gastral openings with the central stomach. This original arrangement has disappeared in most of the other Discomedusæ, as the four interradial septal nodes between the gastral openings have undergone retrograde formation, and the four perradial gastral pouches separated by them are therefore no longer present; both these and the coronal sinus have consequently become merged into the central stomach.

Atolla wyvillii, Hæckel (Pl. XXIX.).

Umbrella, quite flat, discoid, about six times as broad as high. Radius of the central umbrella disk almost twice as large as that of the peripheric corona of the umbrella; disk and corona separated by a very deep coronal furrow. Œsophagus, constricted in the middle, quadrangularly prismatic, two to three times as broad as high. Genitalia, eight elliptical pouches, grouped in pairs, in the periphery of the œsophagus, their perradial distances less than the interradial, 19 to 22 (16 to 32?) rudimentary sense clubs, and the same number of short tentacles (half as long as the radius of the umbrella) alternating with them. Tentacular pedalia broader and shorter than the rhopalar pedalia. Rhopalar canals rudimentary, much narrower and shorter than the tentacular. Marginal lobes elliptical and obtuse. Horizontal diameter of the umbrella, 58–66 mm.; vertical diameter, 10–12 mm.

Habitat.—Antarctic Ocean of the eastern and western hemispheres, in a depth of about 2000 fathoms. The Challenger captured five specimens of this remarkable species, which I was able to examine, preserved in spirits. The state of preservation was unfortunately only imperfect, in spite of the tough nature of the body, the epithelia being almost entirely wanting. All five specimens were mature females. Three of these were taken on 3d March 1874. Lat. 53° 55′ S., long 108° 35′ E. Depth, 1950 fathoms. Station 157, in the Antarctic Ocean nearly in the middle between the Kerguelen Islands and Melbourne. The two other specimens were taken 11th February 1876. Lat. 42° 32′ S., long 56° 27′ W. Depth, 2040 fathoms. Station 318, South Atlantic Ocean, St Mathias Bay, not far from the coast of Patagonia. Bottom temperature, 0·4° C. The three Indian-Antarctic and the two Atlantic-Antarctic correspond completely in structure and show no specific difference. The horizontal umbrella diameter in the first three (from Station 157) amount respectively to 66, 68, and 50 mm.; the diameter of the last two (from Station 318) to 40 and 38 mm. The smallest specimen of the latter (38 mm.) had only 19 tentacles and 19 pairs of lobes; all the four other specimens had 22 tentacles and 22 pairs of lobes. I have named this highly interesting species after Sir Wyville Thomson, the scientific director of the Challenger expedition.

The umbrella (figs. 1–4) of *Atolla wyvillii* forms a circular, thick, perfectly flat disk, nearly six times as broad as high; it is from 60–70 (more exactly 58–66) mm. in diameter, by 10–12 mm. in height. It is very firm in consistency, like cartilage. The exumbrella (fig. 1, fig. 4, right half) is divided by a broad, very deep coronal furrow (*ec*) into a central umbrella disk and a peripheric umbrella corona. The corona surrounds the disk as a wall does a fortress, or an atoll, a circular zone of coral reefs, does the island it encloses, from which it is separated by a ring of lagoons. The central disk ("discus umbralis," *uc*) is flat, smooth, circular, and gelatinous; its radius is nearly twice as great as the breadth of the umbrella corona, and therefore amounts to two-thirds of the whole radius of the umbrella. Its margin is divided by 19 to 22 radial indentations or incisions ("sulci radiales," *es*) into the same number of notches or teeth. These notches of the disk are quadrangular, 5 mm. broad and nearly as long; their height at the external perpendicular fall into the "mural ditch" amounts to 8 mm. The teeth lie in the same radii as the rhopalar pedalia (*uo*); they alternate with the tentacular pedalia (*ut*), which correspond to the radial furrows between the teeth.

The exumbral coronal furrow ("fossa circularis," *ec*) in *Atolla* is so deep, that in its fundus the central umbrella disk is only connected with the peripheric umbrella corona by a very thin gelatinous ring (fig. 4, *ec′*). Its depth amounts to 6-7 mm.; its greatest breadth (in the lower third) to 4 mm. It resembles a circle of lagoons, which separates the central island from the surrounding atoll reef, or the deep ditch which separates the enclosed fortification from its circular wall. But as the teeth of the umbrella disk, project towards the outside with their upper edge over the mural ditch, like overhanging cliffs, the upper, cleft-shaped passage into the coronal furrow appears only 1–2 mm. broad.

The peripheric corona of the umbrella ("corona umbralis") is half as broad as the radius of the central umbrella disk, and is composed of three different zones: an inner zone of tentacular pedalia (*ut*), a middle zone of rhopalar pedalia (*uo*), and an outer zone of marginal lobes (*l*). The inner zone consists of from 19 to 22 gelatinous sockels of the tentacles ("pedalia tentacularia," *ut*). They are thick, almost dice-shaped gelatinous pieces, which lie close together and are only separated by shallow radial furrows. The lateral length of this gelatinous die amounts to nearly 6 mm. Each pedalium forms the basis or socket of a tentacle, which springs from its outer surface. On closer consideration we perceive the following conditions of form:—The upper (aboral) surface (fig. 1, *ut*) is smooth, arched rather convexly and hexagonal; of the six side lines of this hexagon, the inner are contiguous to the coronal furrow, and lies opposite the radial furrow (*es*) between each two adjacent teeth of the central disk (*er*). The two inner lateral lines of the hexagon are contiguous to the corresponding lateral lines of the two adjacent, whilst of the three external lines, the middle touches the tentacle basis, and the two outer lateral lie opposite the two adjacent rhopalar pedalia (*uo*). The lower (oral) surface of the tentacular pedalia has the form of a parallel trapeze, and forms the upper wall of a tentacular pouch. Their inverted lateral surfaces are separated by a radial furrow, which corresponds to the middle line of the disk teeth, and of the rhopalar pedalia. Their axial surface forms the outer, almost perpendicular or only slightly overhanging wall of the coronal furrow, whilst their abaxial surface serves for the insertion of the proximal tentacle bulb.

The gelatinous sockels of the sense clubs ("pedalia rhopalaria") alternate regularly with the gelatinous sockels of the tentacles, and form the second middle zone of the umbrella corona (figs. 1, 4, *uo*). They are nearly as large as the tentacular pedalia, somewhat longer but not so thick, and are inserted with their proximal part between the distal sides of the latter. Their upper aboral surface is almost pentagonal, and depressed (fig. 1, *uo*). Their lateral margins are separated by a broad interspace which is filled by the bulb of the tentacle. Its truncated distal margin bears a pair of thin marginal lobes and the rudiment of a sense club in the incision between the pair.

The marginal lobes ("lobi marginales," fig. 4, *l*) form the third or outer zone of the umbrella corona. They amount in number from 38 to 44, as each marginal lobe is inserted between a tentacle and a rhopalium. Their shape is a longish round, 2–3 mm. broad, 5–6 mm. long. The proximal third of each marginal lobe consists of a thick semi-oval gelatinous part, which is merely the distal bifurcation of a rhopalar pedalium. The middle and distal third of the marginal lobe is formed by a very thin membranous, folded marginal border ("patagium," *lp*). This was invariably torn and badly preserved.

The gelatinous disk (*ug*) of *Atolla* is thick and firm (fig. 4, left half, in vertical meridian sections). It has the consistency of a tolerably firm fibrous cartilage. In the central umbrella disk (*uc*) its thickness amounts to 5 mm., even to 10 mm. at the thickest part at the marginal teeth (*er*); whilst immediately outside these, at the thinnest part of the coronal furrow (*ec'*), it is only ½ mm. The gelatinous substance of the pedalia is from 4–7 mm. thick.

The umbrella margin of *Atolla* includes all the parts lying outside the coronal muscle, and is therefore composed of from nineteen to twenty-two tentacles, the same number of sense clubs alternating with them and twice the number of marginal lobes, inserted between the former and the latter. The rhopalia at the distal margin of the rhopalar pedalia are, however, so small and the two marginal lobes at the distal end of the pedalia, which enclose the rhopalia, are so closely united, that at a superficial glance it looks as if the umbrella margin was merely composed of alternate tentacles and rhopalar pedalia. Closer investigation and comparison with the more completely developed umbrella margin of the closely allied *Collapsis* (System, pl. xxvii.) shows, that the umbrella margin is essentially composed like that of the latter, only that the sense clubs and their pouches have undergone much greater retrograde formation in *Atolla*.

The tentacles (figs. 1–4, *t*) are very weak, hardly half as long as the radius of the umbrella, they are shaped like an awl and finely pointed towards the thin end.

Their basal part is strongly thickened and forms a conical tentacle bulb, which fills the interspace between each two rhopalar pedalia, and is inserted with a broader base at the distal side of the tentacular pedalium. This basal part is also hollow and contains the cæcal end of the thin tentacular canal, whilst the distal part of the tentacles is solid (as in *Nauphanta*). A strong longitudinal muscle runs both on the upper and the lower surface of the tentacle. The upper or external, abaxial tentacle muscle (fig. 4, *mt'*) is the shorter and weaker, only occupies the proximal third of the tentacle, and passes to the outer margin of the upper surface of the tentacular pedalium. The lower or internal axial tentacle muscle (fig. 4, *mt''*) is longer and stronger, runs along the whole length of the tentacle, and passes with two very strong, fusiform radial muscles (*mk*, fig. 3, above, to the right) to the umbral surface of the tentacular coronal pouch (as in *Periphylla*, Pl. XXII.).

The sense clubs ("rhopalia," *or*) in *Atolla* are quite rudimentary and more slightly developed than in any other Discomedusæ hitherto examined, in fact this might be easily overlooked, as their obscure rudiments lie hidden at the distal margin of the rhopalar pedalia, between the basis of the two marginal lobes of a pair. It was only with considerable trouble that I succeeded in determining their existence; they alternate regularly with the tentacles, so that their number also amounts from nineteen to twenty-two. Their anatomic nature could unfortunately not be found out on account of their small size and the bad preservation of the umbrella margin in all five specimens; but as the sense clubs are indubitably in the same position and better developed in the closely allied *Collapsis* (System, pl. xxviii. figs. 3, 4), there can be no doubt as to the significance of the small rudiments in *Atolla*. We have probably to do here, as in many other deep-sea animals, with a phylogenetic retrograde formation of this organ of sense.

The subumbrella (figs. 2, 3, 4) is divided in the same way as the exumbrella, by the deeply incised coronal furrow, into two separate principal areæ, which are only connected by the thin gelatinous ring (*ec*) at the bottom of the coronal furrow. The central area of the subumbrella is therefore the same size as the central disk of the umbrella; it is formed by the gastrogenital membrane, which reaches as far as the distal margin of the coronal sinus, and contains the stomach in its central part and the corona of eight genitalia (*s*) and their alternating deltoid muscles (*md*) in the peripheric part. The deltoid muscles are narrow and slightly developed, especially the four perradial (*md'*) whilst the four interradial appear to be considerably broader (*md''*). All the eight deltoid muscles in *Atolla* are triangular only in the distal half, and rectangular in the proximal half (between the genitalia); the interradial muscles are inserted on the base line of the cathammal areæ (*kt*), the perradial at the distal margin of the gastral openings (*go*).

The coronal area of the subumbrella begins at the distal margin of the genitalia, and is separated from central area by the very thin ring of the gelatinous disk, which forms the bottom of the deep coronal furrow. The coronal area of the subumbrella in *Atolla* consequently corresponds exactly to the umbrella corona of the exumbrella, and is likewise divided into three zones: the inner zone of the internal coronal muscle, the middle zone of the external coronal muscle, and the outer zone of the marginal lobes. The broad, strongly-developed coronal muscle ("musculus coronaris") consists in *Atolla*, as in *Collapsis* (System, taf. xxviii.), of two separate sharply-defined halves. The inner coronal muscle ("musculus coronaris internus," *mc*) is 5 mm. broad, thin and delicate, and extends like a veil over the inner zone of the coronal area of the subumbrella. It leaves the proximal third of this zone free, as it does not extend as far as the coronal furrow; it forms at the same time the proximal third of the coronal pouches, which occupy the greater part of this zone. The outer coronal muscle ("musculus coronaris externus," *mc″*) is only 4 mm. broad but extremely thick; like the outer muscle it consists entirely of circular muscular fibres; these are accumulated in many layers one above the other in such a way that they represent a band-shaped circular muscle, 2 mm. thick. This extremely strong fleshy mass belongs to the most powerful muscular formations hitherto observed in the Medusæ (comp. the transverse section, fig. 4, left, *mc″*, and figs. 7, 8, *mc″*). The 19 to 22 deep radial furrows of the subumbral under surface, which correspond to the tentacles, divide the outer coronal muscle into the same number of sections (figs. 2, 3). Whilst the sharply-defined external coronal muscle forms the middle zone of the coronal area of the subumbrella, its external zone occupies the corona of marginal lobes; at the subumbral side of each lobe we find a weaker longitudinal muscle, which radiates into the thin membranous and folded marginal border, the patagium.

The umbrella cavity in *Atolla* is very small, corresponding with the flatness of the disk. As the wide œsophagus reaches to its opening and fills its axial space, the umbrella cavity actually merely consists of the narrow, circular, hollow space, between the external wall of the œsophagus and the corona of genitalia. Between the four perradial mesenteric folds of the stomach (*wr*) it is depressed in the form of four conical niches projecting inwards, which may be considered interradial funnel cavities, although only of small extent and depth (figs. 1, 3, *ii*).

The gastrovascular system (figs. 3–6) of *Atolla* is closely allied in many and important respects to that of the foregoing *Nauphanta*, but still shows several peculiarities which remind us partly of the Tesseroniæ (Peromedusæ), partly of the Semostomæ. Of the two principal sections, the axial principal intestine is very simply formed, in the shape of a quadrangular, depending œsophagus, whilst the peripheric coronal intestine shows very complicated formations, and extends in the form of a horizontal corona of pouches, communicating with the axial intestine by four perradial gastral openings.

The central principal intestine ("gaster principalis," figs. 3–6, *g*) forms a short, wide quadrangular œsophagus, which hangs freely from the central part of the umbrella disk, and fills the greater part of the umbrella cavity, its oral margin (*am*) reaches to the opening of the latter. Its typical form is a regular quadrangle prism, whose lower surface occupies the simple quadrate oral opening, whilst the upper surface is formed by the endodermal surface of the central gelatinous umbrella. Both these two surfaces and each horizontal transverse section of the œsophagus describe a regular cross, as four perradial cross limbs project centrifugally the whole length, whilst the four interradial oral columns (*ac*) project inwards centripetally. The largest horizontal diameter of the gastral hollow space (in the perradia) amounts, both at the base of the stomach and at the oral opening, to from 22–34 mm., whilst the smallest diameter (in the interradia) amounts to only half as much, 11–12 mm. The entire height or length of the œsophagus is still less, amounting from the base to oral margin, only from 8–10 mm.

The gelatinous fulcral plate (*zw*) is strongly thickened in the upper half of the subumbral gastral wall, and forms several depressed elevations (fig. 5, *gw*) on its inner surface. It is very delicate and thin, however, in the lower oral half. The circular muscular layer of the œsophagus is also only slightly developed. As in *Nauphanta* (Pl. XXVIII. fig. 14), there is a circular constriction in the middle of its length, which divides the œsophagus into two chambers, shaped like truncated pyramids, which are connected by their narrow bases. We may, perhaps, compare this circular stricture, as in *Nauphanta*, with the palatine door of the Tesseroniæ, in which case the lower chamber (which widens below, towards the mouth) must be regarded as the buccal stomach or œsophagus, and the upper chamber (which widens above, towards the bottom of the stomach) as the central stomach fused with the basal stomach. In transverse section, through the circular stricture or palatine opening (fig. 6), the largest (perradial) diameter of its cruciform lumen only measures 15 mm., the smallest (interradial) only 6 mm. Below the circular stricture the thin perradial walls of the buccal stomach project, inflated to the outside, and form buccal pouches (fig. 3, *bb*) which are separated by interradial buccal columns projecting inwards (*wc*), as in *Periphylla* (Pls. XVIII.–XX.), but not so strongly developed. Above the palatine opening, the central stomach arches outwards perradially in the same way, corresponding to the characteristic crossform of the gastral covering.

The covering of the stomach, or that part of the endodermal surface of the central gelatinous umbrella, which forms the upper (aboral) wall of the quadrangularly prismatic œsophagus, shows, when the latter is removed, the distinct crossform shown in fig. 6 and the centre of fig. 3. The four perradial limbs of the regular cross are rounded off, almost circularly, and are separated by the four triangular septa, projecting inwards, which on account of their special importance, we shall immediately describe more minutely as "cathammal plates" (*kt*). In the middle, between the cathammal plates, four broad tangential transverse clefts remain at the distal end of the four cross-limbs; these are the four perradial gastral openings (figs. 3, 6, *go*) through which the central stomach opens into the peripheric coronal intestine.

The septal plates ("tabulæ cathammales," figs. 3, 6, *kt*), are equilaterally triangular plates, in which the umbral and the subumbral wall of the umbrella are firmly fused together, and which subsequently, as interradial septa, separate the four perradial cross pouches of the bottom of the stomach and their peripheric openings, the gastral openings (*go*); they therefore correspond completely to the four small septal nodes of *Nauphanta* or of the Peromedusæ (*kn*), and also to the four long, narrow cathammal ridges of *Lucernaria* and of the Cubomedusæ (comp. above). They are at the same time homologous with the gastral tæniola of *Scyphostoma*, as all such septal or cathammal formations have arisen from fusions of the umbral and subumbral parts of these tæniola. In most Discomedusæ (Semostoma and Rhizostoma) the four primary cathamma have entirely disappeared, and the gastral filaments are consequently placed on the subumbral gastral wall. In *Atolla* the septa are distinguished by their broad flat form; each cathammal plate bears a two-limbed phacellus (as in *Periphema*) and forms an equilateral triangle, whose point is directed centripetally towards the centre of the stomach, whilst the two limbs, concavely bent inwards, are beset with a row of short, closely compacted gastral filaments (figs. 3, 5, *f*). The abaxial (tangential) base of the triangle measures 12 mm., its (interradial) verticle line 6 mm. The limbs of each two adjacent triangles pass externally into one another in a semicircular arch, which is only interrupted in the middle by the perradial gastral opening (*go*). A red-brown arched line, into which numerous radial, rust-red lines covering the surface of the equilateral triangle open, runs towards the exterior, a millimetre apart from, and parallel to, the concave limbs of the triangle (or the line of insertion of the gastral filaments, *f*). These fine rust-red lines are sinuated, tube-shaped glands, which open into the gastral cavity at the rust-red concave line of the limbs, and which we may regard as central liver glands. They have the same formation as the rust-red, peripheric adocular canals, which we shall presently recognise in the rudiments of rhopalar coronal pouches, which have undergone retrograde formation. The narrow hollow space of the simple tubes is lined by a layer of red-brown, irregularly polyhedrical, glandular cells. Masses of yellowish and red-brown pigment granules and fat granules lie round the clear spheroidal nucleus, filling the whole protoplasm.

The gastral filaments (*f*) are placed, compacted in a row, on the two limbs of the triangular septal plates, which may, therefore, be regarded as flattened tæniola. If we suppose these tæniola separated from the umbrella cavity by hollows formed of four interradial conical subumbral funnels, we have the same condition as in *Periphema* (Pl. XXIV. fig. 1). The four centripetal points of the tæniola, from which the four pair of phacelli run out so that the two rows of filaments of each pair diverge simultaneously to the outside and to below, comport themselves in essentially the same way in both species. They are, however, much less strongly developed in *Atolla*; only from fifteen to twenty filaments are placed in a row on each limb of the phacelli, so that their aggregate number only amounts to from 120–160. The filaments are otherwise strong, full of glands, and often tongue-shaped or swollen like a club at their free end, 2–3 mm. long, 10–14 mm. thick.

The gastral openings (figs. 3, 6, *go*) are four horizontal transverse fissures, 4 mm. in breadth, which lie at the distal end of the four cross limbs of the bottom of the stomach and lead from it into the coronal sinus (*cs*). The upper lip, or the upper (umbral) margin ofthe transverse fissure, is somewhat concave and formed by a slightly projecting ridge of the endodermal wall of the gelatinous umbrella. The lower lip, or the lower (subumbral) margin of the gastral opening, on the other hand, is slightly convex, and formed by a thickened crescentic ridge of the subumbrella (at the proximal margin of the coronal sinus (figs. 3, 6, *go*). This lower lip can fall like a valve over the other and so shut off the coronal sinus from the œsophagus; it corresponds to the perradial pouch lobes of the Cubomedusæ. The two lateral oral angles of the gastral openings are bounded by the darkly-pigmented ridges of insertion or roots of the genital fulcra ("sterigmata," *st*, fig. 3).

The peripheric coronal intestine of *Atolla*, which only communicates with the central principal intestine by the four narrow perradial gastral openings, resembles that of *Nausithoë* and *Nauphanta* on the one hand, and that of *Periphylla* and *Periphema* on the other. It is divided into two sections, the proximal coronal sinus and the distal corona of pouches, by a subumbral circular furrow, corresponding exactly to the exumbral coronal furrow (*ec*), and is only separated from it by the thinnest part of the gelatinous umbrella (*ec*). The large coronal sinus ("sinus coronaris," fig. 3, *ec*) corresponds to the narrower sinus of *Nauphanta* (Pl. XXVIII. fig. 14, *cs*) and the broader sinus of *Periphylla* (Pls. XX.–XXII., *cs*). Whilst, however, in both these species it stands vertically (with an upper and lower margin and an inner and outer surface), in *Atolla* it has assumed a horizontal position (with an inner and outer margin and an upper and lower surface), corresponding to the strong depression of the discoid umbrella. It forms here a circular hollow space, 6–7 mm. broad and 1–2 mm. high. The upper or umbral wall of the coronal sinus forms the flat endodermal surface of the corona of teeth of the central gelatinous disk; it also shows externally a fine coronal furrow, from which nnmerous fine radial indentations project centripetally inwards (fig. 3, *zw*). The lower or subumbral wall forms the genital zone of the subumbrella, which is composed of the eight broad adradial genitalia and the eight narrow deltoid muscles alternating with them, four smaller perradial (*md'*) and four broader interradial (*md''*). The inner or axial margin of the coronal sinus is formed by the four perradial gastral openings (through which it communicates with the central stomach) and by the four abaxial base-lines of four interradial septal plates (*kt*) alternating with these. The external or abaxial margin is composed of the tangential transverse fissures by which the pouches of the corona of pouches open into the coronal sinus.

The marginal corona of pouches, the second principal section of the peripheric coronal intestine in *Atolla*, presents at first sight very peculiar conditions of formation, varying considerably from those of all other Cannostomæ. From the distal margin of the coronal sinus (*cs*) nineteen to twenty-two broad, oval, coronal pouches run out, which pass into the tentacles (fig. 3, to the left, below, *bt*). Their distal half is cleft into three narrow branches, of which the middle one (*ct*) enters a tentacle as tentacular canal, whilst the two lateral enter the inverted margins of the two adjacent rhopalar pedalia (*ck*). Between each two coronal pouches, however, a group of three narrow, cæcal, radial canals, which lie on the subumbral side of the rhopalar pedalia, run out from the coronal sinus. The middle one of these cæcal canals is longer and runs as rhopalar canal (*co*) directly to the rudiment of the sense club (*or*), whilst the two lateral, shorter adocular canals (*cx*) already end before reaching the distal margin of the coronal muscle; they are coloured rust-red, and show the properties as the glandular canals of the septal plates already described. If we compare this peculiar condition with that of the closely allied genera *Nauphanta* (Pls. XXVII., XXVIII.) and *Collapsis* (System, taf. xxix.), we see that the last-named group of narrow parallel cæcal canals represent a rhopalar pouch, which has undergone retrograde formation, and is cleft up to its original base into three canals; the middle one of these (*co*) corresponds to a distal rhopalar pouch, whilst the two lateral (*cx*) rudimentary "rhopalar lobe pouches" are transformed into glandular canals. These never enter the true marginal lobes, but are limited to their common basal part, the rhopalar pedalium. The tentacular coronal pouches (*bt*), which vary much less from the usual conditions and send out their two side branches into the marginal lobes, remain separated from the rhopalar pouches by a broad fused lobe clasp (*kl*), which projects centripetally to the distal margin of the coronal sinus. This peculiar modification of the marginal corona of pouches is probably in corelation with the retrograde formation of the sense clubs.

Genitalia (figs. 2–4, *g*). All the five specimens of *Atolla wyvillii* examined were mature females, three of whom had almost completely emptied out their ova. The ovaries (*s*) form eight adradial, broad, flat, elliptical pouches, lying inside the subumbral wall of the coronal sinus, and alternating with its deltoid muscles. They are not, however, regularly distributed as in the closely allied *Collapsis* (System, taf. xxviii. figs. 1, 6). But as the four stronger interradial deltoid muscles (*md''*) are considerably broader than the four weaker perradial (*md'*), the two genitalia originally belonging to one interradial pair lie further from each other, whilst the two reproductive glands almost touching each other, which lie on the two sides of a perradial deltoid mass, belong to two different pairs. The eight ovaries appear to be flattened, elliptical pouches, which lie freely on the outer, ectodermal, subumbral wall of the coronal sinus, and project freely as its pouched-shaped evaginations into the umbrella cavity (fig. 2). Closer examination shows, however, that they are rather enclosed in the hollow space of the coronal sinus, and that they lie on its inner endodermal subumbral wall (fig. 9, *w*); each genitalium is connected continuously with the wall, only at a single, limited spot, which we shall call the root of the genitalia ("sterigma," fig. 3, *st*; fig. 9, *st*, in radial section) as in *Nauphanta*.

Finer anatomy, moreover, shows an extremely complicated structure of the ovarian pouches, instead of the apparently simple conditions. The very thin subumbral wall of the coronal sinus (*cs*) only stretches superficially, like a delicate folded veil, freely over the lower surface of the genitalia (fig. 3, right half). The structure of the ovaries is most nearly allied to that of *Nausithoë* and *Nauphanta*, but is also closely connected with that of the Peromedusæ (*Periphylla* and *Periphema*); it shows, moreover, peculiar complications, which are difficult to understand, and do not occur in other Discomedusæ. We can distinguish two principal component parts in each ovary, the gelatinous fulcral frame or sterigma, and the endodermal germinal epithelium, which covers the sterigma, and produces the ova; the former is a process of the gelatinous supporting plate of the subumbrella of the coronal sinus, the latter is a local production of the endodermal epithelium of the supporting plate.

The "sterigma" (*st*) or the cartilage-like fulcral frame of the ovary gives the latter its characteristic form and corresponds to the "costa genitalis" of the Peromedusæ, to the "sexual axial plate" of the Cubomedusæ, and to the "genital fold" of many Discomedusæ. It consists of a strong scutiform gelatinous plate, hard as cartilage, and shaped like a kidney It is from 10–12 mm. long (in tangential direction), 6–7 mm. broad (in radial direction), and 1–2 mm. thick (in vertical direction). Like the scutiform sterigma of *Nauphanta* (Pls. XXVII., XXVIII. figs. 4–15), the sterigma of *Atolla* hangs freely, for the most part, in the hollow space of the coronal intestine (and here, therefore, of the coronal sinus), and is only connected with its subumbral wall at a single point. This spot, the root of the sterigma (*st*), is a narrow ridge, pigmented brown, from 5–6 mm. long and $\frac{1}{2}$–$\frac{3}{4}$ mm. broad (fig. 3 above to the left, *st*). It nearly fills the interspace between the proximal end of a perradial deltoid muscle and that of an interradial deltoid muscle, and forms part of the distal base-line of a distal cathammal plate (*kt*), whilst the middle third of this base-line serves as the base of insertion of an interradial deltoid muscle (*md''*), and therefore presents a complete homology with the septal nodes of the Peromedusæ, whilst its two lateral thirds are occupied by the sterigma roots of two ovaries which belong together. Like the whole equilaterally-triangular cathammal plate (*kt*), its base consists of a concrescence of the umbral and subumbral wall of the umbrella, immediately below which the cartilage-like gelatinous ridge, which forms the root of the sterigma, rises and then extends scutiformly. In *Atolla* as in *Nauphanta*, this fulcral shield projects, strongly arched into the hollow space of the coronal sinus and turns over at its convex distal margin (where it nearly touches the corona of pouches) in such a way as to originate a nearly closed genital sinus (fig. 9, *ss*). This sinus, therefore, assumes the form of a flat, nearly closed pouch, whilst the inverted ventral fold of the fulcral shield extends axialwards as far as the root of the sterigma with which it is fused in great part. At one single small spot only there remains a narrow opening, which leads from the hollow space of the coronal sinus (*cs*) into the genital sinus (*ss*). This narrow opening, the "apertura sinus genitalis" (fig. 3, left, *sa*) lies at the point where the sterigma root (*st*) touches the proximal margin of insertion of the interradial deltoid muscle (*md″*). The two sinus apertures of the two connected genitalia (of a pair) therefore lie near each other, and are only separated by the insertion of the interradial deltoid muscle (*md″*). The ova are developed from the germinal epithelium in the hollow of the sinus on the concave side of the shield and essentially in the same way as in *Nauphanta* and the other Cannostomæ. The Mediterranean *Nausithoë*, which has never been sufficiently minutely investigated either in this respect or many others, shows no essential difference on this point.

The germinal epithelium of the endoderm, from which the ova in *Atolla* are developed, lies exclusively outside the genital sinus, on the concave inner side of the pouch-shaped folded sterigma, whose convex outer side is only covered by the usual sterile endoderm of the subumbral wall of the coronal sinus. The youngest ova lie inside the genital sinus, on its proximal margin, the oldest ova on the distal margin, both on its dorsal and its ventral wall. We consequently find a double fertile germinal zone, which lies tangentially near the root of the sterigma, and forms a transverse ridge standing perpendicularly on the adradius. The youngest tangential rows of ova, which are followed to the outside distal walls (both on the dorsal and the ventral wall of the fulcral shield) by rows of older ova, lie on both sides of this neutral germinal zone. The oldest and ripest ova lie on the radial margin (radial section, fig. 9, *so*). The younger ova (on the proximal margin) are completely embedded in the gelatinous plate of the sterigma, and therefore lie in closed fulcral capsules, as in *Periphema* (Pl. XXV. fig. 7). This is equally the case in the closely allied *Nausithoë* and *Nauphanta* (Pl. XXVIII. fig. 15). The ripe ova of *Atolla* are very large and spheroidal, they are more than a millimetre in diameter, and contain a visible food-yolk. When completely ripe they fall into the genital sinus (*ss*), from which they are emptied through the narrow aperture (*sa*) into the coronal sinus (*cs*) and thence pass outside through the stomach and mouth. The ovaries both of *Atolla* and of *Nauphanta* were, unfortunately, badly preserved, the epithelium being almost entirely destroyed, so that the finer structure could not be satisfactorily investigated. The peculiar finer structure and development of these very old Cannostomæ appears, however, to present an essential homology with those of the Peromedusæ. In both the former (Ephyridæ and Linergidæ) and the latter (Pericolpidæ and Periphyllidæ) the remarkable and complicated conditions of the genitalia merit more minute investigation of well-preserved material.

Second Sub-order of Discomedusæ, SEMOSTOMÆ, L. Agassiz, 1862.

Flag-mouthed Discomedusæ. Discomedusæ with four large, perradial, folded oral arms, with simple, central oral opening, and with long hollow tentacles.

Family, Cyaneidæ, L. Agassiz, 1862.

Cyaneidæ, Hæckel, System der Medusen, 1879, p. 518, taf. xxx.

Semostomæ with broad radial pouches, and branched, cæcal lobe canals, without coronal canal. Discomedusæ with simple, cruciform, central oral opening, surrounded by four perradial, folded oral arms. Stomach with sixteen or thirty-two broad radial pouches, whose distal margin is cleft into thirty-two or sixty-four branched lobe pouches; the branches of the latter are cæcal, not anastomosed; no coronal canal. Genitalia, four waved bands or frills in the oral gastral wall, usually in the form of wide sacs, hanging freely and without sub-genital cavities. Sixteen to thirty-two or more marginal lobes; eight or sixteen sense clubs (four perradial and four interradial, with sometimes also eight adradial). Tentacles long and hollow, eight or more in number.

Sub-family, Drymonemidæ, Hæckel, 1879.

Cyaneidæ with eight sense clubs (four perradial and four interradial), which lie distant from the umbrella margin in deep niches of the subumbrella; also with numerous tentacles, which are scattered almost over the whole subumbrella, but are wanting in the marginal lobe zone.

Drymonema, Hæckel, 1879.[1]

Cyaneida with 8 sense clubs, lying far from the umbrella margin, in deep niches of the subumbrella. Tentacles very numerous, irregular, scattered almost over the whole surface of the subumbrella and inserted in deep radial furrows, between numerous strongly dendritically branched subumbral radial ribs. Sixteen broad, radial canals; these are very short, their thirty-two lobe pouches, and the dichotomous canal branches of the latter, proportionately more strongly developed.

The genus *Drymonema* is as yet only known from the Mediterranean deep-sea species described below, and is so strikingly distinguished by many peculiarities from the other Cyaneidæ, that it represents a special sub-family of them, the Drymonemidæ. Whilst in all other Cyaneidæ the peripheric tentacle zone remains separated from the peripheric margin of the central stomach by a broad coronal muscle, which is usually laid in many

[1] Δφυμός = a wood; νῆμα = threads.

circular folds, in *Drymonema* both this coronal muscle, and the sixteen broad radial pouches in whose subumbral wall it lies, have undergone such strong retrograde formation that we can only discover faint rudiments of them. On the other hand, the peripheric part of the umbrella corona, with the zone of tentacles and the branched lobe pouches, attains a most extraordinary degree of development. The marginal lobes themselves are fused together, and form a broad marginal border (in some measure a velarium), which is separated from the broad marginal zone, by a deep marginal coronal furrow. The latter occupies nearly the half of the whole subumbrella, and is beset over its whole extent with numerous scattered tentacles. The tentacles are inserted by their basal part in deep radial furrows of the subumbrella, which are separated by its strongly projecting dichotomously branched ribs. The eight sense clubs lie in deep niches of the subumbrella, at the marginal coronal furrow, far from the free umbrella margin. However peculiar these conditions of formation of the subumbrella, and the corresponding modifications of the peripheric vascular system in *Drymonema* may appear, they are really easily derived from the well known conditions of the *Cyanea;* we only require to suppose the eight adradial horseshoe-shaped tentacle areæ, in which the tentacles of the *Cyanea* are inserted in several rows, the one behind the other, so widely extended that the broad coronal muscle at their proximal margin is reduced to a narrow edging. The sixteen broad radial pouches lying below the coronal muscle become likewise rudimentary, and the numerous tentacles are scattered singly on the wide subumbral surface. On the other hand, the broad marginal lobe zone, whose marginal lobes are fused into a connected velarium, remains free from them. The eight rhophalia, which originally lay freely on the umbrella margin between the sixteen Ephyra lobes, are consequently now placed entirely on the lower surface of the umbrella.

Drymonema victoria, Hæckel (Pls. XXX., XXXI.).

Drymonema dalmatina, Hæckel, 1879, System der Medusen, p. 642, No. 606.

Umbrella shallow, discoid, four to five times as broad as high. Marginal umbrella border (velarium) very broad, slightly indented, with eight to ten deep exumbral radial furrows, between which eight to ten double lobes of the gelatinous umbrella appear in each octant (between each two sense clubs). Eight sense clubs in the subumbral velar furrow, in deep niches of the subumbrella, at a distance of nearly one-third of the radius of the umbrella, from the umbrella margin. Four perradial oral arms and four interadial curtain-shaped, delicate-membraned, depending reproductive pouches, the former nearly as long as the radius of the umbrella, the latter half as long. Tentacles very long and very numerous (500–600), scattered all over the subumbrella (inside the velar furrow) and inserted in deep radial furrows between strong, straight, dichotomously branched radial ribs of the subumbrella. Only the marginal velar zone and the central area of the peristom remain free from tentacles. Horizontal diameter of the umbrella, 120–160 mm.; vertical diameter, 30–40 mm.

Habitat.—The Mediterranean. The following description and figure are taken from four large, well-preserved spirit specimens which I owe to the kindness of my friend Gregor Buccich at Lesina, and which he found on the coast of Dalmatia, near the island of Lesina. A small fragment of a Medusa which I found in a bottle of the Challenger collection appeared to be identical with these. This bottle (which also contained the fragment of a *Pectanthes asteroides*, p. 20) was marked Station 4, entrance to the Straits of Gibraltar. Lat. 36° 25′ N., long. 139° 28′ E. Depth, 600 fathoms. 16th January 1873. Further research must prove whether this remarkable Cyaneid (as yet the first and only Cyaneid of the Mediterranean) be really a deep-sea Medusa or not.

The umbrella (Pl. XXX. fig. 1, Pl. XXXI. fig. 8) forms a flat disk 12–16 cm. in diameter and 3–4 cm. in height. The exumbrella is smooth, depressed on the whole, and is divided by a shallow marginal coronal furrow into a thick central umbrella disk and a thin peripheric corona of lobes (velarium). The radius of the former measures 55 mm., that of the latter 25 mm. In the smooth upper surface of the central umbrella disk, which is only slightly vaulted on the whole, we can distinguish sixteen dark radial streaks which are simple in the inner third but cleft into two diverging limbs in the middle third so as to form the same characteristic star figure as in *Chrysaora* (System, taf. xxxi.). The peripheric corona of lobes (or velarium) which is more strongly vaulted outwards, shows sixty-four deeper radial furrows, of which the one half appears as processes of the thirty-two disk streaks, whilst the other half are placed between the streaks. Besides these there are several (usually three) finer furrows visible between every second of these sixty-four deep radial furrows in the exumbrella of the umbrella corona, so that it appears thickly ribbed over its whole outer surface (fig. 8). The gelatinous substance of the umbrella appears thick and firm, almost like cartilage. It is as much as a centimetre in thickness in the central umbrella disk, decreases suddenly at the coronal furrow, so that it is only one to two millimetres thick at the soft and very mobile umbrella margin.

The umbrella margin appears at first sight to be perfectly circular and only slightly indented; closer examination, however, shows that the whole umbrella corona (25 mm. broad) is really composed of eighty long, narrow, marginal lobes, fused together by their edges, whose distal edges project a little at the umbrella margin as slight curves, separated by shallow indentations (as in many Rhizostoma). Sixteen of these eighty fused coronal lobes run out in pairs from the eight rhopalia, and may be regarded as eight pairs of fused ocular lobes; the other sixty-four were originally tentacular lobes, and may also be termed velar lobes, as they have no longer any relation to the tentacles. Eight velar lobes between two ocular lobes, or actually eight velar double lobes, as they appear divided in two by a fine median furrow, therefore fall in each octant of the umbrella. These eighty coronal lobes constitute the very movable and flexible velarium, which extends to the velar coronal furrow, and was retroverted on the inner side of the umbrella in most of the spirit specimens examined. A marginal layer of the circular muscles is developed on its subumbral surface, so that it serves as an admirable swimming organ, as in many Rhizostomæ.

The lower umbrella surface (subumbrella, Pl. XXX. fig. 1) of this Medusa is marked by a very striking peculiarity, which at the first glance distinguishes it not only from all other Cyaneidæ but from all other Medusæ hitherto known. The subumbrella is divided by two deep coronal furrows, an inner peristom furrow and an outer marginal coronal furrow, into three separate zones, viz., an inner peristom area, a middle tentacle zone, and an outer lobe zone. The central peristom area of the subumbrella (fig. 9) contains the oral cross with its four perradial limbs, and the four powerful perradial oral curtains hanging from them, as well as the four interradial genitalia, alternating with the latter. The peristomal coronal furrow, which separates the peristom area from the tentacle zone, cuts deeper into the perradii than into the interradii.

The intermediary tentacle zone of the subumbrella is bounded by the peristomal coronal furrow from the peristom area on its concave proximal margin, and by the subumbral velar furrow, from the peripheric lobe zone at its convex distal margin (fig. 1). Its whole extent is traversed by deep radial furrows, in such a manner that numerous thick radial swellings, branched dichotomously towards the periphery, are placed closely beside each other (quadrant, left, below in fig. 1). Numerous long tentacles are scattered everywhere between these radial ribs or swellings, whilst the peripheric lobe zone of the subumbrella, or the velarium of tentacles, and the central peristom area are entirely free from them. On closer examination we can distinguish on the whole forty such thick radial swellings of the subumbral tentacle zone; a stronger, perfectly straight, unbranched radial rib runs in the eight principal radia, direct to the eight sense clubs, whilst four bunched ribs, or broader, dichotomously branched radial swellings, run between each two such principal ribs from the centre to the peripheric coronal furrow. Of the eight principal ribs (of which two are shown in fig. 1, left below), the four interradial are about one-fourth longer than the four perradial, as the former project further inwards, between the limbs of the oral cross. The four principal ribs are almost linear, rather broader in the middle, quite straight, and unbranched, but divided by a fine traversing principal furrow into two parallel limbs lying close together, so that they really represent double ribs. The four bunched ribs, which occupy the entire space of an octant of the umbrella, between each two principal ribs, form narrow equilateral triangles, whose base line (or the broad distal margin at the velar furrow) is thrice as broad as the truncated point, or the narrower proximal margin, at the peristom furrow. The two medial bunched ribs, on the two sides of the adradial subumbral furrow, are as broad, but rather shorter than the two lateral bunched ribs which lie near the enclosing principal ribs. Each of the thirty-two bunched ribs of the subumbrella is dichotomised nearly three to four times, so that the number of its distal terminal branches (at the subumbral coronal furrow) amounts to from eight to twelve; all the bifurcate branches are extended straight, and only diverge slightly outwards at very sharp angles, so that the terminal branches lie nearly parallel to each other, only separated by narrow radial furrows. The secondary and tertiary furrows between the bifurcate branches are much narrower and shallower than the deep, broad furrows between the separate bunched ribs (comp. the quadrant, left, below in fig. 1).

