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BY

LOUIS AGASSIZ.

SECOND MONOGRAPH.

IN FIVE PARTS.—I. ACALEPHS IN GENERAL.—II. CTENOPHORÆ.—III. DISCOPHORÆ.—IV. HYDROIDÆ.
—V. HOMOLOGIES OF THE RADIATA; WITH FORTY-SIX PLATES.

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PART III.

DISCOPHORÆ

DISCOPHORÆ.

CHAPTER FIRST

DISCOPHORÆ IN GENERAL.

SECTION I.

STRUCTURE OF THE DISCOPHORÆ.

THE order of the Discophoræ, as I believe it to be limited in nature, does not embrace all the Acalephs referred to it by Eschscholtz, but only those which he calls Discophoræ Phanerocarpæ, and which Forbes has designated under the name of Steganophthalmata, and Gegenbaur under that of Acraspeda. To these I think some of the Cryptocarpæ, such as the Charybdeidæ and Æginidæ, which were but imperfectly known to Eschscholtz, must also be added. But, whatever be the true limits of the subdivisions which the progress of science has rendered necessary among the Discophoræ, since these Acalephs were first united as one group by Lamarck, and finally characterized as an order by Eschscholtz, so much is certain, that there are two distinct types among them, differing widely in their structure as well as in their mode of reproduction. I believe, however, that the true principle upon which they may be distinguished has not yet been pointed out, and that neither the presence nor the absence of a veil around the margin of their disk, upon which Gegenbaur has based his division of the Craspedota and Acraspeda, neither the exposed nor the protected position of the marginal eye-specks, which Forbes has taken as a basis for the separation of the Steganophthalmata and Gymnophthalmata, nor the development of the ovaries and spermaries, upon which

Eschscholtz has founded his subdivisions of the Phanerocarpæ and Cryptocarpæ, truly marks the limit between the primary subdivisions which ought to be admitted among the Discophoræ.

In the first place, the marginal veil exists in some of the Acraspeda of Gegenbaur, as well as in his Craspedota: it is, for instance, well developed in the Medusa, or Aurelia aurita, the most common of all the European Discophoræ, and has already been described and figured by Ehrenberg in his elaborate paper upon that species. I have also found it in another species of the same genus, Aurelia flavidula *Pér.* and *LeS.*, which is quite as common upon the Atlantic coast of North America, as the Aurelia aurita is along the shores of Europe. As to the position and structure of the eyes in Discophoræ, there is in that respect no essential difference among them upon which a primary subdivision may be founded; and Gegenbaur, who has paid special attention to these organs, has already been led to discard them as a test of their closer affinities. Indeed, while these organs are altogether wanting in some of the Gymnophthalmata, others of the same division have quite as highly organized eyes as some of the Steganophthalmata; and as to the difference in their position, it is not essentially modified by the folds of the marginal disk which generally protect them, and these folds are also wanting in some of them. Moreover, all the marginal organs of the Discophoræ — those which have been described as eyes as well as those which are considered as auditive sacs — are either simple or modified tentacles, and therefore strictly homologous with one another, so much so that the differences which exist among them constitute, in my opinion, only generic differences, as the modifications, number, and position of the tentacles themselves, and can in no way be made the basis of a primary subdivision, as Forbes maintained.

The distinction introduced by Eschscholtz seems to me of higher importance, though the manner in which he has expressed the differences he perceived does not seem to have impressed other naturalists very forcibly; for all those who have made a special study of the Acalephs since his time have discarded the characters upon which he subdivided the Discophoræ into Phanerocarpæ and Cryptocarpæ, and even gone so far as to consider the distinction as erroneous. It is true, Eschscholtz did not know how the Cryptocarpæ are reproduced: he did not even observe their sexual organs, and therefore united them together under that name. But the discovery of ovaries and spermaries in the majority of the Cryptocarpæ did not increase the resemblance of their reproductive organs to those of the Phanerocarpæ beyond what it really is: it only showed, that, like these, they also have organs of the sexes. Had not the discovery of their presence obliterated the distinction made by Eschscholtz, it would have been remembered that in the Phanerocarpæ the ovaries as well as the spermaries are complicated organs, contained in distinct pouches communicating directly with the main cavity of the body and discharging their eggs into that cavity and then through the mouth; while in the Cryptocarpæ they consist only of folds along the course of the chymiferous tubes or upon the sides of the proboscis, and discharging their eggs immediately into the surrounding medium, but never through the main cavity and the mouth. Here, then, is a typical difference between two natural groups of the Discophoræ of former authors; and it is upon this ground that I would separate the Phanerocarpæ from the Cryptocarpæ as a distinct order, especially since I shall be able to show that while the latter differ in this way from the former, they at the same time agree both in structure and in mode of development with the Hydroids and Siphonophoræ, and should form with them another distinct order.

The discoveries respecting the mode of development of the Acalephs made during the last quarter of the present century add great weight to this distinction, for they show that while the Phanerocarpæ produce, either directly or through the process of a transverse division of a polypoid young, a kind of larva (the Ephyra), which is gradually transformed into a perfect Medusa, the Cryptocarpæ originate in alternate generations as buds from similar polypoid animals. But even if nothing was known of the mode of reproduction of the Discophoræ Phanerocarpæ and Cryptocarpæ, I maintain that these Acalephs, in their adult state, should be separated from one another on account of their structure.

The body of the Cryptocarpæ consists of a disk, of an umbrella or bell-shaped form, the lower layer of which, perforated in the centre, projects from the lower surface in the shape of a longer or shorter proboscis, terminating in various ways in different families. The two layers recede slightly from one another at the base of the proboscis, and form a more or less extensive central cavity, from which arise directly a larger or smaller number of narrow tubes extending to the edge of the disk, where they are united by a similar continuous, simple, circular tube, beyond which the margin of the disk is bent inward in the shape of a projecting veil, more or less closing the space beneath the disk; while from the border, formed by this inversion of the margin, arise, along the circular tube, a larger or smaller number of plain or hollow tentacles, in some families limited to the point of intersection of the radiating and circular tubes, and in others extending around the whole disk. Pigment specks appear upon the base of the tentacles of some; while in others, more complicated eye-specks or auditive vesicles occupy the position of tentacles.

In the Phanerocarpæ, on the contrary, the lower layer of the disk not only recedes from the upper, but thickens around the central opening into four solid pillars supporting the four angles of the digestive cavity and extending downward, in the shape of four so-called arms which surround the mouth. This peculiar structure, while it gives a more definite form to the digestive cavity and keeps its lower floor permanently apart from the upper floor, also secures a greater independence to the apparatus corresponding to the proboscis of the Cryptocarpæ as a whole, and to each of its four prominent appendages separately. Moreover, the side walls of the digestive cavity are comparatively thin in the intervals between the four pillars; so much so, indeed, that the walls appear perforated, and have generally been described as perforated, when in reality these seeming holes are walled over by a veil more or less tightly stretched across the holes, and frequently forming pendent pouches, to the inner surface of which the ovaries and spermaries are attached. The chymiferous system never consists of simple tubes immediately arising from the central cavity and reaching directly a simple circular tube, but always present complicated anastomoses at the margin of the disk, while the channels arising from the central cavity are either simple tubes or wide sacs opening freely into the main cavity. As in the Cryptocarpæ, the tentacles are either few occupying a special position, or many along the whole margin of the disk, or they are entirely wanting. The eye-specks are always at the peripheric end of simple radiating tubes, but never at the base of a tentacle along the circular tube. They are frequently, but not always, protected by folds of the margin of the disk. The margin of the disk is very thin, and sometimes turned inward, in the shape of a veil.

The position of the ovaries and spermaries is so peculiar, and contrasts so strikingly with that of the Cryptocarpæ, that the way in which the eggs are freed is very different. In the Phanerocarpæ the egg sacs are arranged in loops or festoons upon the inner surface of the veil closing the lateral holes or pouches of the main cavity, and when the eggs are detached they move into the digestive cavity, and, following the channels formed by the arm-like prolongations of the four pillars which support its angles, finally reach the little marginal sacs of the arms, in which they remain until they are cast off into the surrounding medium. Peculiar as this structure may seem when compared to that of the Cryptocarpæ, there is yet the closest homology between them, for the large pouches containing the ovaries and spermaries of the Phanerocarpæ are, after all, only dilatations of the chymiferous system along the course of its radiating channels; while in Cryptocarpæ, instead of large pouches there are simple, narrow tubes, upon the sides of which the eggs are developed, and from which they immediately drop into the surrounding medium. The fact, that in some Cryptocarpæ the eggs are developed upon the proboscis, in no way conflicts with this explanation, since the angles of the proboscis, as may best be seen in Bougainvillea, are quite as much the direct prolongation of the radiating tubes, as the ovarian pouches of Cyanea are a direct prolongation of its radiating chymiferous sacs.

SECTION II.

SUB-ORDERS OF THE DISCOPHORÆ PROPER.

Having pointed out the typical differences which distinguish the Discophoræ Cryptocarpæ and the Phanerocarpæ, I feel justified in maintaining that these two groups of Acalephs ought to be considered as belonging to different orders of their class; and that, while the Phanerocarpæ constitute an order by themselves, for which I retain the name of Discophoræ, the Cryptocarpæ must be united with the Siphonophoræ and the Hydroids proper, with which they agree much more closely in their structure than with the Phanerocarpæ. There can be no doubt that the Discophoræ proper are superior to the Hydroidæ and Siphonophoræ, and Eschscholtz has already pointed out their affinity to the Ctenophoræ, arising from the fact that their body has generally eight prominent segments; that is to say, the Discophoræ, like the Ctenophoræ, are built of eight spheromeres, while the Hydroidæ generally number only four.

We have now to consider the natural subdivisions of the Discophoræ proper. Thus far, the many and most diversified representatives of this beautiful order of Acalephs have generally been divided into two families only, the Medusidæ and the Rhizostomidæ, first characterized by Eschscholtz; or, when further subdivisions have been proposed, as was done by Tilesius, Brandt, Lesson, and Gegenbaur, these were also considered as families, the characters upon which the new groups were founded being of the same kind as those adduced by Eschscholtz. But while I believe with Gegenbaur, that the Acraspeda (Discophoræ proper) include a larger number of families than were admitted by Eschscholtz, I am further satisfied that this order contains not only well-marked families, but also several structural types of a higher rank than that to which natural families are entitled.

Assuming for the present, that the groups of Discophoræ called by Tilesius, Rhizostomeæ, Cepheæ, and Cassiopeæ, are natural families; that those he has designated as Pelagiæ and Aureliæ are also natural families; and that to these the Cyaneæ and Charybdeæ must also be added as natural families, the natural limits of which we shall consider hereafter,—it should not be overlooked that the Rhizostomeæ, the Cepheæ, and the Cassiopeæ have certain characters in common which separate them more distinctly from the Aureliæ, Pelagiæ, and Cyaneæ, than the characters by which they are distinguished from one another, and that the Charybdeæ are again very distinct from these two groups. Admitting further, what every naturalist at all familiar with the Acalephs will readily concede, that, whatever may be the characters thus far assigned to the Rhizostomeæ, the Cepheæ, and the Cassiopeæ, they differ most strikingly in their form, and especially in the form of their oral appendages; that similar differences exist in the form of the Aureliæ, the Pelagiæ, and the Cyaneæ; and that the Charybdeæ are still further removed from these two groups by their peculiar form, — the question at once arises, What are the characters which bind the Rhizostomeæ, the Cepheæ, and the Cassiopeæ so closely that Eschscholtz should have united them as one natural group, even though he himself never had an opportunity of examining any of their number? and what are the characters which justified Tilesius in dividing them into three families? On the contrary, What are the characters which led Eschscholtz to unite the Aureliæ, the Pelagiæ, and the Cyaneæ into one group, which is natural, even though the attempts of recent writers to subdivide them into several families be equally justifiable? and what, finally, are the reasons which could satisfy Gegenbaur that the Æginidæ are the most aberrant type among the Craspedota, though among themselves they are very closely linked together?

I believe that these questions are not difficult to answer, if we apply to their solution the tests which I have proposed in analyzing the different categories of structure upon which different kinds of natural divisions may be founded in the animal kingdom. The Rhizostomeæ, the Cepheæ, and the Cassiopeæ may be distinguished as natural families because their form is different: they may be united into one natural group because they agree in certain complications of their structure, by which they at the same time differ from the Aureliæ, the Pelagiæ, and the Cyaneæ. These again agree with one another in some other complications of structure as much as they differ from one another in their form; and this is also true of the Charybdeæ and Æginidæ, which, as I shall show hereafter, ought to be united into one and the same group, on account of the peculiar complication of their structure, though they also constitute distinct families, characterized by their form. We have thus among Discophoræ proper, two categories of characters thus far not sufficiently distinguished, which, when properly analyzed, lead to the recognition of a greater number of natural families than are generally admitted among these Acalephs, and at the same time point out the manner in which these families may be combined into higher groups. But what are these higher groups? Can they be orders?

We have already seen that the class of Acalephs contains only three natural orders, — the Ctenophoræ, the Discophoræ proper, and the Hydroidæ, — characterized by the complication of their structure, and occupying respectively the rank in which they are here enumerated, the Ctenophoræ being the highest and the Hydroidæ the lowest. If, then, there are among the Discophoræ natural groups of a higher rank than families, and yet not entitled to be considered as distinct orders, they ought to be characterized by some special complication of their structure which does not affect their whole organization; or, in other words, they are likely to be sub-orders. Now, such groups unquestionably exist; and if we compare the structural peculiarities which distinguish the numerous Discophoræ allied to Aurelia, Pelagia, and Cyanea on one side from those allied to Rhizostoma, Cephea, and Cassiopea on the other side, we cannot fail to perceive that these structural peculiarities do not embrace their whole organization, but only the appendages around the mouth and those of the margin of the disk. And while all the families allied to Aurelia have marginal tentacles and a mouth opening freely, though surrounded by more or less extensive appendages, all the families allied to Rhizostoma are deprived of marginal tentacles, and the appendages of the mouth are soldered along their margin so as to leave only at intervals narrow passages for the admission of the food. We have thus two distinct sub-orders among the Discophoræ, for which I would propose the names of Discophoræ Semæostomeæ and Discophoræ Rhizostomeæ; and to these a third sub-order must be added, which I would call Discophoræ Haplostomeæ, including the Charybdeidæ and the Æginidæ. A comparison of the latter with the other naked-eyed Medusæ, with which they have generally been associated, will readily show how much they differ from them. Instead of simple radiating tubes communicating freely with a circular tube, they have wide radiating pouches so similar to those of the Ephyræ, about the time the tentacles are beginning to form, that the affinity is unmistakable. Moreover, as far as their mode of reproduction is known, the Æginidæ agree in their development with the Discophoræ Semæostomeæ which, like Pelagia, undergo a direct metamorphosis without intervening strobila-like segmentation. But they constitute a distinct sub-order inferior to the Rhizostomeæ and Semæostomeæ, inasmuch as the mouth is as simple as that of the naked-eyed Medusæ; and the marginal organs, the tentacles and the eye-specks, are also of an inferior character. If these views are correct, the Discophoræ should then be subdivided into the following natural sub-orders:—

I. RHIZOSTOMEÆ.
II. SEMÆOSTOMEÆ.
III. HAPLOSTOMEÆ.

I shall hereafter, I think, succeed in showing that the minor subdivisions of the Discophoræ mentioned above are natural families founded upon such peculiarities of structure as determine the form only; while the three sub-orders just mentioned are founded upon complications of structure limited to some of their parts only.

CHAPTER SECOND

THE GENUS AURELIA AND ITS SPECIES.

SECTION I.

GENERAL REMARKS.

THE methods now pursued, in treating subjects of Natural History, are to a great extent stereotyped, according to the topics under consideration. In descriptive zoölogy it is customary to introduce short characteristic phrases, called diagnoses, pointing out prominently the most striking differences among species, and to have longer and more minute descriptions follow, in which every peculiarity that may have been noticed is enumerated at full length; but, in a laudable zeal for fulness and accuracy, it happens but too frequently that remarks are introduced in no way relating to specific characters. Some naturalists make the study of species an occasion of ascertaining more fully their various degrees of affinity or relationship, with a view to their systematic arrangement; while others study with greater care the habits of animals, or their geographical distribution, or their uses to man. In comparative anatomy the modes of treatment are not less varied. Some authors, devoting themselves chiefly to a thorough investigation of the structure of animals, describe their organization in the minutest manner; but we constantly find structural features which may be common to an entire family, nay even to whole classes, dealt with, in such monographs, as if they were specific peculiarities of the animals under consideration. Other writers aim more especially at a study of the relations which exist between structures seemingly very different from one another; and thus, while they may acquire a deeper insight into the laws of the organization of animals and trace the remotest homologies and distinguish them from analogical resemblances, frequently overlook the typical differences which constitute natural subordinate groups in the animal kingdom. Others limit their investigations to the structure of special classes, either considering them by themselves or comparing them with allied types. Others still, look upon structure chiefly with a view of ascertaining the functions of the organs, and may trace these functions either through the whole series of animals or within the limits of some particular group. The danger of this kind of researches lies in the tendency, forced upon the investigator at almost every step of his inquiry, to take the functions as a safe guide in the appreciation of the true structural character of the organs. On the other hand, the student of microscopic anatomy traces chiefly the elementary parts of all the organic structures; but while he reveals to us a world unseen by the ordinary powers of our senses, he is apt to overlook the more comprehensive relations of all these parts in their extensive combinations. The same may be said of the embryologists. They confine their studies too exclusively to the investigation of the earlier periods in the development of animals, and leave generally unnoticed that state of growth during which the new being, having acquired an unmistakable resemblance to its parent, has still to go through a series of transformations before it is itself capable of reproducing its kind. Moreover, during these changes most animals have very different forms, and display sometimes so striking a resemblance to full-grown animals of other types, that these analogies ought to be traced more closely than is usually done. Finally, palæontologists have of late become so thoroughly satisfied that the animals of past ages are entirely different from those now living, that they too frequently proceed to describe extinct species without due comparisons with the living ones; and even represent fossil remains as distinct species, without first determining how far species may be distinguished by the parts they have on hand. It is now, indeed, one of the most pressing desiderata for the palæontologists to ascertain what are the parts in different classes of animals which may be sufficient to identify a fossil genus, and what is further required to determine the species. When I see how many fossil fishes have been described within the last fifteen years as distinct from those now in existence, without allusion to any comparisons with the skeletons of their living representatives, I think it may well be asked whether it was done with a full consciousness of the limitation which the similarity of the skeleton of species of the same genus forces upon the attempts of the palæontologists.

The study of organized beings, considered from these different points of view, has necessarily led to the division of our science into a number of very distinct branches, now mostly cultivated as specialities by different individuals; and yet all these different branches of Natural History are only the systematized results, as it were, of one-sided considerations. A complete history of an animal should embrace the whole in a proper coördination. Their separation is only the natural consequence of the difficulties inherent in the investigations, and of the necessity of using different means in studying the subject from different points of view, each requiring a special training. Under these circumstances, it has occurred to me that an attempt at combining into one systematic whole the various results obtained during a prolonged investigation of one of our Acalephs might not be useless in showing what may be done in studying steadily, for a great many years in succession, one of our most common species. I propose, therefore, in this chapter, to make the attempt to present one of our most common Discophoræ, the Aurelia flavidula of Péron and LeSueur, in all its different aspects. I hope thus not only to revive the interest for a more careful investigation of our common animals, whose study seems now universally neglected, but also to show that the harvest a student of nature is likely to reap cannot fail to be richer, when he turns his attention to common objects, which he may easily obtain at all seasons, than it can be through seeking opportunities of describing new species.

Following what seems a natural course, I shall first give an account of the formation and growth of our Aurelia, considered morphologically as well as microscopically; next, I propose to consider the structure of the adult, and to trace its homologies; then, to examine its habits, its geographical distribution, and its affinities; and, finally, to analyze all the data thus obtained, with a view to improving the classification of Acalephs in general.

The genus Aurelia, to which this species belongs, was first characterized by Péron and LeSueur, in 1809. Prior to that time the species belonging to it were included in one genus, not only with all the other Discophoræ, but even with all the Acalephs then known. Aurelia flavidula, to which I intend to devote particular attention here, is the North American representative of Aurelia aurita, the most common Medusa of the coast of Europe. The latter species, having been described by most writers on Acalephs, and minutely illustrated by Ehrenberg in a special paper, affords a most desirable opportunity for extensive comparisons, rarely to be had in investigations upon this class of animals.

SECTION II.

FORMATION AND GROWTH OF AURELIA FLAVIDULA, INCLUDING COMPARISONS WITH CYANEA ARCTICA.

THE EGG OF AURELIA FLAVIDULA. Nothing is known of the manner in which the egg-cell originates; whether it is one of the cells of the ovary set free to act in an independent manner, or develops from a fluid mass lying in the interstices of the cells, has never been determined by direct observation.

With a magnifying power of two hundred diameters we have seen simple globular bodies (Pl. X^a. *Figs.* 16 and 17) scattered among the cells of the ovary, but did not ascertain whether they were the discharged mesoblasts of the neighboring tissue, or started from much smaller bodies than were then seen. That these are eggs is proved by easy and direct observation; for, starting here, we may trace a gradated series of similar bodies, of intermediate sizes (*Figs.* 16, 17, 18, 19, and 20), between the smallest and those which have all the characteristics of a genuine egg (*Fig.* 21). The smallest of these little globular bodies (*Figs.* 16, 17, and 18) resemble spheres of jelly, perfectly homogeneous throughout. When, under the same magnifying power, the egg appears to the eye to be about one eighth of an inch in diameter (*Fig.* 19), its contents consist of comparatively large globules, five of which would occupy the whole diameter of the egg. These globules are perfectly clear and homogeneous, and very remarkable, from the fact that so few yolk granules should fill a whole egg. They do not seem to be permanent, for in another egg (*Fig.* 20), not much larger than this, the globules are considerably smaller and much more numerous. The intermediate state between these two eggs we have not seen; but there can hardly be any doubt that there is a total breaking up of the globules of the first egg, and then a new development, in order to produce the smaller globules of the second. It can hardly be supposed that these extensive changes could go on in such a body without being limited by a definite envelope having sufficient consistency to resist the breaking out of the unstable contents; yet such would seem to be the fact at first sight. But when we examine more closely we find, that although it is difficult to detect any definite boundary short of the superficies of the egg, yet it is palpably evident that the globular contents of the first egg (*Fig.* 19) are restrained within an area which has its limits at a very marked distance within the periphery. Here it would seem, then, that the vitelline sac has the same degree of refraction as the fluid portion of the yolk, but possesses a greater degree of consistency, and perhaps a different density. This fact should be borne in mind by those who advocate the formation of the Purkinjean vesicle as a primary step in the development of the egg, and the subsequent deposit of yolk around this vesicle as a nucleus, previous to the development of the yolk-sac.

By the time the egg has grown to be one third greater in diameter (*Fig.* 21) than the last one (*Fig.* 20) mentioned, the Purkinjean vesicle (*Fig.* 21 *p*) has appeared, and developed to a considerable size, in fact fills one half of the diameter of the egg, and the Wagnerian vesicle (*w*) already occupies one fourth of the diameter of the Purkinjean vesicle. Both these vesicles are perfectly clear and homogeneous. The yolk-cells are no larger than in the last phase, but more densely packed; so that their cellular nature is not so easily recognized, and therefore they appear more like a mass of granules, as represented in the figure. If the egg were magnified so as to appear about three times the diameter represented here, the yolk-cells would have the size and appearance of those in *Fig.* 24 *y*. The yolk-sac is so exceedingly thin that the yolk appears to extend to the very periphery of the egg. At this stage of growth the yolk has no longer the transparent, colorless appearance of the earlier periods, but presents a bluish-gray color. From this time forward there is but one remarkable change noticeable in the egg, and that is the dissolution of the yolk-cells and their re-development. That this does occur is proved by the fact, that in a fully grown egg (*Fig.* 22) the yolk-cells (*y*) are smaller than those of the last phase mentioned (*Fig.* 21); and to demonstrate that they are not the mesoblasts of the cells of the previous period, it is enough to say that these cells were not mesoblasted.

For a short time after this, the egg would seem to increase in size, but not as an entire egg. The Purkinjean vesicle (Pl. X^{a}. *Fig.* 23 *p*) bursts, and yet the space occupied by it remains clear, and the Wagnerian vesicle (*Fig.* 23 *w*) continues intact, and might be mistaken for the Purkinjean vesicle, were it not for its peculiar appearance, by which it may be recognized when compared with other Wagnerian vesicles of undoubted character and relations. The yolk-cells, at this period, are larger than ever, and have an apparent diameter, under this magnifying power, of about one thirtieth of an inch, or in reality $\frac{1}{6000}$ of an inch in diameter. The vitelline sac is very thick, a peculiarity also noticeable in the ripe egg of another genus, Cyanea (see Pl. X. *Fig.* 2 *v*), but never in the eggs of any of the naked-eyed Medusæ. Finally, the Wagnerian vesicle bursts, and leaves a homogeneous clear space (Pl. X^{a}. *Fig.* 24 *p*) in the centre of the egg. To what degree this clear space is filled up, or whether it disappears altogether during segmentation, we are not able to state; for we have not seen the segmentation of the yolk either in Aurelia or in Cyanea.[1]

THE PLANULA OF AURELIA FLAVIDULA.[2] After segmentation there is some variation in the age at which the young leave the ovary and enter the pouches of the oral appendages; for they do it by their own strength, being provided with vibratile cilia all over the body (*Fig.* 25). Some go out before they have lost their globular shape (*Fig.* 25), and others remain until they have become oval (*Fig.* 30), or even quite elongate (*Figs.* 31 and 32); but at no time do they leave in an unsegmented state.[3] There would seem to be considerable variation in size among the young,

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[1] If we may judge from Siebold's figures (Neueste Schriften der Naturforschenden Gesellschaft in Danzig, 1839, Tab. 1, *Figs.* 3, 4, 5^{a}, and 5^{b}) of the segmentation of the yolk of Medusa (Aurelia) aurita, we should say that this clear space became obliterated during the process.

[2] See Vol. III. p. 80 for the meaning of the word planula as used here.

[3] SIEBOLD (Neueste Schrift. etc., Danzig, 1839, *Fig.* 18) says in regard to Aurelia aurita, that the eggs escape from the ovary and reach the pouches without the help of vibratile cilia; but then again,

from the earliest stages; but this is a very difficult matter to decide upon, because they have a great degree of contractility and expansibility, and moreover they can change their shape, at least after the walls have become defined.

In the earliest stages after segmentation, when the embryo has a perfectly globular form (*Fig.* 25), it swims about with a rolling motion, ever changing its axis of rotation, and proceeds in a zigzag direction hither and thither, now and then shooting off, for a short distance, in a straight line. In order to reach the pouches of the proboscis, they must of necessity swim in a more definite direction than this, and so we find that the majority of those which have arrived there are more or less elongated in form: these swim very swiftly, and in a direct course, with one end forward, and roll upon the longer axis. Not only are the young ciliated before they leave the ovary, but also the outer and inner walls are apparent (*Figs.* 26, 27, and 28 *a b*), and the digestive cavity (*d*) has begun to form; and others have become oval (*Figs.* 30, 31, and 32), and the incipient formation of the mouth (*Fig.* 30 *c*) may be recognized by a depression at one end. A few ciliated globular embryos reach the pouches; but, when compared with the elongated forms, they may be considered as exceptional cases.

After segmentation has thoroughly done its office, the embryo is endued with a covering of vibratile cilia (Pl. X^a. *Fig.* 25). These cilia are very short, and so exceedingly delicate that they might readily escape the eye of the observer; and in numbers they are fully equal to the cells of the outer wall. Whether each cell is furnished with a single cilium, or not, we cannot say. Notwithstanding that the embryo at this age swims, revolving on a changeable axis, we may see, by the decided and appropriate motions of the cilia, varying according to the direction in which the body proceeds, that volition has to do with every turn the sphere makes. At one moment these cilia are all bent in one direction, and at the next they stop their vibrations and throw themselves, as if by preconcerted signal, to an opposite side; and then, the body assuming a new axis of revolution, they go on with their vibrations until a new course is adopted. It can hardly be said, that the embryo, whilst in this, the globular state, pursues any particular course; but rather that it progresses along a zigzag, or an irregular spiral path, and rarely darts off in a straight line. Now and then one is seen to go for a considerable distance in one direction; but this happens when it is in the midst of the older oval forms, which sweep it along in the current. In this way sometimes, but very rarely, the youngest globular embryos reach the pouches.

at page 21, he would seem to show that these were not in the egg state proper, for he remarks that after they reach this place he "could not find the germinal vesicle nor the germinal spot." At the same time, however, he describes the segmentation of the yolk as taking place in the pouches.

The first indication of any change taking place in the interior of these ciliated globes is a growing transparency of the peripheric portion, just beneath the coating of cilia (*Fig.* 25), and also a similar modification of the centre of the mass. Soon the nature of these changes becomes more obvious, as we find that the outer portion of the embryo grows more and more transparent, until a distinct layer (*Fig.* 26 *a*) declares itself, surrounding the whole mass as if with a thick envelope. At the same time the centre continues to increase in transparency over a larger field, until the whole is lighted up as if by an interior illumination. By plunging the focus of the microscope to the centre of the embryo, we find there a spherical cavity (*Fig.* 27 *d*) with a very clearly marked outline. This at once gives a definite character to the different regions of the body: the outer envelope is the outer wall (*a*) of the body, the part included by this is the inner wall (*b*), and the cavity (*d*) is the digestive cavity in an incipient state. As yet there is nothing present which indicates either right and left or before and behind, but every thing is equally disposed about a central spherical cavity. The average diameter of the majority of the embryos at this time is $\frac{1}{300}$ of an inch: some, however, measure as small as $\frac{1}{333}$ of an inch, and others as large as $\frac{1}{285}$ of an inch. The digestive cavity continues to enlarge until its diameter is equal to half that of the whole body (*Fig.* 28 *d*) before any other sensible changes take place. Up to this time the embryo has been of a uniform, transparent gray color; but now the inner surface of the digestive cavity (*Fig.* 28 *d*) is tinted with a faint rosy color, which suffuses the whole body with a delicate blush.

The next phase introduces the formation of the mouth. This is brought about in the first place by the formation of a depression (*Fig.* 29 *c*) on the outer surface of the inner wall (*b*), and from thence a passage is formed inwardly to the digestive cavity (*d*). The outer wall is pierced, sometimes soon and at other times much later. After the formation of the mouth and the passage-way to the digestive cavity they are seldom seen, because the embryo keeps them closed, except when swallowing its food; and hence some of the older forms figured on this plate appear to have no mouth (*Figs.* 31 and 32), or no passage (*Figs.* 30, 34, 35, and 36) to the interior. The figure which we have referred to for the formation of the mouth and the passage-way to the digestive cavity (*Fig.* 29) was contracted vertically at the moment it was drawn, but the true form is oval like the figure below it (*Fig.* 32). The degree of contractility which these embryos possess is well illustrated by two figures (*Figs.* 31 and 32) placed here side by side; for these figures were copied from the same individual. This faculty is possessed by the embryo from the earliest period after segmentation has finished, and increases in degree with the development of the body. Sometimes one may observe a single organ or part of the body contract or expand, while the rest remains immovable;

for instance, the inner wall (*Fig.* 33 *b*) expands inward until the digestive cavity (*d*) is nearly or entirely obliterated for the time being.

In the next phase the body assumes an ovate form (*Fig.* 34), with the mouth (*c*) at the broader end. From this it soon passes into an elongate pyriform or broadly cylindric shape (*Fig.* 35), at the same time increasing to nearly double the size, but the different regions of the body retaining the same relative proportions. Soon, however, more decided changes occur, and the embryo pursues a more varied and active life. In the first place the body becomes slightly flattened, or four-sided, at the upper half next the mouth (*Fig.* 36 *c*), and the four corners (*e*) project slightly, whilst at the opposite end (c^1) the body assumes a narrower and truncate form; so that, on the whole, the body appears wedge-shaped in outline. The outer wall (*a*) retains the same thickness as in the last phases, but the inner wall (*b*) grows thin at the four corners (*e*) of the actinal end, and the digestive cavity (*d*) embraces twofold the extent that it did in the last stage, and in some cases, when the embryo is unusually large (*Fig.* 36), fourfold. The average length of the body at this time is $\frac{1}{120}$ of an inch, but there are here and there some embryos which measure $\frac{1}{85}$ of an inch long (*Fig.* 36). In the latter case it is probable that the embryo is very much expanded. The vibratile cilia are no longer than at the earliest periods; and, as a natural consequence, the movements of the embryo are heavy and slow to vary, and the onward motion is very tardy in comparison with that of the embryo of Cyanea (Pl. X. *Figs.* 10 and 10^a). The rosy hue of the former phases has deepened to a brownish pink color, which lines the whole digestive cavity and renders it very conspicuous. This phase is the last one in the free life of the scyphostoma of Aurelia, and in the next we find the embryo settling down upon the narrower end of the body and attaching itself to its foundation by a horny secretion.

After this phase the mode of development, and the proportions and size, of the scyphostoma of Aurelia and Cyanea, are to all appearance identical; and we shall therefore describe them together, as if they were one, after having described the earlier stages of Cyanea, corresponding to those of Aurelia already considered.

The Egg of Cyanea arctica. We have observed only two stages in the development of the egg of Cyanea; one at quite an early period, and the other at maturity. It is proper to state here, that the eggs may not have been in a perfectly natural condition, as the animal from which they were taken was in a dying state. The first (Pl. X. *Fig.* 1) of these two stages corresponds in size to *Fig.* 19, Pl. X^a.; but the latter is in a much earlier state of development. The magnifying power used here was about four hundred diameters. The yolk sac is very thin, and appears like a mere film around the yolk. The yolk is very transparent and colorless, and consists of rather coarse granules, not very closely crowded except at one point (Pl. X. *Fig.* 1 y^1), where they are so densely packed together as to appear quite dark. The Purkinjean vesicle (p) is very clear and homogeneous, and is one quarter of the diameter of the egg. The Wagnerian vesicle (w) is a clear cell, which occupies a little less than one half of the diameter of the Purkinjean vesicle. The yolk sac (*Fig.* 2 v) of the mature egg is quite thick, a peculiarity before noticed, when speaking of the mature egg of Aurelia (Pl. X^a. *Fig.* 23). The yolk is divided into two kinds: an outer, thick layer (y) of very transparent, rather coarsely granular substance, and a central mass (y^1) of densely crowded dark grains. The Purkinjean vesicle has burst, but the place which it occupied is marked by a clear space (p) in the darker yolk mass (y^1).

THE PLANULA OF CYANEA. There is a remarkable difference between the mode of development of Aurelia and that of Cyanea, and this, too, from the earliest period after the segmentation of the yolk. The embryo of Cyanea, in its globular state (Pl. X. *Fig.* 3), has not more than two thirds the diameter of that of Aurelia. The figure given here was drawn from a specimen magnified five hundred diameters. The vibratile cilia are very short and faint, and difficult to detect when the animal is revolving rapidly. The cells of the exterior are very prominent, so that the surface of the revolving globe appears as if papillated. They are also very transparent to a considerable depth; but, although appearing like a thick envelope, they do not as yet form a distinct wall apart from the interior mass. The bulk of the body consists of a dark gray mass of cells, in the centre of which is a clear portion, equalling one third of the diameter of the whole body. In this solid state the embryo moves about in the same manner as the young of Aurelia, and gets into the pouches of the proboscis by the same process.

From the globular state the embryo passes to a more active existence, and, increasing considerably in diameter, changes its form to a broadly ovate shape (*Figs.* 4 and 4^a), and its cilia grow to more than double their former length, and become quite conspicuous. The outer transparent layer of the cells retains the thickness of the last phase, but the inner dark gray mass changes to a great extent and its peripheric portion becomes very dark orange red, whilst the interior region, constituting two thirds of the whole body, grows very clear, like the periphery of the embryo. The revolutions of the body are now very rapid, and, its axis of rotation corresponding to its greater diameter, the embryo moves in direct lines from place to place, with the broader end forward. The vibratile cilia incline to the body at different angles at different times; when the rotation is slow they project nearly at right angles, but when it is rapid they incline, contrary to the direction of the revolution, at an angle of forty-five degrees or even less (*Fig.* 4^a). In the latter instance the cilia appear as if swept backward by a swift current, whereas the movement of each one is completely under its own control, as may oftentimes be observed when here and there one or several project for a while at a different angle from the rest, and then fall back to the common inclination, whilst others rise up or subside in the like manner at different points of the body. The trend of the cilia depends upon the velocity of the body as it bores its way through the water: when going swiftly, the cilia point obliquely backwards, at an angle of thirty or forty degrees to the longer axis; but when progressing slowly, they either vibrate with much less rapidity, or else, keeping up the energy of their motions, they assume a trend more nearly at right angles to the axis of revolution, and thus the body rotates very fast, without, however, advancing at a corresponding rate. Thus oftentimes we may see the embryo progressing very rapidly, and all at once almost or altogether cease its forward motion, without retarding the velocity of its rotation.

In the next phase (*Figs.* 5 and 5^a) the body is elongate cylindrical, and, being more active than in the last stage, the motions forward and backward, and the rotations and retroversions, excite the attention more readily. There is another mode of progress sometimes adopted by the embryo, which reminds one of the movements of certain forms of the so-called Infusoria, such as Leucophrys and Paramecium: we refer to its unaccountable habit of whirling over, end for end, as a club does when hurled through the air. This it will do occasionally without moving from the spot, and so persistently and rapidly that the eye sees hardly any thing but a flitting shadow. The outer layers of cells are very clear, and have a crystalline brilliancy, which would seem to result from the sharply polygonal form of the cells; the interior of the body is wholly opaque, and colored deep orange red. It would seem from this, that the clear interior mass had become totally changed into pigment cells; but of this we cannot speak decidedly, since the animal has powers of contraction so great that it is possible the clear centre is reduced to a very small size, and hidden from view by the opacity of the pigment cells. *Fig.* 6, compared with *Fig.* 5, is an example of the variation in size which the embryos exhibit at this age.

As a further step in development the embryo becomes oval in outline, and a hollow space appears in the interior, near one end (*Fig.* 7 *d*). In the numerous embryos which we have examined, this space has always appeared at that part of the body which is behind when the animal swims; yet it may vary in its position, as occurs in a later stage, when the whole of one end of the embryo is hollowed out so as to leave a remarkably clear space (*Fig.* 8 *d*). This space, as in the last stage, is usually seen behind; but occasionally the animal shifts, as it were, its opaque load of orange red pigment to the opposite end. Whether the orange mass within is really loosened from the outer transparent layer, or the embryo has the power of suddenly forming a hollow space where it pleases, we cannot say positively; but it seems quite probable that the former is the case. The degree of contractility which the embryo possesses is shown by *Figs.* 8 and 8^a, which were taken from the same individual.

In an immediately subsequent phase a totally new form presents itself: by the flattening of the scyphostoma it assumes a shape (*Figs.* 9 and 9^a) which strongly reminds one of the blood discs of birds and reptiles; and were it not that the two sides of the oval planula are simply concave, the resemblance would be complete. The anterior end (*Fig.* 9^a *c*) is a little thicker than the posterior (c^1), and the middle is the thinnest and occupied by a clear oval mass. The motions of the planula are just as rapid and varied as in the last stage, but much more remarkable, on account of the alternate presentation of its sides and edges to the eye in rapid succession while it rotates upon its longer axis. The anterior end of the body soon becomes much thicker (*Fig.* 10^a *c*), and, when seen edgeways, presents an angular outline and flat area at the extreme end (*c*). At the posterior end (c^1), however, it does not change much in form. In an end view of the anterior end (*Fig.* 10^b), the outline is oval; the posterior end (*Fig.* 10^c) is also oval transversely but not so thick proportionally. In the middle of the flat area (*Fig.* 10^a *c*) there is a cup-shaped depression (*Figs.* 10 *c*, 10^b *c*, and 10^d *c*), which will at once be recognized as the mouth in its incipient state. Excepting the outer transparent layer, the whole body is very opaque. In a quiescent state the stiffened, bristle-like appearance of the cilia (*Fig.* 10^d) calls to mind a similar phenomenon observable among infusorial forms.[1] At this stage the embryo terminates its free wandering life, and it may be seen diligently seeking a place to lay its foundation; for such it truly has, as we shall presently show.

THE SCYPHOSTOMA[2] OF AURELIA AND CYANEA. We now proceed to describe the development of the scyphostoma of Cyanea and that of Aurelia together. The wandering life of the planula form having come to an end, we may observe it settling down upon its narrower end (*Figs.* 10 and 10^a c^1): it wavers, and sways to and fro as if it were trying to force its way downward into the substance upon which it has fastened itself, and then, as if dissatisfied with the promise of a good basis for its foundation, it suddenly loosens its hold and swims away to another locality, there to repeat the same kind of examination, until finally, after perhaps half a dozen attempts, as we have observed, it finds a suitable place to rest upon permanently. In the process of attaching itself, the posterior end (*Fig.* 11 c^1) becomes simply flattened, or moulded to the shape of the body to which it adheres.[3] The

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[1] Ehrenberg has actually mistaken the embryos of Aurelia for parasitic Infusoria. Dic Acalephen edsot hern Meeres, Berlin, 1836, pp. 20 and 77.

[2] See Vol. III., page 80, for the meaning of the word Scyphostoma as used here.

[3] SIEBOLD loc. cit. page 28, states that this end

opposite or free end, containing the mouth (*Fig.* 11 *c*), becomes relatively the upper end of the body as regards the point of attachment; but homologically speaking it is the actinal pole, and corresponds to the proboscis of the medusoid form. By the time the embryo is fairly attached, the outer layer of transparent cells has separated from the interior mass, and thus defined itself as a distinct wall (*a*). The inner wall (*b*) is in a measure distinct, but, owing to the density of the pigment cells, its outlines are not very clearly defined. Occasionally there may be seen spaces (*d*) between the outer and inner walls, which, as in the present instance, are quite extensive, and seem to show that the two walls are very loosely connected with each other. The nascent tentacles (*e*) are quite prominent. The number of tentacles varies from two to three or four, but usually there are but two in the beginning. At first they are mere thickenings of the outer wall, and appear like small, warty excrescences (*e*) at a short distance behind the mouth (*c*). The cilia still show some signs of life by fitful starts, either all together or in groups at different points of the body. The mouth has not as yet any connection with the digestive cavity; but a few hours later a passage is formed, and one may look directly through it (*Figs.* 12 and 12^a *c*) into the centre of the body. From the earliest moment of its existence as a true mouth, it exhibits all the characteristic movements of later stages: the lips gape (*Fig.* 12 *c*) till the digestive cavity may be looked into as if into a cup, or they open and close and stretch out as if trying to seize upon something. The specimen which we have represented in *Figs.* 12 and 12^a appears indistinctly five-sided when seen from above (*Fig.* 12^a), and the angles correspond to as many incipient tentacles. The cilia, although present, have ceased to vibrate, or to show any signs of vitality. The most remarkable feature of this phase is the commencement of the horny sheath of the stem, which first appears as a layer of transparent, amber-like substance (*Fig.* 12 f^1) beneath the posterior end of the embryo, and serves as a base for its attachment. The laminated structure of the incipient sheath indicates plainly that it is a succession of layers deposited by excretion from the posterior end of the body. The digestive cavity occupies a large portion of the anterior part of the body, but the rest of the embryo is filled by a dense, orange-yellow mass, not to be distinctly recognized as an interior wall; nor does the whole of this congregation of cells always become

of the body has a depression, which acts like a sucker, and enables the embryo to adhere to smooth bodies, or to hang pendent from the surface of water. Were it not that he describes a mouth at the opposite end of the body, we should be inclined to think that the depression he speaks of was the true digestive opening, especially as he says that this end of the body precedes the other parts when the animal is swimming. Now in our Aurelia the depression is also at the broader end of the body, and precedes the narrower end when swimming; but we have already seen that this broad end remains free, whilst it is the narrower end which becomes fixed.

converted into a wall, but portions of it, sometimes to a considerable amount, are torn away from the principal mass and cast out from the body, as if the residue of digestion. The first discharges from the intestines of the higher animals no doubt correspond to the waste matter of this young animal.

The horny sheath does not appear at any precise time, but varies considerably in this respect, as we may see in the next phase which we have to illustrate (*Figs.* 13 and 13^{a}); here the tentacles (e) are quite prominent, and yet there is not the least trace of a sheath to be observed. The digestive cavity is quite small, even less than in the last stage, and the opaque orange mass darkens the whole body to the very base of the tentacles. The cilia are still present, but immovable. In the next phase we may see that the tentacles (*Figs.* 14, 14^{a}, and 14^{b} e) develope very early their characteristic organs, the lasso-cells (Pl. X^{a}. *Figs.* 7 a b and 10), and in such abundance that the parietes of the outer wall appear to be entirely composed of them. The outer wall (Pl. X. *Fig.* 14 a) of the body is very thin, and is composed of a single layer of cells, excepting in the tentacles, where the lasso-cells constitute a single layer by themselves, and the interior of the wall (*Fig.* 14 a^1), which here is very thick, is composed of an irregular mass of cells, identical with those of the rest of the body (Pl. X^{a}. *Fig.* 8). There are also lasso-cells scattered all over the body. The tentacles (Pl. X. *Fig.* 14 e), as far as they project beyond the general surface of the body, are almost entirely made up of a thickening of the outer wall (*Fig.* 14 a^1), the inner wall forming as yet only a short basal portion. The tentacles are so exceedingly contractile that it is next to impossible to determine whether all four of them are of equal age, or any one or two older than the others. In the figure which we have given representing the animal as seen from above (*Fig.* 14^{b}), the two longer tentacles would seem to be much older than the others; but when we see them at the next moment all retracted, and so merged into the walls of the body that the embryo appears like a perfectly smooth cup (*Fig.* 14^{c}), without the least trace of any appendages, it becomes clear, that, at this age, size has nothing to do with the degree of development at which the young has arrived. It is hardly conceivable that the simple, cup-like body with its widely-gaping mouth (*Fig.* 14^{c} c) and perfectly smooth exterior is the same individual that a moment before bore such prominent tentacles (*Figs.* 14, 14^{a}, and 14^{b} e); and yet we have watched the transition from one state to the other without removing the eye from the microscope. The inner wall (b) is very thick and opaque; its interior surface is smooth and well defined, so that we may consider the digestive cavity (d) as firmly established and ready to perform its characteristic function. Taking advantage of the enormous gaping of the mouth, we have been able to study the cells of the interior surface of the inner wall (*Fig.* 14^{c} d), and find them (Pl. X^{a}. *Fig.* 8) to be identical with those of the outer wall, being simple, irregularly polyhedral bodies without any obvious arrangement among themselves. Normally the tentacles are developed by twos or a multiple of two; usually two begin first, and two more immediately follow, so that in the outset the body has a quadrangular shape. In abnormal specimens the embryo continues to grow for some time with only two papilliform tentacles (Pl. X. *Fig.* 15 *e*), although the base (c^1) develops regularly, and the proboscis (*c*) becomes quite prominent; or, in others, the two tentacles increase considerably in length (*Figs.* 16 and 16^a), and the proboscis (*c*) grows very large. At other times, the first two tentacles being far advanced, only a single additional one (*Figs.* 17 *e* and 18) develops on one side, and grows long before another appears on the opposite side of the body.

After four tentacles have developed, a considerable period elapses before any others appear, and in the mean while all the different parts of the body progress very far in growth; the tentacles become very long and slender (*Figs.* 19, 20, 21, and 22), and may be so extended as to more than equal the whole length of the body. When stretched out they are remarkably transparent, and allow a very clear view of their interior structure (Pl. X^a. *Fig.* 2). The cells of the outer wall are so merged into each other that their parietes are with difficulty made out, and hence the transparent, film-like appearance of this wall. The inner wall of the tentacles develops to such a degree that the component cells (*Fig.* 2 b^1) are as fully characteristic in their appearance and conformation as in any of the later stages of growth. The outer wall of the body (Pl. X. *Fig.* 19 *a*), now composed of a single layer of cells (Pl. X^a. *Fig.* 6 *a* a^1), is very thin and transparent. The inner wall (*Fig.* 6 *b* b^1) is also composed of a single layer of very large cells, but in this case they are totally different from those of the outer wall, having an irregular, prismatic form, with the longer diameter transverse to the thickness of the wall. This wall is five times thicker than the outer wall. The most striking change observable since the last phase is in the mouth, which has assumed a quadrilateral shape (Pl. X. *Fig.* 22 *c*), as if it were four-lipped, each lip corresponding to a tentacle. The extensibility of the lips may be seen as represented in a figure (*Fig.* 21 *c*) showing the manner in which the young hydroid catches its prey. This is the earliest period at which we have observed the embryo taking food. The lasso-cells are in full activity, and their extruded threads give the tentacles a bristling appearance (Pl. X^a. *Fig.* 2). In a state of complete expansion the whole body is quite transparent, and has a uniform grayish color tinged with orange, by the reflection from the pigment cells which are scattered over the surface of the digestive cavity. In a contracted state the crowding of the pigment cells renders the interior of the body quite opaque (Pl. X. *Fig.* 19). The general contour of the body, when in full activity, is slender top-shaped (*Figs.* 20 and 21), with a rather slender base, and, at the base of the tentacles, four-sided (*Fig.* 22), with a tentacle projecting from each corner. There is a portion of the slender base of the body where the opposite inner walls (Pl. X^a. *Fig.* 6 *b b*) coalesce, and thus form a solid axis, into which the digestive cavity does not penetrate. Pl. X. *Fig.* 24 e^1 is an instance of irregularity of growth in the tentacles: one of them (e^1) is much smaller than the others, and very transparent and thin, being evidently stretched to the utmost, and therefore, without doubt, here shown at its full size. Sometimes we have found specimens which have the tentacles developed in pairs (*Fig.* 23) on the opposite sides of the body. *Fig.* 26 is a representation of a perfectly robust and flourishing embryo having five tentacles, which would seem to have all developed at one time. The extensibility of the lips of the mouth is here well illustrated by the large proboscis (*c*) formed by their expansion, and which is fully as plastic and active in the various shapes which it assumes, and the motions which it performs, as at any later period. The degree of extensibility of the tentacles (*e*) is also better shown in this figure than in any of those with four tentacles.

In the next stage four more tentacles are introduced, at intermediate points (Pl. X. *Fig.* 25 *e*) to the first four that were developed. Their mode of budding is the same as that of the earlier tentacles, and they continue to grow until they are as long as the first four, before another set begins to develop (Pl. X. *Figs.* 33, 34, 35, 36, 37, and Pl. X^a. *Figs.* 4, 4^b, and 5). One of the most striking peculiarities of this stage of growth is the hydra-like form of the embryo (Pl. X. *Fig.* 33), which might readily be mistaken for a species of that genus upon casual observation. The base (c^1) is quite long and slender, and strongly resembles a tentacle. The lips of the mouth (*c*) project separately, or they may be merged into one and protruded as in younger stages, in the form of a proboscis (*Fig.* 35 *c*). The many protean shapes which the mouth may assume, render it almost impossible to say what is the form of this organ; usually, however, we find it but slightly, if at all, elevated above the base of the tentacles (*Figs.* 34 and 37; Pl. X^a. *Fig.* 5), and each one of the four corners projecting toward the base of a tentacle (*Fig.* 34; Pl. X^a. *Figs.* 1, 5, and 11). By comparing *Figs.* 22 and 27 with *Fig.* 24 of Pl. X. we find that the position of the corners of the mouth is not constant: in the first instance the corners are opposite the intervals of the first four tentacles, whereas in the second they are opposite the tentacles; and so we are unable to judge whether, in the eight-armed stage (Pl. X. *Fig.* 34), the corners are opposite the first four tentacles or alternate with them. This can only be determined when the second set of four tentacles is in an early state of development, as in *Fig.* 27. But here we are again at fault; for if we compare *Fig.* 34 of Pl. X. and *Fig.* 5 of Pl. X^a. with *Fig.* 34^a of Pl. X., all representations taken from the same individual, we shall find that in the last figure (34^a) the corners of the mouth are doubled in number, and each one of them is opposite an interval of the tentacles, instead of being opposite a tentacle, as in the first figures; and so we must finally come to the conclusion, that the normal position of the corners of the mouth is undeterminable, if indeed there is any strict relation between them and the tentacles. At other times all traces of the corners of the mouth are obliterated, and a simple round opening (*Figs.* 25 and 32 *c*) leads to the digestive cavity. This is especially observable when the mouth is thrown wide open (Pl. X^a. *Fig.* 4 *c*), which may be done to an extent so great that the aperture has a diameter equal to the breadth of the body. Again, the mouth contracts in the form of a circle (Pl. X. *Fig.* 36 *c*), and, gradually lessening the aperture, it finally disappears (*Fig.* 30) without leaving a trace of its position, just as the vacuoles in Infusoria.

As in the previous stage, so in this, there are occasional anomalies in the regularity of the development of the tentacles. Sometimes one of the second set of four becomes far advanced in growth before the other three have scarcely begun to bud (*Fig.* 27); in others, two tentacles precede the others (*Figs.* 29, 30, and 31). In a seven-armed embryo (*Fig.* 32) which originally appears to have been five-armed, two tentacles, one on each side of the forked one (*e*), precede the others. A nine-armed specimen has one of the first four tentacles (Pl. X^a. *Fig.* 11 e^1) double from the very base. We have also figured a ten-armed specimen (Pl. X^a. *Fig.* 14), which no doubt originally had five tentacles; here every thing is in fives, or multiples of five. There are five larger (*1*) and five smaller (*2*) tentacles, one of which is contracted down to a mere papilla (*e*), and the lips (*c*) are five in number. These variations recall the variations in the number of segments of the Medusæ. The contractility of the tentacles is almost as unlimited as in the youngest stages, as we have seen a well-developed, eight-armed embryo (Pl. X. *Fig.* 34) withdraw its tentacles so completely within itself that they could be recognized only as slight protuberances (*Fig.* 34^a *e*). The manner of doing this would seem to be by lateral spreading and diffusion of the mass of the tentacle as it sinks down into the disk, rather than by a condensation of the cells into a smaller compass; for in the latter case the protuberances would be much darker than the rest of the body, and the lasso-cells would be crowded together in a bristling mass, which is not the fact. Sometimes, the tentacles being partially contracted, they are curved inwardly toward the mouth (*Fig.* 36), or they may be still more contracted, and the disk narrowed to such a degree that it is less in diameter than the body below it (*Fig.* 34^b).

Here and there we find forked tentacles; some forking at the base (Pl. X. *Fig.* 28 *e*), some near the tip (Pl. X. *Fig.* 32 *e*; Pl. X^a. *Fig.* 14 e^1), and others midway between these points (Pl. X. *Fig.* 38; Pl. X^a. *Fig.* 11 *e*). In Pl. X. *Fig.* 28, the forked tentacles, three in number, are in different states of development; one is as fully grown as the other tentacles, but the other two have only one prong, the other one being in an incipient state and budding from the base of the other. In regard to the second and third forms, we cannot say whether the prongs grow simultaneously or one from the other; but most probably in both ways.

Rarely there are instances of double-headed embryos (Pl. X. *Figs.* 37 and 37^a); the one we have illustrated had a digestive cavity common to both heads, and eight tentacles on one head, but only four on the other. We know nothing of the mode of development of this anomaly.

The walls of the body have about the same proportionate thickness as in the last stage; but there are some new features to be noticed here. The bases of four alternate tentacles are prolonged inwardly so as to project, like triangular buttresses (Pl. X^a. *Fig.* 5 b^2), into the digestive cavity. The breadth of these projections nearly equals that of the base of the tentacles, and they do not extend downwards along the wall of the body much farther than they do laterally, or along the wall of the disk within the circle of the tentacles. They have no relation whatever with the outside of the embryo, but are altogether made up of cells which developed from the inner wall (b). The position of these projections corresponds to the base of the first four tentacles.[1]

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[1] SIEBOLD was the first to discover these projections, which he calls longitudinal swellings (Längswülste), and also points out their relation to the first four tentacles. He says that they extend from the base of the tentacles along the wall of the digestive cavity to its very bottom. See his Beiträge zur Naturgeschichte der Wirbellosen Thiere, Ueber Medusa aurita, Danzig, 1839. — SARS (Wiegmann's Archiv, 1841, vol. 1, pp. 24 and 25, Pl. I. *Figs.* 31, 32, and 33) also calls these projections swellings. He observed them in the scyphostoma of Aurelia and Cyanea, and agrees with Siebold in regard to their extent, and also their relation to the tentacles. — STEENSTRUP, in his remarkable little work upon alternate generation ("Ueber den Generationswechsel," Copenhagen, 1842, pp. 14 and 15, Pl. I. *Figs.* 35–40), describes an animal which he identifies with the scyphostoma of Cyanea, figured by Sars (Wiegmann's Archiv, 1841, etc.); but he goes on to point out certain organs, which he previously intimates the latter had overlooked. "Von inneren Organen hat Sars nur vier rundliche erhabene Längswülste beobachtet," page 14. These organs are, a circular canal which runs along the circle of tentacles, and four other canals running from this, at equal distances apart, to the edge of the aperture in the annular membrane which stretches across the mouth of the bell-shaped disk, and there they join another circular vessel. The four canals which run along the inner surface of the bell, from the apex to the circular canal at the base of the tentacles, he considers to be the same as the four longitudinal ridges in the digestive cavity of Sars's scyphostoma. But when we examine the figures of Steenstrup we are struck with their remarkable resemblance to certain naked-eyed Medusæ, especially Turris. In *Fig.* 40 we see the pendent proboscis from which the four radiating canals take their rise and pass down the inner surface of the bell to the circular canal at the base of the tentacles. As to the four canals, which, Steenstrup says, run to the aperture of the annular membrane, and the circular ring which they empty into, we feel quite positive that they are nothing but the dupli-

The double border of the lips in Pl. X^a. *Fig.* 5 *c* is produced by the overlapping of the edge of the outer or upper wall upon the inner or lower wall. In *Fig.* 1, the inner wall having brought together its edges, excepting around a very small area, *c*, the cruciate mouth appears to be veiled by a thin membrane which has a central perforation, *c*, whilst the upper or outer wall is rendered conspicuous at its eight edges by numerous thickly crowded lasso-cells. At *c* in *Fig.* 4^b the relative thickness of these two walls, as they stand out in profile, is very clearly shown. The lasso-cells are not so uniformly disposed over the body as in the last phase, but beside being generally diffused, they are crowded at the borders of the mouth (*Fig.* 1 *c*), and grouped in semi-globular masses (a^2 a^3) on the tentacles. When the tentacle is contracted (*Fig.* 3), the lasso-cells (a^1 a^2) appear

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cates of the double wall of the velum, which projects from the bell in the form of a four-sided pyramid. The fact that the medusa is fixed by a pedicel to rocks and shells does not invalidate our assertion, for we have on our own coast the genus Rhizogeton (Pl. XX. *Figs.* 17–23), which bears its medusæ on the stolons which run over the rocks. Now, it is possible that Steenstrup overlooked the connection of the medusa with a stolon, and, if the hydroid form was present, supposed that it was another animal, or perhaps the hydroid had been resorbed, as often occurs in Coryne (Pl. XVII. *Figs.* 13, 14, and 15), and nothing but the medusa form is left standing, mouth upward, on the stem (Pl. XVII. *Fig.* 15). We would seem to be borne out in the belief that Steenstrup's scyphostoma is a Turris, from what Dr. Wright (Edinburgh New Phil. Jour. vol. 10, 1859, p. 105, Pl. VIII. *Fig.* 1) has observed on the shores of Scotland. He collected the eggs of Turris neglecta and reared the young until they developed into Hydroids, which, both in size and zoological features, closely resemble, if they are not generically identical with, our Rhizogeton. At any rate, we cannot doubt that Steenstrup's figures do not represent a scyphostoma, but a naked-eyed Medusa, if not the genus Turris; and therefore we are surprised to see that Sars ("Fauna Littoralis Norvegiæ, 1846, p. 14") says, "Steenstrup, more fortunate than I, has found in the Medusa-nurses a vascular system (Gefäss-system) (of which I had noticed only the four radiating canals, which appeared to me like swellings), and in the bottom of the bell a tubuliform stomach or mouth." At this time Sars was conversant with several forms of naked-eyed Medusæ, as his figures show; and yet he overlooks the similar nature of Steenstrup's so-called scyphostoma. In the Ann. and Mag. Nat. Hist. 1848, vol. 1, p. 25, Pl. V., Dr. Reid describes the genuine scyphostoma of Aurelia, which he obtained on the shores of Scotland, and identifies it with the animal of Steenstrup. Under this impression he proceeds to argue that Steenstrup could not have seen any canals in the pyramidal projection of the lips, because he does not in the Scottish animal; but he represents the four longitudinal ridges in the digestive cavity of scyphostoma as hollow, and, moreover, asserts that they "terminate at their upper end in another canal, encircling the mouth and placed between it and the margin of the disk," p. 27, *Fig.* 6 *b*. But we most positively assert that these longitudinal ridges are not hollow, nor is there the least trace of a circular canal in which the ridges are said to terminate. — FRANTZIUS (Siebold und Kölliker Zeitschrift, 1853, Bd. 4, p. 120, Pl. VIII. *Figs.* 1–4) also indorses Steenstrup's mistake, and describes, in the scyphostoma of Cephea borbonica, what he considers to be the homologues of the radiating canals of the bell; but, unlike Reid, he could not persuade himself "that these canals really emptied into a circular canal at the base of the tentacles." What is remarkable, he represents these canals in his figures as if they were situated in the outer wall of the body.

to constitute the whole outer wall, showing the remarkable compressibility of the original cells, among which the lasso-cells are imbedded.

At this age it may be seen that the hydroid form of covered-eyed Medusæ has a horny tube (Pl. X^a. *Figs.* 4 *f* and 4^a *f*), as well developed as any Hydroid of the naked-eyed families. Neither Coryne nor Tubularia can be said to have more fully developed horny tubes than this; nor is there any genus out of the families of covered-eyed Medusæ which have so thick-walled a tube. The inner surface of this tube (*f*) presses very closely to the stem (*Fig.* 4^a *a*) of the embryo, but does not touch it. At its lower end it spreads out into a broad base, and directly under the foot (c^1) of the pedicel (*a b*) it is connected with it by several — four to seven or eight — small, slender, conical props (f^1); passing upwards, it thins out into a mere film (f^2), and finally comes to an edge at a short distance above the bottom of the cup-shaped head. At first sight, owing to the longitudinal wrinkling of the surface, it would appear to be composed of concentric layers, but, on account of its exceeding transparency, no such structure can be discovered; although, considering that such sheaths are formed by successive deposits, there is no doubt that the layers are present. In color the tube resembles amber, and, like that substance, it changes its intensity of coloring according to the light which shines through it. We have not seen a horny sheath around the stem of the scyphostoma of Aurelia, nor has it been observed by European naturalists in this genus.[1]

This is the earliest period at which we have observed the embryo taking food. The first instance of this which we saw was a six-armed individual (Pl. X. *Fig.* 30), which had in its digestive cavity one of its own kind, in the planula state, and revolving by means of its own cilia at a very rapid rate. The planula continued to revolve for three quarters of an hour after we first saw it, and then, being ejected, it swam away. In *Fig.* 35 we have an embryo in the act of casting out the rejectamenta of its food with the help of one of its tentacles.

It frequently happens that an embryo is altogether destitute of a horny sheath, and may be seen moving from place to place by walking on its tentacles. Oftentimes we have seen one of them seated upon the top of another embryo, either on the edge of the upper disk or nearer the mouth; and, in some instances, the base (Pl. X^a. *Fig.* 12 c^1) was embraced by the lips (*c*) of the lower individual. In the latter instance it was always very difficult to determine that the two embryos were

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[1] The absence of the horny sheath in Sars's figures (Wiegmann's Archiv, 1841, Band 1, Pl. I. *Figs.* 25–42), leads us to assume, what he is in doubt about, that they represent the scyphostoma of Aurelia. According to Dr. Wright (Edinburgh New Phil. Journ. 1859, vol. X. p. 106, Pl. VIII. *Fig.* 2), the scyphostoma of Chrysaora has a "gelatinous case, corallum, or polypidom."

not one individual; but, even in the most questionable cases, we have finally seen the lower animal throw open its mouth and the upper one creep away.

In the next stage the embryo normally has sixteen tentacles, but they do not develop so nearly synchronically as in the eight-armed period: the irregularity, however, appears greater than it really is, on account of the increased number of tentacles, and the difficulty of distinguishing between the members of the different sets. The mode of development is the same as heretofore: the new tentacles (Pl. X^a^. *Fig.* 13 *e*) arise in the intervals of the former sets. Neither in Aurelia nor in Cyanea have we actually traced the development of the tentacles beyond the number fourteen (Pl. X^a^. *Fig.* 15); and all the figures in Plates XI. and XI^a^., whether with more or less than fourteen tentacles, were drawn from specimens collected among the wharves in Boston harbor. We have not been able to trace the development of Cyanea beyond the fourteen-armed stage, and therefore what follows relates to Aurelia exclusively. The scyphostoma and strobila forms of these two plates are so irregular in their development, both in regard to the shape of the body and the development of the tentacles, that we suspect they have already cast off one brood of Ephyræ, and that the circle of tentacles now present is not the original primary one, but was developed below the pile of Ephyræ, as in Pl. XI. *Figs.* 1, 4, 5, 6, 11, 13, 14, 16, 17, 25, and 29. On this account we are not surprised to find more than sixteen tentacles, but less than thirty-two, on the oldest scyphostoma. The sixteen-armed specimens (Pl. XI^a^. *Fig.* 3 A B, *Fig.* 4, with one tentacle forked, *Figs.* 8 and 10), we might suppose, were originally four-armed; and the twenty-armed ones (Pl. XI. *Fig.* 7; Pl. XI^a^. *Figs.* 7 and 11) began with five tentacles. This assumption seems the more probable from the fact, that we have never seen a single scyphostoma or strobila which had more than twenty tentacles. We may, therefore, consider the normal number of tentacles of the scyphostoma of Aurelia flavidula to be sixteen; and, occasionally, twenty.

The four buttress-like projections, which we pointed out in the eight-armed stage, do not increase in number with the tentacles, but develop in breadth (Pl. X^a^. *Fig.* 13 b^2) and thickness. By the constancy of their number, and the fact that they originate opposite the first four tentacles, we are enabled to determine the relative age of every tentacle of a full-grown scyphostoma, no matter whether there are sixteen, or, in exceptional cases, twenty of them. Thus, those which are opposite the projections, as in Pl. X^a^. *Fig.* 5 b^2, belong to the first group and are only four in number; and in an eight-armed individual those which alternate with these last appertain to the second set. In a sixteen-armed embryo there will be three tentacles in each interval between those of the first group, and the middle one of the three belongs to the second group of four; whilst the remaining two, out of the three, altogether eight in number, belong to the youngest or third group. *Fig.* 15 of Pl. X^a., although two of the tentacles of the third group are not developed, will illustrate these relations, as the left side is perfect: those tentacles marked *1* belong to the first set, those marked *2* to the second set, and those marked *3* to the third set. In an undeveloped individual, represented by *Fig.* 13, the relative age of the tentacles is doubly set forth: in the first place by the projections, and, secondly, by the difference in the size of the tentacles themselves. In those exceptional cases with twenty tentacles, but which originally have five, there are five corresponding internal projections, instead of four, one being opposite each of the five primary tentacles.

This terminates the description of the scyphostoma period, as far as the zoological characters are concerned. But before we proceed to the strobila stage, we will return to the beginning and trace the histological development of the scyphostoma.

Histology of the Scyphostoma. From the earliest period, immediately after the segmentation of the yolk, to the time when the first four tentacles begin to develop (Pl. X. *Figs.* 3–14, and Pl. X^a. *Figs.* 25–36), the peripheric part of the embryo, whether it be an indistinct layer or has become separated from the interior as a well-defined wall, consists of a mass of irregularly polyhedral cells, which embrace perfectly homogeneous contents, and, except in the four-armed stage, bear vibratile cilia on their outer surfaces. Those cells which enter into the composition of the youngest embryos (Pl. X. *Fig.* 3) differ from those of later planula stages (*Fig.* 10^d) only in being not quite so transparent, and from those of the incipiently four-armed stage in that a part of the latter (Pl. X^a. *Fig.* 8) are lasso-cells which are scattered all over the body and crowded upon the tips of the tentacles (*Fig.* 7). On account of the opacity of the cells of the periphery, we were unable to discover by actual inspection what is the nature of the mass of the cells within the body of the youngest embryos (Pl. X. *Fig.* 3); but when, in later stages, we had an opportunity of looking into the mouth (*Figs.* 14^a and 14^c) of a four-armed individual, and found that the cells of the interior were identical with those of the exterior, we concluded that, like the peripheric cells, they had not changed from their earliest condition. Not till the last of the aforementioned stages do the cells of the periphery undergo any changes in their relative positions, and then they are rearranged so as to form a single layer (Pl. X. *Fig.* 14 *a*), excepting in the tentacles (*e*), where they are replaced by a single layer of lasso-cells (Pl. X^a. *Fig.* 7). The greater part of the outer wall of the tentacles is made up of a mass of unchanged, irregularly polyhedral cells, but they are confined to the interior by the coating of lasso-cells.

By the time that the first four tentacles have become highly developed (Pl. X. *Figs.* 19, 20, and 21, etc.) and the second set of four is about budding, the cells of the outer and inner walls have undergone great changes. The outer wall

(Pl. X^a. *Fig.* 6, *a* a^1) of the body, exclusive of the tentacles, is composed of a single layer of cells, which cannot be distinguished from those of the earlier stages, excepting that they are a little larger than the latter. It is in the tentacles, however, that we find the most palpable changes: here the cells are so transparent that we can get only faint glimpses of their outlines, and on this account the outer wall (*Fig.* 2 a^1) appears to be a structureless layer in which the lasso-cells (a^2) are imbedded. The lasso-cells are crowded at the tips of the tentacles; but elsewhere they are scattered singly over the whole body. That they are fully developed we may judge from the fact, that the lassos are thrown out at times in such numbers as to give the tentacles a ciliated appearance. The cells of the inner wall (Pl. X^a. *Fig.* 6 *b*) have passed through far more extensive changes than those of the outer wall. What was once a thick layer (Pl. X. *Fig.* 14 *b*) of irregularly polyhedral cells, packed together without order (Pl. X^a. *Fig.* 8), is now a single stratum of large prismatic cells (Pl. X^a. *Fig.* 6 *b*). Each cell is about three times longer than broad, the ends are truncated (*b*), and in an end view (b^1) appear polyhedral, and seem to overlap each other; but this is owing to the fact, that the sides of a cell are not parallel, but more or less convergent either toward the outer wall or in the opposite direction. The contents of these cells are perfectly homogeneous and transparent. In the tentacles (Pl. X^a. *Fig.* 2) the inner wall or axis (b^1) consists of a single row of large cells, which are placed end to end, and completely occupy the space embraced by the outer wall (a^1). In a transverse section of the tentacle the cells would appear circular; in profile they resemble short superposed cylinders with truncate ends. Like those in the inner wall of the body, they have homogeneous contents. The figure which we have given represents a tentacle in a partially contracted state, so that the cells of the axis appear broader than long; whereas, when the tentacle is fully extended, they are much longer than broad, as in the next stage (Pl. X^a. *Fig.* 1 b^1), to which we will now proceed.

By the time that the four tentacles of the second set have become as fully developed as the four of the first set (Pl. X. *Figs.* 33–37), not much change has gone on in the outer wall (Pl. X^a. *Figs.* 1 *a*, 4^a *a*, and 5 *a*), except that the cells have grown more transparent; but the lasso-cells have greatly increased in number. Around the mouth (*Fig.* 1 *c*) they seem to constitute the only cells of the outer wall of the lips; but from this point they thin out toward the base of the tentacles. On the tentacles they are crowded in groups (a^2), each group containing from ten to twelve lasso-cells. The groups are arranged in a spiral around the tentacle, and there are usually two groups opposite to each cell of the inner wall or axis (b^1 b^3). Such is the contractility of the cells of the outer wall, that, when the tentacle is retracted (*Fig.* 3), the lasso-cells (a^1 a^2) seem to constitute the whole wall. There is another peculiarity of the lasso-cells, which has not been noticed hitherto; we refer to the variation in their size, according to whether the tentacle is extended or contracted. When the tentacle is stretched to the utmost (Pl. X^a. *Fig.* 1), the lasso-cells are much smaller than those on the rest of the body, for instance around the mouth (c); but, when the tentacle is retracted, they expand (*Fig.* 3 a^1 a^2) to their full size, so that the wall in which they are situated becomes much thicker than in the extended state, in fact as thick as the corresponding wall (*Fig.* 4^a a) of the lower part of the body. The cells of the inner wall (Pl. X^a. *Figs.* 1, 3, 4^a, and 5 b b^1) have not appreciably changed since the last stage. In the base of the body (*Fig.* 4^a b) they form a solid core, and are arranged so that their longer axes radiate from the centre outwardly. At the base of the tentacles, especially when they are retracted (*Fig.* 3), these cells (b^1) are likewise convergent toward the median line, but a prolongation of the cavity of the body bounds their inner ends. The cells which form the buttress-like projections (*Fig.* 5 b^2) differ in no wise from the other members of this wall. They are arranged in two rows, as if they were centripetal prolongations of the double wall at the base of the tentacles, and form a solid column, which extends for a very short distance toward the base of the scyphostoma. The structure of the sheath (*Fig.* 4^a f) has already been described in detail in a former paragraph.

THE STROBILA[1] OF AURELIA FLAVIDULA. The first change that may be recognized in the scyphostoma after it has completed its cycle of tentacles is the occurrence of a well-marked constriction (Pl. XI^a. *Fig.* 10 g) immediately below the outer base of the tentacles. The constriction deepens until it extends at least half way to the centre, and perhaps further, when another constriction (*Fig.* 11 g^1) appears, below the first, at a distance about equal to the combined thickness of the walls of the body. This deepens until it extends as far inwardly as the first, and then a third (*Fig.* 13 g^2) constriction divides off a third disk-shaped portion (*3*). The uppermost segment (*1*) which bears the tentacles does not undergo any change; but by the time the third constriction (g^3) has developed to the same extent as the first and second, the second (*2*) and third (*3*) disks have become sinuate or lobed on the upper edge. The lobes (j) of the second disk (*2*) are more prominent than those (j^1) of the third or younger disk (*3*). There are eight lobes, arranged at equal distances around the disk, and as many sinuses (i), of the same breadth as the lobes. The entire circuit of the edge is slightly raised, so as to give the disk a saucer-shaped figure. The lower side of the disk is also wavy, or rather ribbed, and the ribs, corresponding to the lobes, converge toward the centre.

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[1] See Vol. III. p. 80 for the meaning of the word Strobila as used here.

Whilst the topmost and oldest disks are developing, new ones are forming below by constriction; and as these successively appear, they proceed to develop lobes and sinuses like those above, until the whole scyphostoma is divided into a series of superposed disks in all degrees of growth, from the ephyra (Pl. XI. *Fig.* 6 *1*), just ready to drop off and swim away, to the slightly lobed disk (*13*) at the base. We have observed as many as thirteen of these disks upon one scyphostoma. Below this pile of disks we find another row of tentacles (*Figs.* 1–6 *e*, 11–14 *e*, 16, 17 *e*, and 29 *e*), like those at the top of the scyphostoma in its earlier stages of transverse division (Pl. XI^{a}. *Figs.* 10, 11, and 13 *e*).

The development of one of the disks will illustrate the development of the whole strobila. The eight lobes, which we have already pointed out in the earliest ephyra, soon become pointed, or rather papillate (Pl. XI. *Fig.* 5 *2 h*), and encroach laterally upon the intervals. As soon as the papilla gains a definite outline, so as to appear like a minute lobe or lobule on the end of the larger lobe, the latter begins to assume a new form. On each side of the lobule the lobe rises gradually, at first to a level with it (*Fig.* 10 disk 4), and at the same time the whole lobe grows more prominent, and in consequence the intervals seem to have deepened. The whole disk, in this state, resembles a low battlement. Proceeding to grow, each lobe not only lengthens below the lobule (*Fig.* 20 *j h*), but, on each side of the latter it projects, until in course of time two oval lappets, as long as itself, conjoin to give it the appearance of a broad Y (*Fig.* 4, *2 h*). After this, the principal changes that occur in the process of development are the elongation of the lobe as a whole (*Figs.* 6, *3*, and 17, *3*), a broadening of the upper part, and a lengthening of the lobules. The lappets of the lobes also broaden midway, and become abruptly pointed. The lobule, already twice as long as broad, becomes partially hidden by the overlapping growth of the outer edge between the lappets. The distance between the superposed disks gradually increases from the earliest period of development, until, by the time the topmost ephyra is ready to drop from the strobila, the depth of the constrictions is equal to the length of the proboscis of ephyra next below (*Fig.* 29, *2 a*). At maturity (Pl. XI. *Figs.* 1, *1*; 6, *1*; 11, *1*; 13, *1*; 17, *1*; 24, and 29, *1*) the lobes attain their greatest proportional length, and the lappets (*j*), individually, their widest expanse. The latter have also become asymmetrical, the outer edge of each, next the intervals, having assumed a more decided curve than the inner one, so that, on the whole, it resembles the outlines of a human foot. The lobule (*h*), when seen from the outside, appears to be buried in the folds of the lobe between the lappets; but by looking on the inner, or, homologically speaking, the lower side (*Fig.* 24 *h*), we find that it is perfectly free, and that the edge of the lobe between the lappets has merely extended so as to hide this lobule from exterior view. The edge of the disk, at the intervals (*i*) between the lobes, projects slightly in the form of a broad papilla. The proboscis is four-sided (*Figs.* 24 and 29 *a*), and the corners (*Fig.* 29 a^1) project considerably beyond the general outline. The digestive cavity extends by means of broad, straight, shallow channels (*Fig.* 24 *c e*) to the base of the lobe, and also to each papilla. At a short distance from the base of the proboscis, and opposite each flat side, a group of four or five digitate bodies (*Figs.* 24 *g* and 26 *e*) projects into the digestive cavity. These are all the features which we have observed at the moment the ephyra is ready to drop from the strobila, and thus we terminate the description of the strobila stage of Aurelia flavidula.

We have not ascertained, in a direct manner, how the dorsal side (Pl. XI. *Fig.* 29 *l*) of the matured ephyra becomes separated from the individual next below it; but can only suppose, with much probability, that a gradual constriction, from without inwardly, divides the proboscis (*2 a*) of the lower ephyra at a point which becomes the lip (a^1), and which also is in direct contact with the centre (l^2) of the disk lying above it. This, we say, seems probable, from the fact that the last remnant of attachment is a thin string of matter (l^1), which passes from the centre (l^2) of the mature ephyra to the centre of the proboscis (*a*) of the lower individual, and is, without doubt, the inner wall drawn out by the struggles of the escaping medusa. Finally, by repeated contractions and expansions of the disk, the ephyra breaks loose from its attachment and swims away.

Before we go on to the ephyra state, however, we will point out some curious anomalies of the scyphostoma and strobila stages. Sars, Dalyell, Reid, and others have already illustrated these anomalies more or less in detail; but we have some new ones to present, besides repeating the description of the hitherto known forms for our native Aurelia.[1] The most frequent forms of anomaly are the more or less elongated, tentacle-like processes (Pl. XI^a. *Figs.* 3–9 c^2 c^3 c^4), which arise from various parts of the body, but mostly from the base. They are usually single, but occasionally they are forked, or one develops at right angles from the side of another (*Fig.* 8 c^2 c^3). Similar processes develop from the base of the strobila (Pl. XI. *Figs.* 2, 3 c^2 c^3). Sometimes these processes are terminated by a club-shaped expansion (Pl. IX^a. *Fig.* 2 c^2), as if a new individual were about to be formed. Most frequently, however, a new individual, when developed by the budding process, springs from the side of the parent without the intervention of a secondary basis (Pl. XI. *Figs.* 19 c^2 and 25 c^2 c^3). Instead of a single terminal row of tentacles, we find occasionally as many as two or three (Pl. XI. *Figs.* 18 and 21 *e*), but we cannot say, in these instances, whether the ephyræ had already dropped off, nor that the tentacles precede them: the latter is the more probable, inasmuch as the

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[1] We have never observed these anomalies in those scyphostomas which we raised from the egg.

lower part of the scyphostoma is quite long (c^1), having been, no doubt, retarded in its development till late in the season. We have, however, at least one instance in which two rows of tentacles underlie a pile of disks (*Fig.* 16 *e*).

We have next to present a series of facts to show how perfectly identical, in a homological sense, are the scyphostoma and the ephyra. First, there are those individual ephyræ (Pl. XI. *Figs.* 8, 10, 14, 15, 16, 20, 22, and 28, in various stages of growth) which have developed a tentacular organ (*Fig.* 8 *e*) on the edge of the interval between the lappets (*j*) of the lobe, and just exterior to the lobule (*h*) or peduncle of the eye, and another tentacular organ (*i*) on the edge of each of the intervals between the lobes; making, in all, sixteen tentacular organs. These new organs are constricted at the base (*Fig.* 8 i^2) in the more advanced ephyræ; and since we find them absent from some of the lobes, or intervals of the lobes, of certain individuals (*Figs.* 10 i^2 and 20 i^2), we should judge that the constriction was preparatory to the dropping of these organs. Sometimes the tentacular organs of the ephyra are branched, like the limbs of a tree (*Fig.* 28, *1 e*). In the next place we find those ephyræ which have, beside the tentacular organs, one, two, or three of the lappets of the lobes developed to an extraordinary degree, so as to appear like tentacles (Pl. XI^a. *Fig.* 12, *4*). In Pl. XI. *Fig.* 22, the lobes (*e*) of the second ephyra (*2*) are developing in the form of tentacles; and in the first ephyra (*1*) we may see the metamorphosis of the tentacular organs (*e*) into lobes (*j*), simply by the separation of the extreme three fourths of this organ. Then, again, we find (*Fig.* 19, *1*) not only the tentacular organs in the intervals (*i*) and between the lappets (*e*), but the lappets themselves (*j*) as fully developed into tentacular organs; thus making, in all, thirty-two tentacular organs in a single row, or just double the normal number of the tentacles of the scyphostoma. Sometimes there are pigment dots (Pl. XI. *Fig.* 5 *h*), like eye-specks, on the exterior and basal part of the tentacles of the scyphostoma. This is a very significant fact, and points directly to the perfect identity of the hydroid and ephyroid forms, to which we have just alluded.

In regard to those scyphostomas with two or three rows of tentacles (Pl. XI. *Fig.* 18), we think it not at all improbable that each disk may be developed into a distinct ephyra, every alternate tentacle becoming a lobe, and those alternating with these becoming the tentacular organs of the intervals between the lobes.

Not alone does the scyphostoma proper bud laterally, but the ephyræ of the strobila form exhibit the same phenomenon, especially at the lower part of the pile, where the metamorphic process has about completed its work. Pl. XI. *Fig.* 12 B C is an instance of either lateral budding, or a species of longitudinal self-division of the scyphostoma (c^1) and the superposed ephyræ (*1 2*). The uppermost ephyræ (*1*) are not as yet completely separate.

THE EPHYRA[1] OF AURELIA FLAVIDULA. By the time the young medusa has completed its strobila stage of existence, the different regions of the body are sufficiently developed to be easily identified with similar parts of the adult; and we will therefore now give them their proper names, before proceeding to describe the ephyra in a free state. The eight lobes (Pl. XI. *Fig.* 29 *j*) are the oculiferous lobes (see Pl. VI. *Figs.* 1 and 4), and the lobule (Pl. XI. *Fig.* 24 *h*) is the ocular peduncle (Pl. VI. *Fig.* 4 *o*). The intervals (Pl. XI. *Figs.* 6 and 17 i^2) between the lobes become the tentaculiferous edge (Pl. VI. *Fig.* 2 *b*; Pl. VII. *Fig.* 3 *b*), and the broad papilla (Pl. XI. *Fig.* 24 *i*) in each of these intervals the marginal veil (Pl. VII. *Fig.* 2 *c*; Pl. VIII. *Fig.* 5 *c*). The digitate bodies (Pl. XI. *Fig.* 24 *g*, *Fig.* 26 *e*) are the genital appendages (Pl. VIII. *Figs.* 7 and 8 *c*; Pl. IX. *Figs.* 1 and 2 *c*).

When the young Aurelia has parted from its attachment, it assumes a position reverse to that which it held in the strobila state, and swims with its proboscis hanging downward (Pl. XI^a. *Figs.* 21, 23, 24, 27, and 28). It is true that the strobila is capable of living in any position, either attached to stones, logs, etc., and standing up so that the mouths of the ephyræ are upward; or the base of the strobila may be uppermost, when it is attached to the under-side of floating bodies, such as sea-weeds, floating timbers, and the like, and in this condition the ephyræ hang with the proboscis downward, just as they do when swimming individually. That there is an essential reversal of position when the ephyræ become free is, therefore, only seeming; for, although it is true that the medusæ do not naturally rest with the mouth upward, yet they swim in this position very often. The proper time to ascertain the shape of the young ephyra is when it is in a state of rest, and then we see that it resembles an umbrella, or, perhaps, more closely, that kind of parasol which has a lining to cover the wires on the under-side, or even a common mushroom, inasmuch as that has a thick pedestal: in reality, the geometrical expression for it would be, double convex. When swimming it assumes a variety of shapes, all of which, however, are the result of the upward and downward motion of the periphery of the disk: at one time we may see the umbrella reversed (*Figs.* 21, 24, 27, and 28), so that it resembles a common fruit dish on a pedestal; or, when this position is changed by the vigorous downward stroke of the periphery and the animal shoots forward, the extreme of the opposite shape is assumed, and the body resembles a mushroom with its periphery curved downward and inward, just before its edge breaks loose from the stalk at the moment of expansion (*Fig.* 23). Oftentimes the little medusa may be seen floating with its body slightly depressed above, and its oculiferous lobes stretched outward to the utmost (*Figs.* 24 and 28), as if to offer the greatest amount of surface to the

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[1] See Vol. III. p. 80 for the meaning of the word Ephyra as used here.

water. In this extreme state of extension and tenuity of tissues, the animal, in all probability, is reduced to a degree of density corresponding to that of the water, and therefore floats in a perfectly quiescent state, whether near the surface or at any depth, as if it were part and parcel of the water itself. The moment the body contracts, as it may be made to do by touching it gently, it sinks; thus affording another proof that concentration of tissues is equivalent to an increase in density. Sometimes the body is only partially expanded (*Figs.* 20 and 27), and, not being sufficiently buoyant, the oculiferous lobes (*j*) flap very gently, at shorter or longer intervals, according as the body sinks faster or slower. Whilst swimming upward or downward the upper surface of the disk takes precedence, and is kept transverse to the line of motion; but when going horizontally, the upper side of the disk is tilted forward thirty or forty degrees, so that its plane rests obliquely to the line which it follows. Owing to their peculiar violet color, it is sometimes very difficult to detect these animals, especially in cloudy weather, when we have not the advantage of the reflection of the sun from the surface of the body.

For a while, immediately after the commencement of their wandering life, very rapid changes take place in the structure of the young medusæ. In the first place the whole disk expands very much, and, as we have already mentioned, forsakes its concavo-convex form for a shallow double convex shape. The oculiferous lobes (Pl. XI^{a}. *Fig.* 19 *j*) do not lengthen, but broaden in proportion to the expansion of the body; and in this state they are equal in length to the radius of the disk, and, being twice as broad as the tentaculiferous edges (*i*), occupy two thirds of the circumference of the body. The incipient veil (*i*) also becomes quite prominent, and, losing at the same time its papilla-like character and becoming flattened, resembles a broad tongue. Laterally, it passes directly into the margin of the oculiferous lobes (*j*) on each side of it. The proboscis (*Fig.* 19 *a*) does not assume any new proportions, except that, in consequence of the expansion of the disk, it becomes relatively smaller. We may point out here, however, some of the many protean forms which its plastic nature allows it to assume. Its natural shape, when in a quiescent state, is that of a four-sided prism (*Figs.* 18 and 28 *a* a^1), about twice as long as thick, and having slightly concave sides. Usually the corners of the mouth (a^1) project more or less sharply; and often the whole circuit of the lip is curved outward (*Fig.* 18), thus making the proboscis trumpet-shaped. At times, when in this condition, the four sides (*c*) collapse suddenly at the upper part, and, meeting each other centrally, either close up the passage to the digestive cavity, or leave only a small aperture (*d*). At other times we find it in a similar condition, but retracted down to its very base (*Fig.* 14), so that, with its reverted lips, it resembles a square platter turned upside down. All four sides of the proboscis do not always act together, but each one occasionally seems to have an individuality of its own; one, two, or three sides may collapse, and leave the others undisturbed (*Fig.* 19 *a*), or all four together fold longitudinally (*Fig.* 15) and inwardly, so as to form a cruciform passage (*d*) to the digestive cavity. The corners of the mouth are very active in their versatile contortions and extensions, forcibly bringing to mind the movements of the prolongations of Rhizopods, especially the Difflugia and Amœba forms.

The digestive cavity (Pl. XI^a. *Figs.* 19, 20, and 28 *b*) occupies about two thirds of the transverse diameter of the disk, and in shape may be compared to a double convex lens, the thickness corresponding to the axis of the body. The radiating chymiferous canals (*c d*) of the oculiferous lobes extend their course to the very base of the ocular peduncles (*Figs.* 19, 20, 28, 31, and 33 *h*), but change somewhat in form; the basal part is equal to one third of the breadth of the lobe, the portion corresponding to the mid-region of this lobe (*Fig.* 31 *d*) is slightly narrowed, and then, at the base of the ocular peduncle (*h*), suddenly broadening (d^1), occupies one third more space than at its base. The chymiferous tubes, which go to the tentaculiferous edge, are also broadened near the end (*Figs.* 19, 28, and 31 *e*), but suddenly narrow to the breadth of the basal part. The depth of these canals has also changed, and, with this, the form of the transverse section, as may readily be seen by looking at a foreshortened view (*Fig.* 33 *c*) of an oculiferous lobe, when the pointed, roof-like dorsal side becomes apparent. The floor of these canals is concave, but each half of the roof is convex. The sharply defined, usually irregular line (*Figs.* 19 and 31 *d f*) which runs along the middle of the upper side of each canal indicates the fold of the internal wall at the apex of the roof-like ceiling, and the smaller branches which project obliquely outward and downward from the main line are smaller folds in the slope of the roof. In the oculiferous lobes (*Fig.* 31), the ridge (*d*) of the roof forks, and one branch (d^1) goes to each half of the T-like expansion at the end of the chymiferous canal.

The digitate appendages (Pl. XI^a. *Fig.* 18 *e*, *Figs.* 19 and 28 *g*) of the reproductive organs have doubled their number. Upon close examination we find that they are hollow, closed, deep pouches or tubes, which open downward into the space between the outer and inner walls (Pl. XI^b. *Fig.* 21), and are composed of a single wall (α), which is in direct continuance with the lower, inner wall (β) of the digestive cavity. It is rather remarkable, that they are endowed with numerous lasso-cells; but as we have at times seen them protruded from the mouth of the proboscis, it may be that they have an office to perform exterior to the digestive cavity.

The ocular peduncles (Pl. XI^a. *Figs.* 19, 28, 31, 33, and 34 *h*) are cylindrical for half of their outer end (*Fig.* 34 *h* h^1), and at the basal half (h^2 h^3) broadly conical in a lateral direction; but in profile the upper and lower sides are only slightly convergent outward. They are not attached to the disk at right angles to its surface, but obliquely and by the upper side, so that the base of attachment is as broad centrifugally as transversely. By this mode of attachment the peduncle projects outward (*Fig.* 33 *h*), and not downward, and turns up at the end, so that the eyes (*Fig.* 34 *h*) may survey the upper surface of the disk.[1]

The most distinctly marked features in the next stage which we have observed are the first appearance of the tentacles (Pl. XI^b *Fig.* 2 i^3), and the addition of another row of genital appendages (*Fig.* 1 g^2). The manner of the development of the first tentacle is very simple: the outer and inner walls (*Fig.* 2 i^2 i^4) of the marginal lobule bud out together, and form a papilla (i^3), or hollow vesicle, with a double wall. Near the base of the tentacle, inwards, the outer (i^2) and inner walls (i^4) of the body are separated from each other for a considerable distance, and, just below the tentacle, the outer wall (i^2) projects in the form of a thin, broad, hollow tongue (i), which extends nearly across the whole interval between the oculiferous lobes (j), and is about one fifth longer than the basal breadth. This constitutes the marginal veil. The second row of genital appendages (*Fig.* 1 g^2), which are eight in number, are arranged in a curved line, at a short distance exterior to the first row (g^1); they all communicate with a narrow, curved furrow, (g^3) which runs parallel to the broad furrow (g^1) of the first row (g). The wall of each appendage varies in thickness to a considerable extent, according to the state of expansion or contraction of this organ. On account of the superior length of the appendages of the first row, they at times appear as if they were situated exterior to those of the second row; but they may very easily be traced to their origin nearest to the proboscis. Finally, the chymiferous canals (*Fig.* 2 e) have united with each other at their peripheric ends by means of lateral passages (e^1), and thus the marginal chymiferous canal is formed. But we will give more details of this system in the description of the following stage.

In the next phase (Pl. XI^b *Figs.* 3, 4, 4^a, 7, 8, 9, 11, 12, 14, 15, 16, and 16^a), a more decided advance in development than in the last has been made, the most striking feature of which is the appearance of a broad, concentrically folded band (*Fig.* 4 m m^1), which corresponds to the circular muscular band of Cyanea (Pl. IV *Figs.* 1 and 2 d d^1). The general outlines and proportions of the disk have not materially changed since the last two phases, excepting that the marginal veil (Pl. XI^b *Fig.* 4 i) has become very prominent as a portion of the periphery, and occupies the whole breadth of the interval between the oculiferous lobes (j). The

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[1] The peculiar position, mode of attachment, and structure, of these organs, will be described with fuller illustrations when we come to a little older phase.

shape of the veil is very peculiar, not so much in the lateral ovate outlines as in the disposition of its upper and lower surfaces; the whole thickness is gradually depressed from the edge to the centre (*Fig.* 9 i^8): but the hollow is deepest near the base. In a foreshortened view (*Fig.* 4 A), especially when the veil is turned inward toward the proboscis, this hollow is very marked. The extent of the veil is about half the length of the oculiferous lobes. The proboscis has lost its rounded corners, which now appear as if cut straight across (*Fig.* 4 a^1), the meaning of which will be seen in the next phase. Already the lips (a) have become thin and transparent, approximating the trumpet-mouth form which they soon after adopt. The four columnar supports or buttresses (a^3), so characteristic in the proboscis of the adult (Pl. VII. *Fig.* 5), are here already very marked; they stand opposite four of the eyes, and extend their several bases as far as the borders (Pl. XI^b. *Fig.* 4 b^1) of the digestive cavity.

In the last phase we pointed out the completion of the circular canal; and now we find already the radiating canals are branching. The process by which this is done is very simple. The inner walls of the upper and lower floors of the disk separate along the line intended for the course of the canal, and thus a channel is formed. At k^1 *Fig.* 4 we have this process going on: the upper and lower walls of this projection are separated on the side next the periphery, and a more direct passage to the canal of the oculiferous lobes is made, whilst an isolated column (k^2) is left, around which the chymiferous fluid circulates. In this way the circular canal (*Fig.* 2 e^1) was formed in the previous stage. In order to make this process clearer to the reader, we refer for a moment to a transverse section of the canals of an older stage (*Fig.* 13); here it will be evident, that, simply by the separation of the two walls at k, the two adjacent canals c and e will merge into each other; and this is the way that all the canals are formed in succeeding ages of the ephyra. The breadth of the eight canals (*Fig.* 4 c^2 c^3) which lead to the eyes is remarkable; and their nearly equilateral triangular outline contrasts strongly with the straight, parallel sides of the eight simple canals (e) which go to the margin. We have an instance here, in an incipient state, of the branching (e^1) of a normally simple, straight canal, such as may be seen in an adult specimen (Pl. VII. *Fig.* 5 d). The sexual organs (Pl. XI^b. *Fig.* 4 g) show signs of advancement merely by the increase in the number and length of the digitate appendages.

The margin of the disk has begun to be complicated. In the first place, the separation of the outer and inner walls at this point, as observed in the previous phase (*Fig.* 2 i^2 i^4), has resulted in the formation of two marginal lobules (*Fig.* 3 i^2), one on each side of the single tentacle (i^3). The exact relation of these appendages will be better understood by referring to their adult state (Pl. VII. *Figs.* 2, 3, 4 b).

They have a single wall, which is continuous with the outer wall of the tentacle (Pl. XI^b. *Figs.* 3 and 9 i^3), and also with the single wall of the veil (i) and with the upper wall (*Fig.* 9 i^6) of the disk. The tentacle (*Figs.* 3, 4, and 9 i^3) is about three times as long as its basal breadth, and tapers to a rounded point; the inner wall is hollow to the very tip, and is in open connection with the radiating canal (e). In order to give a better understanding of the relation of all these parts just described, we have made a longitudinal section of the veil, tentacle, and margin of the disk, which can be readily understood by reference to the general lettering at the head of the description of Pl. XI. The lappets (*Fig.* 4 j^1) of the oculiferous lobes have a lancet pointed termination, and are remarkable for a median ridge (j^2, and *Fig.* 12 j^2 j^3), which extends along the under side, a little exterior to the median line, from the apex to the base, and thence, a little nearer the margin of the lobe (j), to the circular canal. On each side of the ridge the surface is concave, as a sectional view (*Fig.* 12) shows. The upper side (j^4) is convex.

THE EYE.[1] This is perhaps the most appropriate period of its life at which the eye of Aurelia can best be studied, in all its details, when it is neither too young to lack any of its characteristics, nor too old and grown opaque by the development of dark pigment masses in its walls. The peduncle (Pl. XI^b. *Figs.* 7 and 15 h to h^3) has a peculiar oblong cylindrical shape, which is broader sideways (*Fig.* 7) than vertically (*Fig.* 15). In the first aspect it is rather elongate ovate than otherwise, with the greater breadth at the base (*Fig.* 7 h^3), whereas in profile (*Fig.* 15) it has the outlines and position of a finger half closed; but even in this it varies considerably; at one time the end is perfectly round (*Fig.* 8), and at another is more or less pointed (*Fig.* 15) or compressed. Its usual position is indicative of its office, being turned upwards (*Fig.* 15) between the lappets of the lobe, and projecting to a greater or less extent above the edge of the disk; but at times it is withdrawn under the lobe (*Fig.* 4 h). There are two distinct walls (*Figs.* 7, 8, and 15 h^1 h^2) to the peduncle, and they are directly continuous with the two walls of the lobe (j^6 j^7) from which it arises, very much in the same manner as the walls of the tentacle are continuous with those of the edge of the disk; in fact, the eye peduncle is nothing more nor less than a solid tentacular organ which hangs from the under side of the oculiferous lobe. The outer wall (*Figs.* 7, 8, and 15 h^1) does not differ in thickness from that of the lobe (j^6), except at the end (h), where it thins out rather suddenly as it passes around the tip; but the inner one (h^2) varies in this respect according as it is seen in

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[1] Since I began the special study of the Acalephs, I have always been inclined to consider the marginal bodies of their disk as ocular organs; but the first direct demonstration of the true nature of these organs was furnished by Prof. H. J. Clark, whose observations upon this subject are given at full length and in his own words in the following paragraph.

profile (*Fig.* 15 h^2) or from above or below (*Fig.* 7 h^2). In profile it would seem to be similar to that of the lobe (j^7 j^8) until we come to the end (*Fig.* 8 h^4 h^6 h^7), where it suddenly thickens to more than double its extent, as seen toward the base; but in the view from above it shows a sudden increase in thickness (*Fig.* 7 h^2), which it retains especially at the base, but toward the end decreases in a measure, and then at the end thickens again as in the profile view (*Fig.* 8). The cells of the outer and inner wall below the eye are very similar among themselves, but vary somewhat according to their situation; and in the eye itself (h) the variation is very strongly marked. The cells of the outer wall (h^1), as well as those of the lobe (j^6), may be compared to broad polygonal prisms, disposed side by side in a single layer; their contents are homogeneous and transparent, nor does there appear to be any mesoblast. At the base (*Figs.* 7, 8, and 15 h^6) of the eye they decrease in length with greater or less rapidity according to the degree of expansion or contraction of the peduncle. Sometimes the decrease is rather gradual (*Fig.* 15 h), and they may be easily traced as cells all over the end of the eye-facets (h); at other times, and this is the most frequent case, they suddenly decrease in length and assume the form of thin polyhedral disks (*Fig.* 8 h), thus constituting a tenuous layer (*Fig.* 8 h, *Fig.* 14 h^1) all over the end of the organ of vision. The cells of the inner wall (*Figs.* 7, 8, and 15 h^2) are also prismatic in shape, and vary in length according to the degree of expansion of the peduncle, and appear different according to the position in which the latter is viewed, whether from above or below or in profile: in the latter aspect (*Figs.* 8 and 15 h^2) they resemble those of the outer wall very closely; but in a view from below (*Fig.* 7 h^2) they have a more prismatic columnar look, and vary in length from double to thrice their breadth. Whether in one view or the other, they rapidly increase in length after they enter the faceted eye; and here they lose their prismatic shape, and take on a polyhedral conical form (*Fig.* 8 h^4 h^7) and converge nearly to one point (h^7). At the base (h^6) of the facets their conical form is not so apparent; but at a short distance beyond this they are strictly conical, and all have their apex at the centre (h^7) of the sphere. And now, too, another element enters into the composition of these cells: as we view them from the outside, and endwise (*Figs.* 7, 14, 15 h^4), they appear much darker and more highly refractive, as if they were filled with some oily substance; but when we obtain a profile and sectional view (*Fig.* 8 h^4 h^7), we find that the highly refractive body (h^4) occupies about one quarter of the outer end of each cell; and all these standing side by side in one layer, each in its respective cell, produce the effect of a third wall (h^4). A closer examination of these bodies reveals the interesting fact that they are lenticular (Pl. XI^b. *Fig.* 16 θ ι), and have the form of a plano-convex lens; the convex face ($\varkappa$) is turned toward the outer end of the cell, and the plane face toward the base (ζ) of the cell; the edge is abrupt and as if cut away, so that it has a polyhedral contour, with generally six sides (Pl. XI^b. *Figs.* 11 and 16 θ ι), and each side fits exactly against the several sides of the cell (δ η). In consequence of the arrangement of the lenses in a spherical contour, these sides are not parallel to the axis of the lens, but converge slightly from the anterior convex face backwards, so that in a view from behind (*Fig.* 11) there appears to be a double outline (ι). The anterior convex face (κ) does not touch the outer end (δ) of the cell, but there is a very shallow space (ε) between the two. The posterior plane face is perforated by a comparatively broad aperture (*Figs.* 11 and 16 ν) leading into a cylindrical cavity (λ), which occupies the axis of the lens, and penetrates a little more than two thirds of its thickness in a direct line toward the anterior face, and terminates abruptly. The sides of the cavity are convergent backward, and trend parallel to those of the lens, and the transverse diameter is a little more than one quarter of the breadth of the lens. When seen from the posterior face (*Fig.* 11), this cavity appears to be divided into as many compartments (μ) as there are sides to the lens; but we find that these compartments, or diverticuli, are superficial (*Fig.* 16 μ), and proceed from the posterior end of the cavity, near its aperture (*Fig.* 16 ν), close beneath the flat face of the lens, to the sides (θ ι), and strike them perpendicularly half way between the angles. The outlines of this cavity are rather irregular, especially in the diverticuli (μ), and, being more or less wavy, they produce the effect of a wall, in profile. It is this cavity which has the appearance of being a mesoblast, in the centre of each cell, when they are looked at endwise (*Fig.* 7 h^4). If the eye is cut to pieces, the lenses drop out, and may then be turned in every direction for the study of their shape. In this manner we have been enabled to turn a lens up on one of its sides, and trace the actual curvature of the anterior face (*Fig.* 16 κ); and we found this curvature to be spherical. Here, then, we have all the elements of an optical apparatus, sufficient to produce a distinct image. No one will pretend to deny that the eye of an insect is a true eye, having all the properties of distinct vision; and if so, we are fully justified in claiming for the eye of Aurelia the same faculty. Curiously enough, too, the relations of the different parts of this apparatus are the same as among higher animals; but whether the several parts perform similar functions we will not pretend to affirm. First, we have the cell of the outer wall (*Fig.* 16 α), with its outer face for the cornea and its contents for the anterior chamber of the aqueous humor; then the posterior wall (β) of the same cell (α) and the anterior wall (δ) of the cell (η) containing the lens, combined, would be the membrana pupillaris, which is imperforate; next, the space (ε) between the membrana pupillaris and the front of the lens would be the posterior chamber of the aqueous humor; then comes the crystalline lens (θ ι);

and, finally, the contents of the cell behind correspond to the vitreous humor (η). As if in confirmation of all this, we find that the focus of the lens corresponds to the bottom (ζ) of the cell. What may be the office of the cylindrical cavity (λ) in the lens, we have no means of ascertaining; but it looks as if it might be a means of correcting the spherical aberration; at least, it must affect the direction of the central rays more or less. Taking the lens by itself and without any reference to the other parts of the organ, we have sufficient warrant, from its form and position, in assuming that it is a true crystalline lens, and subserves the purposes of actual vision. The eye of Cyanea has a similar structure; and such do we think must be the structure of the eyes of many, if not of all, the covered-eyed Medusæ.

THE LASSO-CELLS. The form of these cells (Pl. XI.^{b} *Fig.* 16^a) is oval, and their length is about $\frac{1}{3500}$ of an inch.[1] The straight, rod-like part (*b d*) of the thread projects along the axis of the cell nearly to the opposite extreme, and then bends abruptly upon itself (*d*), and, returning again nearly to its base, curves (*e*) directly across the cell and immediately commences its coil, at the same time closely following the face of the cell-wall (*a*). It makes in all only seven or eight transverse, widely separate coils (*f*), and terminates (*c*) at the end opposite its base (*b*). From this it will be seen that the rod-like base of the thread is not excentric, as in Coryne, but is completely enveloped by the spiral coil.

The principal features which mark the next stage (Pl. XI^a. *Figs.* 16, 17, and 26) are, the broadening of the marginal intervals (*Fig.* 26 i^2), so that they are as wide as the breadth of the oculiferous lobes (*j*); the appearance of two of the marginal fringes (*Fig.* 16 a^1) of the proboscidal prolongations, of which we had an intimation, in the previous stage (Pl. XI^b *Fig.* 4 a^1), by the truncate corners of the lips of the proboscis; and the incipient longitudinal folding of the proboscis into four distinct lobes, so characteristic in the adult.

After this stage, the breadth of the disk begins to increase rapidly, whilst the oculiferous lobes are of comparatively slower growth. Of this we have the beginning in the next phase (Pl. XI^a. *Figs.* 25, 30, and 35); and this is the principal feature which distinguishes it from the last. By the contracted state of one of the ephyræ we were able to get a very good view of the transverse outline of the radiating tubes (*Fig.* 30 *c*), and made out very clearly that the lower wall is concave, and the upper one like the roof of a house, excepting that the two sides are curved inwards. The cellular structure of the surface (*Fig.* 35) begins already to resemble that of the adult; and here and there we find single lasso-cells (Pl.

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[1] The peculiar relations of the lasso-coil to the rod-like portion of the thread were discovered by Prof. H. J. Clark. Compare my remarks on lasso-cells, in Proc. Amer. Assoc. 1849, p. 68.

XI^a. *Fig.* 35 *l*), the first of the numerous groups which stud the disk of the full-grown animal. In the next series of figures (Pl. XI^a. *Figs.* 22 and 32; Pl. X^a. *Figs.* 37, 39, 40, and 41) we have a more decided advance in development than in the two last. The marginal veil (Pl. XI^a. *Fig.* 22 i^1) is quite as prominent, if not more so, than the oculiferous lobes (*j*). The upper margin of the sockets, between the tentacular lobes (see the adult Pl. VII. *Figs.* 2, 3, and 4 *b*), has begun to form, by the projection of a single tongue-like body (Pl. XI^a. *Fig.* 22 i^3) from the edge of the disk, directly above the veil (i^1); and the breadth of each margin is about the same as its length, and corresponds, as regards the latter, to the length of the margin of the disk. The marginal fringes (Pl. X^a. *Figs.* 37, 39, 40, and 41 a^1) of the proboscis have increased considerably in number; but in this respect there would seem to be considerable variation even on the same proboscis (*Figs.* 39 and 40), some of the lobes being entirely destitute of any appendages, whilst others have one or two, or six and seven. The thick, heavy character of the proboscis, as it existed in younger stages, is gone, and in its place we have a long, thin-walled, trumpet-like body, folded into four exceedingly flexible lobes. The digitate sexual appendages (Pl. X^a. *Fig.* 37 *e*) are quite numerous and very much crowded. The outline of the upper surface of the disk (Pl. XI^a. *Fig.* 22 *l*) has a peculiar curve, which has not appeared before to any appreciable extent; it is as if the segment of a smaller sphere had been laid upon that of a larger one. By the inspection of *Fig.* 32 it will be observed that the marginal intervals (i^1) occupy nearly twice as much of the circumference as the oculiferous lobes (*j*).

Although the next phase of development recorded is considerably in advance of the one just described, we do not anticipate any difficulty in tracing the connection between the two. In this ephyra (Pl. XI^b. *Figs.* 18, 10, 13, and 17, and Pl. XI^c. *Figs.* 3 and 4), which, by the way, is a little more than half an inch across, the tentaculiferous margin of the disk is fully twice as long as the space occupied by the oculiferous lobes; there are fourteen tentacles in each segment, and the veil has kept up with the increasing length of the margin; the eight radiating canals, which are opposite to and half way between the sexual organs, are forked from four to six times; the sexual digitate appendages are almost innumerable, and the exterior pouch, immediately below the sexual organs, is proportionately half as deep as in the adult (compare Pl. IX. *Figs.* 6, 7, 8, and 9); and, finally, the fimbriate prolongations of the corners of the proboscis reach half way to the margin of the disk. These are the features which constitute the essential difference between this and the last stage of development; and we do not think the difference is so great as it would appear to be at first sight, being, after all, only a matter of degree. In the first place, the disk has not changed in form, but merely increased in size (Pl. XI^b. *Fig.* 18). The veil (*Fig.* 17 *i*) is comparatively much narrower, but still extends from one oculiferous lobe (*j*) to the other, in the form of a segment of a circle, being broadest at the middle, and narrowing each way till it passes into the disk at the ends. Its base (Pl. XI^b. *Fig.* 17 i^9; Pl. XI^c. *Fig.* 4 π) is nearly on the same line with the bases of the tentacles, and also corresponds to the curved edge of the disk. The corners of the trumpet-shaped proboscis have become prolonged to a great extent (Pl. XI^b. *Fig.* 17 a^1), so that they reach half way to the margin of the disk, running out into a point, and have a strong likeness to those of the adult (Pl. VI. *Fig.* 1), as far as their general outline is concerned. The edge of the lips is either wavy, lobed, or fringed all around. The mouth (Pl. XI^b. *Fig.* 17 a^2), or cavity of the proboscis, is also very much like that of the adult, not only by its four-sided form, but by its furrow-like prolongations into each of the four elongate corners (a^1). The digestive cavity (*b*) is comparatively smaller than in the last phase, whilst, by the increasing diameter of the disk, the radiating canals (*c e*) have elongated considerably. The eight simple radiating canals (*e*) are now narrow tubes, which stretch in direct lines from the digestive cavity to the middle of each marginal canal (e^1 *mc*). The eight forked canals (*c*) are even narrower than the simple ones, and are either twice or thrice forked on each side. The forks (c^1 c^2), as in the adult, all lead to the margin between the oculiferous lobes. The new forks (c^1 c^2) arise from the marginal canal (*mc*), and channel their way toward the centre of the disk until they meet with the main canal, at about one third of its length from its entrance (c^3) and near where all the other forks meet. The marginal canal (*mc*) is as yet quite broad, at least opposite the entrance of the simple radiating canals (*e*), but becomes narrower as it extends right and left of this point.

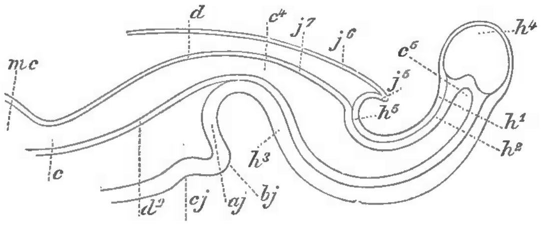
In order that the structure of these canals may be fully understood, we refer to a figure (Pl. XI^b. *Fig.* 13) representing an actual transverse section of one of the simple canals (*e*, and *Fig.* 17 *e*), and two of the branches of the forked canals on each side (*Fig.* 13 *c*). By this it may be seen that the canals are not inclosed by one and the same wall; but that the upper or roof-like side (*d f*) is covered by the inner wall (i^4) of the upper floor of the disk, and that the lower side is inclosed by the inner wall (i^5) of the lower floor of the disk. Here, too, we may see that these two inner canal-bearing walls (i^4 i^5) are suspended or supported by a cellular network, which fills all the space between them and the outer walls (i^6 i^7), and also that the ridge (*d f*) of the canals, as well as the lower wall, is connected with the outer walls of the disk by thicker meshes, or groups of cells with filamentary prolongations (α β). The broad, concentrically plicate band (*Fig.* 17 *m* m^1), which first made its appearance in the fourth stage previous to this (*Fig.* 4 *m* m^1), occupies nearly one half of the diameter of the disk from the margin inwards. It does not, however, seem to have grown more plicate, but, on the contrary, is not so conspicuously folded as in earlier stages. The sexual organs (*Figs.* 10 and 17 g) have made considerable advance; the rows of digitate appendages (*Fig.* 10 g g^2) have increased to six or seven in number, and render this organ very conspicuous even in their natural size (*Fig.* 18). The exterior pouch (*Fig.* 10 α β γ), which opens outwardly directly underneath the sexual organs, is fully as long as the semicircle of digitate appendages, and its distal side (α) corresponds to the margin of the semicircle, although the two are in different walls. The breadth of this pouch is about half that of its length, its depth is about in the same proportion; and it has only one wall, being a simple invagination of the outer wall of the lower floor of the disk. The eye peduncles (*Fig.* 17 h) have changed appreciably, only in becoming hollow to the base of the eye-facets. The oculiferous lobes (j j^1) are less than one quarter as long as the diameter of the disk, and have lost in consequence the conspicuous prominence which they held in earlier stages, and in which they were the chief characteristics of the ephyra. The tentacles have increased to fourteen in number (*Fig.* 17 i^3) in each marginal segment, and the marginal or tentacular lobes (i^2) are correspondingly numerous. The oldest tentacles are at the middle of each marginal segment; and from this point they decrease in age and size each way toward the oculiferous lobes. At this age the relation of the tentacles to the margin of the disk appears to be quite complicated; but when fully understood it is quite simple. In a view either from above (Pl. XI^c. *Fig.* 3) or from below (*Fig.* 4), the tentacular lobes (i^2) which project from the margin of the disk between the tentacles, in the form of vertical ridges with a rounded contour, are quite as conspicuous as the tentacles themselves. These lobes are simply outwardly folded diverticuli of the exterior wall alone (ε); the inner wall projects but a short distance, and stands across the base of the lobes, like a bridge (η); and in this way the lobe becomes a completely closed cavity ($\varkappa$). In a view from above, the inner wall folds upon itself two or three times, and therefore presents as many outlines (η θ ζ) at different depths. Between these lobes there is a deep socket, from the bottom of which a tentacle arises, and the outer (α) and inner (β) walls of the tentacle are directly continuous at the base (γ δ) with the outer (ε) and inner (η) walls of the lobes. At the margin (*Figs.* 3 o and 4 ξ) of the sockets, the outer (ε) and inner (η) walls touch each other, and continue so directly to the bottom, where they are continuous with those of the tentacles, as we have already pointed out. The tentacles are hollow (λ μ) about half way to the tip, and have very thick walls (α β).

In the next stage (Pl. XI^a. *Fig.* 29; Pl. XI^b. *Figs.* 5, 6, 19, and 20; Pl. XI^c. *Figs.* 5, 6, and 13), the development is purely a matter of degree: the disk is a little more than an inch in diameter; the marginal segments extend over more than two thirds of the whole circumference; the tentacles are thirty-two in number on every marginal segment; the oculiferous lobes are as broad as they are long; the plicated concentric folds cover fully one half of the diameter of the disk, and extend very closely to the borders of the digestive cavity; the space occupied by the branches of the forked radiating canals extends as far along the circular canal as the length of the branches themselves, and therefore has the form of a triangle with a broad base; the pouch beneath the sexual organs is proportionately twice as broad as in the last stage, and projects much farther upwards and toward the centre of the disk; and, finally, the lips of the proboscis are very deeply fringed, and the furrows in the prolongations of the corners are very deep.

Such, in general terms, are the characteristics of this phase, which we now proceed to describe in detail. The lips of the proboscis (Pl. XI^c. *Fig.* 5 a^1) are not only very thin and flexible, but they also begin to show the tortuous plications so characteristic in the adult. The fringes (*Figs.* 5 a and 6 a) stretch in one unbroken line, gradually diminishing in length from the ends of the prolongations half way to the base of the same; they are mere digitate diverticles of the outer wall, and have the form of hollow tubes (Pl. XI^b. *Fig.* 19); and in the wall, especially at the tip, are imbedded numerous groups of lasso-cells (a b c). The inner surface of the proboscis is lined by exceedingly minute vibratile cilia (Pl. XI^b. *Fig.* 6 c), which are very difficult to detect even with a power of five hundred diameters; they are as long as the thickness of the two walls (*Fig.* 6 a b) which underlie them. No new branches have been added to the forking canals; but the three branches on each side of the main channel have begun to anastomoze among themselves, and a few anastomozing channels have developed at the base of the oculiferous lobes, and extend a short distance toward the centre of the disk. These have more the character of lacunæ (Pl. XI^a. *Fig.* 29 c^1) than canals, and are so intimately interwoven with the marginal canal, or that part of it (Pl. XI^c. *Fig.* 5 c^4) which diverts into the oculiferous lobes, that they may be said to form, at least in a certain degree, a part of the circular chymiferous system. Beside these, we may see also, between the forks and the simple canals (Pl. XI^c. *Fig.* 5 e), several centripetal prolongations from the marginal canal (mc), which, in time connecting with the forked tubes, will increase their peripheric branches. In the specimen used for this illustration there was an abnormal development of a canal (e^1), which ran from near the outer end of the simple canal (e), obliquely outward and across to the exterior branch of the next forked radiating tube. That the tentacles are not always strictly in a single row, may be clearly shown by an illustration of one of their phases of development. The view (Pl. XI^c. *Fig.* 13) which we present for this purpose is partly sectional; that is, the upper edge of the interlobular sockets is left out, and the bases of the tentacles are exposed, in order to exhibit the connection of the walls of one of them with those of the others. Nearest the eye there is a single tentacle (1) and two tentacular lobes (i^2), one on each side; in the distance are two smaller tentacles (2 and 2^a), one contracted, and the other extended, whose bases have a common wall (τ) directly below the large single tentacle just mentioned; and finally there is a third tentacle (*3*), still further in the distance and on the extreme left, whose walls unite, at the base (τ), obliquely upwards and laterally, with those of the longer tentacle (2^a) of the second row. Beyond all these the lower margin (ξ) of the socket may be seen. The length of the tentacles, when they are fully extended, is about one third of the radius of the disk; they are quite slender and frequently coil upon themselves in spiral tresses.

The next phase is the last of the series which we have studied connectedly. At this age (Pl. XI^c. *Figs.* 1, 2, 7, 8, 9, and 11; and *Fig.* 1) the diameter of the disk is very nearly an inch and a half, and there are fifty tentacles on each marginal segment. The essential addition to the organization is the development of two tubular prolongations (Pl. XI^c. *Fig.* 2 d^1, *Fig.* 11 d^1) of the radiating canals, in each oculiferous lobe. These tubes are formed in the same way as the canals from which they arise, and are peculiar in shape; starting at an angle of forty-five degrees to the canal of the lobe, each one projects, for one half of its length ($\alpha\ \gamma$), in a straight line, into the midst of the lappet, and then bending (γ) slightly inwards, proceeds as far again, and terminates with a closed end. Like the chymiferous canals, these blind tubes are embraced by a single wall ($\zeta\ \varepsilon$), above and below. The exterior edge (*Figs.* 8 and 11 β) is rounded, but the inner one thins out. If we follow the walls ($\zeta\ \varepsilon$) backwards, we trace them on one side into the inner wall (h^2) of the ocular peduncle, and on the other into the wall of the radiating canal (c). Like the latter, this is transversely and finely wrinkled, and has a very delicate, filmy appearance. The relations of the ocular peduncle to the surrounding walls are quite difficult to understand, and therefore we have endeavored to make them clear by means of a highly magnified drawing, which shows this organ as seen from above (Pl. XI^c. *Fig.* 11). In order to make matters as distinct as possible, we will refer at the same time to the wood-cut above, *Fig.* 1, representing the same in profile and with a lettering which corresponds with that of the illustration on the plate. First we have a bridge-like portion (j^5) of the oculiferous lobe, which stretches across the base of the interval between the lappets (j^1), and joins the latter at a short distance (dj) within their inner margin, which it follows all around. Along the commisure (bj) of the lappets the outline of the bridge has the shape of a W (aj), and the wall is very thick;

Fig. 1.



Longitudinal sectional view of the EYE OF AURELIA FLAVIDULA, corresponding to *Fig.* 11, Pl. XI^c.; designed from nature by H. J. Clark.

but it thins out toward the free edge (j^5). From the middle of the lower surface of this bridge, the ocular peduncle (h^1 h^3 h^4 h^5) is suspended, and as we see it from above, we look directly into the base (h^3 h^5), which here presents a circular outline. On the exterior side (h^5), the walls join those of the bridge quite abruptly, and on the opposite side (h^3), at a more oblique angle, though sufficient to produce a strong outline; but on the sides (h^8), the passage is gradual, and with a long curve. The outer wall (h^1) is nearly as thick as one quarter of the diameter of the peduncle, and thus it continues into the base, where it thins out into the outer wall of the bridge. The inner wall (h^2) is about half as thick as the outer one, and is hollow to within a short distance of the facets (h^4); passing inwardly to the base of the peduncle, it gradually decreases in thickness, as it merges into the wall (ε) of the blind tubes (d^1), in the lappets, and of the radiating canal (c^4). The lappets (j^1) of the oculiferous lobe appear to have a double commisural margin (*bj cj*), but the true commisure (*bj*) is a little exterior to the W shaped margin of the bridge, and what appears to be a second commisure (*cj*), is only the end of a sinus or short furrow, which extends baseward, on the under side (see *Fig.* 1 *bj cj*). The eyes (h^4) have increased greatly in number, and the reddish-brown pigment spot, which is so conspicuous in the adult (Pl. VI. *Fig.* 4) just below the facets, is quite dense.

As we have already indicated, the radiating canals (Pl. XI^c. *Fig.* 2 c c^1 c^2) present a ragged outline, owing to the manner in which they are formed or extended (Pl. XI^b. *Fig.* 17 c^1 c^2), the upper and lower walls separating irregularly rather than along a continuous line. The tentacles (Pl. XI^c. *Figs.* 1 and 9 i^3) are channelled (*Fig.* 1, d d^1) to the extreme apex, and communicate at the base (*Fig.* 9 μ) with the circular canal (*mc*).

In the last phase we have shown how the young tentacles (Pl. XI^c. *Fig.* 13 *2* and 2^a) arose side by side, without any intervening lobe; and now we have to show how they finally become separated, and each is inclosed in a separate socket. The outer wall, at the edge of the disk, simply protrudes, hernia-like (*Fig.* 9 ε), between the bases of the tentacles, forcing them apart, as it were, and gradually enlarges to its full dimensions without any further changes. It is plain enough, from this, that the development of the tentacles is not strictly serial, right and left of the first one that appears, but in a degree complicated; although the general progress is along the edge of the disk toward the oculiferous lobes, so that after a while, the middle of each segment supports a single row of tentacles, whilst further along, toward the lobes, the series is less simple, varying from one to two, and finally three rows. The walls of the tentacles are very transparent, and on this account furnish great facilities for the study of their histological structure. The outer wall (*Fig.* 1 a to a^3) varies considerably in thickness, not only on account of the degree of extension or contraction, but on account of the thick beds or groups of lasso-cells (*c e*). Its cells are very thin walled, irregularly polyhedral (*f*), and have perfectly homogeneous, hyaline contents; they are capable of great elongation (a^3) or of contraction (a^2), and are largest in the region of the lasso-cells (a^2), which are imbedded among them, in large numbers, and in all stages of development. The tip of the tentacle especially (*c*) is crowded with lasso-cells; in fact they seem to be the only constituents of the outer wall, so closely are they packed. As they are arranged at pretty regular intervals, in groups, all around the tentacle, they give it a knotted appearance, which in the adult becomes a very marked feature (Pl. VII. *Figs.* 2, 3, and 4). The inner wall (b b^1 b^2) has a more uniform thickness, which is dependent alone on the amount of expansion or contraction of the tentacle. Like those of the outer wall, the cells of this are capable of great elongation (b^3) or of extreme contraction, and have perfectly homogeneous contents. The surface of the disk is studded with collections of lasso-cells (*Figs.* 9 *σ* and 7 *a b*), which as yet only number about a dozen in each group. The epithelial cells (*Fig.* 7 *c*) have very thick walls in a horizontal direction, and numerous young cells are developing between them.

In this condition, the young Aurelia resembles the adult so closely in its general appearance, that it is hardly worth while to trace further, step by step, the successive enlargement of the whole body up to its mature condition, as this would lead to frequent unnecessary repetitions, inasmuch as from this time forwards, some parts undergo hardly any changes, while others only increase in number, and only a few new features are introduced. It may, therefore, suffice now to describe the adult and to allude incidentally to the final transformation of all its parts.

SECTION III.

STRUCTURE OF THE ADULT AURELIA FLAVIDULA.