The tentacles are very numerous (nearly 500–600); they lie scattered over the whole extent of the subumbral tentacle zone and spring from its radial furrows, between its ribs. The tentacles appear, at first sight, scattered very irregularly over the whole extent of the broad tentacle zone; closer examination, however, shows that they are distributed quite regularly. In each octant, there is first an adradial tentacle, usually inserted proximalwards in the middle between every two principal ribs, at the proximal end of the adradial subumbral furrow; this is probably the original tentacle of the *Ephyra*, usually migrated inwards. Next follow two subradial tentacles, lying rather further outwards, in the distal end of the two subradial subumbral furrows, which lie exactly in the middle between the eight adradial and the eight principal furrows of the subumbrella. Outside these three strong, innermost tentacles of each octant of the umbrella, which separate its four bunch ribs, at the distal end, come four more tentacles in the angles of bifurcation of the ribs. The number of tentacles increases towards the outside, corresponding to the repeated bifurcation of the bunched ribs; they always spring at the angle of the bifurcation in the depth of the radial furrow, between each two bifurcate branches. On the whole, fifteen to twenty tentacles may come on each bunched rib, but their number cannot be fixed exactly, as they become smaller, and less distinct towards the peripheric coronal furrow, and at last only appear between the ribs, as unimportant vesicular evaginations of the radial pouches. If we draw concentric circular lines, through the insertions of the tentacles on the subumbrella, an innermost proximal circle will be formed by the eight adradial tentacles, a second circle by the sixteen subradial tentacles; then a third circle of thirty-two tentacles, which are placed in the first bifurcation of the thirty-two bunch ribs, and so on. The distribution becomes irregular towards the outside. The tentacles are quite cylindrical, often swollen like a club at the end, and seem to be of the same nature as in *Cyanea*. Their length and thickness appears very unequal. In the specimens before me, most of the tentacles are short (clearly torn away), the longest are longer than the diameter of the umbrella; the thickness in the thickest tentacles amounts to from 1–2 mm., sometimes to 3–4 mm.; but numerous smaller tentacles, thick as a thread, are placed between them.

The peripheric lobe zone of the subumbrella (or the velarium, which may be also termed "rhopalar zone") is 25 mm. broad, and therefore occupies nearly one-third of the radius of the umbrella. It is divided from the broad tentacle zone by the velar furrow (or the marginal coronal furrow) of the subumbrella, on which the eight sense clubs lie. As the firm gelatinous substance of the umbrella suddenly becomes very much thinned away at the velar furrow, the lobe zone is very flexible; it is more or less bent round, and in most of the specimens before me, turned back towards the tentacle zone of the subumbrella. Its subumbral surface is quite smooth, covered by a layer of circular muscular fibres, bears no tentacles, and is only traversed by very shallow, almost imperceptible, radial furrows, which correspond to the deeper radial furrows between the marginal lobes of the exumbrella. The eight rhopalia or sense clubs (fig. 1, below) lie in the subumbrella, at the proximal margin of the velar zone, immediately outside the velar coronal furrow.

The eight sense clubs (4 perradial and 4 interradial) are remarkable from their completely subumbral position; their distance from the umbrella margin amounts to nearly the half of their distance from the umbrella centre, therefore, to nearly one-third of the whole radius of the umbrella. The sense clubs lie entirely hidden in eight deep subumbral sense niches, at the distal end of the eight principal radial furrows. Each sense niche ("antrum rhopalare," fig. 2, *on*) is broadly lanceolate in shape and is enclosed by a pair of thick, narrow bean-shaped gelatinous swellings, like a pair of fleshy lips; these clearly correspond to the two sense folds of other Discomedusæ, or to the rolled-in medial inner margins, the original ephyra lobes of the umbrella margin; they are here thickened, and have their concave medial margins turned to each other in such a way that both their distal and their proximal ends touch, and the sense club only remains open between them below (fig. 2). Their upper covering (corresponding to the protective scale or protective covering of the other Discomedusæ) is formed by the gelatinous substance of the umbrella. The sense club lies almost in the middle of this deep lanceolate sense niche (rather nearer the proximal margin), and is fastened to the under side of its covering in such a way that its radial longitudinal axis appears directed from the inside and above, towards the outside and below, therefore towards the distal entrance of the niche. The rhopalia themselves are comparatively small, almost acorn-shaped, and were sufficiently well preserved in the spirit specimens before me to admit of closer examination with the aid of fine transverse and longitudinal sections (figs. 2–7). Their form and structure on the whole do not differ essentially from that of *Cyanea*. Each rhopalium consists of a thicker proximal and a thinner distal part; separated by a slight circular constriction; the base of insertion of the proximal part is also strongly constricted (fig. 5, longitudinal section). The sense canal (*co*), which is very much narrowed at this basal stricture, immediately becomes enlarged again and is not limited here to the proximal half (as is usual in the Discomedusæ), but also passes over into the distal half containing the otolite (fig. 6). The acoustic ectodermal epithelium of the sense club is single-layered, and consists of flagellate, cylindrical cells in the basal half, and of thin, flat cells in the distal half. The thin but firm supporting plate lying below the sense club is very much thinned away in the distal half. The endodermal epithelium is single-layered in the wide ampulla-like swollen basal half, but composed in the distal half of from four to five layers of cells, placed one above the other (figs. 6, 7, *ol'*). Each of these cells contains a small crystalline otolite (*ol*). As soon as we dissolve the calcareous otolite in a drop of acid, we see plainly the stratified otolite cells, as well as the cæcal distal end of the sense canals which leads with a double arching outwards as far as the middle of the distal half of the rhopalium containing the otolite (fig. 6, radial longitudinal section; fig. 7, oblique nearly horizontal section).

The gastrovascular system (Pl. XXX. fig. 1) of *Drymonema* is constructed essentially on the same hereditary family type as that of all other Cyaneidæ, but is distinguished individually from the rest in a very striking manner, corresponding to the peculiar transformation of the umbrella corona. The formation of the branched pouches of the peripheric coronal intestine in the latter is in especial very peculiar, whilst the conformation of the central principal intestine and its oral organs do not vary essentially from those of *Cyanea*.

The central principal intestine consists of a flat discoid central stomach, having the oral cross with its appendages in the centre below, whilst its peripheric margin opens into the pouch corona of the coronal intestine. The sharp, peripheric margin of the central stomach shows sixteen projecting corners, corresponding to the sixteen radial pouches opening into it and the sixteen subradial septa or cathammal ridges by which these are separated from each other. The largest diameter of the margin amounts to from one-third to one-fourth that of the whole umbrella. Its upper aboral wall, or the roof of the stomach, is formed by the smooth endodermal surface of the thick firm cartilage-like central gelatinous disk; it is traversed by fine radial furrows, which run out from a central four-lobed coronal furrow and are dichotomised towards the periphery. The lower or oral wall of the discoid central stomach, or the bottom of the stomach, is formed by the thinner but equally firm, cartilage-like peristom disk. The central oral cross (figs. 1, 9), whose four perradial limbs pass into the deep oral grooves on the axial surface of the oral curtains, opens into the middle of the peristom disk. The wall of the cruciform oral opening forms a very firm, thick cartilaginous oral ring, as in *Cyanea*. The latter passes at the four perradial limbs of the oral cross below into the cartilaginous abaxial wall of the arm grooves on the one hand, and outward into the four strong cartilaginous oral pillars on the other. These pillars divide the peristom area into four interradial areæ, which are occupied by the delicate, thin-membraned gastrogenital membrane (*gg*), and from which the four genitalia hang down as four wide, folded cæcal pouches (fig. 9, *s*).

The oral curtains, or arm curtains, comport themselves on the whole the same as in *Cyanea* and *Desmonema* (System, p. 522, taf. xxx. fig. 1–3). They form four powerful, very broad, thin-walled membranes of a roundish triangular outline, whose proximal root proceeds from the four perradial oral pillars. At the root, the thickened, hardened gelatinous lamella of each curtain still forms a very firm, stiff, cartilage-like plate, equilaterally triangular in outline, which represents, in a measure, the peripheric extension of the perradial oral pillar and contains a deep groove on its axial surface, the arm groove or the direct process of a limb of the oral cross. At the distal margin of this triangular cartilaginous plate of the arm root (at the base line of the equilateral triangle) however, the thick cartilaginous mass of the subumbral gelatinous plate suddenly passes into a very thin, delicate, fulcral lamella. This is spread out widely in the form of the powerful arm curtain (*aq*), which lies in numerous longitudinal folds, like a curtain full of folds, and represents an extremely delicate transparent membrane, whose axial surface is covered by endoderm, and the abaxial surface by ectoderm. The two plates of epithelium touch one another at the curled distal margin of the arm curtains. This margin nearly coincides at the flatly extended curtains with the umbrella margin, so that they can also envelop the whole subumbrella from beneath like a veil. The total length of the oral arms is therefore nearly equal to the radius of the umbrella.

The peripheric coronal intestine, which opens with sixteen broad fissures into the peripheric margin of the central stomach in *Drymonema*, is distinguished strikingly from that of other Cyaneidæ by this peculiarity, that the sixteen broad radial pouches of its inner zone are shortened extremely, and appear almost rudimentary, whilst their peripheric ramifications, which correspond to the lobe canals of the other Cyaneidæ with their branch canals, are of extraordinary extent; they here occupy from two-thirds to three-fourths of the whole umbrella, as the radial septa or cathammal ridges advance centripetally between them, nearly to the periphery of the central stomach (comp. fig. 1, quadrant, to the right above).

The sixteen broad radial pouches, which run out from the periphery of the central stomach, are extremely short and hardly recognisable as independent formations, as they immediately become dichotomised. A stright ocular canal (figs. 3, 4, *co*) runs from the eight narrower ocular pouches to the eight sense clubs, whilst a pair of narrow ocular lobe pouches run parallel to the two sides of the canal, and dichotomise towards the periphery (fig. 4, *cl*). The eight adradial tentacular pouches, which alternate with the eight ocular pouches, are much broader, and immediately divided by repeated bifurcations into numerous peripheric branch canals. Whilst these branch canals, or the branched marginal vessels which originally run out from the distal margin of the lobe canals, are usually distinguished in the other Cyaneidæ by their arched course and delicate dendritic side branches, in *Drymonema* they run in a perfectly straight line and almost parallel, close to each other, only diverging radially a little towards the umbrella margin. Corresponding to this straight course of the narrower, rectilinear branch canals, we have the simple ridge form of the rectilinear radial septa or fused ridges by which they are separated. The eighty narrow, long, marginal pouches, which correspond to the lobes of the broad, rhopalar, marginal selvage, are likewise without dendritic side branches. Anastomosed formation between adjacent branch canals never takes place, and there is no trace of a coronal canal (fig. 1, quadrant to the right above).

The genitalia or reproductive glands (Pl. XXXI. figs. 9–11) comport themselves the same as in *Cyanea* and *Desmonema*. They form four long band-shaped frills, which are fastened to the endodermal inner wall of four powerful, many-folded, gastrogenital pouches. The latter are four interradial cæcal sacs of the central stomach, which project as evaginations of the bottom of the stomach between the four perradial oral pillars and hang down as wide, thin-walled sacs, which are nearly half as long as the radius of the umbrella (figs. 1, 8, 9, *gg*). They alternate with the four perradial arm curtains, which are twice the length, and like them, consist of an extremely delicate, thin-walled, transparent membrane. This gastrogenital membrane lies, like the arm curtains, in numerous longitudinal folds, as the peripheric cæcum of the gastrogenital pouches is of far larger extent then its narrow base of insertion. The long, narrow, genital band (fig. 10, *s*) lies at the bottom of the cæcum, fastened to its endodermal inner surface. The genital band is laid together in numerous windings, and folded thickly like a frill. The numerous, short, gastral filaments are spread not far from its proximal margin on the inner surface of the gastrogenital pouch (fig. 11, *f*). Stronger magnifying power shows us that each fold of the frill is composed of a very large number of small follicles (fig. 11, *sb*). The hollow spaces of these follicles, or the genital sinus, open into the gastrogenital pouch. The ripe sexual products fall first into the pouch, from which they pass into the stomach, and are finally emptied out through the mouth. They probably reach the exterior as in *Cyanea*, through the arm furrows in the folds of arm curtains, which shelter the fructified ova for some time, like a protective breeding pouch.

Third Sub-order of the Discomedusæ, RHIZOSTOMÆ, Cuvier, 1799.

Root-mouthed Discomedusæ. Discomedusæ with eight large, adradial, root-shaped, simple or branched oral arms, with numerous mouths of the funnel frills, without central oral opening and without tentacles.

Family, Crambessidæ, Hæckel, 1869.

Crambessidæ, Hæckel, System der Medusen, 1879, p. 614, taf. xxxviii., xxxix.

Rhizostomæ with a single, central, sub-genital porticus, and with both dorsal and ventral funnel frills of the eight oral arms. Discomedusæ without tentacles and without central oral opening; in place of it numerous small funnel openings form funnel frills both on ventral (axial) and on the dorsal (abaxial) sides of the eight oral arms. Eight sense clubs (four perradial and four interradial); eight to sixteen or more narrow radial canals, which are branched and by anastomosis form a vascular network in the subumbrella, usually with a distinct coronal canal. Four interradial genitalia in the aboral wall of a central subgenital porticus, which has arisen from centripetal fusion of four separate gastral, subgenital cavities.

Sub-family, Leptobrachidæ, L. Agassiz, 1862.

Crambessidæ without free upper arms, but with band-shaped, thin, greatly lengthened lower arms, which are naked for the most part, and only bear a tassel-shaped bunch of tuft-like funnel frills at the distal end.

Leonura,[1] Hæckel, 1879.

Crambessid without free upper arms, with band-shaped, very long, thin lower arms, which are naked for the most part, and only bear a bunch of funnel frills towards the distal end, above a naked terminal knob. The suture of the oral cross is eight-rayed, with eight adradial funnel frills, forming a special rosette of tufts round the centre of the arm disk.

The genus *Leonura* (or *Leontura*), along with the closely-allied genus *Leptobrachia*, compose the peculiar small group of the Leptobrachidæ. L. Agassiz erected them (1862) into a special family of the Rhizostomæ, whilst it seemed to me more to the purpose to attach them as a sub-family to the closely-allied family of the Crambessidæ (System, 1879, p. 630). This small group was hitherto known only by a single species, the *Rhizostoma leptopus* (from the Radack islands), of which Chamisso and Eysenhardt gave a tolerably good description in 1821 (Nova Acta Acad. Leop. Carol., tom. x. p. 356, pl. xxvii). In 1879, I myself described the Crambessida *Leonura leptura* from New Zealand as a closely-allied Rhizostom (System, 1879, p. 631). *Leonura terminalis* described below (the only Rhizostom of the Challenger expedition) differs somewhat from *Leonura leptura*. Whilst the structure of the umbrella only varies a little from *Crambessa*, the eight long thin arms are distinguished by the retrograde formation of the fused upper arms, and by the restriction of the funnel frills to the oral disk on the one side, and the distal half of the arms on the other; the proximal half of the arms lying between them, is naked and without frills.

Leonura terminalis, Hæckel (Pl. XXXII.).

Leonura terminalis, Hæckel, 1879, System der Medusen, p. 646, No. 616.

Umbrella depressed, with eighty marginal lobes (eight pointed triangular velar lobes between two small diverging ocular lobes in each octant). Subgenital ostia two to three times as broad as the intermediate pillars. Suture of the oral cross of the arm disk with

[1] Λέων = lion; οὐρά = a tail.

a regular eight-rayed shaggy rosette. Arms moderately long and thin, band-shaped, triangular, nearly as long as the diameter of the umbrella, with a tassel-shaped, three-winged bunch of tufts, enclosing a projecting triangular, terminal knob without frills. Horizontal diameter, 80–90 mm.; vertical diameter, 30–70 mm.

Habitat.—South-east part of the Pacific Ocean, not far from the island of Juan Fernandez. Station 229; lat. 33° 31′ S., long. 74° 43′ W. Depth, 2160 fathoms. 14th December 1875. (Taken at the same time as *Tesserantha connectens*, p. 50.) The specimen was pretty well preserved, but the arms were in great measure torn away.

The umbrella (figs. 1–4) forms a depressed disk, whose central part ("discus") is almost flat, whilst the coronal part ("corona") is sloped gently away. In radial section (fig. 2) we see that, as in all Monodemniæ (*Versuridæ* and *Crambessidæ*), the body consists of two separate principal parts only connected by the four perradial oral pillars, viz., the true umbrella disk (with gastral cavity and umbrella corona) and the underlying arm disk (with its pendant oral arms). The two principal parts are separated by the spacious central subgenital vestibule (*ir*) which opens freely to the exterior by four broad interradial subgenital apertures (figs. 1, 7, *ig*). The gelatinous substance of the umbrella resembles a soft cartilage in consistency, and is of tolerably equal thickness throughout (nearly 10 mm.), whilst it suddenly becomes thinned away towards the margin, and is only slightly developed on the lobes. The gelatinous substance of the arm disk is nearly as thick as that of the umbrella disk.

The exumbrella (figs. 1, 3) is distinguished by a delicate and tolerably regular tabulation, caused by the divisions by the net-shaped connected furrows, of the whole outer upper surfaces of the umbrella into polygonal areæ, projecting somewhat convexly, corresponding to the "pedalia" of *Nauphanta*, *Atolla*, and other Discomedusæ. The size of these exumbral areæ increases from the centre towards the periphery; the diameter of the inner areæ amounts to from 4–5 mm., that of the outer areæ from 6–8 mm.; the former are roundish, the latter extended polygonally, quadrangular, hexagonal, or octagonal. An octagonal central area (in the middle of the apex of the umbrella) is first surrounded by a corona of eight adradial areæ; next to these come a second corona of sixteen subradial areæ; the largest and most distinct areæ are thirty-two hexagonal, forming a circle, whose distal peripheric corresponds to the coronal canal on the subumbrella (fig. 3). The exumbral areæ become less distinct towards the lobe corona, the radial furrows between them pass into the incisions between the marginal lobes.

Eight sense clubs (four perradial and four interradial) are placed on the umbrella margin (figs. 3, 4), as in all Crambessidæ, and particularly in most Rhizostomæ. Each rhopalium is here enclosed by the two small pointed lanceolate, ocular lobes (or rhopalar lobes) which diverge outwards. The octants of the umbrella margin, which compose the lobed velarium, project in the form of shallow arches, between the eight receding rhopalar incisions of the umbrella margin. Between each two rhopalia there are eight triangular, pointed velar lobes, or more accurately four pairs; for the eight adradial and the sixteen subradial incissions of the umbrella margin, as well as the eight principal incisions in which the sense clubs lie, are deeper and stronger than the thirty-two shallower velar incisions inserted between the former and the latter. Moreover, as the adradial middle of the eight velar arches of the umbrella margin projects more strongly than its receding side parts, the sixteen pairs of velar lobes lying on both sides of the eight adradial canals appear larger than the sixteen pairs of weaker velar lobes lying on both sides of the eight principal canals (or of the eight rhopalia). If we add the sixteen smaller ocular lobes to this sixty-four velar lobes, the aggregate number of the marginal lobes amounts to eighty, as in many other Rhizostomæ.

The eight sense clubs show essentially the same conditions of situation, shape, size, and structure which Grenacher and Noll (1876) described minutely in *Crambessa tagi* (comp. also my System, pp. 458, 615, and Hertwig, Die Sinnesorgane der Medusen, 1878). They are acorn-shaped, and divided by a circular constriction into a club-shaped basal part and an oval distal part, the former contains the cæcal distal end of the ocular canal, the latter contains the otolite sac filled with numerous crystals. The sense clubs lie hidden in a subumbral rhopalar niche of the subumbrella, which is roofed over by a broad protective scale and enclosed laterally by the projecting sense folds ("plicæ rhopalares," *of*); these are the medial margins of the diverging ocular lobes or sense lobes which project like arches and overlap one another like a valve at their base. Above, on these subumbral surface, the roof-like projecting protective scale or protective plate is hollowed out by a cæcal funnel-shaped depression or olfactory funnel ("infundibulum olfactorium," *oz*), which is traversed by dendritically-branched folds ("olfactory folds"). Tentacles are entirely wanting in *Leonura* as in all other Rhizostoma.

The inner side of the umbrella (subumbrella, figs. 2, 4–7) and the umbrella cavity enclosed by it, show the same peculiar and remarkable conditions of structure in *Leonura*, which recur in all Rhizostomæ Monodemniæ (*Versuridæ* and *Crambessidæ*), and which were first described by Huxley (1849) in *Crambessa mosaica*, and later (1876) in detail by Grenacher and Noll in *Crambessa tagi* (comp. my System, pp. 472, 615, taf. xxxviii.–xl.). The subumbral umbrella cavity is divided into a peripheric umbrella coronal cavity and a central subgenital vestibule, which communicate only by the four broad interradial subgenital apertures (figs. 1, 7, *ig*). The latter are separated by the four strong oral pillars (figs. 2, 7, *ap*), the only connection between the umbrella disk and the arm disk. The coronal cavity of the umbrella forms a tolerably flat, broad coronal furrow of small extent. Its axial inner wall is formed by the external surface of the oral pillars (*ap*); its abaxial outer wall by the subumbral inner surface of the velarium or of the lobed umbrella corona.

The central subgenital vestibule ("porticus subgenitalis," fig. 2, *ir*) forms a spacious, though low chamber, whose base form is a quadrate prism. The upper wall or the roof of the vestibule is formed by the cruciform gastrogenital membrane and by the four interradial genital plates (fig. 4, *wi*) which fill the interspace between its perradial limbs. Looked at from above, the gastrogenital cross shines through the umbrella disk as in many other Rhizostomæ. The delicate gastrogenital membrane (figs. 2, 4, *gg*) formed by the cross, separates the vestibule from the underlying central stomach, of which it at the same time represents the bottom or lower wall. It consists of a very thin, flexible, and extensible fulcral plate, covered with gastral endoderm above and by subumbral ectoderm below; in the middle only it is strengthened by the gelatinous ridge cross (fig. 4, *gh*), whose four perradial limbs separate the four horseshoe-shaped genitalia from each other and pass at their distal end into the axial wall of the four oral pillars. The interradial interspaces between the four perradial limbs of the gastrogenital cross are filled by the four thick cartilage-like intergenital plates (fig. 4, *wi*); these are strong, equilaterally triangular thickenings of the gelatinous umbrella, having the interradial canals (*ci*) running in their middle line and the delicate gastrogenital membrane inserted at their lateral margins.

The four oral pillars (also termed arm pillars or floor pillars, "pilastri," figs. 2, 4, 7, *ap*) form the only connection between the upper and the lower wall of the subgenital vestibule, and are separated from each other by the four wide subgenital apertures. The oral pillars are four strong perradial gelatinous plates shaped like a parallel trapezum (fig. 7, *ap*). They spring with a narrower base, 10 mm. broad, from the distal end of the limb of the gastrogenital cross from above and outside to below, and inside expanding to a breadth of 15 mm. towards the arm disk which is formed by their confluence. The thickness of the arm pillars amounts to from 5–7 mm., their length to 15 mm. Their inner axial surface is curved concavely, their outer abaxial surface curved convexly, the former is turned towards the porticus, the latter towards the cavity of the umbrella corona. The broad perradial pillar canal (figs. 2, 4, 6, *cd*), the distal process of the limb of the gastral cross, runs in the solid gelatinous mass of the pillars, near their axial surface.

The four subgenital apertures (figs. 1, 7, *ig*) represent, in some measure, the four broad low doors, through which we reach from the outside (from the cavity of the umbrella cavity outwards) in the central vestibule. They are rectangular in form (with obtuse angles), are separated from each other laterally by the four perradial arm pillars, and therefore lie interradially. They are limited above by the distal basal part of the triangular intergenital plates, below by the lateral margin of the arm disk. The breadth, or the largest horizontal diameter of the subgenital aperture in its middle amounts to 25 mm., and is nearly three times as much as the smallest breadth of the pillars separating it.

The arm disk or oral disk ("stomodiscus, discus brachiferous," figs. 2, 6, 7, *ah*) represents the bottom of the floor or the lower wall of the subgenital vestibule. It is only connected with the overlying umbrella disk by the four arm pillars, and forms a thick gelatinous disk of the base form of a quadrate prism, nearly half as thick as broad, (40 mm. side length, by 16–18 mm. thick). If we transect two adjacent arm pillars at their base and then turn back the half-loosened arm disk, its upper or aboral surface which is turned towards the vestibule then becomes visible. It is quadratic and nearly flat, only arched somewhat convexly towards the middle, whilst it slopes away very gently outwards towards the lateral margins. The four perradial obtuse angles of the quadrate pass into the distal ends of the oral pillars; and the distal ends of the eight limbs of the genitalia (fig. 6, *sx*) (which rise in pairs on the axial wall of the pillar canals, *cd*) pass diverging, a little way on the oral surface of the arm disk. The lateral margins of the pillars are slightly indented in the middle, and form at once both the lower margins of the subgenital aperture (*ig*) and the distal margin of the four equilaterally triangular, slightly convex subgenital valves (fig. 6, *wv*); the latter are fused in some measure at their lateral margins with the oral processes of the pillars, and so form the arm disk.

The lower or oral surface of the oral disk is occupied by the frilled oral area ("area orealis"); the suture of the oral cross and the eight-rayed rosette of tufts covering it lies in the centre, whilst the eight arms run out round about it (fig. 7). The central rosette of tufts is actually formed by four pairs of tufted frills, which correspond to the four bifurcate branches of the four limbs of the oral suture, but the eight oral arms which go out in pairs from the bifurcation of the distal end of the four oral pillars divide at its bifurcated base so soon that they lie in the eight adradii almost from the first, and the rosette of tufts also assumes a nearly regularly eight-rayed form, as on the oral axial surface. The branched compacted bunch of tufts composing the rosette have the same structure as the funnel frills at the distal part of the arms. If we cut off the tufts, we see the regular suture of the oral cross ("sutura staurostomalis," fig. 1, *as*); as in all Rhizostoma, it has arisen from the fusion of the frilled margins of the cruciform oral opening, which is open at an early stage.

The eight oral arms in our *Leonura* show, on the whole, the same peculiar formation which was previously only known in *Leptobrachia leptopus* (=*Rhizostoma leptopus*, Chamisso, *loc. cit.*, pl. xxvii.). They appear as eight adradial, slender, band-shaped appendages of the arm disk, whose length nearly equals the diameter of the umbrella or only surpasses it a little. As in all Rhizostomæ multicrispæ (*Pilemidæ* and *Crambessidæ*), there are really two distinct principal parts on each arm, viz., the single-frilled upper arm and the three-frilled lower arm (System, p. 582). In the Leptobrachidæ, however, the short upper arm ("epibrachium") is quite rudimentary, and passed by concrescence into the formation of the thick oral disk. The whole free part of the arm is therefore formed here by the lower arm ("hypobrachium"). The proximal (upper) half of each lower arm is naked, and without frills, and consists of a thin, triangularly prismatic gelatinous band, whose three angles run out into three narrow wings, each of which show a canal in transverse section (fig. 3). The distal (lower) half of the lower arm consists of a frilled, tassel-shaped bunch of tufts, with a projecting, pointed, triangularly pyramidal terminal appendage or gelatinous knob at its end. The bunch of tufts is composed of three strongly frilled, many folded leaves, forming the distal process and expansion of the three angles of the arm. One of these three arm frills lies axially on the inner side of the arm, and appears as the distal part of the originally simple ventral frill, whose proximal part is an arm of the eight-rayed tuft rosette of the oral area; these two are separated from one another by the broad interspace of the naked upper half of the arm. The other two arm frills lie in pairs on the outer side of the arm, and so correspond to the dorsal frills of the Rhizostomæ multicrispæ (*Pilemidæ* and *Crambessidæ*, comp. my System, pp. 464, 581). Of the three narrow wings of the triangularly pyramidal terminal knobs, one also lies axially, and the other two abaxially; they are the terminal processes of the three frills, but they have lost their funnel frills, and look as if they had been ground down. The numerous and irregular oral openings on and between the folds of the frills are sometimes cleft-shaped, sometimes funnel-shaped; the margins of these funnel frills, which were formerly called sucking-mouths, are thickly beset with numerous microscopic small oral tentacles or digitella. Here in *Leonura*, as in all other Rhizostoma, there are "prolonged urticating papillæ of the ectoderm," solid cylindrical processes of the gelatinous substance of the arm, whose ectodermal epithelium partly forms thread cells, partly epithelial muscular cells (comp. Otto Hamann, Die Mundarme der Rhizostomen und ihre Anhangs-Organe; Jena. Zeitschr. für Naturw., Bd. xv. 1881).

The gastrovascular system (figs. 2, 4–8) of *Leonura* is almost completely homologous with that of the closely-allied *Leptobrachia*, and also in many respects with that of *Crambessa*, of which Grenacher and Noll (1876) have given a description which is very accurate and true to nature (comp. my System, 1879, p. 616, taf. xxxviii.–xl.). As in all Acraspedæ, we can distinguish the central principal intestine from the peripheric coronal intestine. The central principal intestine consists of the large cruciform central stomach and of the smaller buccal stomach connected with it by the four pillar canals and the vascular system of the arms, which runs out from the latter. The central stomach (figs. 2, 4, *gc*) has the cruciform shape and extent of the gastrogenital membrane already described (*gg*), which forms its lower wall; the upper wall is formed by the smooth endodermal surface of the central gelatinous umbrella disk. The sixteen radial canals composing the peripheric coronal intestine run towards the outside on the peripheric margin of the central stomach (*gm*), where its upper and wider walls touch, whilst, at the same time, the four perradial pillar canals ("canales pilastrales," *cd*) pass downwards. The latter spring from the distal ends of the four cross limbs of the central stomach, immediately below the starting point of the four perradial subumbral canals, run from above and outside, below and inside on the axial inner side of the four arm pillars, and these open into the buccal stomach (*ga*). We shall apply this name to the small cruciform hollow space found in the middle of the arm disk, and from which the eight arm canals run out downwards (*ch*). These lie adradially, but in pairs, above the eight limbs of the tufted rosette, and must be regarded as distal bifurcate branches of the four perradial pillar canals. Each arm canal immediately divides into three narrow canals, which run parallel to the ends of the three corners of the arm; one of them lies ventrally or axially, the two others dorsally or abaxially. Hence it comes that the whole free, triangular part of the arm must be regarded as the under arm; only the short basal part of the arm, containing a simple canal, which is fused with the arm disk, corresponds to the upper arm of the Rhizostomæ multicrispæ. Numerous branches run from the axial or ventral canals of the arms up to the tufts of the oral rosette (ab') and down to the ventral funnel frill of the distal bunch of tufts (ab^3). The two axial or dorsal canals are only branched below, and this branch runs on the two dorsal funnel frills of the bunch of tufts. The distal ends of the three arm canals run in the three wings of the triangular terminal knobs so far as the point where they seem to open by a common terminal aperture.

The peripheric coronal intestine shows essentially the same conditions which I first described in *Crambessa tagi* (1869). Sixteen strong radial canals pass out from the periphery of the cruciform central stomach, run in the subumbrella to the umbrella margin, ramify thickly, and form a delicate, vascular network. Of the sixteen canals, the shortest are the four perradial, which spring from the distal end of the four limbs of the gastral cross (immediately above the four pillar canals), and which widen like an ampulla at their proximal base (fig. 4, *cp*). The four interradial canals are the longest; they spring from the corner between every two limbs of the gastral cross, and are beset with cæcal diverticula (fig. 4, *ci*). The eight adradial canals are shorter than the latter and stronger than the former; they spring from the two corners of the distal end of the limb and diverge in the form of an arch towards the umbrella margin. All the sixteen canals are connected by a strong coronal canal (fig. 4, *cc*). This lies in the subumbral coronal furrow, which separates the central umbrella disk from the velarium. The peripheric vascular network is divided by the coronal canal into two different sections, of which the narrower lies inside the coronal canal, and the broader outside. The intracircular vascular network is only 4–6 mm. broad, fills the space between coronal canal and the distal ends of the limbs of the cross in the form of a narrow zone, and consists of from three to four rows of loose meshes, irregularly polygonal in shape. The extracircular vascular network is three times as broad (12–16 mm.), consists of an extremely fine thin mesh work (whose finest meshes are hardly visible to the naked eye), and fills the whole subumbral side of the velarium, from the coronal canal, as far as the thin margin of the marginal lobes (fig. 4).

The genitalia (Pl. XXXII. figs. 1–6, *s*) in *Leonura* show, on the whole, the same conditions of form and structure which Grenacher and Noll (1876) described minutely in

Crambessa (*loc. cit.*). They form four narrow bands, folded thickly like a frill, and shaped like a horse-shoe, whose convex proximal arch projects centripetally in the interradius (fig. 4, *s*). The four reproductive bands lie in the delicate gastrogenital membrane, on the inner surface of the central bottom of the stomach, and are separated by a narrow interspace from the outer edge of the stomach (*gn*) on the one side, and from the four limbs of the gelatinous gastral cross (*gh*) on the other. When viewed from above (fig. 3), or from below (fig. 4), it almost looks as if the distal ends of the inverted limbs of each two adjacent arches of the horse-shoe, passed into one another at the distal end of the limbs of the gastral cross, and so formed a connected genital ring. Closer investigation, however, shows that the four interradial genitalia remain completely separated, although the ends of their limbs nearly touch on the axial surface of the perradial oral pillar. The last ends of the genital limbs are here bent down, diverging again laterally; they already lie in the four corners of the arm disk (fig. 6, *sx*). The specimen of *Leonura* examined was a male. The testes are laid in cross folds like a frill, in such a way that the whole genital band seems to consist of a large number of small fusiform sacs. These sacs (the tranverse folds of the horseshoe-shaped band of testes) lie thickly compacted, with their longitudinal axis perpendicular to that of the band; the sacs were slightly filled with ripe spermatozoa. The conditions of the finer structure in the genitalia, as in most other organs, resembled those of *Crambessa*.

Survey of the Families of the System represented among the Deep-sea Medusæ of the Challenger Expedition.

Orders of the Medusæ.	Families of the System not Represented.	Families of the System Represented.	Species Described.
Order I. ANTHOMEDUSÆ (one species).	Codonidæ. Tiaridæ. Cladonemidæ.	Margelidæ (Pl. I.)	*Thamnostylus dinema*, p. 2.
Order II. LEPTOMEDUSÆ (one species).	Thaumantidæ. Eucopidæ. Æquoridæ.	Cannotidæ (Pl. II.)	*Ptychogena pinnulata*, p. 7.
Order III. TRACHOMEDUSÆ (three species).	Petasidæ. Aglauridæ. Geryonidæ.	Trachynemidæ (Pls. III.–VIII.)	*Pectyllis arctica*, p. 11. *Pectis antarctica*, p. 15. *Pectanthis asteroides*, p. 20.
Order IV. NARCOMEDUSÆ (four species).	Solmaridæ.	Cunanthidæ (Pl. IX.) Peganthidæ (Pls. X.–XII.) Æginidæ (Pls. XIII., XIV.)	*Cunarcha æginoides*, p. 24. *Polycopla forskalii*, p. 31. *Pegantha pantheon*, p. 37. *Æginura myosura*, p. 41.
Order V. STAUROMEDUSÆ (two species).	...	Tesseridæ (Pl. XV.) Lucernaridæ (Pls. XVI., XVII.)	*Tesserantha connectens*, p. 50. *Lucernaria bathyphylla*, p. 54.
Order VI. PEROMEDUSÆ (two species).	Pericolpidæ.	Periphyllidæ, (Pls. XVIII.–XXV.)	*Periphylla mirabilis*, p. 64. *Periphema regina*, p. 85.
Order VII. CUBOMEDUSÆ (one species).	Chirodropidæ.	Charybdeidæ (Pl. XXVI.)	*Charybdea murrayana*, p. 93.
Order VIII. DISCOMEDUSÆ (four species).	Linergidæ. Pelagidæ. Flosculidæ. Ulmaridæ. Toreumidæ. Pilemidæ. Versuridæ.	Ephyridæ (Pls. XXVII.–XXIX.) Cyaneidæ (Pls. XXX., XXXI.) Crambessidæ (Pl. XXXII.)	*Nauphanta challengeri*, p. 103. *Atolla wyvillii*, p. 113. *Drymonema victoria*, p. 125. *Leonura terminalis*, p. 133.

Survey of the Eighteen Deep-sea Medusæ previously described, giving their Habitat and Position in the System der Medusen.

Genus and Species. Ocean.	Station.	Depth in Fathoms.	Habitat.	
			Latitude.	Longitude.
1. *Thamnostylus dinema* (Pl. I.). Antarctic. Indian . . . . . . Order, Anthomedusæ; Family, Margelidæ; Sub-family, Thamnostomidæ.	153	120	65° 42′ S.	70° 49′ E.
2. *Ptychogena pinnulata* (Pl. II.). North Atlantic . . . . . . Order, Leptomedusæ; Family, Cannotidæ; Sub-family, Polyorchidæ.	50	1250	42 8 N.	63 39 W.
3. *Pectyllis arctica* (Pls. III., IV.). North Atlantic . . . . . . Order, Trachomedusæ; Family, Trachynemidæ; Sub-family, Pectyllidæ.	50	1250	42 8 N.	63 39 W.
4. *Pectis antarctica* (Pls. V., VI.). Antarctic. Indian . . . . . Order, Trachomedusæ; Family, Trachynemidæ; Sub-family, Pectyllidæ.	152	1260	60 52 S.	80 20 E.
5. *Pectanthis asteroides* (Pls. VII., VIII.). Atlantic, Mediterranean . . Order, Trachomedusæ; Family, Trachynemidæ; Sub-family, Pectyllidæ.	(?) 4	600	36 25 N.	8 12 W.
6. *Cunarcha æginoides* (Pl. IX.). North Atlantic . . . . . . Order, Narcomedusæ; Family, Cunanthidæ; Sub-family, Cunoctonidæ.	354	1675	32 41 N.	36 6 W.
7. *Polycolpa forskalii* (Pl. X.). Pacific. Philippines . . . . . . Order, Narcomedusæ; Family, Peganthidæ; Sub-family, Polyxenidæ.	201	82	7 3 N.	121 48 E.
8. *Pegantha pantheon* (Pls. XI., XII.). Pacific. Philippines . . . Order, Narcomedusæ; Family, Peganthidæ; Sub-family, Pegasidæ.	201	82	7 3 N.	121 48 E.
9. *Æginura myosura* (Pls. XIII., XIV.). Indian. Australian . . . Order, Narcomedusæ; Family, Æginidæ; Sub-family, Æginuridæ.	159	2150	47 25 S.	130 32 E.
10. *Tesserantha connectens* (Pl. XV.). Pacific. Chili . . . . . . Order, Stauromedusæ; Family, Tesseridæ; Sub-family, Tesseranthidæ.	299	2160	33 31 S.	74 43 W.
11. *Lucernaria bathyphila* (Pls. XVI., XVII.). North Atlantic . . . Order, Stauromedusæ; Family, Lucernaridæ; Sub-family, Haliclystidæ.	...	540	60 3 N.	5 51 W.
12. *Periphylla mirabilis* (Pls. XVIII.–XXIII.). Pacific. New Zealand . Order, Peromedusæ; Family, Periphyllidæ; Sub-family, Periphemidæ.	168	1100	40 28 S.	177 43 E.
13. *Periphema regina* (Pls. XXIV., XXV.). Antarctic. Indian . . . Order, Peromedusæ; Family, Periphyllidæ; Sub-family, Periphemidæ.	156	1975	62 26 S.	95 44 E.
14. *Charybdea murrayana* (Pl. XXVI.). Atlantic. Guinea . . . . Order, Cubomedusæ; Family, Charybdeidæ; Sub-family, Tamoyidæ.	348	200	3 10 N.	14 51 W.
15. *Nauphanta challengeri* (Pls. XXVII., XXVIII.). South Atlantic . . Order, Discomedusæ; Family, Ephyridæ; Sub-family, Nausithoidæ.	335	1425	32 24 S.	13 5 W.
16. *Atolla wyvillii* (Pl. XXIX.). Antarctic, Indian; and Antarctic, Atlantic . Order, Discomedusæ; Family, Ephyridæ; Sub-family, Collaspidæ.	157 318	1950 2040	53 55 S. 42 32 S.	108 35 E. 56 27 W.
17. *Drymonema victoria* (Pls. XXX., XXXI.). Atlantic, Mediterranean . Order, Discomedusæ; Family, Cyaneidæ; Sub-family, Drymonemidæ.	(?) 4	600	36 25 N.	8 12 W.
18. *Leonura terminalis* (Pl. XXXII.). Pacific. Chili . . . . . . Order, Discomedusæ; Family, Crambessidæ; Sub-family, Leptobrachidæ.	299	2160	33 31 S.	74 43 W.

GLOSSARY.

	A. ACTINOSTOMA.	MOUTH.	MUND.
a	*Osculum.*	*Central aperture.*	*Osculum.*

Mouth opening of the Medusæ, derived from the primitive mouth (the archistome or blastopore of the gastrula); its margin forms the bounding line between the inner and outer germinal layers (endoderm and ectoderm); the inner (axial) surface of the œsophagus is covered with endoderm; the outer (abaxial) with ectoderm.

aa	Actinostoma, apertura oris.	Mouth aperture, oral opening.	Mundöffnung.
ab	Brachia oralia.	Oral arms.	Mundarme (perradial).
ac	Columnæ buccales.	Buccal columns.	Mundsäulen (interradial).
ad	Alæ oris adradiales.	Adradial oral wings.	Mundflügel (adradial).
ae	Fissuræ buccales.	Buccal clefts.	Schlundspalten.
af	Filamenta oralia (barbulæ).	Oral filaments.	Mundfäden.
ag	Glandulæ orales.	Oral glands.	Munddrüsen.
ah	Stomodiscus (discus oralis).	Oral plate, brachiferous plate.	Mundscheibe, Armscheibe.
ai	Tæniola oralia.	Oral tæniola.	Mundleisten (interradial).
ak	Costæ orales.	Buccal ribs.	Mundkanten (perradial).
al	Lobi orales.	Oral lobes.	Mundlappen (perradial).
am	Margo oralis.	Margin of the mouth.	Mundrand.
an	Crispæ orales suctoriæ.	Sucking frills (of the Rhizostomæ).	Saugkrausen (der Rhizostomen).
ao	Oscula suctoria.	Sucking pores (of the Rhizostomæ).	Saugmündchen (der Rhizostomen).
ap	Pilastri brachiales.	Oral pillars.	Mundpfeiler (perradial).
aq	Catablemata oralia.	Oral curtains.	Mundgardinen (perradial).
ar	Sulci orales.	Oral grooves.	Mundrinnen.
as	Stomostaurus (crux oralis).	Perradial oral cross.	Mundkreuz (perradial).
at	Tubus oralis.	Œsophagus.	Mundrohr.
au	Annulus oralis.	Oral ring (cartilaginous).	Mundring (knorpelig).
aw	Labia oralia.	Lips (interradial).	Lippenwülste (interradial).
ax	Axis oralis.	Central cavity of the mouth.	Mundaxenraum.
ay	Styli orales.	Oral styles.	Mundgriffel.
az	Digitella oralia.	Oral tentacles.	Mundtentakeln.

	B. BURSÆ.	POUCHES.	TASCHEN.
b	*Bursæ gastrocanales.*	*Chymiferous pouches.*	*Gefässtaschen.*

Broad, flat, pouch-shaped hollow spaces of the gastrovascular system, lined with endoderm; partly direct radial diverticula of the central gastral cavity, partly peripheric expansions of different parts.

ba	Bursæ adradiales.	Adradial pouches.	Adradialtaschen.
bb	Bursæ buccales.	Buccal pouches.	Backentaschen.
bc	Bursæ coronales.	Coronal pouches.	Kranztaschen.
bd	Bursæ alares.	Wing pouches.	Flügeltaschen.
bg	Bursæ gastrales.	Gastral pouches.	Magentaschen.
bi	Bursæ interradiales.	Interradial pouches.	Interradialtaschen.
bl	Bursæ lobares.	Lobe pouches.	Lappentaschen.
bm	Bursæ marginales.	Marginal pouches.	Randtaschen.
bo	Bursæ sensillares.	Pouches of the organs of sense.	Sinnestaschen.
bp	Bursæ perradiales.	Perradial pouches.	Perradialtaschen.
br	Bursæ radiales.	Radial pouches (in general).	Radialtaschen.
bs	Bursæ sexuales.	Genital pouches.	Geschlechtstaschen.
bt	Bursæ tentaculares.	Tentacular pouches.	Tentakeltaschen.
bu	Bursæ hipposideri.	Horseshoe-shaped pouches.	Hufeisentaschen.
bv	Bursæ velarii.	Pouches of the velarium.	Velartaschen.
bw	Bursæ mesenteriales.	Mesenteric pouches.	Mesogontaschen.
by	Bursæ pyloricæ	Pyloric pouches.	Pylorustaschen.

C. Canales. — Canals. — Canäle.

c	*Gastrocanales,* *Tubi chymiferi.*	*Chymiferous tubes,* *Gastrovascular tubes, Vessels.*	*Gastrocanäle,* *Gefässe.*

Small, narrow, tube-shaped hollow spaces of the gastrovascular system, lined with endoderm; partly direct radial diverticula of the central gastral cavity, partly peripheric tubes running in various directions.

ca	Canales adradiales.	Adradial canals.	Adradial-Canäle.
cb	Canalis basalis.	Canal of the umbrella-peduncle.	Stiel-Canal (der Schirmkuppel).
cc	Canalis circularis.	Circular canal of the margin.	Ring-Canal am Schirmrande.
cd	Canales pilastrales.	Pillar canals (of the Rhizostomata).	Armpfeiler-Canäle (der Rhizostomen).
ce	Canales centripetales.	Centripetal canals.	Blinde Centripetal-Canäle.
cf	Canalis festivus.	Festoon canal (of the Narcomedusæ).	Feston-Canal (der Narcomedusen).
cg	Canales gastrales.	Gastral canals.	Magen-Canäle.
ch	Canales brachiales.	Brachial canals (Rhizostomata).	Arm-Canäle (Rhizostomen).
ci	Canales interradiales.	Interradial canals.	Interradial-Canäle.
ck	Canales perionales.	Peronial canals (Narcomedusæ).	Spangen-Canäle (Narcomedusen).
cl	Canales lobares.	Canals of the marginal lobes.	Lappen-Canäle.
cm	Canalis marginalis.	Marginal canal.	Rand-Canal.
cn	Canales ramales.	Branches of the canals.	Canal-Aeste.
co	Canales sensillares.	Sense canals.	Sinnes-Canäle.
cp	Canales perradiales.	Perradial canals.	Perradial-Canäle.
cr	Canales radiales.	Radial canals (in general).	Radial-Canäle.
cs	Canalis coronarius.	Coronal sinus.	Ring-Sinus.
ct	Canales tentaculares.	Tentacular canals.	Tentakel-Canäle.
cv	Canales velares.	Canals of the pseudo-velum.	Velar-Canäle.
cy	Canales clavares.	Canals of the marginal sense-clubs.	Canal der Randkolben.

	D. Entoderma.	Endoderm.	Darmblatt.
d	*Entoderma,*	*Hypoblast,*	*Gastralblatt,*
	Lamina gastralis.	*Inner germinal layer.*	*Inneres Keimblatt.*

Internal primary germinal layer, corresponding to the internal simple germinal layer of the gastrula (or to the evaginated half of the blastula). In the Medusa it divides later into the permanent endoderm (or the epithelium of the gastrovascular system), the gelatinous mass (umbrella), and the supporting plates, &c.

da	Entoderma orale.	Oral endoderm.	Gastral-Epithel des Mundes.
dc	Entoderma canalis circularis.	Epithelium of the circular canal.	Gastral-Epithel des Ringcanals.
df	Entoderma filamentorum.	Epithelium of the gastral filaments.	Epithel der Gastral-Filamente.
dg	Entoderma gastrale.	Epithelium of the gastral cavity.	Inneres Magen-Epithel.
dk	Entoderma cathammale.	Endoderm of the lines of fusion.	Gefäss-Platte.
dl	Entoderma loborum.	Epithelium of the lobe pouches.	Epithel der Lappentaschen.
dp	Entodermatis plicæ et processus.	Folds and tufts of the endoderm.	Falten und Zotten des Entoderms.
dr	Entoderma canalium radialium.	Epithelium of the radial canals.	Epithel der Radial-Canäle.
ds	Entoderma sexuale (Acraspedarum).	Germinal epithelium of the sexual organs (of the Acraspeda).	Keim-Epithel der Geschlechts-Organe (der Acraspeden).
dt	Entoderma tentaculorum.	Inner epithelium of the hollow tentacles.	Gastral-Epithel der hohlen Tentakeln.
du	Entoderma umbrale.	Dorsal epithelium of the canals.	Epithel der dorsalen Canal-Wand.
dw	Entoderma subumbrale.	Ventral epithelium of the canals.	Epithel der ventralen Canal-Wand.
dz	Entodermatis cellulæ chordales.	Notochordal cells of the solid tentacles.	Entodermale Chordal-Zellen (Axe der soliden Tentakeln).

	E. Exumbrella.	Exumbrella.	Aussenschirm.
e	*Paries umbrellæ dorsalis,*	*Dorsal wall,*	*Rückenwand,*
	Ectophragma.	*Outer (convex) wall of the umbrella.*	*Aeussere (convexe) Schirmwand.*

External or upper wall of the gelatinous umbrella, covered by a dorsal ectodermal epithelium; arched more or less convexly, corresponding to the calyx of polyps. It is divided by the umbrella margin from the subumbrella.

ea	Costæ adradiales.	Adradial ribs.	Adradiale Rippen.
ec	Fossa circularis.	Circular furrow of the exumbrella.	Ringfurche.
eg	Gyri radiales.	Radial gyri.	Radial-Wülste.
ei	Costæ interradiales.	Interradial ribs.	Interradiale Rippen.
el	Fossa lobaris.	Radial furrow of the marginal lobes.	Lappenfurche.
en	Peronia tentaculorum.	Clasps of the tentacles.	Schirmspangen (der Narcomedusen).
eo	Crypta rhopalaris.	Niche of the rhopalium.	Sinnesnische.
ep	Costæ perradiales.	Perradial ribs.	Perradiale Rippen.
er	Costæ radiales.	Radial ribs (in general).	Radial-Rippen.
es	Sulci radiales.	Radial furrows (of the exumbrella).	Radial-Furchen.

	F. Filamenta.	Gastral-filaments.	Gastralfilamente.
f	*Filamenta gastralia,* *Digituli gastrales,* *Tentacula gastralia.*	*Digitate bodies,* *Digitate appendages,* *Gastral tentacles.*	*Magenfäden,* *Magen-Tentakeln,* *Genital-Tentakeln.*

Finger-shaped processes of the gastral wall, projecting freely into the hollow space of the gastrovascular system, and consisting of solid threads (or tufts of the gelatinous matter of the disk) whose free upper surface is covered by an endodermal epithelium; this is differentiated into flagellate cells, thread cells, glandular cells, and epithelial muscular cells.

fa	Filamenta gastris oralis.	Tentacles of the buccal stomach.	Orale-Magenfäden.
fb	Filamenta gastris basalis.	Tentacles of the basal stomach.	Basale Magenfäden.
fc	Crura tæniolorum.	Branches of the gastral ridges.	Schenkel der Magenleisten.
fg	Filamenta gastris centralis.	Tentacles of the central stomach.	Centrale Magenfäden.
fp	Filamentorum phacelli.	Bunches of filaments.	Filament-Bündel.
ft	Tæniola gastralia.	Ridges of the stomach.	Magenleisten (interradial).

	G. Gaster.	Stomach.	Magen.
g	*Stomachus,* *Cavitas centralis.*	*Central cavity,* *Main cavity.*	*Centralhöhle,* *Haupthöhle.*

The central principal cavity of the body, sometimes discoid, sometimes bell-shaped, whose central vertical axis also forms the principal axis of the Medusa body. The upper (dorsal or umbral) wall of the gastral cavity is always formed by the solid gelatinous mass of the umbrella (covered by the flat epithelium of the dorsal endoderm), while the lower (ventral or subumbral) wall is formed by the central part of the subumbrella (covered by the high epithelium of the subumbral endoderm); the manubrium opens in the centre of the lower wall.

ga	Gaster oralis.	Oral stomach.	Schlundmagen.
gb	Gaster basalis.	Basal stomach.	Grundmagen.
gc	Gaster centralis.	Central stomach.	Mittelmagen.
gd	Glandulæ gastrales.	Glands of the stomach.	Magendrüsen.
gf	Fundus gastris.	Bottom of the stomach.	Magen-Boden, Magengrund.
gg	Membrana gastro-genitalis.	Gastrogenital membrane.	Gastrogenital-Membran.
gh	Crux gastro-genitalis.	Cross of the same membrane.	Leistenkreuz dieser Membran.
gk	Gastris nodi palatini (perr.)	Nodes of the palate.	Gaumenknoten.
gl	Lamina gastralis.	Endoderm-lamella.	Magen-Gefässblatt.
gm	Gastris margo periphericus.	Periphery of the stomach.	Magen-Umkreis.
gn	Antra gastris basalis (perr.)	Niches of the basal stomach.	Nischen des Grundmagens.
go	Ostia gastralia (perrad.)	Openings of the stomach.	Gastral-Ostien.
gp	Gastris porta palatina	Palatine door.	Gaumenpforte.

gr	Gastris sulci basales (perr.)	Gastral basal furrows.	Magen-Grundrinnen.
gs	Gastris sulci palatini (perr.)	Furrows of the palate.	Gaumenrinnen.
gt	Tubus gastralis.	Gastral tube.	Magenrohr.
gu	Paries gastris umbralis.	Umbral wall of the stomach.	Dorsalwand des Magens.
gv	Gastris valvulæ palatinæ (perr.)	Valves of the palate.	Gaumenklappen.
gw	Paries gastris subumbralis.	Subumbral wall of the stomach.	Ventral-Wand des Magens.
gx	Gastris sulci exumbrales (inter.)	Interradial furrows of the stomach.	Interradiale Längsfurchen des Magens.
gy	Pylorus (porta pylorica).	Pyloric door.	Magenpforte.
gz	Laminæ obelisci.	Obelisk plates of the central stomach.	Obeliskenplatten des Central-Magnes.

H. Antrum. Umbrella-cavity. Schirmhöhle.

h *Caverna umbrellæ.* *Cavity of the nectocalyx.* *Schwimmhöhle.*

An open cavity under the concave umbrella, vaulted over by the subumbrella, and opening freely below (or only partially closed at the margin by the circular velum). The oral organs always lie in the central axial space of the umbrella cavity. All the walls of the umbrella cavity are covered by the ectodermal epithelium of the subumbrella.

ha	Apertura antri.	Opening of the nectocalyx.	Mündung der Schirmhöhle.
hb	Basis antri.	Floor of the nectocalyx.	Grund der Schirmhöhle.
hl	Antra loborum marginalium.	Cavities of the marginal lobes.	Lappen-Höhlen (der Narcomedusen).
hr	Recessus antri.	Niches of the nectocalyx.	Nischen der Schirmhöhle.

i I. Infundibula. Funnel-cavities. Trichterhöhlen.

Open cavities lined by the ectodermal epithelium of the subumbrella, which are merely various kinds of processes, lateral spaces or secondary cavities of the umbrella cavity (Antrum).

ia	Apex infundibuli.	Summit of the funnel.	Trichterspitze.
ib	Infundibula basalia.	Basal funnels.	Basal-Trichter.
ig	Ostia subgenitalia.	Apertures of the subgenital cavities.	Oeffnungen der Subgenital-Höhlen.
ii	Infundibula interradialia.	Interradial funnels.	Interradiale Trichter.
il	Infundibula loborum.	Funnels of the marginal lobes.	Lappen-Trichterhöhlen.
io	Infundibula oralia.	Oral funnels (outer buccal pouches).	Mundtrichter (äussere Backentaschen).
ip	Infundibula peduncularia.	Funnels of the peduncle.	Stieltrichter.
ir	Porticus subgenitalis.	Central subgenital vestibule.	Subgenital-Saal (der Monodemnien).
is	Infundibula subgenitalia.	Subgenital cavities (funnel cavities of the umbrella).	Subgenitahöhlen (Schirmtrichterhöhl).
it	Infundibula tentaculorum.	Funnels of the tentacles.	Tentakel-Trichterhöhlen.
iv	Infundibula velaria.	Funnels of the velarium.	Velar-Trichter (der Cubomedusen).

	K. Cathammata.	Lines of Fusion.	Verlöthungen.
k	*Concrescentiæ,* *Partes concretæ.*	*Fused parts,* *Plates.*	*Concrescenz-Platten,* *Verwachsungs-Stellen.*

Places at which the two walls of the peripheric gastrovascular system (umbral or dorsal wall and subumbral or ventral wall) are fused or grown together; they sometimes form round knobs (nodi), sometimes line-like selvages (septa), sometimes flat plates (laminæ). Each cathamma, or junction, always consists originally of two epithelial plates of the endoderm, which are, however, often fused into a single layer of cells.

kl	Loborum cathammata.	Fused clasps of the marginal lobes.	Lappen-Spangen.
kn	Nodi cathammales.	Fused nodes.	Verwachsungs-Knoten.
kt	Tabulæ cathammales.	Fused plates.	Verwachsungs-Tafeln.
ks	Limites cathammales.	Fused ridges.	Verwachsungs-Leisten.

	L. Lobi.	Lobes.	Lappen.
l	*Lobi marginales umbrellæ.*	*Marginal lobes of the umbrella.*	*Lappen des Schirmrandes.*

Leaf-shaped processes of the umbrella margin, separated by clefts in the margin, and usually containing peripheric processes of the gastrovascular system. The true marginal lobes (homologous to tentacles) are only found in the section Ascraspeda; whilst the false marginal lobes, which sometimes appear in the Craspedota (in the Narcomedusæ) are formed in quite a different way (gelatinous lobes, arising from the development of the peronia).

la	Lobi adradiales.	Adradial lobes.	Adradiale Randlappen.
lm	Lobi marginales.	Marginal lobes.	Randlappen.
ll	Lobuli velares.	Lobules of the velar lobes.	Läppchen der Velar-Lappen.
lo	Lobi oculares.	Ocular lobes.	Augenlappen.
lp	Patagium lobare.	Border membrane of the lobes.	Randsaum der Lappen.
ls	Paries loborum subumbralis.	Concave inner side of the lobes.	Ventral-Wand der Lappen.
lt	Lobi tentaculares.	Tentacular lobes.	Tentakel-Lappen.
lu	Paries loborum umbralis.	Convex outer side of the lobes.	Dorsal-Wand der Lappen.
lv	Lobi velares.	Lobes of the pseudo-velum.	Velar-Lappen.

	M. Musculi.	Muscles.	Muskeln.
m			

By far the larger part of the muscles of the Medusæ belong to the subumbrella, and are produced by its ventral ectodermal epithelium; the dorsal muscles which are formed from the ectodermal epithelium of the exumbrella, and the gastral muscles which are formed from the endodermal epithelium of the subumbral gastrovascular wall are much less important.

ma	Musculi adradiales.	Adradial muscles.	Adradiale Muskeln.
mb	M. buccales.	Buccal muscles.	Backenmuskeln.
mc	M. coronarius.	Coronal muscle.	Kranzmuskel.
md	M. deltoidei.	Deltoid muscles.	Deltamuskeln.
md'	M. delt. perradiales.	Perradial deltoid muscles.	Perradiale Deltamuskeln.
md''	M. delt. interradiales.	Interradial deltoid muscles.	Interradiale Deltamuskeln.
me	M. exumbrales.	Muscles of the exumbrella.	Muskeln der Exumbrella.
mf	M. filamentorum.	Muscles of the gastral filaments.	Muskeln der Gastral-Filamenta.
mg	M. gastrales.	Gastral muscles.	Muskeln der Magenwand.
mg'	M. gastrales longitudinales.	Longitudinal muscles of the stomach.	Längsmuskeln der Magenwand.
mg''	M. gastrales circulares.	Transverse muscles of the stomach.	Ringmuskeln der Magenwand.
mh	M. loborum marginalium.	Muscles of the lobes.	Längsmuskeln der Randlappen.
mi	M. interradiales.	Interradial muscles.	Interradiale Muskeln.
mk	M. radicales tentaculorum.	Muscles at the bases of the tentacles.	Wurzelmuskeln der Tentakeln.
ml	M. longitudinales.	Longitudinal muscles.	Längsmuskeln.
mm	M. marginalis.	Marginal muscle.	Randmuskel.
mn	M. congenitales.	Congenital muscles.	Congenitale Muskeln.
mo	M. orbicularis.	Circular muscle of the mouth.	Ringmuskel des Mundes.
mp	M. perradiales.	Perradial muscles.	Perradiale Muskeln.
mq	M. codonoides.	Muscle of the swimming bell.	Glocken-Muskel.
mr	M. radiales.	Radial muscles (in general).	Radial-Muskeln.
ms	M. intergenitales.	Intergenital muscles.	Intergenital-Muskeln.
mt	M. tentaculorum longitudinales.	Longitudinal muscles of the tentacles.	Längsmuskeln der Tentakeln.
mv	M. veli vel velarii (circulares).	Circular muscles of the velum.	Ringmuskeln des Velum.
mw	M. subumbrellæ circulares.	Circular muscles of the subumbrella.	Ringmuskeln der Subumbrella.
mz	M. zonaris exumbrellæ.	Circular muscle of the exumbrella.	Gürtel-Muskel der Exumbrella.

N. Nematillæ. — Urticating Organs. — Nesselorgane.

n — *Urticantia.* — *Stinging bodies.* — *Nesselkörper.*

Organs of different shapes, consisting of one or more thread cells, usually groups of accumulated thread cells; stinging knobs, stinging bands, stinging plates.

na	Nematillæ oris.	Urticating knobs of the mouth.	Nesselknöpfe des Mundes.
nc	Marginis circulus nematalis.	Urticating ring of the umbrella-margin.	Nesselring des Schirmrandes.
ne	Nematillæ exumbrellæ.	Urticating knobs of the exumbrella.	Nesselknöpfe der Exumbrella.
nf	Fila nematalia.	Urticating threads.	Nesselfäden.
nk	Cystæ urticantes.	Nematocysts, thread cysts.	Nesselkapseln.
nm	Nematillæ marginis.	Marginal thread cells.	Nesselzellen des Schirmrandes.
np	Nematillæ peronii.	Peronial thread cells.	Nesselzellen der Schirmspangen.
ns	Nematillæ sexuales.	Thread cells of the genitalia.	Nesselzellen der Gonaden.
nt	Nematillæ tentaculorum.	Thread cells of the tentacles.	Nesselorgane der Tentakeln.
nw	Nematillæ subumbrellæ.	Thread cells of the subumbrella.	Nesselzellen der Subumbrella.
nz	Cellulæ nematales.	Thread cells.	Nesselzellen.

	O. Sensillæ.	Sense Organs.	Sinnesorgane.
o	*Corpuscula marginalia.*	*Marginal bodies.*	*Randkörper.*

Sense organs of various kinds, placed for the most part on the umbrella margin; organs of feeling, smelling, hearing, and seeing; sometimes single, sometimes united into sense clubs, &c. The essential sensitive part of all organs of sense always consist of variously differentiated ectodermal cells, whilst the endoderm cells may also have a share in the formation of the subordinate parts.

oa	Ampulla rhopalaris.	Bladder of the rhopalia.	Ampulle der Sinneskolben.
ob	Claves marginales.	Marginal clubs.	Randkeulen.
oc	Ocellus.	Eye speck.	Auge.
od	Lens crystallina.	Lens of the eye.	Dioptrische Linse.
of	Plicæ rhopalares.	Sense folds.	Sinnesfalten.
og	Ganglion acusticum.	Auditory ganglion.	Hör-Ganglion.
oh	Setulæ auditivæ.	Auditory hairs.	Hörhäärchen.
ok	Cordyli.	Auditory clubs.	Hörkölbchen (acustische Tentakeln).
ol	Otolithi.	Otolites.	Hörsteinchen.
on	Antrum rhopalare.	Niche of the rhopalium.	Nische der Sinneskolben.
oo	Otoporpæ.	Clasps of the cordyli.	Hörspangen (der Narcomedusen).
op	Pulvinar pigmentosum.	Pigmented pad of the rhopalia.	Pigmentpolster der Rhopalien.
or	Rhopalia.	Sense clubs.	Sinneskolben (der Acraspeden).
os	Squama rhopalaris.	Protective scale of the rhopalium.	Deckschuppe der Sinneskolben.
ot	Otocystæ.	Auditory vesicles.	Hörbläschen.
ov	Vesiculæ velares.	Marginal vesicles.	Randbläschen (der Leptomedusen).
oz	Infundibulum olfactorium.	Olfactory funnel.	Riechgrube.

	P. Pedunculus.	Peduncle.	Schirmstiel.
p	*Processus cupularis.*	*Apical process of the umbrella.*	*Scheitel-Aufsatz des Schirms.*

Conical or pyramidal aboral process of the umbrella, sometimes prolonged into a long cylinder or a quadrangular prism, homologous to the peduncle of the gonophores. The peduncle is sometimes fixed at the end (in the sessile Lucernaridæ), sometimes pointed and free (in the swimming Codonidæ, Tesseridæ, &c.).

pa	Axis pedunculi.	Central canal of the peduncle.	Centraler Axenraum des Schirmstiels.
pb	Basis pedunculi.	Adherent caudal disc.	Basis des Schirmstiels.
pc	Costæ pedunculi.	Ribs of the peduncle.	Rippen des Schirmstiels.
ps	Sulci pedunculi.	Furrows of the peduncle.	Rinnen des Schirmstiels.
pt	Apex pedunculi.	Top of the peduncle.	Spitze des Schirmstiels.

	Q. Exoderma.	Ectoderm.	Hautblatt.
q	*Ectoderma,* *Lamina dermalis.*	*Epiblast,* *Outer germinal layer.*	*Dermalblatt,* *Acusseres Keimblatt.*

The external primary germinal layer, corresponding to the external simple germinal layer of the gastrula (or the non-invaginated half of the blastula). In the Medusæ this germinal layer is divided later into the permanent ectoderm (or the external epithelium of the whole body), and the muscles, &c., produced by it.

qa	Exoderma orale.	Oral ectoderm.	Exoderm-Epithel des Mundes.
qe	Exoderma exumbrellæ.	Ectoderm of the exumbrella.	Exoderm-Epithel der Exumbrella.
qg	Exoderma gastrale.	Gastral ectoderm.	Exoderm-Epithel des Magens.
qs	Exoderma sexuale (Craspedotarum).	Sexual epithelium of the Craspedota.	Keim-Epithel der Geschlechts-Organe (der Craspedoten).
qt	Exoderma tentaculorum.	Ectoderm of the tentacles.	Epithel der Tentakeln.
qw	Exoderma subumbrellæ.	Ectoderm of the subumbrella.	Exoderm-Epithel der Subumbrella.

r R. Nervi. — Nerves. — Nerven.

Whilst the peripheric nervous system of the Medusæ consists of a diffused plexus, extending far under the ectoderm, and connected with it, a ring of nerves, which is double in the Craspedota and simple in the Acraspeda, with ganglionic swellings at the organs of sense, appears as a central part at the umbrella margin.

rc	Circulus nervosus.	Nerve ring.	Nervenring des Schirmrandes.
rc'	Circulus nervosus exumbralis.	Upper nerve ring.	Dorsaler Nervenring.
rc"	Circulus nervosus subumbralis.	Lower nerve ring.	Ventraler Nervenring.
rg	Plexus nervosus gastralis.	Nervous plexus of the stomach.	Nerven-Plexus des Magens.
ro	Nervi sensillares.	Nerves of the sense organs.	Sinnesnerven.
rs	Plexus nervosus subumbralis.	Nervous plexus of the subumbrella.	Nerven-Plexus der Subumbrella.

s S. Sexualia. *Genitalia.* — Reproductive Organs. — Geschlechtsorgane. *Genitalien.*

The reproductive organs of all Medusæ consist essentially of reproductive glands or gonads, which are developed in both sexes from the ectoderm in the Craspedota, and from the endoderm in the Acraspeda.

sa	Apertura genitalis.	Genital aperture.	Geschlechts-offnung.
sb	Folliculi sexuales.	Genital follicles.	Gonaden-Bläschen.
sc	Cavitas gonadum.	Cavity of the genital sacs.	Höhle der Geschlechtsbeutel.
sd	Epithelium gastrale gonadum.	Inner epithelium of the genitalia.	Entoderm-Epithel der Gonaden.
se	Lobi gonadum.	Lobes of the genital glands.	Lappen der Geschlechtsdrüsen.
sf	Gonades femininæ.	Ovaries.	Eierstöcke
sg	Gonades.	Reproductive glands.	Geschlechtsdrüsen.
sm	Gonades masculinæ.	Testes.	Hoden.
so	Ova.	Ova.	Eier.
sp	Plicæ genitales.	Genital folds.	Geschlechtsfalten.
ss	Sinus genitalis.	Genital sinus.	Geschlechtsbucht.
st	Sterigma genitale.	Supporting frame of the genitalia.	Fulcral-Gerüste der Gonaden.
sw	Epithelium subumbrale gonadum.	Outer epithelium of the genitalia.	Exoderm-Epithel der Gonaden.
sz	Zoospermia.	Spermatozoa.	Samenfäden.

t	T. TENTACULA.	TENTACLES.	TENTAKELN.

The corona of tentacles in the Medusæ corresponds originally to that of the nearly related Polyps, and is therefore placed on the margin of the umbrella in the Medusæ, as it is on the margin of the peristome in the Polyps; in many Medusæ, however, the tentacles assume a secondary position, and are sometimes transferred to the dorsal, sometimes to the ventral surface of the umbrella.

ta	Tentacula adradialia.	Adradial tentacles.	Adradiale Tentakeln.
tb	Tentaculorum bulbi basales.	Basal bulbs of the tentacles.	Basale Tentakel-Bulben.
tc	Tentacula cava.	Hollow tentacles.	Hohle Tentakeln.
td	Tentacula solida.	Solid tentacles.	Dichte Tentakeln.
te	Cirri spirales.	Spiral cirri.	Spiral-Fäden.
ti	Tentacula interradialia.	Interradial tentacles.	Interradiale Tentakeln.
tk	Tentacula ancoralia.	Margin anchors or marginal papillæ.	Randanker oder Randpapillen.
tp	Tentacula perradialia.	Perradial tentacles.	Perradiale Tentakeln.
tr	Tentaculorum radices.	Roots of the tentacles.	Tentakel-Wurzeln.
ts	Tentacula suctoria.	Suckers.	Saugnäpfe.

	U. UMBRELLA.	UMBRELLA.	SCHIRM.
u	*Discus, campana,* *Discus gelatinosus.*	*Disc, bell,* *Gelatinous disk.*	*Scheibe, Glocke,* *Gallertscheibe.*

The gelatinous concavo-convex disk, the most voluminous part of the Medusa, and in most cases forming the principal part of the body; the upper convex surface (exumbrella) passes into the lower concave surface (subumbrella), at the margin of the umbrella.

ua	Umbrellæ pedalia adradialia.	Adradial pedalia.	Adradiale Schirm-Pedale.
uc	Umbrellæ conus (cupula).	Cone of the umbrella.	Schirmkegel (Schirmkuppel).
ud	Umbrellæ pedalia.	Pedalia of the umbrella.	Schirm-Pedale.
uf	Umbrellæ fibrillæ elasticæ.	Elastic fibrillæ of the gelatinous disk.	Elastische Fasern der Schirm-Gallerte.
ug	Umbrellæ gelatina.	Gelatinous substance of the umbrella.	Schirm-Gallerte.
ui	Umbrellæ pedalia interradialia.	Interradial pedalia.	Interradiale Schirm-Pedale.
uk	Umbrellæ conus lingualis.	Tongue-like cone of the umbrella.	Zungenkegel oder Gastralkegel.
um	Margo umbralis.	Margin of the umbrella.	Schirmrand.
up	Umbrellæ pedalia perradialia.	Perradial pedalia.	Perradiale Schirm-Pedale.
us	Pedunculus gastralis.	Gelatinous peduncle of the stomach.	Magenstiel (gallertiger, solider Stiel).
ut	Tubercula umbrellæ.	Tubercles of the umbrella.	Schirmhöker.
uz	Umbrellæ corona.	Corona of the umbrella.	Peripherer Schirmkranz.

v	V. VELUM.	VELUM.	RANDHAUT.

A muscular, thin, membranous ring, which, in the section of the Craspedota, projects freely downwards and inwards from the umbrella margin, as a process of the subumbrella. The velarium (or pseudo-velum), which is found in some Acraspeda, is a similar but essentially different structure.

va	Velarium (Acraspedarum).	Pseudo-velum (of some Acraspeda).	Velum-ähnliche Randmembran.
vb	Veli basis.	Basal edge of the velum.	Insertions-Rand des Velum.
ve	Velum exumbrale.	Dorsal surface of the velum.	(Untere) Dorsalfläche des Velum.
vf	Velarii frenula (perradiale).	Suspensors of the velum.	Suspensorien des Velarium.
vm	Veli margo.	Free margin of the velum.	Freier Axial-Rand des Velum.
vw	Velum subumbrale.	Ventral surface of the velum.	(Obere) Ventral-Fläche des Vellum.

W. Subumbrella. — Subumbrella. — Innenschirm.

w *Paries umbrellæ ventralis, Opsophragma, Nectocalyx.* — *Lower wall of the umbrella, Nectosac, nectocalyx, Swimming sac.* — *Bauchwand, Inner (concave) Schirmwand, Schwimmsack.*

The inner or lower ventral wall of the gelatinous umbrella, covered by the ventral ectodermal epithelium with an underlying circular muscular layer; it is vaulted more or less concavely, and corresponds to the peristomial plate of the polyps.

wc	Plicæ circulares subumbrales.	Circular folds of the subumbrella.	Ringfalten der Subumbrella.
wf	Frenula subumbralia.	Radial folds of the subumbrella.	Verticale Falten der Subumbrella.
wi	Tabulæ intergenitales.	Intergenital plates (Rhizostomæ).	Intergenital-Tafeln der Subumbrella (Rhizostomen).
wr	Mesenteria (vel Mesogonia).	Circumoral buttresses (perradial) or mesenteric folds.	Gekrösplatten oder Mesenterial-Falten.
ws	Sulci circulares subumbrales.	Circular furrows (between the folds of the subumbrella).	Ringfurchen (zwischen den Ringfalten der Subumbrella).
wv	Valvulæ subgenitales.	Subgenital valves (of the Rhizostomæ).	Subgenital-Klappen (der Rhizostomen).

x X. Organa varia exodermalia. — Various Organs of the Ectoderm. — Verschiedene Organe des Exoderms.

y Y. Organa varia entodermalia. — Various Organs of the Endoderm. — Verschiedene Organe des Entoderms.

Z. Fultura. — Supporting Plate. — Stützplatte.

z *Lamina fulcralis, Lamina basalis.* — *Chondrophys, Fulcral plate.* — *Stützlamelle, Fulcral-Platte.*

A structureless hyaline membrane lying immediately under the epithelium of the endoderm, and excreted by it (more rarely a local production of the ectoderm, as for example in the velum). The supporting plate is sometimes thin but firm, like an elastic plate, sometimes thicker but softer, as a direct process of the gelatinous mass of the umbrella.

za	Fultura actinostomatis.	Supporting plate of the mouth.	Stützplatte des Mundes.
zg	Fultura gastralis.	Supporting plate of the stomach.	Stützplatte des Magens.
zk	Fultura cathammalis.	Supporting plate of the soldered nodes.	Stützplatte der Concrescenz-Knoten.
zl	Fultura loborum.	Supporting plate of the marginal lobes.	Stützplatte der Randlappen.
zt	Fultura tentaculorum.	Supporting plate of the tentacles.	Stützplatte der Tentakeln.
zv	Fultura veli (aut velarii).	Supporting plate of the velum (or velarium).	Stützplatte des Velum (oder Velarium).
zw	Fultura subumbrellæ.	Supporting plate of the subumbrella.	Stützplatte der Subumbrella.
zz	Fultura umbrellæ.	Supporting plate of the umbrella.	Stützplatte der Umbrella.

PLATE I.

THAMNOSTYLUS DINEMA.

Fig. 1.—The entire Medusa, five times the natural size, seen from the side. The long quadrangularly prismatic œsophagus, which is circularly constricted above the oral opening, projects in the middle far out from the opening of the umbrella cavity. The œsophagus is surrounded by the numerous branches of the four powerful, dichotomously branched, blood-red oral styles, whose terminal branches bear an urticating knob. The four leaf-shaped, pinnated genitalia are seen above the oral styles in the side walls of the inverted pyramidal central stomach. The four narrow radial canals run out from the base of the central stomach and are united into a coronal canal at the umbrella margin above the pigmented urticating ring. A pigmented ocellar bulb lies below its opening. Two long tentacles, furnished with urticating rings, run out from two opposite bulbs.

Fig. 2.—Umbrella seen from above, four times the natural size. *gc* Central stomach. *s* Genitalia (ovaria). *gx* Interradial furrow of the gastral wall. *cr* Radial canals. *cc* Coronal canals. *mi* Interradial longitudinal muscles of the subumbrella. *v* Velum. *ug* Gelatinous substance of the umbrella. *ne* Urticating knobs of the umbrella.

Fig. 3.—The central stomach, seen from below, eight times the natural size, with the œsophagus (*at*) and the four oral styles (*ay*) cut off at their bases. The four leaf-shaped, pinnated genitalia (*sf*) cover the greater part of the wall of the stomach (*gc*). Four perradial internal gastral grooves (*gs*) alternating with four interradial external gastral furrows (*gx*).

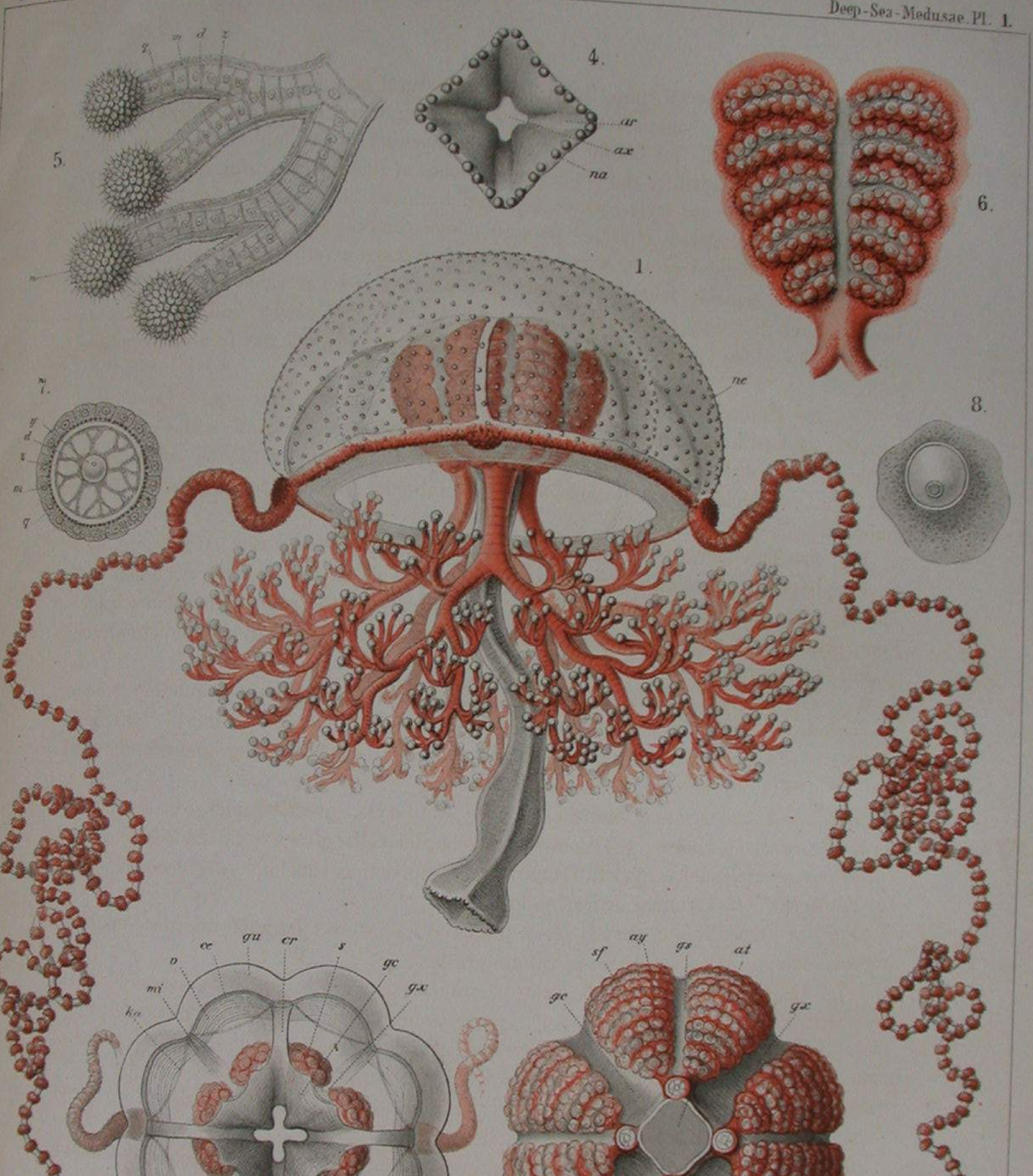
Fig. 4.—The oral opening and the lowest part of the œsophagus surrounding it, seen from below ten times the natural size. *ar* Four perradial oral grooves (on the inner side of the ribs of the œsophagus which project outwards). *ma* Urticating knobs of the oral margin. *ax* Axial hollow space of the œsophagus.