The body of all Acalephs consisting of a repetition of identical parts, symmetrically arranged around a vertical axis, and yet variously combined with one another, it is indispensable to consider this arrangement first, in order to form a correct idea of their structure. In Aurelia, in their adult state, the most conspicuous parts are the gelatinous body or disk, the indentations along its margin, the crescent-shaped organs around the centre, and the prominent appendages on the under side; and, though the number of these parts varies occasionally, there are usually eight indentations along the margin, four crescent-shaped bodies near the centre, and four large appendages below. The variations in number arise from the interpolation of similar parts, or from the abortion of some of them. Ehrenberg has so fully represented these variations, in the Aurelia aurita of Europe, and they are so similar with those observed in our species, that I need only allude to the fact, that besides the normal form, I have observed on our coast specimens with three, five, six, and seven crescent-shaped bodies, and a number of indentations along the margin increased correspondingly. But these deviations from the normal number are rare with our species, and though Ehrenberg does not allude to their frequency in the European, I should infer that they are more frequent in Aurelia aurita, than in the flavidula, for the simple reason that malformations of the crescent-shaped bodies are rarely met with in our species.

Whenever these parts occur in their normal number, it is at once evident that the crescent-shaped bodies, which are the genital pouches, alternate with the appendages of the lower surface, which are the arm-like prolongations of the angles of the mouth. It thus appears that the four corners of the mouth (Pl. XI^b. *Fig.* 17, and Pl. XI^c. *Fig.* 5) alternate with the genital pouches, though in very old specimens (Pl. VI. and VII.) the oral appendages exhibit a tendency towards an approximation to one another, so that their extremity does not appear strictly in the prolongation of the intervals between the sexual pouches, though their base occupies exactly that position. Again, of the eight prominent indentations of the margin, four correspond to the centre of the sexual pouches, while four others, alternating with them, are situated in the radial prolongation of the angles of the mouth. This once ascertained, it is easy to appreciate the peculiar symmetry of the whole framework of this animal, and to perceive the remarkable difference which exists between the different systems of radiating tubes extending from the centre to the periphery. From each corner of the mouth, and between two adjoining genital pouches, arises one main radiating tube, extending straight to one of the marginal indentations, without lateral ramifications, except from near its base, on each side of which arises one branch which divides again and again, anastomosing among themselves. Of such systems there are, normally, only four.

The systems which correspond to the radial prolongations of the genital pouches are far more complicated: in the first place, the sexual pouch itself must be considered as a sack-like enlargement of this radiating system, and from the outer wall of this sack arise the peripheric radiating tubes belonging to it, three of which are simple, and extend directly to the margin without ramifications. The central one extends from the middle of each genital pouch to the corresponding marginal indentation; the outer ones, bordering each genital system, arise independently near the outer angles of the genital pouches, and between these three simple tubes, arise further, from the peripheric edge of the genital pouch, one or two branching radiating tubes, the branches of which anastomose with one another. There is less regularity in the ramifications of these tubes, than of those which correspond to the angles of the mouth, not only in their mode of ramification, but also in their origin. Sometimes there are two independent ramifying branches on each side of the middle tube, equally distant from it and from the simple lateral tubes, while, at other times, there may be two independent branching tubes between the middle tube and the lateral tube of one side, and only one on the other side. At times, again, these branching tubes may be directly connected at their base with the middle tube, either on both sides, or only on one side. But all these irregularities are easily accounted for when it is recollected in what way these tubes are formed, and their normal disposition may best be appreciated by a comparison of younger specimens (as those of Pl. XI^b. and XI^c.) with adults (as those of Pl. VI. and VII.). In the young, in which the radiating tubes are comparatively few, there are hardly any irregularities, and the radiating tubes corresponding to the corners of the mouth form one bundle with a main stem and more or less numerous branches from near the base, the main stem extending straight to the peduncle of the eye, which is placed in the indentation of the margin, thus showing that the corresponding branching and anastomosing radiating tubes of the adult arise from an increase of the branches and more frequent anastomoses among them, while the middle tube is enlarged without further branching. A similar comparison of the tubes corresponding to the genital pouches shows that at an early stage there arise three main branches from the genital pouches, the lateral ones of which remain simple, while the middle one gives off branches from near its base, the middle stem, nevertheless, remaining simple while the branches ramify again and again and form numerous anastomoses. As the genital pouch itself encroaches upon that main stem during its enlargement, the result is that these branches appear in the end more or less independent from the main axis.

We have thus four simpler systems, with a single main central branch arising from the corners of the mouth, and extending in the direction of the oral appendages to those four eyes in the marginal indentations, which are in the prolongations of the same rays, and four more complicated systems arising from a triangular sack, bordered on each side by a simple radiating tube, reaching the periphery without further ramifications, and giving rise at their confluence with the marginal tubes to but slight indentations, while the middle, simple branch terminates in the peduncle of those eyes which occupy the marginal indentations in the prolongations of those rays in which lie the genital pouches. The obvious homology of these parts, with those of Polyps and Echinoderms, enables us to introduce here a more definite terminology to designate them; for, as the radiating chambers are bound by radiating partitions, on the margin of which hang the ovaries, thus alternating with one another, and as the ambulacral tubes, which are homologous to the radiating chambers of the Polyps, alternate with the ovaries in their radiating arrangement, so do we find here the radiating genital system, with its peripheric radiating tubes, alternating with systems of radiating tubes extending directly to the main cavity of the body. It seems therefore justifiable to call the radiating system of chymiferous tubes, corresponding to the angles of the mouth, the ambulacral system of tubes, and those which alternate with them, the interambulacral or genital system of chymiferous tubes.

It thus appears that the peculiar symmetry of our Aurelia arises from the fact that the ambulacral system of chymiferous tubes is comparatively small and simple, alternating with an interambulacral system of chymiferous tubes, expanding into broad pouches, from each of which arises a wide system of peripheric tubes. It appears further, that the main branch of the interambulacral, as well as that of the ambulacral system, terminates at the base of an eye, while the main lateral branches of the interambulacral system, which are also simple, correspond to much less marked indentations of the margin in which there are no eyes, but which Ehrenberg has considered as marking the position of as many marginal, anal apertures. Having injected a great many of these animals in a perfect state of preservation, without ever perceiving an escape of the injected colored fluid at these places, and having watched for days and days the circulation of the nutritive fluid through the whole of these systems of radiating tubes, I venture positively to deny the presence of any aperture in the periphery of these systems of parts. The lumen of these simple tubes being somewhat larger than that of the adjoining branching tubes, their anastomoses with the marginal tubes constitute somewhat wider spaces, in which occasionally an accumulation of undigested minute particles may be observed; but these are always after a while carried along with the circulation, and are brought back to the central cavity in the returning currents, and finally rejected through the oral aperture. Pl. VII. *Fig.* 5, in which parts of the genital pouches and all the oral appendages have been removed, shows distinctly that while the interambulacral radiating tubes arise from the periphery of the genital pouches, the ambulacral tubes extend to the main cavity of the body. Ehrenberg seems to have overlooked this difference, for he represents (Pl. I. *Fig.* 1, and Pl. III. *Fig.* 5, of his paper in the Transactions of the Berlin Academy for 1836), in an injected specimen, all the radiating tubes as arising from one common cavity, which is certainly not the case in the Aurelia flavidula.

In proportion as our species grows older, the anastomoses of the radiating tubes become more numerous along the margin, and the circular marginal tube loses gradually its character of a continuous tube, and assumes more that of a net-work of anastomoses, with which communicate the many marginal tentacles.

In view to a further discussion of the homologies of these animals, I would call special attention to the fact, that we have here eyes in the peripheric prolongation of the interambulacra, as well as of the ambulacra, and that the angles of the mouth and their arm-like appendages extend in the direction of the ambulacral rays.

The only points in the structure of Aurelia, the correct appreciation of which presents some difficulty, are the relations of the central digestive cavity to the genital pouches and to the oral aperture, and perhaps also those of the ocular apparatus to the system of radiating tubes and to the tentacles. A comparison of the magnified views of young specimens of our Aurelia flavidula, as represented Pl. XI^b. *Fig.* 17 and Pl. XI^c. *Fig.* 5, with adult specimens, Pls. VI. and VII. *Fig.* 1, plainly shows, that the central cavity acquires much larger proportions, in comparison to the size of the body as it grows older; for in the adult that cavity occupies about one third of the total diameter, while in the young, it is hardly one sixth. With this change in the relative dimensions, great changes also take place in the outlines and form of the arms which surround the mouth, of the pillars by which they are connected to the lower floor of the body, and of the lower surface of the gelatinous disk forming its upper floor. It has already been stated, that the adit of the main cavity is at first a simple hollow pyramid, with the angles of its opening slightly turned out. These projecting angles soon become pendant appendages with a lobed margin, and these so-called arms very soon increase so far as to equal in length the semidiameter of the disk, so that, when stretched horizontally, their extreme ends reach to the margin, and when hanging down, they project to a considerable extent below the umbrella. This pendant position is constantly observed in younger specimens, and seems to be a natural consequence of their comparative thinness and slenderness; but in proportion as the animal grows larger, they increase considerably in thickness, especially toward the base and along the outer or upper keel of each arm, while at the same time, the free margins spread and widen, becoming folded and lobed to such an extent, that each margin appears like a ruffled curtain, with innumerable fringes along the whole outline. While this is going on, the open cylinder leading to the main cavity, in the young, becomes gradually more and more distinctly quadrangular (Pl. XI^b. *Fig.* 17); the furrow along the middle of the prolongation of the angles of the mouth, which is at first very broad and shallow, grows comparatively deeper and also narrower, the two sides of each oral appendage closing more and more upon themselves; and by the time the Aurelia has reached dimensions of about two inches, the oral aperture itself is almost constantly closed, by the approximation of two of its opposite sides. This tendency to closing reaches its maximum in the adults, in which the combined edges of two adjoining arms are brought into linear contact with the combined edges of the opposite arms, so that instead of a square opening, leading into the main cavity, the entrance to it is a straight line between these opposite folds (Pl. VI. *Fig.* 1). The oral aperture presents thus a longitudinal fissure, and the two arms which have a tendency to approximate one another on opposite sides, are respectively on the two sides of that longitudinal fissure. There is, therefore, a sort of bilaterality introduced in these radiated animals, in consequence of their peculiar mode of increase of the oral appendages, and their tendency to diverge from the uniform radiating disposition which they exhibited at first. The rectilinear radiation of the oral appendages, so conspicuous in the young, is also further lessened by the circumstance, that the enlargement of their margin causes them to wave to and fro in folds which widen gradually from the tip of the arms towards their base, where they are so wide as to become entirely one-sided. In this stage of their development, the oral appendages have become so thick, especially at their base, and the oral tube, which at first was quite distinct from the prolongations of the corners of the mouth, has become so intimately connected with the base of the arms, that these parts have, in a great measure, lost their prior flexibility, with the exception of the margin surrounding the outer oral aperture, and instead of hanging loosely down, the arms have a tendency to remain stretched horizontally, their tips only bending downwards; and when the gelatinous disk is strongly arched, and its margin bent inward toward the appendages of the lower surface, as in Pl. VIII. *Fig.* 1, and Pl. VI. *Fig.* 2, the arms do not project at all beyond the outlines of the body, but are, on the contrary, coiled up sideways in the concavity formed by the arching of the whole body.

On separating the mesial fold of the arms, and turning sideways their opposite margins, the short canal between them, which leads to the central cavity, appears still quadrangular (Pl. VI. *Fig.* 3). But here also, great changes have taken place in the outline of the sides of that opening, as a comparison with Pl. XI^b. *Fig.* 17, may show. The angles of the inner opening of the oral tube are more prominent, in consequence of the closer folding of the back of the arms, and the sides of the quadrangular aperture are deeply emarginate, while they are straight in the young; and these emarginations lead to the channels, by which the genital pouches communicate with the main cavity. The main cavity itself is at first an open space between the upper floor or gelatinous disk of the umbrella, and the lower floor from which arises the oral peduncle; but in proportion as the genital pouches, which at first are only small, enlarge so far as to occupy almost entirely the central space where their inner margins are brought close together, as in Pl. VII. *Fig.* 1, the lower surface of the gelatinous disk begins to bulge in the centre, and to press down between the inner angles of the four genital pouches, until they reach the upper and inner surface of the oral appendages, with which they are brought into immediate contact (Pl. IX. *Figs.* 8 and 9 *o*), thus lessening the main digestive cavity greatly, and finally reducing it to a narrow space, between the base or pillars of the oral appendages (same figure, *b*) and the central projection of the upper floor, *o*. In very old specimens, when the spawning season has passed and the ovaries and spermaries have discharged their contents, the central projection of the upper floor has become so prominent as to assume the form of a four-sided pyramid, filling the whole space between the four arms, and terminating as a four-sided roof, the point of which hangs down towards the external oral aperture, and, in the end, the contact between the arms and this plug is so close, that probably all connection between the surrounding medium and the main cavity is stopped, except along the angles of the mouth and the emargination of its sides leading to the genital pouches. The roof-like termination of the plug presents, at this time, as regular facets, as a four-sided pyramid with truncated angles.

The development of the genital apparatus, as it progresses, is accompanied by equally great changes in the form of the surrounding parts and their relation to one another. At first we notice only the oval depressions on the lower surface of the lower floor, in the interambulacral spaces near the intervals between two projecting angles of the oral tube, on the outer side of which arise the digitate bodies; but in proportion as these depressions deepen, and the corresponding parts of the main cavity above them encroach upon the bases of the radiating tubes, to form distinct genital pouches, the lower surface of the gelatinous disk, corresponding to the interval between two genital pouches, projects in the shape of a keel between them (Pl. IX. *Figs.* 6, 7, 8, and 9 *d*, and *Fig.* 5 *o* in the distance), thus tending to isolate more and more the genital pouches from the digestive cavity, until the central prominence of the gelatinous disk has been entirely developed, when they are fully separated as distinct cavities, preserving only a narrow communication with that cavity, through the channels marked *s* in *Figs.* 5, 8, and 9. At the same time the lower floor has become greatly thickened, at points marked *e* in *Figs.* 7, 8, and 9, in consequence of which the sexual pouches are underlaid by ample cavities communicating freely with the surrounding medium, from which they are separated, however, by thin floors stretching across the whole lower side, and supported by two stronger arches, which, seen from above, as in Pl. VII. *Fig.* 1, appear like folds arising from the inner angle of each pouch and diverging towards its outer angles. These arches (Pl. IX. *Fig.* 6 *p*) are distinctly seen in a transverse section of a genital pouch, where the floor of the cavity is marked *p′*; they are equally well seen in an oblique side view of the genital pouch (*Fig.* 9 *p*), and in a longitudinal section through a pouch (*Fig.* 8 *p′*). It thus appears that while the genital pouches (*Figs.* 5, 6, 7, 8, and 9 *n*) communicate freely with the main cavity through the channels (*s*), they have no direct communication whatever with the wide cavities (*f*), which are immediately below them; though these cavities, with their round opening, as seen between the arms (Pl. VI. *Fig.* 1) and through the genital cavities themselves (Pl. VII. *Fig.* 1), seem at first sight to be the natural outlets of the sexual apparatus, and have generally been considered as such. Ehrenberg, in the paper quoted above, has entirely overlooked the floors with double arches which separate the genital pouches from the open cavities below, and has represented the round opening of these cavities as leading directly into the genital sacs. See Pl. VII. *Figs.* 1 and 2, of his memoir.

The natural consequence of this arrangement is, that the ovaries, which are developed along the periphery of the lower floor of the genital sacs, discharge their eggs into the cavity above that floor, from which they have no other escape than through the channels leading into the main cavity of the body, from which they pass along the medial canals of the arms, into the little pouches formed by the folding of their margin, where they undergo their first development. This structure explains fully how it happens that, at the spawning season, the fringed margins of the arms are so heavily laden with eggs (Pl. VIII. *Figs.* 1 and 9). Were the eggs discharged through the lower opening below the genital pouches, as Ehrenberg supposed, they would immediately be scattered in the water, and could hardly be gathered again into the folds of the arms; but following the course above described, at the time when the arms have ceased to be very active, and when their margins are brought into close contact with one another from both sides, it is hardly possible that the eggs should readily escape; and, indeed, we find that while they accumulate in large numbers in the little pouches formed by the folds of the margin, in which they remain even when the animals are shaken in the water, it is only late in the season, when the margins of the arms begin themselves to decompose, that the young, already in their planula state, are successively dropped.

Having thus considered the general relations of these organs, we may now consider more closely some other points of their structure. It is already known that the Discophoræ have distinct sexes, but what is not so generally understood is, that at the spawning season, the males and females may readily be distinguished by their external appearance. In our Aurelia, at least, the distinction is very easy. In the first place, the oral appendages of the females (Pl. VI. *Fig.* 6) are much stouter and thicker than those of the males (*Fig.* 5), their upper side is more rounded, while those of the males show a prominent keel, and the marginal fringes are more extensively folded and the folds more intricately interwoven, preventing, no doubt, the ready escape of the eggs in their undeveloped condition. It may also be noticed, that even in their full-grown condition, the oral appendages of the males are more pendant, while those of the females are usually coiled up. In the second place, the ovaries are of a lighter, more yellowish color, while the spermaries are more purplish, or rose color. At the time of spawning, this difference in color is very striking, and the distended ovaries and the marginal folds of the arms filled with eggs, impart to the females a characteristic, yellowish appearance, whence the name Aurelia flavidula; though, at a later time, when the young begin to develop, the yellowish tint passes into a more brownish-orange tint. The males, on the contrary, have their spermaries more deeply purple before fecundation takes place; afterwards their genital organs assume a paler, more rose-colored tint, and finally fade into dull white, the marginal fringes of their oral appendages never swelling, as they do in the females, in consequence of the enlargement of the young. When the genital pouches begin to grow large, the inner peripheric margin of their lower floor gradually swells and projects into the genital sac, until a garland of folds (Pl. VIII. *Fig.* 7), waving along the whole edge, is formed, in the plications of which the ovarian and spermatic cells are developed, as seen in Pl. VIII. *Fig.* 8, and Pl. IX. *Figs.* 1 and 2. Near the folds which contain the eggs and the sperm-cells, hang the many rows of digitate appendages already described, which by the time of the maturity of these organs are extremely numerous, and occupy a band of about the same dimensions as the sexual organs themselves. The function of these digitate organs is probably to determine currents in the immediate vicinity of the eggs, and thus to secure a constant supply of fresh, aerated water in their immediate vicinity.

There are marked differences in the parts along the margin of the disk between the young and the adult. Not only are the tentacles growing more and more numerous and proportionally longer, but the lobules which separate them are greatly enlarged, so much so, that they appear like flat, broad lobes (Pl. VII. *Fig.* 4), between which the tentacles seem to arise as from sockets, *Fig.* 3, when seen from above; while the thickness of the lobules themselves is greater on their lower side, as shown in *Fig.* 2, and from their inner and lower margin hangs the veil, as seen in Pl. VIII. *Fig.* 5 *c d*. The character of the tentacles in the intervals between two eyes is very uniform. As in earlier age, however, they are thicker at the base, with a wider cavity tapering to a blunt end (Pls. VII. and VIII. *Fig.* 6), the cavity extending nearly to the tip, but gradually narrowing, while the outer surface appears as if covered with beads, owing to the crowded clusters of lasso-cells with which they are set; near the eyes they are gradually smaller, so that the margins of the indentations in which the peduncles of the eyes, with their visual lappets, are situated, appear like free spaces, destitute of tentacles; and, indeed, there are here no ordinary tentacles, but the margin of the disk assumes a peculiar appearance, as in Pl. IX. *Fig.* 4. The sockets for the tentacles are wider, and the lobules between them flat and broad; while the ocular apparatus itself may be considered as a modified tentacular margin, the eye, with its peduncle, being a tentacle with a specialized termination, and the lappets of the eye, so prominent, and comparatively very large, in the young, are a kind of flat tentacles, now hardly more projecting than the lobules between the adjoining tentacles.

In view of a proper appreciation of the morphology of the Acalephs, it is important to bear in mind that all the marginal appendages of these animals, whether solid or hollow, whether in the direct prolongation of the radiating tubes, or arising from the circular tube, bear the same relations to the aquiferous system. They are everywhere implanted upon its outer edge, and when hollow, are in direct communication with it. This is the case of the tentacles proper (Pl. IX. *Fig.* 3 *d′ d′*), as it is, also, with the lappets of the eye (*c i′ i′*) and with the eye proper (*o*). Compare, also, Pl. VI. *Fig.* 4 and Pl. XI^{b}. *Fig.* 17 and XI^{c}. *Fig.* 11. And if we take into consideration the fact that there is no essential difference between the tentacles at the base of which there is no accumulation of pigment, and those in which pigment accumulates to such a degree as to assume the appearance of an eye-speck, and further that we have well-developed eye-specks at the base of equally well-developed tentacles, we shall not be inclined to consider as essentially different, these organs in which the tentacular element is reduced to a minimum, or entirely wanting, and the ocular element developed to a maximum degree of specialization, as is the case in the eye of Aurelia with its peduncle, hollow as a tentacle, and its lobules projecting like tentacles. But, however perfect and eye-like the visual apparatus of these animals may appear, it must be remembered that, in its morphological relations, it is a dependence of the system of radiating tubes, and can in no way be homologized with the eyes of animals belonging to other branches of the animal kingdom, in which the organs of sight are formed in a totally different way. I hold that in all Radiates, from the Echinoderms to the Polyps, the marginal pigmented appendages of the aquiferous system are homologous to one another, and that, by their function, they are visual organs, even though they are not eyes, as we find them in other types.

The gelatinous disk, at first regularly lenticular, with a uniformly convex outer surface and a uniformly concave inner surface, thickest in the centre and gradually thinning out to the margin, remains uniform on the outside, and the only change which its upper surface presents, consists in an increased unevenness, arising from the crowding of epithelial and lasso-cells, which form little inequalities on the surface, as represented Pl. VIII. *Fig.* 4. The inequalities which are gradually forming on the lower surface of the upper gelatinous floor, and which consist chiefly in the rising of a central eminence projecting into the main digestive cavity, and four radiating keels intercepting the four genital pouches, have already been described. But a profile view of our Aurelia, such as Pl. VIII. *Fig.* 1 represents, exhibits these inequalities most distinctly, and especially the encroachment of the sexual pouches into the substance of the disk, and shows further, very plainly, how the interambulacral radiating tubes arise from the periphery of the sexual pouches, while the ambulacral ones extend further inward between these pouches. The whole system of these cavities, the radiating tubes, the sexual pouches, and the main digestive cavity, are hollowed out, as it were, between the upper floor of the body, which consists of the main gelatinous disk and is by far the thickest, and a lower floor equally gelatinous, which is everywhere much thinner, as Pl. VIII. *Fig.* 2 shows, (magnified in part *Fig.* 3), though it is thickest below the genital pouches (Pl. IX. *Figs.* 7, 8, and 9 *e*) and at the base of the oral appendages (*b*), which are themselves a prolongation of that lower floor. A thorough comparison of the histological peculiarities of our adult Aurelia, with those of the earlier periods of its growth, remains a desideratum in its anatomical history.

Professor H. J. Clark has furnished me with the following memorandum of an investigation of part of this subject, upon which he has been engaged during the last summer. "Excepting upon the dorsal, or, as recently denominated by Professor Agassiz, the abactinal region of the disk, the outer and inner walls of the body are underlaid by a thin, fibrous, muscular stratum. In that region of the actinal side, which extends from the base of the tentacles to the outer margin of the reproductive organs, the muscular fibres are fibrillate, and the fibrillæ are arranged in concentric circles, and are as distinctly striated as in the highest form of muscle; yet they are not arranged in fascicles, but lie side by side in a uniform succession, from the inner to the exterior edge of the concentric series. In every other part of the body where the fibres are found, excepting in the marginal canal, they trend radiatingly, and are nearly or altogether destitute of fibrillæ and striæ; these features being detected with the greatest difficulty, and, after all, with some degree of uncertainty. In the tentacles, and ocular peduncles, they run parallel to the axis, and give them a longitudinally banded appearance; in the marginal lobes, they converge at their blunt apices; and from the bases of the three above-mentioned organs, they spread laterally, and gradually pass into the concentric series. From the inner edge of the latter, they again assume the radiating trend, and pass in direct lines, without changing their course as they traverse the depths of the reproductive pouches, to the base of the actinostome, and thence to the extreme border of its four lobes.

"Within the body the fibres trend radiatingly, traversing the cavity of the actinostome in lines parallel to those without, and then expanding in the digestive cavity, they pass directly to its border, following all the convolutions of the reproductive organs, and then entering the radiating canals, they course longitudinally to the point of junction with the marginal canal, where they diverge laterally, and follow a circular direction along the channel and parallel to the margin of the disk. At the bases of the tentacles, the interior and exterior muscular layers unite and form a single structure, just within the outer wall, and immediately without the inner wall, thus forming a quasi third, or middle wall to the tentacles. Lest it may be doubted that these fibres are contractile within the digestive cavity and chymiferous canals, I would state, that upon being touched with a needle, when they are laid open by a section, a distinct contraction and a wrinkling of the wall of the canal may be observed.

"The great contractility of the digitate bodies of the reproductive organs is well known and undisputed, and yet the muscular layer of these appendages is directly continuous with that which underlies the wall of the digestive cavity and chymiferous tubes, and, moreover, with the wall, embraces a solid core or axis, which is a direct prolongation of the gelatinous layer, the same layer which constitutes the greater bulk of the body, and gives it a certain degree of rigidity.

"In young specimens, two and a half inches in diameter, within the region where the fibrillæ are concentric in the adult, the inner side of the cells of the outer wall have their granular contents arranged in parallel lines, which form concentric circles about the disk. The cells are fusiform and their longer axes trend parallel to the granular lines. At a little later period, the interior half of each cell gradually divides off, after the manner of self-division of cells, and then the muscular portion of each cell constitutes a layer hardly distinct from the cell itself, and is more like a filamentous prolongation of the parietes of the same, than a truly separate stratum. We may see the tendency to these prolongations in the branching cells which are imbedded in the gelatinous layer, not only of the actinal, but also of the abactinal side, where they connect more or less with those in the muscular layer; and in the digitate bodies appended to the reproductive organs, the branching, scattered cells, so characteristic of the gelatinous layer of the disk, are very rare, and are imbedded in the solid, fibrous, muscular layer, which constitutes the whole core of each appendage."

There is another stage in the existence of our Aurelia, which deserves to be noticed. After the spawning period, a large number of them, reduced in their natural strength, and unable to resist the influence of the approaching stormy season in the autumn, are cast upon the shore, while even at that time, large numbers may be seen still floating upon the water, near its surface, in a more or less dilapidated condition, though still alive. At this time they have lost, to a great degree, their transparency, owing to the thickening of their tissue by an increased deposition of animal substance. Their disk has become tough and almost leathery, and is more elastic, though at the same time more brittle than it was before. The tentacles are, for the most part, gone, as well as the eyes; and this decomposition of the margin extends so far, that even the marginal tube and parts of the anastomoses of the radiating tubes disappear. Yet even in that condition, the fluid continues, in a measure, to move to and fro from the main cavity, through the radiating tubes and back again, the contractions of the injured margin obliterating the canals through which it would otherwise ooze out at the periphery. The same is the case with the fringes along the margin of the oral appendages; they gradually drop off, and with them parts of the arms themselves, especially toward their extremities, which become blunt. Evidently they are now in a dying condition, and can scarcely regulate their course. They are frequently capsized, and air accumulates in the cavities of the body, especially in the genital pouches, the lower floor of which is also destroyed. As soon as air has been lodged in these cavities, the Aurelia is forced to the surface of the water, where it floats at the mercy of the elements. No sooner has it ceased to regulate and control its motions, than swarms of little shrimps fix themselves upon its surface, and enter its interior cavities, where they are occasionally found crowded in hundreds. A small species of Hyperia seems particularly to delight in resorting to our species. The gelatinous disk is the last part of our Medusa which may be found floating in this way upon the water, deprived of all its appendages. But such is the continuity of the tissues of the umbrella, in Aurelia, that it does not break up in regular organic segments, as does that of our Cyanea.

The manner in which stranded Medusæ are sometimes covered in hot, dry, and windy days, by floating sand, and moulded in it, explains the possibility of the preservation of Acalephs in a fossil state. The few specimens found in the fine-grained limestone of Solenhofen were probably preserved in that way.

With a view to a closer comparison of these animals with other Radiates, it may not be out of place to notice here, that the whole upper floor of the body of the Medusæ bears the same relations to the main cavity and its radiating tubes, as the roof of a Starfish does to its furrowed under surface. We are, therefore, justified in considering this disk as an abactinal structure; and it may well be said that a Medusa, with its convex bell-shaped umbrella, resembles closely some of the bell-shaped Crinoids, the abactinal parts of which form the calyx, so called, while the ambulacral area may be compared to the lower surface of a Medusa, since the absence of a stem in Comatula has already taught us, that this support is not an essential element of the structure of a Crinoid. Moreover, while attached to their Hydroids, the naked-eyed Medusæ do not differ from the Crinoids, even in that respect.

SECTION IV

HOMOLOGICAL RELATIONS OF AURELIA AND ECHINODERMS.

Leuckart, and with him most of the German naturalists, have urged their convictions of a typical difference between the Acalephs and Echinoderms with so much confidence, that, holding, as I do, the contrary opinion, I feel bound to avail myself of every opportunity of opposing their conclusions; and Aurélia furnishes so striking an instance of a close resemblance to Echinarachnius, that, as a complement to the anatomical description of our Medusa, I may be permitted to compare, more closely than might otherwise be necessary, two representatives of the classes in question. That the plan of structure of the Cœlenterata bears a striking resemblance to that of the Echinodermata, is, I believe, conceded even by those who would separate them, as two primary divisions of the animal kingdom. But it is not generally understood that this resemblance is founded upon as perfect an identity of the structural elements of the two divisions as exists between the classes of Vertebrata; for were this identity fully appreciated, the complications of structure which distinguish them, could not be so strongly insisted upon as evidence of their typical difference, as is done by Leuckart and his followers.

Before proceeding, I would remind the reader of the little value which numerical differences undoubtedly have in this question, notwithstanding the constancy of the number of parts in most of the Radiates; for though the number five is the typical number among Echinoderms, there are Crinoids and Starfishes, and even Echinoids, with four and six spheromeres, and others with an unusually large number; and though the number four and multiples of four are the typical numbers of Acalephs, we find those which have five and six spheromeres, and other numerical combinations. We need, therefore, not hesitate to compare an Aurelia with a quadripartite and an Echinarachnius with a quinquepartite arrangement of their parts; and I trust that at least upon that ground, no exception may be taken to the conclusions at which I have arrived.

The first question to which I would call attention is, whether Aurelia consists of eight or of four spheromeres. At first sight it would seem unquestionable, that there are eight equivalent rays in the body of an Aurelia or Cyanea, all having an eye at their peripheric termination, but four and four of which, alternating with one another, differ in supporting an oral appendage and a sexual pouch. If, however, the peculiarities of other families are taken into consideration, it will at once appear that neither the presence nor the position of the eyes, is in itself sufficient to determine the number and the relations of the spheromeres, for in Tiaropsis[1] the eyes are not in the medial prolongation of the radiating chymiferous tubes, though they occupy that position in Coryne (Sarsia) mirabilis and many other Acalephs. Again, in Polyclonia (Pl. XIII. *Figs.* 2, 3, and 4), there are no eyes in the prolongation of the rays in which the sexual pouches are situated, though there is an eye in the medial prolongation of each ray occupied by a sexual pouch in Aurelia and Cyanea (Pl. IV and VII). On the other hand, the corners of the mouth always coincide with one radiating chymiferous channel; and in most Hydroids there are no other chymiferous tubes besides those which thus correspond to the main avenues of the mouth, while the sexual organs follow these channels in bands, on each of their sides, and in all Echinoderms we find the sexual organs occupying an interambulacral position. The question, therefore, turns upon this point: Are the spheromeres of Radiates necessarily identical, or may heterogeneous spheromeres alternate with one another? or, in other words: Does the body of an Aurelia consist of eight spheromeres, four of which are connected with the oral appendages and four with the sexual pouches, and that of an Echinus of ten, five of which are ambulacral and five interambulacral? or, are the interambulacral zones only a special expansion of the sides of the ambulacra, and not by themselves distinct zones in the body of Radiates? If we take a comprehensive view of the whole type of Radiates, there seems to me no difficulty in the solution of these questions. In Crinoids and Starfishes the prominent rays of the body are essentially ambulacral in their structure and homologies, and if in Echinoids the interambulacra assume an apparent independence, it is solely owing to the widening of the little plates extending along the ambulacral plates of the Starfishes, and the consequent swelling of the whole body into a more spheroidal form; but even here the so-called interambulacra are only the flanks of the ambulacral zones, and owe their prominence more to the circumscription and separate development of the plates of which they consist than to any intrinsic importance, since nothing of the kind exists in the Holothurians. And if we extend the comparison to Polyps, we see this conclusion fully sustained by the fact, that the radiating partitions, which separate the radiating chambers, bear the same relations to these chambers and their peripheric tentacles, as the interambulacra of the Echinoderms bear to the ambulacra; or, in other words, we become satisfied that the radiating chambers are homologous to the ambulacral system, and the radiating partitions homologous to the interambulacra. Now in Polyps, as well as in Echinoderms, the sexual organs alternate with the ambulacra, that is to say, in Polyps they are attached in a double row

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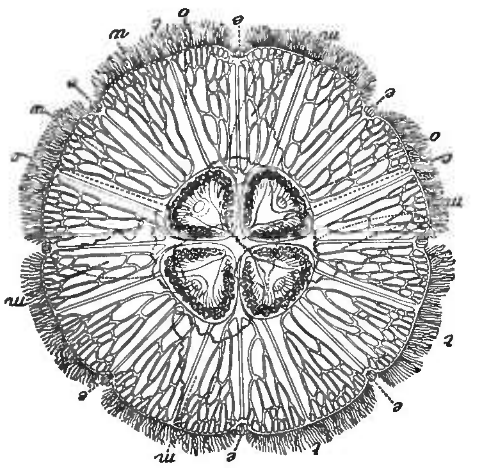
[1] See my Contributions to the Nat. Hist. of the Acalephæ of North America, Part. I. Pl. VI. *Figs.* 1, 3, 4, and 5, in Mem. Amer. Acad. vol. 4, and the chapter on Tiaropsis in this volume.

to the projecting edges of the radiating partitions, and in Echinoderms they rest upon the interambulacral zones, either as a compact mass or in two rows, one on each side of adjoining ambulacra. In the naked-eyed Medusæ the same arrangement obtains throughout, whether the sexual organs are situated along the chymiferous tubes or upon the proboscis; for in both cases these organs are upon the sides of the medial channel of the ambulacral system, which is tantamount to occupying an interambulacral position.

Now is it probable that the covered-eyed Medusæ should alone form an exception to the plan of structure which obtains in all the Radiates? Such exceptions exist nowhere in the animal kingdom; and if there is any difficulty here, it can only be in the interpretation of the facts, and in the construction thus far put upon them. Let us therefore examine what the facts of the case are. It has already been shown, page 52, that the radiating chymiferous tubes of Aurelia (*Fig.* 2) have not all the same origin, and that while four systems of them communicate directly with the main cavity of the body, four other systems, alternating with the former, arise from the sexual pouches of which they are a direct continuation, as the others are a direct continuation of the digestive cavity.

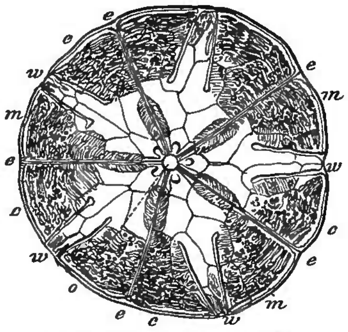
Fig. 2.



AURELIA FLAVIDULA, *Pér. & LeS.*
oral aperture.—*o o* genital organs.—*m m m* oral appendages, in outlines.—*e e e* eyes.—*t* tentacles.

The chief difference, then, between Aurelia and the Hydroid-Medusæ, consists in the greater isolation of the sexual organs from the main chymiferous tubes; but this separation is precisely in accordance with the general progress of the organization of the Radiates, from the lowest Polyps to the highest Echinoderms. In Polyps the ambulacra are wide chambers, and the interambulacra narrow partitions, upon the edges of which the sexual organs are inserted; in the naked-eyed Medusæ the interambulacral system has become wide, and the ambulacral system is reduced to narrow tubes, but the sexual organs are still in the immediate proximity of the chymiferous tubes; in the Echinoderms, in which these organs have become entirely independent of the ambulacral system, they are placed in the middle of the interambulacral zones. In the Discophoræ proper, they present an intermediate combination; separated from the four systems of chymiferous tubes which arise from the main cavity of the body, they are connected with special systems of chymiferous tubes, no longer directly opening into the main cavity, but arising from the wide pouches in which the sexual organs are suspended. The circumstance that there is an eye at the peripheric termination of each median tube of these sexual chymiferous systems, cannot be an objection to considering these systems as interambulacral structures, since we have already seen that in Tiaropsis the eyes are not in the ambulacral rays, but in the interambulacral spaces; and the presence of chymiferous tubes in the interambulacral spaces is no more exceptional in these Medusæ, than in many Echinoderms, among which I have observed and described them in Echinarachnius, more than twelve years ago.[1] An objection to this explanation might perhaps be made on the ground that, in so viewing the Discophoræ, the parts considered as interambulacral are more extensive, more conspicuous, and more characteristic than those regarded as ambulacral. No doubt they are; but this does not alter their homologies, any more than the fact that in Cidaris the ambulacra are also much narrower, and less conspicuous than the interambulacra. Indeed, the relative development of the ambulacral and interambulacral zones varies from one family to the other, in one and the same class, throughout the type of Radiates.

Fig. 3.



ECHINARACHNIUS PARMA.

oral aperture. — *e e e* ambulacra. — *c* and *m* ambulacral ramifications. — *w w* interambulacra.

A more direct comparison of Aurelia (*Fig.* 2) and Echinarachnius (*Fig.* 3), or some other member of the family of the Scutellidæ, cannot fail to remove other doubts, respecting the close structural resemblance of the Acalephs and Echinoderms, which may linger in the minds of those who have become accustomed to consider them as belonging to different types. In the first place, the prevailing idea that while Acalephs have a body consisting of a continuous mass of gelatinous substance, in which there are only limited cavities, the Echinoderms have thin, solid walls, surrounding a wide hollow space, in which all the organs of the body are inclosed, is far from accurate. In many of the Scutellidæ, the central cavity of the body is hardly more extensive than that of Aurelia, and certainly not so wide as that of Cyanea; and far from being circumscribed by thin walls, it is surrounded by a spongy mass quite as continuous, and forming as large a proportion of the bulk of the body, as the disk of any Medusa. The difference in the rigidity of that mass cannot be considered as typical, any more than the peculiarity of the skeleton of the Selachians or Myzonts constitutes a typical difference between them and the other Vertebrates. Moreover, among the Echinoderms there are those, such as the Holothurians, the body walls of which are not rigid; and among the Acalephs there is a numerous group, the Tabulata, the largest part of the body of which is as rigid as the hard-shell Echinoderms. All this goes to prove, that among the Radiates, the distinctions adopted upon the ground of the presence or absence of solid parts, are losing their

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[1] Comptes-Rendus de l'Académie des Sciences for 1847, in a letter to Humboldt, p. 677.

importance, with every step of our progress in the knowledge of their structure, just as similar distinctions among Mollusks have lost their value as tests of the natural affinities of these animals.

If we next consider the systems of radiating tubes, it must be borne in mind that the Echinoderms have not only ambulacral tubes, as is believed, but also, in some of their representatives at least, peculiar interambulacral tubes, quite as extensive as those of the Acalephs, even though these tubes have generally been either overlooked or considered as belonging to the ambulacral system proper. In my third monograph, which is to contain the Natural History of the North American Echinoderms, I shall give a full account of the structure and connections of this complicated system. It may suffice for the present to show, that there exists a system of radiating tubes in the interambulacral zones of the Echinoderms, corresponding to the system of chymiferous tubes radiating from the sexual pouches of the Acalephs to the periphery of the disk, where it anastomoses with the circular tube of the margin, and through this with the ambulacral system, in the same manner as the interambulacral system of radiating tubes of certain Echinoderms anastomoses with a similar circular tube of the margin of their disk, and through this with the ambulacral system proper. This system of radiating tubes is nowhere more extensive, among Echinoderms, than in the families of the Scutellidæ, the Clypeastroidæ, and the Laganidæ; but the resemblance with the Discophoræ is particularly striking in the Scutellidæ, where the broad expansion of the margin of the disk leads to an obvious similarity of form to the flat disk of our common Medusæ. When tracing these homologies, however, it should not be forgotten that, like Starfishes, the Discophoræ have a broad abactinal area, in consequence of which the whole ambulacral and interambulacral area is brought down to the lower surface of the body; while in the Echinoids the ambulacral and interambulacral zones extend over the sides of the spherosome, and occupy nearly its entire surface, the abactinal area being limited to a comparatively small space, occupied by the ovarian and ocular plates and the apparatus which, in different families of Echinoids, may be connected with that region. To facilitate these comparisons, it is, therefore, indispensable to assume that some of the parts seen from the dorsal side of an Echinoid may be brought to the peripheric margin, and even to the lower side of the animal without modifying their homological relations.

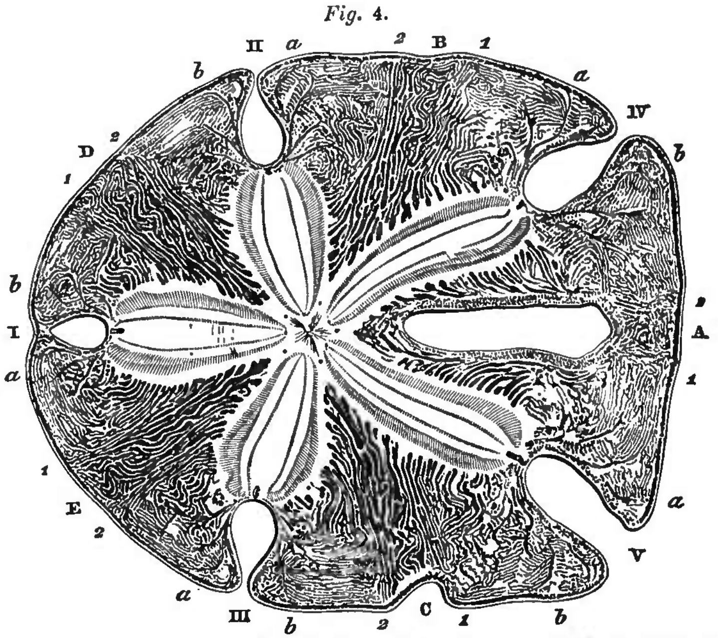
Of all the systems of organs, the ambulacra, with their diversified appendages, are the most characteristic in Echinoderms, and, therefore, the most likely to form a true basis in the appreciation of these homologies. In all Echinoderms, the most important parts of that system are about the mouth, around which they form, at a greater or less distance from the oral aperture, a ring with radiating branches, extending more or less towards the opposite pole of the body, in different families.

The limits of their extension mark the boundaries of that area of the spherosome, which I have called the actinal area, and the complication of their ramifications characterizes the different zones of this area, and the various fields of each zone. In Synapta, for instance, there arise a number of digitate appendages from the ring encircling the mouth, which are quite characteristic of that family, while the radiating tubes, upon the sides of the tubular body, are simple, and destitute of ambulacral suckers. In Pentacta and Cuvieria, the appendages around the mouth assume the character of complicated and highly ramified tentacles, while the radiating tubes are provided with ambulacral suckers, varying even in different rows. In Echinoids, the differences in the structure of the ambulacra are much greater, in different families, than among the Holothurians: in Echinus and Cidaris, the five zones have identical ambulacra, though in each zone the ambulacral suckers, and the other appendages of that system, differ with their distance from the centre of radiation; in Echinolampas, and still more in different genera of Spatangoids, the zones of ambulacra differ among themselves, and each zone within itself; but in all they extend, as in the Holothurians, nearly over the whole surface of the body, with the exception of a small abactinal area opposite the mouth.

Not so in the Starfishes. Here the ambulacra occupy only a narrow space on the lower surface of the body, while the abactinal area occupies the whole upper surface and the sides of the arms. The ambulacral or actinal area is, indeed, very similar in all the Asteroidæ. It is uniformly composed of a broad, double series of ambulacral plates, between which project the ambulacral suckers, and a narrow series of interambulacral plates on each side of the former, both kinds of which are larger about the mouth, and gradually smaller towards the extremity of the rays. The abactinal area varies much more; and while in some it is occupied by very similar plates, forming a more or less open net-work, in others it presents the most diversified combinations of heterogeneous plates, regularly linked together in distinct rows or well defined and distinct fields. And yet nothing is easier than to transform an Asterias into an Echinus. It is only necessary to contract the abactinal area of any Starfish, to such an extent, that the ambulacral area may be curved upwards, and the interambulacral plates, on opposite sides of adjoining furrows, meet; or to stretch the abactinal area of a Sea-urchin to such an extent, that the extremity of the ambulacra, with the ocellar plate, are brought to a level with the plane of the mouth. In this position, the abactinal area of an Echinus may directly be compared to that of an Asterias, and the latter with a Discophorous Acaleph. Whether the circular tube, connecting the ramifications of the chymiferous tubes, be at the peripheric extremity of the system, as in Aurelia, or around the mouth, as in Idyia, or half way between the mouth and the abactinal area, as in the Scutellidæ, does not alter their homologies.

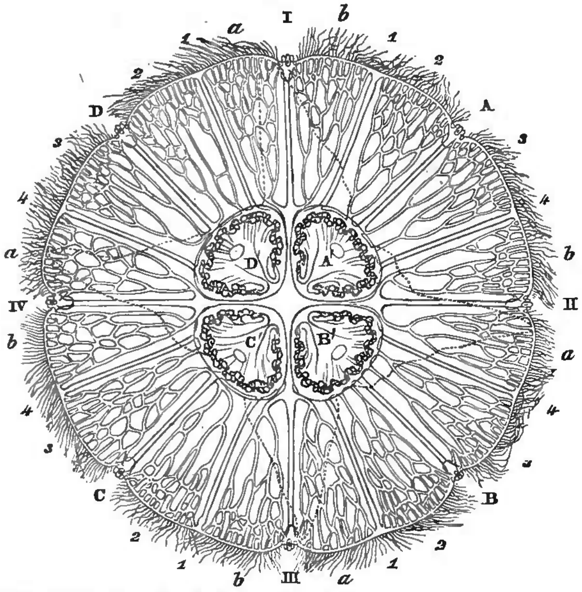
This being once understood, there can be no difficulty in homologizing the systems of radiating tubes of the Acalephs with those of the Echinoderms, as represented from the abactinal surface in Encope Michelini, *Fig.* 4. Upon removing the outer layer of the solid envelope of this Sea-urchin, there appear, in the interambulacral zones, five systems of tubes (A, B, C, D, and E), radiating towards the periphery, and there anastomosing with a circular marginal tube, no mention of which has thus far been made by any anatomist. These tubes are as numerous and as complicated, and anastomose as freely with one another, as the radiating tubes of any Acaleph; they occupy, as in the Acalephs, the same structural zone as the sexual organs, and are closely connected with them, as I shall show on another occasion. With these alternate the five ambulacral zones (I, II, III, IV, and V), the tubes of which anastomose, near the periphery, with those of the interambulacral zones, as may be seen on every point of the circumference, where the tubes *a* and *b* of their respective ambulacra I, II, III, IV, and V, unite with the tubes *1* and *2* of their respective interambulacra A, B, C, D, and E. And these two sets of tubes correspond equally to the two sets already described in Aurelia flavidula; the ambulacral tubes I *a b*, II *b a*, III *a b*, and IV *b a* of *Fig.* 5, corresponding to the ambulacral tubes I *a b*, II *b a*, III *a b*, IV *a b*, and V *b a* of Encope Michelini, *Fig.* 4, and the interambulacral tubes A *1 2 3 4*, B *1 2 3 4*, C *1 2 3 4*, and D *1 2 3 4* of *Fig.* 5, corresponding to the interambulacral tubes A *1 2*, B *1 2*, C *1 2*, D *1 2*, and E *1 2* of *Fig.* 4; the only differ-

Fig. 4.



ENCOPE MICHELINI, *Ag.* A, B, C, D, E, the interambulacral zones. — I, II, III, IV, V, the ambulacral zones. — *a*, *b* and 1, 2, the respective halves of these systems.

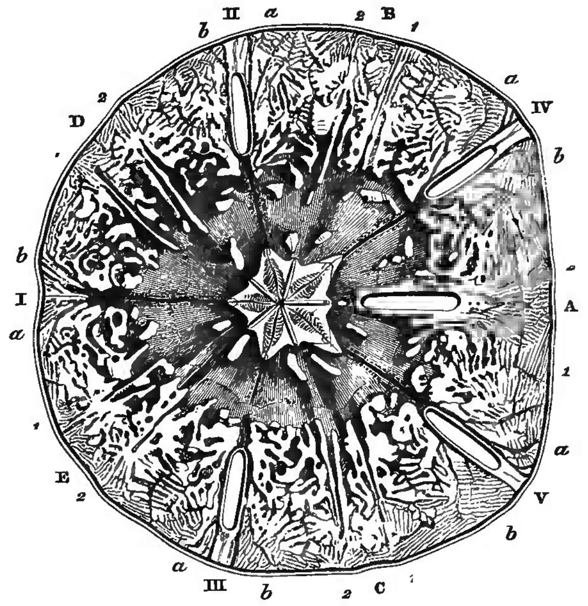
Fig. 5.



AURELIA FLAVIDULA, *Pér. & Le S.* I, II, III, IV, the ambulacral zones. — A, B, C, D, the interambulacral zones. — *a*, *b* and 1, 2, 3, 4, the respective halves of these systems.

ence consisting in the greater complication of the ambulacral system of the Encope, and in the presence of five ambulacra, whereas Aurelia has only four. But when it is remembered how simple the ambulacra of Synapta are, and how great a diversity exists in the relative development of the ambulacral and interambulacral zones, throughout the type of the Radiates, such differences cannot be considered as impairing the homology of these parts.

Fig. 6.



MELITTA QUINQUEFORA.

I, II, III, IV, V, ambulacral system. — A, B, C, D, E, interambulacral system. — *a*, *b* and 1, 2, the respective halves of these systems.

A further comparison with Melitta quinquefora, *Fig.* 6, will only confirm these conclusions, and, I trust, also go far to show how little foundation there is for a typical separation of the Cœlenterata and Echinodermata. In this figure the ambulacral and interambulacral systems are seen from the inside of the lower floor of the spherosome, I, II, III, IV, and V representing the ambulacral system, and A, B, C, D, and E the interambulacral system of radiating tubes, and *a* and *b*, and *1* and *2*, for their respective ambulacral and interambulacral zones, the branches by which they anastomose with one another. There is, in this genus, as well as in the genera Dendraster and Echinarachnius, *Fig.* 3, an additional point of correspondence with Aurelia, not observed in Encope: in the interambulacral zones may be seen two simple tubes (*1* and *2*) bordering upon the wider pouches, facing A, B, C, D, and E, into which the sexual organs extend. The innumerable lacunæ in the peripheric portion of the spherosome are only dilatations of the radiating tubes, and might at first sight appear to have little resemblance to the chymiferous tubes of the Acalephs; but if, instead of comparing the mode of ramification and the combinations of these lacunæ with the ramifications of the chymiferous system of Aurelia, we turn to Polyclonia, as represented Pl. XIII. *Fig.* 2, or to Rhizostoma, as represented by Milne-Edwards,[1] the resemblance is most striking, and I am satisfied that there is no exaggeration in the statement I made before, that Echinoderms are Acalephs with a somewhat more complicated organ-

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[1] See Recherches Anatomiques et Zoologiques faites pendant un Voyage sur les côtes de la Sicile, Part I. Pl. I., or Cuvier's Règne animal, illustrated edition, Zoophytes, Pl. 50.

ization, the spherosome of which is largely charged with calcareous spiculæ. I would add, that, considering all these relations of the two classes, the Echinoderms appear to me as closely related to the Acalephs, as the Acalephs are to the Polyps, and so completely built upon one and the same plan, that it is out of the question to regard them any longer as the representatives of two distinct, primary divisions of the animal kingdom.

SECTION V

CLOSER AFFINITIES OF AURELIA.

As soon as the ephyræ have freed themselves from the strobila stock, they lose rapidly their hydroid affinities. We have seen, in a former paragraph, how intimate the relations of all the parts of an Ephyra are to those of the Scyphostoma, from which they are derived. An ephyra, properly speaking, is only a transverse segment of a scyphostoma, which has become independent of the stem from which it was once a part. But as soon as it has accomplished its liberation, new tendencies are manifested, leading towards new affinities, not perceptible in the strobila state. The ephyra grows to be a genuine Discoid medusa, with all the structural characteristics of the Discophoræ proper. As a free ephyra, however, it is already a Medusa and no longer a Hydroid; and it is interesting now to look back upon the time when the origin of the Ephyræ was unknown, and to consider what place was then assigned to them in the system. They were, for a long time, considered as an independent genus among the Discophoræ. When a naturalist, so extensively acquainted with the Acalephs as Eschscholtz was, found it natural to separate the Ephyra, as a genus, from the genus to which he referred the adult Aurelia, and to place it at the end of the family of the Medusidæ, in the immediate vicinity of the naked-eyed Medusæ, this is significant, as indicating the great difference existing between the young and the perfect Medusa; but it also marks the direction in which the difference points: it is towards the lower Discophoræ, the Cryptocarpæ of Eschscholtz, which I propose to unite with the Hydroids. Yet, even at this early period of its existence, our Aurelia shows already signs of its true affinities; for, as soon as the sexual organs begin to be formed, they occupy distinctly an interambulacral position, as in all genuine Discophoræ, and do not follow the course of the radiating chymiferous tubes, as in the naked-eyed Medusæ. The points in which the younger ephyræ agree more nearly with the Cryptocarpæ than with the Phanerocarpæ, are the direct origin of the chymiferous tubes from the main cavity of the body, while, in a more advanced state, the interambulacral tubes communicate only indirectly with the digestive cavity, through the sexual pouches. And among the Cryptocarpæ this affinity is towards the Æginidæ, rather than towards any other family, if we take into consideration that in the ephyræ the radiating chymiferous channels are at first rather broad and flat, like the radiating pouches of Ægina and Cunina, and become more tubular only at a later period. Presently we shall have to consider more fully these affinities. The second point of resemblance, between the ephyræ and the Cryptocarpæ, lies in the simpler structure and greater prominence of their eyes, which at first resemble a speck upon a short tentacle, more than at any later period; and it is a fact, that, in most Cryptocarpæ provided with eyes, these stand out from the base of the tentacles. The comparatively large size of the veil is another striking feature common to the ephyræ and the Cryptocarpæ; and so prominent is this membrane in the latter, that Gegenbaur has insisted upon its presence, as a distinctive character of the Craspedota, to which all the Cryptocarpæ of Eschscholtz belong, from the Acraspeda, to which he refers Aurelia, overlooking the existence of a veil in this genus. The simplicity of the mouth in the ephyræ is also a structural feature characteristic of the adult Cryptocarpæ, when compared to the extraordinary development of the oral appendages in the adult Phanerocarpæ. It is, therefore, evident that the young Aurelia has greater affinities with the naked-eyed Medusæ, in proportion as it is nearer its earlier ephyra condition, and we shall soon see that it loses, gradually, these affinities, as it assumes, gradually, more and more, the structural peculiarities of its adult state.

The difference already noticed between the Æginidæ and the other Cryptocarpæ in the structure of their radiating chymiferous cavities, is of great importance with reference to the natural affinities of this family. Gegenbaur, who first called attention to their peculiarities, and separated them as a distinct family from the other Craspedota, justly remarks that they have but a remote affinity to them. He calls special attention to the pouch-like, radiating prolongations of the main cavity and the mode of insertion of their tentacles above the margin of the disk, and the sheath-like protection afforded their base by this peculiar relation. Now these characters are entirely foreign to the type of the Cryptocarpæ proper, in which the tentacles are always marginal and in direct connection with the marginal chymiferous tube, while the radiating channels are always simple tubes. On the contrary, we find that in the Discophoræ proper, and especially in their lower representatives, such as Pelagia and Nausithöe, the radiating channels are pouch-like prolongations of the main cavity of the body, and the tentacles arise between deep indentations of the margin of the disk, exactly as in the Æginidæ. And even in Aurelia, in which the tentacles seem to be marginal, a careful examination shows them to arise between lobes of the disk (Pl. VII. *Figs.* 1, 2, and 3), which form, around their bases, as distinct sheaths as in the Æginidæ. Moreover, though in the adult Aurelia the radiating channels are tubular, in the young they are flat pouches, as in the Æginidæ and Pelagidæ. I have, therefore, no doubt that the Æginidæ must be removed from the order of the Hydroidæ, and that they are an embryonic type of the order of the Discophoræ proper, bearing to the higher Discophoræ the same relation as the simple, deciduous, medusæ-buds of the Hydroids bear to the more highly organized free naked-eyed Medusæ. The special homologies of the Æginidæ to the young Aurelia and the lower Phanerocarpæ is most striking, as a comparison of the plates of Gegenbaur[1] with Pl. XI^b. *Fig.* 4 may show. But even when the young Aurelia has so far advanced in its development as to exhibit all the prominent structural features of the genuine Discophoræ it has not yet assumed the true characters of its own genus, as they appear in the adult. In the first place, the lobes of the eyes remain for a time more prominent than the rest of the margin of the disk, and, in the second place, the tentacles are much fewer than afterwards. In these respects our young Aurelia may, therefore, fairly be compared to those genuine Discophoræ which, in their adult state, have prominent ocular lobes and a few tentacles only, such as Nausithöe, Pelagia, and Chrysaora, and even Sthenonia, though in the latter genus the tentacles are almost as numerous as in the adult Aurelia; but the ocular lobes preserve their prominence over the tentacular lobes, while in Cyanea the tentacular lobes of the margin are the larger. The fact that, in the young Aurelia, the tentacles appear rather like bunches than like a marginal fringe, ought not to be overlooked; and in this connection it may be noticed, also, that the homology of the ocular apparatus to the tentacles is most satisfactorily traced in the young Aurelia (Pl. XI^b. *Figs.* 2, 3, 4, and 17), where the marginal lobules (i^2) of the disk (see also, Pl. VII. *Figs.* 2 and 3) correspond to the lappets (j) of the ocular lobes, and the tentacles themselves (i^3) to the eye (h); a radiating chymiferous tube (c) penetrating into the peduncle of the eye, in the same manner as into the tentacles.

But this is not all: if the youngest Aureliæ resemble the Æginidæ, and the more advanced young have striking affinities to the lower Discophoræ, it is equally certain, that the adult Aurelia resembles more closely the Rhizostomeæ, than any other genus of the Discophoræ Semæostomeæ does. This resemblance arises chiefly from the structure of the oral appendages. In the Rhizostomeæ, the opposite margins

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[1] See Gegenbaur, in Zeitsch. f. wiss. Zool. vol. 8, pl. 10, and V. Carus, Icones Zoologicæ, Pl. II. f. 17. I suspect that in this last figure the parts are not represented in their natural relations. I do not know a single Acaleph in which the corners of the mouth point in the direction of an interambulacrum, as is the case in this figure. Nor are the four bunches of tentacles of the sexual organs here symmetrically connected with the bunches of ovaries, as they always are in nature.

of each oral appendage are brought together very closely and soldered along the edges, for nearly their whole extent, leaving, however, at short distances, small openings between the marginal lobules, which arise from the circumstance, that the junction of the edges is not continuous for the whole length of the margin, but remains gaping at intervals. In Aurelia, the margins of the oral appendages are also brought into close proximity as it grows older, each appendage folding along its middle line, and thus inclosing a continuous channel for its whole length, but the edges are not soldered. In many other Discophoræ, the oral appendages resemble those of Aurelia, with this difference only, that the appendages are not so closely folded, and in others they remain broadly open, as, for instance, in Cyanea and allied genera. This latter structure recalls an earlier condition of the young Aurelia, as represented in Pl. X^{a}. *Figs.* 39, 40, and 41, at which time the whole proboscis resembles more a loose curtain surrounding the mouth, as in Cyanea, than a specialized, quadripartite, oral apparatus, as exists in the higher Semæostomeæ and in the Rhizostomeæ. Another point of resemblance between Aurelia and some of the Rhizostomeæ, may be traced in the mode of ramification of the chymiferous system, which in Rhizostoma and Polyclonia consists, also, of straight, simple tubes, alternating with more or less complicated anastomoses, while in the others it forms broad pouches. Thus Aurelia appears as a standard, for the appreciation of the relative rank of all the principal representatives of the order of Discophoræ, to which it belongs, so far as their natural affinities and their respective standing, in their adult state, can be determined by a comparison with the successive stages of growth of one of their highest types.

SECTION VI.

HABITS OF AURELIA.

After this digression, let us now return to the special history of the Aurelia. The appearance of these medusæ along our coast is as regular as the return of the seasons, and as they live only during one summer, they may truly be said to be annual animals, in the same sense as we distinguish between annual and perennial plants. They make their appearance, as free swimming Medusæ, towards the latter part of April, when they are not yet an inch in diameter; they grow rapidly during the months of May and June, when they have acquired their average size, from eight to ten inches in diameter, though they are then much thinner and more transparent, and their genital organs are less conspicuous, owing to their paler color, than during the month of July, when they complete their entire development, at the approach of the spawning season.

When they first make their appearance, early in the spring, these Medusæ may be seen, as the sun rises higher above the horizon, floating in immense numbers near the surface of the water, as long as the sky is clear, the sun shines brightly, and the surface of the water remains smooth; though, at that time, they do not seem to seek the places most exposed to a glaring sun, but, on the contrary, appear more frequently about sheltered places, in the neighborhood of wharves, or near prominent rocks. They are, at this time, gregarious, but evenly scattered through the water, and nowhere crowding upon one another. As they grow larger they scatter more, and are found, at a greater distance from the shore, sometimes far apart one from the other, and evidently preferring the sunniest exposures. They may then be seen floating in every attitude, moving to and fro by the rythmical contraction and expansion of their disk, which, as they advance, is always turned in the direction of the progress. These contractions and expansions are as regular as respiratory movements; their rhythm presents slight variations only, larger specimens, however, contracting and expanding at somewhat longer intervals than smaller ones. The average number of these movements is from twelve to fifteen in a minute. There can be no doubt that these animals perceive what is going on about them, and that they are very sensitive to changes in the condition of the atmosphere. As soon as the surface of the water begins to be ruffled, ever so slightly, by the unequal pressure of the atmosphere, or the sky becomes cloudy or overcast, they sink into deeper water and vanish out of sight. Even accidental disturbances are perceived by them, for when approached, however carefully, the change of their course, or the unusual rapidity with which they sink, shows plainly that they are making the utmost efforts to escape, though their ability to do so is very limited. But under such circumstances their rythmical movements are plainly accelerated, their contractions more powerful, in consequence of which their increased specific gravity may accelerate their progression or facilitate their descent into deeper water.

At the time of spawning, towards the end of July or the beginning of August, they may be seen gathering again and clustering nearer together. That at this time they seek one another is unquestionable. I witnessed once, in front of my house at Nahant, a shoal of them, which was evidently in the act of spawning. It could be seen from the shore, at about half a mile's distance. Myriads of specimens had clustered together so closely that they formed an unbroken mass, between which an oar could not be thrust without hitting many at one blow. They were in such a deep phalanx, that it was impossible to ascertain how far below the surface they extended, while those in the uppermost layer were partially forced out of the water by the pressure of those below. Two such shoals, in close proximity, stretched over an extent of about fifty feet. That they were actually spawning was ascertained by raising specimens out of water, when sperm was seen streaming freely from the appendages of their lower surface, and eggs flowing along the channel of their arms. It was about sunset, and the closing night prevented me from ascertaining how long they remained together. The next day they were scattered by the wind, and a few days afterwards immense numbers were found stranded upon the rocks and the long sand-beach at Nahant.