Fig. 5.—Four terminal branches of an oral style, greatly enlarged, with their terminal urticating knobs. (*d*) Coin-shaped chordal cells of the solid endodermal axis, with their central nuclei. (*z*) Internal plate or supporting lamella. (*m*) Muscular plate. (*g*) Ectoderm. *fn* Terminal urticating knob.

Fig. 6.—A genitalium shaped like a pinnated leaf, whose perradial midrib forms both a gastral rib and the gastral groove running in it.

Fig. 7.—Branch of an oral style in transverse section, greatly enlarged. *d* An endodermal chordal cell with its nucleus *y*, surrounded by branched filaments of protoplasm, which are united into a thin layer of protoplasm both inside round the nucleus, and outside on the inner wall of the cell. *z* The supporting lamella belonging to the cell. *m* Muscular plate (longitudinal muscular fibrillæ in transverse section). *q* Ectodermal epithelium.

Fig. 8.—A mature ovum, with large clear germinal vesicle and dark double-contoured germinal spot.



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THAMNOSTYLUS DINEMA.

PLATE II.

PTYCHOGENA PINNULATA.

Fig. 1.—The entire Medusa, twice the natural size, seen half from the side, half from below. The quadrangular œsophagus, which hangs from the middle of the umbrella cavity, is wide opened below. The four radial canals, whose pinnated proximal halves bear the genitalia, spring, with a conical enlargement, at the base of the œsophagus. The numerous tentacles at the umbrella margin are rolled together near their ends into delicate festoons.

Fig. 2.—The entire Medusa, twice the natural size, seen from below. Through the wide open central mouth, whose free margin (*al*) is irregularly lobed, we can look into the quadrangular cavity (*gc*) in whose quadratic fundus the rectangular cross of the central ciliated groove is visible (*gs*). Four conical funnels (*ch*) passing immediately into the four perradial canals (*cr*) run out from the four corners of the bottom of the stomach. The proximal part of the radial canals is occupied by the genitalia, whose pinnated leaves are delicately lobed beneath (*s*). *t* Tentacles. *ob* Marginal clubs. *v* Velum. *w* Subumbrella. *u* Umbrella.

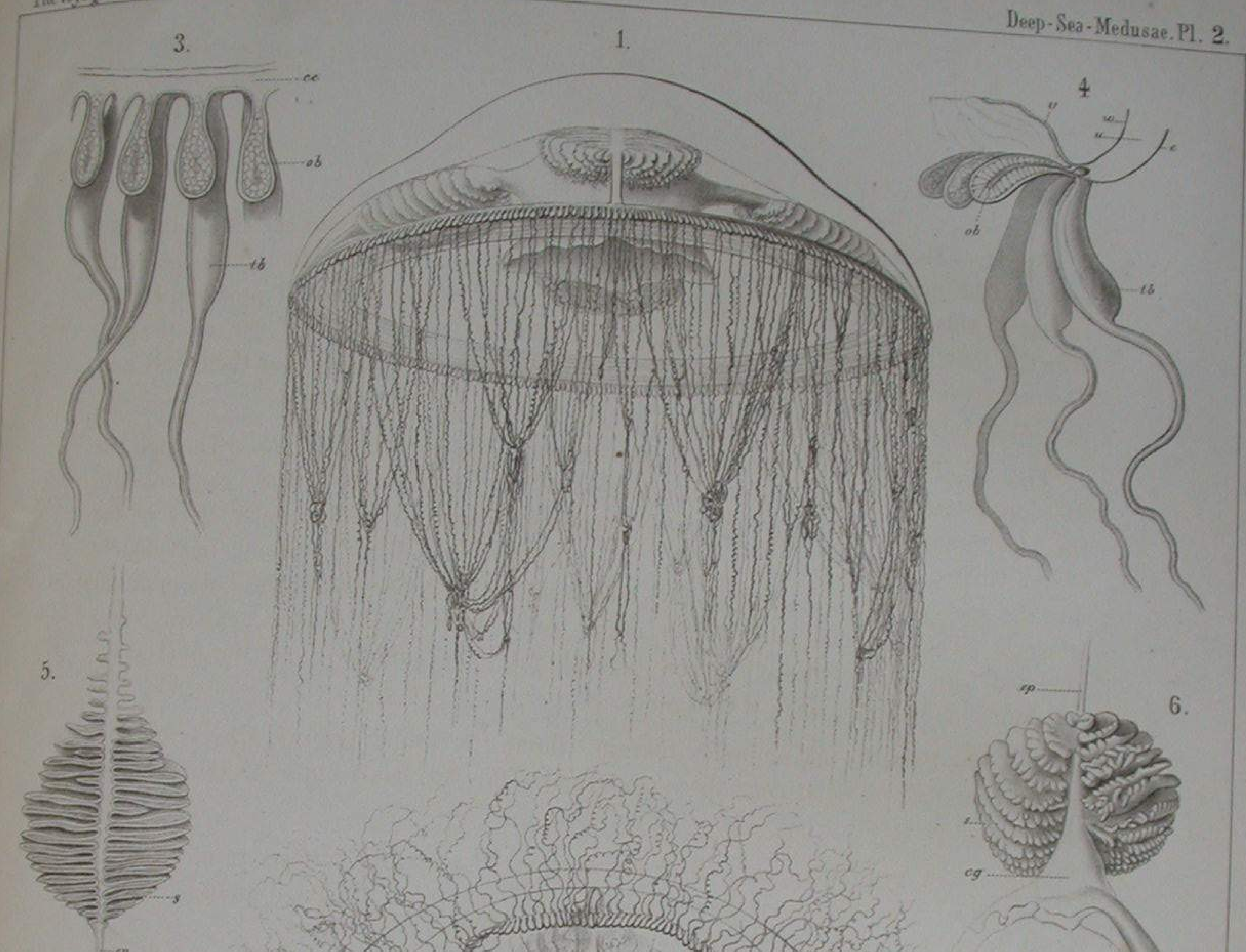
Fig. 3.—Part of the umbrella margin, three times the natural size. *v* Velum. *w* Subumbrella. *u* Gelatinous disc. *e* Exumbrella. *tb* Basal bulbs of the tentacles, *ob* Marginal clubs.

Fig. 5.—A genitalium, seen from above, from the umbral surface, three times the natural size. *cp* Peripheric part of the radial canal. *s* Pinnated branches of the radial canals, leading into the cavities of the reproductive leaves.

Fig. 6.—A genitalium, seen from below, from the subumbral surface, three times the natural size. *cp* Peripheric part of the radial canal. *ck* Conical basal part of the radial canal. *s* Reproductive leaf. *g* Gastral cavity.

Fig. 7.—Cruciate ciliated groove in the bottom of the stomach (on the gastral surface of the gelatinous umbrella, *u*), twice the natural size. It is amphithect here (not regular as in fig. 2). The four limbs of the cross, touch each other in pairs and the two pairs are connected like an H by a transverse grove.

Fig. 8.—A marginal club (cordylis, olfactory club ?) in longitudinal section, ten times the natural size. *cy* Narrow central canal. *h* High cylindrical cells of the endoderm *q* Flat sense cells of the ectoderm. *z* Supporting plate or fulcral lamella (fultura) between the two layers of cells.



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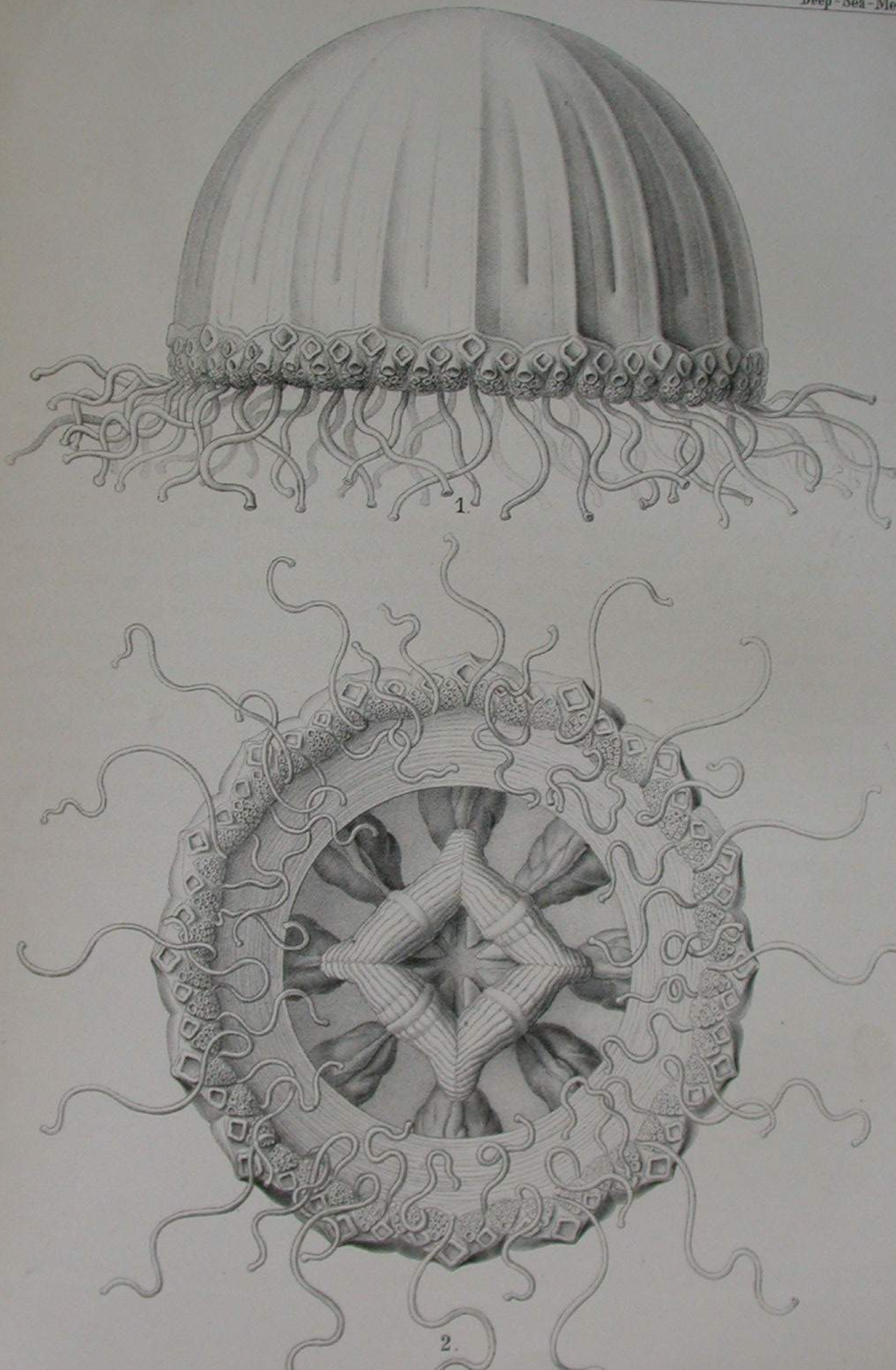
PTYCHOGENA PINNULATA.

PLATE III.

PECTYLLIS ARCTICA.

Fig. 1.—The entire Medusa in profile, five times the natural size. Both the sixteen complete radial ribs of the exumbrella and the sixteen alternating incomplete ribs in the middle of the exumbral intercostal depressions are both distinctly visible, also the numerous sucking-cups and the longer sucking tentacles at the umbrella margin.

Fig. 2.—Subumbral view of the entire Medusa seen from below, five times the natural size. One of the two perradial diameters stands vertically, the other horizontally. We look through the quadrate oral opening into the gastral cavity, in which four adradial ridges of the gastral wall project. Strong folds of the circular muscle pass from the margin of the mouth on the inner gastral wall, interrupted by four perradial labial furrows of the corners of the mouth and four interradial bands of the longitudinal muscle. The larger part, the eight folded genital sacs, is visible in the bottom of the umbrella cavity. Their distal part is covered by the broad velum, which was extremely dilated. Outside the velum we see sixteen lobes of the umbrella margin, on its lower side the forty-eight triangular sucking plates (composed of many small sucking-cups) and the alternating forty-eight larger sucking-cups (sixteen of the first size, and thirty-two of the second): inside, projecting from the insertion of the velum, forty-eight longer, thinner tentacles with terminal sucking-cups.



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PECTYLLIS ARCTICA.

PLATE IV.

PECTYLLIS ARCTICA.

Fig. 3.—Perradial section through the entire Medusa, five times the natural size. Strong longitudinal and transverse muscular folds are visible in the interior of the gastral cavity (*gp*), also eight gastral grooves (*gr*) between the eight adradial ridges of the gastral wall. The eight radial canals (*cr*) open above into the gastral cavity, by the gastral opening (*go*). Eight wide, folded genital sacs (*sc*) run out from the proximal halves of the radial canals, and are fastened to the subumbrella (*mw*) by the vertical leaf-shaped mesogoniæ (or genital mesenteries, *wr*). *ug* Gelatinous substance of the umbrella. *al* Oral lobes. *cc* Circular canal. *v* Velum. *vm* Freer margin of the velum.

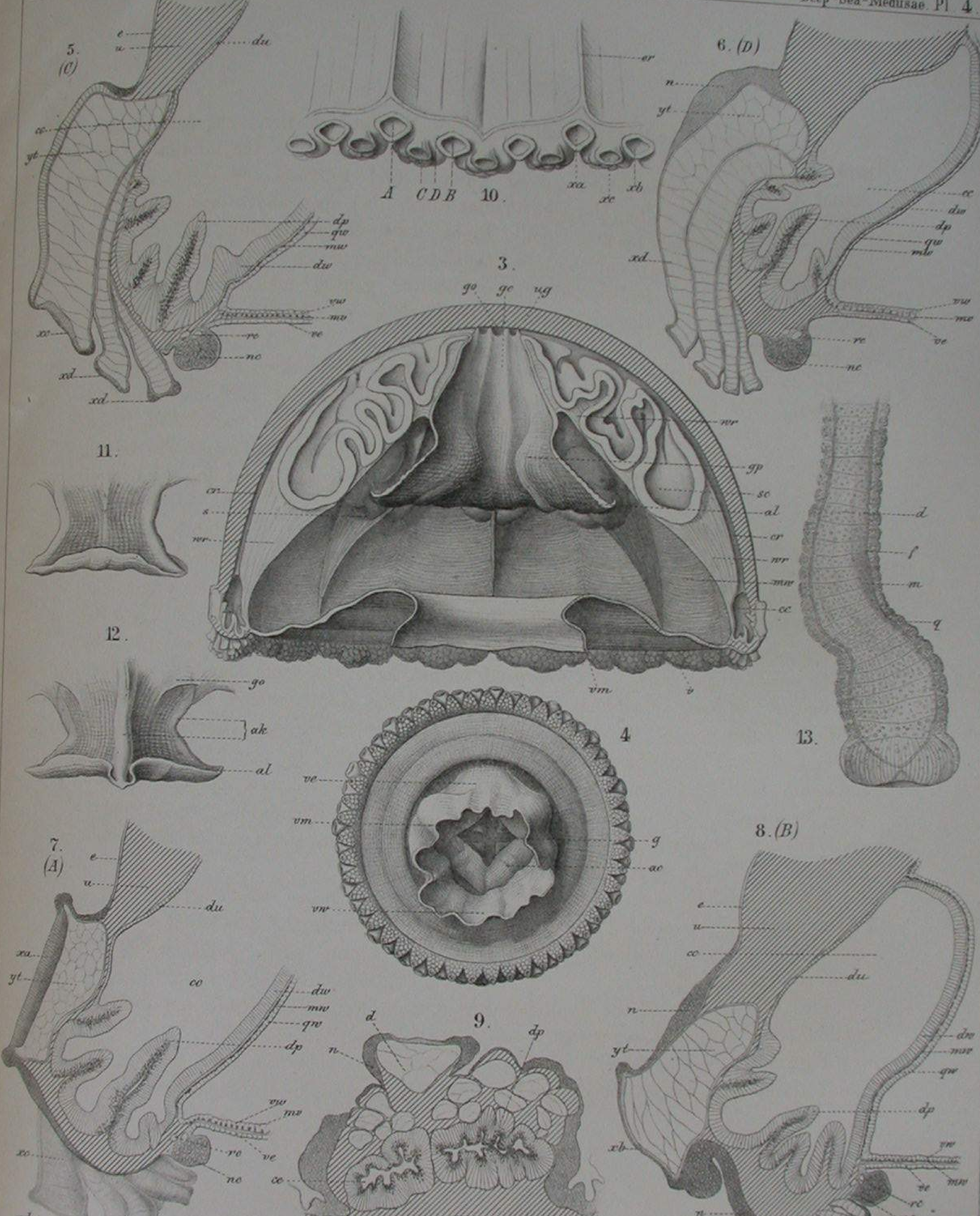
Fig. 4.—Subumbral view of the Medusa, seen from below, three times the natural size (comp. Pl. III. fig 2). The outer thick-walled abaxial half of the broad velum is separated by a deep circular furrow from the inner thin-walled half, which projects like a folded œsophagus. *vw* Subumbral, *ve* exumbral surface of the velum. *vm* Freer margin of the velum. *aw* Oral marginal with the lobial swelling. *g* Gastral cavity.

Figs. 5–8.—Four radial sections through the umbrella margin, slightly enlarged, in four directly following meridian planes, at the four points indicated in fig. 10 by the letters *ABCD*. The radial section in fig. 7 (*A*) touches a sucking-cup of the first size (*xa*), in fig. 8 (*B*) a sucking-cup of the second size (*xb*), in fig. 5 (*C*) a sucking-cup of the third size (*xc*), in fig. 6 (*D*) a sucking-cup formed of many smaller sucking-cups (*xd*). The following letters have the same signification in all the figures: *yt* the endodermal chordal axis of the solid sucking tentacle, *u* the gelatinous substance of the umbrella, *e* the exumbrella, *cc* the circular canal, *du* its umbral, *dw* its subumbral endodermal epithelium; *dp* glandular endodermal tufts and folds of the marginal wall of the circular canal, *mw* muscular layer of the subumbrella, *gw* ectodermal epithelium of the subumbrella, *vw* subumbral epithelium, *ve* exumbral epithelium of the velum; *mv* muscular layer of the velum; *nc* urticating ring, *rc* nerve ring.

Fig. 9.—Oblique tangential section through a portion of the umbrella margin, slightly enlarged, *cc* arching of the circular canal between the projecting folds and tufts of its marginal wall (*dp*); *n* urticating epithelium, and *d* solid chordal axis of several sucking-cups.

Fig. 10.—Portion of the umbrella margin, seen from the outside, ten times the natural size. Lettering, comp. figs. 5–8. *er* Radial rib of the exumbrella.

Figs. 11, 12.—The lower, free half of the œsophagus, three times the natural size; fig. 11 interradial, fig. 12 perradial section. *ak* Perradial angles. *al* Oral lobes.



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PECTYLLIS ARCTICA.

PLATE V.

PECTIS ANTARCTICA.

Fig. 1.—The entire Medusa, seen in profile, three times the natural size. A deep exumbral coronal furrow separates the upper hemispheroidal half of the umbrella from the lower funnel-shaped half. In the former, only extremely numerous and very delicate radial exumbral ribs are visible, in the latter besides these, there are sixty-four deep radial furrows. On the umbrella margin, thirty-two groups of sucking-cups and tentacles, alternating with thirty-two larger isolated sucking-cups inserted higher up.

Fig. 2.—Perradial section through the whole Medusa, three times the natural size. A gelatinous cone (*uk*) projects downwards in the bottom of the gastral cavity from the apex of the gelatinous umbrella (*ug*). The eight conical adradial oral funnels (*io*) project inwardly in the oral part of the gastral cavity; between the funnels we see the fissure-shaped entrances into the eight pair of alternating buccal pouches (*bb*). The eight sac-shaped genitalia (*s*) contain wide genital pouches (*bs*). *mw* Subumbral circular muscles. *cr* Radial canals. *ce* Centripetal canals. *cc* Circular canals. *ts* Tentacles with sucking-cups.

Fig. 3.—The œsophagus, seen from the outside, six times the natural size. The eight radial canals (*cr*) which open above, pass into the gastral wall as longitudinal gastral grooves (*gs*) whose outer wall projects. *bb* Buccal pouches. *mo* Folds of the circular muscles of the quadrate oral margin. *al* Oral lobes.

Fig. 4.—The œsophagus in perradial longitudinal section, six times the natural size. Letters as in figs. 2 and 3. The conical gelatinous cone of the umbrella (*uk*) projects above into the gastral cavity. Below, alternating with the eight gastral grooves (*gs*) the eight adradial conical oral funnels (*io*) opening to the outside into the umbrella cavity, whilst a pair of buccal pouches (*bb*) open to the inside into the oral cavity below each oral funnel (comp. fig. 5).

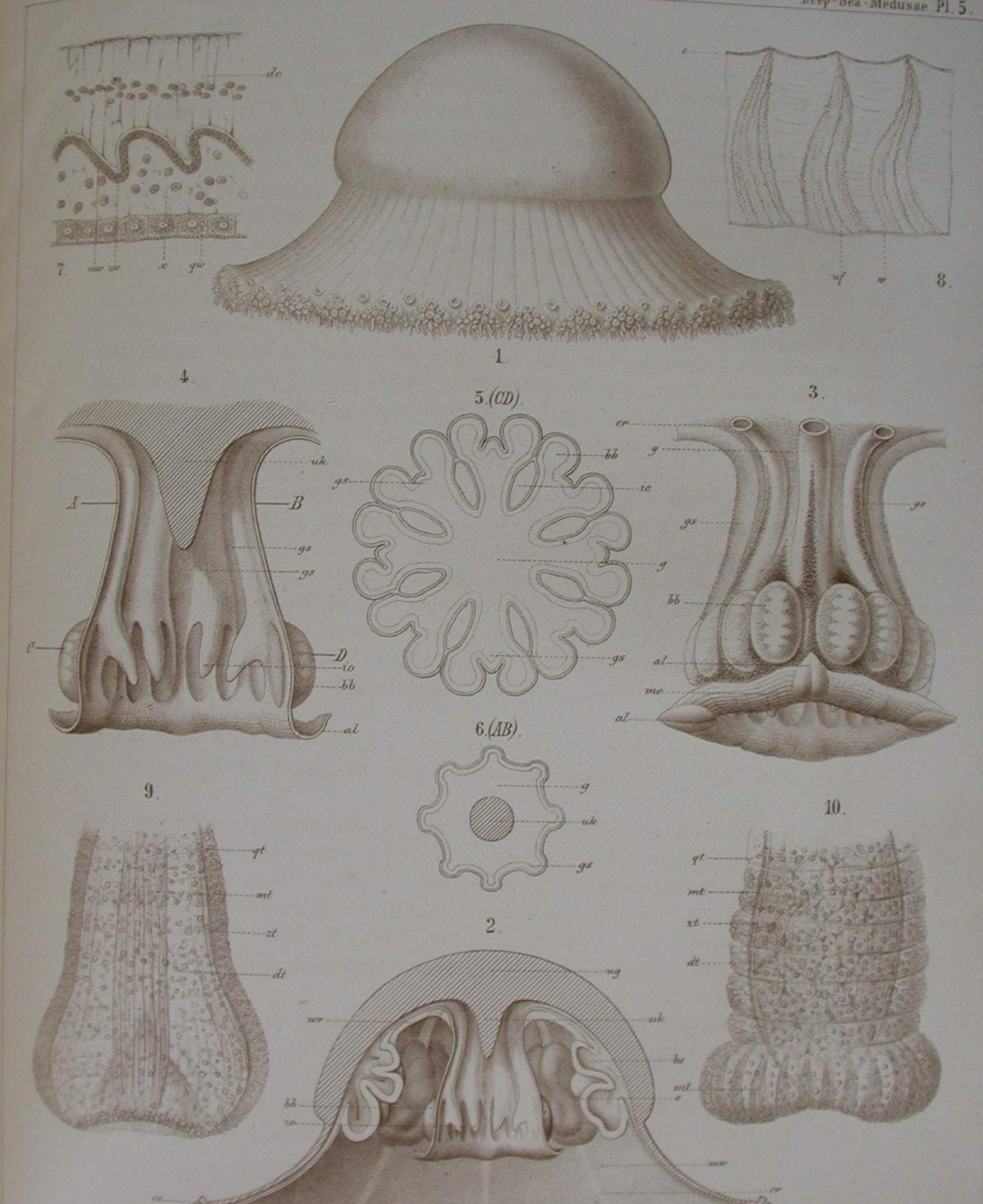
Fig. 5.—Horizontal transverse section through the œsophagus (*z*) at the height of the line *CD* (fig. 4), six times the natural size. *bb* Buccal pouches. *gs* Gastral grooves. *io* Oral funnels.

Fig. 6.—Horizontal transverse section through the œsophagus at the height of the line *AB* (fig. 4), six times the natural size. *g* Gastral grooves. *uk* Gelatinous cone.

Fig. 7.—Transverse section through the subumbral wall of the circular canal, greatly enlarged. *dc* Thick, cylindrical endodermal epithelium; a nucleus in the middle of each cell. *zw* Endodermal supporting lamella. *mw* Muscular folds of the subumbrella. *x* Plate of connective tissue below the muscular folds. *qw* Ectodermal epithelium of the subumbrella.

Fig. 8.—Transverse section through the thin peripheric part of the gelatinous umbrella, greatly enlarged. *e* Exumbrella. *w* Subumbrella. *uf* Bundle of elastic supporting fibres.

Figs. 9, 10.—Two tentacles with terminal sucking-cup, greatly enlarged. *qt* Ectoderm. *mt* Muscles. *zt* Supporting lamella. *dt* Endodermal axis.



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PECTIS ANTARCTICA

PLATE VI.

PECTIS ANTARCTICA.

Fig. 11.—Subumbral view of the entire Medusa (from below), three times the natural size; one of the two perradial diameters stands vertically, the other horizontally. We look through the wide quadrate oral opening into the gastral cavity, in which the eight conical white, adradial oral funnels project. The sixteen hemispheroidal buccal pouches are visible round the swollen oral margin; outside these, the eight wide genital sacs. In the peripheric part of the umbrella, the broad velum with its deep circular furrow is shown to the right, the circular muscular layer of the subumbrella and the cæcal centripetal canals (11–13 between each two radial canals) to the left (after removal of the velum). The umbrella margin shows the thirty-two groups of sucking-cups, to the left without the longer tentacles, to the right with the latter.

Fig. 12.—Radial section through the velum (*v*) and the marginal part of the umbrella with the circular canal (*cc*); slightly enlarged. *yc* Marginal fold in the circular canal. dc^1 Umbral, dc^2 subumbral endodermal epithelium of the circular canal. *mw* Muscular folds of the subumbrella (*w*). *qw* Ectodermal epithelium of the subumbrella. *uf* Elastic fibres in the gelatinous umbrella (*ug*). *e* Exumbrella. *ts* Tentacles with sucking-cups. *td* Tentacles without sucking-cups. *nc* Urticating ring. *rc* Nerve ring. *ve, vw, mw*, comp. fig. 13.

Fig. 13.—Radial section through the basal part of the velum, greatly enlarged. *vw* Subumbral or ventral epithelium. *x* Layer of vesicular connective tissue. *mv* Ramifications of the muscular plate. *zv* Supporting lamella. *ve* Exumbral or dorsal epithelium (comp. fig. 12).

Fig. 14.—Radial section through the deep circular fold of the velum, in the middle. Letters as in figs. 12 and 13. Greatly enlarged.

Fig. 15.—Longitudinal section through a tentacle with sucking cup, slightly enlarged. *qt* Ectodermal epithelium. *mt* Muscular plate. *zt* Supporting plate or fulcral lamella. *dt* Endodermal axis. *ng* Gelatinous substance of the umbrella margin. *uf* Elastic fibres of the gelatinous substance.

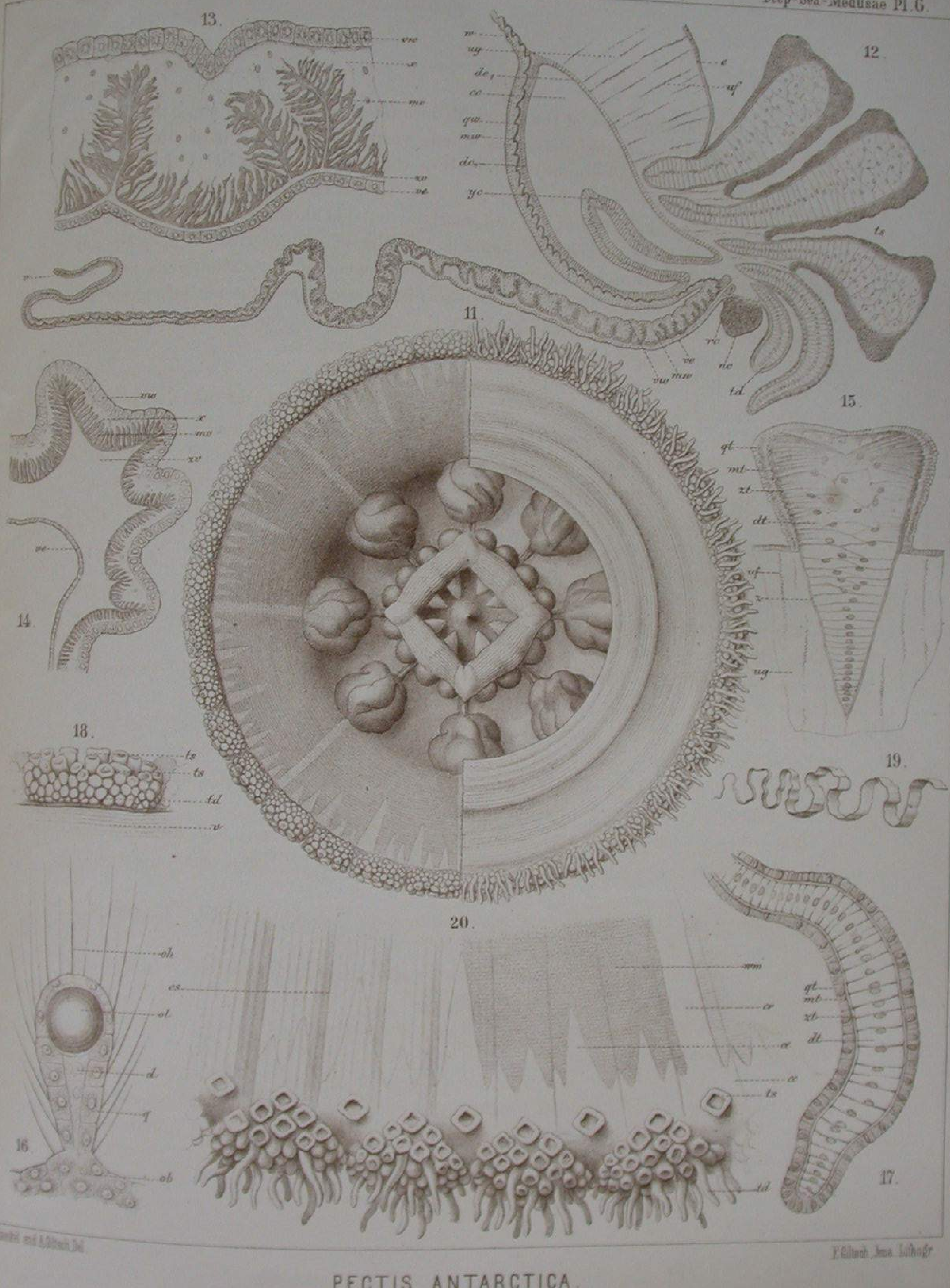
Fig. 16.—A sense club of the umbrella margin greatly enlarged. *oh* Auditory hairs. *ol* Otolite (enclosed in the last endodermal cell of the axis). *d* Endoderm. *q* Ectoderm. *ob* Sense pad.

Fig. 17.—A tactile tentacle, without sucking-cup, slightly enlarged. Letters as in fig. 15.

Fig. 18.—A tentacle group of the umbrella margin, slightly enlarged. *td* Tentacles without sucking-cups: *ts* with sucking-cups. *v* Velum.

Fig. 19.—A band-shaped elastic fibre from the gelatinous substance of the umbrella, greatly enlarged.

Fig. 20.—A piece of the umbrella margin seen from the outside, twelve times the natural size. *es* Exumbral radial furrow. *wm* Subumbral circular muscles. *cr* Radial canal. *ce* Centripetal canals. *cc* Circular canals. *ts* Sucking-cups. *td* Tentacles without sucking-cups.



PECTIS ANTARCTICA.

PLATE VII.

PECTANTHIS ASTEROIDES.

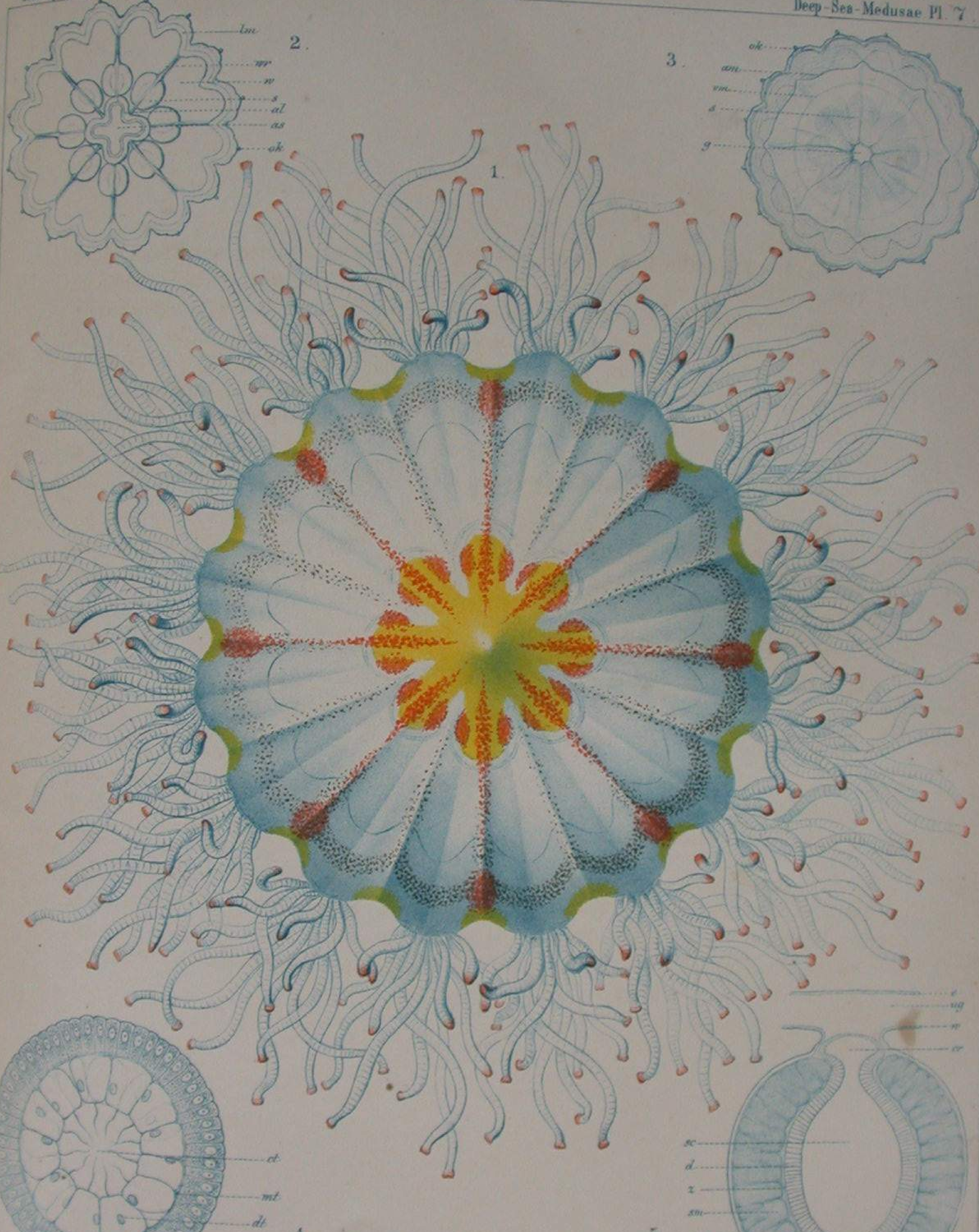
Fig. 1.—The entire Medusa, exumbral view (from above); painted by me from life in Pola, twenty times the natural size. The eight principal ribs (four perradial and four interradial) of the sixteen projecting radial ribs of the exumbrella are distinguished by blood-red pigment, accumulated, like an ocellus, at the distal end, whilst the eight adradial ribs, alternating with them only show the same black pigment (yellow white in reflected light) as the festoon-shaped urticating band of the exumbrella, running parallel to the umbrella margin. In the middle the golden-yellow base of the stomach with the surrounding corona of red genitalia shines through the umbrella. The numerous sucking tentacles are divided into sixteen bunches on the umbrella margin.

Fig. 2.—Umbrella (without tentacles) subumbral view (from below) with strongly contracted œsophagus ten times the natural size. The velum is omitted. *as* Oral cross. *al* Oral lobes. *s* Genitalia. *wr* Mesogonia. *w* Subumbrella. *lm* Marginal lobes. *ok* Auditory club.

Fig. 3.—Umbrella (without tentacles) subumbral view (from below) with widely extended œsophagus, ten times the natural size. *am* The octagonal margin of the flatly extended oral disc, through whose thin wall both the genitalia (*s*) and the free margin of the velum (*vm*) shines. *g* Central gastral cavity. *ok* Auditory club.

Fig. 4.—Transverse section through a hollow sucking tentacle (or "ambulacral foot") greatly enlarged. *qt* Ectoderm. *zt* Fulcral plate. *dt* Endoderm (flagellate cells). *ct* Axial canal of the tentacle.

Fig. 5.—Tangential transverse section through a genitalium, fifty times the natural size. *e* Exumbrella. *ug* Gelatinous umbrella. *w* Subumbrella. *cr* Radial canal. *sc* Reproductive pouch. *d* Endodermal epithelium of the pouch. *z* Fulcral plate. *sm* Spermarium. *sw* Subumbral ectodermal epithelium of the testis. *wr* Transverse section of the mesogonium.



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PECTANTHIS ASTEROIDES.

PLATE VIII.

PECTANTHIS ASTEROIDES.

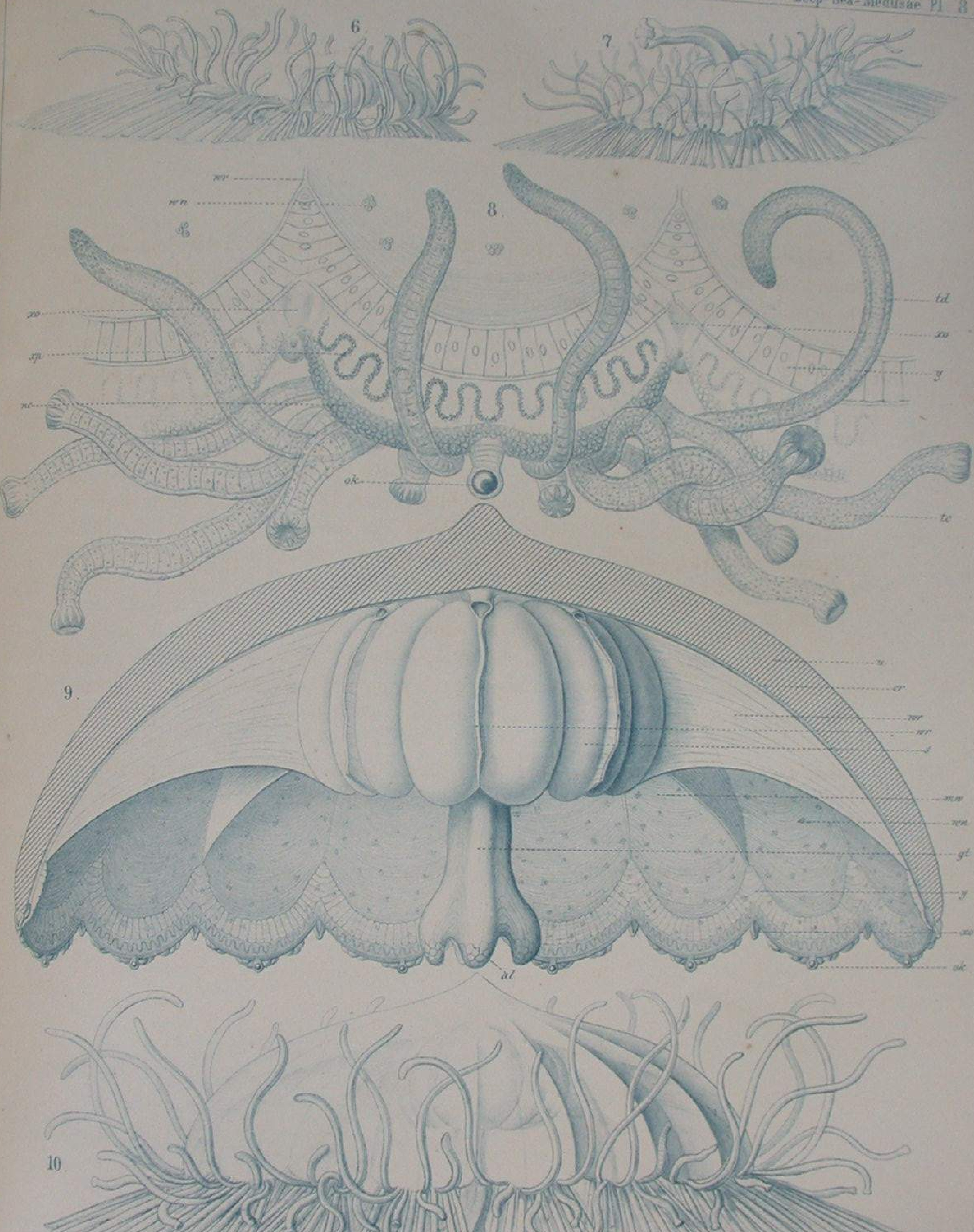
Fig. 6.—The entire Medusa in profile, ten times the natural size; crawling on the ground like an Echinoderm, with sucking tentacles, which partly adhered by suction like ambulacral feet, partly move about as if groping. (Drawn by me from life in Pola.)

Fig. 7.—The entire Medusa, in profile, ten times the natural size, anchored on its back. The long œsophagus, surrounded at the base by the corona of genitalia, projects and moves tentatively from the narrow opening of the strongly contracted velum. Tentacles as in fig. 10. (Drawn by me from life in Pola.)

Fig. 8.—A piece of the umbrella margin, greatly enlarged, seen from below and inside. *wn* Urticating knobs of the subumbrella. *wr* Distal end of the mesogonia. *g* Chordal ring of the endodermal cells, above the circular canals (?). *xp* Black pigmented, waved ring of cilia below the circular canal. *xo* Olfactory depression (?). *td* Tactile tentacles. *tc* Sucking tentacles. *ok* Auditory club.

Fig. 9.—Perradial section through the umbrella; the front half of the umbrella is removed leaving intact the central œsophagus with the corona of genitalia; thirty times the natural size. *u* Gelatinous substance of the umbrella. *wr* Mesogonia. *s* Spermarium. *mw* Muscular plate of the subumbrella. *wn* Urticating knobs of the subumbrella. *zt* Œsophagus. *al* Oral lobes. *y* Chordal ring on the subumbral wall of the circular canal (?) *xo* Sense body with ciliated depression (olfactory depression ?). *ok* Auditory club. Of the eight mesogonia (*wr*) three are cut away and five are preserved.

Fig. 10.—The entire Medusa in profile, twenty times the natural size. Whilst the sucking tentacles adhere below to the ground, the tactile tentacles are directed upwards and grope freely about. (Drawn by me from life in Pola.)



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PECTANTHIS ASTEROIDES.

PLATE IX.

CUNARCHA ÆGINOIDES.

The meaning of the letters is the same throughout.

a Oral opening.
bg Perradial gastral pouches.
bl Lobe pouches (ovaries).
ck Peronial canals.
cm Marginal canals.
d Endoderm.
du Umbral epithelium of the festoon canal.
dw Subumbrella epithelium of the festoon canal.
cc Coronal furrow of the exumbrella
en Peronia or umbrella clasps.
er Perradial ribs of the exumbrella.
es Peronial furrow of the exumbrella.
gc Central stomach.
gt Œsophagus.
gu Umbral wall of the central stomach.
gw Subumbral wall of the central stomach.
h Umbrella cavity.
hl Cavities of the marginal lobes.
mp Peronial muscle (perradial).
mv Circular muscles of the velum.
mw Circular muscles of the subumbrella.
n Urticating organs.
nb Urticating swelling at the base of the tentacle.
nc Urticating ring of the umbrella margin.
oh Auditory hairs (" setulæ acusticæ ").
ok Auditory clubs (cordyli).
ok, Larger perradial auditory clubs.
ok,, Smaller adradial clubs.
ol Otolites.
oo Otoporpæ.
op Auditory pad in the peduncle of the auditory club.
q Ectoderm.
qe Ectoderm of the exumbrella.
qw Ectoderm of the subumbrella.
r Nerves.
rc, Dorsal nerve ring.
rc,, Ventral nerve ring.
s Ovaries.
so Egg cells.
t Tentacles.
tr Tentacle root.
u Umbrella.
uf Elastic fibres of the umbrella.
ug Gelatinous substance of the umbrella.
v Velum.
ve Exumbral epithelium of the velum.
vw Subumbral epithelium of the velum.
z Supporting (fulcrum).
zv Supporting plate of the velum.
zw Supporting plate of the subumbrella.

Fig. 1. Ventral view of the entire Medusa (from below), with folded collar lobes and tentacles, fifteen times the natural size.

Fig. 2. Dorsal view of the entire Medusæ, with collar lobes extended flatly, ten times the natural size.

Fig. 3. Profile view of the entire Medusa, with stiffly extended collar lobes and extended œsophagus, fifteen times the natural size.

Fig. 4. A collar lobe (or a quadrant of the umbrella collar), with the surrounding parts, flatly extended, thirty times the natural size.

Fig. 5. Horizontal transverse section through a peronial furrow, and the peronium lying in it, greatly enlarged.

Fig. 6. Radial section through a quadrant of the umbrella, projected semi-diagramatically, twenty-five times the natural size.

Fig. 7. Radial section through the umbrella margin and the auditory club with peronium lying on it, greatly enlarged.

Fig. 8. An auditory club, with the peronium belonging to it, and the surrounding part of the umbrella margin, greatly enlarged.

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CUNARCHA AEGINOIDES.

PLATE X.

POLYCOLPA FORSKALII.

Fig. 1.—Ventral view of the entire Medusa (from below), four times the natural size *gc* Central part of the flat gastral cavity. *am* Oral margin, swollen and thickened. *gw* Subumbral wall of the central gastral cavity. *sf* Ring-shaped genitalium (ovary). *h* Umbrella cavity (peripheric part). *v* Velum. *l* Collar lobes. *ok* Auditory clubs. *t* Tentacles.

Fig. 2.—Profile view of the entire Medusa (from the side), three times the natural size, drawn from life. The central gelatinous umbrella lens touches the expanse of water and the knee of the genuflected tentacles with its vaulted arch. The tentacles are inserted in the circular coronal furrow, which separates the central umbrella lens from the peripheric umbrella collar and alternates with the twenty-five collar lobes of the latter.

Fig. 3.—Radial section through the umbrella, six times the natural size. *ug* Gelatinous lens of the umbrella. *ec* Coronal furrow of the exumbrella. *t* Tentacle. *tr* Tentacle root. *l* Collar lobes. *hl* Cavities of the collar lobes. *oo* Peronium. *ok* Auditory club. *cf* Festoon canal. *nc* Urticating ring. *v* Velum. *sf* Ovary. *gc* Central stomach. *at* Œsophagus. *am* Margin of the mouth. *h* Umbrella cavity.

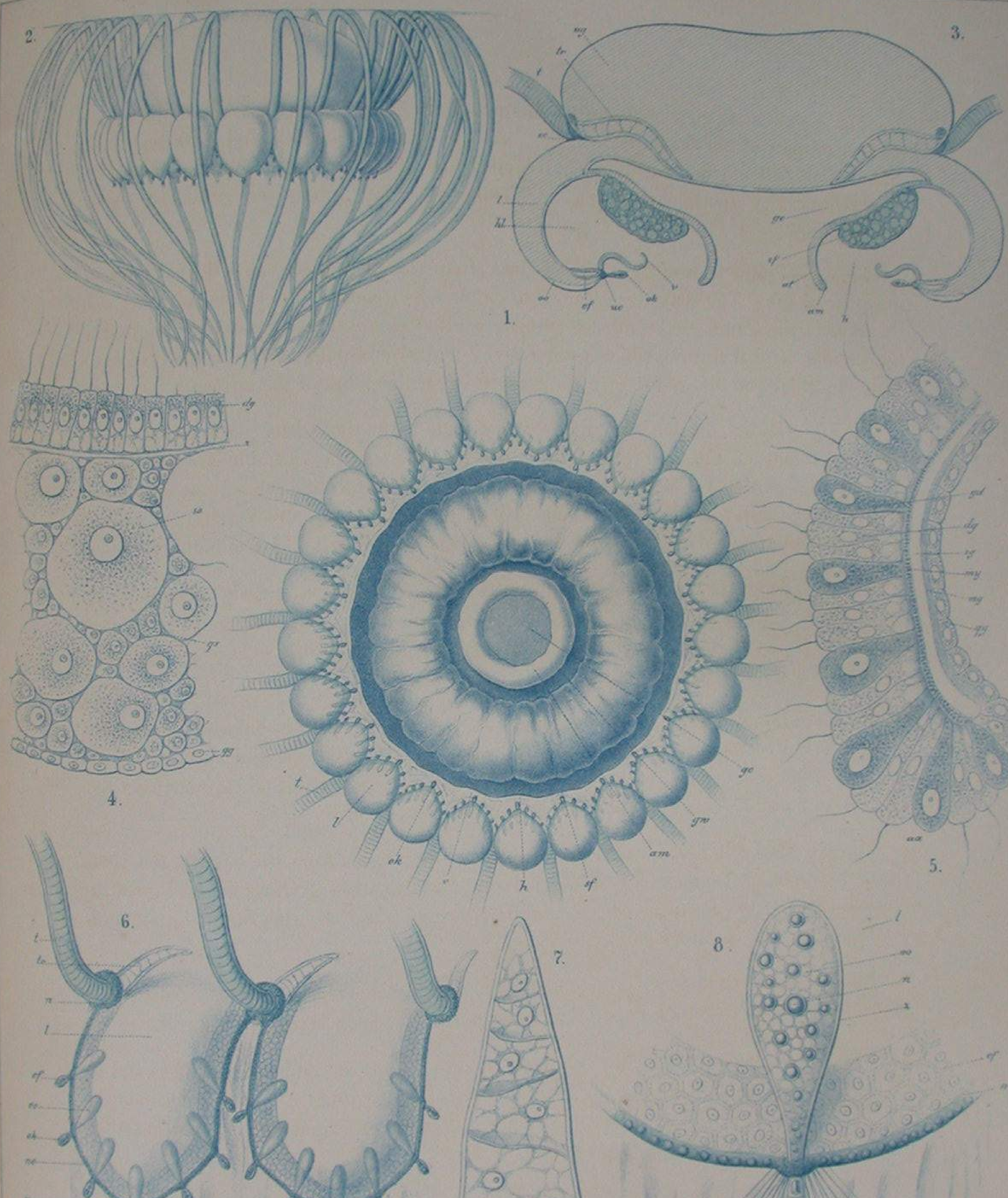
Fig. 4.—Tangential transverse section through the ovary, greatly enlarged. *dg* Endodermal epithelium of the subumbral gastral wall. *z* Supporting plate (fulcral lamella). *qs* Ectodermal germinal cells (young ova). *so* Mature ova cells. *qg* Ectodermal epithelium of the subumbrella.

Fig. 5.—Longitudinal section through the œsophagus, greatly enlarged. *dg* High cylindrical epithelial cells of the endoderm. *gd* Flask-shaped glandular cells between the epithelial cells. *zg* Thick supporting lamella. *mg*, Longitudinal muscles. *mg*, Transverse muscles. *qg* Flat epithelial cells of the ectoderm.

Fig. 6.—Two collar lobes, with the surrounding parts seen from the outside, ten times the natural size. *t* Tentacles. *tr* Tentacle roots. *n* Urticating swelling at the bars of the tentacle roots. *cf* Festoon canal. *nc* Urticating ring of the umbrella margin. *oo* Otoporpæ. *ok* Auditory clubs. *v* Velum.

Fig. 7.—A tentacle root, greatly enlarged and foreshortened. We see clearly the branched streams of protoplasm running from its nuclear layer to its mural layer.

Fig. 8.—A small piece of the umbrella margin, with an auditory club (*oh*) and its otoporpæ (*oo*); greatly enlarged. *n* Spheroidal nematocysts. *z* Supporting lamella. *l* Gelatinous substance of the umbrella collar. *cf* Festoon canal. *nc* Urticating ring. *oh* Auditory hairs. *ot* Otolites. *v* Velum.



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POLYCOLPA FORSKALII.

PLATE XI.

PEGANTHA PANTHEON.

Fig. 1.—The entire Medusa, seen from the side and somewhat from below, four times the natural size. The eighteen tentacles are retroverted upwards. The lobes of the umbrella collar are delicately bordered with otoporpæ and auditory clubs, below which the velum projects freely.

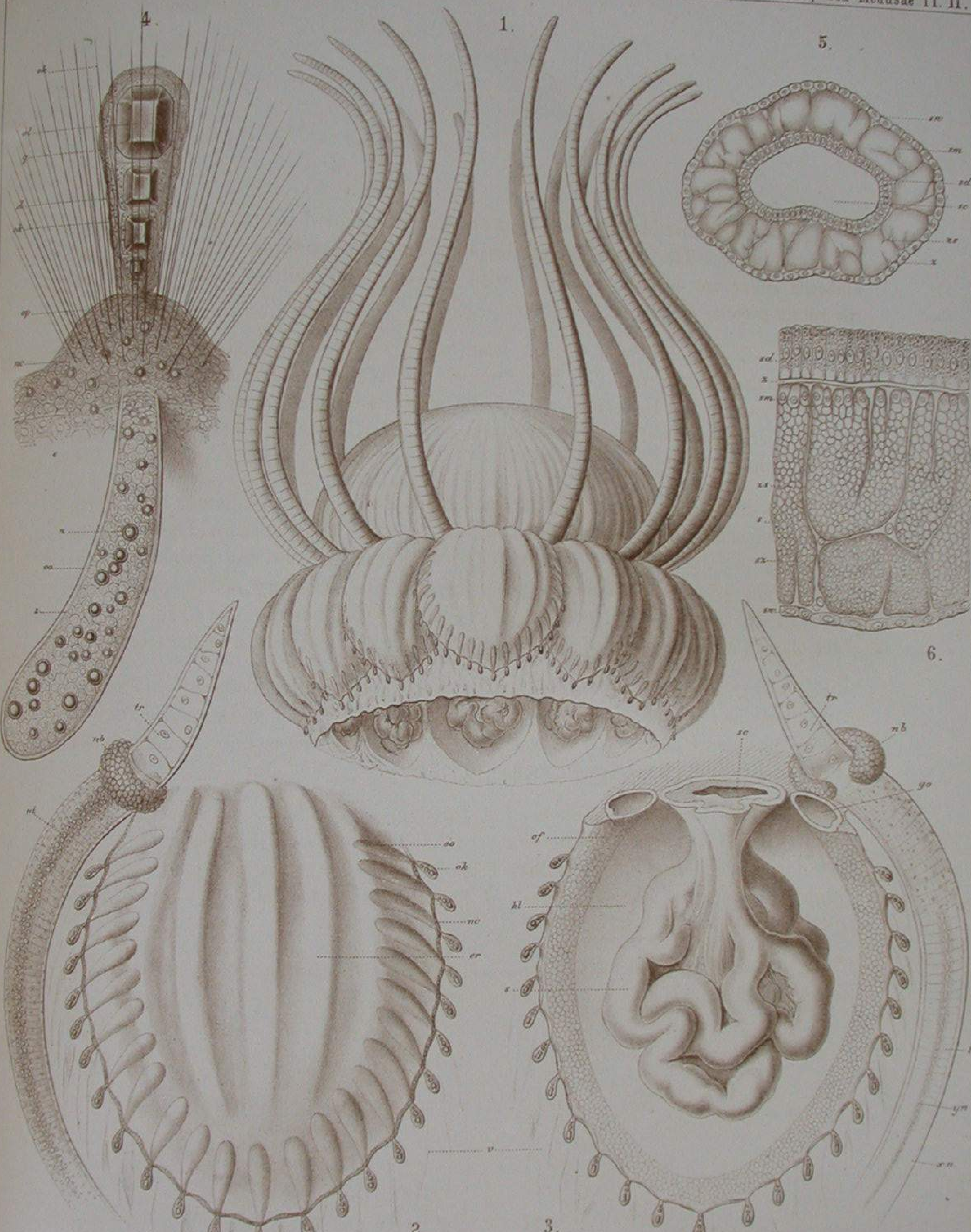
Fig. 2.—Exumbral view of a collar lobe (from outside) with an adjacent tentacle (*t*) ten times the natural size. *er* Longitudinal ribs of the exumbrella. *oo* Otoporpæ. *ok* Auditory club. *nc* Urticating ring of the umbrella margin. *v* Velum. *tr* Tentacle root. *nb* Urticating swelling at the tentacle base. *nt* Urticating streaks on the abaxial surface of the tentacle.

Fig. 3.—Subumbral view of a collar lobe (from inside) with an adjacent tentacle (*t*), ten times the natural size. The folded testis sac (*s*) hangs freely in the middle in the lobe cavity (*hl*). *sc* Opening of the cavity of the spermarium into the periphery of the stomach. *go* opening of the festoon canal (*cf*) into the periphery of the stomach. *tr* Tentacle root. *nb* Urticating swelling at the base of the tentacle. *yn* Chain of nuclei of the chordal cells of the endodermal axis. *xn* Urticating epithelium of the ectoderm.

Fig. 4.—An auditory club (*ok*) with its otoporpa (*oo*) greatly enlarged. *q* Ectoderm. *oh* Auditory hair of the ectoderm. *d* Endoderm. *ol* Otolites of the endoderm. *op* Auditory pad (sense knob). *nc* Urticating ring of the umbrella margin. *e* Exumbrella. *n* Urticating cells. *z* Supporting lamella.

Fig. 5.—Horizontal transverse section through a testis sac. *su* Subumbral ectodermal epithelium. *zs* Supporting fibres containing nuclei, of the testis. *sz* Mature spermatozoa (zoospermia). *sm* Mother cells of the spermatozoa (male nuclear cells). *z* Supporting plate or fulcral lamella. *sd* Endodermal epithelium of the cavity of the genital sac (*sc*).

Fig. 6.—A small piece of the same section of the testis (fig. 5) greatly enlarged. Letters as in fig. 5.



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PEGANTHA PANTHEON.

PLATE XII.

PEGANTHA PANTHEON.

Fig. 7.—Radial section through the entire Medusa five times the natural size (semi-diagramatic). *ug* The solid gelatinous umbrella lens. *t* Tentacles. *tr* Tentacle roots. *ec* Horizontal coronal furrow of the umbrella. *lm* Gelatinous collar lobes. *oo* Otoporpæ. *v* Velum. *cf* Festoon canal. *sm* Testes. *sc* Gastral cavity of the testis. *yc* Central gastral cavity. *ga* Œsophagus. *a* Oral opening. *dg* Endoderm of the subumbral gastral wall. *qg* Ectodern of the subumbral gastral wall.

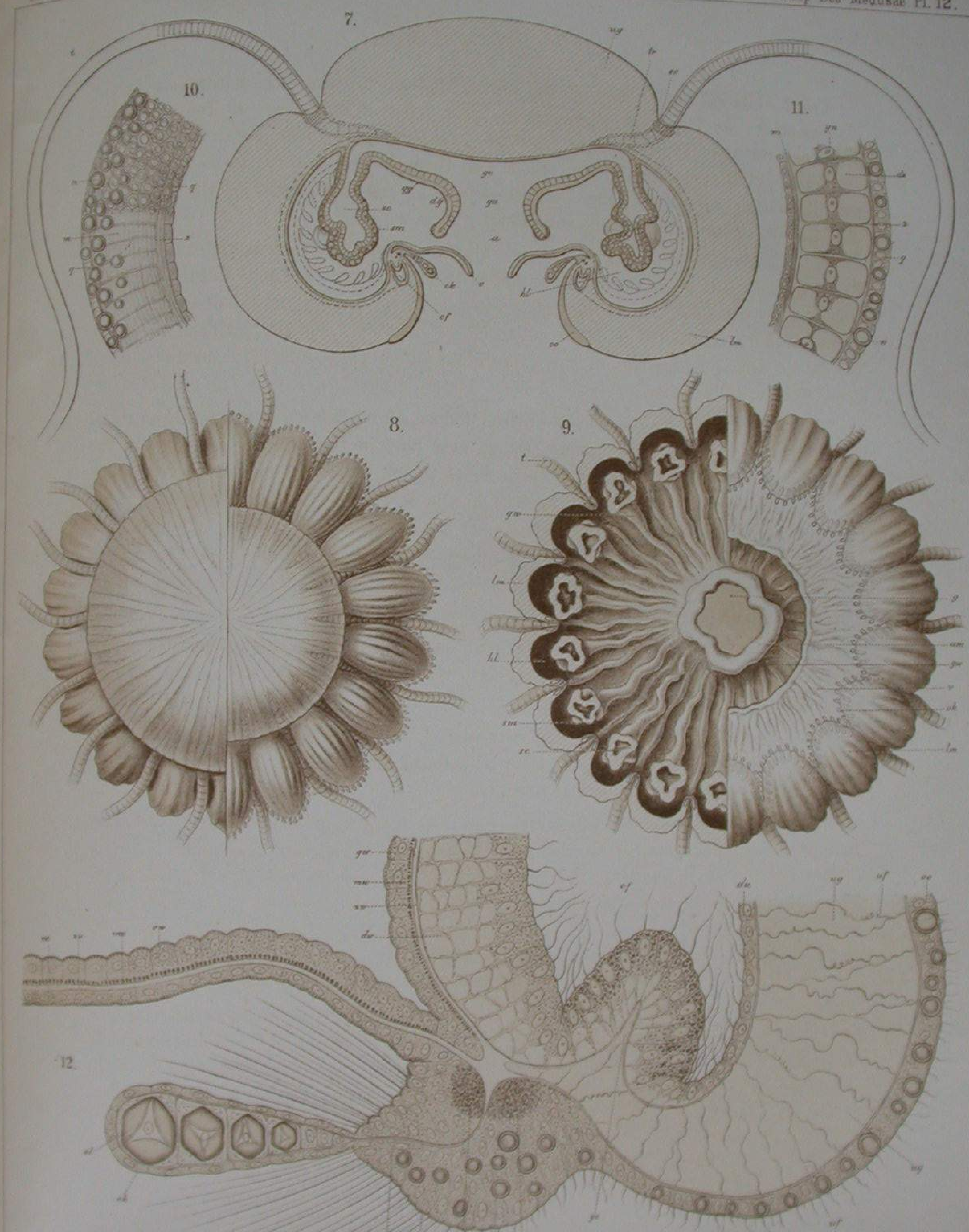
Fig. 8.—Exumbral view of the entire Medusa (from below), four times the natural size. In the left half of the figure the umbrella lens is spead out flat, and the umbrella lobes turned inwards (in their natural position), whilst in the right half the umbrella lens is strongly contracted and the collar lobes spread out flat (by artificial pressure). We see the strong radial ribs of the exumbrella which pass from the central lens on to the peripheric collar lobes.

Fig. 9.—Subumbral view of the entire Medusa (from below), four times the natural size. In the right half of the figure the greater part of the umbrella is hidden by the broad folded velum (*v*) and by the collar lobes which are turned inwards (*lm*), whilst these are removed by a horizontal section in the left half. By this section the testes (*sm*) are halved and their cavity opened; we see how they lie protected by the lobe cavities (*hl*) and run out from the peripheric walls of the shallow stomach whose subumbral wall (*gw*) is laid in deep folds. *g* Bottom of the shallow gastral cavity. *am* Margin of the mouth.

Fig. 10.—A portion of the distal part of a tentacle, moderately enlarged. *q* Ectoderm cells. *n* Spheroidal nematocysts of the ectoderm cells. *m* Longitudinal muscular fibres. *z* Supporting plate.

Fig. 11.—A similar portion of the tentacle in longitudinal section, moderately enlarged. Letters as in fig. 10. *dz* Chordal cells of the endoderm. *yn* Central nuclei of the chordal cells (in the axis of the tentacle).

Fig. 12.—Radial section through the umbrella margin, greatly enlarged. *v* Velum. *vu* Subumbral epithelium of the velum. *mv* Circular muscles of the velum (in transverse section). *zv* Supporting lamella of the velum. *ve* Exumbral epithelial of the velum. *ok* Auditory club. *ol* Otolites (in which a nucleus, tinged red, is visible after treatment with acetic acid and carmine). *oh* Auditory hairs. *nc* Urticating ring of the umbrella margin. *rc'* Dorsal nerve ring (in transverse section). *rc"* Ventral nerve ring. *oo* Otoporpa. *ug* Gelatinous substance of the umbrella. *uf* Elastic fibres in the gelatinous substance. *cf* Distal part of the festoon canal (in transverse section). *yc* Lobe on the lower margin of the festoon canal. *du* Umbral endoderm epithelium. *dw* Subumbral endoderm epithelium of the festoon canal. *zw* Supporting lamella of the subumbrella. *mw* Circular muscular layer of the subumbrella. *qw* Ectoderm epithelium of the subumbrella.



PEGANTHA PANTHEON.

PLATE XIII.

ÆGINURA MYOSURA.

Fig. 1.—The entire Medusa in profile, twice the natural size. *ug* Gelatinous substance of the umbrella. *t* Tentacles. *en* Peronia. *ck* Peronial canals. *cm* Marginal canal. *nc* Urticating ring of the umbrella margin. *bs* Internemal genital pouches (lobe pouches). *ok* Auditory clubs. *z* Supporting plate. *v* Velum (hanging loose).

Fig. 2.—The entire Medusa seen from below with strongly contracted umbrella margin, three times the natural size. Letters as in fig. 1. The four-lobed oral opening (*aw*) is visible below in the middle. *w* Subumbrella.

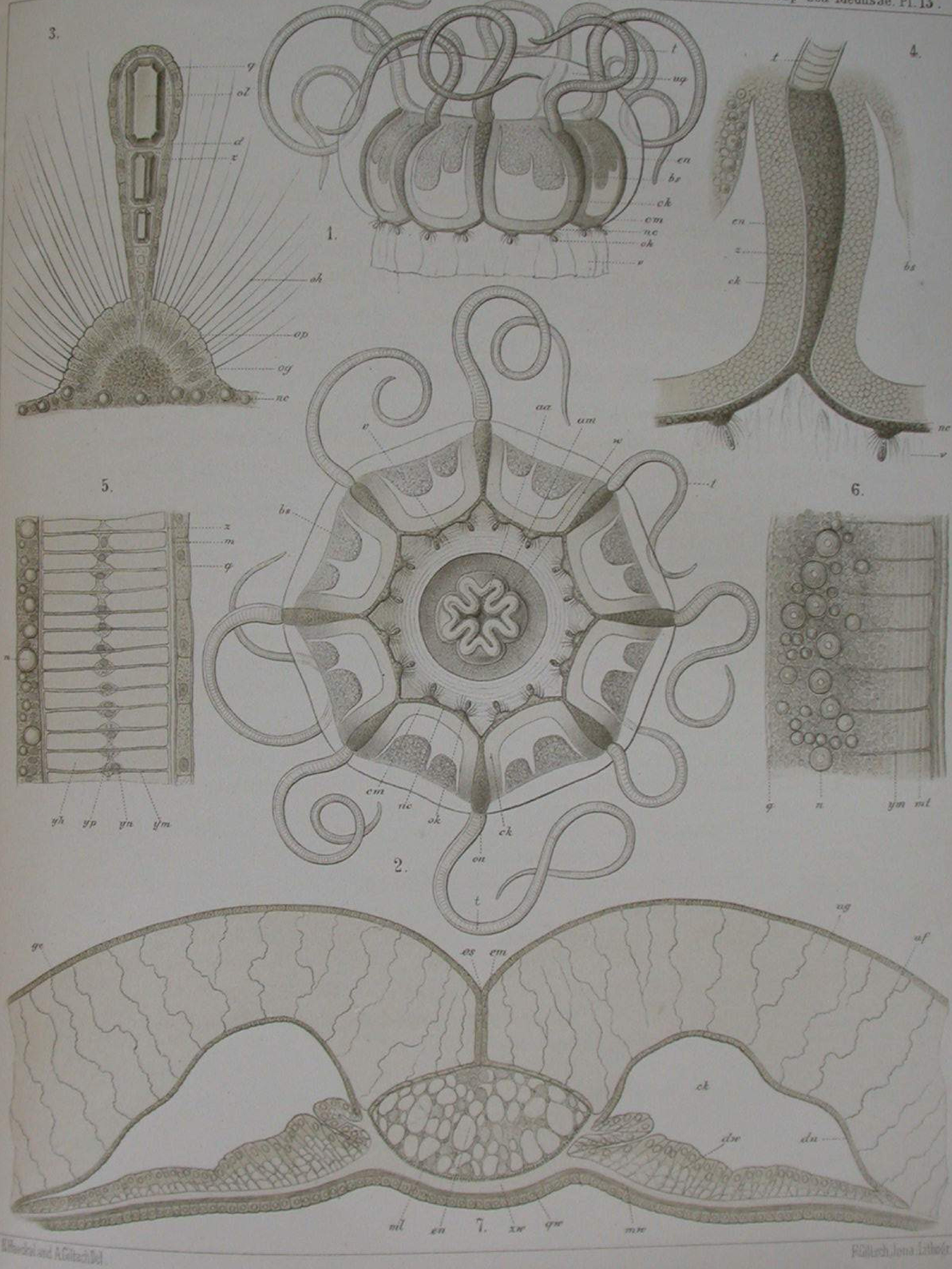
Fig. 3.—An auditory club greatly enlarged. *q* Flat sense cells of the ectoderm. z Supporting plate. *d* Endodermal otolite cells. *ol* Otolite. *oh* Auditory hairs. *op* Auditory pad. *og* Ganglion acusticum. *nc* Urticating ring of the umbrella margin.

Fig. 4.—A peronium (*en*) with the surrounding parts, seen from outside, eight times the natural size. Letters as in fig. 1.

Fig. 5.—Longitudinal section through a portion of the distal part of a tentacle greatly enlarged. *q* Ectodermal epithelium; *h* its nematocysts. *m* Longitudinal muscles. *z* Supporting plates. *y* Coin-shaped discoid cells of the endodermal axis. *ym* Thick membranes of the axis. *yh* Cavity of the axis filled with clear gelatinous substance (?). *yp* Protoplasmic cord in the axis of the cavity. *yn* Central cell nucleus.

Fig. 6.—A portion of the distal part of a tentacle seen from the outside, greatly enlarged. *q* Ectodermal epithelium; *n* its nematocysts. *mt* Muscular plate (with longitudinal fibres). *ym* Septa of the chordal cells of the endodermal axis.

Fig. 7.—Horizontal section through a peronium (*en*), with the two adjacent peronial canals (*ck*), and the surrounding parts of the umbrella, 120 times the natural size. *es* Peronial furrow of the exumbrella. *em* Peronial plate. *qe* Ectodermal epithelium of the exumbrella. *ug* Gelatinous substance of the umbrella. *uf* Elastic fibres of the gelatinous substance. *ck* Peronial canals. *du* Flat umbral endodermal epithelium; *dw* high subumbral epithelium of the peronial canals. *en* Urticating skeletal cells of the peronium. *ml* Peronial muscle (longitudinal fibres). *g* Supporting plate of the subumbrella. *mw* Circular muscular layer of the subumbrella. *qw* Ectodermal epithelium of the subumbrella (comp. Pl. XIV. fig. 12).



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AEGINURA MYOSURA.

PLATE XIV.

ÆGINURA MYOSURA.

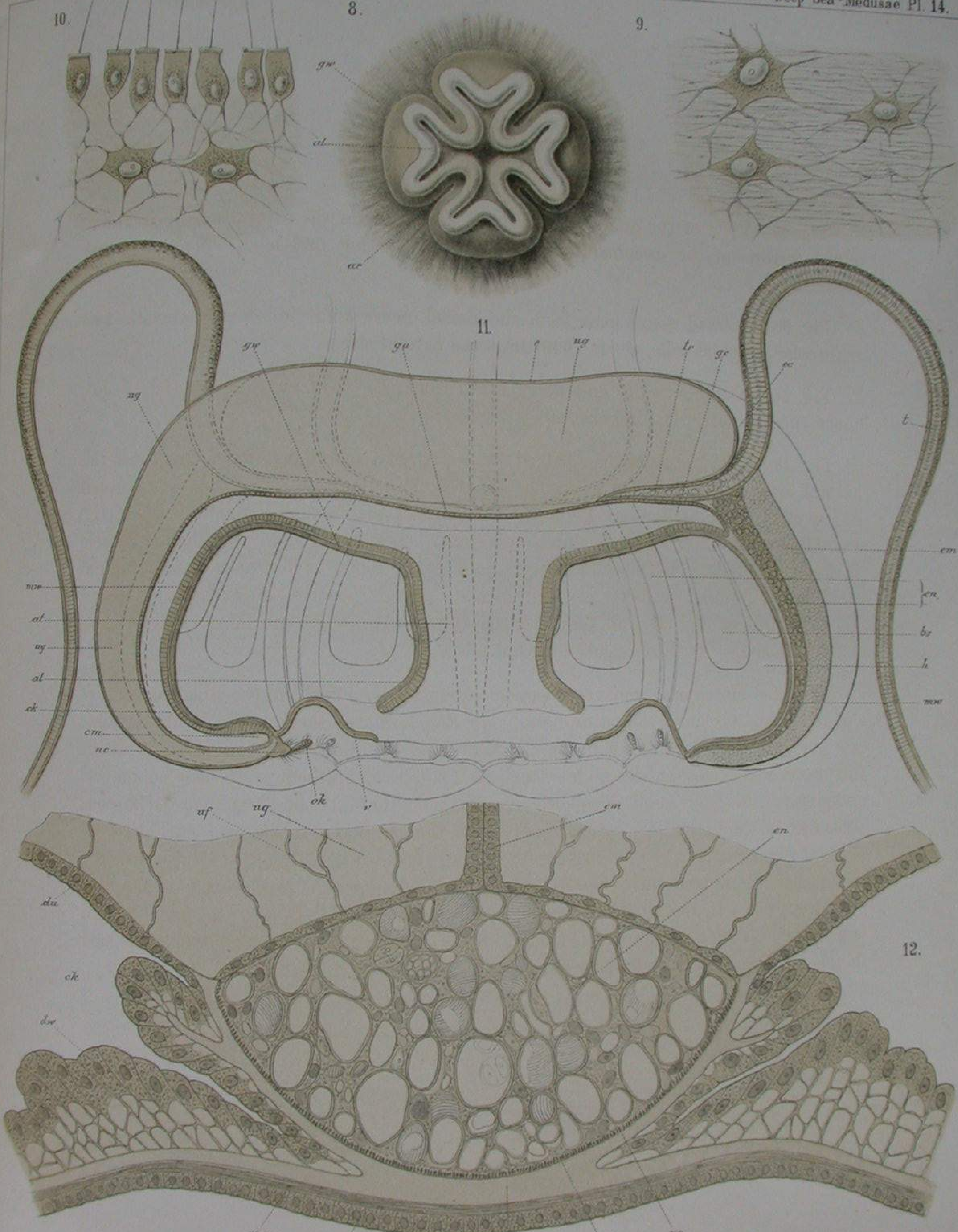
Fig. 8.—View of the œsophagus from below, six times the natural size. *ar* Interradial furrows of the œsophagus. *al* Perradial bordering oral lobes. *gw* Subumbral gastral wall.

Fig. 9.—Isolated sense cells from the dorsal nerve ring, in connection with two multipolar ganglion cells, about 1000 times the natural size.

Fig. 10.—Ganglion cells and nerve fibres from the auditory ganglion (fig. 3, *og*), about 1000 times the natural size.

Fig. 11.—The entire Medusa halved by a perradial meridian section, five times the natural size. *ug* Gelatinous substance of the umbrella. *e* Exumbrella. *ec* Coronal furrow of the exumbrella. *en* Peronia. *em* Peronial plates. *nc* Urticating ring of the umbrella margin. *ok* Auditory clubs. *v* Velum. *w* Subumbrella. *mw* Circular muscle of the subumbrella. *h* Umbrella cavity. *tr* Tentacle roots. *t* Tentacles. *cm* Marginal canal. *ck* Peronial canals. *bs* Internemal gastral pouches (testes). *gc* Central stomach: *gu* its umbral wall (cover of the stomach); *gw* its subumbral wall (bottom of the stomach). *at* Œsophagus. *al* Oral lobes.

Fig. 12.—Horizontal transverse section through a peronium and the adjacent parts of the umbrella, 400 times the natural size. *qw* Ectodermal epithelium of the subumbrella: *mw* its muscular layer; *zw* its supporting plate. *ck* Lumen of the peronial canals (in transverse section): *dw* high vacuolised cylindrical epithelium of their subumbral endoderm; *du* flat, small dice-epithelium of their umbral endoderm. *ug* Gelatinous substance of the umbrella. *uf* Elastic fibres of the gelatinous substance. *en* Urticating skeletal tissues of the peronium (the urticating thread, whose spiral windings have the appearance of fine transverse streaks, has fallen out of many of the transected thick-walled nematocysts). *ml* Longitudinal muscular fibres on the axial side of the peronium, in transverse section. *zp* Supporting lamella of the peronium. *en* Peronial plate (embedded double lamella of the ectodermal epithelium, comp. Pl. XIII. fig. 7).



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AEGINURA MYOSURA.

PLATE XV.

TESSERANTHA CONNECTENS

The meaning of the letters is the same throughout.

a Oral opening.
ak Buccal ribs (perradial).
al Oral lobes (perradial).
ar Oral grooves (interradial).
bp Gastral pouches (perradial).
cs Coronal sinus.
er Exumbral urticating ribs.
er' Eight larger principal urticating ribs.
er'' Eight smaller adradial urticating ribs.
f Gastral filaments.
ft Tæniola.
ga Oral stomach (œsophagus).
gb Basal stomach (apical canal).
gc Central stomach (principal cavity).
gn Grooves of the basal stomach (perradial).
go Gastral openings (perradial).
gp Palatine opening (porta palatina).
gy Pyloric opening (porta pylorica).
hc Cavity of the umbrella corona (autrum coronæ).
ii Funnel cavities (interradial).
kn Septal nodes (cathamma).
l Marginal lobes.
mb Buccal muscles.
mc Coronal muscle.
md' Perradial deltoid muscle.
md'' Interradial deltoid muscle.
oc Ocelli (pigment eyes).
p Apical process (umbrella peduncle).
s Genitalia (or reproductive glands).
ta Adradial tentacles.
ti Interradial tentacles.
tp Perradial tentacles.
ug Gelatinous substance of the umbrella.
uw Subumbrella.
wr Mesenteries (mesogonia, perradial).
z Supporting plate (fulcral lamella).