It might be supposed that the great destruction of these animals by the autumnal gales, would put an end to the development of the eggs of the stranded specimens, but this is not necessarily the case. On the contrary, I believe, from the observations I have had the opportunity of making, under such circumstances, that the coincidence of their period of spawning with the stormy season of the year, is a provision to bring them into the proper condition for their future development and growth. Thrown among the rocks, upon the sea-weeds, they become entangled and break up; but, by the time they are torn in pieces, the eggs, which have been accumulating in the little pouches formed by the folds of the margins of the arm, have reached their planula state, and are ready to swim about as independent animals, as soon as they are cast off. I have frequently raised, in confinement, eggs and planulæ taken from such stranded specimens, found, at low-water, dry, among the sea-weed. Even from such specimens as had been thrown up on the beach, I have raised young which have gone through the first stages of their scyphostoma state, though the mother animal had been left high and dry for hours. As with the returning tide such specimens are set afloat again, it is evident that their brood may frequently make its escape into the water and undergo their normal development after having been for a time ashore.

The fate of these young has already been described in a previous section; they soon become attached to rocks, dead shells, or sea-weeds, and assume their Polyp-like condition, during which, owing to their strong adherence to their resting surface, they are free from the dangers to which their delicate organization would be exposed during storms. The succession of fine days, along our shores, during the month of October, following the equinoctial gales, is the season during which the planulæ, set free by the decomposition of their parents, float about in search of a resting-place. The winter is the season during which they undergo their transformation from the scyphostoma state to that of the strobila, which has completed its growth about the middle or towards the end of the month of February. At this time, the wreath of tentacles which crowns these bodies is cast off, and, during the fair days of that season, in the month of March or early in April, the saucer-like disks of the strobila begin to separate. This takes place earlier or later, according to the weather, and towards the end of the spring, if we can speak of a spring in this climate, the young Ephyræ are set free, and soon afterwards appear near the surface as small Aureliæ, which the approaching summer soon brings to their adult state.

SECTION VII.

NOMENCLATURE OF AURELIA.

The type of Discophoræ, to which the genus Aurelia belongs, constitutes a natural family, the species of which are very similar among themselves, and distributed in all the seas. Some of them have been described over and over again, in different stages of growth, and in different states of preservation, and erroneously considered as distinct species, and even as distinct genera. In consequence of these mistakes, the synonymy of these animals is very complicated, and the more difficult to decipher, as most descriptions of these Medusæ are very imperfect. Leaving out of consideration the genera Scyphostoma, Strobila, and Ephyra, which are now known to have been founded upon various stages of development of different species, belonging even to different genera, we find, in different authors, Medusæ of this family described under the generic names of Medusa, Aurelia, Claustra, Ocyröe, Biblis, Macrostoma, Evagora, Orythia, Cyanea, Monocraspedon, and Diplocraspedon. Some of them have even been referred to the genus Rhizostoma. Notwithstanding the apparent diversity which might be supposed to exist among them, if we look only upon this array of names, I am unable to distinguish more than one genus among them all, unless the difference mentioned by Brandt, upon which he has distinguished the genus Diplocraspedon, really indicates a different genus. That Scyphostoma is only the earliest stage of the Hydra of different Discophoræ has already been shown, while the great similarity of the Scyphostoma of our Aurelia and that of our Cyanea is at once apparent, upon comparing the figures of Plates X. and X^a. Vol. III. The Strobila state of Aurelia and of Cyanea are equally similar, and we shall see presently that the Ephyræ of Pelagia resemble, to the same extent, those of Aurelia.

It is a great misfortune that Eschscholtz and DeBlainville published their works upon Acalephs at the same time, and still more, that when DeBlainville reprinted separately his article "Zoophytes," of the "Dictionnaire des Sciences Naturelles, Vol. 60," under the title of "Manuel d'Actinologie," he did not harmonize his nomenclature with that of Eschscholtz. The consequence was, that in France, the tradition of Péron and LeSueur was kept up through DeBlainville, and, afterwards, through Milne-Edwards, whilst the German naturalists, taking Eschscholtz as their guide, left many genera of Péron and LeSueur unnoticed, which, as we shall see presently, ought to have been retained, and described them anew. The nomenclature of Eschscholtz himself is not entirely unobjectionable, and it is a question whether he was justified in retaining, in 1829, the name Medusa, in which all Discophoræ, and even other Acalephs, had been mixed up, as a distinct genus for the common Medusa aurita of Europe, when, in 1809, Péron and LeSueur had already shown, that that species should be considered as the type of a distinct genus, to which they gave the name of Aurelia, which is exactly synonymous with Eschscholtz's Medusa. Though, as a question of principle, I am satisfied that generic names ought not to be discarded, when a better knowledge of the species referred to them shows the necessity of further divisions, I think that such groups as the genus Medusa of Linnæus, which includes a whole class of animals, can hardly claim a restoration after a quarter of a century; especially when that name is needed to designate the adult condition of Acalephs generally. I shall, therefore, give the preference to Péron and LeSueur's name for our Aurelia, and hereafter employ the word Medusa, as I have those of Scyphostoma, Strobila, and Ephyra, to designate one stage of growth of these animals. The genera distinguished by Péron and LeSueur as Ocyröe, Evagora, and those mentioned under the names of Claustra and Biblis, by Lesson, being founded only on mutilations of true Aureliæ, can have no claim to recognition; and the fact that, owing to mistaken estimations of their affinities, some species of the same genus have been referred to the genera Cyanea, Rhizostoma, and Orythia, which belong really to other families, justifies us in setting aside, for the present, the consideration of the true affinities of the last genera. There remains, therefore, only one doubtful point respecting the nomenclature of Aurelia, namely, whether Diplocraspedon of Brandt differs generically from it or not; for Monocraspedon of Brandt is unquestionably identical with Aurelia of Péron and LeSueur. It is equally unquestionable, that Macrostoma of Lesson is synonymous with Biblis, the latter name having been substituted for the former, which was already preocupied. Ocyröe, of Péron and LeSueur, without being objectionable on that ground, has an homonym among the Ctenophoræ.

SECTION VIII.

PECULIARITIES OF THE AURELIDÆ AS A FAMILY.

If form, as determined by structure, constitutes the essential character of a natural family in the animal kingdom, it is incumbent upon us to show that our Aurelia has a pattern of its own, to justify us in considering it as the type of a distinct family. This is the more necessary, since Eschscholtz associates it with the genera Sthenonia, Cyanea, Pelagia, and Chrysaora, as a member of the family which he calls Medusidæ. Even the most recent writer on the classification of Acalephs, Professor Gegenbaur, unites it in the same way with other Discophoræ, which, in my estimation, belong to different families.

What prominently distinguishes Aurelia as a family, is the even curve of the outer surface of its disk, while the lower surface is excavated in its central portion by four large genital pouches, between which hang four stout arms, closing upon one another in the centre, so as to form a rectilinear opening, prolonged in undulating curves or folds between the lower margins of the arms. The whole edge of this opening, to the extremity of the arms, is set with uniform, minute fringes. The whole margin of the disk is evenly provided with comparatively small tentacles, except where the eight eyes occupy comparatively slight indentations, which give the outline the appearance of an eight-lobed disk, the lobes of which are evenly arched outside, with a slight depression in the middle. All these peculiarities in the form of our Aurelia depend upon structural features. The absence of undulations on the outer surface of the disk, which are so characteristic of Cyanidæ, arises from the even diminution in the thickness of the whole disk, from the centre to the periphery. The four triangular excavations of the lower surface are owing to the peculiar widening of the interambulacral system of radiating tubes, near their base, and the corresponding thickening of the lower floor under these pouches, in consequence of which an open space is circumscribed below them, which communicates with the surrounding medium through large, circular apertures. The stoutness and comparative rigidity of the arms, when contrasted with the long, pendent and flowing folds of the oral appendages of Cyanea, are owing to the manner in which the primitive oral tube thickens at its base, while its outer edges, extending horizontally, fold respectively with their margins against each other, and to the circumstance that the margins grow wider than the arched back, in consequence of which they are drawn in folds around the whole oral rim; for the aperture which leads into the main cavity is not limited to the opening immediately below the digestive cavity, but extends to the extremity of the so-called arms. The peculiar lobed outline of the disk is owing to the development of the system of radiating tubes; and the evidence of this connection may be found in the fact, that the deeper emarginations correspond to the position of the eyes, at the end of eight simple, radiating tubes, and the lesser emarginations to the ends of similar simple tubes without eyes, combined with an even development of comparatively small tentacles, along the whole margin, with the exception of the spaces occupied by the eyes, which are, however, themselves modified tentacles. It is, therefore, plain that the form of Aurelia presents a pattern distinct from that of Cyanea, in which the tentacles are gathered up in large bunches, on the under surface of the disk, at considerable distance from the margin, facing deep indentations of its outline, much deeper, indeed, than those of the Aurelia, and occupying a position homological to that of the lesser indentations of the latter. It differs equally, though in a different way, from Sthenonia, in which the position and arrangement of the tentacles recall Cyanea, while the lobes of the margin are different from both, and the oral appendages quite diminutive. We shall have an opportunity, hereafter, to show that Pelagia must be considered as the type of another family.

SECTION IX.

GENERIC CHARACTERS OF AURELIA, AND SPECIFIC CHARACTERS OF THE AURELIA FLAVIDULA OF NORTH AMERICA.

In families composed of a single genus, naturalists have generally been satisfied with the statement, that the generic character coincides with that of the family; but, if genera are founded in nature and based upon a different category of characters from those which distinguish families, this practice ought not to prevail. It may be more difficult to ascertain the characteristics of a genus which stands alone, and to discriminate between those structural features which are generic and those which belong to the family; but, surely, if a second genus should be discovered at a later time, belonging to a family up to that period containing a single genus, from that time forward, at least, the older genus could no longer be said to be characterized by the same features as the family. Our ignorance, therefore, of the existence or non-existence of other genera in nature does not alter the case, and I hold that it is incumbent upon a naturalist, at least to attempt to trace the characters of such a genus. In the family of Aurelidæ, it appears to me, that the single genus of which I have any knowledge is likely to be characterized by those structural peculiarities which, having no direct bearing upon the form, are yet easily noticed. Now, the mode of ramification of the branching chymiferous tubes, the form of the lobes protecting the eyes, the arrangement of the folds of the ovaries and spermaries, the form and position of the digitate appendages of the sexual organs, the mode of insertion of the tentacles along the margin of the disk, the extension of the veil below the tentacles, the character of the fringes along the margin of the mouth and of the arms, are likely to belong to this category. I would therefore consider, in Aurelia, as generic characters, the fact that there is a narrow veil along the inner margin of the disk; that the tentacles are covered with beads of lasso-cells, and arise in sockets between flat, vertical lobules; that the eyes are protected by two broad-spreading lappets, which may be bent over the eye-peduncle; that the margins of the mouth and arms are fringed with small feelers; that the ovaries and spermaries form a wreath of lobes around the sides of the sexual pouches; that the digitate appendages, consisting of simple fusiform feelers, are arranged in many rows along the folds of the spermaries and ovaries, and occupy a band about as broad as those organs themselves; that the cavity below the sexual pouches is coextensive with them, but tapers downwards in the shape of an open funnel; and that the branching chymiferous tubes form a network of anastomoses, becoming more and more intimate towards the margin of the disk, where they lose, in a measure, their radiated arrangements, to form a closer network. But if all the points I have here enumerated are truly generic characters, and if the illustrations of the structure of the Aurelia aurita of Europe given by Ehrenberg are correct in their details, I entertain some doubts as to the generic identity of our species and its European representative; for Ehrenberg represents the eye on a very large scale, and yet his figure does not at all agree with that of our species; nor do the tentacles appear to be inserted in sockets and separated from one another by distinct lobes, as I have represented them, Pl. VII. *Figs.* 2, 3, and 4. No one of the many observers, who have described the Aurelia aurita of Europe, has made the slightest allusion to the existence of such lobes; nor is the veil below the tentacles mentioned, though it seems to be figured by Ehrenberg in Pl. IV. *Fig.* 1 of his paper, while Gegenbaur refers Aurelia to a group of Acalephs, his Acraspeda, which he characterizes as destitute of a veil. Again, Ehrenberg's representation of the appearance of the marginal feelers of the arms, in his Plate VIII. *Fig.* 1, does not agree with what I have seen and represented in our species (Pl. VII. *Fig.* 7, and Pl. VIII. *Fig.* 9). Whether these discrepancies indicate generic differences, such as I consider the insertion of the tentacles in the sockets, and the presence of distinct and comparatively large flat lobes between the tentacles to be, or only specific differences, such as I consider the club-shaped fingers of the arms of the European species, compared to the pointed fingers of our species to be, or whether part of these differences are the result of imperfect observations, future researches alone can decide, and I trust European zoölogists will soon make a renewed comparison of their species with that of our coast.

From an examination of alcoholic specimens of the European species, which I have obtained since the above was written, I ascertain that the veil not only exists, but is as well developed as in the American species. I cannot, however, detect the lobules between the tentacles, nor are sockets around the base to be distinguished; but this does not yet prove their absence, as the margin of the disk is highly contractile. For the opportunity of examining these specimens, I am indebted to Thomas J. Moore, Esq., of the Free Public Museum in Liverpool, who has lately sent to me great numbers of interesting marine animals from the coast of England, many of which reached me alive, thanks to the care bestowed upon them by my friend, Captain James Anderson, during their passage across the Atlantic.

Mertens has also observed a broad and conspicuous veil in a species from Kamtschatka, which he has figured under the name of Aurelia limbata, and upon this character Brandt has founded the genus Diplocraspedon; but unless other generic differences are pointed out, this species must be united with the Aureliæ of Europe and North America, which do not differ in that respect from one another.

There are almost insuperable difficulties to the comparative studies of the species of Acalephs. Thus far no attempts have been made to collect and preserve them for repeated study, and the figures and descriptions, which have been published, are generally so imperfect, that it is utterly impossible, from their comparison, to arrive at any kind of satisfactory result as to the true character of the species. Notwithstanding the discrepancies already pointed out between the Aurelia of our coast and that of Europe, it may still be questionable whether they differ specifically, if the differences which are apparent by a comparison of the figures of the European species with ours should prove to be the result of imperfect observation. Fabricius, at least, considers the Medusa, observed by him on the coast of Greenland, the same as the European species. It should, however, be remembered, that this identification was made at a time when it was not suspected that there could exist specific differences between animals resembling one another very closely; and Fabricius himself described a Starfish, also found on the coast of Greenland, as identical with the Asterias rubens of Europe, though a direct comparison of American and European specimens has satisfied me that they are quite distinct, as are also many other animals supposed for a long time to be common to the two sides of the Atlantic. I am, therefore, inclined to believe that our Aurelia will prove different, and that some of the differences between them, pointed out above, may be specific. I have, on that account, adopted for our species the name of Aurelia flavidula, given by Péron and LeSueur to the Medusa aurita of Fabricius, knowing that our species extends at least as far north as Labrador, and it is not likely that that sea-coast will prove the limit of another Acalephian fauna, when it is known that other marine animals, having a similar range as our Aurelia, occur also on the coast of Greenland. The differences between the figures of the Aurelia aurita, published by Ehrenberg, which I would consider as specific, consist in the less numerous anastomoses between its radiating tubes, which are so frequent in our species as to form a net-work of meshes near the margin. The space occupied by the sexual pouches in Aurelia aurita is, also, much less than in Aurelia flavidula. In our species, the diameter of the area occupied by these organs is fully one third of the total diameter of the disk; in no one of the figures of Ehrenberg does it amount to that, and in most of them it is much less. The crescent-shaped sexual organs themselves appear also further apart in the European than in the American species. The sexual organs are everywhere represented as rose-colored or purple in the European, while in our species they are so only in the males, and have, in the females, a rather yellowish tint, varying to yellowish brown. I have already alluded to the difference in the form of the fringes along the rim of the mouth and the margin of the oral appendages. All these differences belong to the category which I have found to indicate specific differences, whenever I have had the materials to make satisfactory comparisons. I think, therefore, that it may safely be admitted that the Aurelia flavidula is the North American Atlantic representative of the Aurelia aurita of the northern shores of Europe.

Since Aureliæ have been found in every part of the globe, I may be permitted here to make some further remarks upon the species described by different authors, and referred to this genus. The first question which I would submit to zoölogists is the following. Is there but one species of Aurelia upon the European coasts, or are there more than one? All modern authors, Ehrenberg, Milne-Edwards, Sars, Lovèn, Gegenbaur, who have described the common Medusa of the European shores, call it Aurelia aurita, while older writers, and among them those who have contributed most to give a scientific character to the study of Acalephs, Péron and LeSueur and Eschscholtz, mention several species as found upon the coasts of Europe. Eschscholtz enumerates Medusa aurita, surirea, campanula, granulata, radiolata, tyrrhena, globularis, and crucigera; while Péron and LeSueur enumerate Aurelia suriray, campanula, rosea, melanospila, lineolata, phosphorica, amaranthea, purpurea, and rufescens, to which Lesson adds Aurelia Reynaudii (Biblis Reynaudii *Lesson*). Now it is evident to me, that the different stages of growth of our species, and the different states of preservation in which specimens are frequently found at sea, or stranded on the shore, might furnish the means of distinguishing about as many species among our Aureliæ, as these authors have described from the coasts of Europe, did not a continued study of the changes they undergo, during the whole season of their occurrence in our bay, furnish satisfactory evidence that there exists but one species of Aurelia along the coast of the northern United States, which is also found along the coast of the British Provinces, beyond Newfoundland as far as Labrador, and, probably, also on the coast of Greenland. Under these circumstances, I cannot believe that the many species described by Péron and LeSueur, Eschscholtz and Lesson, are any thing more than the various stages of growth and different states of preservation of one, and perhaps two, species. I say perhaps two species, because on comparing the elegant figure of Aurelia aurita, published by Milne-Edwards in his "Voyage en Sicile," I perceive, between it and the figures published by Ehrenberg of the Aurelia aurita of the German Ocean, differences similar to those pointed out above, between our species and that of northern Europe. This inference is sustained by the circumstance that, as a fauna, the animals of the Mediterranean differ specifically from those of the Celtic zoölogical province. Upon this basis I consider Aurelia suriray, campanula, rosea, menalospila, and lineolata of Péron and LeSueur, and Medusa cruciata of Linnæus and Baster, as well as Aurelia aurita and radiolata of Lamark, and Medusa purpurata of Modeer (Medusa purpurea of Pennant), as synonymous with the Aurelia aurita described by Ehrenberg; while Medusa aurita of Forskål, Medusa crucigera of Eschscholtz, Aurelia crucigera of Lamark, Aurelia rufescens of Péron and LeSueur, Medusa cacuminata of Modeer, Medusa stelligera of Hemprich and Ehrenberg, Ocyröe persea of de Blainville (Medusa persea of Forskål), Evagora tetrachira of Péron and LeSueur, Orythia tetrachira of Lamark, are synonymous with the Aurelia aurita of the Mediterranean, described and figured by Milne-Edwards, as are also the Aurelia purpurea of Péron and LeSueur (Medusa aurita of Kalm), Aurelia Reynaudii of Brandt (Biblis Reynaudii of Lesson), and Aurelia globularis of Chamisso and Eysenhardt, if the Bay of Biscay and the Azores also belong to the Lusitanic acalephian fauna. I am the more inclined to believe that the southern European species of Aurelia differs from that of the coast of England and northern Europe, since I have observed along the southern coast of the United States an Aurelia, which appears to me to differ specifically from that found along the coast of the northern States.

The species of Aurelia described by travelling naturalists, which seem to differ from those observed along the coast of Europe and the Atlantic side of North America are: the Aurelia labiata of Chamisso and Eysenhardt (Ocyröe labiata *de Bl.*), observed on the coast of California, of which Aurelia limbata *Br.* and Aurelia hyalina *Br.* may be the representatives on the coast of Kamtschatka and the Aleutian Islands; the Aurelia clausa of Lesson (Claustra pissiniboque *Less.*) from

New Ireland; the Aurelia lineolata (Ocyröe lineolata, *Pér.* and *LeS.*) from New Holland; the Aurelia colpota *Br.* from the South Pacific, not far from Cape of Good Hope, and the Aurelia aurita *Cham.* and *Eys.* (not *Auct.*) from Radack. But an attempt to characterize these species, and define their natural boundaries, would be premature, in the present state of our information respecting their true characters. Their occurrence, however, in the localities enumerated, is sufficient evidence that the genus Aurelia is cosmopolite.

The Aurelia which I have observed along our southern coast differs from that of the northern States in the following particulars. It grows much larger than the northern species, specimens exceeding one foot in diameter being quite common. The genital organs are constantly of a pale rose-colored tint in both sexes. But what is far more characteristic, the genital pouches are, proportionally to the size of the body, much larger than in any other species thus far described, occupying at least one half of the whole diameter, so much so, that the distance from the peripheric outline of these organs to the margin of the disk is as great, if not greater, than that to the centre of the disk. The arms, on the contrary, are comparatively small. For this species I propose the name of Aurelia marginalis. I have observed it upon the reefs of Florida.

CHAPTER THIRD.

THE GENUS CYANEA AND ALLIED GENERA.

SECTION I.

GENERAL DESCRIPTION OF CYANEA ARCTICA.

I HAVE never felt more deeply the imperfection of our knowledge of some of the most remarkable types of the animal kingdom, than in attempting to describe the beautiful representative of the genus Cyanea found along the Atlantic coast of North America. I can truly say that I have fully shared the surprise of casual observers, in noticing this gigantic Radiate stranded upon our beaches, and wondered what may be the meaning of all the different parts hanging from the lower surface of the large gelatinous disk. It is true that naturalists have long ago given particular names to all of them, — they have distinguished a mouth, a stomach, ovaries, tentacles, and even applied the name of eyes to some prominent specks on the margin. But if the aim of our science is not, simply, to adopt arbitrary designations, by which we may describe animals, in such a manner as to distinguish them with precision from any others, but to acquire an insight into their true relations, the question at once arises, how far the names in use to designate the different parts of the lower animals are justifiable, when they recall familiar organs of well-known types, allied to man himself. Is that which is called mouth, in Jellyfishes, truly a mouth? is the so-called stomach truly a stomach? are the so-called ovaries really ovaries? are their tentacles in any way comparable to those of Mollusks and Worms? have the parts designated as arms any resemblance to the upper limbs of the Vertebrates? In the present state of our knowledge of organic structures, we must unconditionally answer, that there is only a remote analogy between the parts designated under the same names in different types of the animal kingdom, and that these names were adopted, in the infancy of our science, in accordance with a fancied similarity, but by no means in consequence of a careful comparison. And, if some of these appellations are still used by modern zoölogists, it is hardly because they acknowledge a real resemblance between them, but rather to avoid useless innovations. The time has come, however, when such apprehensions should no longer prevent us from a critical comparison, and if the result should show essential differences between all the parts which bear names otherwise in use to designate characteristic parts of other animals, then the dread of a large increase of technical terms ought to be superseded by the hope that the changes may be for the real advantage of science.

Let us take a general survey of the curious animal to which this chapter is devoted. Seen floating in the water it exhibits a large circular disk, of a substance not unlike jelly, thick in the centre, and suddenly thinning out towards the edge, which presents several indentations. The centre of that disk is of a dark purplish-brown color, while the edge is much lighter, almost white and transparent. This disk is constantly heaving and falling, at regular intervals; the margin is especially active, so much so, that, at times, it is stretched on a level with the whole surface of the disk, which, in such a condition, is almost flat, while, at other times, it is so fully arched that it assumes the appearance of a hemisphere. These motions recall so strongly those of an umbrella, alternately opened and shut, that writers, who have described similar animals, have generally called this gelatinous disk the umbrella.[1] From the lower surface of this disk hang, conspicuously, three kinds of appendages. Near the margin there are eight bunches of long tentacles, moving in every direction, sometimes extending to an enormous length, sometimes shortened to a mere coil of entangled threads, constantly rising and falling, stretching now in one direction and then in another, but generally spreading slantingly in a direction opposite to that of the onward movement of the animal. These streamers may be compared to floating tresses of hair, encircling organs which are farther inward upon the lower surface of the disk. Of these organs, there are also eight bunches, which alternate with the eight bunches of tentacles, but they are of two kinds; four are elegant sacks, adorned, as it were, with waving ruffles projecting in large clusters, which are alternately pressed forward and withdrawn, and might also be compared to bunches of grapes, by turns inflated and collapsed. These four bunches

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[1] The name of umbrella, for the gelatinous disk of all Discophorous Medusæ, is so characteristic, that I would unhesitatingly have retained it to designate that part of the body of an Acaleph, were there not many members of the class in which it assumes forms so entirely different from the flat, bell-shaped outline it exhibits here, that the simile would no longer be appropriate. I need only remind the reader of the globular form of Pleurobrachia, or of the cylindrical form of Idyia, or of the winged Bolina, or of the polygonal form of many compound Siphonophoræ, and, perhaps still more, of the club-shaped Hydroids, and of the young Discophoræ.

alternate with four masses of folds, hanging like rich curtains, loosely waving to and fro, and as they wave, extending downwards, or shortening rapidly, recalling, to those who have had an opportunity of witnessing the phenomenon, the play of the streamers of an aurora borealis. All these parts have their fixed position; they are held together by a sort of horizontal curtain, which is suspended from the lower surface of the gelatinous disk. This horizontal curtain is itself connected with the disk, fastened to it as it were by ornamental stitches, which divide the whole field into a number of areas, alternately larger and smaller, now concentric, now radiating, between which the organs already described are inserted.

The most active imagination is truly at a loss to discover, in such a creature, any thing that recalls the animals with which we ourselves are most closely allied. There is no head, no body, there are no limbs, and, if the most zealous advocate of the serial arrangement of the animal kingdom were to urge the necessity of, at least, designating as a mouth the opening which leads into the inner cavity of the body, I should almost feel inclined to concede that there is such a series, if he would undertake to point out where that opening is placed, without having made a thorough study of this singular being.

A glance at the beautiful plates (Pls. III., IV., V., and V^a.) of this animal, drawn by Mr. Sonrel, which adorn the third volume of this work, will at once facilitate the further illustration of our inquiry. Plate V. *Fig.* 1 represents the aspect of the disk as seen from above. Though no attempt has been made to represent, in connection with it, any parts of the lower surface which may extend beyond the limits of the disk, yet, when seen floating near the surface of the water, the marginal threads, as well as the curtains hanging from the centre, are often observed extending far beyond it, — the tentacles even to a distance of ten, twelve, or twenty feet, and more. Pl. III. gives a profile view of the same, and as the disk is seen edgewise, with the edge slightly bent downward, its thickness is, of course, brought into sight, at the expense of its circumference; while, on the contrary, all the organs that hang from the lower surface are beautifully exposed to view, and their diversity cannot fail to excite surprise, even though, from the manner in which they are represented, only one half of them is seen, and the marginal threads are, in a great measure, represented as cut, in order not to enlarge still more the frame of the plate. A specimen of the size of that here figured, when fully expanded, would have some of its threads, at least, stretching to twice the length of the plate, and in a specimen of about three feet in diameter, I have seen them extending in every direction from twenty to thirty feet beyond the outline of the disk.

The two bunches, which occupy about the middle of the figure, are the organs generally designated as ovaries, — the three bunches of curtain-like folds, to the right and left of them and between them, but hanging lower down than the ovaries, are commonly called the fringes of the mouth.[1] Plate IV. represents the lower surface, fully expanded; yet, to avoid confusion, the parts that are visible in the natural state of this animal are not all reproduced, but only one bunch, or one set of each kind, the others being omitted. The parts preserved are so selected as to give an accurate idea of the respective position of all the different organs, and some are laid out in a manner which may explain their structure more fully than the complete profile figure of Plate III. In the first place, the quadrangular opening in the centre, or what is commonly called the mouth, would not be visible at all, had the four masses of curtain-like folds, which hang from its outer edge, been all preserved, and on that account only one and one half of another are represented; but even these are not shown foreshortened and folded, as they should be when the animal is turned mouth downward; they are, on the contrary, flattened out, so as to show the furrows which extend along the middle of each, from the corners of the so-called mouth to their lower edge. Owing to this artificial position, several parts which hang from the lower surface of the disk are concealed; but identical parts are exhibited in other directions, where the other lobes of the mouth are cut away. Of the ovarian bunches, only one is represented, and it will easily be noticed that it occupies the space between two angles of the mouth, so that the four bunches of mouth fringes and the four bunches of ovaries alternate upon eight diverging rays, extending from the centre of the disk to its margin; but, as Pl. III. clearly shows, the mouth fringes hang lower down than the ovarian bunches. Again, of the eight bunches of threads one only is represented in Pl. IV. *Fig.* 1, and the others are either entirely omitted, or their base of attachment only indicated; but from the position which they occupy, it is at once plain that each bunch alternates with the eight spaces intervening alternately between a bunch of mouth fringes, and an ovarian bunch; so that the four mouth fringes, the four ovarian bunches, and the eight bunches of threads, occupy sixteen different imaginary rays, extending from the centre to the periphery of the disk. It is important that the reader should make himself familiar with this remarkable arrangement before proceeding further, for it constitutes one of the essential features in the symmetry of this animal.

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[1] As the introduction of letters or figures to designate the different parts of the plate would have injured its appearance, if they had been sufficiently numerous to mark them all, I have omitted them altogether; but I trust the attentive reader will easily connect the description and the plates in his mind, and thus supply the reference.

SECTION II.

THE ABACTINAL SYSTEM OF CYANEA.

It has already been shown, in the preceding chapter, that the so-called umbrella of the Discophoræ represents the abactinal system of the Radiates generally, and more particularly corresponds to the abactinal area of the Asterioids, since in these the actinal area is stretched out in one plane with the mouth or actinostome, as in the Medusæ proper.

A view of the disk from above (Pl. V.) shows plainly that the whole body of Cyanea is symmetrically divided, along its margin, by eight deep indentations into eight identical parts, each of which shows again two minor emarginations. The edge of each of these eight equal parts is thus divided into four lobes, two smaller ones in the middle, and two broader ones, of which there is one on each side of the smaller. Such an eighth part of the whole disk appears circumscribed by lines easily seen from above, reaching an inner circle, the interior of which is divided into unequal small fields. The lines which indicate the separations of the eight equal parts converge from the deep emarginations to the inner circle and other lines, passing between the two smaller middle lobes, and also reaching to the inner circle, subdivide each eighth of the body into symmetrical halves. Thus the whole disk is divided into sixteen equal parts, in such juxtaposition that two and two form an eighth of the whole. Besides these straight lines, there are, nearly upon the middle of each of these sixteenths, other lines running, in a somewhat crooked course, from the smaller emarginations, between the larger and smaller lobes, inward toward the inner circle, which they, however, do not reach. These bent lines are broader toward the centre than toward the circumference. There appear, also, at some distance from the edge, and facing the large emarginations, broken lines extending from one crooked line to another, the angular projection of which is turned toward the centre. Similar broken lines, but shorter, more waving, and nearer the margin, exist also in front of the lesser emarginations, between these and the eyes. In order to be able to designate these different outlines with more precision, and without circumlocution, I propose to call the short radiating lines between the deep emarginations and the inner circle, the short junctions, and the longer radiating lines, extending from the small emarginations to the inner circle, the long junctions. These names are justifiable inasmuch as they do not designate lines marked on the surface, but indicate the points where the long side and the short side of each sixteenth segment of the disk unite with the corresponding sides of the adjacent ones, — they are, in fact, the optical effect of a difference in the substance along these lines, and are rendered conspicuous by the fact that the lower surface of the disk is tinged with bright colors, which leave narrow spaces in the direction of these junctions unoccupied, the colorless streak being narrower along the long junctions, and somewhat broader along the short junctions. The crooked lines, on the contrary, are the optical effect of a projecting ridge of the hyaline substance of the disk, rising from the lower surface, partly in a straight line and partly in an undulating course. The longer, broken lines, in front of the deeper emarginations, as well as the smaller ones facing the lesser emarginations, are the optical effect of the sudden reduction of the thickness of the disk, near the margin; and as the gelatinous mass thins more abruptly, and over a wider area, in the direction of the short junctions than in that of the long junctions, the first are larger, and further removed from the margin of the disk than the latter.

To understand correctly this description, and *Fig.* 1 of Plate V., referred to above, it must be borne in mind, therefore, that what might be taken for lines upon the surface of the disk, are, in reality, the optical effect of parts occupying the thickness of the disk, and its lower surface, but seen through a considerable thickness of the peculiar hyaline tissue which constitutes the disk, and which is so transparent that every structure within it, or upon its lower surface, is visible at the upper surface. It is as if a mass of transparent jelly of a flat, hemispheric form, was resting upon a surface adorned with various structural details, which could all readily be seen through the jelly. But this is not all. The disk has a very unequal thickness in different parts of its expansion, and neither the upper nor the lower surface is even. It is true the upper surface seems to be uniformly arched, and yet on closer examination it will readily be perceived that whether the animal is at rest and fully expanded, so that the upper surface is nearly flat, or whether it is arched upward by the bending down of the edges, the whole surface exhibits undulations which stand in direct relation with the thickness of the disk, in the direction of the short and long junctions, along the intervening spaces, and along the marginal curves; and these undulations form really symmetrical bulgings and depressions, some extending radiatingly from the centre towards the circumference, and others, festoon-like, from one of the radiating swellings to the other.

The lower surface of the disk, when the lower floor is removed, presents still greater irregularities, Pl. IV. *Fig.* 1, in the segment *a′*, in the shape of deep furrows, extending from the inner circle alluded to above, along the short and the long junctions, and of marked bulgings in the masses limited by these furrows. The thickness of the gelatinous mass is very unequal here. It is most prominent at a short distance from the long junctions, along the crooked lines, and rounded off towards the inner circle, as well as along the long and the short junctions, lessening gradually in thickness in the part nearest the long junctions, so that here the disk remains comparatively thicker, near the margins, than is the case at the peripheric end of the short junctions, where it suddenly loses its thickness in rounded outlines, passing obliquely towards the periphery in the direction of the crooked lines. The natural consequence of this disposition is that the part of the disk which embraces the deep indentations is comparatively thin, and remains so to a greater distance from the margin; while the part embracing the lesser indentations is comparatively thicker. Besides this, there is a deep furrow along the short and the long junctions, and a prominent keel along the crooked lines. The colored pigment, however, covers only the bulging, rounded part of this surface, but does not extend over the crooked lines, nor over the short and the long lines of junction of the segments of the disk, so that these lines naturally appear more transparent than the spaces which they circumscribe.

From this it will easily be understood why the disk, seen from above, presents, as the optical effect of its structure, the various lines already described, and how important it must be for those engaged in drawing Acalephs to understand this accurately, in order correctly to represent what they see. The figures of a great many Discophoræ, published by different authors, and especially those in the voyages of the Uranie and of the Coquille, however beautiful in their appearance, represent these lines as surface features of the Medusæ. Mr. Sonrel, who has drawn the plates quoted above, has succeeded admirably in reproducing the transparency of the gelatinous disk, in such a way as to make it apparent that all these outlines are only the optical effect of structures seated on the lower surface of the disk or in its thickness, and not upon its upper surface. A comparison of Plate V. with Plate III. confirms plainly this impression, as in the latter figure the furrows following the long and the short junctions appear like keels in the direction of the deeper and lesser emarginations, and the inequalities which mark the tessellate appearance of the lower surface of the central circular area are visible as slight prominences within these ridges.

The most marked depression observed upon the upper surface of the disk lies in the prolongation of the long junction, near the margin; — it is scooped out, so as to render that portion of the long junction thinnest which extends immediately above the ocular apparatus. The spaces of each gelatinous mass, contained between the long junction and the adjoining crooked lines, are so bulging towards the circumference, that the small lobes are thickest in the middle and thinnest along their edge, Pl. V^a. *Fig.* 1. This is particularly well seen, when the lobes are bent downward, as in Pl. IV *Fig.* 6 and Pl. V *Fig.* 2. The spaces between the short junctions and the adjoining crooked lines are also bulging, so that the large lobes are likewise thicker in the middle than on the margin, and this, again, is best seen when the lobes are bent downwards (see the same figures as above). The festoon-like arches, or broken lines, within the deep emarginations, on the contrary, correspond to a thinning of the disk, forming, therefore, arch-like depressions, while the spaces along the short junctions, and along the scooped excavations above the ocular apparatus, are somewhat flattened. These bulgings and depressions form, in their combinations, the various irregularities which may be noticed upon the surface of the disk; they are, however, so slight that they may easily be overlooked. And yet, when the animal emerges upon the surface of the water, and the disk is slightly raised above its surface, spreading uniformly in every direction, and the light shines obliquely upon it, it is easy to see how the centre, which corresponds to the inner circle, is slightly depressed, and how that depression is surrounded by a circular wall, corresponding to the periphery of the inner circle, and how, again, the sixteen bulging masses of jelly separate sixteen unequal depressions, extending radiatingly from that circular wall towards the thinner edge, the inequality in width of these depressions arising from the circumstance that the more prominent parts of these bulging ridges follow the direction of the crooked lines, and are therefore nearer the long junctions than the short junctions. These unequal depressions are further limited towards the circumference of the disk, on one hand, by the festoon-like depressions in front of the short junctions, and this is the case for the wider depressions; and, on the other hand, by the scooped depression above the ocular apparatus, and this is the case for the narrower depressions. When, however, the disk is active, and, bending downward, bulges as a whole, in the shape of a gelatinous balloon, all these inequalities vanish almost entirely in a uniform hemispherical surface, with scalloped edges.

Between the lower surface of the disk and the floor from which the appendages of the lower surface are suspended, there is a wide cavity, divided into a number of chambers, radiating from a common central space to the circumference, where they terminate in numerous minute ramifications. But of this more presently. When the lower floor and all its appendages are removed from the lower surface of the disk (see Pl. IV. *Fig.* 1, in which a part of these organs is removed, in segments *a* and *a'*), all its inequalities are at once brought prominently into sight. In the centre there appears a flat, circular space, divided by colorless furrows into a number of unequal, irregular fields, the larger of which, however, are on the periphery of the circle, their defining outlines alternating more or less regularly with the radiating furrows outside of the circle. The circle itself is defined by a rather deeper circular furrow, also colorless. Following the short (*a'*) and the long (*o*) junctions, there appear sixteen deep furrows, the outlines of which, on a section, have the form of spherical triangles, more acute and deeper along the long junctions (Pl. V^{a}. *Fig.* 3, *o'*), more open and shallower along the short junctions

(*Fig.* 6, *a′*). The bulging masses between these furrows have, therefore, a rounded surface, but the most bulging part (*Fig.* 3, between *b* and *c*) extends straight, in the direction of the crooked lines and nearer to the long junctions, towards the small lobes. The natural consequence of this is, that the more acute and deeper furrows, along the long junctions (*Fig.* 7, *o′*), extend more evenly towards the ocular apparatus (*o*), between the two small lobes, while the more open and shallow furrows along the short junctions terminate more abruptly, the bulging mass rounding off towards the upper surface more suddenly in the direction of the short junctions than in that of the long junctions. Another consequence of this form of the bulging portions of the disk upon the lower surface is, that the spaces which follow the large festoons, or broken lines, inside of the great emarginations, are steeply slanting (*Fig.* 3, *a′*), and this is the more marked, as there is a furrow along the large festoons between the bulging masses and the marginal portion of the disk which forms the large lobes. Though less prominent, there is also a similar depression between the less abrupt termination of the long furrows, and the small lobes; but this part is further distinguished by small lobes of hyaline substance (*Fig.* 7, *o*), of a semi-oval form, hanging vertically upon the two sides of the prolongation of the furrow, in which the ocular tubercle is secured.

SECTION III.

THE LOWER FLOOR OF CYANEA AND ITS CONNECTION WITH THE UPPER FLOOR.

The form of the crooked lines (Pls. IV. and V. *Fig.* 1) is quite peculiar; in the part nearer the inner circle they are straight, they then bend towards one another in pairs, and diverge again to converge anew, and again diverge to reach the margin, their distance from one another increasing gradually, however, at each curve. To the prominent ridges of the bulging, gelatinous masses, which determine these lines on the lower surface of the disk (Pl. V^a. *Figs.* 3 and 4), is attached the lower floor, which is otherwise free, with the exception of its connection with the upper floor along the numerous, arborescent ridges (Pl. V^a. *Figs.* 23 and 24) of the thinner portion of the margin, which indicate the lines of connection between the two floors in that part of the animal. Thus arises the large cavity between the two floors, with its radiating pouches, extending toward the periphery along the short and the long junctions and their numerous branches, ramifying to the edge of the margin. There are, therefore, eight narrow pouches (Pl. IV. *Fig.* 1, *o o′ o″ o‴*) in the direction of the eight long junctions, and eight wider pouches (*a a′ a″ a‴*) in the direction of the short junctions. Of the eight narrow pouches, four are in the direction of the corners of the mouth (o''), and four correspond to the centre of the genital pouches (o'), while the eight broader pouches are immediately above the eight bunches of tentacles.

With these data, we may now proceed to an inquiry into the combination of these structural elements, with reference to their homology with similar parts in Aurelia, and, at the same time, with reference to the whole constitution of a Cyanea. We have seen, that in Aurelia there are four simpler systems of radiating tubes, alternating with the genital pouches, the main branch of which terminates at four eyes, and which we were led to consider as the ambulacral system of that genus. This conclusion was founded upon the fact, that these systems correspond to the corners of the mouth and alternate with the sexual pouches. For the same reasons, we shall consider the four narrow pouches of the Cyanea, which are in the same trend with the corners of the mouth, and also alternate with the genital pouches, as the four ambulacral systems of Cyanea; and the four other narrow pouches, in the radial prolongation of the genital pouches, as the interambulacral system, since they stand in the same relation to the genital organs as the more complicated system of radiating tubes in Aurelia, the branches of which arise from the genital pouches. The only question which may here present some difficulty is the connection of the broader pouches, of which we have seen that there are eight in Cyanea. At first sight, it might appear as if there was nothing like them in Aurelia, and as if they, alone, should be considered as interambulacral structures.[1] Their alternate position, between the narrow pouches corresponding to the corners

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[1] At the time of the publication of the third volume of this work, I was still under the impression that the eight broad pouches alone belong to the interambulacral system, and considered then the four narrow pouches, in the direct prolongation of the genital pouches, as ambulacral. I had not yet divested myself of the belief that the presence of an eye, at the termination of these pouches, indicates an ambulacral structure. A closer comparison of Cyanea with Aurelia has satisfied me that I was mistaken. There can be no doubt, in Aurelia, that the complicated system of radiating tubes is, in its totality, the peripheric prolongation of the genital pouches, and therefore entirely interambulacral. It is equally certain now, that the broad pouches of Cyanea are homologous to those simple chymiferous tubes of the Aurelia which terminate at the margin without eyes; they must, therefore, by homology, be considered as the lateral parts of the narrow pouches in the direct prolongation of the genital pouches, with which they freely communicate, and on that account be referred, two and two, as part of that interambulacrum, to which the narrow pouch which they embrace belongs. In the chapter on Aurelia, I have already alluded to Tiaropsis, as furnishing satisfactory evidence that the presence of eyes does not necessarily indicate an ambulacral structure, since this genus has no eyes in the prolongation of the radiating chymiferous tubes, while there are two in each interambulacrum. Moreover, the ambulacra of a large number of Radiates terminate without eyes, as, for instance, in all Holothurians, in all Crinoids, and in all Ophiurans, while they are well developed in all Asterians and in all Echinoids. They are also wanting in most Polyps.

of the mouth and those in the direct prolongation of the genital pouches, favors the view already discussed, of the possibility of eight spheromeres in Aurelia. But a more careful comparison between Cyanea and Aurelia, will disclose an unexpected correspondence between the two, in the relation to the broad pouches flanking the narrow pouches in the prolongation of the genital pouches and the complicated system of radiating tubes arising from the genital pouches in Aurelia. In the latter genus this system exhibits three main branches, starting from each pouch, the middle of which terminates at an eye, while the outer ones, which unquestionably arise from the same genital pouch, border on the simpler ambulacral systems of radiating tubes. Now, in Cyanea, the narrow pouches, in the direct prolongation of the genital pouches, which terminate at an eye, also correspond to the middle main branch of the complicated system of Aurelia, while the broader pouches, on each side of these, correspond to the outer main branches of the complicated system of Aurelia. To complete the identity, it may easily be ascertained that the broader pouches communicate freely with the genital pouches, as seen Pl. IV *Fig.* 1, in the prolongation of o''', and in the prolongation of a and a', where the sack of the genital pouches has been removed. There can be no doubt, therefore, that, widely developed and highly complicated as these systems may appear, the whole segments, from which hang a genital pouch and two adjoining bunches of tentacles with their broad pouches, as well as the narrow pouch between them, terminating in an eye, are interambulacral systems. To facilitate comparisons in tracing these homologies, the figures representing our Cyanea on Pls. IV and V., have been drawn exactly in the same position as those of Aurelia, in Pls. VI. and VII. With these facts before us, it must be evident that the indentations along the margin of Cyanea, though a very important feature in the form of that genus, in no way indicate the organic divisions of its body. Nor are, indeed, these indentations homologous to those of Aurelia, according to the degree of their prominence; for in Aurelia the most marked indentations correspond to the position of the eyes, and the least marked ones, to the termination of the simple branches of the complicated system of radiating tubes, which have no eye; while in Cyanea the lesser indentations are in front of the eyes, and the deeper indentations in front of the wider pouches, which correspond, as we have just seen, to the simple radiating tubes without eyes.

The essential elements of the structure of Cyanea, therefore, are four narrow ambulacra, in the direction of the four corners of the mouth, alternating with four very wide and complicated interambulacra, facing the genital pouches. In these interambulacra we may distinguish the middle pouch, which is in the direction of the centre of the genital pouches, and the tentacular or lateral pouches, of which there is one on each side of the middle pouch. The middle pouch, in its peripheric part, resembles exactly the ambulacral pouches, but its actinal termination is on the margin of the genital pouches, while the actinal part of the ambulacral pouches communicates directly with the main central cavity. The tentacular or broad pouches communicate also with the genital pouches, and in this respect they stand in the same relation to the main cavity, as the middle interambulacral pouch; thus disclosing their interambulacral nature.

An attempt to designate the radiating segments of the gelatinous disk, in accordance with their homological relations, presents great difficulties, owing to the fact that these segments do not correspond to the circumscription of either the ambulacral or interambulacral areas of the actinal system. On the contrary, in comparing the description of the disk with what has just been said of the essential elements of the structure of Cyanea, it appears that of the eight long junctions, four correspond to the middle of the ambulacral system, and four to the middle of the interambulacral system; while the eight short junctions correspond to the middle of the eight large pouches, which are themselves the equivalent of the eight simple radiating tubes without eyes in Aurelia; so that each of the four ambulacral systems corresponds to portions only of the adjoining segments along four long junctions, while the four interambulacral systems correspond to two entire adjoining segments along the long junctions, in the direction of the interambulacral eyes, plus that portion of the other segments which is not covered by the ambulacral systems. In this disagreement between the segments of the disk, and the main cavities of the body, we have a new evidence that the disk itself does not belong to the same organic system as the radiating pouches. In fact, these segments may be homologized with the rows of plates in the calyx of those Crinoids in which these rows do not coincide with the arms or ambulacra, and, from this homology, I infer that the disk of our Medusæ is as truly an abactinal structure as the calyx of the Crinoids.

As in all Discophoræ, the substance of the disk is a gelatinous mass, consisting of immense cells, the caudate prolongations of which traverse it in different directions, assuming the appearance of flat muscular fibres. But this appearance is deceptive, and the substance of the disk does not, in reality, contain distinct muscles, though it is highly contractile, especially in the thinner part of the margin. Its movements are owing to the structure of the lower floor.

The amount of water contained in the tissue of the disk is truly extraordinary. A specimen, weighing thirty-five pounds, exposed to evaporation, left a viscous mass, chiefly composed of common salt, showing the water to be common sea-water. The salt having been washed out with fresh-water, and the organic substance dried simply in the sun, weighed less than an ounce.

Returning now to the lower floor, and leaving out of consideration all the organs which hang down from its surface, we have first to consider its appearance as an horizontal curtain, stretched from the margin of the disk to the outline of the actinostome. For some distance from the margin, inward, it is everywhere a comparatively thin, gelatinous membrane, with a smooth surface, connected with the upper floor by innumerable branching bridges, intercepting narrow channels, which communicate freely with the pouches of their respective areas, as seen Pl. V^a. *Figs.* 23 and 24, and Pl. IV *Fig.* 1. It would require a slight extension in the length of these bridges, in the direction of the main cavity, to transform all the channels which they inclose into a system of radiating tubes, similar to those of Aurelia or of Rhizostoma and Polyclonia. The pouches themselves must, therefore, be considered as homologous to chymiferous tubes. They are, in reality, wide-spreading chymiferous tubes, branching only at their peripheric termination, and resemble, in this respect, the chymiferous tubes of the young ephyra of Aurelia, as represented Pl. XI^b *Figs.* 4 and 17.

In the spaces of the lower floor, not occupied by the tentacles, the genital pouches, and the actinostome, the lower floor is not only thicker than along the margin, but it is also folded in a very peculiar manner. Some of the folds trend in the direction of the ambulacral and interambulacral pouches themselves, that is, from the centre towards the periphery; while others are concentric. All these folds are combined into well-defined systems. Pl. IV. *Figs.* 1 and 2, shows their distribution. Between each narrow pouch and the adjoining broad pouch, there is a bundle of radiating folds, each of which is readily seen to consist of two halves, the longer of which (Pl. IV. *Fig.* 2 *b*) flanks the narrow pouches, while the shorter (*c*) surrounds the bundles of tentacles from the side. The concentric folds, on the contrary, occupy, alternately, wider and narrower areas, in such a way that the narrow areas are stretched across the actinal termination of the ambulacral pouches and of the middle pouches of the interambulacra, Pl. IV. *Fig.* 2 *e*, while the broader areas cover the actinal part of the tentacular pouches, upon which they do not advance in a triangular prolongation, as the narrow areas do, but form a straight border to the actinal part of the field occupied by the tentacles. Towards the part of the lower floor immediately adjacent to the genital pouches, the concentric folds are continuous, and present none of the interruptions which further outside divide them into distinct areas. In fact, the lower floor, immediately outside of the actinostome, is a smooth membrane, as near the margin, and from this smooth floor hang the genital pouches, as sacks folding downwards, Pl. IV. *Fig.* 1, and the peduncle of the actinostome, Pl. IV *Fig.* 2 *1 1*; while outside of the genital pouches the floor is gradually drawn into more and more distinct, continuous, circular folds (*Fig.* 2 *d′*), and becomes divided into distinct areas of concentric folds further outward (*d*). These divisions arise from the manner in which the lower floor becomes here connected with the upper floor along the crooked lines, Pl. V^{a} *Fig.* 23 *k.* We have thus sixteen defined areas of concentric folds, eight of which are narrow and eight broad, and thirty-two bundles of radiating folds. sixteen of which are longer, bordering on the narrow pouches, and sixteen shorter, bordering on the broad or tentacular pouches, though at first it may appear as if there were only sixteen such radiating bunches. A closer examination (Pl. IV *Fig.* 2) shows plainly how the triangular prolongation of each narrow area of concentric folds is connected with two bundles (*b*) of longer radiating folds, and each wider area of concentric folds is equally connected with two bundles (*c*) of short radiating folds. The dividing line between these longer and shorter bundles corresponds to the crooked lines; and as the gelatinous ridges, which form these lines, separate the narrow from the broad pouches, it is plain that the long bundles are folds of the lower floor of the narrow pouches, and the short bundles folds of the lower floor of the broad pouches.

In describing the folds of the lower floor, I have thus far only alluded to their most prominent aspect, as seen from the lower surface of the disk; but it is evident that, unless their structure be more complicated than it seems to be at first sight, it would not be possible for such prominent ruffles, placed so close to each other, to retain their relative position in a curtain stretched over the extensive surface which they cover, unless they were held together by immovable fastenings. This is secured in two ways. In the first place, they are soldered to the upper floor along the crooked lines; in the second place, they are not simple folds, but the lower floor consists of two layers folding in opposite directions, in such a manner that the longitudinal folds of one layer are held together by the transverse folds of the other layer, and vice versâ; while, at the intersections, the surfaces circumscribed are pressed against each other in the form of little serial sacks, as may best be understood by a comparison of figures 12 and 13, of Pl. V^{a}., *Fig.* 12 representing the concentric folds, *e′* and *d′*, as seen from the outer surface, and *Fig.* 13, the same folds on a somewhat larger scale, in a transverse section. *Fig.* 3 *b* and *c* represents the same arrangement, on a smaller scale, for the radiating folds. Pl. IV *Fig.* 7, represents the concentric folds from the inner surface turned towards the main cavity, where the radiating folds of the inner layer, which hold them together, are more strongly marked than the concentric folds themselves, which are most prominent on the outer surface. Secured in this way, this double system of concentric and radiating folds is not only held together, but forms innumerable serial pouches, alternately gaping inwardly and outwardly; and as Cyanea advances in age, each pouch becomes more complicated by the deepening of the pouches and the further folding of their walls, eventually giving them the aspect of rows of comb-like sacs. It has already been stated, that the folded part of the lower floor is attached to the upper floor along the crooked lines; but it may not be superfluous to add, that in proportion as Cyanea grows older, the gelatinous mass which forms these ridges, grows not only wider, but also more prominent, and isolates the different fields of folds more completely from one another, as seen in Pl. V^a. *Fig.* 12 *k*. These prominent ridges of the crooked lines are best seen in transverse sections, as in *Fig.* 4, between *e* and *e'*, and in *Fig.* 5, between *e* and *a*. In Pl. IV *Fig.* 1, the ridges have barely begun to be visible at the lower surface, and in *Fig.* 2 of the same plate they are not yet apparent.

The most prominent difference between the tentacles of Cyanea and Aurelia, consists not only in the difference of their position, but also in the nature of their connection with the main cavity of the body. In Aurelia, the tentacles communicate indirectly with the main cavity through the marginal circular tube; while in Cyanea, they communicate directly with the wide pouches, which open freely into the central cavity of which they are in reality only radiating prolongations. This constitutes, unquestionably, another distinctive family character of the Cyanidæ, as the tentacles of this genus are not strictly homologous with those of Aurelia; while the eyes, which are modified tentacles, are truly homologous with those of Aurelia. The tentacles themselves are more complicated in Cyanea than in Aurelia; they are far larger in proportion to the size of the animal, and much more diversified among themselves, as a mere glance at Pl. III. may show. Their power of contraction and expansion is truly wonderful, and the changes they undergo are quite surprising. When fully expanded to the utmost limit of their capability, they appear like mere threads of a uniform thickness for their whole length. When retracted they thicken at the places which are most contracted, and this thickening is in proportion to the degree of contraction. The extremity, however, is generally the most swollen part, though occasionally several swellings may be noticed along the length of one and the same tentacle, while it is drawing in. When the contraction takes place regularly, from the tip towards the base, they may appear like large clubs suspended to a thin thread. I cannot suppress my admiration for the skill with which Mr. Sonrel has reproduced all these tentacles in their wonderful entanglement, and yet with such distinctness, that every one may be traced in unbroken continuity, from its point of attachment to the furthest distance to which it stretches. He has succeeded in giving them all the variety of aspect which they present in active motion, when in the same bunch some of the tentacles may be entirely drawn in to within a fraction of an inch of their point of attachment, and others stretched to their utmost length, while others, again, wave from one bunch across the other bunches, or flow in undulating lines, or bend upon themselves, or are twisted in a spiral, and still others appear like heavy leads sinking among the rest. This independence of motion among the many tentacles of one and the same bunch, and among those of different bunches, is truly remarkable in an animal in which no trace whatsoever of an independent nervous system can be found. Nor is the mode in which they change their aspect, when considered singly, less curious. A single tentacle may be shortened suddenly, as if by a jerk, and rise among those which surround it, without producing the slightest apparent disturbance, until it is shortened to its minimum; or many may be seen playing in that way at the same time, in different bunches; but I have never seen the majority of the tentacles of one bunch, or the larger portion of several bunches, suddenly contracting at the same time, even when irritated, though, under such circumstances, a great many tentacles may contract together. The manner in which they elongate is equally varied; at times they stretch gradually, and, apparently, uniformly along their whole length, while at other times, and this is seen particularly in tentacles which have been shortened into a club-shaped attitude, the thicker extremity seems to drop, as if it were falling off from the thin thread to which it is attached, when a marked elongation of the thinner part takes place, and the club pauses again for some time immovably suspended at the same height; then another and another fall brings it lower and lower, until it is uniformly stretched for its whole length. At other times, again, they may be seen alternately contracting and expanding in rather quick succession, as if undecided whether to elongate or to shorten; when, by a sudden jerk, they may be entirely withdrawn or fall to their full length. A closer examination of the thickest tentacles in Pl. III., will bring to view zigzag or spiral lines in their interior, or a seeming difference in the transparency between different points of their thickness. This is owing to the circumstance that all these tentacles are hollow, and that their cavity assumes different shapes, in different stages and in different modes of contraction. When the tentacles are at rest, in their contracted state, their extremity is generally club-shaped, and the cavity assumes the appearance of an elongated bead in their interior; but while shortening rapidly and unequally, the cavity becomes undulating, and presents the appearance of zigzags or of a spiral, as is best seen in magnified views, Pl. V. *Figs.* 4, 7, 8, and 9. The internal structure of the tentacles fully explains this inequality; for, though tubular, there is in all tentacles, on one side of the tube, between the outer layer of cells which form its surface and among which are imbedded the clusters of lasso-cells, as may be particularly well seen in Pl. V. *Figs.* 5 and 6, a band of contractile fibres, which runs for the whole length of the tentacle (Pl. V *Figs.* 4, 7, 8, 9, and 10 *b*), and by its contraction must necessarily produce inequalities in the shortening of different sides of the tentacle, as well as undulations in its cavity. These fibres, however, are themselves very elongated cells.

An examination of the arrangement of the tentacles may readily be made by cutting them off at their base, as in Pl. IV *Fig.* 1 *a*, or by an inspection of the inner surface of the lower floor, Pl. IV. *Fig.* 7, where the round apertures, arranged in rows, indicate the lumen of the tentacles. It is then seen, that those nearer to the concentric and radiating folds are the larger ones, and those more outward, towards the margin, the smaller ones; while it also appears that these rows, which follow the outlines of the folds, form, in their combination, a crescent-like figure, the arms of which are but slightly open. This, again, explains the peculiar appearance of the bunches, as seen in Plate III., in which the two middle bunches are visible from the outside, so that the smaller and shorter tentacles are in front, and the larger and longer ones further backward, in the convex part of their surface of attachment; while the lateral bunches of the same figure are brought to view in such a position that the part nearer the middle bunches is seen from the inner side of the crescent-shaped surface of attachment, and the further part, from its outside. The aspect presented by all these tentacles, taken as a whole, is further rendered more varied by the difference in their color; the majority of them are of a purplish-red tint, similar to that of the surface of the disk, but there are always a number which have a more yellowish, or orange tint, and others which are more reddish, and when all tentacles are in full play, the changes of color add greatly to the effect of the motion.

A comparison of the tentacles with the folds of the lower floor discloses, between them, an unexpected resemblance, which can leave no doubt in the mind that, after all, the most diversified organs of these animals are only modifications of very simple structural elements. Like the folds and the lower floor itself, the tentacles consist of two distinct layers of cells, between which there is a larger or smaller amount of the characteristic gelatinous mass of the Acalephs, and the chief difference between the tentacles and the pouches of the folds consists in their form, as *Fig.* 7 of Pl. IV. shows. In the folds, the cavities are the result of straight plications, intersecting one another, and thus forming angular sacs, projecting but slightly; in the fields occupied by the tentacles, which are immediately adjoining the folds, we have similar pouches, with rounded outlines, projecting enormously in the shape of hollow cylinders, and lined by a prolongation of the inner layer of the floor, while the outer surface is the direct prolongation of the outer layer. Between these two layers there are larger or smaller masses of gelatinous substance, varying in thickness near the base of the tentacle, or between the folds of the pouches, according to their various stages of development with an advancing age.

The genital pouches themselves share this structure, being, in fact, large sacs, formed by a projection of the whole thickness of the lower floor, between the pillars to which the actinostome is suspended; Pl. IV. *Fig.* 2, and Pl. V^a. *Fig.* 15, seen from the outside, and Pl. V^a. *Fig.* 14, seen from the inside. The pillars themselves, Pl. IV *Fig.* 2 *1 1*, and Pl. V^a. *Fig.* 15 *1*, are also a simple prolongation of the lower floor, only that the gelatinous substance, between its outer and inner layer, is so thickened as to form solid columns between adjoining genital pouches, attached to the margin of the broad concentric areas of folds, which are immediately adjoining the ambulacral areas of concentric folds facing the intervals between the two adjoining arms of the pillars. As these pillars are themselves connected with one another, at the corners of the so-called mouth, by similar thick beams of gelatinous mass, trending horizontally, while the pillars trend radiatingly, the genital pouches are surrounded, from three sides, by these thickened portions of the lower floor; sideways, by the pillars (*1 1*), as best seen in Pl. V^a. *Fig.* 15, and Pl. IV. *Fig.* 2, near the mouth, by the transverse beams *3 4*, and outside, by the radiating folds, which may be seen gradually fading into the outer surface of the pouches themselves. Owing to the extraordinary amplitude of the genital pouches, which are much wider than the outline of their attachment, their walls are thrown into innumerable folds, gathered into fewer bunches, as may be seen Pl. IV. *Figs.* 1 and 2, and Pl. V^a. *Figs.* 15, 18, and 19. In a transverse section of the whole animal, as seen in Pl. V^a. *Fig.* 14, we look directly, in the centre of the figure, into the cavity of one of these pouches, where the attachment of its margin to the concentric folds and to the pillars of the actinostome and the horizontal beam which connects them, is plainly visible; while right and left of it two other genital pouches, opposite one another, are seen in profile. The essential difference between the genital pouches of Cyanea and Aurelia consists in the even thickness of the lower floor, over the whole of its extent occupied by the pouches; while in Aurelia the lower floor thickens around the genital pouches, and its thickened portions converge from all sides, so as to form a funnel-shaped cavity below the genital pouches, which remain stretched on a level with the spread of the disk; while in Cyanea, they hang down like large sacks, floating between the bunches of tentacles and the flowing curtains of the actinostome, as may be seen in Pl. III. and in Pl. V^a. *Fig.* 14.

In order the better to appreciate the relations of the sexual organs to the genital pouches to which they are attached, one of them (Pl. V^a. *Fig.* 18) has been represented as separated from the other parts of the lower floor, in such a position as to show the interior of its cavity; *o s* being the folds attached to a transverse beam of the actinostome, while the semicircular outline is the margin connected with the pillars of the actinostome and with the concentric folds. The lobes on the outside, *o f*, are the result of the folding of the sexual organ itself, forming small sacs, arranged in undulating lobes, alternately turned in opposite directions. *Fig.* 19 represents a portion of the pouch, showing its connection with the concentric folds, in their natural relation, but seen from the internal surface of the genital sacs. *Fig.* 20 exhibits a small portion of a lobe magnified, in order to show how the tentacles of the genital pouches are scattered on a broad band, immediately adjoining the folds of the sexual organ, in which the eggs may be seen projecting from the surface of the ovarian lobes. In a younger specimen, *Fig.* 21, the ovaries are not yet fully developed, and the eggs do not project beyond the folds of the ovarian lobes. *Fig.* 22 represents the male organ, which, even in its mature condition, resembles more, by the form of its lobes, the ovaries of the young, than those of the adult; in *o s* the connection of the concentric folds with the genital pouch (*s*) is exhibited. In the male the tentacles of the genital pouches are less numerous than in the females, in their adult condition. The young female has, also, fewer than the adult.

Considered as a whole, the genital pouches, with their festoon-like lobes of sexual organs, winding in elegant folds around the whole sac, as shown in *Fig.* 18, have nothing of the rigidity which that figure seems to exhibit; for it is in unceasing motion, the sac itself being highly contractile. Not only does it wave constantly to and fro, but the folds, into which the whole is drawn, are alternately contracting and elongating, and in these movements the single lobes of the sexual organs are unceasingly changing their relative position. It is only in younger specimens, in which these lobes are comparatively few, as seen in *Fig.* 18, that their regular arrangement may be traced; the pouch itself being then shallow and projecting but slightly. As it grows larger the number of folds increases (Pl. IV. *Fig.* 2, Pl. V^a. *Fig.* 14), and even in specimens of moderate size, as those represented in Pl. IV *Fig.* 1, and Pl. V^a. *Fig.* 15, they are so numerous that their connection may easily escape observation. In very old specimens, in which the genital pouches hang down upon the curtains of the actinostome (Pl. III.), these folds are innumerable, and their play presents a most striking spectacle. These movements seem to be a provision to bring the sexual organs constantly into renewed contact with fresh surfaces of water, and the tentacles, arranged in broad bands along the sexual organs, which are also unceasingly playing in their immediate vicinity, must powerfully contribute to this result.

When the eggs are mature, they drop from the ovarian folds and fall into the genital pouches, and are certainly not cast into the surrounding element, in the normal condition of these organs; for eggs are always found, at the time of spawning, in innumerable quantity, upon the inner surface of the actinostome, between its folds, which, though not provided with little sacks for their reception, as in Aurelia, are, nevertheless, adapted to lodge them between their plications, and to retain them until they are so far advanced in their transformation, as to be fit to live in open water. Even stranded specimens may frequently be found upon our beaches, in the latter part of the month of September, in which the eggs still remain between the folds of the actinostome, in such numbers as to be readily distinguishable by the peculiar, yellowish orange tint, which they impart to the places where they are accumulated in greatest quantity. These genital pouches, however, are so delicate that they are frequently found torn open, when the eggs necessarily escape at once into the water. Whether such eggs undergo their development or not, must depend upon the stage of growth they have reached before leaving the ovarian lobes.

The connection of the actinostome with the other parts of the lower floor described above, has already been alluded to; but this apparatus is far more complicated than in Aurelia, and requires a special description to be fully understood. Within the concentric folds of the lower floor, its actinal prolongation towards the central oral aperture presents marked differences. In four directions, in the actinal prolongation of the ambulacra, this floor is thickened, to form the pillars which support the whole oral apparatus with its appendages; while the intervening spaces, alternating with these pillars, are occupied by the thin-walled genital pouches, as seen in Pl. IV. *Fig.* 2, and Pl. V^a *Fig.* 15, and also in *Fig.* 14, in which these same parts are shown in a profile section, exhibiting two of the pillars of the actinostome from the inside, in their connection with the concentric folds and with the genital pouches. Each pillar arises with two branches (Pl. IV *Fig.* 2, *1 1*) converging downwards to a point which corresponds to a corner of the quadrangular mouth; and the oral apparatus is suspended to four such pillars, placed in the radial prolongation of the four ambulacra. As in Aurelia, the actinostome consists of four so-called arms, as shown in Pl. V^a. *Fig.* 16, but these arms are not, as in that genus, massive prolongations of the lower floor, thickest around the oral aperture and gradually tapering to a thin extremity; they form, on the contrary, thin, broad, flowing curtains, hanging from the two sides of a somewhat thicker axis or peduncle, radiating from the corners of the mouth to the periphery of the four great curtains. Each of these masses of flowing folds is, as it were, gathered up round that peduncle, near its base (Pl. IV. *Fig.* 2, *5*, and Pl. V^a. *Fig.* 15, *5*). The flowing curtains (*d d*), properly correspond to the fringed margin of the Aurelia; while the stronger medial folds (Pl. IV. *Fig.* 1, *s*, and Pl. V^a. *Fig.* 16, *s s s s*), answer to the back of the arms in Aurelia. At the junction of the pillars with the medial folds of the four curtains, there is developed, in the thickness of the prolongation of that part of the lower floor which forms the genital pouches, a thick cylindrical beam (*3*), which connects the four pillars together, and while keeping them from spreading, gives the oral aperture a quadrangular form. The flowing curtains themselves extend also along the margin of these beams, as seen in Pl. V^a. *Fig.* 14, d^4, and *Fig.* 15, d^4; so that the entrance to the main central cavity is so entirely surrounded by the innumerable folds of the curtain, that it is entirely shut out of sight in the natural position of the animal; even when reversed, the mouth becomes visible only when the curtains are either removed or stretched out horizontally, as in Pl. IV. *Fig.* 1. It is then seen that the corners of the mouth present an indentation corresponding to the middle of the heavier fold of the arms, which forms the axis of the flowing curtains. These parts are seen from the under-side in Pl. IV *Fig.* 1; they are seen in profile from the inside in Pl. V^a. *Fig.* 14, and from above in *Fig.* 16, in which the pillars of the actinostome (*1 1*), and the genital pouches (*o s*), are cut through at different heights, in order the better to show the structure of these parts. On the right side of the figure, these pillars are cut near their connection with the concentric folds and shown to consist of two branches, separated from one another, as seen in Pl. IV. *Fig.* 2, *1 1*; while on the left side of the figure, they are cut immediately above the transverse beams (*3*), so as to show that their two branches are here close together, and pass in unbroken continuity into the rod-like main folds (*s s*) of the flowing curtains. The gelatinous substance which gives strength to these pillars extends also into the main fold of the curtains, and stretches even sideways into the upper portion of that part of the curtains which is attached to the transverse beams (Pl. V^a. *Fig.* 17, *4*). In this figure, *o s* is a portion of the genital sac, *3* exhibits a transverse section of the horizontal beam, and *4* a section of the gelatinous thickening of the lateral parts of the flowing curtains. The horizontal beams, though stretching across from one pillar to the other, are slightly arched outward, as *Fig.* 1, Pl. IV. shows. It is not difficult to understand how the curtain-like portion of the actinostome is thrown into the innumerable folds it presents, as seen in Pl. III. and Pl. IV. *Fig.* 1, and Pl. V^a. *Figs.* 14, 15; since the main fold (*s s*), which corresponds to the axis of each of these curtains, is, properly speaking, homologous to the more solid portion of an arm of Aurelia, while the flowing folds correspond to its thin margin; only that in Cyanea these margins are very long and thin, and grow broader and broader as they are further removed from the medial line. At the same time, they are shorter near the junction of two arms (d^4), and longest about mid length; while the medial prolongation of each arm becomes as thin and waving as its lateral folds. The natural consequence of this arrangement is, that the main mass of the folds (Pl. V^a *Figs.* 14 and 15, *d*), have nearly the same length, while those occupying the interval between two arms (d^4 d^4) are gradually shorter, up to the point where two bunches meet. Compare also, Pl. IV. *Fig.* 1.

Without being as active as the tentacles, the flowing curtains of the actinostome, with their many folds, are in unceasing motion, rising, or falling, or spreading, in parts, so that larger or smaller masses of these folds may be seen shortening or elongating, as if raised or dropped, almost independently of the parts with which they are, nevertheless, continuous. At times, however, the whole mass of the actinostome is raised in a bulk, and brought nearer to the disk. When at rest, floating near the surface of the water, the gentle contractions of the margin of the disk alone maintaining the animal in its position, the pillars of the actinostome are more elongated than at other times, as is the case in Pl. III., and the folds of the curtains are gathered up in large rounded masses. When moving actively, however, they are more stretched, sometimes to a length exceeding several times that which they exhibit in Pl. III.

It is very difficult to keep large specimens of this species alive, in confinement, for protracted observation. It is evident that these animals require a very large supply of the purest water, since they rapidly decompose, in a very short time, when kept in a limited quantity of water. A few hours after they have been confined in glass cylinders, even sufficiently large to allow them to stretch their tentacles to a greater extent than is exhibited in Pl. III., and wide enough to hold them without touching the sides, the tentacles begin to drop off, one after the other, and the marginal folds of the actinostome to decompose; and no care, not even the frequent changing of the water, can keep them alive beyond twenty-four hours. They soon discolor the water, and their whole mass becomes soft and offensive. I have, however, observed a very singular phenomenon in a specimen which I had placed in fresh sea-water, after removing all the tentacles, the genital pouches, and the actinostome, and leaving only the gelatinous disk and the horizontal part of the lower floor. The specimen remained alive for many days; from which I infer that it is chiefly the most active parts of the body, hanging from the lower floor, which require the largest supply of fresh, aerated sea-water. A specimen which I had divided into halves, and a segment representing about one fourth of the whole disk, to which fragments of the lower floor remained attached, but from which all the tentacles, and the genital pouches, with the actinostome, had been removed, continued to live and contract and move about, in a large tub, during a fortnight. Such a persistence of life, in portions of the animal, contrasts strangely with the rapidity with which entire specimens decay and die in confinement, and can only be explained by the more delicate nature of the parts hanging from the lower floor, when compared to the tougher texture of the horizontal part of that floor, and the peculiar consistency of the disk.

SECTION IV

GROWTH OF CYANEA.

There must be something peculiar in the habits of the young Cyaneæ to render them, apparently, so rare, when, in the adult state, they are so common along our coast. I suppose that during the early stages of their existence they remain near the bottom of the water, as they are very seldom seen floating near the surface. During the many years I have been watching for our Acalephs, I have only on three occasions seen specimens measuring less than an inch in diameter; though, as stated in a former chapter, I have had ample opportunities of tracing some of the first stages of their development, in the egg and in the scyphostoma state. The youngest free Cyanea arctica seen along our shore was observed by my son in Buzzard's Bay; it measured about half an inch in diameter, and the outline of the disk was very similar to that of a common ephyra of Aurelia, as represented in Pl. XI^a. *Fig.* 28; but the actinostome was already very large in proportion to the diameter of the animal. Its four lobes hung like waving curtains, but were still quite distinct one from the other, their lobes being but imperfectly developed. When extended, they reached to twice the length of the diameter. The tentacular pouches were still comparatively small, and from each of their crescent-shaped folds hung only six tentacles, two of which were already very long, extending to double the length of the actinostome, or about four times the diameter of the disk. The other four were still very short, extending but slightly beyond the outlines of the disk. No trace of the sexual organs was yet visible, but the color of the disk was already similar to that of the adult, only lighter. In other species of the genus, which I had an opportunity of observing in a somewhat more advanced state, the tentacles appeared more numerous, though only a few had grown large: for instance, in specimens of Cyanea versicolor, of South Carolina, measuring an inch and a half in diameter, three tentacles appeared larger than all the others, and the genital pouches, though circumscribed between the pillars of the actinostome and the concentric folds of the lower floor, did not yet hang down as pendant pouches. In specimens of a third species, Cyanea fulva, from Long Island Sound, measuring already over two inches in diameter, the genital pouches were still stretched in the same plane as the lower floor, and, though the tentacles projecting from the broad pouches were already numerous, and began to appear in several rows, there were only four in each bunch which hung beyond the actinostome, as in the adult.

Incompletely as these facts represent the history of the growth of our Cyanea, they are already important in a systematic point of view, for they show how cautious naturalists should be in characterizing genera and species by the number and form of the appendages of the lower floor. On examining the many illustrations of similar animals, which have thus far been published, I find that Brandt, in describing the species observed by Mertens, of which he has given an account in the Memoirs of the Academy of Sciences in St. Petersburg, for the year 1838, characterizes as a distinct genus, under the name of Cyaneopsis, a small Medusa of this family, which I believe to be only the young of the species represented in the same work, under the name of Cyanea Postelsii. Mertens himself had considered it as a variety of that species. The close resemblance of this Medusa with specimens of Cyanea versicolor of about the same age, observed in Charleston, leaves no doubt in my mind that the genus Cyaneopsis is only founded upon the peculiarities exhibited by young specimens of Cyanea.

Though unable, upon a renewed examination of my notes, to verify the fact, I would, nevertheless, call attention to the circumstance, that in the drawings of the youngest Cyanea versicolor which I possess, the tentacles are represented as three in number in each lobe, the middle one being by far the largest; and so it is also in the Cyaneopsis Behringiana of Brandt, while in the youngest Cyanea arctica, observed by my son, there are two large tentacles to four small ones, in each bunch. In the youngest Cyanea fulva there are also three tentacles to each bunch, while in somewhat older ones, there are three in some bunches and four in some others. This seems to indicate an inequality in the mode of development; but whether it is individual or specific, I am unable to say.

We have already mentioned that the young Cyanea arctica resembles the adult in its coloration. The same is also the case with the Charleston species; its brilliant pink or rose-colored tentacles give it an appearance very different from that of the young of the other species, in which the tentacles are of the same tint as the disk. The rosy color of Cyanea versicolor is, however, limited to the lining of the cavity of the tentacles, the walls themselves being perfectly white and transparent. The upper surface of the disk is covered with hollow papillæ, of which those in the centre of the disk are the largest; near the margin they are more numerous and very minute, and seem most crowded in the direction of the radiating pouches.

The youngest specimen of Cyanea versicolor seen by me was found swimming near shore, in the channel along Sullivan's Island, in Charleston harbor, and was kept for some time in confinement. It often suspended itself, by the folds of the actinostome, to the sides of the glass vessel in which it was kept, and I am led to infer, from this circumstance, that this is a natural habit of the young Cyaneæ, which may explain their rare appearance near the surface. The youngest specimen of Cyanea arctica, observed by my son, was in the habit of remaining attached to the bottom of the jar in which he kept it alive for about ten days, hardly ever moving unless disturbed. We are so accustomed to consider Medusæ as animals floating in the water and basking near its surface, that the explanation here given of the rare occurrence of young Cyaneæ may appear questionable, and I would hardly have ventured to suggest it, had I not become acquainted with a kind of Medusa, in Florida, of which I shall give an account in another chapter, which is hardly ever seen at the surface of the water, at any time, even when adult, but found by thousands, groping in the mud and hardly moving, crowded upon one another, like barnacles upon rocks.

Though it does not exhibit such marked changes as those noticed among the tentacles, it is interesting to see how the actinostome is gradually modified during its growth. In the young, the four corners of the mouth are prolonged as four independent, distinct, arm-like appendages, similar to those of Pelagia or Chrysaora, the middle part of which is evidently much thicker than the margins; but with advancing age, the sides of each arm widen, and assume the curtain-like appearance characteristic of the adult. The degree of enlargement of these pendant curtains varies in different species, as well as with age. They are most expanded, and exhibit the largest number of folds in Cyanea arctica, and least so in Cyanea versicolor, while C. fulva stands intermediate between the two, in that respect. These changes of the actinostome not only show the close homology between the so-called arms of the Aurelia and the pendant curtains of the Cyanea, but also the relative standing of the different genera of Discophoræ which are most nearly allied to Cyanea. For it is plain that Pelagia and Chrysaora, in which the actinostome retains, through life, the structure it has in the young Cyanea, must be inferior to Cyanea itself, and the changes which the horizontal part of the lower floor undergoes, confirm this inference. In the youngest Cyanea observed thus far, the pouches, radiating from the central cavity towards the periphery, were defined merely by the attachment of the lower floor to the upper floor, along the long and short junctions; but no traces of concentric or radiating folds were observed. When, however, these folds make their appearance, they are comparatively few, occupying narrow bands, which go on widening and enlarging with age, and with their development the number of tentacles increases regularly. In these features, again, we find an agreement between the young Cyanea and the genera Pelagia and Chrysaora, and also a coincidence with the genera of the family of Cyaneidæ proper, which rank below Cyanea, such as Stenoptycha.

In a morphological point of view, the changes of the ocular lobes are also highly instructive. In the young Cyanea, they resemble very much the oculiferous lobes of Aurelia, as represented in Pl. XI^a. *Figs.* 19, 25, 26, and 28, *h h,* and Pl. XI^b. *Figs.* 4 and 17; and the resemblance is greater, in proportion as they are younger. The eye is truly a tentacle-like prolongation of its radiating pouch (Pl. IV *Fig.* 1, *o o,* and Pl. V^a *Fig.* 8, *o*), which is alike in the adult and the young, except that in the young the peduncle of the eye is flanked by two simple lappets, as in the young Aurelia, while in the adult the lappets have become complicated lobes, with ramified channels, branching from the main pouch, with two horns toward the margin. The lappets of the oculiferous lobe of the young, with the intervening eye upon its peduncle, have, in reality, become the complicated termination of the ambulacral pouches and of the main ovarian pouch (Pl. IV. *Fig.* 1, $o\ o'\ o''\ o'''$), their medial emargination corresponding to the space intervening between the two lappets in the young, at the base of which projects the eye, with its peduncle, as seen Pl. IV. *Fig.* 3, *a b c.* The lappets themselves have become hollow lobes, as is seen to particular advantage in Pl. V^a. *Fig.* 24, *o′*, and *Fig.* 23, *o o,* the main cavity of each lappet sends off dendroid ramifications to the margins of the lobes. In proportion as the Cyanea grows older, these ramifications become more and more complicated, and extend even upon the sides of the slit separating the two lappets, as seen in Pl. V^a *Fig.* 23, *o,* and *Fig.* 7, *o,* in which *c* indicates the eye, with its peduncle. The same is highly magnified in *Fig.* 8, in which *o′* marks the main cavity of the ocular chamber, and *o* the eye itself. Like a tentacle, this organ is capable of a certain extension and contraction; in *Fig.* 8, Pl. V^a., it is represented in its utmost state of contraction, in *Fig.* 3, Pl. IV., it is shown in its utmost state of elongation, as seen from below.

SECTION V

HISTOLOGY OF CYANEA.

Little has been done, thus far, towards an histological investigation of Cyanea, and a thorough survey of all its parts would, no doubt, lead to interesting results, judging from those which have already been examined. The curtain of the actinostome especially presents interesting points; the folds of the flowing curtains, when elongating and shortening, present, alternately, prominent longitudinal and transverse lines, which are undoubtedly the result of the change of their tissue; for when inactive they are smooth. The longitudinal lines between the folds are particularly distinct in the state of utmost relaxation, when the elongated cells, hanging in bundles, in a vertical direction, between the folds, are most clearly visible, and upon their contraction transverse wrinkles appear between them. The outer surface of the actinostome exhibits mainly epithelial cells, of a very uniform appearance, between which are scattered a few lasso-cells; but on the inner surface of the whole actinostome a different arrangement prevails, there being innumerable clusters of lasso-cells scattered over the whole of that surface, and especially crowded towards the margin of the lobes (Pl. IV *Fig.* 4). *Fig.* 4, *a*, represents such a cluster, magnified 250 times in diameter. The form of these lasso-cells is peculiar; they are more globular than is generally the case among Acalephs, and, in that respect, resemble the lasso-cells of Physalia very closely, and when the coil is everted, the neck, which connects the thread with the bag in which it was coiled up, is smooth, and entirely destitute of those hook-like projections which are characteristic of the lasso-cells of the Hydroids. The whole margin of the lobes or fringes of the actinostome is entirely occupied by a narrow seam of smaller lasso-cells, as seen in Pl. V. *Fig.* 3, which represents a band along the inner surface of one of these lobes, extending from its margin towards the interior, up to a distance, where the clusters of lasso-cells are less crowded. Following, in the same direction, the arrangement of these cells upon that surface, it is seen, that above the narrow band which is entirely occupied by lasso-cells, the epithelial cells intervening between the clusters of lasso-cells are smallest, and become gradually larger higher up, until, increasing in size, in proportion as the clusters of lasso-cells are fewer, they have become singly, almost as large as a cluster of lasso-cells. *Fig.* 3, *d*, represents the small lasso-cells of the margin, more highly magnified; *Fig.* 3, *c*, represents a portion of the surface immediately above, where the epithelial cells are smallest; *Fig.* 3, *b*, a space higher up, where larger lasso-cells intervene between the smaller ones, and *Fig.* 3, *a*, a space higher up, where the larger epithelial cells cover the whole surface, with a few scattered small ones between. This arrangement, and the prevalence of clusters of lasso-cells on the inner surface, is probably intended to facilitate the introduction of the food along the complicated system of folds of the actinostome up to the oral aperture, and probably, also, to retain the eggs between these folds, at the time of spawning, and to prevent them from dropping into the water, at a time when the embryos are not yet so far developed as to be capable of swimming freely about, before attaching themselves to the surfaces upon which they undergo their further development.

The tentacles present a still greater diversity, both in the arrangement and in the appearance of their cells. The hollow channel which traverses the tentacles, for their whole length, is uniformly lined with exceedingly minute epithelial cells, as represented in Pl. V *Figs.* 11 and 12. These cells vary in color, being yellow, orange, purple, or brown, in different tentacles, and they chiefly determine the color of these organs, for the walls of the tube consist of a transparent gelatinous mass, as shown in *Fig.* 4, while the surface, again, is covered with cells varying in size and arrangement, and assuming different appearances in the various states of contraction of the tentacles themselves. Where the lasso-cells are scattered uniformly over the whole surface, as in *Fig.* 9, the tentacles appear more even, but where they are grouped in clusters, as in *Figs.* 7, 8, and 10, their surface is already more uneven, and in a state of contraction these clusters are more or less raised, like tubercles, as in *Fig.* 8, and at times many project like warts attached to an otherwise smooth surface (*Fig.* 5). This appearance, however, is presented only in a state of utmost contraction of the tentacles, when the more elongated epithelial cells, which define the areas occupied by clusters of lasso-cells, as seen in *Fig.* 6, are contracted in the form of prominent ridges, as in *Fig.* 5.

It has already been stated, when describing the young Cyanea versicolor, that the surface of its disk is covered with hollow papillæ; but what becomes of these in course of time, has not been ascertained. The outer surface of the lobes of the actinostome is also covered with similar, but very minute papillæ, in the young; but nothing of the kind has been noticed in the adult.

SECTION VI.

CYANEIDÆ AS A FAMILY.

The form of the Cyaneidæ is so characteristic, that there is no difficulty in distinguishing it from that of other Discophoræ. The sudden reduction of the thickness of the gelatinous disk towards its margin, in connection with the width of the radiating pouches, which extend from the main cavity to the margin of that disk, and the manner in which the narrow pouches terminate in small lobes, while the broad pouches, alternating with them, terminate in broad lobes, combined with the ramifications of these pouches into branching sacs, extending to the very margin of the lobe, give these Medusæ an appearance quite peculiar. The position of the eyes at a considerable distance from the margin, and the circumstance that the tentacles hang from the lower side of the disk, at a still greater distance from the disk, contributes further to distinguish this family from all other Medusæ. If to these characters we add the prominent concentric and radiating folds of the lower floor, the large, pendant genital pouches, and the extraordinary development of the actinostome, we have a combination of characters not found in any other Discophoræ, and which justly entitle these Acalephs to be considered as a distinct family. They differ from the Aurelidæ, not only by the presence of their wide radiating pouches, while in Aurelidæ we have branching chymiferous tubes, but also in the sudden thinning of the margin of the disk, which diminishes very gradually in thickness in Aurelidæ. The consequence of this is, that while in Aurelidæ the disk always expands and contracts uniformly in every direction, in Cyaneidæ there is much greater independence in the movements of different segments of the body; some lobes of the umbrella may even be moved separately from the others, no doubt owing to the independent action of the different bundles of the radiating folds of the lower floor. Another result of this peculiar structure is, that the centre of the disk of the Cyaneidæ may sink, while the margin is raised, and the whole body assume the form of a broad funnel.

The Sthenonidæ resemble the Cyaneidæ already more than the Aurelidæ, owing to the great development of their tentacles, and to the fact that their genital pouches hang below the surface of the lower floor. But in this family we have, as in Aurelidæ, branching chymiferous tubes, instead of radiating pouches, and the indentations of the margin retain the lobulate character of the young; while the actinostome varies as in Cyaneidæ, the arms being more distinct in some genera, and assuming the appearance of flowing curtains in others.

Of all the Discophoræ, it is to the family of Pelagidæ that the Cyaneidæ bear the greatest resemblance; but I do not believe that I have exaggerated the importance of their difference in considering them as distinct. It is true, in Pelagidæ the main cavity extends to the periphery in the shape of radiating pouches, as in Cyaneidæ; but in the Pelagidæ these pouches are more uniform, their terminal lobes less diversified, and the tentacles arise between the lobes of the margin and not from the lower floor. Again, owing to the greater equality among the pouches, the gelatinous disk thins more uniformly towards the margin, and on that account the disk assumes a more hemispheric shape in its contraction and expansion. The genital pouches, also, do not protrude like pendant sacs from the lower side, and the actinostome, forming a kind of tube before dividing, projects downward, and then splits into four distinct, long, waving arms, with thin margins.

SECTION VII.

THE GENUS CYANEA COMPARED WITH OTHER GENERA.

Notwithstanding the fulness of the description of Cyanea arctica which has been presented in preceding sections, I deem it important to call attention once more to those peculiarities of structure of that Acaleph, which, in my estimation, constitute its generic characteristics. For, unless attempts are made to analyze the meaning of the facts observed, zoölogy will forever retain a purely descriptive character, and never assume the true dignity of science. That the Cyaneidæ constitute a distinct family has already been shown, and yet, unless the genus Cyanea is carefully contrasted with certain genera of other families, it may not always be easy to distinguish it from them. A Phacellophora, for instance, floating in the water, must have a very striking resemblance to a Cyanea, judging from the figures of Mertens published by Brandt. For in that genus the actinostome is very large, the genital pouches form pendant sacs, of considerable size, and the tentacles, of large dimensions, are grouped in bunches on a crescent-shaped base of insertion, at some distance from the margin, and must, therefore, present an aspect quite similar to that of our Cyanea. But as soon as we consider the relations of their structure to their form, we find the greatest difference between them. In the first place, the chymiferous cavities, which radiate from the main central cavity, are broad pouches in Cyanea, terminating in rounded lobes at the margin. In Phacellophora they consist of numerous radiating tubes, ramifying towards the margin, in a manner similar to, and yet distinct from, Aurelia; for here the simple tubes are those which correspond to the bunches of tentacles, and the branching tubes those which terminate in the intervening lobes of the margin of the disk, while in Aurelia it is the reverse. Moreover, there are, in Phacellophora, four bunches of tentacles in each interambulacrum; namely, two bunches on each side of the chymiferous tubes, radiating from the middle of the genital pouches, while in Cyanea there is only one bunch on each side of the genital pouches. The total number of the large bunches of tentacles is, therefore, sixteen in Phacellophoræ, beyond which projects a rounded lobe of the margin of the disk. There are, further, sixteen three-leaved lobes, alternating with the tentacular lobes; four in the prolongation of the corners of the mouth; four in the prolongation of the middle of the genital pouches, and eight corresponding to the angles of the genital pouches. Whether all these have eyes, or only those in the prolongation of the angles of the mouth and of the genital pouches, cannot be ascertained from the figures of Mertens.

The genus Heccædecoma, which belongs to the same family as Phacellophora, has, in some respects, a still greater general resemblance to Cyanea, and is considered by Brandt simply as a sub-genus of Cyanea; and yet I am satisfied that it does not even belong to the same family, for, like Phacellophora and Sthenonia, it has branching chymiferous tubes, extending from the main cavity to the margin of the disk, instead of pouches as Cyanea has; but it approximates Cyanea more by the structure of its actinostome, which consists of four thin, flowing curtains. The margin of the disk is also very differently scalloped, consisting of sixteen lobes, each of which has four rounded lobules. In the deeper indentations which separate the sixteen lobes, there are sixteen eyes, a circumstance which leads me to suppose that Phacellophora also has the same number of eyes. Morphologically, the tentacles, which are very large, are arranged in sixteen bunches; but as their insertion follows the regular curve of the circular chymiferous tube, and does not form a crescent, as in Phacellophora, and as the lappets of the eyes are not separated from the tentacle-bearing lobes, the tentacles seem to form a continuous row along the whole margin, as in Aurelia, instead of assuming the appearance of bunches, as in Phacellophora.

The affinity of Cyanea with the genus Sthenonia is more remote, even though the indentations of the margin of the disk be more similar to those of Cyanea than those of the genera Phacellophora and Heccædecoma; for in Sthenonia, the actinostome consists of four diminutive arms, and the resemblance between the two genera results only from the arrangement of the long slender tentacles, hanging in eight bunches from the lower side of the disk, in the intervals between the oculiferous lobes. The evidence that neither Sthenonia, nor Phacellophora, nor Heccædecoma, can be associated in the same family with Cyanea, appears to me chiefly to rest upon the fact, that while in Cyanea the bunches of tentacles correspond to the deepest indentation in the margin of the disk, in the above-named genera, which I refer to a distinct family, the Sthenonidæ, they correspond to prominent lobes of the margin, and are separated from the lobules of the eyes by deep indentations; and as these outlines are determined by the mode of ramification of the chymiferous system, they must be considered as family characters.

The true characters of the genus Cyanea consist in the deep indentations of the margin, in the radial prolongation of the bunches of tentacles, and in the greater width of the lobes of the margin corresponding to the tentacular pouches, while those of the ocular pouches are small and more closely united with the broad lobes than with each other. The crescent-shaped insertion of the bunches of tentacles, arranged in several rows, the largest of which are on the inside, and the smaller outside, is another generic peculiarity. The division of the concentric lobes into alternately broader and narrower contiguous areas, appears also generic, as well as the division of the radiating folds into a shorter and a longer band.

The other genera which I refer to the family of Cyaneidæ are Stenoptycha *Ag.*, based on the Cyanea rosea *Q.* and *G.*, Couthouyia *Ag.*, Medora *Couth.*, Patera *Less.*, and Donacostoma *Ag.* The genus Stenoptycha is unquestionably a member of the family of Cyaneidæ, as the concentric and radiating folds of its lower floor show; but in this genus the band of concentric folds is very narrow, and the radiating folds alternate with the concentric folds. The tentacles are few, and arranged in a single row. This genus has some affinities to Chrysaora, from which it is, however, readily distinguished by the circumstance that the tentacles arise from the lower floor, and not between the marginal lobes, as is the case in Chrysaora.

The genus Couthouyia, named Nerinea by Mr. Couthouy, and handsomely illustrated by him, in unpublished drawings, made during the U. S. Exploring Expedition, under the command of Capt. Charles Wilkes, is closely allied to Cyanea by its sixteen broad radiating pouches and eight large bunches of tentacles; but it differs in having four distinct, long, pendant arms, like Chrysaora, and in having the tentacles arranged in a single row, as in Sthenonia. The indentations of the margin are also peculiar, and recall, in a measure, those of Phacellophora more than those of Cyanea, the eight bunches of tentacles corresponding to eight prominent marginal lobes, instead of fronting deep indentations, and the ocular lobes being quite distinct from the tentacular lobes; but the essential character in Couthouyia consists, as in Cyanea, in the presence of sixteen large radiating pouches, the only distinction between the two genera, in this respect, consisting in the great inequality of the eight ocular and the eight tentacular pouches in Cyanea, while in Couthouyia they are nearly equal. The genital pouches of Couthouyia are not so extensive as in Cyanea. Only one species of this genus is known, from Orange Harbor, Cape Horn, for which I propose the name of C. pendula, on account of the extraordinary length of the arms. The name Nerina being preoccupied, I have substituted for it that of the discoverer of the species.

The unpublished genus Medora of Couthouy, which I know from drawings made under the same circumstances as those of the preceding genus, is closely allied to Couthouyia, but differs, however, in having the margin of the tentacular pouches divided into two broad lobes, like Cyanea, with only one tentacle between them, and one on each side of them. There are representations of two species among the drawings of the U. S. Exploring Expedition, one from Orange Harbor, called Medora reticulata by Mr. Couthouy, the other from the Pacific Ocean, in sight of Cape Horn, called M. capensis by the same naturalist. All these drawings are shortly to be published.

The position of the genus Patera, of Lesson, in this family, remains doubtful, Lesson having made no mention of the genital pouches in his description, and his plate furnishing no information to supply the deficiency. The extraordinary development of the actinostome, and the lobation of the margin of the disk, suggest, however, a close affinity with Cyanea; but the oral appendages form a convolute mass of meandering folds instead of light-flowing curtains, and their main branches terminate in a pinnate lobe. The arrangement of the tentacles is similar to that of Stenoptycha, but there are twice as many.

The genus Donacostoma has sixteen bunches of tentacles, like Patera, arranged in a single row in each lobe, and as there are only eight eyes, there are, respectively, two bunches in the intervals between two eyes. The genital pouches are so large that they conceal nearly the whole actinostome, with the exception of its central peduncle, which projects like a siphon, at the extremity of which are a number of slender tentacles.

Pelagia proper has no other affinity with Cyanea, except the pouch-like arrangement of the radial prolongations of the chymiferous system; but among the species thus far referred to Chrysaora there are those, the actinostome of which is so largely developed, that it bears a close resemblance to the flowing curtains of the genus Cyanea. The tentacles, also, are sometimes so numerous and so long, that they assume the appearance of those of certain Cyaneidæ, but their mode of insertion is always different. In all the members of the family of the Pelagidæ, whether true Pelagia or Chrysaora, or the different genera which it is necessary to distinguish from Chrysaora, they invariably arise from the indentations separating the lobes of the margin of the disk, and not from the lower surface of the lower floor, as in the Cyaneidæ.

SECTION VIII.

THE SPECIES OF CYANEA COMPARED WITH ONE ANOTHER.

Though I have had opportunities of examining three species of the genus Cyanea alive, in their natural element, and of studying them carefully, I have never had an opportunity of comparing them, side by side, with one another, as the period of their appearance along our coast occurs in different seasons of the year. Cyanea arctica begins to show itself in numbers towards the end of the summer, Cyanea fulva in midsummer, and Cyanea versicolor in the spring. Moreover, Cyanea arctica is common north of Cape Cod, and eastward along the coast of Maine, New Brunswick, Nova Scotia, and further northwards; while Cyanea fulva extends south of Cape Cod, and is most common in Long Island Sound, and Cyanea versicolor on the coast of South Carolina. These species are readily distinguished from one another by their color. The disk of C. arctica is of a bright purplish red, deeper over the space occupied by the central cavity and along the margin of the wide tentacular pouches, while the margin is of a whitish color, with a light tinge of grayish blue. The genital pouches are yellowish, especially bright along the edges of their folds. The tentacles vary in color, from yellow orange to reddish brown and deep purple. The flowing curtains are of a chocolate-brown color. Cyanea fulva has a general tinge of cinnamon color, darker about the centre of the main cavity, and much lighter along the margin of the disk, though this is never so transparent as in Cyanea arctica. The flowing curtains are the darkest part of the whole animal. In Cyanea versicolor the whole disk is of a bluish milky white, with a purplish tint spread over the chymiferous cavity. The genital pouches are rose color, the flowing curtains light brown, and the tentacles pink. There are, also, some differences in the proportions of the parts: the flowing curtains are by far the largest in Cyanea arctica, and the tentacles most numerous, and the marginal indentations less deep. In Cyanea fulva the lobes of the margin are more rounded, and also deeper, and in Cyanea versicolor rather truncate. There is, however, a great difference in the aspect of the margin, according to its state of contraction. When fully expanded, the ocular lobes are slightly prominent, and the tentacular lobes very broad; in a state of contraction, however, the tentacular lobes are so folded in, that the ocular lobes become most prominent, and the whole outline of the disk has somewhat the form of an octagonal bastion, the prominent angles of which are formed by the ocular lobes. Another difference occurs in the extent of the concentric and radiating folds; the areas of the concentric folds are comparatively broadest, and the radiating folds shortest, in C. fulva; the radiating folds are largest and narrowest, and the concentric folds narrowest, in Cyanea versicolor; and in Cyanea arctica they occupy an intermediate position. The flowing curtains are not only widest in Cyanea arctica, but they lose almost entirely the appearance of arms; while in Cyanea versicolor they are smallest, comparatively, and retain, in a measure, the character of four wide, pendant arms. In Cyanea fulva they are remarkably thin and deciduous. Similar differences seem to distinguish the species noticed by other writers. Cyanea Postelsii, which has been considered, by Dr. Gould, as identical with our Cyanea arctica, differs, however, from it by the deeper indentations of the margin of the disk, and by its color, which seems uniformly bright cinnamon, the tentacles only being paler, and the margin of the disk light blue. Of the two European species, the Cyanea capillata, which is also the more northern, resembles more nearly our C. arctica, while the C. Lamarkii comes nearer to our C. versicolor, at least in the hue of its disk; but its tentacles, its actinostome, and the genital pouches seem to share the color of the umbrella, judging from the figures of Dalyell, while in our species they are widely different. The figures published by Gaede of the true Cyanea capillata give it a more brownish color than that of our Cyanea arctica; but it will require more accurate figures and descriptions of these animals than have been published thus far, before their specific characters can be distinctly brought out. I am unable to ascertain whether Cyanea Postelsii of Brandt truly differs from Cyanea ferruginea of Eschscholtz.

CHAPTER FOURTH

THE GENUS PELAGIA AND ALLIED GENERA.

SECTION I

THE FAMILY OF PELAGIDÆ.

THE genus Pelagia, as defined by Péron and LeSueur, embraces species which, in my estimation, belong, unquestionably, to different genera, if the differences noticed between the other genera allied to Pelagia, thus far admitted by naturalists, afford any standard of appreciation of generic differences. Be this, however, as it may, Pelagia and Chrysaora constitute a natural family, first recognized by Gegenbaur, and characterized by him, in the "Zeitschrift für wissenschaftliche Zoologie," Vol. 8, p. 210, as distinguished from the other families of Acraspeda, by the pouch-like appendages of the stomach or main cavity, to which he adds the more or less bulging form of the disk and the oral appendages, varying from the simplest form to that of four-lobed arms. Correctly as the family is circumscribed here, the characters assigned to it are insufficient to distinguish it from the Cyaneidæ, in which there are also radiating pouches, and in which the other structural characters vary in the manner ascribed by Gegenbaur to Pelagidæ. It is my opinion that the essential structural characteristics of the Pelagidæ, in their adult condition, consist in a combination of spheromeres peculiar to them, there being four ambulacral pouches in the prolongation of the four corners of the mouth, between the marginal indentations of which there is an eye, and four interambulacra, each one of which consists of three pouches, similar in dimensions to those of the ambulacra; the central one of these pouches has an eye, in the indentation between its lobes, while the other two have single tentacles, or sets of tentacles, variously combined. The genital organs consist each of three lobes, the middle of which (Pl. XII. *Fig.* 2, *b b*) is in the radial prolongation of the middle interambulacral pouch, while the two others extend to the pillars of the actinostome. The structure of these genital pouches is well represented in Wagner's Icones Zootomicæ, Pl. XXXIII. *Fig.* 6, but their relations to the tentacles are incorrectly drawn, the tentacles standing in the radial prolongation of the interval between the main lobe and the lateral lobes of each genital sac. The difference between Pelagidæ and Cyaneidæ consists in this: that in Pelagidæ the tentacles are in the indentations of the interambulacral lobes, which alternate with ocular lobes; while in Cyaneidæ they are inserted upon the lower surface of homologous lobes. These tentacular lobes are by far the most developed in the Cyaneidæ, while in Pelagidæ they have about the same dimensions as the ocular lobes. The family may, therefore, be characterized thus: four ambulacral pouches with one eye in the indentations between its marginal lobes, alternating with four interambulacra, each of which consist of a medial or genital pouch with one eye between its marginal lobes, and two tentacular pouches, alternating with the ambulacral pouches and the genital pouches. The radiating pouches of the Pelagidæ always terminate in simple marginal sacs, without dentritic ramifications, while in all the Cyaneidæ which have been carefully examined, they branch again and again, forming the most elegant marginal ramifications. The genital pouches remain suspended within the main cavity of the body, and do not form pendant and flowing sacs, as in the Cyaneidæ.

From what I know of the mode of development of the Pelagidæ, it differs essentially from that of the Cyaneidæ; for in Pelagidæ the young, hatched from the egg, passes directly into the ephyra form (Pl. XII. *Figs.* 4, 5, 6, 7, 8, 9, 10, 11, 12), while in Cyaneidæ it passes into the scyphostoma and strobila condition before the ephyræ are developed. It follows, therefore, from the observations which I have made upon Pelagia Cyanella, that each egg produces only one Pelagia, while it has long been known that in Cyanea and Aurelia each egg, being transformed into a strobila, produces as many individuals as there are ephyræ freeing themselves from the strobila.

Besides Pelagia and Chrysaora, Gegenbaur also refers the genus Nausithöe to the family of Pelagidæ. I am, however, strongly inclined to consider this genus as based upon young Pelagiæ, representing a stage immediately following that which I have represented in Pl. XII. *Fig.* 12, of the third volume of this work, in which the tentacles are not yet developed, though the tentacular pouches (*Fig.* 12 *a*), which alternate with the ocular pouches (*b*), just begin to be formed. Should Nausithöe prove to be an adult animal, it would have to be considered as a distinct family, inasmuch as it has no tentacular lobes, while all Pelagidæ have eight, alternating with eight ocular lobes. But a comparison between my figures (Pl. XII. *Figs.* 3 and 12) readily shows, that while the young has eight ocular lobes, each with two lappets, the adult has double that number of lappets, though the number of lobes remains the same, the tentacular lappets being united with the ocular lappets. The lobes of the adult are, therefore, only partially homologous to the lobes of the young, each lobe being increased, in course of time, by the addition of a lappet from the intervening tentacular lobe. It is true Gegenbaur states that the specimens he has observed had already ovaries and spermaries, with eggs and spermatic cells, but it should not be forgotten that in Aurelia the genital organs are already beginning to be developed before the tentacles make their appearance (Pl. XI^b *Fig.* 4). There is, therefore, nothing extraordinary in finding, as Gegenbaur has observed, from nine to twelve eggs in one ovary; and far from satisfying me that this is an evidence of maturity, I would rather infer from the small number of these eggs, that the Medusæ called Nausithöe are young animals, since in all mature Discophoræ thus far known, the number of eggs is always enormously large. There is, further, something in the figure of Nausithöe published by Gegenbaur, in Carus' Icones Zootomicæ, Pl. II. *Fig.* 17, which excites my distrust, and to which I take the liberty of calling his attention. In all the Discophoræ which I have examined, the angles of the mouth are in the radial prolongation of eyes, and the genital organs alternate with them. In the figure just quoted, on the contrary, the angles of the mouth alternate with ocular pouches, and there are four genital organs in the radial prolongation of the angles of the mouth, while four others alternate with them. Should this be true to nature, it would be contrary to every thing which I have thus far observed in the symmetrical arrangement of the parts in Discophoræ. I am, therefore, inclined to believe that the cross formed by the angle of the mouth has been incorrectly drawn in the figure of Gegenbaur, and that it should be turned so that the angles of the mouth should be brought in the radial prolongation of four of the eyes, and alternate with the ovaries. This change in the figure would bring other parts into natural relations which I also believe to be incorrectly represented here. The digitate appendages, *x* (Pl. II. *Fig.* 17, of Carus' Icones), which, as I have shown in the description of Aurelia, belong to the sexual system, do not appear here to be at all connected with the ovaries, for one set of the ovarian sacs is represented in the radial prolongation of the angles of the mouth, while the other set stands in a somewhat asymmetrical relation to these digitate appendages. But if the corners of the mouth were brought into the position I have alluded to above, each of the bundles of the digitate appendages (*x*) would at once assume symmetrical relations to two ovarian sacs, and if we now go one step further, and compare the figure so altered with either *Fig.* 2, Pl. XII. of my third volume, or Pl. XXXIII. *Fig.* 6 of Wagner's Icones, it will appear that the eight genital sacs of Nausithöe, as figured by Gegenbaur, are homologous to the lobes of the genital pouches, which, in Pelagia, extend towards the peduncles of the actinostome, and, if my supposition that Nausithöe is a young Pelagia is correct, the middle lobe of the genital pouches (*b b*), of my *Fig.* 2, are not yet developed.

I have ventured to introduce here these remarks, which may seem irrelevant, in consequence of the deep conviction which has gradually grown up in my mind, that there is a uniformity of plan among Acalephs far more strongly impressed upon all their various types than could be inferred from the manner in which they have been described, or from the manner in which they are represented. I venture to make this case a test of the validity of this conviction, even though I have, in so doing, to question the accuracy of so sagacious an observer as Gegenbaur.

SECTION II.

THE GENERA OF PELAGIDÆ.

Thus far the genera admitted among the Pelagidæ have been distinguished by the number of their tentacles, Pelagia proper containing those with eight tentacles, Dodecabostrycha those with twelve, Heccædecabostrycha those with eighteen, and Polybostrycha those with twenty-four or more tentacles. As characterized by Péron and LeSueur, the genus Chrysaora is very indefinite, as he simply assigns to it a peduncle perforated in the centre, entirely distinct arms, which do not branch, and a large central cavity. Eschscholtz has characterized it more precisely, by showing its affinity with Pelagia, as founded upon the pouch-like appendages of the main cavity and the insertion of the tentacles, which are more numerous. On this last account, however, Eschscholtz, who considers the number of tentacles as of trifling importance, is inclined to regard Chrysaora as hardly generically distinct from Pelagia; but if, instead of considering only the number of these appendages, we take into account their connection with the lobes of the margin, it will be at once apparent, not only that Chrysaora, as defined by Eschscholtz in imitation of Péron and LeSueur, is a distinct genus, but that it embraces, like Pelagia, several distinct generic types.

Pelagia proper embraces all those species thus far referred to the genus, which, like Pelagia noctiluca, cyanella, and panopyra, have sixteen equally developed pouches, each of which branches off into two distinct sacs near the margin, and are there so combined that the marginal lobes embrace one sac of two adjoining pouches, and that in the indentations dividing these lobes there are, alternately, one eye and one tentacle, the whole margin being divided into sixteen lobes, with eight eyes and eight tentacles between them. The best figures representing these generic characters, may be found in Eschscholtz's Acalephs, Pl. VI. *Fig.* 2, *a*, in Milne-Edwards' (Cuvier's Animal Kingdom) Zoophytes, Pl. XLV., and in Brandt's description of the Medusæ observed by Mertens, Pl. XIV A, *Fig.* 5. The figure in Wagner's Icones (Pl. XXXIII. *Fig.* 5), though correct, has the tentacles partly so turned out of their natural position that their symmetry is not very obvious.

PLACOÏS *Ag.* In this genus, the type of which is Pelagia discoidea *Esch.*, each marginal sac of the radiating pouches forms a small shallow lobe by itself, the sacs being only short lateral prolongations of the pouches themselves; and in consequence of this arrangement the eyes and tentacles are nearer the margin than in Pelagia proper. There are thus thirty-two small lobes, between two and two of which alternate eight eyes and eight tentacles. The radiating pouches are much shorter than in Pelagia proper, owing to the very extensive dimensions of the central cavity. The disk is flat and spreading, while in Pelagia proper it is hemispherical. See Eschscholtz's Acalephs, Pl. VII. *Fig.* 1.

CHRYSAORA *Pér.* and *LeS.* Type, Medusa hysoscella *Lin.* In this, as in the preceding genus, the alternating ocular and tentacular pouches form separate lobes, instead of being soldered two and two together, as in Pelagia, in consequence of which the margin has thirty-two indentations; but Chrysaora differs from Pelagia in this, that instead of a single tentacle in the middle, between the two lobes of the tentacular pouches, it has also one tentacle in the indentation which separates the tentacular and the ocular pouches; while in Placoïs there are none. The genus Chrysaora may, therefore, be characterized thus: ocular pouches bilobed, with an eye between the two lobes; tentacular pouches bilobed, with a tentacle between the two lobes and another on each side of them. The consequence of this arrangement is, that Chrysaora proper has twenty-four tentacles, arranged in groups of three, alternating with eight eyes. See Eschscholtz' Acalephs, Pl. VII. *Fig.* 2, and Milne-Edwards' Cuvier's Animal Kingdom, Zoophytes, Pl. XLVII. Though somewhat wider, the tentacular pouches have exactly the same structure as the ocular pouches. With reference to their homologies, the Medusæ of this genus consist of four ambulacral pouches with one eye between their two marginal lobes, and four interambulacra, consisting each of one genital pouch with an eye between its two marginal lobes and two tentacular pouches, with three tentacles in each, one between, and two on the sides of its marginal lobes.

DACTYLOMETRA *Ag.* In this genus, the tentacular pouches are not only much broader than the ocular pouches, but their marginal sacs present also a different combination. In the ocular pouches they end in two sacs forming two distinct lobes, between which are situated the eyes; but in the tentacular pouches each of the two sacs forms two lobes, and there is a longer tentacle between the two sacs and another, of a similar length, between them and the ocular lobes, and one short tentacle between the two small lobes of each sac, so that each tentacular pouch sustains five tentacles, three of which are long and two short. The margin of the disk is, therefore, divided into forty-eight lobes, sixteen of which are ocular lobes and thirty-two tentacular lobes, two and two of which are separated by a short tentacle, while there is one large tentacle between the two pairs and another outside of each pair, so that the total number of tentacles, large and small, is forty. As in Placoïs, the central cavity is very wide, and the radiating pouches comparatively short. The disk is flatter than that of Pelagia proper. The type of this genus is Chrysaora lactea *Esch.* (Acalephs, Pl. VII. *Fig.* 3), to which must be added the Pelagia quinquecirra *Des.*

POLYBOSTRYCHA *Brandt.* The general aspect of Chrysaora helvola *Br.*, which I consider as the type of this genus, is so similar to that of the genus Chrysaora proper, that it may well be questioned whether they do not belong to one and the same natural group. In both there are eight tentacular pouches, terminating in two marginal sacs, and forming two distinct marginal lobes, separated by a deep indentation in which there is an eye; and eight tentacular pouches with two distinct lobes, between which and on the sides of which hang the three tentacles characteristic of the tentacular pouches of Chrysaora. However, a closer comparison at once shows differences which are unquestionably structural differences, and therefore indicate different genera. In the first place, instead of being similar to one another, there is a marked difference in the outline of the ocular and tentacular pouches. The ocular pouches are widest midway, and narrowest towards the central cavity, and again narrower near the margin; while the tentacular pouches are widest near the margin, and branch off into four sacs, the middle ones forming the tentacular lobes, between which projects one tentacle, while the other two tentacles start from the lateral sacs near the ocular lobes. See the figure of Mertens', in the paper quoted above, Pl. XV. *Fig.* 4. To this genus Brandt also refers the Chrysaora melanaster, represented in the same paper, Pls. XVI. and XVII.; this species shows, however, another combination of characters which I consider as generic, and for it I propose the following name:

MELANASTER *Ag.* Ocular pouches terminating in two distinct sacs, forming broad, distinct lobes, separated by deep-rounded indentations; tentacular pouches terminating also in two distinct sacs, forming broad, distinct lobes, between and on the sides of which there are three tentacles, as in Chrysaora and Polybostrycha. But here the tentacular and ocular pouches are similar in structure, as in Chrysaora, and not alternately broader, near the margin and near the main cavity, as in Polybostrycha; they differ, however, from Chrysaora in the great development of these marginal lobes, and in the presence of an auxiliary small lobe between the ocular and the tentacular pouches. The total number of lobes is forty-eight, thirty-two of which are large, and sixteen small. In that respect, this genus resembles Dactylometra, but it differs from it in having only three tentacles to each tentacular lobe, which, considering the homologies of the structure of these segments of the body, do not correspond to the three large tentacles of Dactylometra, but to the middle large tentacles and the two small ones, combined with a great development of the two middle lobes, while the lateral ones are almost rudimentary. From the figure of Mertens', it would appear that the small marginal lobes belong to the ocular, and not to the tentacular pouches. If this is truly the case, this constitutes an additional reason for separating generically Chrysaora melanaster from Chrysaora helvola, as in that case the marginal structure of the radiating pouches would be reversed in the two genera; the tentacular pouches branching into four sacs in Polybostrycha, while there are only two in the ocular pouches; and four sacs in the ocular pouches of Melanaster, two of which are large and two small, and only two in the tentacular pouches. The two last genera are thus far only known from the Pacific Ocean, Polybostrycha helvola between Sitka and the Aleutian Islands, and Melanaster Mertensii on the coast of Kamtschatka. My son has observed another species of each of these two genera on the coast of California.

The genus Dodecabostrycha of Brandt is passed over in this enumeration, as it does not belong to the family of Pelagidæ. The genus Heccædecabostrycha I have no means of characterizing.

ZYGONEMA *Ag.* Among the drawings made by Mr. J. Drayton, during the United States Exploring Expedition under the command of Captain Charles Wilkes, I find a Medusa, from the harbor of Rio Janeiro, represented under the name of Pelagia volutata *Couth.*, which evidently belongs to this family, but presents a combination of characters not observed in the species thus far mentioned. All the segments between the eyes show four larger lobes, subdivided by shallow indentations, from which arise four tentacles. Such a combination of characters is only intelligible on the supposition that, as in Pelagia proper, the marginal sacs of the ocular pouches unite with the marginal sacs of the adjoining tentacular lobes, and that each of the tentacular pouches has six marginal sacs, two of which are united with the sacs of the adjoining ocular pouches, while two and two others, united together, form two independent lobes. But until this Medusa has been examined anew, with reference to this point, the genus to which it belongs must remain doubtful.

SECTION III.

DESCRIPTION OF PELAGIA CYANELLA.

Returning, now, to the Pelagidæ observed along the Atlantic coast of North America, I have only to notice two species, one of which, the Pelagia cyanella, is represented on Pl. XII. of the third volume, while the other has not yet been figured. Our Pelagia cyanella has already been accurately described by Eschscholtz, but a figure with details of its structure was still wanted, and I have attempted to supply the deficiency. Like Pelagia noctiluca, which is its European representative, our Pelagia cyanella is remarkable for the striking rotundity of its umbrella, the margin of which is usually more contracted than the middle of the disk, *Fig.* 1. The whole of the surface, but especially the middle space, is dotted with little reddish-brown warts, arranged in radiating lines. The prevalent color of the whole disk, and of the arms, is bluish white, hyaline, through which shines reddish-brown pigment (*Fig.* 3) in the marginal sacs of the radiating pouches, and along the whole length of the tentacles, which are of a more brick-red color, while the ovaries shine through with a more purplish tint; upon the outer surface of the pendant arms there are reddish-brown dots, as upon the outer surface of the umbrella. The tentacles are capable of very great elongation and contraction, hanging at times far beyond the actinostome, while at other times they are shortened to a length less than the diameter of the disk. The actinostome consists of a slender peduncle, formed by eight pillars (*Fig.* 2, *a*), alternating with the main lobe (*b*) of the genital pouches, and uniting into a cylinder, which divides again into four long slender arms (*Fig.* 1, *s*) with thin lobulate margins. This specimen was observed in the Gulf of Mexico, at the Tortugas Islands, and an opportunity was offered to trace some stages of its development, embracing five days, beginning at the time when the imperfectly developed young, having the appearance of a planula or of an imperfect scyphostoma (*Fig.* 4), were seen dropping from its actinostome. The embryos corresponded in their structure to those of Cyanea arctica represented on Plate X. *Fig.* 12, without, however, showing the slightest inclination to attach themselves to the ground. They soon presented a wider excavation (Pl. XII. *Figs.* 5, 6, and 7), approaching to the condition of Cyanea represented in Pl. X. *Fig.* 13, and on the third day, Pl. XII. *Figs.* 8 and 9, the beginnings of eight tentacles (*b*) were unmistakable, and the mouth appeared like a distinct opening in the centre (*a*). In this stage the young Pelagia may be compared to the scyphostoma of a Cyanea which is already attached (Pl. X. *Fig.* 14), and yet the Pelagia remains free, and soon assumes an ephyra-like condition (*Figs.* 10 and 11). In *Fig.* 10, which represents it as swimming, *b b* indicate the lobes of the ephyra, which, in *Fig.* 11, are seen stretched on a plane, and disclosing the terminal emarginations, between which arise the eyes; *b* marks the termination of the radiating pouches, and *a* the mouth. We have thus a direct and gradual transition from embryos similar to a scyphostoma which has not yet got tentacles, *Fig.* 7, to one which has seeming tentacles, *Figs.* 8 and 9, eight in number, and which, instead of developing into slender tentacular appendages, are enlarged into lobes, corresponding to those of the ephyra of Aurelia, as represented in Pl. XI^a. *Fig.* 26, traversed by broad chymiferous pouches, such as exist also in Aurelia (Pl. XI^b. *Fig.* 4) during the earlier stages of their ephyra condition, showing that in this type the development takes place by a gradual metamorphosis of the scyphostoma into an ephyra, without the intervening strobila condition, and therefore without a multiplication of individuals from one and the same egg.

This direct transformation of the scyphostoma into the ephyra is important, not only as exhibiting a special mode of development in the Pelagidæ, when compared to the Cyaneidæ and Aurelidæ, but also in a morphological point of view, since it shows, beyond a question, that the radial prolongations of the body, which arise on the actinal edge of the scyphostoma, may be developed into two different kinds of organs in different types, becoming tentacles in Aurelidæ and Cyaneidæ, by direct metamorphosis, and becoming radiating pouches, with an eye in its radial prolongation in Cyaneidæ; thus showing, through embryological evidence, what I have already maintained on other grounds, that the ocular apparatus is a tentacular apparatus, and the eye a metamorphozed tentacle, or, in other words, that the tentacles in Radiates are the lowest condition of that structural element which, in its highest development, appears as an eye. Thus the pigmentation of a tentacle, near its base, is the first indication of an approximation towards an eye, and the reduction of the tentacular element is generally accompanied by a higher development of the ocular element. It has already been shown, also, that in abnormal states of strobilas there are all possible transitions and combinations of both. See Pl. XI. In the state of development represented *Fig.* 11, Pl. XII., the radiating pouches are simple, and extend only to the base of the eyes, in the emargination of the eight lobes; but within twenty-four hours such an ephyra passes into the condition represented in *Fig.* 12, in which the radiating pouches have enlarged into marginal sacs, on the two sides of each eye peduncle. In this stage the ephyra of Pelagia closely resembles that of any Aurelia in which the veil and tentacles have not yet begun to be developed, as represented on Plate XI^a. In that condition of the Aurelia, the radiating prolongations of the chymiferous system are not yet closed branching tubes, as in later periods, but flat pouches, as in Pelagia and Cyanea;

and while, at an earlier period, there are only eight of them corresponding to the ocular lobes, there are sixteen in the next stage, the new set alternating with the ocular lobes and corresponding to the tentacular pouches, which, even in Aurelia, appear for a time like flat pouches (Pls. XI^a. *Fig.* 20, and XI^b. *Fig.* 4), and not like chymiferous tubes. In *Fig.* 12, Pl. XII., the tentacular pouches (*a*) are just beginning to project between the basal part of the ocular pouches, but there is not yet any trace of tentacles. The mouth has become a quadrangular aperture (*Fig.* 12, *c*), projecting somewhat like a quadrangular funnel (*Figs.* 13 and 14), in which the angles of the mouth project but slightly, and do not yet show the slightest sign of their later elongation into four slender pendant arms. In this condition, the mouth of Pelagia corresponds to that of Aurelia as shown in Pl. XI^a. *Figs.* 18 and 28. The development of the genital organs seems to be more tardy in Pelagia than in Aurelia, for our most advanced ephyra of Pelagia (Pl. XII. *Fig.* 12) shows no signs of them. The eyes present a conical tube, with a round faceted termination.

The condition of the young Pelagia here described resembles so closely the structure of the small Medusæ from the Mediterranean, described under the name of Octogonia by J. Müller, and under that of Nausithoë by Kölliker and Gegenbaur, that I have hardly any doubt that these Medusæ are only undeveloped specimens of the Pelagia noctiluca of the Mediterranean, in that state of growth which would naturally follow immediately the one represented in my *Fig.* 12, Pl. XII., in which the tentacles and genital organs would begin to make their appearance. It is true, Gegenbaur states that with these Nausithoë he found also the young of Pelagia, but he may have considered as Pelagiæ those only which already showed the character of that genus, and referred their earlier condition to the genus Nausithoë. At all events, if they differ, it is much to be regretted that he has not pointed out the difference between the two, and has allowed an opportunity to escape of establishing, beyond the possibility of a question, the generic difference between the young of Nausithoë and Pelagia.

CHAPTER FIFTH

THE DISCOPHORÆ RHIZOSTOMEÆ.

SECTION I.

THE RHIZOSTOMEÆ IN GENERAL.

EVER since the Medusæ of this type have begun to be investigated, they have excited great wonder, and have been represented as differing widely from the others in their structure and mode of existence. While in all other Medusæ a so-called mouth has been observed in the centre of the lower surface of the body, through which the food could readily be introduced into the main digestive cavity, with the aid of the so-called arms, Rhizostoma and other Medusæ allied to it have been described by Reaumur, Cuvier, Eysenhardt, and even recently by Milne-Edwards, as destitute of mouth, and only capable of absorbing food through innumerable suckers traversing the arms and reaching the stomach through narrow channels. According to these representations, the Rhizostomidæ would appear widely different in their structure from the other Discophoræ, and they have been contrasted with them, as Polystomes; but their true relation seems to have escaped the penetration of those who sought for a solution of the difficulty. In his latest paper on the classification of Acalephs, Gegenbaur once more calls attention to this problem of the polystomy of the Rhizostomidæ, without, however, offering a solution. It seems to me to be very simple, and that a careful comparison of Aurelia, in all the successive stages of its growth, may explain how the Rhizostomidæ may appear widely different, and yet have the same structure as the common Medusæ. It is true, there is no central broad opening in the middle of the lower floor in Rhizostoma, as in Aurelia; but the margin of the arms shows innumerable minute pores, communicating with narrow tubes, gradually uniting into wider channels, and finally reaching the central cavity; while in Aurelia there is a quadrangular central aperture, from the corners of which project four long arms, furrowed along the middle, and leading into the main cavity. This structure, however, varies greatly with age in Aurelia. In the young the central aperture is only a broad funnel with four sides, more or less flattened, the angles of which become prominent, lobed, and fringed, until regular arms, with a deep furrow in the centre, have been formed, communicating with the wide central opening; and the edges of the arms themselves are so folded as to present numerous minor furrows, leading from the sides towards the main central channel. In fact, the arms, with their middle and lateral channels, are only the prolonged margins of the mouth, the whole surface of which leads to the mouth.

As Aurelia grows older, the arms become thicker along their centre, and the thin margins are folded against one another, their edge alone remaining pliable upon the sides of the stiffer axis; but as these edges are themselves wider, longer, and more spreading than the axis, they fold, bend, and twist in every direction, from both sides, until, at last, these winding folds become also harder and stiffer, and can neither be fully opened nor stretched, so that, though the margin of the arms is free and open, from tip to base, and can be laid out like a flat leaf, with comparatively little effort, each arm of an adult Aurelia forms, in reality, a system of flat channels, gaping along the margin, and uniting into fewer and fewer ramifications toward the middle line of the arm, along which runs the larger channel which terminates in the mouth. The central aperture, or the mouth itself, undergoes identical changes. Its walls become thicker and stiffer, and less movable, and are finally thrown into such folds as fit one against the other so closely, that, in the end, the oral aperture is transformed into a system of capillary surfaces, between the folds of the actinostome, leading into the main cavity.