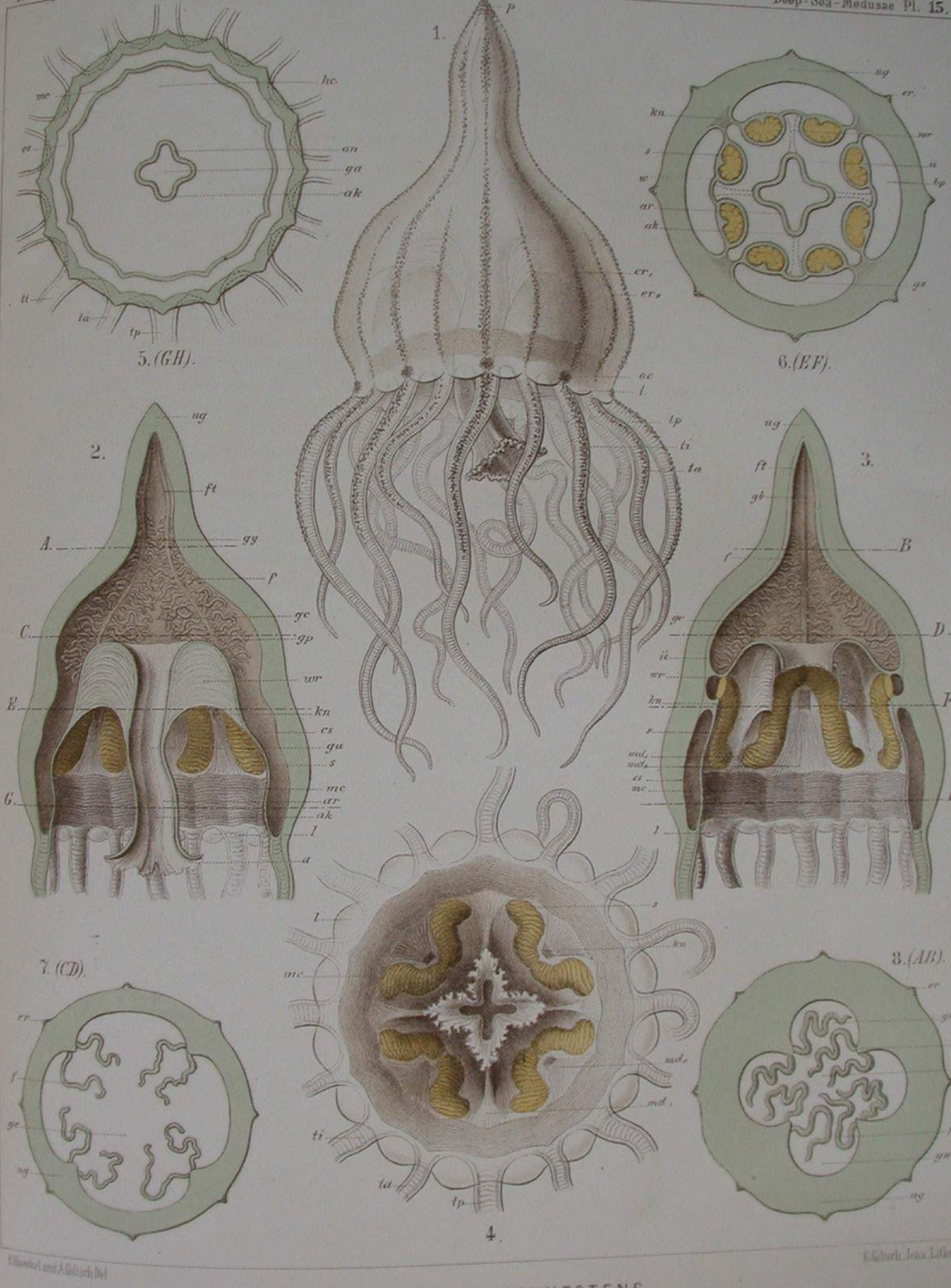
Fig. 1.—The entire Medusa in profile, ten times the natural size. Sixteen darkly pigmented longitudinal urticating ribs project on the exumbrella; eight longer principal ribs (four perradial and four interradial, *er'*), and eight alternating shorter adradial ribs (*er''*) only strongly developed below. Eight black ocelli (*oc*) lie at the base of the eight principal tentacles.

Fig. 2.—Perradial section through the umbrella, ten times the natural size; in the middle, the pendant œsophagus, fastened at its base by the mesenteries (*wr*).

Fig. 3.—Interradial section through the umbrella, ten times the natural size; the œsophagus is removed in order to show the genitalia and muscles of the subumbrella.

Fig. 4.—The subumbrella seen from below, ten times the natural size. In the middle, the perradial oral cross with the frilled oral lobes; round these the four interradial septal nodes (*kn*) and the genitalia (*g*).

Figs. 5–8.—Transverse sections through the umbrella, at the four heights, given in figs. 2 and 3, by the horizontal lines *AB*, *CD*, *EF* and *GH*. Figs. 5–7 are ten times, fig. 8 forty times, the natural size. The first transverse section, (fig. 5, *GH*) is made through the coronal sinus (*cs*) and coronal muscle (*mc*); the second (fig. 6, *EF*) through the four septal nodes (*kn*) and mesogonia (*wr*); the third (fig. 7, *CD*) through the central stomach (*gc*); and the fourth (fig. 8, *AB*) through the basal stomach (*gb*).



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TESSERANTHA CONNECTENS.

PLATE XVI.

LUCERNARIA BATHYPHILA.

The meaning of the letters is the same in all the figures.

aa Oral opening.
ak Buccal ribs (perradial).
am Oral margin.
bl Lobe pouches (arm pouches).
bp Perradial gastral pouches.
cc Circular canal.
d Endoderm.
e Exumbrella.
f Gastral filaments.
ft Tæniola (interradial gelatinous ridges).
ga Oral stomach (oral tube).
gb Basal stomach (peduncle canal).
gk Palatine nodes (perradial).
gn Niches of the basal stomach.
go Gastral openings (perradial).
gp Palatine opening (porta palatina).
gy Pyloric opening (porta pylorica).
h Umbrella cavity.
ii Interradial funnel cavities.
ks Cathammal septa (interradial fused ridges).
l Marginal lobes (arms).
md' Perradial deltoid muscles.
md" Interradial deltoid muscles.
ma" Bending muscles of the arms.
mm' Perradial marginal muscles.
mm" Interradial marginal muscles.
nt Urticating knobs of the tentacles (stalked sucking cups).
p Umbrella peduncle.
pb Adherent caudal disc (base of the peduncle).
q Ectoderm.
g Genitalia (ovaries).
sb Sacs of the ovaries.
sk Follicles of the ovarial sacs.
so Ova.
tf Bunches of tentacles.
ug Gelatinous substance of the umbrella.
um Umbrella margin.
w Subumbrella.
wr Mesogonia (perradial mesenteric folds).
z Supporting plate (fulcral lamella).

Fig. 1.—The entire Medusa, in interradial profile view, the natural size.

Fig. 2.—Interradial section through the entire Medusa, one and a half times the natural size.

Fig. 3.—Perradial section through the entire Medusa, one and a half times the natural size.

Fig. 4.—Subumbral view of the entire Medusa (from below), the natural size.

Fig. 5.—Horizontal transverse section through the distal part of the body at the height of the line *CH* (fig. 3), natural size.

Fig. 6.—Horizontal transverse section through the middle part of the body (through the palatine opening), at the height of the line *EF* (fig. 3), natural size.

Fig. 7.—Horizontal transverse section through the proximal part of the body (through the gastral openings) at the height of the line *CD* (fig. 3), natural size.

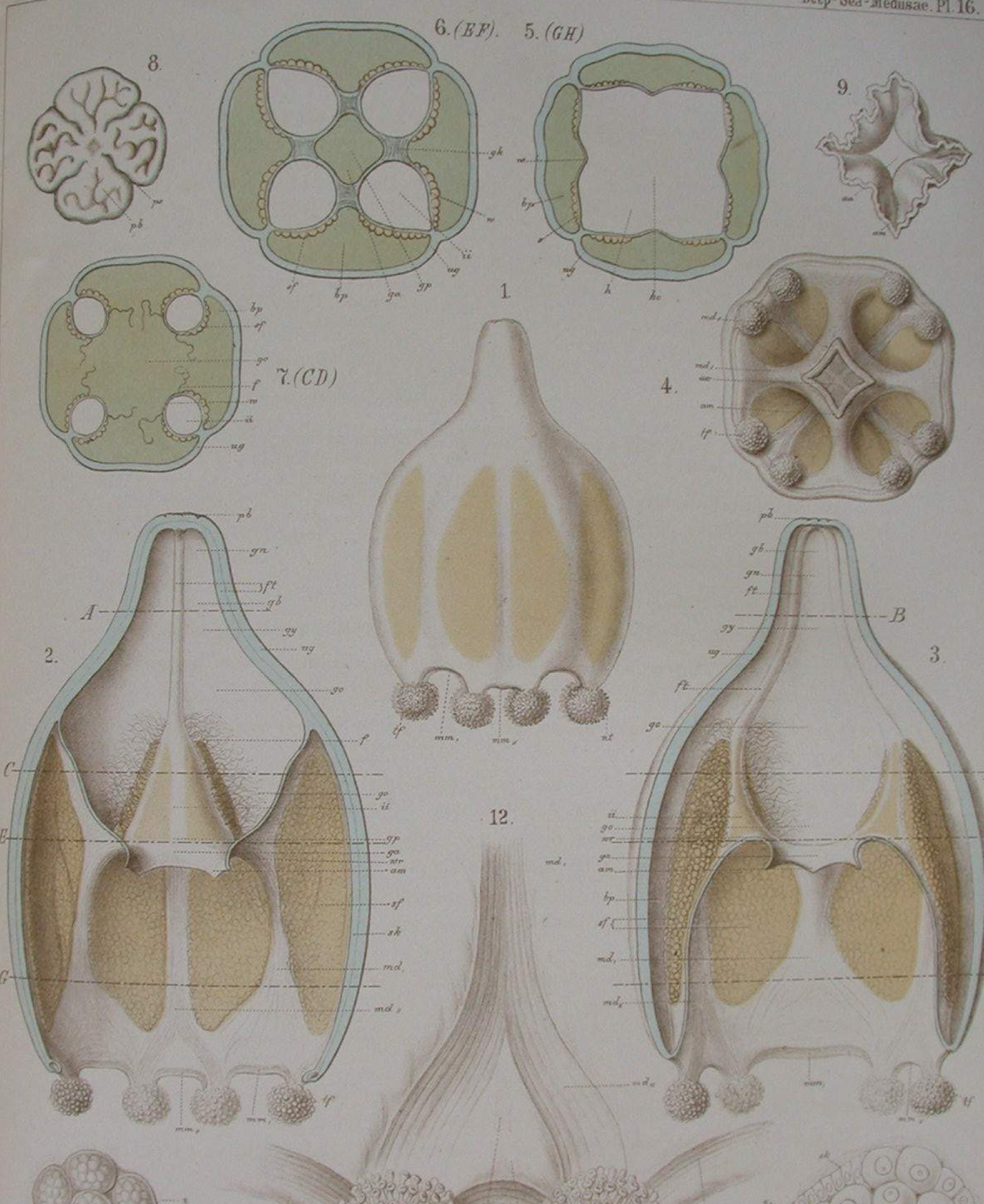
Fig. 8.—The adherent caudal disc of the umbrella peduncle seen from above (from the ectodermal surface of adhesion), with four interradial furrows and with irregular swellings, four times the natural size.

Fig. 9.—The oral opening with the four slightly developed oral lobes from below (seen from the oral surface) four times the natural size.

Fig. 10.—A saculus of the ovarium, composed of numerous follicles separated by fulcral sheaths, seventy times the natural size.

Fig. 11.—A folliculus of the ovarium, composed of endodermal germinal epithelium and numerous ova, enclosed in a fulcral sheath, 300 times the natural size.

Fig. 12.—A pair of arms with their interradial deltoid muscles and the cathammal septal ridges, four times the natural size.



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LUCERNARIA BATHYPHILA.

PLATE XVII.

LUCERNARIA BATHYPHILA.

Fig. 13.—Horizontal transverse section through the umbrella peduncle above the adherent caudal disk (at the height of the line *AB*, fig. 3), twenty times the natural size. *gb* Basal stomach (central peduncle canal). *gn* Peripheric niches of the basal stomach. *ug* Gelatinous wall of the umbrella peduncle. *uf* Elastic fibres in the gelatinous wall. *q* Ectodermal epithelium of the exumbrella. *d* Endodermal epithelium of the basal stomach. *ft* The four interradial tæniola (or gelatinous longitudinal ridges of basal stomach). *z* Gelatinous plate of the tæniola. *m* Longitudinal muscles of the peduncle. *ed* The four interradial longitudinal furrows of the peduncle (on the exumbral side of the tæniola).

Fig. 14.—Horizontal transverse section through a tæniolum (or a longitudinal muscular gelatinous ridge of the umbrella peduncle), eighty times the natural size (comp. fig. 13). *d* Endoderm of the basal stomach. *ft* Gelatinous substance of the tæniolum. *m* Longitudinal muscular fibres, distributed in dendritically branched folds of the gelatinous plate. *q* Ectoderm cells (epithelial muscular cells ?) in the centre of the tæniolum.

Fig. 15.—Adradial longitudinal section through one of the eight bunches of tentacles, ten times the natural size. *bl* Lobe pouch (or "brachial cavity"). *d* Endoderm. *z* Thickened gelatinous plate. *m* Longitudinal muscle (limb of a deltoid muscle). *q* Ectoderm. The single tentacles (which all have a sucking-cup at the end) are only free in the distal half, but are all connected with each other by a gelatinous mass in the proximal half.

Fig. 16.—Longitudinal section through a sucking-cup (at the distal end of a tentacle), fifty times the natural size. *gx* Dimple-like depression in the middle of the sucking-cup, with low epithelium without nematocysts. *q* High cylindrical epithelium of the sucking-cup, with adhesive glands and nematocysts (*n*). *g* Gelatinous supporting plate. *d* Endoderm of the central tentacle canal (*ct*). *y* Peculiar conical axial cones in the cæcal distal end of each tentacle canal, which dye deep red by carmine.

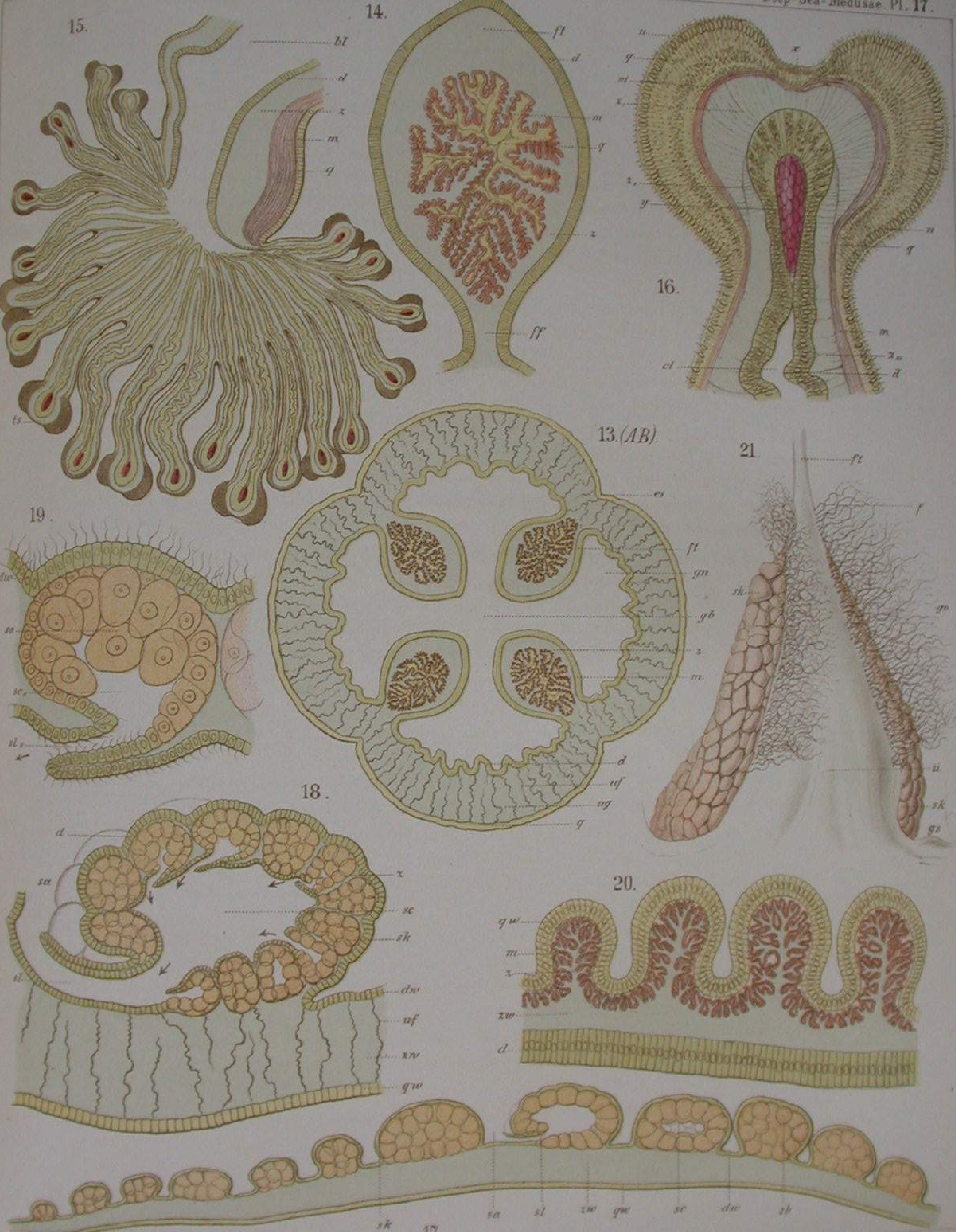
Fig. 17.—Horizontal transverse section through an ovary (in the subumbral wall of a perradial gastral pouch), slightly enlarged. *qw* Ectodermal epithelium of the subumbrella. *zw* Gelatinous supporting plate of the subumbrella. *sk* The separate lobes or sacculi of the ovary, moderately enlarged (comp. fig. 11). *sb* The small follicles composing the sacs. *sc* Genital sinus. (*sl*) Oviduct. *sa* Opening of the oviduct into the radial pouch. *dw* Endoderm.

Fig. 18.—Longitudinal section through a folliculus of the ovary, moderately enlarged (comp. fig. 10). The arrows show the openings of the ovarial follicles (*sb*) by which the latter open into the "genital sinus," *sc* (or cavity of the sacculus). The sinus opens by the oviduct (*sl*) into the perradial gastral pouches. Letters as in fig. 17.

Fig. 19.—Longitudinal section through a follicle of the ovary, greatly enlarged (comp. fig. 11). *dw* Endodermal epithelium of the perradial gastral pouch. *so* Ova. *sc*" Follicle cavity, from which the mature ova reach the genital sinus (or cavity of the sacculus) by the oviductulus, *sl*" (comp. fig. 18).

Fig. 20.—Radial transverse section through the circular marginal muscle, showing the dendritic supporting folds of the fulcrum, slightly enlarged. *qw* Ectodermal epithelium of the subumbrella. *m* Muscular plate. *zw* Supporting plate of the subumbrella. *d* Endodermal epithelium of the gastral pouches.

Fig. 21.—An umbrella funnel with the adjacent gastral openings (*go*) slightly enlarged, seen from the inside. *gd* Palatine groove (oral end of the gastral opening). *gk* Ovarial sacculi. *f* Gastral filaments bordering the margins of the gastral openings). *ft* Tæniola.



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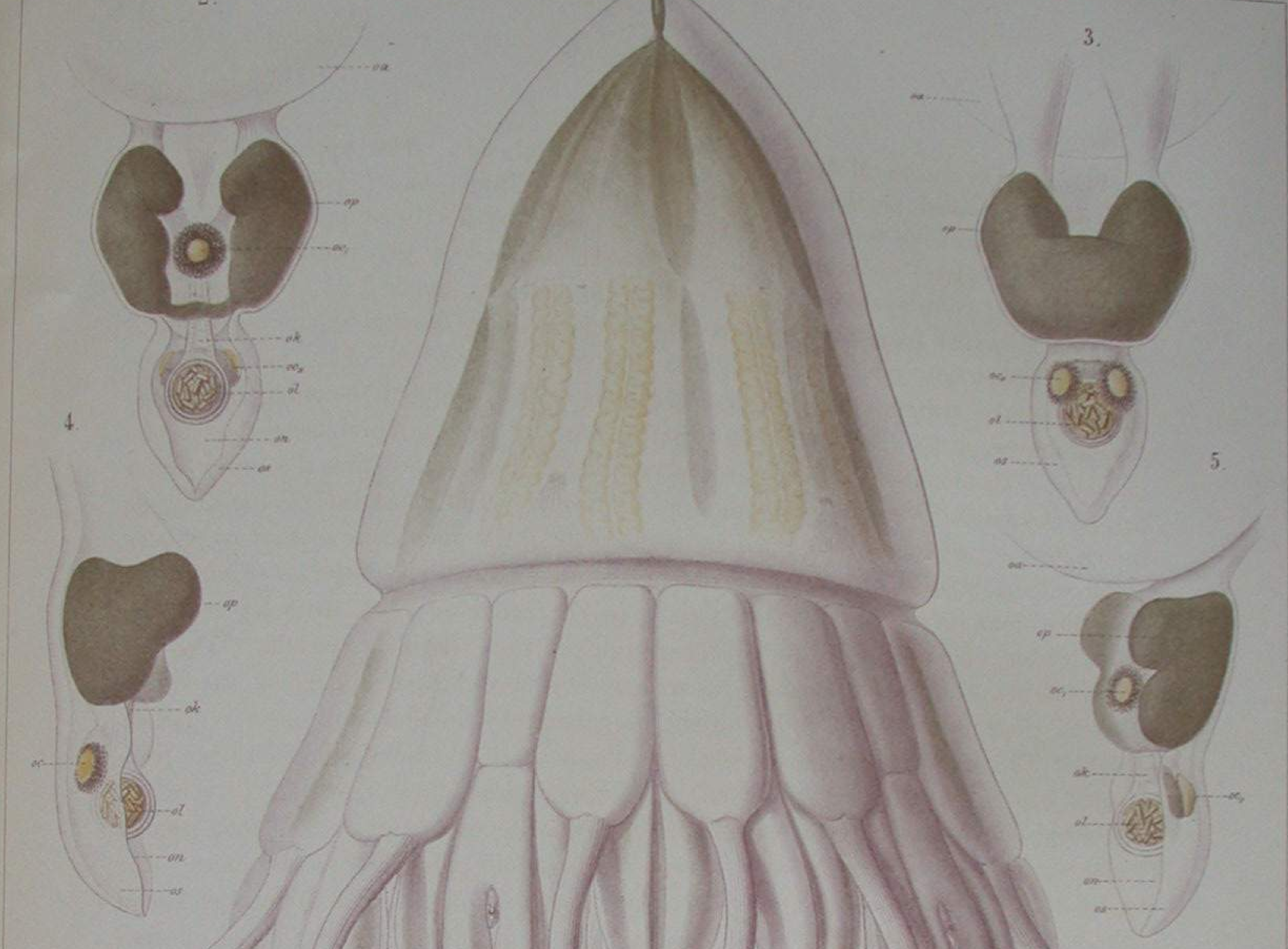
LUCERNARIA BATHYPHILA.

PLATE XVIII.

PERIPHYLLA MIRABILIS.

Fig. 1.—The entire Medusa (profile view), natural size. The upper half of the umbrella is occupied by the smooth, thick-walled umbrella cone ("conus umbralis"), whose thick gelatinous wall is traversed at the point by the basal peduncle canal. A perradial (lanceolate) niche of the basal stomach, enclosed by two conical basal (interradial) funnel cavities, shines in the middle through the upper half of the umbrella cone. A perradial (narrowly lanceolate) gastral opening, having a pair of yellowish testes on either side, shines in the middle through the lower half of the umbrella cone. A deep circular stricture is formed at the middle of the height of the umbrella, by the coronal furrow, at the bottom of which circular fibres of the exumbral zonal muscles are indicated. The umbrella corona ("corona umbralis"), which occupies the entire lower half of the umbrellas begins below the coronal furrow. The upper half of the umbrella corona (or the pedal zone) is formed by the sixteen thick gelatinous sockets or pedalia, which are separated by sixteen subradial longitudinal furrows, whilst the lower half of the umbrella corona (or the lobe zone) is formed by the corona of lobes, tentacles and sense clubs, which are fastened at the distal margin of the gelatinous pedalia. The four interradial sense clubs lie on four narrower and shorter ocular pedalia, whilst the twelve tentacles (four perradial and eight adradial) are borne by broader and longer tentacular pedalia. The sixteen subradial coronal lobes consist of a thick oval gelatinous plate divided by a deep (precisely subradial) longitudinal furrow of the exumbrella into two limbs, and of a broad, thin membraned marginal selvage (patagium). The four pairs of ocular coronal lobes are longer but narrower than the four pair of tentacular lobes. The twelve tentacles form four groups, each consisting of a middle (perradial) and two lateral (adradial) tentacles. A strong longitudinal muscle is visible on the (axial) side of each tentacle, whilst the outer abaxial side shows transverse constrictions (comp. fig. 7, Pl. XIX.).

Figs. 2–5.—A sense club (rhopalium) seen from four different sides, moderately enlarged, in the natural position, with the point of the protective scale directed downwards, distalwards. Fig. 2. Axial view (from inside). Fig. 3. Abaxial view (from outside). Fig. 4. Profile view (from the side). Fig. 5. Oblique view (half from inside, half from the side). The letters have the same meaning in all four figures. *oa* Ampulla rhopalaris, below it the two limbs of the peduncle of the rhopalium. *op* Collar-shaped pigment pad with two limbs, closed like a circle below. *oc'* Axial unpaired eye with lens, between the limbs. *oc"* Abaxial paired eye. *og* Protective scale of the rhopalium. *on* sense niche on the hollow axial surface of the scale. *ok* Stalked auditory club. *ol* Spheroidal otolite sac with crystals.



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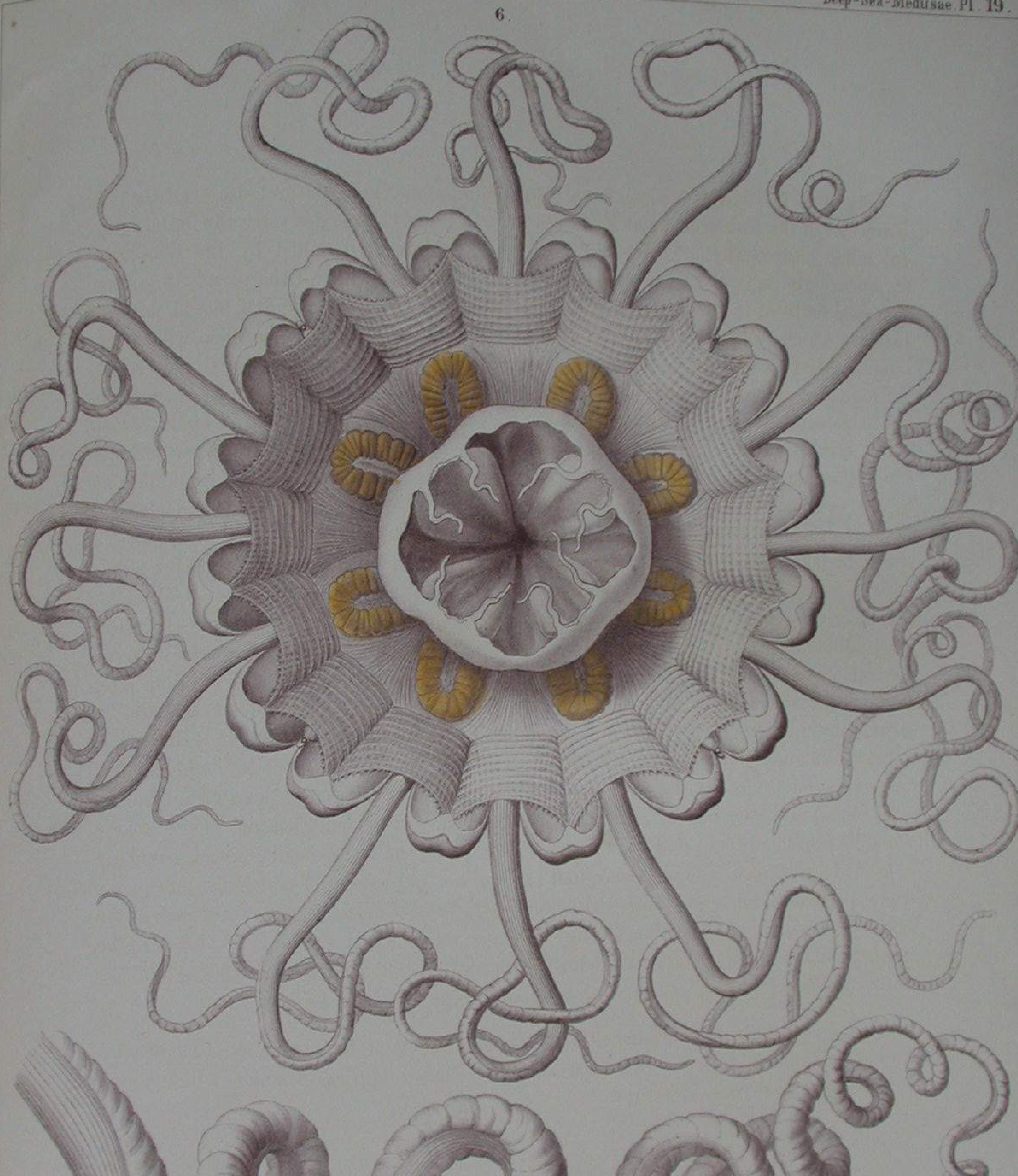
PERIPHYLLA MIRABILIS.

PLATE XIX.

PERIPHYLLA MIRABILIS.

Fig. 6.—The entire Medusa from below (subumbral view), natural size. Of the two diameters of the first order (which contain the four perradia) one lies vertically in the figure, the other horizontally. The central part of the figure is occupied by the œsophagus (or buccal stomach), the peripheric part by the subumbral view of the peripheric corona. The four limbs of the central oral cross are formed by the four perradial buccal pouches, between which the four interradial buccal columns with their broad adradial wings come prominently forward (in the diagonals of the figure). These wings are partly covered by the four pair of adradial oral filaments (barbulæ), which project centripetally towards the inside, from the inverted (clear) oral margin. The subumbrella of the umbrella corona, which surrounds the clear, almost quadrate oral margin is divided into three zones, of which the inner zone is formed by the deltoid muscles and the genitalia, the middle zone by the coronal muscle, and the outer zone by the lobe corona with its tentacles and rhopalia. The inner zone of the "subumbrella coronaris" shows the lower (oral) halves of the eight horseshoe-shaped adradial genitalia, whilst their upper (above) halves are hidden in pairs in the four interradial funnel cavities, and not visible in the figure. The eight reproductive glands (testes) are separated by eight triangular deltoid muscles (with longitudinal fibres, diverging distalwards); the four perradial deltoid muscles (in the vertical and horizontal diameter of fig. 6), are broader but shorter than the four alternating interradial deltoid muscles. The middle zone of the "subumbrella coronaris" is entirely occupied by the broad coronal muscle ("musculus coronaris"). It is divided by sixteen subradial peronia (which lie in the radia of the fourth order) into sixteen quadrangular coronal plates; the four interradial or ocular plates (corresponding to the four sense clubs) are considerably narrower than the twelve tentacular coronal plates, four of which lie perradially and four adradially. The outer zone of the "subumbrella coronaris" is formed by sixteen subradial marginal lobes or coronal lobes; of which the four pair of ocular (exradial) lobes are somewhat larger, and project more than the four pair of tentacular (corradial). The twelve strong tentacles are of equal size and divided into four groups, each of which consists of one medial (perradial) and two lateral (adradial) tentacles. An interradial sense club lies between each two groups of tentacles.

Fig. 7.—A tentacle, four times the natural size, showing the strong axial longitudinal muscle on its inner surface. The abaxial outer surface appears annulated like a worm by numerous transverse strictures.



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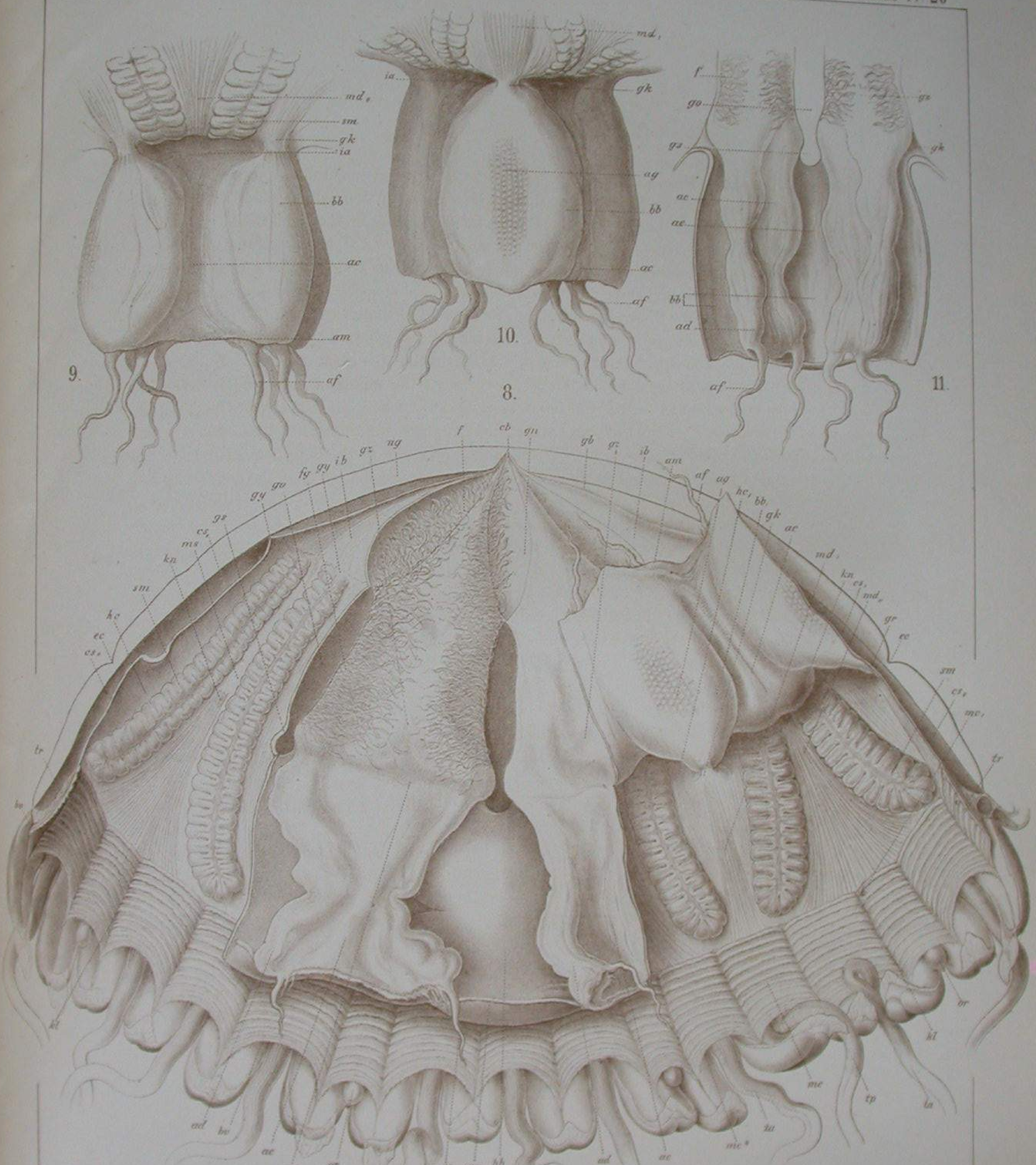
PERIPHYLLA MIRABILIS.

PLATE XX.

PERIPHYLLA MIRABILIS.

Fig. 8.—The entire Medusa, natural size, opened by a perradial longitudinal section and spread flat out. The œsophagus or buccal stomach (*ga*) is removed in the left third of the figure, is opened and flattened in the middle third, and retroverted upwards in the right third. A perradial buccal pouch of the œsophagus (from inside *bb*), and also an interradial buccal column (*ac*) with its adradial wings (*ad*) and oral filaments (*af*) are visible below in the middle. The buccal glands (*ag*) shine through on the subumbral surface of the retroverted buccal stomach. The middle of the figures gives a complete view of the three sections of the stomach. The central stomach (*gc*) is separated by the pyloric opening (pylorus *gy*) from the basal stomach, by the palatine opening (palatum *gp*) from the buccal stomach. The upper third of the principal intestine, the basal stomach (*gb*) forces itself through the narrow apical canal (*cb*) as far as the point of the umbrella cone, and is divided by four interradial conical funnel cavities (*ib*) into four peripheric niches (*gn*). The entire length of the margins of the niches are bordered by four pairs of diverging phacelli (or rows of filaments, *fb*). The central stomach (*gc*) communicates with the surrounding upper half of the large coronal sinus (*cs'*) by four fissure-shaped perradial gastral openings (*go*). The eight phacelli (*fy*) edge the entire length of the margins of the gastral ostia up to the palatine groove (*gd*). The delicate quadrangular obelisk plates (*gz*) lie between the phacelli. The entire extent of the subumbrella (*w*) is visible in the left third of the figure, but only its distal halves in the right third. The eight testes (*gm*), which lie in the subumbral wall of the coronal sinus (*cs*) form four pairs, separated by the four perradial gastral openings in their upper half (*go*), by the four palatine nodes (*gk*) in their middle, and by the four perradial deltoid muscles (*md'*) in their lower half. The two testes of each pair, on the other hand, are only separated by the four narrow interradial intergenital muscles (*ms*) in their upper half, by the four septal nodes (*kn*) in their middle, and by the four interradial deltoid muscles (*md"*) in their lower half.—The broad subumbral coronal muscle (*mc*) is divided by sixteen subradial fused clasps (*kl*) into sixteen coronal plates. Its upper proximal margin (mc_1) forms at the same time the lower boundary of the large coronal sinus. Its lower (distal) margin (mc_4) forms sixteen subradial scallops, which are inserted at the fused clasps. The concave incisions between them form small funnel cavities, from which the tentacles spring out. Of the twelve tentacles, four are perradial (*tp*) eight adradial (*ta*); the four sense clubs lie interradially. The sixteen subradial marginal lobes lie between them.

Figs. 9–11.—Three different views of the œsophagus or buccal stomach (proboscis), natural size. Fig. 9. Interradial view from outside. Fig. 10. Perradial view from inside. Fig. 11. Perradial longitudinal section, from inside. The letters have the same meaning throughout. *af* Oral filaments. *am* Oral margin. *ac* Interradial oral pillars; *ad* their adradial wings. *bb* Buccal pouches. *ag* Glands of the buccal pouches (in several longitudinal rows). *ae* Perradial buccal fissures. *io* Subumbral oral funnels (ectodermal interradial niches at the base of the œsophagus). *gk* Perradial palatine nodes, between the funnels. *gd* Palatine grooves on their axial surface. *t* Lowest gastral filament. *go* Gastral openings. *md"* Interradial deltoid muscle. *gm* Spermaria.



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PERIPHYLLA MIRABILIS.

PLATE XXI.

PERIPHYLLA MIRABILIS.

N.B.—The solid gelatinous mass of the umbrella is coloured blue, the subumbral wall of the umbrella cavity, and the funnel cavities running out from it, violet, and the whole hollow space of the gastrovascular system, yellow.

The letters have the same meaning in all the figures.

ac Oral columns (interradial).
ad Wings of the oral columns (adradial).
ae Buccal clefts (perradial).
af Oral filaments (adradial).
bb Buccal pouches (perradial).
bc Coronal pouches.
bd Wing pouches (adradial).
bl Lobe pouches.
bp Gastral pouches (perradial).
cb Peduncle canal of the umbrella cone.
cs Coronal sinus (sinus coronaris).
ct Tentacle canal.
d Endoderm.
ec Coronal furrow of the exumbrella.
f Gastral filaments.
fb Filaments of the basal stomach.
fg Filaments of the central stomach.
ga Buccal stomach.
gb Basal stomach.
gc Central stomach.
gk Palatine nodes (perradial).
gn Niches of the basal stomach (perradial).
go Gastral openings (perradial).
gp Palatine opening (porta palatina).
gs Palatine grooves (perradial).
gy Pyloric opening (porta pylorica).
gz Obelisc plates of the central stomach.
h Umbrella cavity.
i Subumbral funnel cavities.
ib Basal funnels.
ii Central funnel.
kl Fused clasps of the lobes (peronia).
kn Cathammal nodes (interradial).
lp Selvedge of the marginal lobes (patagium).
mc Coronal muscle (musculus coronaris).
md Deltoid muscles.
n Urticating organs.
or Sense clubs (interradial).
q Ectoderm.
sm Testes (four pairs).
ta Adradial tentacles.
tp Perradial tentacles.
ua Adradial tentacles pedalia.
ug Gelatinous substance of the umbrella.
ui Interradial pedalia of the sense clubs.
up Perradial tentacle pedalia.
w Subumbrella.
g Supporting plates (fultura).

Figs. 12–21.—Longitudinal sections and transverse sections three-fourths the natural size (only fig. 21 is ten times the natural size).

Fig. 12.—Perradial longitudinal section through the entire animal (meridian section of the first order).

Fig. 13.—Interradial longitudinal section through the entire animal (meridian section of the second order).

Fig. 14 (*AB*).—Horizontal transverse section through the basal stomach (at the height of the line *AB*, figs. 12, 13).

Fig. 15 (*CD*).—Horizontal transverse section through the pyloric opening (at the height of the line *CD*, figs. 12, 13).