Now such is exactly the structure of a Rhizostome, with this exception only, that the margins of these capillary surfaces interlocked with one another, are soldered up, and present, only at intervals and in particular places along the edge, which vary in different genera, apertures which through life remain open and keep up a communication between the surrounding medium and the main cavity, and through which the food necessary for their sustenance is absorbed. I know, from direct observation of the young of Polyclonia frondosa, one of the earliest Rhizostomidæ known to naturalists, that in this species at least, the young has a simple funnel-shaped mouth, as widely open, as freely gaping, and as directly communicating with the central cavity of the body, as in the young Aurelia and the young Pelagia (Pls. X. and XII.). I know, further, that in more advanced young the angles of the mouth begin to project, in the shape of arms with open and free margins, as in Aurelia, Cyanea, and Pelagia. And though I have not actually seen the margins of the mouth of any specimen of this species grow together, in such a manner as to close up the mouth, yet the fact, that in a more advanced stage of growth, specimens found together in the same shoal, and in no way differing from one another in other respects, have the margins of the arms and of the edges of the mouth so united, at intervals, that they cannot be spread out or easily opened without tearing, as well as the additional fact, that in still older specimens, not, however, exceeding one or two inches in diameter, the extent of the union of the edge of the mouth is so great, as to leave only comparatively few passages for a free communication of the surrounding medium, with the main cavity of the body, shows most unquestionably that the seeming absence of the mouth in Rhizostomeæ is only the result of a gradual closing up of the margins of the actinostome, which takes place, sooner or later, and to a greater or less extent, in different genera. In the adult Aurelia the margins of the arms are approximated together closely, and all but closed up in the latest period of their growth, though, when young, they form simply a wide funnel. In Rhizostomidæ, the edges of the actinostome, starting also from a wide funnel, are very early closed up, leaving only passages between their edges, in their peripheric prolongation; so that, through life, nutrition goes on through the narrow channels between the comparatively few open spaces in the peripheric portion of the arms, which are very early closed in its central portion. With such a tendency to the obliteration of the passage between the marginal prolongation of the actinostome, in the centre of the lower floor, it is not surprising that among the Rhizostomidæ the central part of that system should acquire the singular complications which we observe among the Cassiopeæ and in Polyclonia; but all these complications in no way conflict with the explanation I have here given of the polystomy of these Acalephs.

In order fully to appreciate the differences upon which genera, and perhaps families also, may be distinguished among the Rhizostomeæ, it is important to analyze the elements of structure of the lower surface of their umbrella, and especially that of its central part. The great cavity which hangs, like a sac, under the centre of the umbrella, has walls of very unequal thickness. Very thin where the ovaries are situated, this sac seems there to be perforated by holes, when, in reality, the wall is only extremely thin, movable, and capable of great expansion and contraction; but the bunches of ovaries and spermaries, which project from these holes, like a hernia, into the main cavity, are mostly so large as to increase the impression that there are real holes in those places. The spaces of the walls alternating with the ovaries are much thicker, and form, as it were, pillars, converging toward the central disk in the shape of a branching stem. Now, in this region, we must distinguish three parts: first, the pillars or arches arising between the ovaries and converging toward the centre. These arches may be compared to roots of the stem, which hangs down in the form of arms. They are longer or shorter in different genera, and vary from four to eight, as do also the openings facing the genital sacs. Secondly, the stem, or central disk, towards which these roots converge above, and in the centre of which there is a cavity in the form of a cross. From this point the walls of that cavity branch again, radiatingly, and form, thirdly, the so-called arms. The arms themselves may be uniform throughout, and exhibit only a swelling near their extremity, as in Leptobrachia; or there may be a bunch of ramifications near the base, and the remainder of the arm be a simple thread, as in Cephea; or there may be two bunches of ramifications, at a distance from one another, and a simple termination to each arm, as in Rhizostoma; or the whole arm may be uniformly branching as in Polyclonia.

Another point of importance is the degree of independence or isolation which the central disk, intervening between the pendant arms, acquires from the arches or roots of the arms, from which it is derived morphologically, and the character and complication of that disk. In the Cassiopeæ the central disk seems raised, as if detached from the surrounding parts of the lower floor, and completely independent from the side walls of the main cavity. So it is, also, in Leptobrachia and in Cotylorhiza; but in Rhizostoma it is confluent with the basal arches of the arms, which alternate with the genital sacs, so that this part of the actinostome differs least in Rhizostoma from the ordinary structure it exhibits in the Aurelidæ and Cyaneidæ.

The relations of the arms to the eyes or marginal ocelli are equally important. In Rhizostoma, which have four genital sacs and four oral arches, there is one eye in the radius of each ovary, and one in the radius of each oral arch. In the Cassiopeæ, which have eight genital sacs and eight arms, apparently independent of the oral arches, there is one eye in the radius of each ovary, and the arms alternate with the eyes. The relations of the cross of the mouth are not easily defined; it seems, however, to correspond to four of the arms, and not to four eyes. In Polyclonia the four arms are likewise in the radial prolongation of four eyes, but there are no eyes fronting the radial prolongation of the centre of the four genital sacs, though there is one eye in each segment of the disk which alternates with the oral segments and the centre of the genital segments. Elaborate as the figures of Cotylorhiza, published by Delle Chiaje, seem to be, they do not represent the marginal ocelli. In Leptobrachia, which has four genital sacs and eight arms, which are also independent of the oral arches, it would seem, from the figures of Chamisso, that there are four arms alternating with four ovaries, and corresponding to the angles of the cross of the mouth, and four facing the ovaries and alternating with the cross of the mouth. But such a combination is so contrary to the symmetry of the Acalephs, that I suspect here an error of observation. The position of the eyes cannot be ascertained from the figures thus far published of this genus. In Cephea proper there are four genital sacs and four oral arches dividing into eight arms, alternating two and two with the genital sacs, as in Rhizostoma. But the position of the eye cannot be ascertained from the figures of Forskål.

Having thus far analyzed the actinostome of the Rhizostomidæ, with the view of ascertaining the nature of its different structural elements and its relations to the other parts of the lower floor and of the margin, it may not be out of place here to show, that what has been called the peduncle or proboscis in Acalephs, is a central prolongation on the lower side of the animal, composed of very heterogeneous elements in different families of Acalephs: in Geryonia and allied genera, it is a tube, formed by the prolongation of the lower floor, into which a conical central prolongation of the gelatinous disk extends like a prop. Nothing of the kind exists in any of the Discophoræ proper, though we have something similar, morphologically speaking, in the bulging of the lower surface of the gelatinous disk in Æquorea, and still more so in Tima and allied genera. In Sarsia, on the contrary, the proboscis consists only of a prolongation of the lower floor, without any corresponding pyramid from the gelatinous disk; but the tubular proboscis of Sarsia has none of those thickenings of the walls, near its base, which characterize the peduncle of the Discophoræ proper. We have already seen that in Rhizostoma the peduncle is formed by four pillars, which alternate with the genital sacs and, dividing again below their junction, branch to from the eight arms, and that in Cassiopea the space intervening between these arms forms a central disk, raised above the surrounding parts of the lower floor, and from the margin of which arise the radiating arms. In these Discophoræ there is no central aperture leading into the main cavity, owing to the close union of the margins of the arms which form the disk. In Salamis there is a similar central disk, from the margin of which the branching arms radiate; but if the figure of Quoy and Gaimard can be depended upon, there is a central opening in that disk, as there is, also, in the genus Homopneusis, figured by Lesson as a Mollusc, though it is, however, unquestionably, an Acaleph, closely allied to the genus Salamis, founded by Lesson upon the Orythia incolor of Quoy and Gaimard. In Favonia and Limnorea, finally, the centre of the actinostome is developed in another way. Between the pendant arms hangs a kind of central peduncle, which can hardly be compared to that of Geryonia, since it is surrounded by branching arms. Judging from the figures of LeSueur, this peduncle is probably homologous to the central disk of Cassiopea, forming a proboscis-like central prolongation between the arms, instead of a flat disk. But it remains to be ascertained whether that peduncle is solid or hollow, or whether, after all, it is not simply a prolongation of the gelatinous disk projecting beyond the arms. The travelling naturalists who have studied these Medusæ have given a very scanty account of their structure, and no species of this family have thus far been found within reach of sedentary observers. the only ones known being those described by Péron and LeSueur.

The largest number of species belonging to the family of Rhizostomidæ, are foreign to the shores where observers could investigate them with the degree of care and precision which, of late, has been bestowed upon all Medusæ inhabiting the seas of Europe and North America. It has, however, appeared to me very desirable to compare all these species with ours, as far as the materials on hand would permit, and to revise their arrangement in the light of our present knowledge of the Acalephs. In order to derive as much information as possible from these materials, I have read, over and over again, every description, and compared every figure relating to these animals, which has been published since the days of Pallas and Forskål, weighing every word and trying to find out its true meaning. I feel confident that I have in this way acquired an acquaintance with these Medusæ, and arrived at a knowledge of their true relations, more full and more accurate than the observers who described them seem themselves to have possessed. I have, therefore, ventured to express, in another chapter, the results of these comparisons, in the shape of a tabular view, in the hope of presenting, as far as practicable, a complete systematic review of all the Medusæ known at present, and also of showing what may be done by a careful comparative study of old, and apparently antiquated, materials.

If I have read these data aright, the Rhizostomidæ are not simply a family among the other Discophoræ, but constitute a distinct structural type among them, of equal importance and value as the other Phanerogamous Discophoræ of Eschscholtz. This type appears to me to have the value of a sub-order, inasmuch as it shares the general complication of its structure with Aurelia, Pelagia, Cyanea, and other Discophoræ, while it differs from them in such structural complications as affect only the organization of some of its parts. These differences consist chiefly in the absence of marginal tentacles along the edge of the disk, though the eyes are present, and in the structure of the arms, the margins of which are soldered together, for a greater or less extent, leaving only minute holes or short fissures along their edge, which communicate with the main digestive cavity. The structure of the lower floor, the formation and connection of the arms with that floor, the structure of the genital pouches, the ramification of the main cavity in radiating chymiferous channels extending to the margin of the disk, the structure of the eyes, in fact all the leading structural features of these Acalephs are the same as in the other Discophoræ; they belong, therefore, to one and the same order. But as they differ greatly in form among themselves, they constitute a number of distinct families, which I have attempted to characterize in the next chapter, under the names of

Rhizostomidæ proper, Leptobrachidæ, Cassiopeidæ, Cepheidæ, Polyclonidæ, and Favonidæ, all of which are held together, as a sub-order, by the structural peculiarities mentioned above. Some of these families have already been pointed out as natural groups by Tilesius, in his interesting paper on Cassiopeæ, published in the Nova Acta Academiæ Naturæ Curiosorum, Vol. XV. In this paper the learned author makes, however, several statements which cannot be correct, and must be distrusted by every one familiar with the structure of the Acalephs. He states, for instance, that water is expelled through the eight respiratory ventricles; but what he calls respiratory ventricles are the closed sacs formed by the genital pouches, which have no communication whatsoever with the main cavity of the body of these animals. Water, therefore, can only fill these cavities, and be moved in and out by the contractions and expansions of the genital pouches, which shut the cavities below them from all communication with the main cavity. He also affirms that a luminous gas is exhaled from the decomposed water, through the eight branchial tubes and the marginal vesicles. I suppose that, under the name of marginal vesicles, he alludes to the eyes, but I am at a loss to see how they can, in any way, contribute to the decomposition of the water and the emission of a luminous gas.

Our remarks upon the polystomy of the Rhizostomes lead, naturally, to some further considerations upon the opinions which have, at different times, been expressed, with respect to the position and the absence of the oral aperture among Acalephs. Péron and LeSueur have, in their classification of these animals, one division which they call "Agastriques," some of which have been called "Astomes" by Cuvier, and which they suppose to have neither central cavity, nor mouth, nor peduncle, nor tentacles. In modern times, no Medusæ have been observed exhibiting such characteristics. The genera referred to this division by Péron and LeSueur were, no doubt, founded upon imperfect specimens. The others, which are called "Gastriques," are divided into Monostomes and Polystomes; the Polystomes being all those which have distinct genital sacs, inserted above large openings of the lower floor, formed by the thinning of that floor and its inversion into the main cavity, or its eversion in the shape of a pendant sac below it. These openings Péron and LeSueur have mistaken for mouths, and they have overlooked, in some of them, the real oral aperture. This is, for instance, the case in Aurelia, which is characterized as having four mouths, by which can be meant only the four large funnels below the genital sacs, while the mouth, between the four arms, has not been observed by them.

SECTION II

THE GENUS STOMOLOPHUS.

This genus is closely allied to Rhizostoma, and belongs to the same family with it; but it is easily distinguished by the manner in which the eight arms are soldered together for their whole length, forming a large cylindrical tube, and leaving only a small entrance into its interior, between its terminal lobes. The arms are so closely united in this cylinder, as seen in Pl. XIV. *Fig.* 2, that it would be difficult to distinguish them, were they not, in a measure, isolated at their end, 1^a, 2^a, 3^a, 4^a, which are the folded terminations of the four arms, visible from one side. This apparatus is represented from different sides in Pl. XIV. *Fig.* 1 shows only its lower termination, the greater part of the central cylinder being hidden by the umbrella, and the complicated terminations of the arms alone visible; but *Fig.* 2, which represents the whole cylinder, separated from the other parts of the lower floor, shows the arms to be far more complicated in their termination than would at first appear. Eight vertical ruffles are here presented, corresponding to the duplicated angular projections of the terminations of each arm, two such ruffles corresponding to each arm, 1 and 2 to the termination of the arm 1^a, 2 and 3 to the termination of the arm 2^a, 5 and 6 to the termination of the arm 3^a, and 7 and 8 to the termination of the arm 4^a These ruffles are seen from above in *Fig.* 3, which shows that each one of them is attached by a narrow base to a projecting ridge of the cylinder, formed by the junction of the arms themselves, and each ruffle consists of two folds, the edges of which are themselves folded and lobed. Their upper part, *Fig.* 5, *a*, is rounded, and their lower part terminates in a prominent lobe, as this figure shows, which presents such a ruffle in profile; in *Fig.* 6 the same is represented from its outer surface, its two folded halves being spread open. The manner in which the arms terminate shows in them also the same disposition to divide into two distinct ruffles, only that here these ruffles meet at the very end of the arms, while higher up, they divide into two horn-like projections, facing the ruffles above, from which they are separated by deep depressions. But these projecting angles (h^1 h^2 h^7 h^8) are evidently the counterpart of the ruffles, to which they correspond, and each horn is subdivided into two folds, corresponding to the two folds of the ruffles, as *Fig.* 8 shows, in which *a* and *b* indicate the less developed horns. *Fig.* 7 represents one of these terminations of the arms in profile, h^1 and *a* corresponding in this view to the parts marked by the same letters in *Fig.* 8. *Fig.* 4 gives another view of these same parts, as seen from below, the letters h^1, *a*, h^2, *b*, corresponding to the same letters of *Figs.* 2, 7, and 8, and h^3, h^4, h^5, h^6, h^7, and h^8, corresponding to the ruffles 3, 4, 5, 6, 7, and 8 of *Fig.* 2. A close examination of *Fig.* 4, however, shows that alternate arms differ in their structure, c, c^1, and c^3 projecting more towards the central cavity of the oral cylinder than the arms t and t^1; this difference has no doubt reference to the primary number of arms, which in all true Rhizostomidæ is only four, dividing below the pillars, from which they arise, into eight, and each having its edges subdivided, as Milne-Edwards' figure of Rhizostoma shows, in a manner which fully corresponds to the complication of the ruffles and crested terminations of the oral tube of Stomolophus. An additional evidence of this quadripartite primary division is afforded by the outline of the centre of the oral cylinder (*Fig.* 3, s^1 s^2) leading into the main digestive cavity. The umbrella is hemispherical, and its margin divided into eight segments, by the presence of eight eyes, the outline of the edge of each segment being crescent-shaped, and divided into twelve angular lobes. I know only one species of this genus, which I have called Stomolophus meleagris, on account of the spotted appearance of the marginal portion of the umbrella. The color seems to be of a whitish blue, passing into a yellowish brown near the margin, the marginal lobes being dark brown, as are also the spaces intervening between the marginal spots. I say this seems to be the color of this Acaleph, because I have only twice had an opportunity of seeing it, and, in both instances, under the most unfavorable circumstances. The first time, I saw myriads of them (in April) stranded upon the sand on the beach of Warsaw Island, below Savannah, in Georgia, all of which had been exposed for hours to the sun, and were partially decomposed. In most of them the umbrella and the arms, which are of a very tough consistency, seemed perfectly well preserved. Many years afterwards, a specimen was brought to me in Charleston, South Carolina, which had been found floating in the harbor, in the latter part of May, and was in precisely the same state of preservation as those I had seen before. Much remains, therefore, to be done in the investigation of the internal structure of this interesting Medusa.

SECTION III.

THE GENUS POLYCLONIA.

Under the name of Medusa frondosa, Pallas has described, from the Caribbean Sea, in his "Spicilegia Zoologica," an Acaleph which Péron and LeSueur have afterwards referred to the genus Cassiopea, in which it was maintained by all later writers. Mertens, on the other hand, has figured another Acaleph, which Brandt has described in the Mémoires of the Academy of St. Petersburg under the name of Cassiopea Mertensii (Pls. XXI., XXII., and XXIII), and afterwards under that of Rhizostoma Mertensii, considering it, however, as a sub-genus of Rhizostoma, to which he gave the name of Polyclonia. These two Medusæ belong, unquestionably, to the same genus, and Polyclonia differs so much from the type of Rhizostoma proper, Rhizostoma pulmo, that I do not only consider it as a separate genus, but also as the type of a distinct family among the Rhizostomeæ. That Polyclonia constitutes a distinct family, is at once apparent when the ramifications of the arms are considered; and a comparison of the structure and mode of combination of its spheromeres still further justifies their separation.

In order to avoid repetitions, I would first point out the figures in which I have represented anew the Medusa of Pallas, on my Plates XIII. and XIII^a. These figures differ in appearance so much from that of Pallas, drawn from specimens preserved in alcohol, which had been sent to him by Dr. Drury, that it is necessary I should here insist upon the identity of the Medusa I have represented under the name of Polyclonia frondosa, and the Medusa frondosa of Pallas. His description, in the first place, agrees with the specimens I have seen; secondly, my specimens were obtained in the same part of the ocean from which he obtained his; and, finally, specimens which I preserved myself in alcohol exhibit exactly the appearance of that figured by Pallas. Under these circumstances there can be no doubt that they all belong to one and the same species.

This Medusa is one of the most singular Acalephs I know, both on account of the different aspects it presents in different attitudes, and on account of its habits. It is quite common upon the reef of Florida; I have seen immense numbers at Key Largo and at Key West, and occasionally at other points along the reef, and yet it is hardly ever seen near the surface of the water. This is owing to its habit of groping in the coral mud, at the bottom of the water, where thousands upon thousands may be seen crowded together, almost as closely as they can be packed upon the bottom, at a depth of from six to ten feet. When disturbed they do not rise, but crawl about like creeping animals, now and then only flapping their umbrella, like other Discophoræ. That Polyclonia Mertensii has similar habits, I infer from the statement of Mertens, that he observed his species, in large numbers, in shady places of the lagoons of Ualan, overhung with Sonneratiæ and Mangroviæ. The Polyclonia frondosa is also found among the mangrove islands of the Florida Reef, in shady places, near the roots of mangrove trees. Mertens, however, states that he found them constantly with their arms spread and turned upward, resting upon the ground; I have always seen them in the reverse position, the arms downward. Otherwise, my observations agree with those of Mertens as to the mode of living of these Acalephs.

When brought into large glass jars, in a swimming attitude, they assume, alternately, two very different positions. When at rest (Pl. XIII^a. *Fig.* 1) and floating, the umbrella is slightly and uniformly arched downward, the margin alone expanding and contracting gently, while the peduncle, with its eight arms, hangs loosely down, the ramifications of the arms being turned inward, and slightly folded together. In this condition the actinostome projects so far below the umbrella, that the holes, leading into the genital pouches, are easily seen. When more active (Pl. XIII.), the actinostome is drawn up and spread under the umbrella, in such a manner, that all the ramifications of the arms are turned outside, and present the appearance of innumerable ramifications interlocked with one another. The disk is alternately expanded and contracted, so as to assume, in its contracted condition, an hemispherical form, while in the expanded condition, Pl. XIII. *Fig.* 1, the centre of the umbrella is alone raised above the level of the peripheric part of the disk, and the margin hangs abruptly down. Pl. XIII^a. *Fig.* 6, represents this species from above, part of the outline being suppressed; Pl. XIII. *Fig.* 2, represents it from below; but, to avoid a useless multiplication of the figures, different parts are drawn in different segments, or the same parts in a different state of preservation, or in a different state of contraction, and one segment, *7*, is represented as injected. In segments *1* and *2*, two arms are drawn in their natural expanded condition, showing their junction near the centre, and the peculiar appendages which cover the surface of the centre, in the females. In segments *4* and *5*, two other arms are represented without the delicate fringes of their margin, in order to show how the edges of the arms are soldered in Rhizostomeæ. This mode of connection extends to the very centre of the lower floor, even to the part covered by the peculiar appendages of the centre. In segments *7* and *8*, near the centre, these appendages are represented as they appear in the males, *m*. Outside of these appendages, in segments *7* and *6*, the chymiferous tubes are injected, in order to show their ramifications and anastomoses. In segments *8*, *9*, *10*, *11*, and *12*, the surface of the lower floor is exhibited in a natural condition, but in different states of expansion and contraction. When most contracted, as in segment *8*, it is marked by undulating furrows, following mainly the direction of the principal branches of the chymiferous tubes; in a less contracted condition, as in segments *9* and *10*, the wrinkles are more numerous, but less deep, and do not so distinctly exhibit their relation to the chymiferous tubes, near the margin, though it is quite apparent nearer the central cavity. In segments *11* and *12*, the lower floor is entirely stretched, and appears smooth. Notwithstanding the changing aspect of the lower floor, the folds described above are unquestionably determined by structural relations, and it is a significant fact, that their general disposition recalls, in the most striking manner, the ramifications of the ambulacral furrows, upon the lower surface of the Scutellidæ, and other Echinoderms. Small pores, like punctures, are visible at the angles of these folds, and may be a means of communication between the chymiferous system and the surrounding medium, akin to the minute pores of the lower floor of the Clypeastroids. *Fig.* 3 of Pl. XIII. represents a young, showing fewer ramifications and a much less complicated structure of the arms near the centre, than in the adult; though even at this age their margins are already closed, and it is evident that there are eight arms resulting from the division of four main stems, the arms remaining generically closed together (t t^2), though they separate occasionally (t^1 t^1, t^3 t^3), to a greater or less degree. The other figures exhibit structural details to which I shall allude presently.

The characteristic combination of spheromeres which distinguishes the family of the Polyclonidæ, consists in a central sub-quadrangular cavity (Pl. XIII. *Fig.* 4), formed by the combination of four spheromeres, in the ambulacral rays of which are, morphologically considered, only four arms, extending in the radial prolongation of the four rounded corners of the main cavity, but dividing at once into two symmetrical branches, *Figs.* 2 and 3; while, in the interambulacral rays, there are four genital pouches, alternating with two and two of the arms, and occupying the middle of the sides of the main cavity, through the wall of which open the holes leading from the outside into these pouches (*Fig.* 4, *oc oc*), though the pouches themselves (*o os os′*) are closed; so that there is no possible communication between the main cavity into which the genital pouches project and the sacs below them, opening outward between the arms. Another very unusual combination is noticeable in the position of the eyes, of which there are twelve, four in the radial prolongation of the axis of the arms, and two corresponding to each of the four sides of the main cavity; no one of these, however, being in the radial prolongation of the centre of the genital pouches. In the true Rhizostomidæ there are only eight eyes, four in the radial prolongation of the arms, and four in the radial prolongation of the genital pouches. Here we have two eyes to each genital pouch, neither of them in its radial prolongation, but both, on the contrary, occupying a lateral position with reference to the genital pouches, though, with reference to the ambulacral eyes, they are placed at equal distances in the margin of the disk.

The system of radiating chymiferous tubes presents corresponding differences when compared to that of Rhizostoma. In the latter genus there arises one main chymiferous tube, in the radial prolongation of each of the four arms and of each of the four genital pouches, extending in the direction of the eight eyes, while eight others alternate with those of the eyes. These sixteen main branches extend for half their course without giving off any branches; while in their peripheric course they form innumerable small anastomoses, connected with each other and with the main branches by transverse branches and by a few large meshes projecting towards the central cavity, without, however, communicating with it. In Polyclonia, on the contrary, there are twelve main branches of the chymiferous system, extending in a direct course towards the eyes, and forming a fork, between the branches of which the eyes are placed (Pl. XIII. *Fig.* 2, 7, *o o*). With these branches alternate twelve somewhat smaller radiating chymiferous tubes, which are lost in the network of anastomoses occupying the whole field between the main branches. There is, however, a marked difference between these anastomoses. Nearest to the margin, they are very small, and go on increasing towards the forks of the main branches, between the base of which they are largest; while the space nearer the main cavity is occupied by a net-work of large meshes, formed, however, by smaller lobes. The ramifications and anastomoses of the chymiferous tubes, along the margin, are represented magnified in *Fig.* 9, a^3, Pl. XIII^a. Repeated injections of this chymiferous system has satisfied me that the main radiating chymiferous tubes, in the direction of the eyes, are afferent vessels, and that the stems, alternating with them, which seem lost in the marginal anastomoses, are recurrent tubes, through which the fluid passing from the main cavity, through the main branches to the periphery, is brought back to the main cavity. I am unable to say whether there is a similar difference of function among the chymiferous tubes of Rhizostoma. Occasionally the chymiferous tubes of Polyclonia present some irregularity in their course, and the marked arrangement of the adult, just described, is not yet visible in younger specimens (Pl. XIII. *Fig.* 5), in which the anastomoses between the main branches of the chymiferous system are comparatively few.

The main cavity of the body is formed by the combination of the bases of the eight arms arising from the thickened part of the lower floor, which closes the lower side of that cavity. *Fig.* 4 of Pl. XIII. shows these relations, *t t*, t^1 t^1, t^2 t^2, and t^3 t^3 representing the eight arms which form, respectively, the rounded corners of the quadrangular cavity, *sc sc* marking the even thickness of the wall above the origin of the arms, and *oa oa* the intervals between two and two arms, corresponding to the sides of the main cavity, upon which open the holes leading into the cavity below the genital pouches, *oc oc*. In this figure the main cavity is seen from above, and its outer walls are cut immediately below the origin of the radiating chymiferous tubes. The lower floor of that cavity is even, and from it rise the walls of the four genital pouches, which project, like four lozenge-shaped sacs, into the main cavity. In this figure, two of the pouches are removed, so that the cavities, *oc oc*, which they cover, and which open outside, are visible; while the two other pouches (*o os*, *os'*) appear in their natural position. The genital organ proper (*o o*) forms a transverse band of folds across the middle of the pouches which are kept in their respective position by the smooth fold of the pouch itself, one part of which (*os'*) is turned towards the centre of the cavity, while the other part (*os*) is turned toward the openings of the wall of the cavity, which communicate with the surrounding medium. From this arrangement, it is evident that the genital pouches cannot be turned inside out through these openings, as is the case in the Cyaneidæ, though water is constantly flowing in and out, in consequence of the expansion and contraction of the pouches themselves. Along the edges of the sexual organs there are short, hollow tentacles, projecting inward, which, by their motion, must contribute to the aëration of the eggs, by the constant change of the surface of the water with which they are brought into contact. These tentacles are homologous to the digitate appendages of the sexual organs of Aurelia.

Between the four genital pouches there are four openings in the lower floor (*s s*), magnified in *Figs.* 6 and 7, Pl. XIII., which lead into the main channels traversing the arms, and communicate, therefore, with the surrounding medium, through the narrow apertures or pores scattered between the fringes of the arms. Through these pores the food is introduced into the branching channels of the arms, and through these into the main cavity, into which the apertures (*s*), above described, directly lead. As the mature eggs fall into the main cavity, they have no other way to make their escape except through these same apertures and channels. As these apertures, *s s*, *Fig.* 4, are the only openings through which the food reaches the main cavity of the body, they might be considered as mouths, but it would certainly be a violation of all homologies, to call by this name openings which are removed from the holes leading to this cavity by the whole distance of the length of those parts of the arms where they communicate with the surrounding medium. Far, therefore, from being mouths, they are truly homologous with those emarginations in the angle of the arms, in Aurelia (see Pl. VI. *Fig.* 3, *i i*), which also lead into the main cavity of the body, and we must look for the mouth elsewhere. Now, a comparison of the arms, represented Pl. XIII. *Fig.* 2, segments *4* and *5*, with the arms of Aurelia, represented Pl. VI. *Fig.* 1 (where their marginal lobes are closed upon one another), and *Fig.* 3 (in which the same marginal lobes are spread open, to show how the capillary surface inclosed between these margins lead into the main cavity of the body), will leave no doubt upon the mind of an unprejudiced observer, that there is no essential difference between the structure of the arms of Polyclonia and Aurelia, except in the mode of branching of the whole arm, and the closer approximation of their margins in Polyclonia, in which they are soldered at intervals, and cannot, therefore, be spread, as those of Aurelia. *Figs.* 15 and 16 show these margins, and the way in which their terminal lobules are approximated, leaving, here and there, wider fissures between them. In fact, but for the connection between opposite margins of the same arm, the structure of these parts is the same in Aurelia and Polyclonia. *Fig.* 7 of Pl. VII., which represents a portion of an arm of Aurelia, shows the same marginal tentacles (*b b*) along its edge, as we have in Polyclonia (Pl. XIII. *Figs.* 15 and 16, *t t*), and the narrow openings (*s s*), leading into their channels, correspond to the fissure which extends between the same tentacles in Aurelia (Pl. VII. *Fig.* 7), and leads, also, into the main channel (*a*) of the arm. If we can speak of a mouth among Radiates, it is, therefore, the whole extent of the margin of the branching arms which forms its outline, exactly as in Aurelia, Pl. VI. *Fig.* 3. But for a mouth so constructed, a distinct name was needed, and as that structure is homologous throughout the type of Radiates, I have called it actinostome. The actinostome of Polyclonia has only this peculiarity, that near the base of the arms, where their margins are entirely soldered together, there are no apertures at all leading into the main cavity, and yet, even here, the sutures of these margins may be noticed as shallow furrows along the middle of the main branches of the arms (Pl. XIII^a *Fig.* 5, *s s*), while at their extremities (*d d*) the terminal marginal lobules conceal these furrows, as well as the pores, or fissures, scattered along their course (Pl. XIII. *Figs.* 15 and 16, *s s*). Besides the mere fissures, indicating the points at which the margins of the arms are not soldered together, there are specialized pores, or small rounded apertures, scattered, at greater intervals, along the soldered margins of the arms, *Fig.* 2, well seen upon the arms of segments *4* and *5*, in which the marginal lobules are removed. Two such pores are particularly noticeable, about the centre of the lower floor, *Fig.* 2, in a position which is homological to the extremities of the straight line formed by the closing of the margins of the arm, across the mouth, in Aurelia, Pl. VI. *Fig.* 1. The outer surface of the arms is rounded and smooth (Pl. XIII^a. *Figs.* 1 and 4).

In the centre of the lower floor, between the connected base of the arms, hang peculiar appendages, consisting of a variety of papillæ, or lasso-tentacles, of a most diversified size and form. They are thinner, larger, and more pointed (*Fig.* 11) upon the ramifications of the arms, and more club-shaped (*Fig.* 10) upon the centre of the actinostome; here and there there are large ones, paddle or shovel-shaped, or cylindrical, with one or several patches of lasso-cells, either on one side only or on both sides (*Figs.* 8 and 9) of the papillæ. The lasso-patches are white, with yellow specks; the stems of the lasso-tentacles are greenish, and their lobes yellow, and the tentacles themselves white. The microscopic structure of these singular appendages is very peculiar; the yellow patches consist of clusters of strongly pigmented cells (Pl. XIII. *Fig.* 12, *y*); the position of these patches upon the tentacles may be seen in *Fig.* 14, *y y*. The shovel-shaped tentacles with lasso-patches (*Fig.* 13) have a similar structure as the preceding, but on opposite sides there are comparatively broad patches of lasso-cells, closely packed together, and varying somewhat in size and structure (Pl. XIII. *Fig.* 17, *a b c d e*); when uncoiled, these cells exhibit the structure of the lasso-cells of Hydra, with a neck and hooks at the base of the thread (*c*), or the thread may be simple (*d*). The bags of the cells themselves are slightly pear-shaped. The variety of these appendages may be appreciated by comparing those represented, *Figs.* 8, 9, 10, and 11. I have noticed an unexpected difference between these appendages in the two sexes. In the males (Pl. XIII. *Fig.* 2, *m*, and Pl. XIII^{A}. *Fig.* 5, d') they are much more uniform than in the females, in which they exhibit the greatest variety of appearance (Pl. XIII. *Fig.* 2, *f*). What may be the function of these singular organs I am at a loss to say; the constant difference which I have noticed among them, in the two sexes, justifies the inference that in some way or other they must be connected with the laying of the eggs and the diffusion of the spermatic particles.

I have already stated, that the sexual organs project into the main cavity, and that the eggs make their escape from that cavity outward, through the four small openings alternating with the genital pouches. When mature, the eggs rise from the stroma of the ovary like beads (Pl. XIII^{a}. *Fig.* 22); they are surrounded by a chorion which forms a neck, connecting them with the walls of the genital organ. When the eggs are fully mature (*Figs.* 18 and 19), this neck breaks, and forms a large micropile above the germinative vesicle. In younger eggs (*Fig.* 20) the sacs containing the eggs are pear-shaped, and the neck slender; this grows shorter and wider (*Fig.* 21) as the eggs enlarge. The spermatic sacs (*Figs.* 16 and 17) have the same structure; the spermatic particles themselves have the form of an arrow-head, with a long, slender thread. The eyes have the usual form and structure observed among our common Discophoræ; they are short, hollow peduncles, with a round, faceted termination (Pl. XIII^{a} *Figs.* 11, 12, *o o*, 13, 14, and 15). Occasionally two eyes are developed, side by side (*Fig.* 8, o^1 o^1), there being an eye at the termination of each fork of the radiating tube of their respective segments.

The gelatinous disk is flat, comparatively thin, and gradually tapering in its thickness, from the centre to the margin (Pl. XIII^{a}. *Fig.* 2). In the central part, on the lower side, corresponding to the main cavity, it is slightly thinner than at the point from which the lower floor recedes from the disk, to form the actinostome. A magnified section, *Fig.* 3, shows that the gelatinous disk, *g*, is traversed by numerous fibres, in a vertical direction, across its whole thickness, and that the lower floor, *o*, is comparatively thin; between the two is the layer a^3, traversed by the radiating chymiferous tubes.

The generic characters of Polyclonia, I believe, consist in the peculiar mode of ramification of the arms, which are deeply divided to the base of the central cavity, and then unite, two and two, upon the lower floor of the main cavity. The strong, ramified branches of these arms, are no doubt also generic, as well as the different kinds of lobes and appendages along their soldered margins, and upon the surface of their base (Pl. XIII^a. *Fig.* 5). The marginal crenulations of the disk are, no doubt, also generic. The disk is very thin along the margin, but a little further inward its thickness is suddenly increased, and that thickened portion is so furrowed as to assume a crenulate appearance (*Figs.* 6, 7, 8, 10, and 11). A comparison of our Polyclonia frondosa with the Polyclonia Mertensii of Brandt, leaves no doubt that the species of the Gulf of Mexico differs from that of the Pacific Ocean. Plate XXII. of Mertens shows that, in the species of Ualan, the lasso-tentacles are of an enormous size, in comparison to those of our species, and are more uniformly distributed upon the whole lower surface of the arms, to their very tips, though the largest are about the centre, while in Polyclonia frondosa they are chiefly clustered upon the base of the tentacles, and only a few of them are found between their branching ramifications. The arms of Polyclonia Mertensii seem also to be more slender, and longer than those of Polyclonia frondosa, and the marginal crenulations of the first, more distinct and isolated than those of the latter. The color of Polyclonia Mertensii is represented as a uniform yellowish brown, the lasso-tentacles alone being white. Our species, on the contrary, has brighter hues, the prevailing tint being a grayish blue, passing, sometimes, into olive color, and sometimes into yellow, with lighter broad rays trending radiatingly in the direction of the eyes. At some distance from the margin there is a broad circle of a different tint, sometimes slightly marked, at other times quite distinct, with concentric bands of different tints, varying in different specimens from light gray to bluish gray, or yellowish gray to paler or darker blue and purple. The whole upper surface of the disk is adorned with minute epidermal wrinkles or folds, radiatingly reticulate.

Whether Polyclonia, contrary to what I have observed in Aurelia and Cyanea, survives for a long time the period of breeding or not, I am unable to state from direct observation; but this much is certain, that, while adult specimens of Polyclonia frondosa were found in the greatest abundance upon the reef of Florida, I occasionally noticed, floating near the surface of the water, small Medusæ, varying from a quarter to half an inch in diameter, which, owing to a general resemblance to our Polyclonia, I was led to consider as the young of this species. They presented the same distribution of color, and the same unusual number of eyes, which in itself distinguishes this genus from all the other Acalephs of the American coast. There is, therefore, every probability that these young Medusæ were young Polycloniæ. But if this is truly the case, these young are highly instructive, as showing the great resemblance there is between the Rhizostomeæ and Semæostomeæ in the earlier periods of their growth; for, in the smallest of the young, the mouth was wide open, as in the young Aurelia (Pl. XI^a. *Fig.* 18), the whole oral apparatus consisting in a broad funnel, with an entire margin, of a somewhat quadrangular shape, but without the slightest indication of prolongations at the four corners of the aperture. In somewhat older specimens the corners of the mouth were drawn out into four open lobes, as in Aurelia (Pl. XI^b. *Fig.* 17), so that the closing of the arms, and the soldering of their margins, must be the result of a later progress in their growth.

When describing the mode of development of Pelagia cyanella, page 128, I ought to have stated that, long previous to those observations, Krohn had already given a much fuller account of the direct transformation of the embryo of the Pelagia noctiluca of the Mediterranean into a genuine Medusa, without strobila stage, than I have been able to trace in our species. See Müller's Archiv, 1855, p. 491. According to Kölliker and Gegenbaur, Zeitschrift fur wiss. Zoologie, 1853, p. 328, the development of Cotylorhiza (Cassiopea borbonica) follows, probably, the norm of Aurelia.

CHAPTER SIXTH

ENUMERATION AND GEOGRAPHICAL DISTRIBUTION OF THE DISCOPHORÆ.

SECTION I.

TABULAR VIEW OF THE DISCOPHORÆ KNOWN AT PRESENT.

In the following enumeration, I have only quoted the most important references, and only those in full from which the most accurate knowledge of the species may be obtained. The other references may be found in Eschscholtz and in Lesson, whose general works on Acalephs must be in the hands of all those who study these animals.

Order of DISCOPHORÆ *Esch.*: Medusariæ *Lmk.* 1816 (pro parte). — Méduses *Pér.* and *LeS.* 1809 (p. p.). — Acalèphes Simples *Cuv.* 1817 (p. p.). — Æquoreæ *Goldf.* 1820 (p. p.). — Medusæ *Cham.* and *Eysenh.* 1821 (p. p.). — Cyclomorpha *Latr.* 1825 (p. p.). — Discophoræ phanerocarpæ *Esch.* 1829, and cryptocarpæ *Esch.* (p. p.). — Pulmograda *Bl.* 1830 (p. p.). — Medusidæ *Br.* 1833 (p. p.). — Medusæ *Less.* 1843 (p. p.). — Steganophthalmata *Forbes,* 1848. — Acraspeda *Gegenb.* 1856, and Craspedota (p. p.). — Discophoræ *Ag.*, see page 3 of this volume, where the natural limits of this order are more fully discussed.

1st Sub-order. RHIZOSTOMEÆ *Ag.*, see pp. 9 and 131 of this volume. — Rhizostomidæ *Esch.* 1829. — Polystomæ *Br.* 1833.

1st Family. RHIZOSTOMIDÆ *Ag.* (*Esch.* p. p.). The family of Rhizostomidæ, as here circumscribed, contains only those Rhizostomeæ in which the actinostome is composed of four pillars, between which open the four genital pouches, and from which hang eight simple arms, with numerous lobes of the marginal folds, extending along the greater part of their length, but without marginal tentacles, and pedunculated clusters of lasso-cells. The body consists of four spheromeres, and has eight marginal eyes, four in the prolongation of the ambulacral chymiferous tubes, and four in the prolongation of the medial chymiferous tube of the genital pouches. To the sides of each of these pouches there are radiating chymiferous tubes without eyes. For one half of their extent, near the margin, the chymiferous tubes form a close network of anastomoses, closest near the margin, and rather loose between the main branches of the system. Milne-Edwards has published, from injections of the Rhizostoma Cuvieri, the only accurate illustrations existing of these ramifications.

Rhizostoma *Cuv.* 1817. — Cephea *Lmk.* — Holigoclonia *Br.* — Claustra *Less.* (p. p.)

As now circumscribed, the genus Rhizostoma embraces only those species in which the actinostome is divided into eight arms, the marginal lobes of which are clustered into two distinct bunches, one smaller, near the base of the arms, another larger, extending to near their extremity. The arms terminate in a simple point.

R. Corona *Esch.* — Medusa Corona *Forsk.* — Cephea Corona *Lmk.* — Rhizostoma Corona *Esch.* — Rhizostoma Forskålii *Pér.* and *LeS.* — Rhizostoma Forskålii *Less.* — *Red Sea* (Forskål). This, and the following species, are very imperfectly known.

R. tetrastylum *Less.* — Medusa tetrastyla *Forsk.* — Rhizostoma Cuvieri *Ehrenb.* — *Red Sea*: *Suez* (Forskål), (Hemprich and Ehrenberg).

R. Cuvierii *Pér.* and *LeS.* — *Gosse,* Tenby Pl. 1. — Rhizostoma Cuvieri *Esch.* (p. p.). — Rhizostoma undulata *Flem.* — Cephea Rhizostoma *Lmk.* — Rhizostoma pulmo *Forbes.* — *Atlantic Ocean: English coast* (Forbes); *English Channel* (Péron and LeSueur).

R. pulmo *Ag.* — *πνεύμων* *Arist.* — Urticæ quinta species *Rond.* — Medusa pulmo *L.* — Rhizostoma Aldovandi *Pér.* and *LeS.* — Cephea Aldrovandi *Lmk.* — Cephea Rhizostoma *Eysenh.* (Act. nov. Nat. Cur. Vol. X. Pl. 34. Excellent anatomical description). — Rhizostoma Cuvierii *Esch.* (p. p.). — Rhizostoma Cuvierii *Milne-Edwards* (Voyage en Sicile, Pl. IX.; copied in Cuvier's Règn. Animal, Pls. 49 and 50, here for the first time represented as fully injected). — *Mediterranean: Nice* (Péron and LeSueur).

R. capensis *Less.* — Cephea capensis *Q.* and *G.* Zool. Uran.; Céphée Guérin, Pl. 84, fig. 9. — Cephea capensis *Esch.* — *Cape of Good Hope* (Quoy and Gaimard). As in the figure of Quoy and Gaimard, the umbrella is too much closed to allow the base of the arms to be seen, I am doubtful whether this is a genuine Rhizostoma.

A renewed study of these species, based, as far as possible, upon direct comparisons, is necessary to make it certain that they are truly distinct; though their geographical distribution renders it already probable. A comparison of the handsome figures published by Milne-Edwards and Gosse, of the Rhizostomeæ of the Mediterranean and of the British Channel, shows differences which, if not specific, have not yet been noticed as belonging to the cycle of development of one and the same species. Whether the two species described from the Red Sea differ one from the other, I am unable to say; nor is the assertion of Ehrenberg, that one of them is identical with Rhizostoma Cuvieri, to be considered as settling its affinity, as he himself states he never saw well preserved specimens.

Claustra Mertensii *Less.* — Cyanea? *Brandt*, Pl. 31, — is unquestionably a genuine Rhizostoma; but we have no information upon its origin and its specific characters.

Stomolophus *Agass.* See p. 138. Differs chiefly from Rhizostoma by the great length of the upper bunches of the marginal lobes of the arms, and the peculiar form of the lower ones.

St. Meleagris *Ag.* — *Atlantic Ocean, coast of Georgia* (L. Agassiz).

Stylonectes *Ag.*—Orythia *Q.* and *G.* (p. p.).—Rhizostoma *Esch.* (p. p.).

The fate of the genus Ephyra admonishes one to be extremely cautious in distinguishing genera among Acalephs, and I would, therefore, suggest that the Orythia lutea *Q.* and *G.* may be a young Rhizostoma Pulmo, respecting the embryology of which nothing, whatever, is known at present. But if it is an adult Medusa, then its peculiar actinostome, with eight connate arms, each ending in a long tricuspidate stylet, and the small bunch of marginal fringes at their base, show it to constitute a distinct genus.

St. luteus *Ag.* — Orythia lutea *Q.* and *G.*, Ann. Sc. Nat. 1827, vol. X. Pl. 4, B, fig. 1.—Rhizostoma lutea *Esch.*—Rhizostoma lutea *Less.* — *Mediterranean: Straits of Gibraltar* (Quoy and Gaimard).

Mastigias *Ag.* — Eight arms, arising from a comparatively narrow actinostome, with a double row of interlocked marginal folds near their base, and a long, simple, terminal appendage.

M. Papua *Ag.* — Cephea papua *Less.*, Voy. Coquille Pl. 11, figs. 2 and 3). — Cephea papuensis *Griffith*, in Cuvier's An. King. Pl. 3, fig. 3.—Rhizostoma papua *Less.*— *Waigiou Island* (Lesson).

Himantostoma *Ag.* — Eight slender arms, arising from a wide actinostome, ruffled with marginal folds for their whole length, with the exception of their cuspidate termination. Five slight marginal lobes, in each segment, between two of the eight eyes.

H. Sueurii *Ag.* Very pale reddish purple; margin of the disk and fringes of the arms deeper. — *China Sea* (W W. Wood). — From a drawing and notes by W. W. Wood, Esq.

Catostylus *Ag.*— Cephea *Q.* and *G.* (p. p.).—Rhizostoma *Esch.* and *Less.* (p. p.). Judging from the position of the eight arms, near the margin of the disk, the centre of the actinostome must be a widely-spread horizontal floor.

C. mosaicus *Ag.* — Cephea mosaica *Q.* and *G.*, Zool. Uran. Pl. 85, fig. 3. — Rhizostoma mosaica *Esch.* — Rhizostoma mosaica *Less.* — *New Holland: Port Jackson* (Quoy and Gaimard).

C. Wilkesii *Ag.* — Large, new species, fourteen inches in diameter, drawn by Mr. J. Drayton during the U. S. Exploring Expedition. It has a general resemblance to C. mosaicus, and the figure before me shows the reticulation of the arms represented by Quoy and Gaimard, to be small bunches of marginal lobes. Slaty colored, rim transparent, with radiating white lines; surface of the disk crenulate, dotted near the margin. — *Illiware Lake* (J. Drayton).

Rhacopilus *Ag.* Four large, pointed lobes, in each segment, between two of the eight eyes. Large actinostome, consisting of four pillars, between which are the large openings leading into the four genital pouches, and from which hang eight large arms, covered with numerous folds of the marginal lobes.

R. cyanolobatus *Ag.*—Rhizostoma cyanolobata *Couthouy*, Manuscript. —Whole surface of the disk granulated, bluish white; lobes of the margin deep blue; fringes of the arms edged with crimson. — *Harbor of Rio de Janeiro* (Couthouy). From a drawing and notes made by Mr. J. P. Couthouy, during the U. S. Exploring Expedition, under the command of Capt. Charles Wilkes.

R. cruciatus *Ag.* — Rhizostoma crùciata *Less.*, Voy. Coquille, Pl. 11, fig. 1. — *Coast of Brazil* (Lesson).

Toxoclytus *Ag.* — Eight short arms with cylindrical base, widening at their extremity into broad, arrow-head like, appendages, bordered with numerous folds of the marginal lobes.

T. roseus *Ag.* — Rhizostoma rosea *Reyn.* in *Less.*, Cent. Zool., Pl. 34. — *Atlantic Ocean, in the Tropics* (Reynaud).

T. Dubreuilli *Ag.* — Cephea Dubreuilli *Reyn.* in *Less.*, Cent. Zool., Pl. 23. — Rhizostoma Dubreuilli *Less.* — *Gulf of Bengal* (Reynaud).

Melitea *Pér.* and *LeS.*, 1809 (name preoccupied). — Orythia *Lmk.* (p. p.). — Rhizostoma *Esch.* and *Less.* (p. p.). — I suspect that the base of the arms alone are preserved in the only figure published of this genus, and that, besides the short lobes represented, it had long arms, like Thysanostoma.

M. purpurea *Pér.* and *LeS.* — *DeBl.*, Man. d'Actinol., Pl. 35, fig. 5, from a drawing by LeSueur. — Rhizostoma purpurea *Esch.* — Orythia purpurea *Lmk.* — *New Holland: DeWitt's Land* (Péron and LeSueur).

Thysanostoma *Ag.* — Eight very long, papillate arms, with a distinct round lobe, projecting outward from their base.

Th. Lessoni *Ag.* — Melitea brachyura *Less.*, Cent. Zool., Pl. 80. The name brachyura, for a species with very long arms, cannot be retained. — Rhizostoma brachyura *Less.*, Zool. Coq. — *New Guinea: Dorehy* (Lesson).

Evagora *Pér.* and *LeS.* 1809. — Orythia *Lmk.* (p. p.). — Rhizostoma *Esch.* (p. p.). Owing to the number of the arms, which exceeds that of the other genera, I have some doubts as to the position of this genus, in the family of Rhizostomidæ proper. As characterized by Péron and LeSueur, this genus embraces two distinct types, one of which, the E. tetrachira, has been removed to Ocyroë (Aurelia) by Blainville.

E. capillata *Pér.* and *LeS.* — *DeBl.*, Man. d'Actin., Pl. 35, fig. 3, from a drawing by LeSueur. — Orythia capillata *Lmk.* — Rhizostoma capillata *Esch.* — *New Holland: Endracht's Land* (Péron and LeSueur).

2d Family. LEPTOBRACHIDÆ *Ag.* This family embraces Rhizostomeæ with very long, slender arms, provided with a small cluster of marginal fringes near their termination. Four genital pouches.

Leptobrachia *Br.*, Bull. Ac. Sc. Pet., 1838.

L. leptopus *Br.* — Rhizostoma leptopus *Cham.* and *Eyscnh.*, Act. Nov. Ac. Leop., Vol. X. Pl. 27, fig. 1. — Rhiz. leptocephalus, *DcBlainv.* (misspelled for leptopus). — *Pacific Occan: Radack Islands* (Chamisso and Eysenhardt).

L. lorifera *Ag.* — Rhizostoma loriferum *Hemp.* and *Ehr.*, Akal. des roth. Meeres. — *Red Sea* (Hemprich and Ehrenberg).

3d Family. CASSIOPEIDÆ *Til.* Representatives of two very distinct families have thus far been associated under the generic name of Cassiopea. It becomes, therefore, a question which of these should retain the name applied by Péron and LeSueur to both of them. As Tilesius, in his elaborate monograph of the Cassiopeæ, Act. Nov. Nat. Cur., Vol. XV., considers Cassiopea Andromeda (Medusa Andromeda *Forsk.*) as the type of the genus, and Brandt calls the other type Polyclonia, it seems proper to follow their lead, even though the oldest species known is a Polyclonia, as this species was also included in the genus Cassiopea by Péron and LeSueur. The family of Cassiopeidæ differs from all the other Discophoræ by the presence of eight genital pouches, alternating with eight arms which form a shield in the centre of the actinostome. The genera differ chiefly in the structure of the arms and the manner in which they are united in the centre of the lower floor. In Cassiopea the arms form a single, eight-rayed rosette, and have numerous lateral dendritic ramifications; each genital pouch has two lateral pouches, corresponding to the tentacular pouches of Cyanea, though there are no marginal tentacles in this genus. In Crossostoma the arms form also a simple rosette, and are branching in the same way, but each arm has a separate tuft of fringes at its base, upon the rosette, and the genital pouches have no lateral or tentacular pouches. In Stomaster the central rosette is double, in consequence of the special combination of the separate tufts of the basal branches of the arms, but the genital pouches do not divide near the margin of the disk, as in Crossostoma. In Holigocladodes the arms are simple, and only crenate along the margin, but they have each a double crescent of dendritic ramifications at the base, and unite in the centre to form a double cross.

Cassiopea *Pér.* and *LeS.* — Polycladodes *Br.*

C. Andromeda *Esch.* — Cassiopea Andromeda *Tilesius,* in Act. Nov. Ac. Nat. Cur., Vol. XV. Pls. 69 and 70; copied by Milne-Edwards in Cuvier's Règne animal, pl. 51, f. 1. — Medusa Andromeda *Forsk.* — Cassiopea Forskålea *Pér.* and *LeS.* — *Red Sea* (Forskål and Ehrenberg); *Mauritius* (Péron and LeSueur); *Sumatra* (Tilesius). It would be very important to compare anew specimens from these different localities.

Crossostoma *Ag.* See p. 154.

C. frondosa *Ag.* — Cassiopea frondosa *Tiles.,* Act. Nov. Nat. Cur., Vol. XV. Pl. 72. — Not Cassiopea frondosa *Lmk.,* which is a Polyclonia! — *Macao and Canton* (Tilesius); *Radack Islands* (Chamisso).

Stomaster *Agass.* See p. 154.

S. canariensis *Ag.* — Cassiopea canariensis *Tiles.,* Act. Nov. Nat. Cur., Vol. XV Pl. 73. — *Atlantic Ocean: Canary Islands* (Tilesius).

Holigocladodes *Br.*

H. lunulatus *Ag.* — Urtica marina octopedalis *Borlase,* Nat. Hist. Cornw., p. 258, Pl. 25, figs. 16 and 17. — Medusa lunulata *Penn.* — Cassiopea Borlase *Pér.* and *LeS.* — Cassiopea lunulata *Flem., Esch.* — Cassiopea rhizostomoidea *Tiles.,* Nov. Act. xv. text, p. 273. — Cassiopea anglica *Tiles.,* Ib. pl. 71. — *British Channel* (Borlase, in 1758, and Tilesius).

4th Family. CEPHEIDÆ *Ag.*

The genus Cephea, as characterized by *Pér.* and *LeS.,* contains all the members of this family then known. They are Rhizostomeæ whose short arms are very complicated, polychotomous, with intervening long cirrhi. They differ only morphologically from Rhizostoma proper: the four arms dividing soon into eight branches, the ramifications of which are so clustered as to form terminal bunches, with intervening cotyles or pedunculated clusters of lasso-cells, and terminate in slender, long cirrhi, varying in number.

Our knowledge of these Medusæ has not made one step since Forskål, in whose "Descriptiones Animalium, &c.," two species are described and figured; but by a mistake of his editor, C. Niebuhr, the figures of Forskål are erroneously referred in the explanation of the plates, the description of Medusa octostyla applying to Pl. 29, and that of Medusa

Cephea to Pl. 30. This glaring mistake has been copied by all subsequent writers, and this circumstance seems to indicate that no one of them has taken the trouble of reading the text. We find it reproduced in *Pér.* and *LeS.*, who first distinguished the genus Cephea. Their diagnosis of Cephea cyclophora is drawn up from Pl. 29, but the name Medusa Cephea, and the description on page 208, are referred to among the synonyms; while the Cephea rhizostomoidea is drawn up from Pl. 30, and the name Medusa octostyla *Forsk.*, and the description on page 206 referred to. And this runs through the works of Lamarck, DeBlainville, Eschscholtz, Lesson, &c. It is very surprising that the name Medusa octostyla should not have excited the attention of compilers, and especially that of such observers as are quoted above. It is true, Forskål's drawing is in so far inaccurate as to represent nine instead of eight cirrhi, and these appendages are not mentioned in his text; but in Medusa Cephea he says distinctly, *fila plurima.* Taking my acquaintance of other Rhizostomidæ as a guide to interpret the descriptions and figures of Forskål, I do not hesitate to express my conviction that the two species of the celebrated Scandinavian traveller belong to two distinct genera.

Cephea *Pér.* and *LeS.*

C. octostyla *Ag.* (non *Esch.*, non *Less.*). — Medusa octostyla *Forsk.*, Descr. An., Pl. 29. — Cephea cyclophora *Pér.* and *LeS.*, *Lmk.*, *DeBl.*, *Esch.*, *Less.* (exlus. synon.), *Milne-Edw.* in Cuvier's Règne An., Pl. 51, fig. 4 (figure copied from *Forskål*; the same in Encycl. Méth.). — *Red Sea* (Forskål).

C. ocellata *Pér.* and *LeS.*, *Lmk.*, *Esch.*, *DeBl.*, *Less.* — Medusa ocellata *Mod.* — Origin unknown.

Polyrhiza *Agass.*

Polyrhiza Cephea *Ag.* — Medusa Cephea *Forsk.*, Descr. An., Pl. 30. — Cephea octostyla *Esch.*, *Less.* (exclus. synon.). — Cephea rhizostomoidea *Pér.* and *LeS.*, *Lmk.*, *DeBlainv.* (exclus. synon.). — *Red Sea* (Forskål).

P. fusca *Ag.* — Cephea fusca *Pér.* and *LeS.*, *Lmk.*, *Esch.*, *DeBl.* — *New Holland, DeWitt's Land* (Péron and LeSueur).

P. vesiculosa *Ag.* — Cephea vesiculosa *Hemp.* and *Ehrenb*, Akal. des roth. Meeres. — *Red Sea* (Hemprich and Ehrenberg).

Besides the two species of Forskål, Péron and LeSueur refer three others to the genus Cephea: 1, C. polychroma *Pér.* and *LeS.*; 2, C. ocellata *Pér.* and *LeS.*; and 3, C. fusca *Pér.* and *LeS.* An attentive comparison of the descriptions of these species shows the first to be a Cotylorhiza, the Cassiopea borbonica *Delle Ch.*, or Rhizostoma borbonica *Esch.*; the second a genuine Cephea, allied to C. octostyla; and the third a Polyrhiza, allied to P. Cephea. Lamarck has added nothing to this genus, but simply copied Péron and LeSueur. The Cephea capensis *Q.* and *G.*, Zool. Uran., p. 568, is, very likely, a genuine Rhizostoma, while the Cephea mosaica *Q.* and *G.* (Rhizostoma mosaica *Esch.*) constitutes a distinct genus, which I have called Catostylus. To these must be added the following new genera.

Diplopilus *Ag.* In the figure of Polyrhiza Cephea, published by Forskål, the summit of the umbrella is depressed, and evidently injured. In the centre of the depression there appear singular bodies which could not be understood by reference to any known Medusa. Among the drawings of Discophoræ made during the U. S. Exploring Expedition by J. P. Couthouy, Esq., there is, however, one representing an Acaleph of the same family, which explains this puzzle. From the centre of the umbrella arises a cupola, occupying about one third of the whole diameter, made up of large conical tubercles, and standing out prominently from the upper part of the disk. This dome corresponds, in extent, to the central cavity, and is the part sunk in the figure of Forskål. From its outline arise eight simple radiating tubes, which reach the base of the eight eyes. In each of the segments thus circumscribed arise ten or twelve simple chymiferous tubes, which anastomose in arches at some distance, and then, doubling their number, radiate in a straight course for twice the distance, towards the margin, where they anastomose again, and, increasing further in number, reach the margin in a network of anastomoses. The margin of the disk is divided, in each segment, into eight pointed lobes. The actinostome consists of four broad arms, with numerous fringes and many slender tentacles along their whole margin. Each flat arm is broadly furcate at its extremity.

D. Couthouyi *Ag.* The pointed tubercles of the cupola, and the whole margin of the disk, are papillate. — *Wilson's Island* (J. P. Couthouy).

Hidroticus *Ag.* — Eight short, foliated arms, terminating in eight short, club-shaped tentacles, hanging among the foliaceous appendages. Margin of the disk crenulated. Named in remembrance of LeSueur, whose name is hellenized.

H. rufus *Ag.* Disk pale, rufous, dotted with whitish specks; margin deeper. Arms rufous, with small, sparse, white papillæ; their club-shaped termination diaphanous, with a fine blue band near the tip. — *Straits of Sunda* (W. W. Wood). From a drawing and notes by Mr. W W. Wood.

Cotylorhiza *Agass.* — Cephea *Pér.* and *LeS.* — Cassiopea *Delle Ch.* — Rhizostoma *Less.*

Morphologically considered, this genus is a Cephea, with pedunculated suckers and without cirrhi. It cannot be referred to the family of Cassiopeidæ, with which Delle Chiaje had associated it, since it has only four genital sacs; nor to that of Rhizostomidæ proper, with which Eschscholtz had united it, since it has a central disk and no pillars.

C. tuberculata *Ag.* — Medusa tuberculata *Macri.* — Cephea tuberculata *Esch.* — Cephea polychroma *Pér.* and *LeS.*, *Lmk.*, *DeBl.*, *Risso*, *Less.* — Cassiopea borbonica *Delle Chiaje*, Memorie sulla Storia e Notomia, &c., Pls. 3 and 4; copied by Milne-Edwards in Cuvier's Règne An., Pl. 51, fig. 2. — Rhizostoma borbonica *Esch.*, *Less.* — *Naples* (Péron and LeSueur and Macri); *Nizza* (Risso).

Phyllorhiza *Ag.* Allied to Cotylorhiza, but the eight arms divide into three fringed lobes, like the leaves of clover, instead of being dichotomous, with numerous pendant filaments.

Ph. chinensis *Ag.* Disk papillous or tuberculated, the tubercles pearly and the interstices transparent, giving it a beautiful reticulated appearance; the tubercles larger toward and on the summit of the disk. Eight narrow lobes, respectively, between the eight eyes; lobes reddish brown, horizontally lineate with darker streaks. Arms finely punctured, reddish beneath; filaments reddish, with whitish, opaque dots. — *China Seas* (W. W. Wood). From a drawing and notes by W. W Wood.

5th Family. POLYCLONIDÆ *Agass.* Not only are the long branching arms characteristic of this family; it differs also from all the other Rhizostomeæ by its peculiar symmetry, there being no eyes in the radial prolongation of the genital pouches. Compare page 139.

Polyclonia *Br.*

P. Mertensii *Br.*, Mém. Ac. St. Petersb., 1838, Vol. II. Pls. 21, 22, 23. — Rhizostoma Mertensii *Br.*, Bull. — Cassiopea Mertensii *Br.*, Prodr. — *Caroline Islands: Ualan* (Mertens).

P. frondosa *Ag.* — Medusa frondosa *Pall.*, Spicil. Zool., X. Pl. 2, figs. 1–3. — Cassiopea frondosa *Lmk.*, *Esch.* — Cassiopea Pallas *Pér.* and *LeS.* — *West Indies* (Pallas); *Florida: Key West* and *Key Largo* (L. Agassiz).

P. theophila. — Cassiopea dieuphila *Pér.* and *LeS.* — Cassiopea theophila *Lmk.*—Rhizostoma theophila *Esch.*—*New Holland: With's Land* (Péron and LeSueur).

Salamis *Less.* Prodr. (name preoccupied). — Orythia *Q.* and *G.*

S. toreumata *Less.* — Orythia incolor *Q.* and *G.*, Voy. Astr., Pl. 25, fig. 10. — *Moluccas Islands* (Lesson).

Homopneusis *Less.*

H. frondosus *Less.*, Voy. Coquille, Mollusques, Pl. 12. — *Waigiou Island* (Lesson).

6th Family. FAVONIDÆ *Agass.* See p. 135 of this volume.

Favonia *Pér.* and *LeS.* — Orythia *Lmk.* (p. p.).

F. octonema *Pér.* and *LeS.* — *New Holland* (Péron and LeSueur).

F. hexanema *Pér.* and *LeS.* — *Tropics: Atlantic* (Péron and LeSueur).

Lymnorea *Pér.* and *LeS.*, *DeBl.*, *Esch.*, *Less.* — Dianæa *Lmk.* (p. p.).

L. triedra *Pér.* and *LeS.* — *New Holland* (Péron and LeSueur).

2d Sub-order. SEMÆOSTOMEÆ *Agass.* See page 9 of this volume, in which the characteristics of this sub-order are contrasted with those of the Rhizostomeæ and Haplostomeæ.

1st Family. AURELIDÆ *Agass.* See p. 80 for the characters of the family.

Aurelia *Pér.* and *LeS.*, 1809. — Medusa *Lin.*, 1746, *Esch.* — Ephyra *Pér.* and *LeS.*, 1809. — Ocyroë *Pér.* and *LeS.*, 1809. — Evagora *Pér.* and *LeS.*, 1809 (p. p). — Orythia *Lmk.*, 1815 (p. p.).— Cyanæa *Cuv.*, 1818 (p. p.).— Scyphistoma *Sars*, 1829. — Rhizostoma *Esch.*, 1829 (p. p.). — Strobila *Sars*, 1835. — Diplocraspedon *Br.*, 1835. — Monocraspedon *Br.*, 1835. — Claustra *Less.*, 1837. — Biblis *Less.*, 1837. — Macrostoma *Less.* — Laodicea *Less.*, 1843.

A. cruciata *Ag.* — Medusa cruciata *Bast.* — Medusa aurita *Lin.* — Medusa aurita *Ehrenb.* — Medusa purpurea *Penn.* — Medusa purpurata *Mod.* — Aurelia suriray *Pér.* and *LeS.* — Aurelia campanula *Pér.* and *LeS.* — Aurelia rosea *Pér.* and *LeS.* — Aurelia melanospila *Pér.* and *LeS.* — Aurelia lineolata *Pér.* and *LeS.* — Aurelia radiolata *Lmk.* — Aurelia granulata *Lmk.* — *Northern Europe: Norway* (Sars); *German Ocean* (O. F. Müller, Ehrenberg); *England* (Pennant, Forbes); *Coast of France* (Lesson).

A. aurita *M.-Edw.* — Medusa aurita *Kalm.* — Cyanæa aurita *Cuv.* — Medusa Persea *Forsk.* — Ocyroë Persea *DeBl.*, text; Ocyroë labiata, Pl. 35, fig. 1. — Aurelia purpurea *Pér.* and *LeS.* — Evagora tetrachira *Pér.* and *LeS.* — Orythia tetrachira *Lmk.* — Aurelia globularis *Cham.* and *Eysenh.* — Rhizostoma Persea *Esch.* — Cyanea quadricincta *Reyn.* — Aurelia quadricincta *Br.* — Medusa stelligera *Hemp.* and *Ehrenb.* — Biblis Reynaudii *Less.* — Biblis Aquitaniæ *Less.* — Laodicea crucigera *Less.* — *Mediterranean* (Forskål); *Azores* (Chamisso and Eysenhardt); *Atlantic* (Reynaud); *Bay of Biscay* (Lesson); *Sicily* (Milne-Edwards); *Alexandria* and *Red Sea* (Hemprich and Ehrenberg).

A. flavidula *Pér.* and *LeS.* — Medusa aurita *Fabr.*, *Gould.* — *Greenland* (Fabricius); *New England* (Dr. Gould, L. Agassiz).

A. labiata *Cham.* and *Eysenh.* — Medusa labiata *Esch.* — Ocyroë labiata *DeBl.* — *North California* (Chamisso and Eysenhardt); *California* (Eschscholtz).

A. marginalis *Ag.* See p. 86 of this volume. — *Florida: Key West* (L. Agassiz).

A , — A. aurita *Cham.* and *Eysenh.* (non auct.). — *Radack* (Chamisso and Eysenhardt).

A. colpota *Br.* — *Lat.* 35° *S., and Long.* 334° *W., near Cape of Good Hope* (Mertens).

A. limbata *Br.* (Diplocraspedon). — *Kamtschatka: Awatscha Bay* (Mertens). — Aurelia hyalina *Br.*? — *Aleutian Islands* (Mertens).

A. clausa *Less.* — Claustra pissiniboque *Less.* — *Port Praslin, New Zealand* (Lesson).

A , — Ocyroë lineolata *Pér.* and *LeS.* — *North of New Holland* (Péron and LeSueur). — As this is the type of the genus Ocyroë, and the two species added to it by DeBlainville also belong to Aurelia, the whole genus must be erased from the system of Acalephs.

2d Family. STHENONIDÆ *Agass.* See p. 115 for the characters of this family.

Sthenonia *Esch.*, 1829.

S. albida *Esch.*, Acal., Pl. 4.—*Coast of Kamtschatka: Awatscha Bay* (Eschscholtz).

Heccædecomma *Br.*, 1838.

H. ambiguum *Br.*, Ausführl. Beschr., &c., in Mém. Acad. St. Petersburg, 1838, Pls. 27 and 28.—*Origin undetermined.* From drawings left by Mertens. My son has observed a species of this genus at *Port Townsend, Straits of Fuca,* so closely allied to the H. ambiguum, that I am unable to distinguish it. I suppose, therefore, that Mertens may have seen the species he figured at Sitka, or off that coast.

Phacellophora *Br.*, Prodr., 1835.

P. camtschatica *Br.*, Ausführl. Beschr., &c., in Mém. Acad. St. Petersb., 1838, Pl. 8.—*Harbor of Petropaulowsk, Kamtschatka* (Mertens). The species mentioned by Huxley as Phacellophora, in Philos. Trans., 1849, Pl. 33, fig. 18, is a genuine Cyanea.

3d Family. CYANEIDÆ *Agass.*—Cyaneæ *Til.* See p. 114.

Cyanea *Pér.* and *LeS.*, 1809.—Cyanæa *Cuv.*, Règne An., 1818.

C. capillata *Esch.*—Medusa capillata *Lin.*—Cyanea baltica *Pér.* and *LeS.*—Cyanea borealis *Pér.* and *LeS.*—*Gæde* has published a good anatomical description of this species: Beiträge zur Anatomie und Physiologie der Medusen, Berlin, 1816, 8°.[1]—*In the German Ocean and the Baltic* (Linnæus, Gaede); *about Kentshire* (Chamisso and Eysenhardt).

C. Lamarckii *Pér.* and *LeS.*, *Esch.*—Cyanea britannica *Pér.* and *LeS.*—Cyanea capillata *Dalyell*, Rare Anim., Vol. II. Pl. 51, figs. 5 and 6.—*British Channel: Havre* (Péron and LeSueur); *Scotland* (Dalyell).

The more northern Cyanea capillata differs from the C. Lamarckii in the same manner as our C. versicolor and C. arctica differ from one another. C. lusitanica *Pér.* and *LeS.* may be a third European species.

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[1] It would seem that Ehrenberg never read Gæde's accurate description of Aurelia and Cyanea, for he makes him represent the ovaries as a liver (Ehrenberg, p. 18), while Gæde distinctly states, p. 23, "Dass nun der vorher beschriebene Faltenkranz Genitalien und die auf demselben befindlichen Körner Eier sind, davon hat mich folgende Beobachtung überzeugt., &c."

C. arctica *Pér.* and *LeS.*, *Ag.*, p. 87, Pls. 3, 4, 5, and 5ª — Medusa capillata *Fabr.* (non *Linn.*). — Cyanea Postelsii *Gould* (not *Br.*). — *North-eastern American coast, from the Bay of Fundy to Boston harbor* (Dr. A. A. Gould and L. Agassiz); *Greenland* (Fabricius).

I have no doubt that the Medusa capillata of Fabricius is identical with the Cyanea arctica of Péron and LeSueur, and that it is the species found along the Atlantic coast of the North American British Provinces and the northern United States, north of Cape Cod.

C. fulva *Ag.* See p. 119. — *Long Island Sound* (L. Agassiz).

C. versicolor *Ag.* See p. 119. — *South Carolina* (L. Agassiz).

All the problems which have engaged naturalists, respecting the identity of animals in different parts of the world, begin to come up, with reference to these species, as the knowledge of the Medusæ advances. At first the North American Medusæ were considered as identical with those of Europe, but a closer comparison shows them to be different.

C. ferruginea *Esch.* — *Kamtschatka, Aleutian Islands, and north-west coast of North America* (Eschscholtz).

C. Postelsii *Br.*, Ac. St. Petersb., 1838, Pls. 12, 13, and 13ª. — Cyaneopsis behringiana *Br.*, Pl. 11, fig. 1, is only a young of this or the preceding species. — *North Pacific, Norfolk Sound, and between Sitka and Unalaschka* (Mertens); *Port Townsend* (A. Agassiz). It remains to be ascertained whether there are real specific differences between the Cyaneæ found on the Asiatic and on the American sides of the Pacific. Brandt maintains that Cyanea Postelsii differs from C. ferruginea, but he assigns to both the same range of distribution, which is not probable.

Lesson's Cyanea plocamia, Voy. Coquille, Pl. 12, from the coast of *Peru,* and Raynaud's Cyanea caliparea, in Lesson's Cent. Zool., Pl. 20, from *Pondicherry,* may both belong to the following genus, Stenoptycha.

Stenoptycha *Agass.* The narrow band of concentric folds alternating with radiating folds, readily distinguishes this genus from Cyanea. The tentacles, also, are fewer in number and arranged in a single row.

St. rosea *Ag.* — Cyanea rosea *Q.* and *G.*, Zool. Uranie, Pl. 85, figs. 1 and 2. — *New South Wales, Port Jackson* (Quoy and Gaimard).

Couthouyia *Agass.* See p. 118.—Nerinea *Couth.*, Manuscript.

C. pendula *Ag.*—Nerinea pendula *Couth.*—*Orange Harbor, Terra del Fuego* (J. P. Couthouy in Capt. Wilkes' Expedition).

Medora *Couth.*, Msc. See p. 118.

M. reticulata *Couth.*, Msc.—*Orange Harbor, Terra del Fuego* (J. P. Couthouy in Capt. Wilkes' Exploring Expedition).

M. capensis *Couth.*, Msc.—*Pacific Ocean, in sight of Cape Horn* (J. P. Couthouy in Capt. Wilkes' Exploring Expedition).

Patera *Less.* I refer this genus, with doubt, to the family of Cyaneidæ, no mention being made by Lesson of the genital pouches. The arrangement of the tentacles, though there are twice as many, is similar to that of Stenoptycha; but the oral appendages form a convolute mass of meandering folds, the main branches of which terminate in a pinnate lobe.

P. cerebriformis *Less.*—Dianæa cerebriformis *Less.* (Zoologie de la Coquille, Zoophytes, Pl. 10).—*Atlantic Occan, under the equator, Long.* 25° *W.* (Lesson).

Donacostoma *Agass.* From the centre of the actinostome projects a fleshy proboscis, at the extremity of which are a number of slender tentacles. Like Patera, it has sixteen bunches of tentacles, arranged in a single row in each lobe. The genital pouches are very wide, and conceal the whole actinostome, with the exception of its central peduncle, which hangs below them. Lobes of the margin of the disk angular, so that the margin itself appears straight, and is only cleft at intervals.

D. Woodii *Ag.* Disk purplish, with white margin; upper surface papillous. Tentacles of the same color as the disk; genital pouches paler.—*China Sea, off Tulo Timoan* (W W. Wood). From a drawing and notes by Mr. Wood.

4th Family. PELAGIDÆ *Gegcnb.*, Zeitsch. f. wiss. Zool., 1856.—Agass. p. 121.—Pelagiæ *Til.*—Chrysaoræ *Til.*

Pelagia *Pér.* and *LeS.*, 1809.

P. noctiluca *Pér.* and *LeS.*, *Esch.*, *Less.*, *Milne-Edw.*, in Cuvier's Règne An., Pls. 45 and 46, *Wagner*, Icones Zootom., Pl. 30, *Figs.* 1–25.—Medusa noctiluca *Forsk.*, *Delle Ch.*—Medusa phosphorea *Spallanz.*—Aurelia phosphorica *Pér.* and *LeS.*—Pelagia purpurea *Pér.* and *LeS.*—Pelagia parthenopensis *Less.*—Pelagia phosphorea *Esch.*—*Mediterranean* (Forskål and all modern authors on the subject).

P. Lessoni *Br.* — Pelagia panopyra *Less.*, Centurie Zoologique, Pls. 62 and 63. — Nothing can be worse than the figures of this Acaleph published by Lesson, who represents it in one of his plates without indentations, and without eyes along the margin of the disk (Pl. 62), and in the other (Pl. 63), with a disk divided into twelve unequal lobes. I am not acquainted with a single Medusa presenting such a combination of characters. I have, however, before me drawings, made by Mr. J. Drayton, in the same quarter of the world, under the supervision of Mr. Couthouy, during Capt. Wilkes' Exploring Expedition, which show the existence of a Pelagia along the western coast of Africa, closely allied to P. noctiluca, but different from P. cyanella, for which I feel bound to retain the name of P. Lessoni, inscribed by Brandt, for one of the plates of Lesson. This species is more transparent and hyaline than P. noctiluca, of a lighter rose color, and does not seem to grow so large. — Medusa pelagia *Forsk.*, and Pelagia guineensis *Pér.* and *LeS.*, may also belong here. — *Cape de Verd Islands* (Couthouy in Capt. Wilkes' Expedition); *from* 7° *N. Lat. to* 4° *S. Lat., and* 22° *W. Long.* (Lesson).

P. cyanella *Pér.* and *LeS., Esch., Bosc., Ag.*, Pls. 13 and 13ª. — Medusa pelagia *Swartz.* — Medusa pelagia *Löffling.* — Pelagia americana *Pér.* and *LeS.* — Pelagia noctiluca *Cham.*, in Choris' Voy. — Pelagia denticulata *Pér.* and *LeS.* — Dianæa cyanella *Lmk.* — Dianæa denticulata *Lmk.* — *Caribœan Sea* (Swartz and Löffling); *Coast of Florida: Tortugas* (L. Agassiz).

P. panopyra *Pér.* and *LeS.*, Voy. aux Terres Austr., Pl. 31, fig. 2 (not *Br.*), *Esch.* (p. p.). The specimens seen by Eschscholtz in the Atlantic, which he refers to P. panopyra, were probably P. Lessoni *Br.* — Dianæa panopyra *Lmk.* — *Australia* (Péron and LeSueur); *Pacific* (Eschscholtz).

P. Brandtii *Ag.* — Pelagia denticulata *Br.*, Ac. St. Petersb., 1838, Pl. 14, fig. 2 (not *Pér.* and *LeS.*, which is P. cyanella). — *Aleutian Islands* (Mertens).

P. tuberculosa *Couth.*, Msc. — Pelagia panopyra *Br.*, Ac. St. Petersb., 1838, Pl. 14, figs. 1 and 14ª (not *Pér.* and *LeS.*). — *Coast of Chili* (Couthouy, in Capt. Wilkes' Expedition); *Peru* (Mertens).

P. flaveola *Esch.*, Acal., Pl. 6, fig. 3. — *North Pacific*, 34° *N. Lat. and* 201° *W. Long.* (Eschscholtz).

P. Labiche *Esch.* — Cyanea Labiche *Q.* and *G.*, Voy. Uran., Pl. 84, fig. 1. — *Pacific, under the Equator* (Quoy and Gaimard).

What Pelagia australis *Pér.* and *LeS.*, and Pelagia conifera *Less.*, may be, I am unable to say. The species of this genus are very closely allied, and vary greatly, according to their age. Most of the descriptions thus far published contain only delineations of individuals, and not specific characteristics.

Placoïs *Ag.* — See p. 125. — Pelagia *Esch.* (p. p.).

P. discoidea *Ag.* — Pelagia discoidea *Esch.*, Acal., Pl. 7, fig. 1. — *Southern Atlantic, near the Cape of Good Hope* (Eschscholtz).

Chrysaora *Pér.* and *LeS.*, *Esch.* — Restricted by *Ag.*, p. 125.

C. hysoscella *Esch.* — Medusa hysoscella *Lin.* — Medusa fusca *Penn.* — Medusa tuberculata *Penn.* — Aurelia (?) crenata *Cham.* and *Eys.*, Nov. Act., 1821, Pl. 29. — *Dalyell*, Rare Anim., Vol. I. Pls. 15 and 17. — Cyanea chrysaora *Cuv.* and *M.-Edw.*, in Cuvier's Règne Anim., Pl. 47. — Cyanea punctata *Lmk.* — Chrysaora LeSueur *Pér.* — Chr. aspilonota *Pér.* and *LeS.* — Chr. cyclonota *Pér.* and *LeS.* — Chr. spilhemicona *Pér.* and *LeS.* — Chr. spilogona *Pér.* and *LeS.* — Chr. pleurophora *Pér.* and *LeS.* — Chr. mediterranea *Pér.* and *LeS.* — Chr. macrogona *Pér.* and *LeS.* — Chr. cyclonota *Gosse*, Devonsh., Pl. 2. — Chr. heptanema *Pér.* and *LeS.* — Chr. oculata *Less.* — *German Ocean* (Linnæus); *British Channel* (Chamisso and Eysenhardt); *Havre* (Péron and LeSueur); *Atlantic Ocean* (Vandelli and Lesson); *Mediterranean* (Péron and LeSueur).

Thus far, only one species of this genus is satisfactorily known; but no comparisons have as yet been made to ascertain whether specimens from the Mediterranean are identical or not with those of the Atlantic and of the German Ocean, though Péron and LeSueur have distinguished several species among them. A comparison of the best figures, such as those of Milne-Edwards, Gosse, Dalyell, and Chamisso, does not afford the means of settling this question. Nor does Lesson's figure of Chrysaora oculata, Acal., Pl. 6, fig. 2, differ. It is impossible, from the descriptions, to ascertain what are the generic affinities of the species named by Péron and LeSueur, Chrysaora pentastoma, from *Napoleon's Land* (Australia) and hexastoma, from *Van Dieman's Land;* nor can Lesson's Chrysaora cruentata be identified.

C. Reynaudi *Less.* — Rhizostoma fulgida *Reyn.*, in Lesson, Cent. Zool., Pl. 25. — *Cape of Good Hope* (Reynaud). — Seems to be a distinct species.

Lesson has figured two other species, under the names of Chrysaora Gaudichaudi and Chr. Blossevillii, which, unquestionably, constitute two distinct genera, though his descriptions afford only imperfect means of characterizing them:

Desmonema *Ag.* Marginal lobes very large and triangular, twelve in number, and terminating in twelve fasciculated tentacles. Twelve small lobes, eyes (?), alternating with the large lobes.

D. Gaudichaudi *Ag.* — Chrysaora Gaudichaudi *Less.*, Voy. Coquille, Pl. 13, fig. 1. — *Bay of Soledad, Malouine Islands, and off Cape Horn* (Lesson).

Lobocrocis *Ag.* Margin doubly lobed; the outer row containing twice as many pointed lobes as the inner one, the lobes of which are broadly rounded. Tentacles between alternate marginal lobes.

L. Blossevillii *Ag.* — Chrysaora Blossevillii *Less.*, Voy. Coquille, Pl. 13, fig. 2. — *Coast of Brazil: St. Catherine's Island* (Lesson).

Dactylometra *Ag.* See p. 125. — Chrysaora *Esch.* (p. p.).

D. lactea *Ag.* — Chrysaora lactea *Esch.*, Acal., Pl. 7, fig. 3. — *Bay of Rio de Janeiro, Brazil* (Eschscholtz).

D. quinquecirra *Ag.* — Pelagia quinquecirra *Desor*, Proc. Bost. Nat. Hist. Soc., 1848, p. 76. — *Nantucket Bay* (Desor); *Naushon* (A. Agassiz); *between the Bermudas and Azores* (J. Drayton, in Capt. Wilkes' Expedition).

Polybostrycha *Brandt*, 1838; *Ag.* See p. 126.

P. helvola *Br.*, Ac. St. Petersb., 1838, Pl. 15. — *Off Sitka and the Aleutian Islands* (Mertens).

P , *A. Ag.*, Msc. — *California* (A. Agassiz). This, and other species noticed here, will shortly be described.

Melanaster *Ag.* See p. 126.

M. Mertensii *Ag.* — Chrysaora melanaster *Br.*, Ac. St. Petersb., 1838, Pls. 16 and 17. — *Kamtschatka: Awatcha Bay* (Mertens).

M , *A. Ag.*, Msc. — *California* (A. Agassiz).

Zygonema *Ag.* See p. 127.

Z. volutata *Ag.* — Pelagia volutata *Couth.*, Msc. — *Harbor of Rio de Janeiro* (J. Drayton, in Capt. Wilkes' Expedition).

Respecting the following genus, see my remarks, p. 122.

Nausithoë *Köll.*, 1853. — Octogonia, 1852, *J. Müll.*, Gesellsch. Nat. Freunde; and Arch. f. Anat., 1854, p. 97.

N. punctata *Köll.*, Zeit. f. wiss. Zool., 1853, IV. p. 323. — *Messina* (Kölliker).

N. marginata *Köll.*, Zeit. f. wiss. Zool., 1853, IV. p. 323. — *Messina* (Kölliker).

N. albida *Gegenb.*, Zeit. f. wiss. Zool., 1856, VIII. p. 211. — *Messina* (Gegenbaur).

3d Sub-order. HAPLOSTOMEÆ *Agass.* See page 9, where the characters of this sub-order are compared with those of the Semæostomeæ. Thus far, these Medusæ have been associated with the naked-eyed Acalephs, but their structure (and what is known of their mode of development) brings them nearer to the true Discophoræ, than to the Hydroidæ. On p. 59 of the third volume, I have alluded to the Hydroid affinities of the genus Lucernaria. A closer comparison induces me to adopt, to some extent, the view of Huxley, who refers these singular animals to the type of the Discophoræ. But I cannot agree with him in bringing them, as he does, into such close proximity with the highest Discophoræ, and separating them altogether from the group which he has called Medusidæ, most of which correspond to this sub-order of Haplostomeæ. Lucernaria is closely allied to Marsupialis and kindred genera, and these, with Ægina and Cunina, must be separated from the other naked-eyed Medusæ, and referred to the Discophoræ proper, but as a distinct and inferior group. The use Huxley makes of the name Lucernaridæ, to designate the true Discophoræ, is certainly unfortunate, and likely to lead to misapprehensions; it is also contrary to usage, which requires older names to be retained, as far as possible.

1st Family. THALASSANTHEÆ *Lesson*, 1843. — Æginidæ *Gegenb.*, Zeitsch. f. wiss. Zool., 1856, VIII. p. 258.

Long before Gegenbaur, Lesson had already separated the Æginidæ from the Æquoridæ, as a distinct family, under the name of THALASSANTHEÆ. I do not understand why Gegenbaur did not adopt this name; for Lesson's family, tribe as he calls it, contains exactly the same genera as Gegenbaur's.

Euryale *Pér.* and *LeS.*, 1809.

E. antarctica *Pér.* and *LeS.*—*Furneaux Island* (Péron and LeSueur).

Foveolia *Pér.* and *LeS.*, 1809. — Cunina *Esch.*, 1829, *DeBl.*, *Less.*, *Köll.*, *Lmk.*, and *Gegenb.*

F. pilearis *Pér.* and *LeS.*, *DeBl.*, *Less.* — *Atlantic* (Lesson).

F. bunogaster *Pér.* and *LeS.*, *DeBl.*, *Less.* — *Nizza* (Péron and LeSueur).

F. mollicina *Pér.* and *LeS.*, *DeBl.*, *Less.* — Medusa mollicina *Forsk.*, Pl. 33, fig. C; *Bosc*, Encycl., Pl. 95, figs. 1 and 2; also copied by *DeBl.*, Pl. 33, fig. 1. — Æquorea mollicina *Esch.*, *Lmk.* — *Mediterranean* (Forskål); *Nizza* (Lesson).

F. diadema *Pér.* and *LeS.*, *DeBl.*, *Less.* — *South Atlantic* (Péron and LeSueur).

F. lineolata *Pér.* and *LeS.*, *DeBl.*, *Less.* — *Nizza* (Péron and LeSueur).

F. pulvinata *Less.* — *India?* (Lesson).

The following species have been described under the name of Cunina.

C. campanulata *Esch.*, Acal., Tab. IX. fig. 2, *DeBl.*, *Less.* — *Atlantic Ocean, north of the Azores* (Eschscholtz).

C. globosa *Esch.*, Acal., Tab. IX. fig. 3, *DeBl.*, *Less.* — *Pacific, near the Equator*, 150° *W.* (Eschscholtz).

C. Moneta *Leuck.*, Arch. Nat., 1856, p. 36, Pl. 1, fig. 13, and Pl. 2, fig. 12. — Porpita Moneta *Risso.* — *Nizza* (Risso, Leuckart).

C. costata *Leuck.*, Arch. Nat., 1856, p. 38. — *Nizza* (Leuckart).

C. dodecimlobata *Köll.*, Zeitsch. f. wiss. Zool., 1853, IV. p. 321. — *Messina* (Kölliker).

C. vitrea *Gegenb.*, Zeit. wiss. Zool., 1856, VIII. p. 259, Pl. 10, fig. 1. — *Messina* (Gegenbaur).

C. lativentris *Gegenb.*, Zeit. f. wiss. Zool., 1856, VIII. p. 260, Pl. 10, fig. 2. — *Messina* (Gegenbaur).

C. albescens *Gegenb.*, Zeit. f. wiss. Zool., 1856, VIII. p. 260, Pl. 10, figs. 3 and 4. — *Messina* (Gegenbaur).

C. octonaria *McCr.*, Proc. Elliott Society, Pl. XII. figs. 4 and 5. — *Charleston, South Carolina* (J. M'Crady).

Without attempting to identify all the species here enumerated, which may be synonymous, I venture to state that Cunina Moneta *Leuck.* is the Foveolia lineolata *Pér.* and *LeS.*, with which Cunina albescens *Gegenb.* also agrees. Cunina lativentris *Gegenb.* does not differ from Foveolia bunogaster *Pér.* and *LeS.*; nor his Cunina vitrea from their Foveolia mollicina.

This genus, when better known, will probably be subdivided. Gegenbaur has already pointed out marked differences in the form of the radiating pouches, which may be considered as generic. He has also indicated, for the first time, a most important distinction between Cunina, on one side, and the other genera of this family (in the mode of insertion of the tentacles, in the radial prolongation or between the radiating pouches), which Eschscholtz had simply considered as a generic character, though it may lead to the further separation of the two groups as distinct families.

Eurybia *Esch.*, 1829. This genus is a Cunina or Foveolia, with four pouches and four tentacles.

E. exigua *Esch.*, Acal., Pl. 8, fig. 5. — *Pacific Ocean, near the Equator* (Eschscholtz).

Campanella *DeBlainv.*, 1834 (not *Lesson*). — Æginopsis *J. Müll.*, 1851, *Leuck.*, *Köll.*, *Gegenb.* (not *Brandt*). — Charybdea *Q.* and *G.* (p. p.). This genus is characterized by its eight radiating pouches, in which the genital organs are developed, and its two tentacles arising from the sides of the umbrella in opposite directions. The genus Campanella *Less.* is synonymous with Melicertum. Saphenia and the bitentaculated Geryonidæ have only a remote analogy with this genus.

C. Capitulum *Q.* and *G.*, Msc., DeBl. auct.[1] — Aeginopsis bitentaculata *J. Müll.* — Charybdea bidentaculata *Q.* and *G.*, Zool. Astr., Vol. IV. p. 295, Zooph., Pl. 25, figs. 4 and 5. — *Less.*, Ac., p. 265. — *Amboina* (Quoy and Gaimard).

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[1] DeBlainville quotes Quoy and Gaimard for Campanula Capitulum; but there is no species described by them under that name. When it is remembered, however, that DeBlainville used Quoy and Gaimard's notes for his references, we should not wonder at occasional discrepancies between their works, nor be surprised that the nomenclature of Quoy and Gaimard, in the Astrolabe, is not always identical with that of DeBlainville's Actinologie, as they have, now and then, themselves altered the names which occurred in the manuscript used by DeBlainville. It is, nevertheless, much to be regretted that Quoy and Gaimard should not refer to DeBlainville more frequently in their final publication. This has led to a difficulty respecting the synonymy of this species. The genus Campanella, which Q. and G. had proposed in their manuscript, but finally dropped, is good, and the species was new at the time of its publication by DeBlainville. The name Campanella Capitulum must, therefore, be retained, with the authority, *Q.* and *G.*, even though, in the work of Quoy and Gaimard, Zoologie de l'Astrolabe, neither the generic nor the specific names, said by DeBlainville to have been given by them to this species, were retained for it.

C. mediterranea *Ag.*—Aeginopsis mediterranea *J. Müll.*, Arch. Anat., 1851, p. 272, Pl. 11.—*Leuck.*, Arch. Naturg., 1856, p. 33, Pl. 2, figs. 8 and 9.—*Gegenb.*, Zeitsch. f. wiss. Zool., 1856, VIII. p. 266.—Aeginopsis bitentaculata *Köll.*, Zeitsch. f. wiss. Zool., 1853, IV. p. 320. Not Æg. bituberculata as *Leuck.* quotes it. —*Messina* (Müller, Kölliker, and Gegenbaur); *Nizza* (Leuckart).

Æginopsis *Br.*, 1835 (not *J. Müller*). Characterized by its lobed actinostome and four tentacles, each one alternating with four radiating pouches.

Æg. Laurentii *Br.*, Ac. St. Petersb., 1838, Pl. 6, *Less.*—*Laurent Bay*, *Behring Sea* (Mertens).

Aegina *Esch.*, 1829. Actinostome simple. Four tentacles, each one alternating with two radiating pouches which terminate in a bilobed sac. As characterized, from Ægina citrina, the genus Ægina is a very natural group; but, besides Ægina rosea, Eschscholtz has added to it a number of species described by other writers, which do not belong here, although they belong to the same family, and probably to the genus Pegasia, to which some Æquoreæ *Pér.* and *LeS.* may also belong.

Ægina citrina *Esch.*, Zool. Atl., Pl. 5, fig. 2; Acal., Pl. 11, fig. 4; copied in *DeBl.*, Pl. 39, fig. 1.—*North Pacific*, 34° *N. Lat.*, and 201° *W. Long.* (Eschscholtz).

Ægina rosea *Esch.*, Acal., Pl. 10, fig. 3, is likely to become the type of a distinct genus, on account of the numeric relations of the tentacles and radiating pouches, and the form of the latter.—*North Pacific* (Eschscholtz).—Mr. W. W. Wood has forwarded to me a drawing of another species from the vicinity of the *Cape of Good Hope*, on its Atlantic side, which belongs to the same type as Æg. rosea. Its actinostome is tentaculated; that of Æg. rosea is not described.

Pegasia *Pér.* and *LeS.*, 1809, *DeBl.*, *Less.*—Aegina *Esch.*, 1829 (p. p.). —Scyphis *Less.*, 1843.—Pachysoma *Köll.*, 1853.—Ægineta *Gegenb.*, 1856.—Paryphasma *Leuck.*, 1856.—Stenogaster *Köll.*, 1853.

There is no excuse for this multiplication of names, unless it should hereafter be proved that there are structural differences between the species here referred to, for Pegasia *Pér.* and *LeS.* is not only described in Ann. du Museum, Vol. XIV., but *Lesson* and *DeBlainville* have also reproduced that description, and *DeBlainville* even published one of the drawings of *LeSueur*. This is certainly quite sufficient to establish the priority of the genus Pegasia, and even more satisfactory than the descriptions of *Kölliker*, no one of which is illustrated. Here are included all the Thalassantheæ, with more than six tentacles, alternating with single radiating pouches. Lesson's genus Scyphis contains many-rayed species of the same type; no structural differences being indicated. Many species still referred to Æquorea may also belong here, as, undoubtedly, some Polyxenia do, while others are true Æquoridæ.

P. dodecagona *Pér.* and *LeS.*, *DeBl.*, Pl. 33, fig. 2, *Less.* — *South Atlantic* (Péron and LeSueur).

P. cylindrella *Pér.* and *LeS.*, *DeBl.*, *Less.* — *New Holland: Arnheim* (Péron and LeSueur).

To avoid unnecessary changes, I enumerate here the species described by different authors, under the names under which they were published, though some of those of Quoy and Gaimard, and especially those of Leuckart, of Gegenbaur, and of Kölliker will, no doubt, prove identical, as they were all observed in the Mediterranean.

Ægina cyanogramma *Esch.* — Æquorea cyanogramma *Q.* and *G.*, Zool. Uran., Pl. 84, figs. 7 and 8. — *Admiralty Islands, north-west of New Holland* (Quoy and Gaimard).

Æ. grisea *Esch.* — Æquorea grisea *Q.* and *G.*, Zool. Uran., Pl. 84, figs. 4 and 5. — *Admiralty Islands* (Quoy and Gaimard).

Æ. semirosea *Esch.* — Æquorea semirosea *Q.* and *G.*, Zool. Uran., Pl. 84, fig. 6. — *New Guinea* (Quoy and Gaimard).

Æ. capillata *Esch.* — Æquorea capillata *Q.* and *G.*, Ann. Sc. Nat., Vol. X. Pl. 63, fig. 1. — *Gibraltar* (Quoy and Gaimard).

Scyphis mucilaginosa *Less.* — Medusa mucilaginosa *Cham.* and *Eysenh.*, Act. Nov. Nat. Cur., Vol. X. Pl. 30, fig. 2. — Æquorea mucilaginosa *Esch.* — Cunina mucilaginosa *DeBl.* — *Pacific, under the Equator* (Chamisso and Eysenhardt).

Sc. punctata *Less.* — Æquorea punctata *Q.* and *G.*, Zool. Uran., Pl. 85, fig. 4. — Ægina punctata *Esch.* — *N. Pacific*, 36° *N. Lat., between the Sandwich and Mariane Islands* (Quoy and Gaimard).

Ægineta rosea *Gegenb.*, Zeitsch. f. wiss. Zool., 1856, VIII. p. 261, Pl. 10, pages 6 and 7. — *Messina* (Gegenbaur).

Æ. prolifera *Gegenb.*, Zeitsch. f. wiss. Zool., 1856, VIII. p. 262. — *Messina* (Gegenbaur).

Æ. paupercula *Gegenb.*, Zeit. f. wiss. Zool., 1856, VIII. p. 263, Pl. 10, fig. 10. — *Messina* (Gegenbaur).

Æ. globosa *Gegenb.*, Zeit. f. wiss. Zool., 1856, VIII. p. 263, Pl. 10, fig. 8. — *Messina* (Gegenbaur).

Æ. hemisphærica *Gegenb.*, Zeit. f. wiss. Zool., 1856, VIII. p. 263. — *Messina* (Gegenbaur).

Æ. flavescens *Gegenb.*, Zeit. f. wiss. Zool., 1856, VIII. p. 263, Pl. 10, fig. 9. — *Messina* (Gegenbaur).

Æ. Sol maris *Gegenb.*, Zeit. f. wiss. Zool., 1856, VIII. p. 265, Pl. 10, figs. 4 and 5. — *Messina* (Gegenbaur).

Paryphasma planiusculum *Leuck.*, Arch. f. Naturg., 1856, p. 39, Pl. 2, figs. 10 and 11. — *Nizza* (Leuckart).

P. rhodoloma *Leuck.*, Arch. f. Naturg., 1856, p. 39, note. — Æquorea rhodoloma *Br.*, Ac. St. Petersb., 1838, Pl. 3, figs. 1–5. — *Bay of Conception* (Mertens).

Pachysoma *Köll.*, Zeit. f. wiss. Zool., 1853, IV p. 322. Gegenbaur has changed this name to Ægineta. There is, therefore, no doubt as to their generic identity. He considers Stenogaster as belonging also to Ægineta. These names were both preoccupied.

P. flavescens *Köll.*, Zeitsch. f. wiss. Zool., 1853, IV p. 322. — *Messina* (Kölliker).

Stenogaster *Köll.*, Zeitsch. f. wiss. Zool., 1853, IV p. 322. Belongs to Ægineta, according to Gegenbaur.

S. complanatus *Köll.*, Zeitsch. f. wiss. Zool., 1853, IV p. 323. — *Messina* (Kölliker).

Polyxenia flavibrachia *Br.*, Ac. St. Petersb., 1838, Pl. 7. — *Between Peru and the Marquesas Islands*, 5° *S. Lat., and* 127° *W. Long.* (Mertens).

P. Alderi *Forbes*, Naked-eyed Medusæ, Pl. 4, fig. 2. — *England, Devonshire* (Forbes). The other species referred to this genus are probably genuine Æquoridæ.

2d Family. BRANDTIDÆ *Agass.* Inscribed to the learned and eminent editor of Mertens. This family is readily distinguished by the peculiar lobation of the margin of the disk, but it is doubtful whether it truly belong to this sub-order. Its quadripartite structure is indicated by the presence of four eyes, between which hang long tentacles. Judging from the figures of Mertens, which give the only available information respecting this type, the genital organs and the actinostome differ from all the other Discophoræ known at present, but recall somewhat those of the Lucernariadæ; while the marginal portion of the lower floor resembles Cyanea. In Quoyia the eyes have probably been overlooked, or mistaken for torn tentacles.

Dodecabostrycha *Br.*

D. dubia *Br.*, Acad. St. Petersb., 1838, Pls. 29 and 30. *Origin unknown.* From drawings by Mertens.

Quoyia *Agass.* The dark-colored pigment, lining the main cavity and its radiating pouches, renders the structure of this genus very conspicuous. The margin of the disk is deeply indentated, and between its lobes hang the tentacles.

Q. bicolor *Ag.* — Charybdea bicolor *Q.* and *G.*, Zool. Astr., Pl. 25, figs. 1–3. — *Cape de Verd Islands* (Quoy and Gaimard).

3d Family. CHARYBDEIDÆ *Less.*, Prodr., 1837 (not *Gegenb.*).

Charybdea *Pér.* and *LeS.*; spelled Carybdea by *Pér.* and *LeS.*

C. periphylla *Pér.* and *LeS.*, *DeBlainv.*, Act., Pl. 31, fig. 1; *Milne-Edw.*, in Cuvier's Règne An., Pl. 55, fig. 2, copied from LeSueur. — *Atlantic Ocean, under the Equator* (Péron and LeSueur).

The figure of this species, drawn by LeSueur, and published for the first time by De Blainville, represents, unquestionably, a mutilated animal; but, applying to its restoration the method so successfully employed in palæontology, it is evident that there are two kinds of marginal lobes, while in the Marsupialidæ there is but one kind. Four sets of these appendages are double, and between each pair there is a tentacle. In the four intervals between these double lobes, there are two simple lobes. The simple lobes are folded on both sides, the double ones, only on one side, the tentacle representing, as it were, the axis of the simple lobes, set free. Fundamental number of parts four, as in Marsupialidæ.

As established by Péron and LeSueur, this genus contains the types of two very distinct families, the Charybdeidæ and the Marsupialidæ, first pointed out by Lesson, who, however, associated with both of them several species which have not the remotest affinity with the type. So the genus Obelia, which belongs to the Campanularians, is numbered among the Charybdeidæ proper, and many most heterogeneous genera are associated with the Marsupialidæ.

The species added to this genus by later observers do not belong to the same genus, and not even to the same family. They are Thalassantheæ and Brandtidæ. Charybdea bitentaculata *Q.* and *G.*, is a Campanella; Ch. bicolor *Q.* and *G.*, constitutes a distinct genus, Quoya *Ag.*; Ch. campanella *Less.*, may also constitute a distinct genus.

4th Family. MARSUPIALIDÆ *Less.*, Prodr., 1837. — Charybdeidæ *Gegenb.*, Zeit. f. wiss. Zool., 1856, VIII. p. 214.

Marsupialis *Less.* — Charybdea, *Pér.* and *LeS.*, *Milne-Edw.*, and *Gegenb.*

M. Planci *Less.* — Charybdea marsupialis *Pér.* and *LeS.*; *Milne-Edwards*, Ann. Sc. Nat., Vol. XXVIII. p. 248, Pls. 11 and 12. — Medusa marsupialis *Linn.* — Oceania marsupialis *Esch.* — *Mediterranean* (Plancus, Milne-Edwards, Gegenbaur).

Tamoya *Fr. Müll.*, Abhandl. Naturf. Halle, 1859. I have restricted the genus Tamoya *Müll.* to the species with simple tentacular lobes, and referred the other to Chiropsalmus.

T. haplonema *F. Müll.*, Abhandl. Naturf. Halle, 1859, Pl. 1. — *Brazil: St. Catherine Island* (Fritz Müller).

T. alata *Ag.* — Carybdea alata *Reyn.* in *Less.*, Cent. Zool., Pl. 33, fig. 1. — *Atlantic Ocean* (Reynaud). — It remains doubtful to what genus Lesson's Marsupialis flagellata, from *New Guinea*, ought to be referred. It constitutes, probably, a distinct genus, on account of its tentacles.

Bursarius *Less.*, 1836. Closely allied to Tamoya, as restricted above; but differs by the marginal folds of the disk.

B. Cythereæ *Less.*, Zool. Coq., Pl. 15, fig. 1. — Beroe Gargantua *Less.*, Zool. Coq., Pl. 15, fig. 1, seems to be only a large, decayed specimen of the same species. — *New Guinea* (Lesson).

Chiropsalmus *Ag.* This genus differs from Tamoya by the palmate form of the lobes from which hang the tentacles. This structure is very similar to that of Lucernaria, and were the tentacles club-shaped, as in the latter genus, instead of being long and slender, the resemblance would be striking.

Ch. quadrumanus *Ag.* — Tamoya quadrumana *F. Müll.*, Abhandl. Naturf. Halle, 1859, Pl. 2. — *Brazil: St. Catherine Island* (Fritz Müller).

5th Family. LUCERNARIADÆ *Johnst.*, Brit. Zoöph., 2d edit., 1847, p. 244 (not *Huxley*, who, ten years later, applied the name Lucernariadæ to the whole order of Discophoræ). — Calycozoa *Leuck.*, Morphologie und Verwandtsch. der Wirbellosen Thiere, 1848. — Podactinaria *M.-Edw.* and *Haime*, Brit. Foss. Corals, 1850.

This family bears the same relations to the Marsupialidæ as the Comatulidæ do to the Pentacrinidæ. The Lucernariadæ are pedunculated Discophoræ.

Lucernaria *Müll.* As characterized by the illustrious author of the Fauna danica, this genus still embraces several distinct types; all of which, however, agree in having eight bunches of tentacles, alternating, in some of the species, with short, simple tentacles. These simple tentacles resemble, in their appearance, the ocelli of the Marsupialidæ, as the fasciculated tentacles recall those of the genus Chiropsalmus, of the same family; thus showing, in another way, the homological relations which exist between the tentacles and the marginal organs of all Acalephs, described as ocelli and otolithes. Long associated with the Polyps, this family at last seems to be referred to its true position, by the side of the free-moving Haplostomeæ, to which they bear the same relation as the pedunculated Crinoids to the genus Comatula. Allman, who has correctly traced their homologies, refers them, however, to the Hydroids. As I have had no opportunity of comparing the American with the European species with which they have been identified, I must leave it doubtful whether they are the same or not. To the genus Lucernaria proper, I refer only the species in which two and two bunches of tentacles are approximated, without simple tentacles.

L. quadricornis *Müll.*, Zool. Dan., Pl. 39, figs. 1–6; *Sars*, Fauna littor., Pl. 3, figs. 1–7; *Johnston*, Brit. Zoöph., Pl. 15, figs. 3–7. — L. fascicularis *Flem.*, Wern. Soc. — *Scotland, Shetland* (Fleming); *German Ocean* (O. F. Müller); *Norway: Floröe and Kind Islands, Bergen* (Sars); *Donaghadee, Ireland* (Templeton); *Grand Manan, Nova Scotia* (Stimpson); *Chelsea Beach and Swampscott Beach, near Boston* (Dr. A. A. Gould and L. Agassiz); *Greenland* (Fabricius). The shortness of the arms and the thickness of the body of the American specimens incline me to the belief that they differ from those of Europe.

L. inauriculata *Owen*, Rep. Brit. Assoc., 1849.—*British Channel, Dover* (Owen). If this species is truly distinct from L. quadricornis it would appear that the boreal Fauna of Europe nourishes a different species from that of the Celtic Fauna.

L. campanulata *Lamourx.*, *Johnst.*, Brit. Zoöph., p. 248.—Lucernaria Convolvulus *Johnst.*, Mag. Nat. Hist.—Lucernaria auricula *Milne-Edwards*, in Cuvier's Règne Anim., Pl. 63.—*Calvados* (Milne-Edwards); *England* (Johnston). Judging from the description and figures of Johnston and Milne-Edwards, this species will no doubt form a distinct genus, on account of its peculiar foliaceous actinostome, and the absence of single, simple tentacles.

L. auricula *Müll.*, Zool. Dan., Pl. 152; *Montagu*, Lin. Trans., Vol. IX. Pl. 7, fig. 5; *Johnst.*, Brit. Zoöph., p. 246; *Sars*, Bidr. Söedyr., Pl. 4, figs. 1–13.—Lucernaria octoradiata *Lmk.*—*Norway* (Sars); *German Ocean* (O. F. Müller); *England, Devonshire* (Montagu); *Scotland* (Fleming). This species is the type of a third genus. The propriety of subdividing the Lucernariæ has already been felt by Milne-Edwards, who, in the 3d volume of his Hist. des Corall., makes three sections of them.

L. Fabricii *Ag.*—L. auricula *Fabr.*—*Swampscott Beach* (L. Agassiz); *Greenland* (Fabricius). Differs from L. auricula by its slender stem and the deep emarginations of the disk.

L. typica *Greene*, Proc. Dubl. Univ. Assoc., Vol. I., is not known to me.

L. phrygia *Fabr.*, Faun. Greenl., from *Greenland*, has been referred to the Sipunculidæ by DeBlainville.

Depastrum *Gosse.*, Ann. and Mag. Nat. Hist., 1858 and 1860.

D. stellifrons *Gosse*, Ann. and Mag. Nat. Hist., 1860, Vol. VI. p. 480, figs. in the text.—*British Channel, Weymouth* (Gosse).

Carduella *Allm.*, Micr. Journ., 1860.—Depastrum *Gosse* (p. p.).—Calicinaria *Milne-Edw.*, 1860.—Lucernaria *Sars* (p. p.).

C. cyathiformis *Allm.*, Micr. Journ., 1860, Vol. VIII. Pl. 5.—Lucernaria cyathiformis *Sars*, Fauna litt., Pl. 3, figs. 8–13.—Depastrum cyathiforme *Gosse.*—*Norway, Bergen and Floröe* (Sars); *Island of Arran* (Landsborough); *Stromness, Orkney Islands* (Gilchrist and Allman).

SECTION II.

GEOGRAPHICAL DISTRIBUTION OF THE DISCOPHORÆ.

Although there are extensive tracts of the sea, the Discophoræ of which have never been noticed, and there are also vast regions, probably including several distinct Faunæ, the Acalephs of which are entirely unknown, it is, nevertheless, already possible to draw interesting results from the data on hand, especially by comparing the character of the Faunæ which have been extensively explored, with the few types known from other quarters. The accessions furnished by the United States Exploring Expedition, under command of Captain Charles Wilkes, the data obtained from Mr. W. W. Wood, and the observations of my son along the coast of Oregon and California, are highly valuable in that respect, as affording the means of contrasting the Faunæ of the Pacific coast of North America, of Terra del Fuego, and of China, with those explored by Eschscholtz, Mertens, Lesson, and the resident naturalists of Europe and North America.

It appears from the data recorded in the preceding tabular view, that the lowest Discophoræ, the Lucernariadæ, are the only ones which extend to the boreal Faunæ, and that some genera, Aurelia and Pelagia for instance, are cosmopolites, while others, such as Cyanea proper, are peculiar to the northern hemisphere; others are tropical, such as Mastigias, Leptobrachia, Cephea, Polyrhiza, Diplopilus, and Hydroticus; others still, Rhacopilus, Placoïs, and Lobocrocis, are only to be found in the southern hemisphere, and many are quite local in their distribution, as, for instance, the genera Stomolophus, Stylonectes, Cotylorhiza, Sthenonia, Phacellophora, Heccædecomma, Couthouyia, Medora, Desmonema, and Marsupialis proper. The grouping of the species in their respective zoölogical provinces is also interesting to notice, and shows that every region of the ocean has its own species, variously associated. It is much to be regretted that the localities from which many of the species described by older writers were obtained, are not given with greater precision, as they cannot now be referred with accuracy to their Faunæ.

It is not yet possible to separate, with precision, the arctic and boreal Faunæ, as far as the Discophoræ are concerned. In the Celtic Fauna we find Rhizostoma Cuvierii, Holigocladodes lunulatus, Aurelia cruciata, Cyanea capillata and Lamarckii, Chrysaora hysoscella, Polyxenia Alderi, Lucernaria quadricornis, which is rather boreal, inauriculata, campanulata and auricula, Depastrum stellifrons, and Carduella cyathiformis, the latter boreal only. In the Acadian Fauna, we find Aurelia flavidula, Cyanea arctica, Lucernaria quadricornis, if identical with the European, and L. Fabricii;

the absence of Rhizostomeæ is remarkable. In the Columbian Fauna, including Sitka and the Aleutian Islands, with which the Asiatic species of the same latitude, and as far north as Behring Strait, are here united, from want of sufficiently precise data to separate them, we have Aurelia labiata and limbata, Sthenonia albida, Heccædecomma ambiguum, Phacellophora camtschatica, Cyanea ferruginea and Postelsii, Pelagia Brandtii, Polybostrycha helvola, Melanaster Mertensii, and Æginopsis Laurentii. Aurelia limbata and Cyanea ferruginea are common to Kamtschatka and the Aleutian Islands; Sthenonia albida, Phacellophora camtschatica, and Melanaster Mertensii, are only known from Kamtschatka, and Heccædecomma ambiguum, Cyanea Postelsii, and Polybostricha helvola, only from the north-west coast of America, while Æginopsis Laurentii is from the Behring Sea. No Rhizostomeæ have thus far been noticed in this northern area of the Pacific; but the whole family of Sthenonidæ belongs to this region, no representatives of it having been found anywhere else. The abundance of Cyaneidæ and Pelagidæ is also remarkable.

In the Mediterranean and Lusitanic Faunæ we find Rhizostoma pulmo, Stylonectes luteus, Stomaster canariensis, Cotylorhiza tuberculata, Aurelia aurita, Cyanea lusitanica, if different from the Celtic species, Pelagia noctiluca, including the species referred to Nausithöe, Chrysaora mediterranea, if not identical with Chr. hysoscella of the Celtic Fauna, Campanella (Æginopsis) mediterranea, several species of Foveolia (Cunina) and Pegasia (Æginata), and Marsupialis Planci. The many Rhizostomeæ and Haplostomeæ, and especially the latter, are very characteristic of the Mediterranean Fauna. Off Cape de Verd Islands, we have Pelagia Lessoni, Quoyia bicolor, and probably also Dodecabostrycha dubia. In the southern Atlantic and off Cape of Good Hope, Rhizostoma capensis, Aurelia colpota, Placois discoidea, Chrysaora Reynaudii, Foveolia diademata, Pegasia dodecagona, and a species allied to Ægina rosea have been observed. There is a striking resemblance between the Fauna of the Cape and that of the Mediterranean.

On the American side of the Atlantic, south of Cape Cod and north of Cape Hatteras, we find Cyanea fulva and Dactylometra quinquecirra, the latter extending far to the eastward, in the Atlantic; in the Carolinian Fauna, Stomolophus meleagsis, Cyanea versicolor, and Cunina octonaria; in the Charybæan Fauna, Polyclonia frondosa, Aurelia marginalis, and Pelagia cyanella; in the Brazilian Fauna, Rhacopilus cyanolobatus and cruciatus, Lobocrocis Blossevillii, Dactylometra lactea, Zygonema volutata, Tamoya haplonema, and Chiropsalmus quadrumanus. Under the tropics only four species have thus far been noticed, in the Atlantic Ocean: Toxoclytus roseus, Favonia hexanema, Patera cerebriformis, and Charybdea periphylla.

In the Patagonian Fauna the following species have been observed, Couthouyia pendula, Medora reticulata and capensis, and Desmonema Gaudichaudi. Off Peru and Chili, Pelagia tuberculata, Stenoptycha plocamia, and Æquorea (Pegasia) rhodoloma, have been found. Among the low islands of the Pacific, Leptobrachia leptopus, Crossostoma frondosa, if identical with that of China, Diplopilus Couthouyi, Polyclonia Mertensii, a species of Aurelia, Pelagia panopyra, if identical with that of Australia, and P. Labiche, Cunina globosa, Eurybia exigua, Scyphis mucilaginosa, and Polyxenia flavibrachia. Between the Sunda Islands and New Guinea, Cassiopea Andromeda, if identical with that of the Red Sea, Hydroticus rufus, Mastigias papua, Thysanostoma Lessoni, Salamis toreumata, Homopneusis frondosus, Campanella capitulum, Ægina semirosea, Marsupialis flagellata, and Bursarius Cythereæ. The prevalence of Rhizostomeæ, in this part of the ocean, to the complete exclusion of other large Discophoræ, is very striking. In the Indian Ocean, Catostylus Wilkesii, Toxoclytus Dubreuillii, and Stenoptycha caliparea. In the Red Sea, Rhizostoma corona and tetrastylum, Leptobrachia lorifera, Cassiopea Andromeda, Cephea octostyla, Polyrhiza Cephea and vesiculosa, and a species of Aurelia. Almost none but Rhizostomeæ; a striking contrast with the western coast of North and South America, where no Rhizostomeæ have yet been found.

Around Australia, to the north of it, Melita purpurea; to the west, Evagora capillata, Polyrhiza fusca, Polyclonia theophila, Favonia octonema, Aurelia lineolata, Pelagia panopyra, and Ægina cyanogramma and grisea; to the east, Catostylus mosaicus and Stenoptycha rosea; to the south, Limnorea triedra, Chrysaora pentastoma and hexastoma, Euryale antarctica, and Pegasia cylindrella. Off New Zealand, Aurelia clausa.

In the North Pacific, about the 36° of N. Lat., Pelagia flaveola, Ægina citrina and rosea, and Scyphis punctata have been found; in California, a species of Polybostrycha, and one of Melanaster; and in China, Hymantostoma Sueurii, Crossostoma frondosa, Phyllorrhiza chinensis, and Donacostoma Woodii.

It thus appears that nothing whatsoever is known of the Acalephs of Japan, and very little of those of the west coast of Africa, and South America, judging from the few species enumerated above. Those of the east coast of Africa, with the exception of the Red Sea, are also entirely unknown. It can hardly be doubted that the Pacific and Indian Oceans, and the seas south of Tasmania and Terra del Fuego, will yet yield a richer harvest of Acalephs than has thus far been gathered there. From want of materials, the precise limits of the Acalephian Faunæ, alluded to above, cannot yet be determined. From the facts observed along the coasts of North America and of Europe, I have no doubt, however, that the principle of limitation of the Faunæ, which I have pointed out, in my third Report of the Museum of Comparative Zoölogy at Harvard, will also be applicable to the Acalephs. Natural Faunæ, as far as I have been able to trace them, are defined by the geographical range of representative species living in adjoining regions. This principle has already been tested, for the Discophoræ, by the geographical distribution of the Cyaneæ and Aureliæ of the American coast, and it is highly desirable that a closer comparison should now be instituted between the species of the Mediterranean and of the Celtic Faunæ, between which similar differences seem to obtain as between the Faunæ of the Atlantic coast of North America. It can hardly be expected that similar facts should soon be brought to light for the whole extent of the two great oceans.

PART IV.

HYDROIDÆ.

HYDROIDÆ.

CHAPTER FIRST

CORYNE AND ALLIED MEDUSÆ

SECTION I.

GENERAL REMARKS UPON HYDROIDS AND NAKED-EYED MEDUSÆ.

As the facts bearing upon the genetic connection and zoölogical affinities of the Hydroids and certain Medusæ, which have been described as independent animals, are not yet sufficiently known, or generally acknowledged, to be made the basis of comprehensive generalizations, I find it necessary, in this part of my work, to adopt a different method of presenting my subject, from that pursued in the preceding chapters. Thus far, when considering the representatives of the Ctenophoræ and Discophoræ, I have found it possible to discuss their natural affinities, the combinations of their structural elements, their mode of development, and their special classification, without regard to the contributions I have had an opportunity of making myself to their Natural History. But respecting the order of Hydroidæ, in which I have been led to include animals thus far considered as widely different from them, I am compelled to adopt another course, and first, to describe, minutely, those which I have had an opportunity of examining, before I proceed to discuss their natural relations. To avoid misapprehensions, however, I will here briefly state, that I see no reasons for separating, as distinct equivalent groups, the Siphonophoræ from the naked-eyed Medusæ and Hydroids proper; nor do I believe any of these animals to be more closely allied to the Polyps than to the higher Acalephs. Even those among the Hydroids proper, from which no free Medusæ arise, are not to be associated with the Polyps; their special structure and mode of reproduction showing them to be genuine Acalephs, as I trust to be able presently to prove, upon a broad basis of carefully considered facts. It may, however, facilitate the perusal of the next few chapters, if I add, that among the Hydroids, as I limit this order here, two more or less distinct forms occur, one of which leans towards the Polyps by their general appearance, though in their structure they agree with the brood of the Discophoræ, and not with that of Polyps; the other, resembling in every respect genuine Medusæ. Between these extreme forms, there exists every possible gradation, from Hydroids assuming medusoid characters, to true Medusæ, with some of the characteristic structural features of the Discophoræ either abortive or entirely wanting. Again, among these Acalephs we find a great variety of combinations of individuals: some forming compound communities, either attached to the ground or entirely free, in which the hydroid elements are predominant, and the medusoid elements assume the appearance of simple reproductive organs; others, forming similar compound communities, in which the hydroid and medusoid elements are more equally combined; others forming free compound communities, in which the medusoid elements are predominant, and the hydroid elements more or less subordinate; and, finally, others still in which the hydroid elements appear only in the young brood.

As the mode of development of the Medusa long known under the name of Sarsia, and its genetic relations to the Hydroid described under the names of Coryne and Syncoryna, afford the best opportunity of proving that free Medusæ may be produced by Hydroids, I shall make a beginning with this type, and first refer to the publications in which the information already on hand, respecting its history, may be found. In this type the hydroid and medusoid forms of the animal appear separately, in alternate generations; the hydroids forming communities or colonies which are attached to the ground, while the medusæ, budding from their branches, become free, and are found, at certain periods of the year, floating in the water as independent Acalephs, with distinct sexual organs, the males and females being developed upon different hydroid communities.

REFERENCES TO THE PAPERS IN WHICH THE INFORMATION NOW ON HAND UPON THE GENUS CORYNE OF GAERTNER MAY BE FOUND.

Coryne, Gaertner, in Pallas, Spic. Zoöl., fasc. 10, 1774, p. 40, Tab. IV *Fig.* 8, A, *a.*
" Johnston, Brit. Zoöph., 2d ed., 1847, p. 36, et *Fig.*
" Gosse, Devonshire coast, 1853, p. 189, Pl. IX., &c.
" Alder, Catal. Zoöph., 1857, p. 12, Pl. VII.

Coryne, Wright, Edinb. New Phil. Trans., 1857, Vol. VI. p. 83, Pl. II. *Fig.* 7.
" " " " " " 1858, Vol. VII. pp. 282 and 296, Pl. VII. *Fig.* 5.
" Allman, Annals and Mag. Nat. Hist., 1859, p. 141.
Stipula, Sars, Bidrag til Sördyrenes Naturhistorie, 1829; transl. in Isis, 1833, p. 221, Tab. X. *Fig.* 1.
Syncoryna, Ehrenberg, Corallenthiere, Königl. Akad. Wissenschaft., Berlin, 1834.
" Lovèn, Handl. Kongl. Svensk. Vetensk. Akad., 1835, and translated in Wieg., Archiv, 1837, p. 321, Tab. VI.
" Steenstrup, Generationswechsel, 1842, p. 19.
" Van Beneden, Embryogénie des Tubulaires, Acad. Roy., Bruxelles, 1844, p. 51, Pl. III.
" Dujardin, Ann. Sc. Naturelles, 1845, IV. p. 275, Pl. XIV.
" Sars, Fauna Litt. Norvegica, 1846, p. 2, Pl. I.
" Agassiz, Lect. Embryol., 1848, p. 39.
" Desor, Ann. Sc. Naturelles, 1849, XII. p. 204, and *Fig.*
" McCrady, Proc. Elliot Soc., Charleston, S. C., 1858, *Fig.* 35.
Acrochordium, Meyen, Nov. Acta Acad. Nat. Cur., 1834, XVI. p. 165, Tab. XXVIII. *Figs.* 8 and 9. (?)
Hermia, Johnston, Brit. Zoöph., 1st ed., 1838, p. 111, and *Fig.*
" Hassal, An. Mag. Nat. Hist., 1841, VII. p. 283, Pl. VI. fig. 2.
Oceania, Sars, Beskrivelser, 1835, p. 22, Pl. V. *Figs.* 11^{a} and 11^{g}. — Dujardin in Lam'rk, 2d ed. — Agassiz, Lect. Embryol., pp. 33 and 44.
Sarsia, Lesson, Acalephs, 1843, p. 333.
" Forbes, Naked-eyed Medusæ, 1848.
" Agassiz, Mem. Amer. Acad. 1850.

SECTION II.

THE HYDROID FORM OF CORYNE MIRABILIS.

In order to obtain a correct idea of this Hydroid, the observer must watch it in its native element, under all the circumstances and conditions of its natural mode of existence and development. After it has been kept in confinement for a day or two, it loses its brightness and color, in a great measure, and assumes strange attitudes; such as an excessive elongation of the club-shaped head and tentacles, which look as if reaching after something, or a stiff, angular position, bristling with straightened, rigid tentacles. But when floating freely in the water, nothing can be more graceful than the manifold curves and waving lines caused by the motion of the branches and tentacles of this little animal. A community of Coryne mirabilis resembles, somewhat, a tuft of moss (Vol. III. Pl. XVII. *Fig.* 1). It attaches itself to almost any thing that comes in its way, whether it be a shell, stone, sea-weed, or a log, and may be found either in pure sea-water, or at the mouths of rivers where there is more or less brackish water. It does not seem to be dependent upon the purity and cleanliness of the water, if it is kept in constant agitation by the ebb and flow of the tide. It is not known by what means the Hydroid attaches itself to any object on which it rests; probably, however, by a kind of agglutination, at the time when the horny sheath of the young is forming. There is no distinct stoloniferous, or creeping portion, apart from the upright branches, such as exists in Campanularians. The stem creeps as far as it can find support, throwing up here and there a minor branch, and then launches out freely, becoming all the more irregular in its divisions, for want of a definite point of attachment, and diverging in every possible direction around an imaginary axis. There does not appear to be any regularity in the mode of branching of the stem, nor any particular angle at which the branches diverge from each other. It is seldom, however, that angles of more than sixty or seventy degrees intervene between any two branches.