Fig. 16 (*EF*).—Horizontal transverse section through the central stomach (at the height of the line *EF*, figs. 12, 13). (Half).

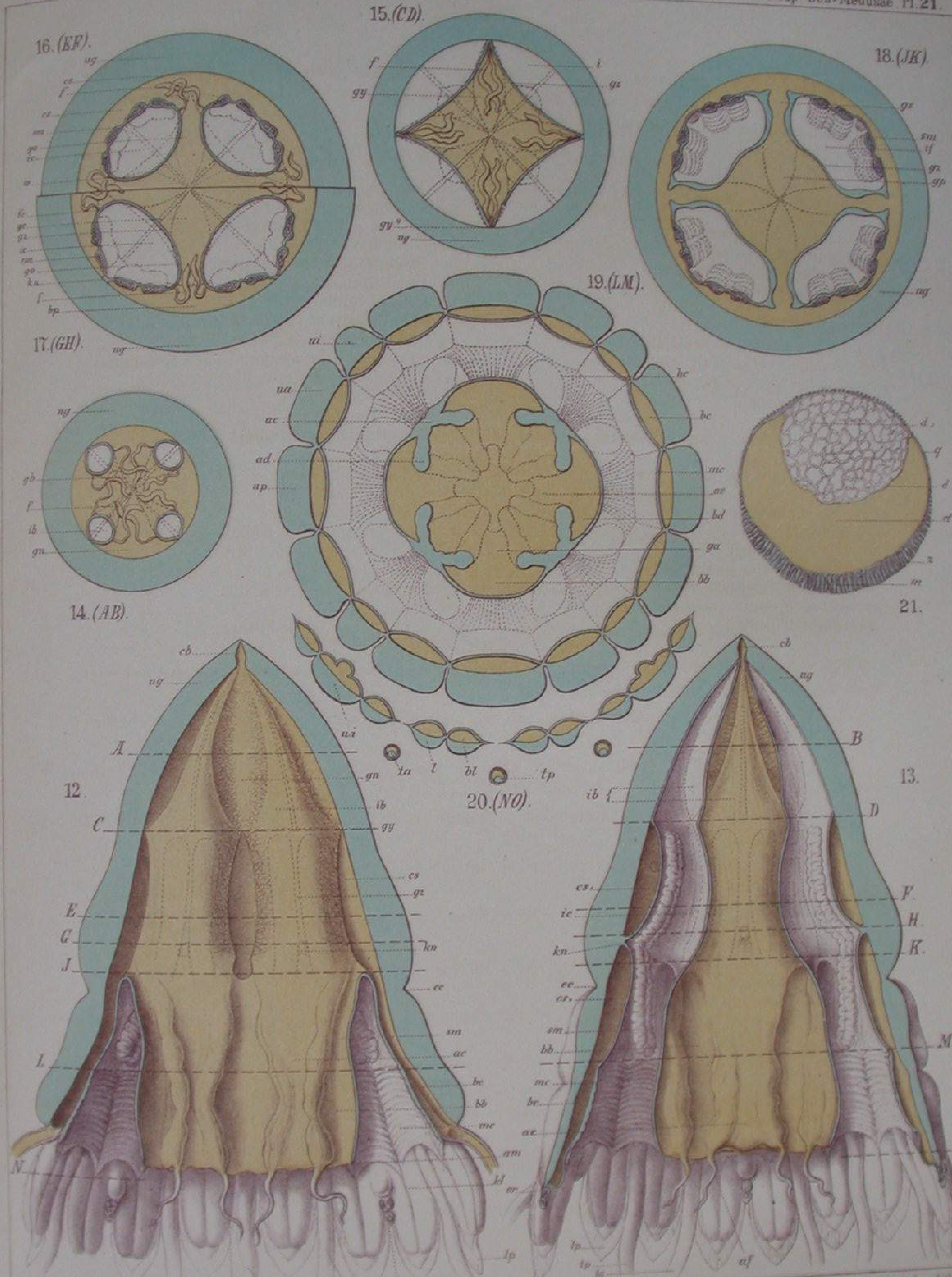
Fig. 17 (*GH*).—Horizontal transverse section through the central stomach at the height of the line (*GH*, figs. 12, 13). (Half).

Fig. 18 (*JK*).—Horizontal transverse section through the palatine opening (at the height of the line (*JK*, figs. 12, 13).

Fig. 19 (*LM*).—Horizontal transverse section through the pedal zone of the umbrella, along with the coronal muscle and buccal stomach (at the height of the line *LM*, figs. 12, 13).

Fig. 20 (*NO*).—Part of a horizontal transverse section of the lobe corona (at the height of line *NO*, figs. 12, 13).

Fig. 21.—Transverse section through a tentacle, ten times the natural size.



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PERIPHYLLA MIRABILIS.

PLATE XXII.

PERIPHYLLA MIRABILIS.

Fig. 22.—A quadrant of the umbrella corona with a sense club in the middle, twice the natural size, subumbral view. Exactly in the middle of the figure, we see an interradial rhopalium (*or*), half concealed by its ampulla (*oa*) into which a spheroidal air bubble has found its way. A sense lobe (*lo*), the point of whose marginal selvedge is turned over inwards (above), is visible on either side of the sense club (*or*). Next comes an adradial tentacle (*ta*), then a tentacle lobe (*lt*), and finally a perradial tentacle (*tp*). Only the basal parts of the tentacles are given. The coronal muscle (*mc*), whose upper or proximal margin (mc_1) forms the lower or distal boundary line of the large coronal sinus (*cs*), is drawn in the right half of the figure. The subumbral surface of the coronal muscle is laid in ten to twelve strong circular folds (mc_2) which decrease in height the lower they are and alternate with the same number of circular furrows (mc_3). The lower or distal margin of the coronal muscle (mc_4) is inserted with a projecting point in the middle of each marginal lobe (at its fused clasp *kl*), whilst it forms a projecting roof, under which a small subumbral funnel cavity remains open (*it*) above the basal insertion of each tentacle and each sense club. The broad distal margins of insertion of the longitudinal deltoid muscles, the perradial (*md'*) and the interradial (*md''*), are visible above the upper margin of the coronal muscle (mc_1). Each of the four visible marginal lobes (*l*) is surrounded at the free distal margin by a delicate folded membraneous selvedge ("patagium, *lp*"), and is halved in the middle by a strong cartilage-like fused clasp ("cathamma lobare," *kl*). This arises by a fusion of the umbral and subumbral wall of the lobe pouch, by means of which the latter is divided into two parallel canals (*bl*). But as the thickened distal end of the fused clasp (*kl*) does not reach to the distal end of the lobe pouch but stops above it, the two parallel canals of each lobe communicate below by a U-shaped "horse shoe canal," whilst they open separately above into the coronal sinus (*cs*). In the left lobe of the figure, a large air bubble expands the horse shoe canal enclosing the distal end of the fused clasp (*kl''*) in its concavity. In the adjacent ocular lobe, the horse shoe canal is opened and its subumbral wall retroverted on both sides; we see the branched, blackish streaks of pigment (*gd*, glands ?) which lie along the fused clasp (*kl*) in the umbral wall (*dn*). In the figure to the left above, the coronal muscle is removed for the most part to show the peculiar insertion of the tentacle (*tp*), with its two root muscles (*mk*), and also the peculiar septal fissure (*bc''*) by which the abaxial avelar pouch (*bc''''*) communicates with the axial velar pouch (*bc'*). The sequent (second) tentacle (left from the sense club) is cut off short below its insertion (*ct*). The third tentacle (right from the sense club) is cut open at the base of its length in order to show the remarkable double valved vent hole which separates the tentacle cavity (*ct*), from the coronal pouch (*bc*). The roundish cavity of the venthole (*ex*) opens between the upper (*yk'*) and the lower (*yk''*) vent valve.

Fig. 23.—A band-shaped gastral filament, six times the natural size.

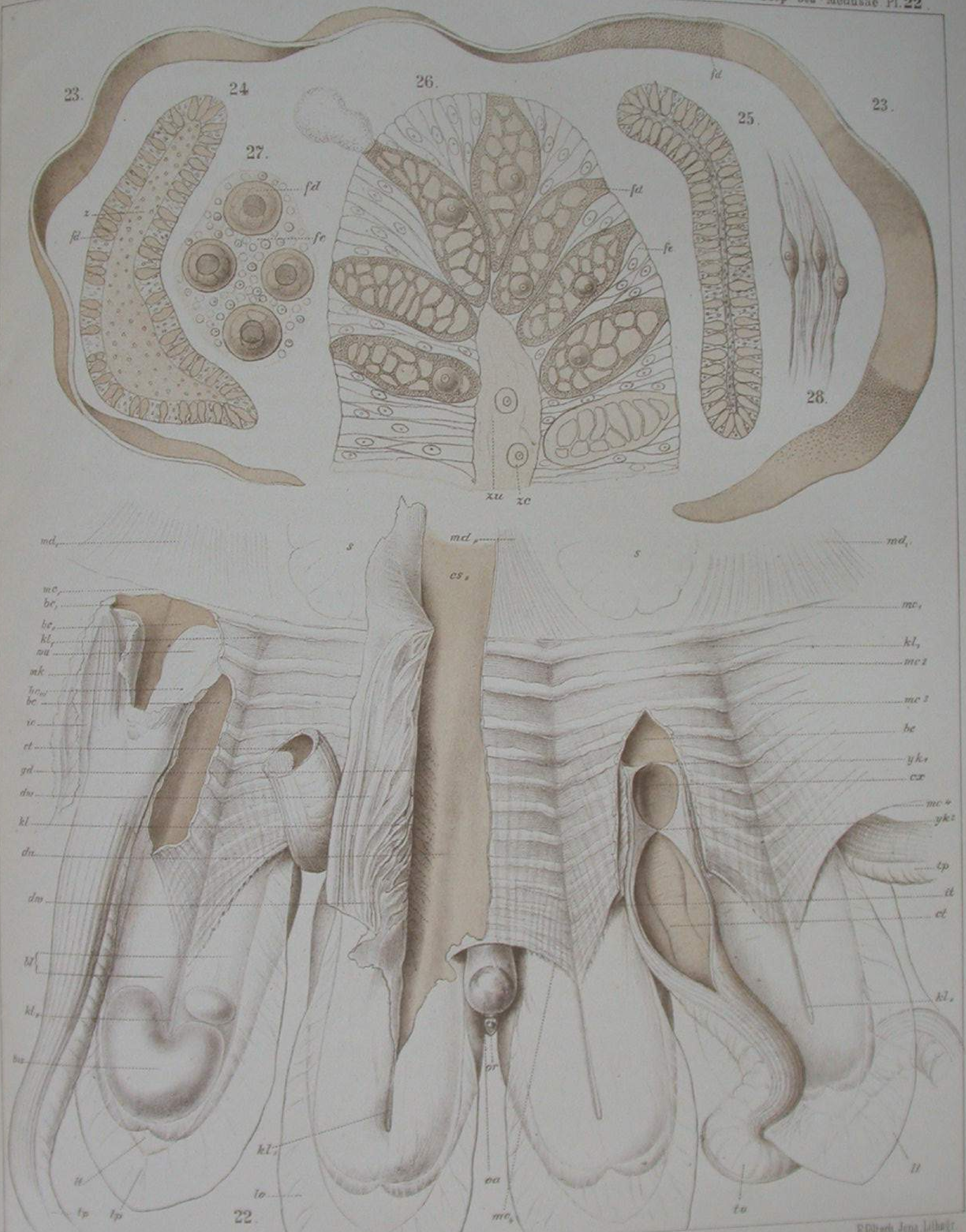
Fig. 24.—Transverse section though a thick gastral filament, with strong gelatinous plate, 100 times the natural size.

Fig. 25.—Transverse section through a thin gastral filament, with weak gelatinous plate, 100 times the natural size.

Fig. 26.—End of the narrow margin of a gastral filament, 600 times the natural size. *z* Supporting gelatinous plate. *ze* Cells of the gelatinous plate (colloblasta). *fd* Bottle-shaped gland cells. *fe* Narrow cylindrical endoderm cells between the glands.

Fig. 27.—Small piece of a gastral filament, seen from the surface in order to show the distribution of the gland cells (*fd*) between the narrow cylindrical cells of the endoderm (*fe*), 600 times the natural size.

Fig. 28.—Gastral epithelial muscular cells (?) from a gastral filament, isolated by maceration, 600 times the natural size.



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PERIPHYLLA MIRABILIS.

PLATE XXIII.

PERIPHYLLA MIRABILIS.

Fig. 29. A piece of the umbrella corona, with a marginal lobe (*l*) and the proximate insertion of a tentacle, twice the natural size. The subumbral wall with the coronal muscle has been removed in order to show the condition of the opened pouch. The two parallel lobe canals (*bl*) of the lobe which are separated by the fixed clasp (*kl*) are connected below its distal end (*kl*") by the U-shaped horse shoe canal (*bw*). The upper (*kl*') and the lower (*kl*") end of the fibrous cartilaginous fused clasp are thickened. *lp* Delicate margin selvedge of the lobe (patagium), *cs*" Distal margin of the coronal sinus, *mk* root muscles of the tentacle (*t*). *du* ümbral wall of the coronal pouch. *bc*" Septal fissure, between the two root muscles (*mk*) which represents the communication between the axial velar pouch (*bc*') and the abaxial avelar pouch (*bc*'"). Comp. fig. 22.

Fig. 30. Perradial longitudinal section through a tentacle (*t*) and the coronal pouch (*bc*) belonging to it, natural size. *mk* Root muscle of the tentacle. *cx* Vent hole of the tentacle. *mc* Coronal muscle. *l* Marginal lobes. *kl* Fused lobe. *lp* Patagium. *ec* Coronal furrow. *cs* Coronal sinus. *ug* Gelatinous substance of the umbrella.

Fig. 31. Interradial longitudinal section through a sense club (*or*) and the coronal pouch belonging to it (*bc*), natural size. *oa* Ampulla of the rhopalium (*or*). *bl* Lobe pouch. *mw* Subumbrella. *ug* Gelatinous substance of the umbrella. *ec* Coronal furrow of the exumbrella. *cs* Coronal sinus; *du* its umbral endoderm. *bc* Coronal pouch. *mc* Coronal muscle.

Fig. 32. A sense club (*or*) with its ampulla (*oa*) and the two bordering ocular lobes (*l*), seen from below, twice the natural size. The two lobes are drawn apart and retroverted. *lp* Patagium of the lobes. *kl* Fused clasps. *mc* Coronal muscle. *ta* Adradial tentacles.

Fig. 33. An interradial cathamma or septal node (*kn*) seen from the subumbrella, twice the natural size; having the intergenital muscle (*ms*) above, the interradial deltoid muscle (*md*") below.

Fig. 34. A bit of the exumbral zonal muscle ("M. zonaris," *mz*) along with the two subradial triangular points (*mz*") which it sends out in the longitudinal furrow between two pedalia (*ud*). *ec* Coronal furrow of the exumbrella (thinnest part of the gelatinous body). Twice the natural size. (Comp. fig. 35.)

Fig. 35. Radial section through the exumbral coronal furrow (*ec*) and the exumbral zonal muscle (*mz*) lying beneath it. *ug* Gelatinous substance of the umbrella. *du* Endodermal epithelium of its abaxial side. *ge* Ectodermal epithelium of its abaxial side. Twice the natural size (comp. fig. 34).

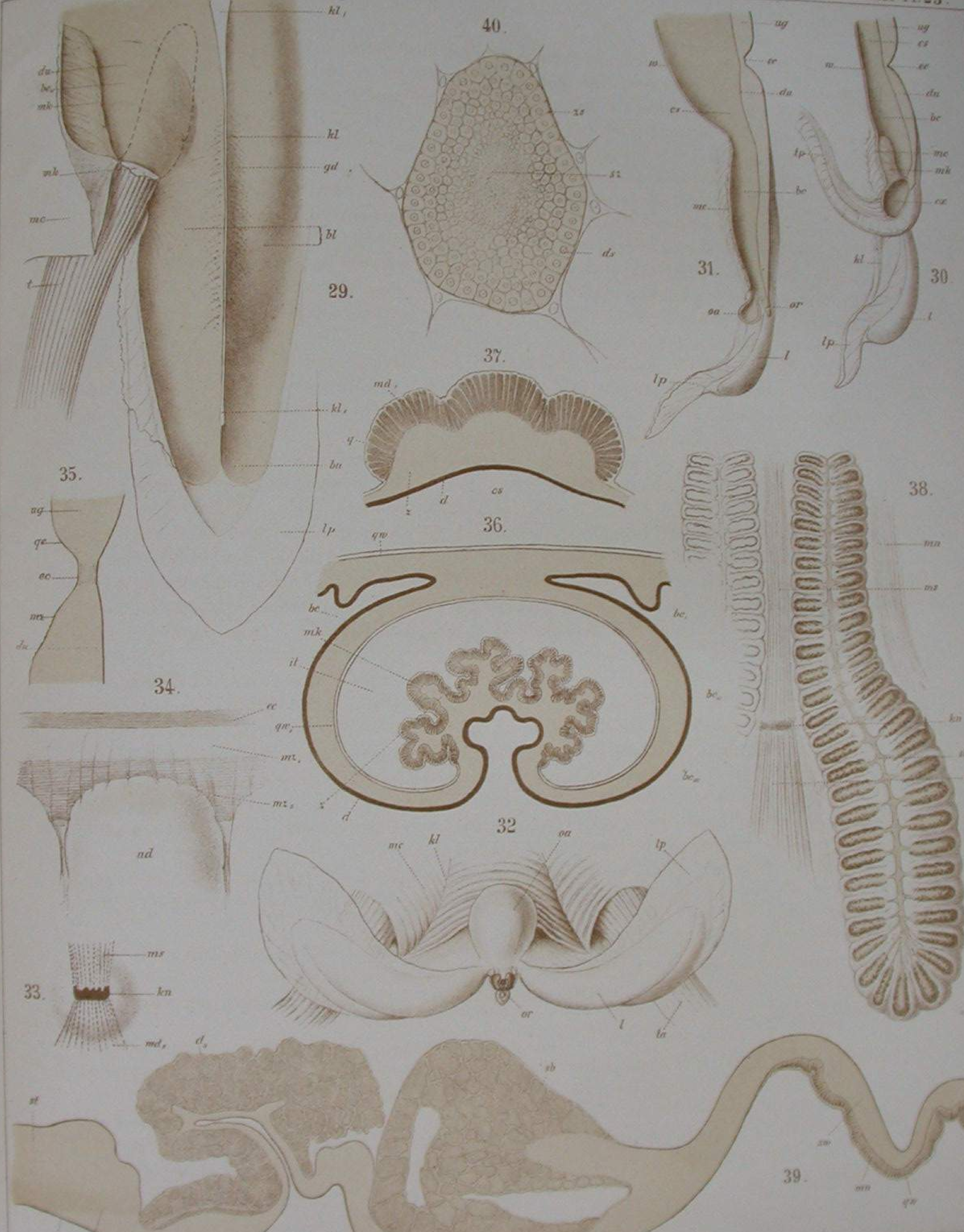
Fig. 36. Horizontal transverse section through the root muscle of a tentacle, slightly enlarged. *mk* Muscular folds of the root muscle; *z* its supporting plate. *it* Subumbral funnel cavity of the tentacle. *qw* Ectodermal epithelium of the funnel cavity. *qw* Ectodermal epithelium of the subumbrella. *bc*' Inner coronal pouch (velar pouch). *bc*'" Outer coronal pouches (avelar pouch). *bc*" Fissure of communication between the two pouches (septal fissure).

Fig. 37. Transverse section through the interradial deltoid muscle (*md*") below the cathamma, slightly enlarged. *g* Supporting plate. *d* Endoderm of the coronal sinus (*cg*). *q* Ectoderm of the subumbrella.

Fig. 38. A genitalium (sperarium) along with the upper part of another genitalium of the same pair, twice the natural size. *mg* Musculus intergenitalis. *kn* Interradial cathamma (septal nodes). *md*" Interradial deltoid muscle. *mn* Musculis congenitalis. *gt* Sterigma genitalie (framework of the testis).

Fig. 39. Transverse section through a fold of the spermarium, slightly enlarged. *gb* The follicles comprising the fold. *gt* Sterigma (fulcral framework) of the spermarium. *zw* Supporting plate of the subumbrella. *qw* Ectoderm of the plate. *mn* Musculus congenitalis.

Fig. 40. A follicle of the spermarium greatly enlarged. *gt* Sterigma (endodermal), framework of the spermarium, made of connective tissue, and forming sheaths round the follicles. *dg* Endodermal germinal epithelium (in the periphery of the follicle). *gz* Mature spermatozoa in the interior of the follicle.



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PERIPHYLLA MIRABILIS.

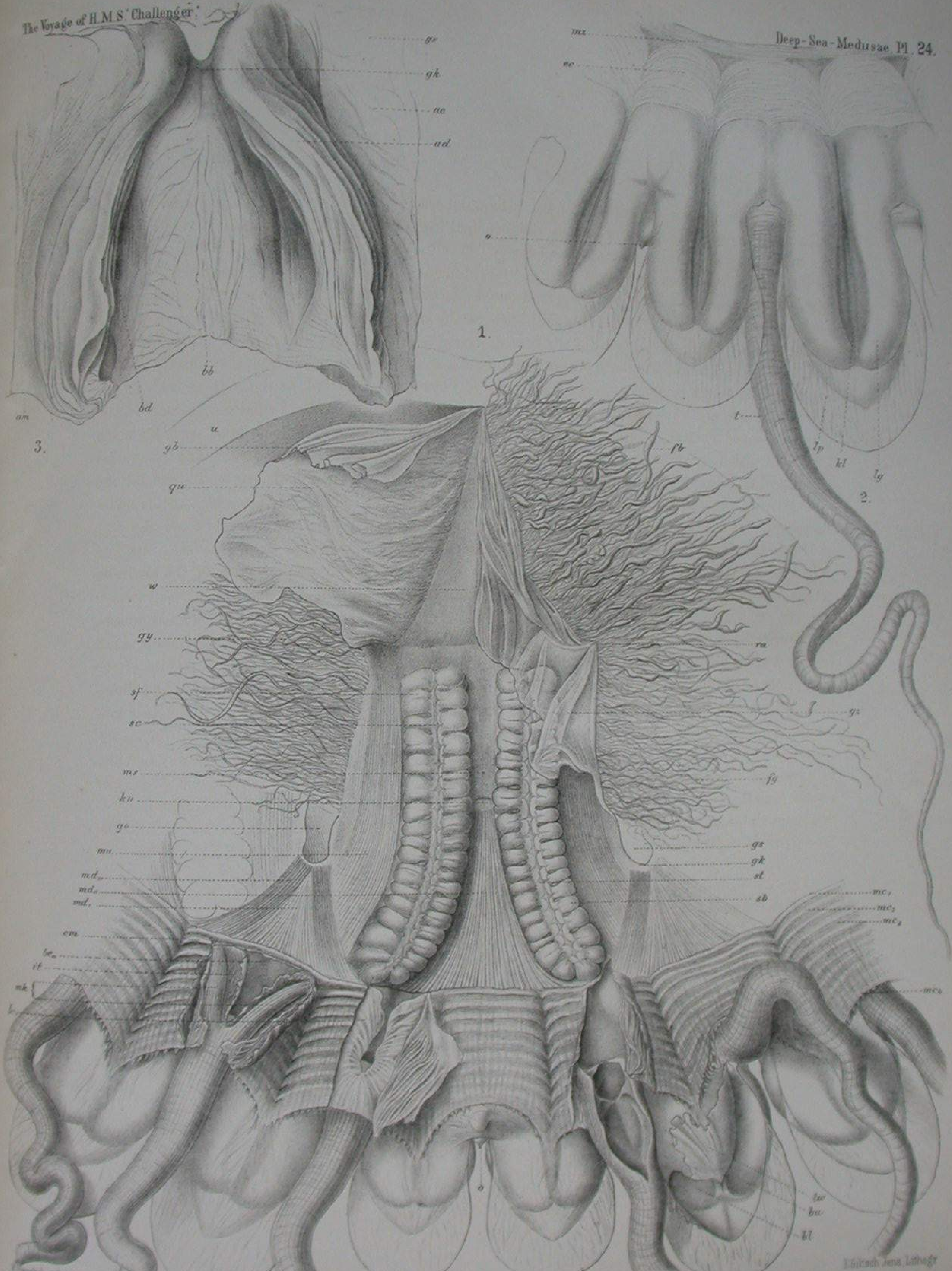
PLATE XXIV.

PERIPHEMA REGINA.

Fig. 1.—A quadrant of the umbrella, subumbral view, natural size (the only portion of this species preserved). The greater part of the principal intestine (especially the whole buccal stomach, fig. 3) was torn away. An opened funnel cavity (*ib*) of the basal stomach (*gb*) is visible in the middle of the upper third of the figure. We see the torn, folded subumbral wall of the funnel cavity, whose ectodermal subumbral surface (*gw*) is spread out flat to the left, whilst part of its endodermal gastral surface (*gb*) is turned over. The powerful bush of the enormously developed gastral filaments (*fb*), which extend from the basal point of the funnel nearly as far as the palatine groove (*gk*), is visible to the right. The pylorus or pyloric opening (*gy*) separates the basal stomach from the central stomach, of which only a torn fragment of an obelisk plate (*gz*) has been preserved, to the right above. In the middle of the figure we see a more complete quadrant of the subumbrella, bounded on either side by the cleft-shaped gastral openings (*go*). The margins of the latter are thickly beset with filaments (*fg*), from which, however, the lowest part with the palatine groove remains free. The interradial cathammal nodes (*kn*) gleam through the middle of the subumbral wall of the coronal sinus (at the same time in the centre of the whole figure). The intergenital muscle (*mg*) is joined to the nodes above the interradial deltoid muscle (*md*") below. The latter separates the two ovaries (*sf*). *gt* Midrib (sterigma) of each ovary. *mn* Congenital muscle. *md* Perradial deltoid muscle; *md*"' its paired marginal bundles. The lower third of the figure gives the subumbral view of the umbrella corona, whose upper boundary is formed by the proximal margin of the coronal muscle (mc_1) (which is at the same time the distal margin of the coronal sinus). mc_2 Circular folds of the coronal muscle. mc_3 Furrows between the folds. mc_4 Distal margin of the coronal muscle (with numerous small coronal furrows). A sense club (*o*) with the round ampulla above it is visible in the middle of the margin of the umbrella corona; three tentacles and three marginal lobes on either side. The subumbral wall of one lobe (the second from the right) is opened in order to show how the two lobe canals (*bl*) (separated by the fused clasp) are connected by the U-shaped horseshoe canal (comp. fig. 22, Pl. XXII.). Three of the seven visible areæ of the coronal muscle have been cut away in order to show the complications of the tentacle insertion. *mk* Root muscles of the tentacle. *bc*' Velar pouch (axial). *bc*"' Avelar pouch (abaxial), the septal fissure by which the two communicate, is visible in the third tentacle (from the left). The fourth tentacle (from the left) is cleft open to the base in order to show the vent cavity with the double valved vent hole (comp. Pl. XXII. fig. 22, *cx*).

Fig. 2.—A bit of the umbrella corona from outside (exumbral view), natural size. *mz* Zonal muscle in the broad coronal furrow (*ec*). *kl* Fused clasp. *lg* Gelatinous swelling of the lobes on either side of the clasp. *lp* Delicate wing selvedge of the marginal lobes. *t* Tentacles. *o* Sense clubs.

Fig. 3.—Quadrant of the œsophagus or buccal stomach from the inner surface, natural size. *gs* Palatine groove. *gb* Palatine nodes. *bb* Perradial buccal pouches; *bd* their lateral wing pouches. *ac* Interradial fleshy oral columns; *ad* their thickly folded adradial wings. *am* Margin of the mouth.



PERIPHEMA REGINA.

PLATE XXV.

PERIPHEMA REGINA.

Fig. 4.—A mature ovum, 100 times the natural size. The spheroidal egg cell is enclosed in a thick structureless chorion (*yc*); a projecting micropyle (*ym*) opens at one point of it. The yolk is composed of spheroidal, thickly compacted yolk granules (*yd*) of equal size. The clear spheroidal germinal vesicle (*yn*) contains a large dark germinal nucleus (*yf*), and this, again, a visible double contoured germinal nucleolus (*yp*).

Fig. 5.—A follicle of the ovary, seen from the inner (endodermal and abxial) surface, four times the natural size. The ova are distributed on the free endodermal surface (turned to the coronal sinus) of the fan-shaped transverse folds of the follicle in such a way that the smallest and younger ova lie on the basal margin of insertion of the folds, but the larger and older on its freely projecting margin.

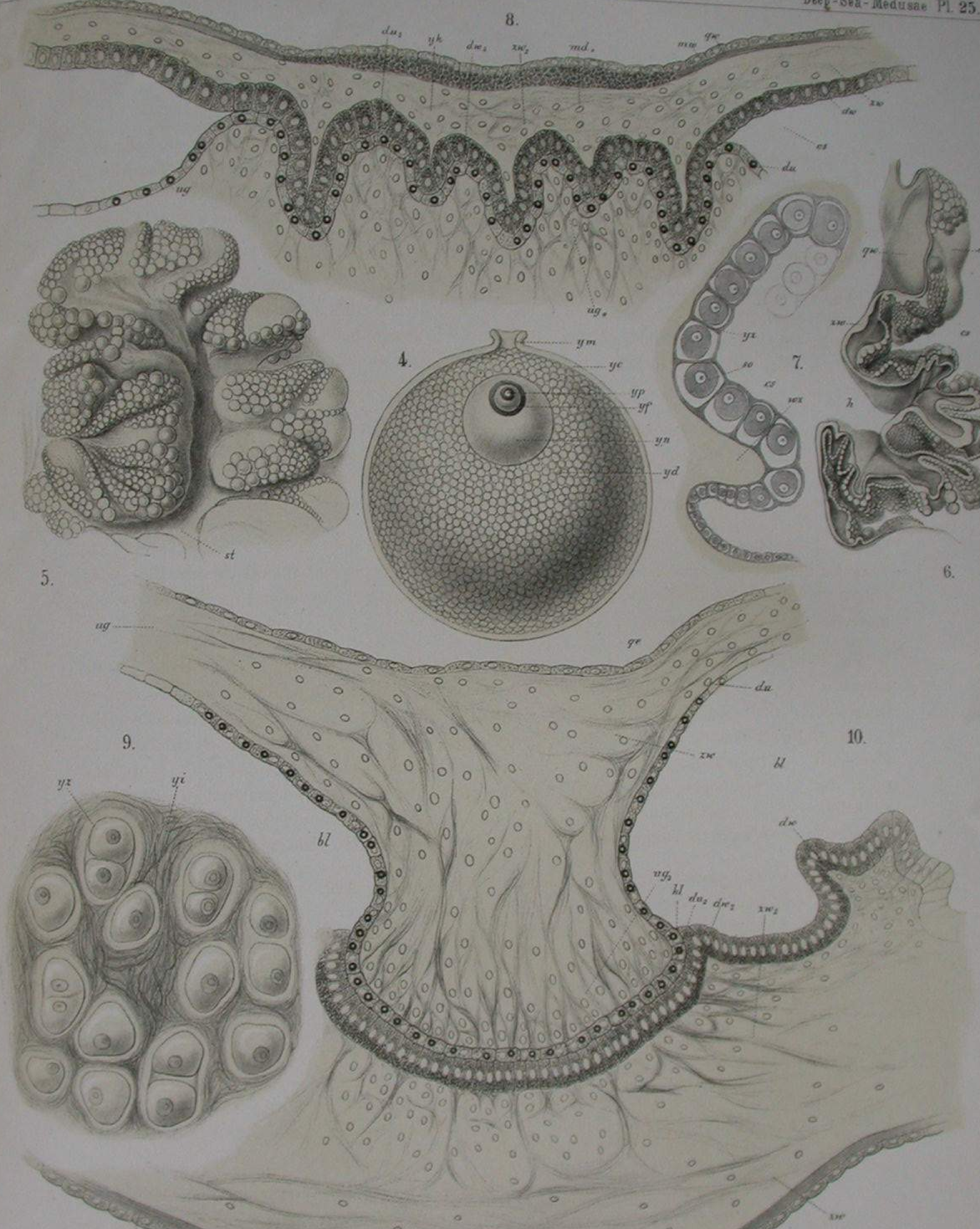
Fig. 6.—A follicle of the ovary in longitudinal section, four times the natural size. The flat axial ectodermal surface of the subumbrella (*qw*) is separated by a thick gelatinous fulcral plate (*zw*) from the thickly folded abaxial endoderm surface, from whose germinal epithelium (*ds*) the ova are originated. *h* Umbrella cavity. *cs* Hollow cavity of the coronal sinus.

Fig. 7.—Fold of a follicle of the ovary in longitudinal section, eight times the natural size. The more mature ova (*so*) surrounded by a chorion, are enclosed in special fulcral capsules (*yz*), wide, separate, gelatinous sheaths formed by a superficial abaxial growth of the supporting plate of the subumbrella (*wz*). *cs* Hollow cavity of the coronal sinus.

Fig. 8.—Horizontal transverse section through an interradial cathammal node, 300 times the natural size. *ug* Gelatinous substance of the umbrella, transformed into fibrous cartilage (ug_2) at the point of fusion. du_2 Umbral endodermal lamella of the cathamma. dw_2 Subumbral endodermal lamella of the cathamma. *zw* Gelatinous supporting plate of the subumbral transformed into fibrous cartilage (zw_2) at the point of fusion. *cs* Coronal sinus (in this case divided by the four septal nodes into four perradial spaces). *du* Umbral endodermal epithelium; *dw* subumbral endodermal epithelium of the coronal sinus. *md*" Insertion of the deltoid muscle (in transverse section). *mw* Circular muscles of the subumbrella. *qw* Endodermal epithelium of the subumbrella.

Fig. 9.—A small piece of fibrous cartilage from the hardened gelatinous tissue of the cathamma (fig. 8, ug_2), 600 times the natural size. The histological structure of this modified gelatinous tissue immediately at the point of fusion is similar to the fibrous cartilage of the vertebratæ. *yz* Cartilaginous cells enclosed in cartilaginous capsules. *yi* Fibrous cords of the intercellular substance.

Fig. 10.—Horizontal transverse section through a fused clasp, 300 times the natural size. *qe* Ectodermal epithelium of the exumbrella. *qw* Ectodermal epithelium of the subumbrella. *du* Umbral endodermal epithelium. *dw* Subumbral endodermal epithelium of the lobe pouch. *ug* Gelatinous substance of the umbrella transformed in ug_2 into fibrous cartilage. *zw* Gelatinous substance of the subumbrella transformed in zw_2 into fibrous cartilage. *kl* Cathamma lobare. *bl* Lobe pouches.



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PERIPHEMA REGINA.

PLATE XXVI.

CHARYBDEA MURRAYANA.

The letters have the same meaning in all the figures.

aa Oral opening.
al Oral lobes.
bm Adradial marginal lobes.
bp Perradial gastral pouches.
ct Tentacle canals.
cv Velarium canals.
dk Cathammal plates (or endodermal lamellæ of the septa).
du Endoderm of the umbrella
dw Endoderm of the subumbrella.
e Exumbrella (external surface of the umbrella).
ea Exradial exumbral furrows.
ec Coronal furrow of the exumbrella.
ei Interradial exumbral furrows.
eo Sense niche of the exumbrella.
ep Perradial exumbral furrows.
f Gastral filaments.
gb Basal stomach.
go Gastral openings (perradial).
gp Palatine stricture.
gs Palatine groove.
gy Pyloric valves.
gw Subumbral wall of the stomach.
h Umbrella cavity.
i Interradial funnel cavities.
it Tentacle funnels (axial cavities).
ks Cathammal ridges (septa).
mi Interradial longitudinal muscles of the subumbrella.
mp Perradial longitudinal muscles of the subumbrella.
mw Layer of circular muscles of the subumbrella.
or Rhopalia (perradial sense clubs).
qw Ectoderm of the subumbrella.
rc Nerve ring.
s Leaf-shaped genitalia.
sd Germinal epithelium of the endoderm.
so Ova cells.
t Tentacles.
u Umbrella.
uf Elastic fibres of the gelatinous umbrella.
ug Gelatinous substance of the umbrella cone.
ui Gelatinous sockel (pedalia).
va Velarium.
vf Frenula velarii.
vm Free margin of the velarium.
w Subumbrella (inner surface of the umbrella).
wr Mesogonia (mesenteric folds).
z Supporting plate (fulcral lamella).
zg Supporting plate of the genitalia.
zw Fulcrum of the subumbrella.

Fig. 1.—The entire Medusa profile view, natural size. We see two sides of the cubical umbrella, which touch at the interradial furrow of the angle (*ei*).

Fig. 2.—Perradial section through the umbrella, natural size. On either side we look into an opened radial pouch (*bp*). The complete middle radial pouch is mostly occupied by the leaf-shaped genitalia, which project from the interradial septal ridges (*ks*).

Fig. 3.—Interradial section through the umbrella, natural size. We see two side walls of the cubical subumbrella, which meet in the septal ridges (*ks*) in the interradial angles and whose coronal muscle is halved by the perradial band-shaped longitudinal muscle (*mp*).

Fig. 4.—Subumbral view of the umbrella, from above (from the apical surface), natural size. In the middle the cross of the perradial gastral grooves (*gs*) gleams through the quadrate apex.

Fig. 5.—Subumbral view of the umbrella from below (from the surface of the oral opening) natural size. Through the opening of the velarium (*va*) in the bottom of the umbrella cavity, we see the bottom of the stomach with its subumbral circular muscles (*gw*) and perradial gastral grooves (*gs*); in the middle the oral cross with the oral lobes (*al*).

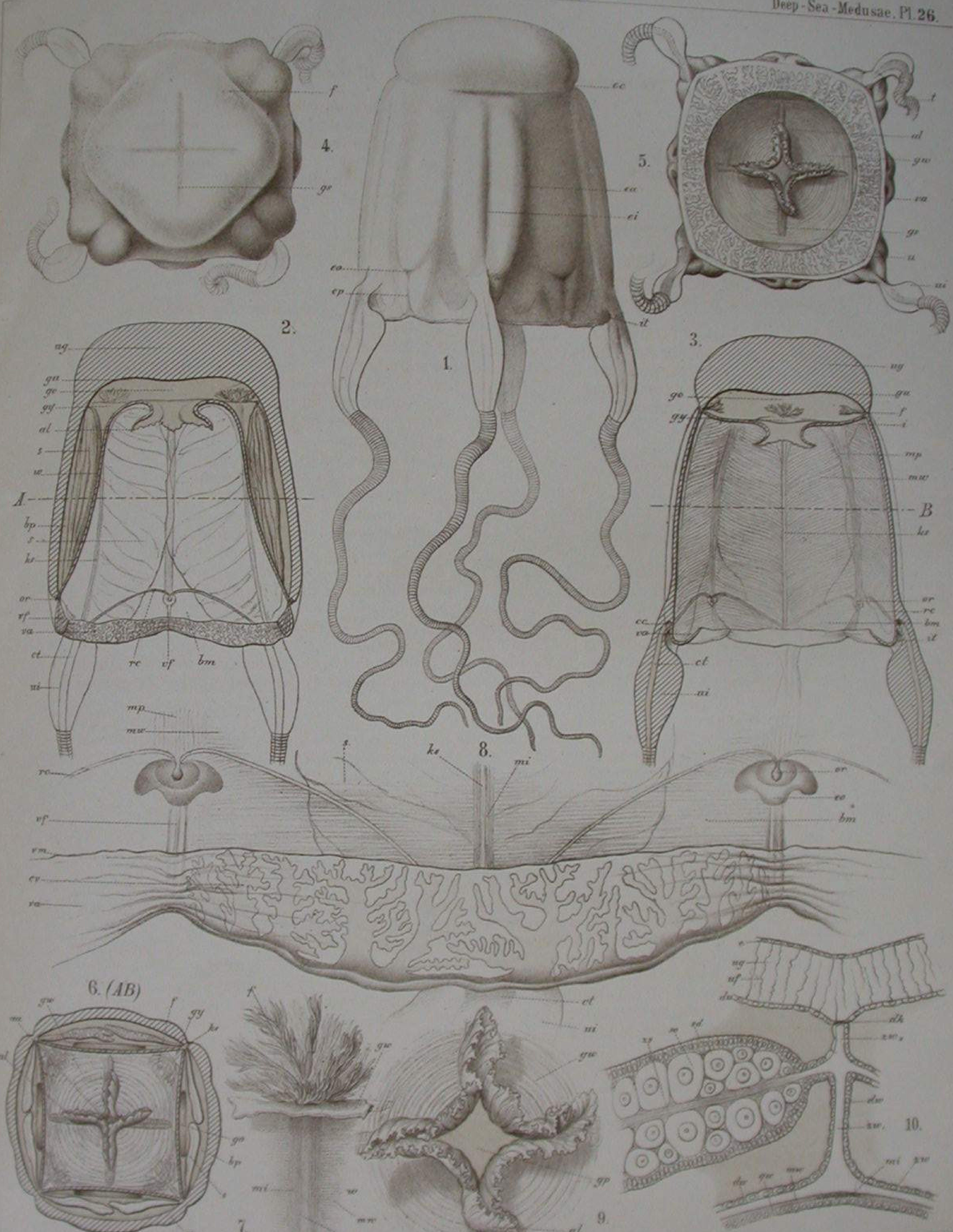
Fig. 6.—Transverse section through the umbrella, nearly in the middle of the height, from below, natural size. The four pairs of reproductive leaves (*s*) are visible in the opened radial pouches (*bp*) and the four gastral openings (*go*) in their bases.

Fig. 7.—A phacellus or bunch of filaments, slightly enlarged, consisting of a group of dendriform gastral filaments, which is placed upon an interradial pylorus valve in an angle of the bottom of the stomach. Below, a piece of the subumbral wall of the pouch (*w*) and of a cathammal septum (*ks*).

Fig. 8.—A quadrant of the velarium with the surrounding parts, seen from the subumbral side, four times the natural size. The velarium (*va*) with its dendriform canals is fastened by the perradial frenula (*vf*) to the subumbrella (*w*) and retroverted upwards. The nerve ring (*re*) rises in an arch from the sense niche (*eo*) to the interradial tentacle pedalium.

Fig. 9.—The oral cross with the four oral lobes, which are folded and thickly frilled, seen from below, three times the natural size.

Fig. 10.—Transverse section through a cathammal septum (*ks*) with the surrounding parts greatly enlarged. We see that the reproductive leaves run out from the subumbrella, on the axial side of the cathamma.



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CHARYBDEA MURRAYANA.

PLATE XXVII.

NAUPHANTA CHALLENGERI.

Fig. 1.—The entire Medusa, from above, spread out flat (exumbral view), eight times the natural size. The inner half of the central umbrella disk is undivided, the outer half is divided into sixteen subradial swellings. The peripheric umbrella is divided by sixteen deep subradial furrows into sixteen gelatinous sockels or pedalia, of which the eight narrower (principal) bear the sense clubs, the eight broad (adradial) bear the tentacle.

Figs. 2–10.—Horizontal transverse section at different heights, indicated in fig. 14. (Pl. XXVIII.) by the numbers II.—X. The gelatinous substance or supporting plate of the umbrella is invariably coloured blue, the ovaries red, and the hollow space of the gastrovascular system yellow; eight times the natural size. From want of room only half of the sections are given. *h* Umbrella cavity. *i* Funnel cavity. *st* Supporting plate of the ovaries (sterigma). *so* Egg cells. *bo* Ocular pouches. *bt* Tentacle pouches. *dp* Endodermal folds of the subumbral wall of the ocular pouches. *mc* Coronal muscle. *w* Subumbrella. *gb* Basal stomach. *gc* Central stomach. *ga* Buccal stomach.

Fig. 2.—Transverse section through the basal stomach immediately above the septal nodes, at the height of the pyloric valves (*gi*). *f* Gastral filaments.

Fig. 3.—Transverse section through the central stomach at the height of the interradial cathamma or septal nodes (*kn*); the four broad horizontal gastral openings of the four perradial gastral pouches (*bp*) alternate with these. *ii* Interradial funnel cavities.

Fig. 4.—Transverse section through the coronal intestine, immediately below the coronal sinus, through the uppermost (proximal) part of the genitalia (*s*). Four broad interradial pouches (br_2) alternate with four narrow perradial ocular pouches (bo_1) from which, but somewhat deeper, the four interradial ocular pouches (bo_2) and the eight adradial tentacle pouches (*bt*) run out. Comp. fig. 5.

Fig. 5.—Transverse section through the coronal intestine, somewhat lower than the preceding. The eight wide adradial tentacle pouches (*bt*) containing the genitalia (*s*), alternate with the eight narrow ocular pouches (*bo*) and project, as if inflated, into the umbrella cavity (*h*). The supporting plates (*st*) of the two genitalia belonging to one pair, are rolled inwards so that their concavities are opposite one another.

Fig. 6.—Transverse section through the coronal intestine, somewhat above the coronal muscle. The supporting plate of the genitalia (sterigma *st*) springs from the subumbral wall of the eight adradial pouches (*bt*), apparently with a double root, as the simple root is crescentic and cut out concavely above (the section touches both horns of the crescent, comp. fig. 7).

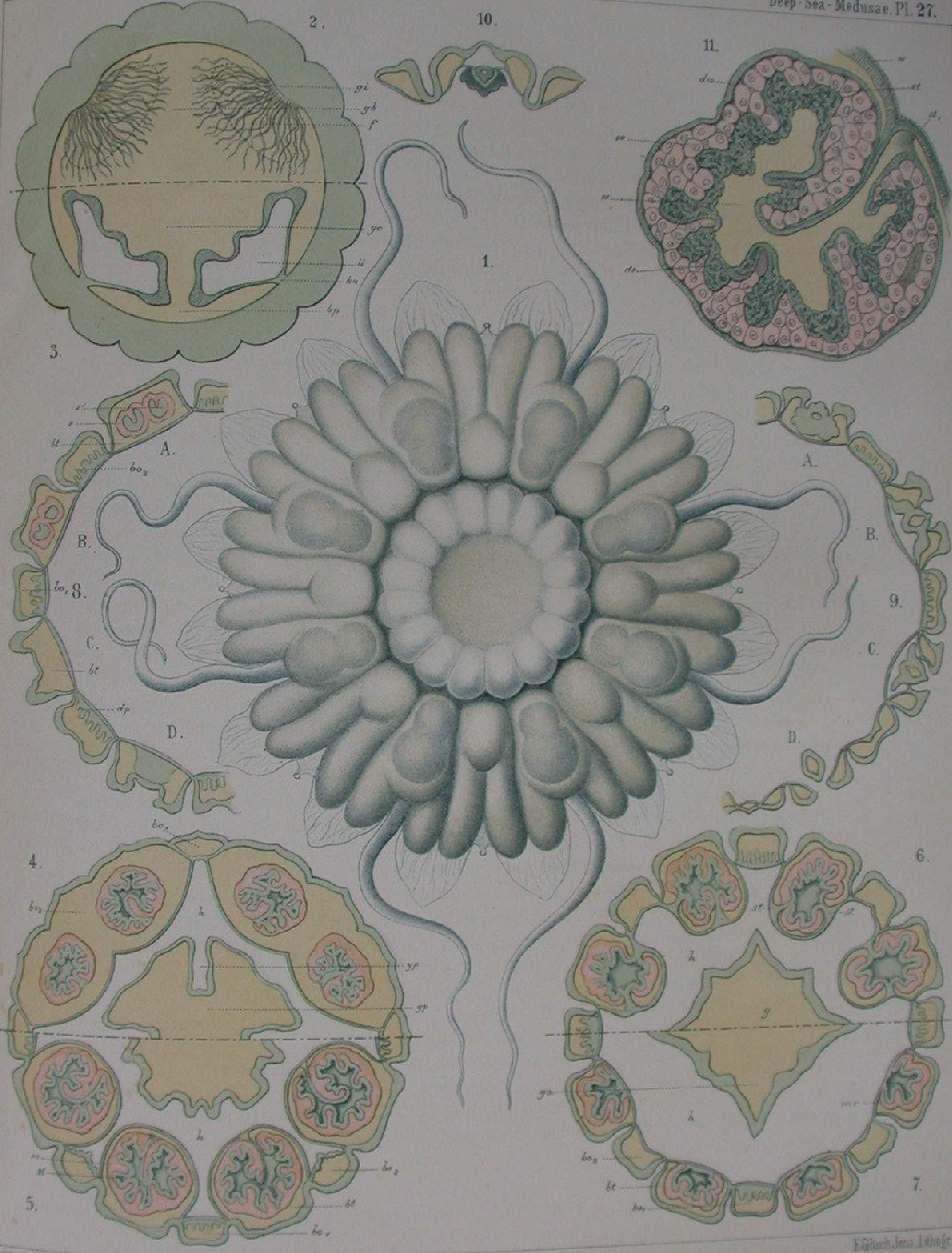
Fig. 7.—Transverse section through the coronal intestine, somewhat below the proximal margin of the coronal muscle (*mc*). The supporting plate of the genitalia (sterigma, *st*) springs with a simple root from the subumbral wall of the coronal muscle (*mc*). Of the eight ocular pouches only the four perradial are furnished with subumbral endodermal tufts.

Fig. 8.—Transverse section through the coronal intestine in the lower third of the coronal intestine (*mc*). All the eight ocular pouches (*bc*) are furnished with endodermal tufts. The section is taken obliquely so that the four pairs of tentacles, from above to below, correspond to four different heights or horizontal planes, lying one above the other. The distal ends of the genitalia are still visible in the two upper tentacle pouches (*A*, *B*) but not in the two lower (*C*, *D*).

Fig. 9.—Transverse section through the lobe corona at the base of the tentacle insertion. This section is also taken somewhat obliquely at four different heights (*A–D*).

Fig. 10—Transverse section through a sense club and the surronnding sense lobes (*lo*).

Fig. 11.—Transverse section through an ovary thirty times the natural size. *w* Subumbrella. *st* Supporting plate of the ovary (sterigma). st_1 Root of the sterigma. *so* Egg cells. *ds* Germinal epithelium of the endoderm. *dw* Subumbral endodermal epithelium on the free upper surface of the ovaries. *ss* Genital sinus.



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NAUPHANTA CHALLENGERI.

PLATE XXVIII.

NAUPHANTA CHALLENGERI.

The meaning of the letters is the same in all the figures.

aa Mouth.
al Oral lobes (perradial).
as Oral cross (perradial).
bc Coronal pouches.
bl Lobe pouches.
bo Ocular pouches (principal coronal pouches, four perradial and four interradial).
br Radial pouches.
bt Tentacular pouches (adradial coronal pouches).
cs Coronal sinus.
ds Endodermal germinal epithelium.
dw Endoderm of the subumbrella.
ec Coronal furrow of the exumbrella.
es Radial furrows of the umbrella disk.
f Gastral filaments.
ga Buccal stomach.
gb Basal stomach.
gc Central stomach.
gi Valves of the pylorus.
go Gastral ostia.
gp Palatine opening.
gy Pyloric opening.
gw Subumbral wall of the stomach.
h Umbrella cavity.
i Interradial funnel cavities.
kl Subradial septa (fused clasps).
kn Interradial septa (cathammal nodes or fused nodes).
l Subradial marginal lobes.
lp Selvedge of the marginal lobes (patagium).
mc Coronal muscle.
mc_1 Proximal margin of the coronal muscle.
mc_4 Distal margin of the coronal muscle.
md' Perradial deltoid muscles.
md" Interradial deltoid muscles.
o Sense clubs.
q Ectoderm.
s' Free proximal part of the genitalia.
s" Veiled distal part (covered by the coronal muscle) of the genitalia.
sb Follicle of the testis.
so Egg cells.
ss Genital sinus.
st Sterigma (genital fulcral framework).
st' Root of the sterigma.
t Tentacles.
ua Adradial pedalia (of the tentacles).
uc Central disk of the umbrella.
ug Gelatinous substance of the umbrella.
ui Interradial ocular pedalia.
up Perradial ocular pedalia.
w Subumbrella.
z Supporting plate (fulcral lamella).

Fig. 12.—The entire Medusa from below, spread out flat (subumbral view), eight times the natural size.

Fig. 13.—The entire Medusa, from the side (profile view), eight times the natural size (comp. fig. 1, Pl. XXVII.).

Fig. 14.—Interradial section through the entire Medusa, eight times the natural size.

Fig. 15.—Adradial section through an octant, twenty-five times the natural size, to show the sterigma (*st*) of the ovaries and the origin of its root (*st'*) from the umbrella. The genital sinus (*ss*) is lined by endodermal germinal epithelium (*ds*). The pyloric valves (*gi*) with the gastral filaments (*f*) are visible above at the pyloric opening.

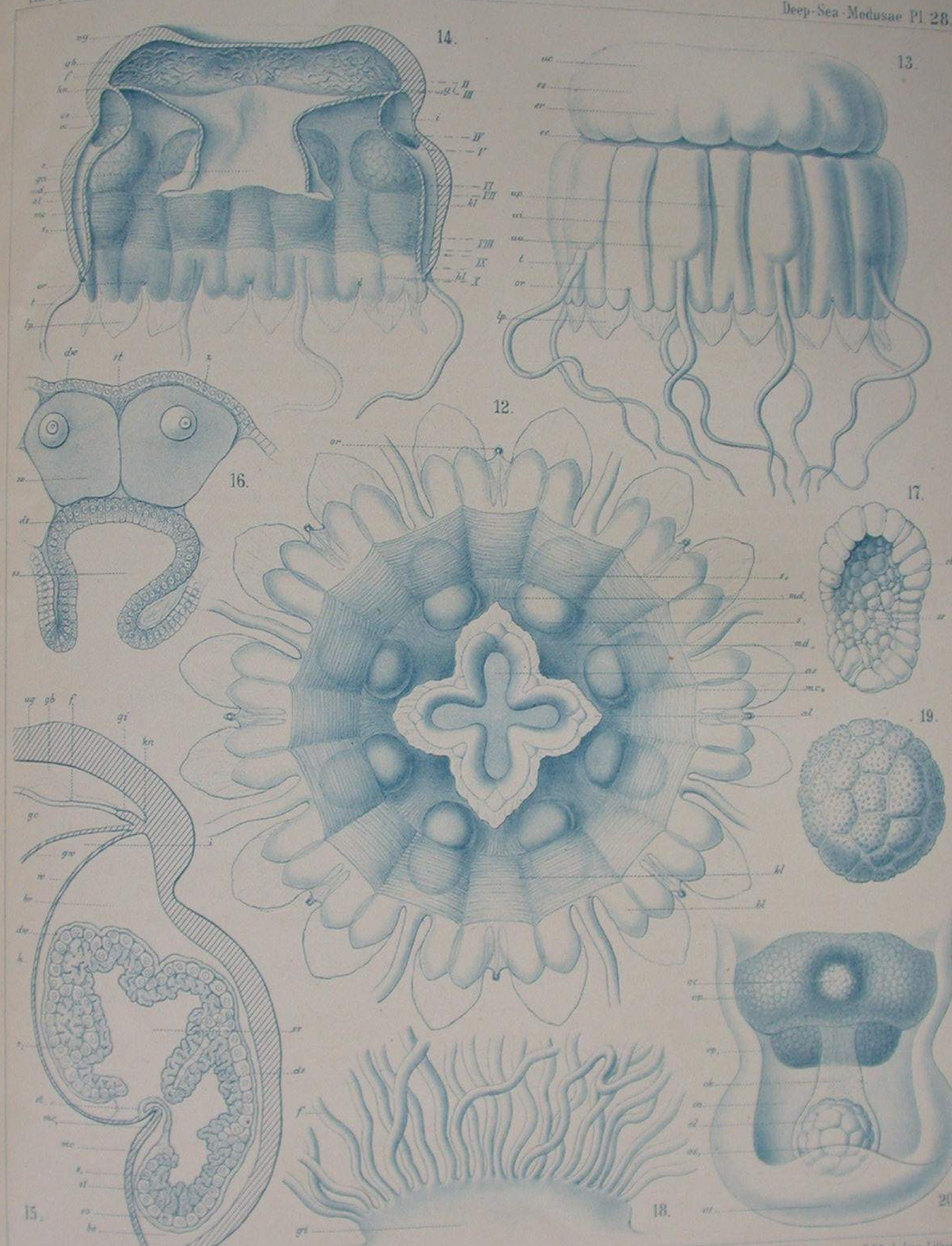
Fig. 16.—Radial section through an ovarial fold, greatly enlarged, to show the cylindrical germinal epithelium of the endoderm (*ds*) which produces the egg cells (*so*) and lines the genital sinus (*ss*).

Fig. 17.—A testis, sixteen times the natural size, to show the composition of the follicles of the testis, which are enclosed by a spacious genital sinus (*ss*).

Fig. 18.—A pyloric valve, along with the phacellus placed on it, which is formed by a bow-shaped series of gastral filaments.

Fig. 19.—An octant, with granulated polyhedric facets, greatly enlarged.

Fig. 20.—A sense club from the inner axial side, greatly enlarged. *oc* Eye (with lens ?). *ok* Auditory club. *ol* Otolite. *on* Auditory niche. *op* Pigment pad with tactile plate (*op'*). *os* Protective scale (auditory fold). *os'* Free inverted margin of the protective scale.



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NAUPHANTA CHALLENGERI.

PLATE XXIX.

ATOLLA WYVILLII.

The meaning of the letters is the same in all the figures.

aa Oral opening.
ac Oral columns (interradial).
al Oral lobes.
am Margin of the mouth.
bb Buccal pouches (perradial).
bp Perradial gastral pouches.
bt Tentacular coronal pouches.
ck Tentacular lobe canals.
co Ocular canals (sense pouches).
ec Coronal furrow of the exumbrella.
ec' Thinnest part of the gelatinous substance of the umbrella.
cs Coronal sinus.
ct Tentacle canals.
cx Adocular canals.
dg Endodermal surface of the stomach.
er Marginal teeth of the umbrella disk.
es Marginal indentations of the umbrella disk.
f Gastral filaments.
ga Buccal stomach.
gb Basal stomach.
gc Central stomach.
gi Pyloric valves.
go Gastral openings.
gp Palatine opening.
gw Swellings of the subumbral gastral wall.
h Umbrella cavity.
i Funnel cavities.
kl Fused clasps.
kt Cathammal plates (septal plates).
l Marginal lobes.
mc' Thinner inner coronal muscle.
mc" Thicker outer coronal muscle.
md' Perradial deltoid muscle.
md" Interradial deltoid muscle.
mk Root muscles of the tentacles.
mt' Abaxial tentacle muscle.
mt" Axial tentacle muscle.
or Rudimentary sense clubs.
q Ectoderm.
s Ovaries.
sa Aperture of the genital sinus.
so Ova.
ss Genital sinus.
st Fulcral frame of the sterigma.
si Basal root of the sterigma.
t Tentacles.
uc Central umbrella disk.
uo Pedalia of the rhopalia.
ut Pedalia of the tentacles.
w Subumbrella.
wr Mesenteries (perradial).
yu Circular furrow on the subumbral wall of the coronal sinus.
zw Supporting plate of the subumbrella.

Figs. 1 and 2 are natural size, the other figures twice the natural size.

Fig. 1.—Exumbral view of the entire Medusa (from above), natural size. The deep coronal furrow (*ec*) separates the indented umbrella margin (*uc*) from the corona of tentacle pedalia (*ut*) and sense pedalia (*uo*).

Fig. 2.—Subumbral view of the entire Medusa (from below), natural size. The eight ovaries (*g*) lie in pairs round the stomach, whose eight mesenteries separate the four pairs.

Fig. 3.—Subumbral view of the entire Medusa (from below), in four quadrants, twice the natural size. The first quadrant (to the right, below) gives the complete subumbral view, whilst the coronal muscle is removed in the three other quadrants. The corona of pouches is shown in the second quadrant (to the left, below), the deltoid muscles and tentacle muscles in the third quadrant (to the right, above). All the subumbral organs are removed in the fourth quadrant (to the left, above) to show the endodermal surface of the gelatinous substance of the umbrella. A pair of the eight genitalia is removed to the left above, a pair opened to the left below. The subumbral wall of the stomach is complete only to the right below.

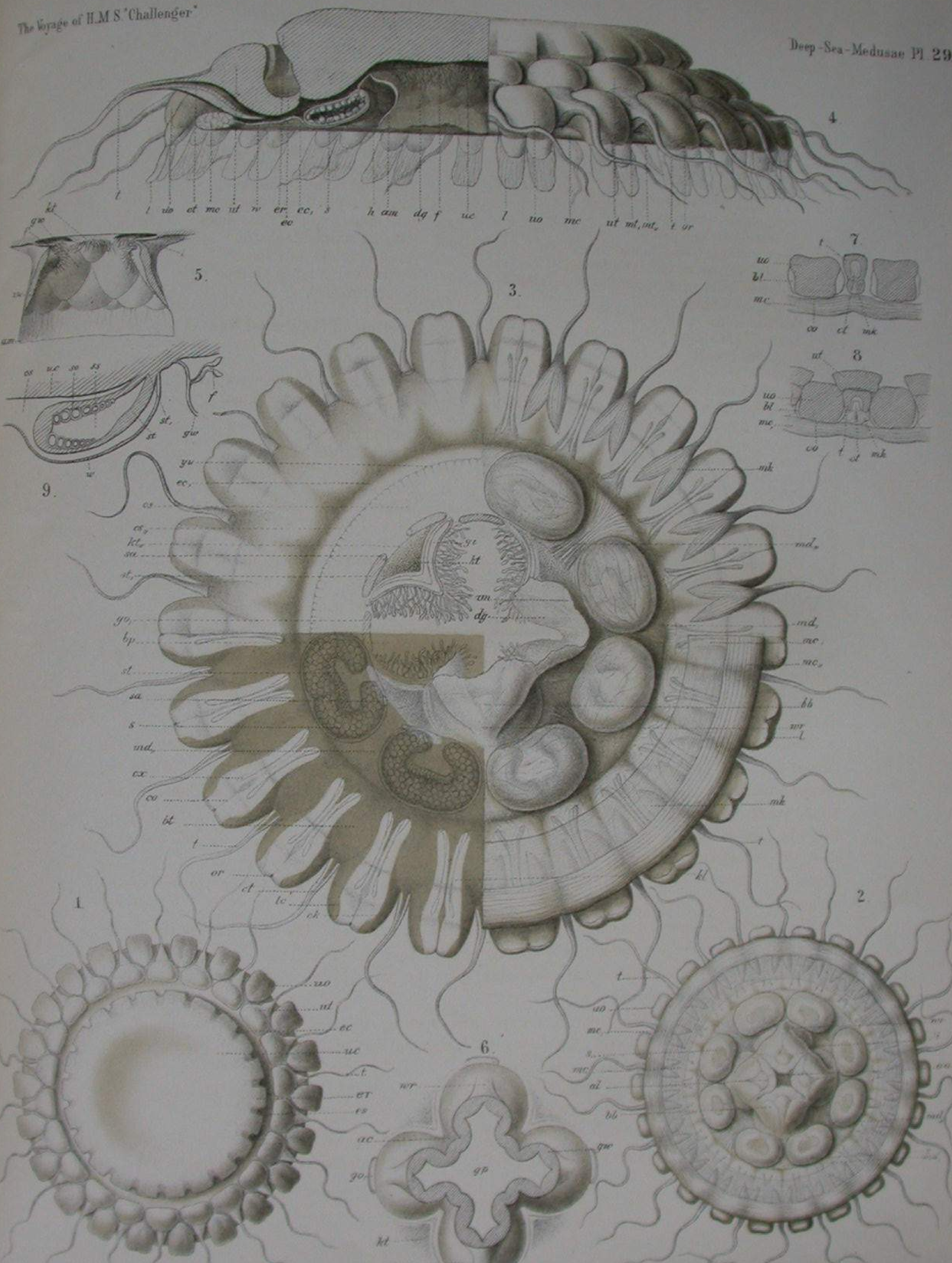
Fig. 4.—Profile view of the entire Medusa, twice the natural size. The right half of the figure shows the outer profile view, the left half, a radial section.

Fig. 5.—Radial section through the œsophagus, twice the natural size, to show the swellings (*gw*) and phacelli (*f*) on its inner wall.

Fig. 6.—Horizontal section through the palatine opening (*gp*) or constricted middle of the œsophagus, twice the natural size; the triangular interradial cathammal plates (*k*) project centripetally between the four perradial limbs of the cross.

Figs. 7–8.—Two tangential sections through a tentacle root and the two adjacent rhopalar pedalia (*uo*), twice the natural size; fig. 7 further out, fig. 8 further in.

Fig 9.—Radial section through an ovary and the surrounding coronal sinus, twice the natural size, showing the insertion of the sterigma (*st*) at the subumbral wall (*w*) of the coronal sinus (*cs*).



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ATOLLA WYVILLEI.

PLATE XXX.

DRYMONEMA VICTORIA.

Fig. 1.—The entire Medusa, subumbral view, from below, in four quadrants, natura size. In the middle we see through the oral cross into the central stomach. The first quadrant (to the left, above) shows the repeatedly folded brachial curtains or the delicate, thin-membraned extensions of the oral arms, thickly frilled at the edges. The whole subumbral wall is removed in the upper half of the second quadrant (to the right, above) so as to show the upper (umbral) gelatinous wall of the dichotomously branched coronal pouches and lobe pouches, which are only separated by narrow, radial, cathammal ridges; the tentacles, which spring in large numbers between the dichotomous radial ribs of the subumbrella, are visible in the lower half of the second quadrant. The third quadrant (to the right, below) shows a complete gastrogenital pouch, which springs with a narrow, interradial base between every two perradial oral pillars; the frilled genital band is deeply inserted in the distal bottom of the repeatedly folded evagination of the fundus of the stomach. The tentacles are cut away at their base in the fourth quadrant (to the left, below) so that we merely see their insertion in the deep radial furrows (between the projecting dichotomous radial ridges of the subumbrella). The four sense niches are visible in the lower half of the figure; they lie far from the umbrella margin on the deep velar furrow, which separates the broad zone of tentacles from the marginal velarium (or zone of fused marginal lobes).

Figs. 2–7.—Different views of the sense clubs or rhopalia and the adjacent parts, enlarged.

Fig. 2.—A subumbral sense niche seen from below, slightly enlarged in the middle, the lanceolate sense niche (*on*). The sense club (*or*) lies hidden in the middle of the lanceolate sense niche (*on*), somewhat nearer its proximal margin; it is surrounded on either side by the labiate sense folds (*of*) which rise from the subumbrella (*w*).

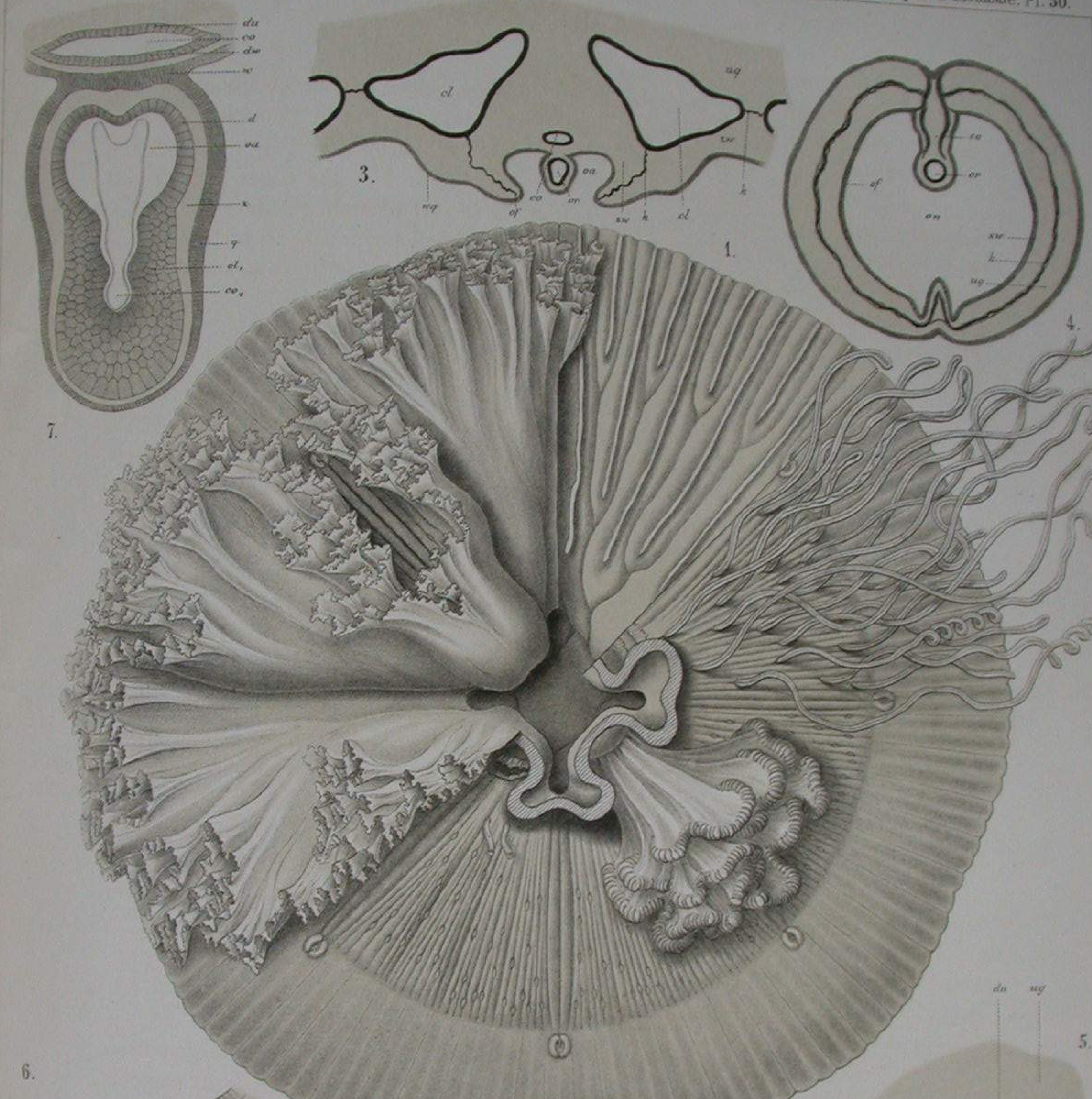
Fig. 3.—Vertical tangential section through a sense niche (*om*) slightly enlarged. *or* Sense club. *of* Sense folds. *co* Sense canal. *cl* Lobe canal. *ug* Gelatinous substance of the umbrella. *zw* Gelatinous substance of the subumbrella. *k* Cathamma between the subumbrella and exumbrella (fused plate). *wq* Ectoderm of the subumbrella.

Fig. 4.—Oblique section through a sense niche (*on*) from above and within, slightly enlarged. *k* Cathamma (fused suture between the subumbral (*zw*) and umbral (*ug*) gelatinous plate of the sense folds, *of*). *co* Canal of the sense club (*or*).

Fig. 5.—Vertical radial section through a sense club and its nearest surroundings, greatly enlarged. co_1 Sense canal. co_4 Blind distal end of the sense club, *oa* its ampulla-shaped enlargement. *ol* Otolites. *q* Ectoderm. *w* Subumbrella. *z* Supporting plate. *d* Endoderm. *du* Umbral endoderm. *dw* Subumbral endoderm. *ug* Gelatinous substance of the umbrella.

Fig. 6.—Vertical radial section through the distal part of a sense club, whose otolites have been dissolved by acid, very much enlarged. Letters as in fig. 5.

Fig. 7.—Oblique longitudinal section through a sense club, almost horizontal, greatly enlarged. Letters as in fig. 5.



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DRYMONEMA VICTORIA.

PLATE XXXI.

DRYMONEMA VICTORIA.

Fig. 8.—The entire Medusa, profile view (from the side and somewhat from above), natural size. The external velar furrow, which separates the central umbrella disk from the peripheric corona of lobes or velarium, is distinctly perceptible above on the umbrella. The eighty fused marginal lobes are visible on the velarium and the sixteen bifurcate radial streaks, forming a star-like figure, like that of *Chrysaora*, on the central umbrella disk. The powerful bush of oral curtains hangs down from the subumbrella, with the genitalia and tentacles outside it. The numerous tentacles are scattered all over the broad tentacle zone of the subumbrella, not grouped in eight bunches (as in the allied *Cyanea*). The four powerful perradial oral arms (or oral curtains) hang down from the peristom disk, like delicate, richly folded drapery, daintily frilled at the edges. The four interradial gastrogenital pouches, which are only half as long but are also folded like curtains, alternate with the oral arms. Only two of the pouches are visible in the figure; the frill-like folded genital band forms repeated windings in the bottom of the pouches.

Fig. 9.—The peristome disk with the central oral cross and the adjacent organs, of a young persona, seen from below, natural size. The four perradial oral arms (*ab*) alternate with the four interradial genitalia, of which the two lower only are completely visible, the two upper are half hidden under the bases of the oral arm: the frilled, repeatedly twisted genital band (*s*) lies below in the distal bottom of the thickly folded gastrogenital pouches (*gg*) whose proximal end is inserted at the cartilaginous oral ring (*au*). Only the basal piece of the four oral arms or arm curtains is visible in the figure and represented in such a way as to be fully visible on the upper arm, half cut away in the two middle arms, and removed for the most part in the lowest arm. The upper arm shows how the two diverging side margins of the strong, equilaterally triangular cartilaginous plate (which forms the basal part of the oral curtains and the distal extension of the brachial pillars) lie one over the other at one point (at *ab*) like valves, so that the shallow oral groove (*ar*) after a short course, is almost transformed into a canal. The lower valve (or the lower lateral margin of the triangular cartilaginous plate) is cut away, so that the oral groove (or arm groove) lies entirely open (*ar*). The latter is laid still more open on the lower arm, of which only the dorsal middle piece of the cartilaginous plate is preserved. Only a small basal piece (*aq*) of the delicately membraned, richly folded oral curtains, which run from the retroverted side margins of the basal cartilaginous plate, is visible; it shows, however, how the four oral curtains are connected below the oral ring (*au*) and form a short œsophagus (*at*).

Fig. 10.—A genitalium, with the adjacent oral part, from a mature female, natural size. *s.* The band-shaped ovary, folded like a frill. *gg* The delicate membraned gastrogenital pouch. *au* Cartilaginous ring. *ap* Perradial oral pillars. *at* Œsophagus. *am* Frilled margin of the oral curtains, retroverted upwards.

Fig. 11.—A small piece of a genital band (spermarium) slightly enlarged. *g* Follicles of the testis. *gg* Gastrogenital membrane. *f* Gastral filaments, scattered over its endodermal inner surface.

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DRYMONEMA VICTORIA

PLATE XXXII.

LEONURA TERMINALIS.

The letters have the same meaning in all the figures.

a	Oral opening (fused).	*gc*	Central stomach.
ab	Oral arms.	*gg*	Gastrogenital membrane.
ah	Oral disk (brachial disk).	*gh*	Cross of the gastrogenital membrane.
an	Funnel frills (sucking frills).	*gm*	Margin of the central stomach.
ao	Frill mouths (sucking mouths).	*ig*	Subgenital openings (portale).
ap	Brachial pillars (oral pillars).	*ir*	Subgenital porticus.
as	Oral cross (fused).	*lo*	Ocular lobes.
ca	Adradial subumbral canal.	*lv*	Velar lobes.
cc	Circular canal.	o_1	Perradial rhopalia.
cd	Pillar canals (perradial).	o_2	Interradial rhopalia.
ch	Brachial canals (adradial).	*g*	Genitalia (genital frills).
ci	Interradial subumbral canals.	*gx*	Distal ends of the genitalia.
cp	Perradial subumbral canals.	*ug*	Gelatinous substance of the umbrella.
cv	Velar canals (lobe canals).	*w*	Subumbrella.
ga	Buccal stomach.	*z*	Supporting plate (fultura).

With exception of figs. 5 and 8 all the figures are drawn in natural size.

Fig. 1.—The entire Medusa, profile view (from the side), natural size. To the right, an octant of the velarium is cut away, to show a subgenital ostium (*ig*), bounded on either side by an oral pillar (*ap*).

Fig. 2.—Radial section through the entire Medusa, natural size. The umbrella is only connected with the brachiferous disk (*ah*) by the perradial oral pillars (*ap*). The central stomach (*gc*), from which the radial canals run out, is also only connected by the four pillar canals (*cd*), with the buccal stomach (*ga*) from which the eight brachial canals diverge.

Fig. 3.—The entire Medusa, exumbral view, from above, natural size. The cruciate central stomach, with the genital cross, shines through the umbrella, which appears divided into polygonal areæ; twice the natural size. The eight sense clubs are visible on the margin.

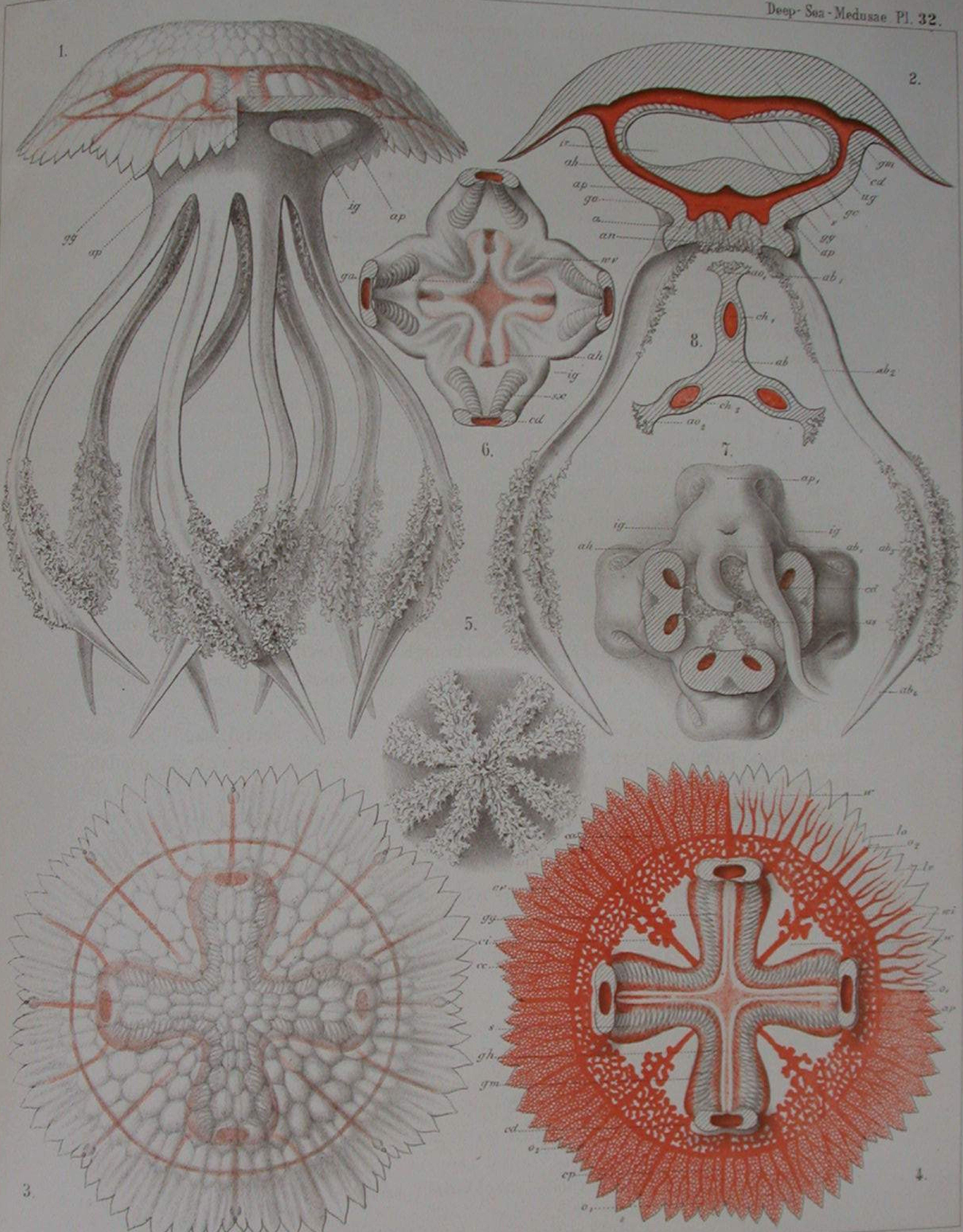
Fig. 4.—The entire Medusa, subumbral view (from below), natural size. The four perradial oral pillars (*ap*) are cut away at the base and removed along with the pendant oral disk, and the eight arms, so as to show the whole subumbral surface freely; in the middle the cruciate gastrogenital membrane (which forms the fundus of the central stomach).

Fig. 5.—Rosette of tufts of the oral disk, in the middle of its ventral surface, from below; twice the natural size; the eight adradial limbs of the disk hang in pairs from its base.

Fig. 6.—The dorsal surface of the oral disk, from above, natural size; the buccal stomach (*ga*) shines through in the middle. Sections through the four pillar canals (*cd*) are shown at the four perradial angles, with the distal end of the genitalia (*gx*) on either side.

Fig. 7.—The ventral surface of the oral disk, from below, natural size. Three of the four pair of arms are cut away at the base; the rosette of tufts in the middle is removed, to show the fused suture of the oral cross (*ao*).

Fig. 8.—Transverse section through an arm, at the beginning of the formation of the frills, slightly enlarged. an_1 Ventral (unpaired) frill. an_2 Dorsal (paired) frills. ch_1 Ventral (unpaired) brachial canal. ch_2 Dorsal (paired) brachial canals.



E. Haeckel and A. Giltsch Del.

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LEONURA TERMINALIS.