A colony of these hydroids may be described as an irregularly branching tube, with club-shaped terminations, commonly called the head, open at the summit, each one of which bears a number of scattered, spirally arranged, tentacles, with globular tips (Pl. XVII. *Figs.* 1 and 1^a). In the spring and autumn, the general appearance of the club-shaped termination is modified by the presence of more or less globular expansions (Pl. XVII. *Figs.* 2, *m md,* 3, *a,* 5, *a a,* and 9, *md*), of various sizes, either intermixed with the tentacles, or on the neck, just below them. These spheroid bodies are the alternate Medusa generation, budding from the heads of the Hydroids, while the Hydroids themselves are developed from the eggs of the free Medusæ. Every such organically connected Hydroid community is either male or female; or, without insisting upon the sexuality of the hydroid form, we may say that every colony bears either only male or only female Medusæ. The club-shaped head may assume an infinite variety of forms, changing, successively, from an exceedingly elongated cylindrical shape (Pl. XVII. *Fig.* 12) to shorter and shorter proportions (Pl. XVII. *Figs.* 4, 11, 3, 5, 2, 6, and 9); or it may be very much inflated at times (*Fig.* 6), showing, indeed, as great a power of extending and contracting as the Actinioids, and perhaps a greater diversity of forms. Below the head, the stem is rather constant in form, being restrained by the rigid, horny sheath (Pl. XVII. *Figs.* 11, *c,* and 15, *c,* and Pl. XX. *Fig.* 2, *c*). The whole community, from the base to the tip of the club-shaped terminations of the branches, is a double-walled, branching tube (Pl. XVII. *Figs.* 9, *a b*, and 15, *a b*, Pl. XIX. *Fig.* 4, *a b*, and Pl. XX. *Fig.* 2, *a b*). The walls of the head differ very much from each other in their comparative thickness, the outer one (Pl. XVII. *Figs.* 9, *b*, and 11, *b*, Pl. XIX. *Fig.* 2, *b*) being much thinner than the inner one (Pl. XVII. *Figs.* 9, *a*, and 11, *a*, Pl. XIX. *Fig.* 2, *a*). In young heads, however, just budding out from the pedicel (Pl. XX. *Figs.* 4 and 5), the walls (Pl. XX. *Fig.* 6, *a b*) are more alike in thickness; in fact, they hardly differ in this respect. The disproportion between the thickness of the respective walls diminishes as we follow the stem downward toward its base. Just below the head (Pl. XIX. *Fig.* 4, *a b*) the difference remains about the same as in the head itself, and is then a little irregular for a short distance further down, but in the main part of the stem the walls are equal in thickness (Pl. XX. *Fig.* 2, *a b*). It is from this position that the young heads, with walls of equal thickness, take their rise.

The outer wall of the head suddenly thins out, and diminishes in thickness by one half, where it forms the exterior wall (Pl. XIX. *Figs.* 2, b', and 3, *c*) of the tentacles, except at the globular tip, where it becomes much thicker than below (Pl. XIX. *Fig.* 2, *f*), and really forms nearly the whole bulk of the spherical expansion at this point. The inner wall (Pl. XVII. *Fig.* 11, *t*, Pl. XIX. *Figs.* 2, a^2–a^4, and 3, *a b*), or solid axis of the tentacles, is a lateral growth from the inner wall of the head. It far exceeds, in diameter, the thickness of the outer wall, which forms a sheath around it. The outermost, or apical, portion of this axis ends in a narrowed, blunt point, which projects a short distance into the globular expansion of the tentacle.

Within these double walls, the chymiferous fluid of the body circulates, and may be traced by means of floating granules passing in currents from the head, where the so-called digestive cavity (Pl. XVII. *Fig.* 11, *d*) is situated, down the stem, where the common circulatory channel of the whole community begins (Pl. XVII. *Figs.* 9, *d*, 11, d^1, and 15, *d*, Pl. XIX. *Fig.* 4, *d*), and thence, throughout the whole branching stem (Pl. XX. *Figs.* 2, *d*, 3, *d*, 4, *d*, and 5, *d*), to its very base, and then back again. It has never been possible to trace the circulation to vibratile cilia as the propelling organs. Within the digestive cavity there is, at times, an exclusive circulation, limited to the space above what might be called the neck (Pl. XVII. *Fig.* 11, *cn*), where, on such occasions, the stem contracts, so as to shut off, almost entirely, the communication with the lower chymiferous channel. This mode of circulation takes place, most frequently, when the head assumes a very distended condition (Pl. XVII. *Fig.* 6), as if to allow the greatest possible extent of absorbing surface for the nutritive fluid. The whole extent of the digestive cavity and chymiferous tube is lined with brownish-red granules (Pl. XI^{c}. *Fig.* 14, *dd*, Pl. XXIII^{a}. *Fig.* 12, *dd*), more or less closely attached to the surface of the walls. These granules frequently become loosened, and are borne along in the circulation, and others keep up a constant quivering motion, as if disturbed by the agitation of some neighboring body. The general rosy tint of the community is due to the presence of these brownish-red granules. The outward opening of the chymiferous canal is above, and constitutes the mouth, serving also for the exit of refuse matters. It is situated at the apex of a conical eminence, which projects considerably beyond the region of the tentacles. The border of the mouth, and the cone itself, is perfectly smooth (Pl. XVII. *Figs.* 9, *m*, 11, *m*, and 11^a, *m*), and free from appendages of any kind.

The prehensile organs, or tentacles (Pl. XVII. *Figs.* 2, *t*, 9, *t*, and 11, *t*), have evidently a spiral arrangement, upon the head, but according to what order or combination cannot be absolutely determined, on account of the protean shapes which the head assumes. From all appearances, however, the $\frac{1}{4}$ arrangement is probably the order in which the tentacles are disposed. This agrees also with the numbers in which the tentacles are developed; first, two appear, then two more, next, four more, making eight in all, and these last being duplicated, make sixteen, the highest number usually observed. These being arranged upon the $\frac{1}{4}$ formula would account for the cross-like appearance that frequently prevails in their disposition. The fact that the first two tentacles are developed apparently opposite to each other (Pl. XX. *Fig.* 4, *t*), seems to confirm this view.[1] Although the tentacles are developed in geometrical proportion, commencing with two, next four, and then eight, &c., yet they are not, nor need they be, arranged on the head symmetrically, in the order of their development, since the growth of their base of attachment, may modify their apparent connection. Again, in all probability the tentacles, besides being not exactly opposite in the beginning, do not originate, in the first instance, simultaneously with each other. Owing to their great contractility and the variable shape of the head, it has not been possible, so far, to determine their exact relation to each other, as may be done with the rigid and fixed parts of a plant. The axis of the tentacles is solid, and does not, therefore, admit the circulation of the chymiferous fluid into their interior, as is the case with the tentacles of the free Medusæ budding from these Hydroids. The globular tips of these organs serve, chiefly, to seize the prey, being filled with a multitude of lasso-cells (Pl. XIX. *Figs.* 2, *f*, 3, *f*, 5, and 5^a), from which the long lasso-threads shoot out, and coil around their victim, whilst the lower tapering part of the tentacle serves to embrace and force into the mouth whatever may be caught. The contractility and extensibility of the tentacles is remarkable; at one time they stretch out as

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[1] See Alexander Braun's "Das Individuum der Pflanze," in the "Abhandlung der Königlichen Akademie der Wissenschaften zu Berlin vom Jahre, 1853."

long as the head (Pl. XVII. *Figs.* 11 and 12), and at another contract to hardly more than twice (Pl. XIX. *Fig.* 1) or thrice their diameter (Pl. XVII. *Fig.* 9, *t*). In the latter condition they are strongly wrinkled, transversely.

The whole community, including even the medusæ, when these are present, is covered, from the base to the very tips of the tentacles, by a horny sheath (Pl. XVII. *Figs.* 9, *c*, 11, *c*, and 15, *c*, Pl. XVIII. *Fig.* 8, and wood-cut G, *i*, p. (23), *Fig.* 10, and wood-cut K, *i*, p. (24), *Fig.* 12, and wood-cut M, *h*, p. (24), *Fig.* 14, and wood-cut N, *h*, p. (24), Pl. XIX. *Figs.* 2, *c*, 3, *c* c^1, and 4, *c*, Pl. XX. *Figs.* 1, *a*, 2, *c*, 4, *c*, 5, *c*, 6, *c* c^1). At the lower part of the branches, the sheath is quite thick, tough, and like parchment in texture, but just below the heads it thins out, and becomes an excessively delicate film, which yields to every flexure of the upper part of the body and tentacles. It appears to be made up of irregular concentric layers (Pl. XX. *Figs.* 2, *c*, and 6, *c*). There are no traces of rings or twisting in this sheath, as obtains in other species; but it has a uniform surface, and the diameter of the whole stem being about equal to that of a fine cambric needle (see Pl. XVII. *Figs.* 1 and 10), up to the base of the head, and thence expanding into the club-shaped head, the sheath follows, also, over its surface and that of the tentacles. Over the latter it becomes an exceedingly thin film, not to be easily observed (Pl. XIX. *Fig.* 2, *c*).

At the end of the season of the budding of the medusæ, in the spring, a very remarkable change takes place, not only in the head of the hydroids, but also in the medusæ. As late as the 26th of March, in 1855, the head of the hydroids appeared perfectly normal in its characters, and the medusæ, then budding (Pl. XVIII. *Fig.* 14), had every appearance of being fully developed in all their parts, and about ready to drop from the parent stem. Not three weeks later, April 13, 1855, so remarkable a change had come over the hydroids and the medusa form, that, at first, the specimens then found were thought to be of a different species from those studied in March. There was no appreciable difference to be noticed in those hydroids which had the tentacles all perfect, but everywhere the medusoid was unlike those found in the middle of the breeding season. Very few hydroids had more than one medusoid adherent to them (Pl. XVII. *Figs.* 10, 11, 12, 13, 14, and 15). In some instances the heads were perfect (Pl. XVII. *Figs.* 11 and 12), in others the tentacles were shrunken, and looked more like prominent papillæ (Pl. XVII. *Fig.* 13), and again, the tentacles were all gone, and nearly the whole head with them (Pl. XVII. *Fig.* 14), and finally, no trace of a head was to be seen, but the stem was terminated by a medusoid with its mouth turned directly upwards (Pl. XVII. *Fig.* 15). Still greater and more essential modifications were found in the medusoids. All of them had an elongate, oval or ovate, form (Pl. XVII. *Figs.* 11, 12, 13, 14, and 16), contrasting strongly with the globular contour of the budding brood usually observed (Pl. XVIII. *Fig.* 14). Some had tentacles, while others were destitute of them or had mere papillæ in their places. But the most remarkable phenomenon connected with these modifications was, that they all had eggs or spermatozoa, in various stages of development. Some of them were casting their eggs, others had apparently finished laying, while some had just begun to develop them. So it was with the degree of development of the spermatozoa. In the section on the development of the medusoid form, the details of these peculiarities will be given in a more extended form.[1]

SECTION III

THE REPRODUCTION OF CORYNE MIRABILIS.

We have never been so fortunate as to see the development of Coryne mirabilis, from the egg. Since, however, we know that the medusoid form produces eggs, it can safely be affirmed that Coryne originates, primarily, from an egg. Including this mode of reproduction, we may say that there are three ways in which Coryne develops its young, namely: first, from the egg, whence a hydroid is produced by direct growth; secondly, from the stem of this hydroid other hydroids bud, and, remaining attached, build up a branching community; and, lastly, Medusæ-buds arise from the head of the Hydroid.

The Budding of hydroids. — Nothing can be more simple than the manner in which the stem of the Hydroids pushes out, sideways, its double wall, and forms a hollow, semi-globular bud, and thus lays the foundation of a young Hydroid (Pl. XX. *Fig.* 3, *a b*). It is very rare, however, that true buds are formed opposite to each other, as seen in the figure to which we have just referred. The bud being hollow is supplied directly with nourishment, by the circulating currents from the stem. As the bud grows larger and longer, it swells near the end, becoming club-shaped (Pl. XX. *Fig.* 4); and soon the walls at the apex are perforated. The perforation is the mouth (*Fig.* 4, d^1), and the swollen part the head. Synchronically with the formation of the mouth, two broad swellings or knobs

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[1] In the Memoirs of the Royal Swedish Academy, 1835, translated in Wiegman's Archiv für Naturgeschichte, 1839, p. 321–326, Tab. VI. *Figs.* 19–28, Lovèn describes the same peculiarities as occurring in Syncoryna (Coryne) ramosa *Ehr.* and S. Sarsii *Lovèn*; but he considers them as appertaining to the usual mode of reproduction of these species. His investigations were made in June, but had he seen Syncoryna in the previous months, in May, for instance, as did Sars, in 1838, according to his remarks published in his Fauna Norvegiæ, in 1846, he would have also observed the earlier and usual mode of reproduction. S. Sarsii is no doubt identical with S. ramosa.

(Pl. XX. *Fig.* 4, *t*) appear, nearly opposite to each other, on the head, and not far below its apex. These knobs are densely crowded with lasso-cells, which give them the appearance of being the globular tips of the tentacles. A bud a little older (Pl. XX. *Fig.* 5) not only discloses the nature of these knobs, but also shows that they belong to a hydroid form exactly like the stock from which it arises. The knobs of the last phase have become elongated on a short pedicel, and broadened a little, and two more of the same kind have grown out nearly opposite to each other (Pl. XX. *Fig.* 5, *t*), at two points ninety degrees from the situation of the first two, but a little higher up on the head. They have now every characteristic of tentacles, and unmistakably demonstrate that the globular tip of the tentacle is developed first, as suggested in regard to the earliest phase (Pl. XX. *Fig.* 4, *t*). At this stage the young Hydroid resembles the genus Stauridia of Dujardin,[1] in the relation of the tentacles to each other, and to the head, on which they are so arranged as to resemble a Maltese cross, when seen from above. We have already alluded to the probability that the tentacles do not develop absolutely by twos and multiples of two, but so closely one after another, and so nearly on the same level in the early stages, that they have the appearance of originating in pairs. In a not much further advanced phase, there are six tentacles (Pl. XVII. *Fig.* 8), four of them arranged as in the last stage, and two higher up, which appear to be placed at intermediate points, over two opposite angles of the lower cross. That the tentacles are very irregular, at times, in their development, may be seen in a figure of a young Hydroid on which eight tentacles (Pl. XX. *Fig.* 6, *t*) were counted, all of them mere knobs, filled with lasso-cells. We have no doubt that in this case the tentacles were all pretty nearly equal in development, and, moreover, just beginning to bud. By the time the Hydroid has ten tentacles it may be considered as adult, if we may judge from the fact that it may bear medusæ (Pl. XVII. *Fig.* 9, *md*). In the oldest Hydroids which we have seen, the tentacles very seldom exceed sixteen in number (Pl. XVII. *Figs.* 11, 11^a, and 12).

Since the Hydroid never buds from any other part of the parent except the stem, it must of necessity pass through the horny tube, in order to be able to develop. It does not, however, make an open passage through the tube (Pl. XX. *Fig.* 3, *c*), but absorbs the horny substance where it touches it, and at the same time elaborates a thin sheath (Pl. XX. *Fig.* 3, c^1) for itself, which is united to the edge of the opening in the old tube, resulting in a continuity of the two. Before the formation of the mouth, in the young Hydroid, the new sheath remains a

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[1] Annales des Sciences Naturelles, 1843, Vol. XX. p. 370, and 1845, Vol. IV. p. 271, Pl. XIV. *Figs.* C^1 to C^7. Cladonema *Dujard.* (later Stauridia *Wright*) is the free Medusa of Stauridia.

blind sac (Pl. XX. *Figs.* 3, c^1, and 6, c^1), following more or less closely the surface of the head. As the Hydroid grows older, this sheath seems to cling more closely to the surface of the head, and, as we have mentioned above (p. 189), forms an almost imperceptible film over the tentacles, to their very tips.

If, by accident, the head of a hydroid is destroyed, a new one is reproduced at the end of the stem of the old stock. In this process the injured end of the stem (Pl. XX. *Fig.* 1, *b*) spreads laterally (b^1), till it touches the horny sheath (*a*), to which it becomes attached, while at the same time the open end is closed over. When it reaches the end of the horny tube, it forms, in connection with the old one (Pl. XX. *Fig.* 6, *c*), a new sheath (Pl. XX. *Fig.* c^1), which covers it like a hood. From this new head the tentacles develop, as we have described above.

The budding of medusæ. Hitherto the medusoid generation of Coryne has been referred to the genus Sarsia, of Lesson, and the species, here described, called Sarsia mirabilis;[1] but inasmuch as, long before these medusæ were known, their hydroid form had been referred to the genus Coryne of Gaertner, the name Sarsia, as the generic appellation of this type, must yield to a prior claim. The medusæ-buds appear at two different seasons of the year, one lasting from January to April, the other in November. Each medusoid originates directly from the head, either just below (Pl. XVII. *Figs.* 2, *m*, 3, *a* a^1, 5, *a*, 9, *md*, 11, 12, and 13), or, now and then, intermixed with the tentacles (Pl. XVII. *Fig.* 2, *md*). Usually, however, they develop below the tentacles, and, being not more than five or six in number, at the utmost, do not cluster like those of some other genera. There may be seen on the same head all stages of development, from those just beginning to bud (Pl. XVII. *Fig.* 2, *m*), to such as are about ready to drop (Pl. XVII. *Fig.* 2, *md*). It is worth while here to recur to the fact that the hydroid form buds only from the stem, below the head and neck, in order to contrast it with another fact, namely, that the medusoid form buds only from the head, or at the junction of the latter with the neck.

The earliest indication of the formation of a medusa-bud, is a thickening of the exterior wall of the head of the Hydra (Pl. XVIII. *Fig.* 1, *d*), which produces a papillate elevation (Pl. XVII. *Fig.* 3, a^1) on the outer surface. This is soon followed by a corresponding thickening of the inner wall (Pl. XVIII. *Fig.* 1, *c*), at its exterior surface, and directly under the thickening of the outer wall. This advance is made without tending to form a true diverticulum of the conjoined walls. But soon both walls protrude, perpendicularly, from the surface of the head, in the form of a blind sac (Pl. XVIII. *Fig.* 2, *c d*), into which the digestive canal

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[1] See Mem. Amer. Acad. of Arts and Sciences, Vol. IV.

diverts its course, forming there a narrow cavity (*Fig.* 2, *e* e^1). At this early period the medusa-bud has the power of extending and distending itself, to a great length and breadth, so as to be at one time twice (Pl. XVIII. *Fig.* 3) or thrice as large as at other times. The simple hernia-like state is soon superseded by one which offers unmistakable evidences of the medusoid nature of these buds (Pl. XVIII. *Figs.* 4, 5, 6, and 7, and wood-cuts 7, 8, and 9). Taking the simplest view of this stage, at the plane of the axis, as if the bud were split longitudinally into halves, we may see that the inner wall (Pl. XVIII. *Fig.* 7, *c*) has reverted upon itself, and assumed a cup-shaped form, the hollow of which forms a close-fitting receptacle, or mould, as it were, for the thickening (d^1) of the under side of the outer wall. By receding from this point of view, toward the surface of the bud (Pl. XVIII. *Fig.* 5, and wood-cut 8), the rim (f^1) of the cup comes into sight. In consequence of the reversion of the inner wall upon itself, the cup naturally is formed of a double layer (*Fig.* 6, wood-cut 9, c^1 c^2, and *Fig.* 7). In doubling upon itself, the retreating fold (c^1) does not press closely, at all points, upon the stationary one (*c*), but leaves four equidistant spaces, into which the chymiferous fluid penetrates. This gives the cup a four-lobed appearance, each lobe (*Fig.* 4 and wood-cuts 7, *c* c^1 c^2 c^3, and 8, *c* c^1) containing a chymiferous channel (*ch*). When seen from a point opposite the end of the bud, all four channelled lobes (wood-cut 10, *c* c^1 c^2 c^3) come into view at once, standing at four equidistant points, ninety degrees from each other, around the cup. Between the lobes, the wall (*iw*) is single, and, on account of the thickness and dark color of the lobes, not easily recognized in profile, but, as we have pointed out before, that part of it which helps to form the edge (*Fig.* 5 and wood-cut 8, f^1) of the cup is readily detected. In a view obliquely from the end, the rim (*Fig.* 4 and wood-cut 7, *f* f^1 f^2) of the cup, whether composed of a single or double wall, is distinctly recognizable. Looking at the side of the bud, in a line perpendicular to the outer surface of one of the lobes (*Fig.* 6 and wood-cut 9, *c*), two others (c^2) appear in profile, at a distance of ninety degrees from the first, and the fourth one, on the distal side, at the same distance from the two in profile. Advancing a little further, we find the channelled lobes (Pl. XVIII. *Fig.* 8,

Fig. 7.

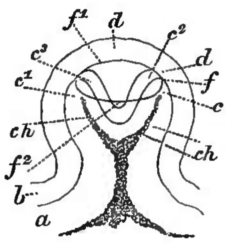


Fig. 8.

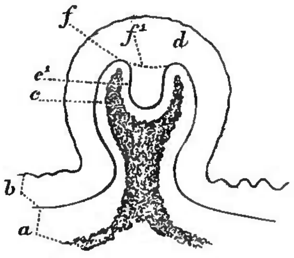


Fig. 9.

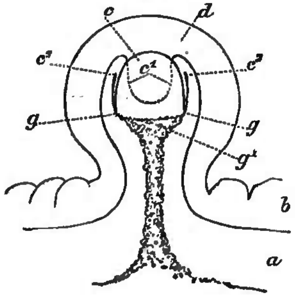
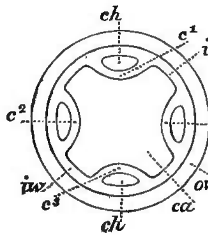
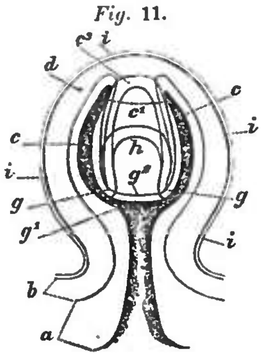


Fig. 10.



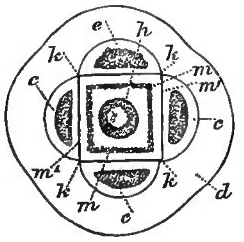
and wood-cut 11, *c* c^1 c^2) have become twice as long as they are broad, and, in addition to this, a new feature is introduced, in the form of a broad and short hernia (wood-cut 11, *h*), which arises from the bottom of the cup. The four channelled lobes, or radiating chymiferous tubes, as they are designated in the full-grown medusa, press closely against the hernia. From the relation which this hernia bears to the radiating tubes, and its position in the bud, it is evident that it is the proboscis of the growing medusa, and as such we will hereafter designate it, even though it is not yet open, as in the adult. The chymiferous fluid circulates freely in the proboscis, and may be seen, at various times, whirling to and fro, in gyratory currents, with greater or lesser velocity.

Fig. 11.



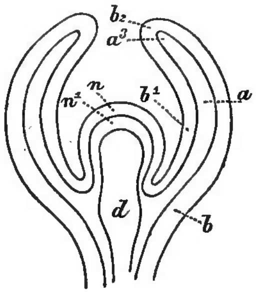
On account of the position of the medusoids, it is not easy to obtain a distinct end view of them, except now and then, when they are situated on the neck of the hydroid, which is not so dark as the head. In this position we have observed a medusoid, hardly older than the one just partly described, which may very well serve to illustrate the peculiar relations which the radiating tubes bear to each other and to the proboscis. These tubes (Pl. XVIII. *Fig.* 8^a, and wood-cut 12, *c*) are a great deal broader than at the time they were formed (wood-cut 10, *c*); they are, in fact, so much expanded that they touch each other at their extreme edges (wood-cut 12, *k*). In consequence of this, the single wall (wood-cut 10, *iw*), which was quite conspicuous between the chymiferous tubes of the earliest stages, is here almost evanescent. In a transversely sectional view, the chymiferous tubes are semi-cylindrical, and have the flat side (*Fig.* 8^a and wood-cut 12, m^1) next to the proboscis (*m*). The channels of these tubes are also segments of a cylinder. The rectangular disposition of these tubes corresponds with the shape of the proboscis, which has a square outline, with sides (*m*) running parallel to the faces of the tubes. Its cavity (*h*), however, does not accord with the contour of the wall, but is perfectly circular in outline. The space not occupied by the proboscis is still filled by the thickening of the outer wall (Pl. XVIII. *Fig.* 8, and wood-cut 11, *d*; *Fig.* 8^a, and wood-cut 12, *m* m^1). Presently, however, this thickened part becomes hollowed, at the region opposite the proboscis, to such an extent, that only a moderately thick layer (Pl. XVIII. *Fig.* 9, b^1 *n*, and wood-cut 13, b^1 *n*) is left as a lining to the cup (*a*) formed by the inner wall and its hernia, the proboscis (n^1). An ideal vertical section through the medusæ-bud, cutting the walls at two opposite points, between the radiating tubes, may lead to a clearer view of the relations

Fig. 12.



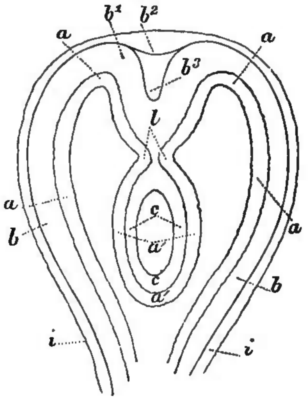
of its component layers (wood-cut 13). The outer wall (*b*), embracing the whole medusa-bud, bends upon itself (b^2), at the edge (a^3) of the cup of the inner wall (*a*), and, following the inner surface of the latter, there becoming the innermost of the three walls of which the umbrella is composed in the newly freed medusa, passes to and over the proboscis (n^1), where it constitutes the outer wall. In this way, the cup-like disk of the medusa becomes triple-walled ($b\ a\ b^1$), and the proboscis double-walled ($n\ n^1$). If we include the radiating tubes in a section, the inner wall being doubled by having a channel hollowed in its thickness, then the disk appears quadruple-walled (Pl. XVIII. *Fig.* 9, $b\ a\ a^1\ c$), and may be mistaken as having really four walls, unless carefully examined in all its relations.

Fig. 13.



Other parts of the organism have also developed new features; the radiating tubes have broadened considerably, especially at two points (Pl. XVIII. *Fig.* 9, *l*) of each, half way between the base and extremity, so that the channels of neighboring tubes are diverted laterally into broad sinuses. Of course this will be understood to be a hollowing in the thickness of the middle wall. As the medusa grows larger and older, these sinuses become narrower and deeper (Pl. XVIII. *Fig.* 10, and wood-cut 14, *l*), and consequently each one approaches its neighbor. What appear to be intervening walls, both in the last stage (Pl. XVIII. *Figs.* 9, $b^1\ l\ c$) and in this (*Fig.* 10 and wood-cut 14, $b^1\ l\ c$), through which the approximating sinuses would appear to be forcing their way, are profiles of an oblique view of the innermost wall, seen at a deeper focus.[1] That portion beyond the approximating sinuses, and the outer end of the disk (Pl. XVIII. *Fig.* 10, and wood-cut 14, b^1), is deeply four-lobed on the inner surface, each lobe (b^1) being separated from its neighbor by a deep sinus (b^3). This sinus extends so far, outwardly, that the edge of the disk is reduced to a quite thin stratum (b^2). These four lobes are the incipient hollow tentacles, which, as they grow older and longer, are gradually bent inward, as may be seen Pl. XVIII. *Fig.* 14, and wood-cut 17, *f*.

Fig. 14.



In a little older stage, we find that the lateral sinuses, of the last phase, have come together and formed a continuous channel (Pl. XVIII. *Fig.* 11, and wood-cut

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[1] In order to avoid confusion, only two of the radiating tubes, nearest to the eye, are shown in *Figs.* 9 and 10. Being very broad, those portions of the tubes which are next the centre of the figure, are seen facing the observer, and those at the periphery nearly in perfect profile.

15, *l*; *Fig.* 12 and wood-cut 16, b^5) from one radiating canal to the other, so that the four transverse channels, connecting the four radiating tubes, constitute, as a whole, the circular chymiferous canal of the medusa. The contracting edge (wood-cut 13, a^3) of the cup, formed by the middle wall (*a*) in earlier phases, has, in the present stage, closed over, and forms a continuous wall (Pl. XVIII. *Fig.* 12, and wood-cut 16, b^3). In doing so, it has separated the outer wall (wood-cut 16, a^5) from its continuation, the innermost wall (c^4). These three walls (a^5 b^3 c^4) constitute the transverse septum which shuts off the concavity of the disk from exterior communication. The exterior wall (*a*) of the disk is still very thick, and the innermost one (*c*) none the less so, but the middle wall (*b*) is much thinner than in earlier stages; all three, however, are considerably thinner in the transverse septum (a^5 b^3 c^4). The four sinuses (Pl. XVIII. *Fig.* 10, and wood-cut 14, b^3), pointed out in the last stage, have passed through the whole thickness of the disk, and completely separated it into four lobes (Pl. XVIII. *Fig.* 11, and wood-cut 15, *o*; *Fig.* 12 and wood-cut 16, a^1). Each one of these lobes, or young tentacles as they may more properly be called, is hollow to the very tip, and in direct communication with a radiating canal (wood-cuts 15, l^1, and 16, b^1). These last are as yet very broad and deep channels, whose walls occupy a large proportion, at least one half, of the thickness, and nearly the same amount of the circumference of the disk. On account of the extensibility and contractility of the disk, this last proportion is quite variable, as a glance at the two figures (Pl. XVIII. *Figs.* 11 and 12) referred to above, will show. After this, the radiating tubes apparently diminish very rapidly in diameter, and become gradually more slender (Pl. XVIII. *Fig.* 13), with the growth of the disk; but in reality they increase not only in length, but also in diameter, and the apparent reduction is owing to the more rapid growth of the umbrella. The tentacles, also, correspond in rapidity of growth. It will be noticed that they project centrifugally, so that their ends overlap each other.

Fig. 15.

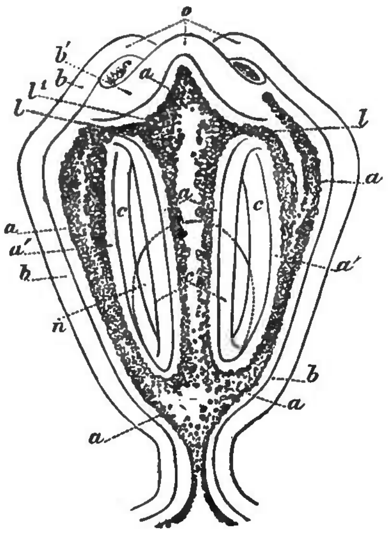
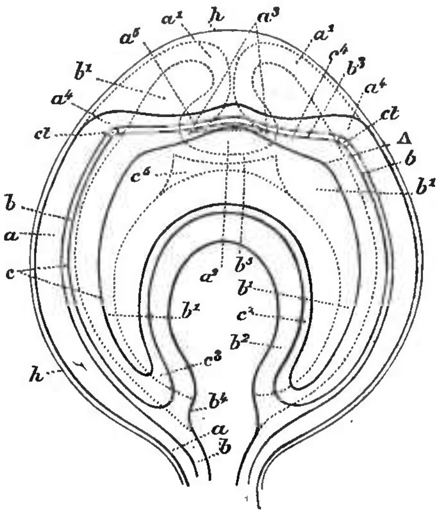
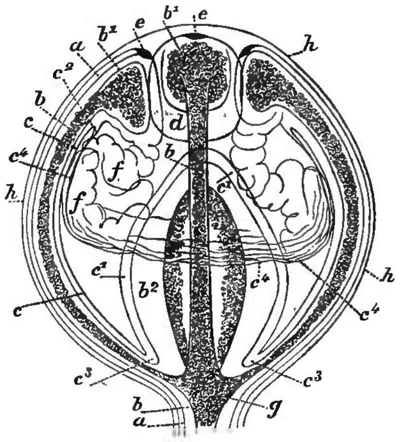


Fig. 16.



As the medusa grows older, the tentacles (Pl. XVIII. *Fig.* 14, and wood-cut 17, *f*) curl themselves within the cavity of the disk. They are prevented from coming in direct contact with the inner surface (*c*) of the cavity and the procoscis (c^1), by the transverse septum (c^4), which is forced inwards with them. The tentacles might very naturally project outwardly, were it not that they are restrained from doing so by the prolongation of the horny sheath of the hydroid, which envelopes the medusæ very closely with a thin film (*h*). The base of each tentacle is swollen into a large bulb (*d*), the interior of which contains a cavity of considerable capacity (b^1). Here the radiating and circular tubes mutually empty, and here the chymiferous fluid keeps up a continual whirling. At the base of each tentacle, on the outer side, there is a small black mass (*e*) imbedded in the outer wall. This spot, being in the same position as the eye in the adult, must be that organ. The transverse septum (c^4) is very thin, except at its periphery (c^2); in fact, it is not possible, in a profile of its thickness, to see its three component walls. It has great extensibility, and, judging from its numerous wrinkles, it must be in a very lax state, although pushed inwards by the tentacles. The outer (*a*), middle (*b*), and innermost walls (*c*), are much thinner than in the last phase, not only absolutely so, but in proportion to the size of the disk. The proboscis (b^2 c^1) offers nothing remarkable or noteworthy, except, perhaps, that it possesses the power of enormous distension, such as has never been noticed in the free medusæ. As we might naturally suppose, from the present relations of the medusa to its hydroid, the proboscis has no opening at the end.

Fig. 17.

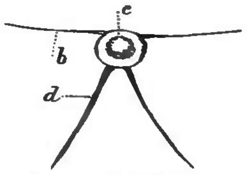


At this time the medusa begins to contract more rapidly, and occasionally with a sudden jerk. The frequency of these jerks increases, as the animal grows older, till very often three or four succeed each other in rapid succession. The enveloping horny film at last is torn open, and allows the medusa to expand more freely, and the tentacles to withdraw themselves from the cavity of the disk, and stretch outwardly. The transverse septum becomes perforated, in the centre, by a hole which rapidly enlarges, till, by the time the medusa has been free two or three days, it equals about one fifth (Pl. XVIII. *Fig.* 17, *a*) of the diameter of the disk. This hole gives ingress and egress to the water, which is forced out as the disk contracts, and rushes in as the disk expands; at the same time the transverse septum is pushed inward or outward, according to the direction in which the water is running. In order to free itself, the peduncular attachment (Pl. XVIII.

Fig. 14, and wood-cut 11, *a b*) of the disk gradually grows smaller and smaller by constriction, till finally it is cut through, and the medusa drops from the parent stem, and swims away. Shortly before dropping from the hydra, the medusa becomes very restless; it contracts and expands in rapid succession, by jerks which throw it to and fro about the stem of the hydra. The hydra itself contributes also to the liberation of the medusa, by coiling itself around the peduncle, which still holds the medusa fixed by its abactinal summit to the place from which it has been budding. In thus coiling itself around the base of the medusa, the hydra gradually pushes the medusa off, and the next jerk sets it altogether free. At the time of its birth, the medusa is about one sixteenth of an inch in diameter (Pl. XVIII. *Fig.* 15). For a while the outer and inner walls cling to each other at the point where the peduncle was divided (Pl. XVIII. *Fig.* 15^a, *a*; Pl. XIX. *Fig.* 16, *n*), so that the summit of the medusa exhibits a funnel-shaped depression. As soon as the disk is freed from the restraint of the horny film, the whole animal expands, and the outer wall separates for a considerable distance from the middle one, except where they form the transverse septum, and at the point where they were attached to the parent. At this last-mentioned place, the outer (Pl. XIX. *Fig.* 16, o o^1) and inner walls (h^4) are drawn toward each other by their mutual efforts to separate, and the outer one (o^1) being drawn in, forms a depression (*o*) very often noticed in young Medusæ, whilst the inner one, being drawn out, becomes conical. As they retreat from each other, the depression (Pl. XIX. *Fig.* 15, *o*) becomes deeper, the cone (h^4) more pointed and higher, and the point of adherence (*n*) less and less, till finally the two walls suddenly separate. The outer one retires till it comes nearly to a level with the surrounding portion, still remaining slightly depressed (wood-cut 25, a^1, p. 202) and the inner one sinking, the hollow cone disappears. The widely separated outer and middle walls of the medusa just born (Pl. XVIII. *Fig.* 15^a), form a very remarkable feature when contrasted with their relations at a period just before birth (Pl. XVIII. *Fig.* 14), where the outer (wood-cut 17, *a*) and middle (*b*) ones press very closely against each other. It is not possible to say, precisely, at what time the mouth of the proboscis is formed, but it is certainly open (Pl. XVIII. *Fig.* 15^a, *e*) by the time the medusa becomes free. The radiating tubes (Pl. XVIII. *Fig.* 15^a, *c*; Pl. XIX. *Figs.* 16, e^2, and 17, *b*) are, proportionally, a great deal larger than in the full-grown animal, and have very irregular walls; a peculiarity not noticed in earlier stages, nor in later ones. At the junction of the radiating and circular tubes (Pl. XIX. *Figs.* 17, b^2, 18, *b*, and 19, *b*), and also where the four radiating tubes mutually empty into the proboscis (Pl. XVIII. *Figs.* 16, *d*, and 17, *d*; Pl. XIX. *Figs.* 16, i^1, and 20, *a*), their walls are lined with dense accumulations of dark-brown granules, which are constantly loosening, and circulating with the chymiferous fluid, and finally cast out from the mouth.

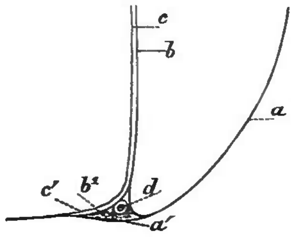
The three component walls of the disk are excessively thin, making it very difficult, even with a magnifying power of five hundred diameters, to recognize any thing more than a thick, dark line, as the representative of the thickness of each (Pl. XIX. *Figs.* 16, g^1 h^2 o o^1, and 17, *a c*, wood-cuts 18, *b d*, and 19, *a b c*, a' b^1 c'). For a short distance before the middle (Pl. XIX. *Figs.* 15, h^2, and 16, h^2) and innermost walls (g^1) join the proboscis, they become more easily discernible, from an increase in thickness, which reaches its maximum (*g h*) in the organ just mentioned. The middle wall is quite thick where it becomes an integral part of the radiating tubes (Pl. XIX. *Figs.* 16, *e*, and 17, *b*, wood-cut 18 *c*). Just before the medusa frees itself, and whilst confined within the close embrace of the horny film (Pl. XIX. *Fig.* 14, *c*), the unexpanded outer (*a*), middle (*b*), and innermost walls (*c*), exhibit considerable thickness, allowing the component cells (a^1 c^2) of the outer and inner ones to be recognized; but the moment these walls are liberated from restraint, they take on the conditions described above. The innermost wall is perfectly free from the middle wall, except at the radiating tubes and the four intermediate points. This becomes apparent when the disk is contracted, at the time the animal is dying. Then this wall shrinks from the middle one, between the points of attachment, and, according to the degree of contraction, forms a figure with eight angles, more or less sharply defined (Pl. XVIII. *Figs.* 16, *a*, 17, *e*, and 18). The bulbous swelling (Pl. XVIII. *Figs.* 15^a and 17; Pl. XIX. *Figs.* 17, a^1, and 18, *c*) on the under side, at the base of the tentacles, and the eyes (Pl. XIX. *Figs.* 17, *d*, 18, *a*, and 19, *a*), are, proportionally, from three to four times as large as in the full-grown medusa. When seen in profile, either from above or laterally, it becomes evident that the eyes occupy the whole thickness of the outer wall of the tentacle, and that they have a truncated, conical shape, with the narrower end turned inwards (Pl. XIX. *Figs.* 17, *d*, and 19, *a*).

Fig. 18.



Sectional view of a radiating tube (*c*), and the adjoining middle (*b*) and innermost (*d*) walls.

Fig. 19.



Vertical section of the edge of the bell.

a a' outer wall. — *b* b^1 middle wall. — *c c'* innermost wall. — *d* circular tube.

As to a nervous system, it has not been possible to detect the least signs of a structure indicating its presence. When the innermost wall (Pl. XIX. *Figs.* 16, g^1, and 17, *c*) is seen in profile, along the radiating tubes and at the four intermediate points, its thickness resembles a thin cord, which might be easily mistaken for a nervous thread. The most intimate structure, the cells (Pl. XIX. *Fig.* 13, *b*), of the innermost wall, along the radiating tubes, do not differ from those on each side (*a*); all are alike excessively transparent, and round. When the animal is contracted in the manner described above, the innermost wall, at its eight points of adherence, comes strongly into profile, and, on this account, the nerve-like appearance of its thickness is more apparent than at any other part; but when the disk is uncontracted, and the innermost wall presses uniformly against the whole surface of the middle one, it is possible to observe this same appearance (Pl. XIX. *Fig.* 16, g^1) anywhere between these eight points. Looking at the disk from above, the innermost wall, where it bends downwards to become the outer wall of the proboscis, resembles, in profile, a quadrangularly-disposed cord (Pl. XIX. *Fig.* 20, c^2), surrounding the inner wall (c^3) of the proboscis like a nervous ring. At the junction of the transverse partition with the edge of the disk (wood-cut 19), the innermost wall bends upon itself at right angles, and there (Pl. XIX. *Fig.* 17, c^1), again, when looking across the edge of this angle, its thickness appears like a nervous ring, running along the inner edge of the circular tube. The statement, in my paper on Sarsia, Mem. Amer. Acad. of Sc. and Arts, Vol. IV pp. 246 and 247, that these Acalephs have a specialized nervous system, was based upon these appearances.

The tentacles are highly developed (Pl. XX. *Fig.* 9), and covered with numerous groups of bristling lasso-cells (*b b*), admirably adapted to perform the functions for which they are designed. Even at this early period the proboscis has all the flexibility of the adult; this is manifested in a curious way sometimes, by revealing the edge of the mouth so that it doubles upon the superior portion of the proboscis for a considerable distance (Pl. XX. *Fig.* 7, *a*), and then again redoubles in a downward direction (*Fig.* 7, *b*), upon the first fold. When the disk is in a contracted state, we may oftentimes see, in a view from above, a remarkable arrangement of wrinkles. In the centre, directly over the proboscis, these corrugations form two concentric, quadrilobate rosettes (Pl. XVIII. *Fig.* 18), each lobe being situated directly above a radiating tube. From the end of each lobe two parallel rows of wrinkles proceed about half way down, toward the lower edge of the bell-shaped disk, including, on their way, a deep furrow (*a*), the bottom of which lies close to the chymiferous tube. Parallel to these wrinkles, two other double rows (*b*) run from each side of a lobe of the rosette, half way down the disk; and a double row (*c*) also starts from the angles between the lobes, and runs outwards in a direction forty-five degrees from the trend of the other rows, and only half as far down the disk. At the lower termination of the rows of wrinkles a band of the same nature runs horizontally around the disk, following all the sinuosities of the umbrella.

In order to complete the proof that the hydroid form of Coryne mirabilis is the parent of our full-grown Sarsia mirabilis, an attempt was made to rear the young medusæ freed from the hydra. In this attempt a partial success was obtained. In six days from the time of birth, the medusæ increased from one sixteenth to about one eighth of an inch in diameter (wood-cuts 20, 21, and 22); after this they died, owing, no doubt, to their excessive tenderness, and the difficulty of keeping the water sufficiently aerated. However, this did not preclude the possibility of examining them in all stages of growth, from the youngest to the full-grown condition, inasmuch as the water of Boston Harbor was filled with the same medusæ, of all ages. By comparing specimens found in the open ocean, with those of the same size, just born in confinement,[1] it was impossible to see any difference, and so it was with those collected at the same time, and placed by the side of the largest which were reared. These facts being established to a certainty, no one could fail to see that the series of specimens, of five different sizes, from one sixteenth to one fifth of an inch in diameter (wood-cuts 20, 21, 22, 23, and 24), all collected on the same day, belonged to one and the same species of Medusa, in various stages of growth. These comparisons were made in two different years; March 26, 1855, and March 29, 1858. Nearly a month after the first-mentioned date, on the 21st of April, specimens, some about two thirds of the size of full-grown ones, were obtained (wood-cut 28, p. 211), measuring one third of an inch in diameter, and by

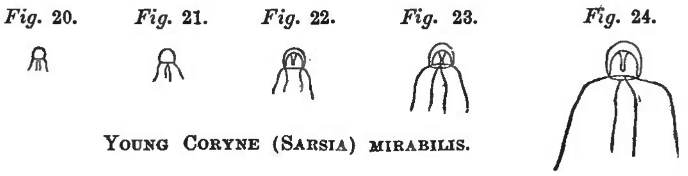


Fig. 20. *Fig.* 21. *Fig.* 22. *Fig.* 23. *Fig.* 24.

YOUNG CORYNE (SARSIA) MIRABILIS.

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[1] Wood-cuts 20, 21, 22, 23, and 24 represent a series of young medusæ of Coryne mirabilis, drawn from nature by H. J. Clark. The specimen represented by wood-cut 20 was seen to drop from the parent stem; that of wood-cut 21 was found in Boston Harbor, and was as large as that of wood-cut 20 when three days old; that of wood-cut 22 was found with that of wood-cut 21, and was as large as that of wood-cut 20 when six days old; those of wood-cuts 23 and 24 were also found with the preceding, but their precise age could not be ascertained. In order to facilitate the comparisons between our Sarsia and the European species, during their development, I submit here references to the different descriptions thus far published of the young Sarsia of Europe, with the dates of the observations.

Coryne ramosa, Gosse, Devon. Coast, p. 190. Simple sac (Medusa), with eggs, July, 1852.

Coryne gravata, Wright, Edinb. New Phil. Jour., 1858, Vol. VII. Aborting Medusa attached, with spermatozoa. Spring.

Coryne glandulosa, Wright, Ed. Ph. Jour., July, 1857. Simple sac, with eggs.

Coryne (Syncoryna) *ramosa*, Lovèn, Wieg. Arch., 1837. Aborting medusa with eggs. June.

Coryne (Syncoryna) *Sarsii*, Lovèn, Wieg. Arch., 1837. Nearly perfect medusa (aborting), June. Compare Pl. XVII. *Figs.* 14, 15, and 16.

Coryne (Syncoryna) *Sarsii*, Sars, Faun. Litt., Pl. I., 1846. Perfect and free medusa. May and June, 1838.

Coryne (Syncoryna) *decipiens*, Dujardin, An. Sc. Nat., 1845, IV. Perfect free medusa, Sthenyo (Sarsia). December, 1842.

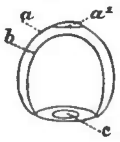
Coryne (Syncoryna) *pusilla*, VanBeneden, Acad. Brux., 1843. Simple sac, with four-armed hydroids! Summer, ? 1843.

Coryne (Stipula) *ramosa*, Sars, Bidrag, 1829, and Isis, 1833, Tab. X. *Fig.* 1. Simple sac with eggs. ? July.

Desor's paper, Ann. Sc. Nat., 1849, Vol. XII., represents the American *Coryne mirabilis*.

the eighth of May the adult (wood-cut 30, p. 212) occurred in great numbers. On the 17th of May the males and females contained, severally, abundance of spermatozoa and eggs.

Fig. 25.



From a specimen of the same size and age as that of wood-cut 20.[1]

Fig. 26.

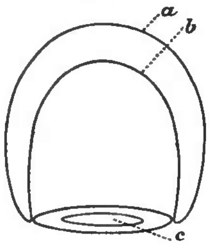
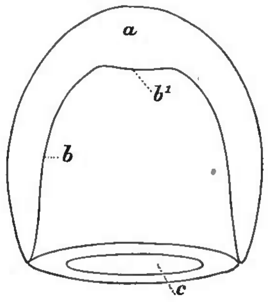


Fig. 27.



As we have said before, the outer and middle walls become widely separated, at birth, but are nearly parallel to each other at first (Pl. XVIII. *Figs.* 15ª and 17, wood-cut 25). Soon, however, they begin to assume very different outlines; the outer one becoming more rounded and expanded above, and the middle one more open below, so that the two seem to approximate near the edge of the disk, and gradually recede, going upward (wood-cut 26). This disparity increases till the outer wall becomes oval in outline, and the middle one conical (wood-cut 27). The outer wall, in this instance, is more elongate-oval than in the adult, so that the disk is much higher than it is broad. After this the disk grows proportionally broader (wood-cut 28), and the top of the dome less pointed, till it has reached the adult state (wood-cut 30). The aperture (wood-cuts 25, 26, and 27, *c*) in the transverse partition gradually increases in diameter with the growth of the disk, till, by the time the latter is one fifth of an inch in diameter, it is as large, in proportion to the size of the animal, as in the adult. Specimens of this Medusa which have reached two thirds of their normal size (wood-cut 28, p. 211), are capable of stretching their tentacles to as great a length as the adults. The adult is not only able to contract into a very small compass, but also to stretch longitudinally at the expense of its breadth, till it is twice as long as broad (wood-cut 31, p. 212). While doing this the transverse partition (c^1) is oftentimes allowed to hang down loosely, in an inverted truncate-conical shape. The extent to which the proboscis may contract and expand may be inferred from a comparison of the two figures, wood-cuts 29, *d*, and 31, *d*, p. 212; in the first, it is stretched to four times the length of the disk, and considerably expanded withal, and in the second retracted so as hardly to equal one half the height of the disk in a quiescent state. The tentacles, at times, remind one of the long cirrhate arms of Pleurobrachia, when, instead of stretching uniformly,

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[1] Wood-cuts 25, 26, and 27 represent the successive changes which take place in the shape of the disk as the medusa develops after being freed, magnified 25 diameters. *a* indicates the outer surface, and *b* the inner surface, of the disk; a^1 the depression in the top of the disk; b^1 the thickening of the centre of the disk; *c* the aperture of the veil.

as is generally the case, they contract into little knobs at several points along their length, and bend at sharp angles upon themselves. (Compare wood-cut 29, page 212.)

The peculiarities of the medusoids, which are developed at the latter end of the breeding season, have already been pointed out in brief (page 189). We will here revert to them, and describe the nature of these apparent anomalies in a more detailed manner. The medusoid goes on developing, after the usual manner, for the greater part of the period of its embryonic growth, and then there follows an excess of development in some of the organs, and a deficiency in others. The proboscis grows to an enormous size, so that in the females (Pl. XVII. *Fig.* 16, *n*), with the walls full of eggs, it occupies the whole cavity of the disk, and projects far beyond it; and in the males (Pl. XVIII. *Fig.* 11, *n*), being gorged with mature spermatoza, it crowds upon the walls of the disk as much as in the females. At this stage it is very active, and constantly changing its shape; at one time the end is sharp (Pl. XVII. *Figs.* 12, 13, 14, and 16), at another blunt (*Fig.* 15), and then broad and pear-shaped (*Fig.* 11). Sometimes it distends itself with chymiferous fluid (*Fig.* 16) till it protrudes far beyond the edge of the disk, and then again suddenly contracts to moderate dimensions. In no instance could a mouth be discovered at the end of the proboscis. The radiating and circular tubes are developed to perfection, and oftentimes the radiating tubes are more than four in number, varying from five (*Figs.* 13 and 15) to seven, and not always arranged symmetrically around the disk. The tentacles vary in the degree of development to which they arrive, some medusoids, in fact, have not any (*Fig.* 13), or only some very slight protuberances in their places (*Fig.* 14, *r*); others have quite prominent papillæ (*Figs.* 11, 15, and 16), growing longer and longer, till, in some instances, we find them with tentacles as long as the disk is high (*Fig.* 12). In the latter cases the tentacles have a stiff, jagged, and awkward appearance, very unlike the graceful and flexible forms of the perfectly formed embryo; nor have they any swelling at the base, nor an eye-speck, but simply a slight thickening of the outer wall (Pl. XIX. *Fig.* 9, *a*), which suddenly thins out below. The eggs, occupying a space between the inner and outer walls (Pl. XVIII. *Fig.* 21^a, *b a*), are discharged by rupturing the outer wall (*a*). The transverse partition (Pl. XVII. *Fig.* 12, *pr*), in some of the more fully developed medusoids at least, has all the perfection of the same organ in well-matured embryos, and may be seen flapping upward and downward as the water rushes in and out with the expansion and contraction of the disk. The withered and wrinkled condition of the majority of these abnormally developed medusoids, justifies the inference that they do not become free, but cast their eggs or spermatoza, and then shrivel up and die. Some of the more normally developed of these forms (Pl. XVII. *Fig.* 12), perhaps, do at least drop from the parent stem, judging from their violent and rapid contractions and the smallness of their peduncle (*Fig.* 12, *d*), but they have never been found swimming freely in the sea, like the perfect medusæ.

SECTION IV

HISTOLOGY OF CORYNE MIRABILIS.

Proles hydroidea. *Adult.*— The outer wall appears, at first sight, to be a homogeneous layer, with numerous striæ (Pl. XIX. *Fig.* 1, *g* g^1) running lengthwise, along the stem, on its surface. Below the head these striæ are double (*Fig.* 1, g^1), and run together for a greater or lesser distance, and have the appearance of being the outlines of closely approximated bands, which remind one of unstriated muscle. Upon closer examination, however, these striæ turn out to be mere furrows, caused by the longitudinal wrinkling of this wall. In profile (*Fig.* 1, *b* b^1), they may very readily be seen to be superficial, especially on the tentacles (*Fig.* 1, b^1, *Fig.* 3). The cells of this wall, as seen with objectives having wide apertures (Pl. XI^c. *Fig.* 14; Pl. $XXIII^a$. *Fig.* 12, *b* b^1 *c*) are fully as broad as those (*d e*) of the inner wall; but they are far shorter, being equal in length to the thickness of the wall which they constitute. They have a flat inner face, next to the interior wall, and the outer ends are rounded, and each one contains a single, excessively transparent mesoblast (b^1), imbedded in perfectly homogeneous contents. When the hydra is stretched to its fullest extent, these cells have a hemispherical shape; but upon the contraction of the animal, they become short prisms, by mutual pressure.

In the young hydroid (Pl. XX. *Fig.* 6, *a*), which affords the best opportunity for the investigation of the structure of this wall, it is seen to be transversely striated, in a profile of its thickness. The striæ are, without doubt, the parallel sides of columnar cells, each one of which occupies the whole thickness of the wall. But with an ordinary microscope a close examination of the thickness of this wall (Pl. XIX. *Figs.* 2, *b*, and 4, *b*; Pl. XX. *Figs.* 2, *a*, and 3, a^1) did not disclose the least trace of cellular structure, in the adult, excepting that there were numerous lasso-cells in the stem (Pl. XX. *Figs.* 2 and 3), a few scattered along the tentacles, and the usual densely packed layer at their tips (Pl. XIX. *Figs.* 1, *f*, 2, *f*, and 3, *f*). It is well worthy of notice that, although the lasso-cells are very numerous in the outer wall of the stem (Pl. XX. *Fig.* 2, *a*), they are totally prevented from exercising any function, such as obtains with those on the tentacles, by the thick horny sheath which shuts them off from the surrounding medium.

The inner wall is made up of large cells, of various shapes, according to their position in the animal. Low down in the stem (Pl. XX. *Fig.* 2) the brown cells of the digestive cavity cover this wall so thickly, that the cells cannot be discovered very distinctly; but at the neck, which is, comparatively, quite transparent, they may be made out with considerable clearness. Here they are curiously curved, prismatic, wedge-shaped cells (Pl. XI^c. *Fig.* 14, *d e*; Pl. XXIII^a. *Fig.* 12, *d e*; Pl. XIX. *Fig.* 4, *a*), with their narrower ends inward, and each one occupying the whole thickness of the wall. Their outer, broader ends, do not conform to the inner surface of the outer wall (Pl. XI^c. *Fig.* 14, *b*; Pl. XIX. *Fig.* 4, *b*); but each one is more or less rounded, so as to leave interspaces between them and the aforesaid wall. In the head these cells are much larger (Pl. XIX. *Fig.* 2, a a^1), and have straight parallel sides above and below; but, like all cells which converge around a central axis, they are wedge-shaped laterally. Their outer ends (*Fig.* 2, a^1) have an irregularly polygonal shape, and overlap each other with lateral expansion. Like those in the neck, they have very transparent, homogeneous contents, and do not appear to be mesoblasted. The red, granular lining of the digestive cavity and the stem, consists of very irregular cells (Pl. XI^c. *Fig.* 14; Pl. XXIII^a. *Fig.* 12, *d d*), which project their tail-like prolongations between the rounded ends of the cells of the inner wall; they contain a large, irregular, dark mesoblast, which seems to be the cause of the color in this lining.

The cells of the inner, or axial wall of the tentacles, meet in the centre, and form a double row (Pl. XIX. *Figs.* 2, a^2, and 3, *a d*). When seen under a low magnifying power, they appear like transverse partitions, in the axis of the tentacles (Pl. XVII. *Figs.* 11, *t*, and 11^a); but a closer examination with highly magnifying powers shows them to be arranged in two rows, one above (*Figs.* 2, a^3 a^4, and 3, *b*) and one below (*Figs.* 2 and 3, *a*). At the base of the tentacles there is, oftentimes, an irregularity in their arrangement, sometimes one cell and sometimes three occupying the axis; but this is owing to the fact that the inner walls of the head and tentacles pass gradually into each other, so that there is no dividing line between the two. The thick, irregular column (*Fig.* 2 and 3, *g*) running along the middle of the tentacles, as seen laterally, is the double wall, formed by the meeting of the cells of the upper and lower sides. The mesoblasts of these cells appear like coarse, irregular granules, imbedded in the double walls at their line of junction. In the perpendicular plane of the axis the walls of the cells meet each other in such a manner as to form uniform lines, from the upper to the lower side of the tentacles (*Fig.* 2); but, at the surface (*Fig.* 3), they often meet with opposite curves, or at broad angles.

The horny sheath (Pl. XVII. *Figs.* 2, *s*, 9, *c*, 11, *c*, and 15, *c*; Pl. XIX. *Figs.* 2, *c*, and 4, *c*; Pl. XX. *Figs.* 1, *a*, 2, *c*, 3, *c*, and 6, c c^1) is composed of irregular concentric layers. When the thickness of the sheath is examined in profile, it appears to be fibrous (Pl. XX. *Fig.* 2); but this is owing to the minute concentric layers of which the tube is composed; since, in a view from the superficies (Pl. XX. *Fig.* 1, *a*), nothing like fibres is to be seen. In the young hydroid (Pl. XX. *Fig.* 6) the outer (*a*) and inner (*b*) walls are built up of columnar cells of much smaller size than in the adult. See p. 203.

Proles medusoidea. No definite information has been obtained about the cellular structure of the embryo medusa-bud, in its earliest stages. At that time the outer and inner walls appear like perfectly homogeneous and very transparent layers. As soon, however, as the innermost wall (Pl. XVIII. *Fig.* 9, b^1 *c*) has been established, the outer wall (*b*) may be seen, in profile, to be composed of wedge-shaped, faintly granulated, prismatic cells, the broader ends (Pl. XIX. *Fig.* 7^a, *a*) of which are turned outward, while the narrower ends (*b*) form the inner surface of the wall. The inner ends (*Fig.* 7^b), in a front view, present an irregularly polygonal mesh. At a still later period, when the tentacles are considerably elongated (Pl. XVIII. *Fig.* 13, *a*), but before they coil inwards into the cavity of the disk, the cells of the outer wall (Pl. XIX. *Fig.* 7, *a*) have become proportionally broader and shorter, in fact, nearly as broad as long, and have very little of the wedge-shaped form of earlier stages. The outer wall (*Fig.* 7, a^1) of the tentacles is composed of the same sort of cells as are found in the outer wall of the disk. The cells of the middle wall (*Fig.* 7, *b*) are very obscure, except in its prolongation in the inner wall (b^1) of the tentacles. There they have much the same character as those of the outer wall (a^1).

About the time the medusa is ready to drop from the parent stem, or just at the time when it becomes free, the cells of the outer wall (Pl. XIX. *Figs.* 14, *a*, and 14^a) have expanded laterally, so as to be a great deal broader than long. When seen in front (*Fig.* 14^a) they are conspicuous for their irregular form, giving the disk the appearance of being covered by a network of irregular meshes. In profile, the inner ends appear like slightly prominent papillæ (*Fig.* 14, *a* a^1). Each cell contains a very large, distinctly granulated mesoblast *Fig.* 14^a, *b*), and each mesoblast a very faint entoblast (*c*). The cells of the outer wall (Pl. XX. *Fig.* 8, a^1) of the short papilliform tentacles of a medusoid, which lays its eggs before becoming free (Pl. XVII. *Fig.* 15), are broadly pear-shaped, and very transparent, resembling very closely the cells of the outer wall in a much younger stage (Pl. XIX. *Figs.* 7^a and 7^b). The only trace of organization that could be found in the middle wall (Pl. XIX. *Figs.* 11, *b*, and 14, *b* b^1) of the disk, was a faint horizontal striation (Pl. XIX. *Fig.* 11, *d*), caused by rows of granules (*Fig.* 12, *a* a^1) arranged in close parallel lines; and even these were brought out by the agency of water or alcohol. There seems to be only a single layer of these granules, judging from a profile view (*Fig.* 12, a^1). The innermost wall (*Figs.* 10, *b*, and 14, *c*) is papillate on its inner surface (*Figs.* 10, *b*, 13, *a b*, and 14, c^2), owing to the slightly projecting ends of the cells. The cells (Pl. XIX. *Fig.* 14^b) are much smaller than those of the outer wall, and also differ in having distinct granular contents, a smaller mesoblast (*b*), not granulated, and a much more conspicuous, but smaller, dot-like, dark entoblast (*c*).

When the medusa is fairly free from the restraint of the horny sheath, and has had a few hours to expand itself, the individual cells of the different walls are found to have dilated considerably. The cells which compose the outer wall of the disk and its transverse septum, are in one layer, excessively transparent, and very difficult to recognize. They are usually six-sided (Pl. XIX. *Fig.* 22), and nearly symmetrical, with smaller and fainter mesoblasts (*a*) than those of the last phase, and mere dot-like entoblasts (*b*). An extremely faint granulation pervades the whole cell. Freshwater swells these cells (*Fig.* 21), and causes the granulation to vanish, but does not seem to affect the mesoblasts. At the base of the tentacles, the outer wall of the bulb (Pl. XIX. *Fig.* 26) is a solid mass of very transparent, small, rounded cells, hardly larger than the mesoblasts of the disk cells (*Fig.* 22). The surface of this bulb is covered by large lasso-cells (*Fig.* 25). The outer wall (Pl. XX. *Fig.* 9, *c*) of the tentacles is more transparent than the outer wall of the disk, and does not afford the least trace of cellular structure, except in the case of the lasso-cells (*b*), which are imbedded in heaps within its thickness. A few scattering cylindrical papillæ (*a*) give a peculiar appearance to the tentacle at this age, but they disappear very soon. By plunging a fully-grown medusoid into freshwater, the cellular structure of the radiating tubes was brought out very clearly. In profile (Pl. XIX. *Fig.* 27, *b*), the wall presents only a single layer of broad and short cells, closely resembling those of the inner wall of the tentacles. Each cell contains a single, moderate-sized mesoblast. Viewed in front (*a*), these cells appear polygonal, and much broader transversely to the axis of the tube. The middle wall of the disk shows no trace of organization, beyond the parallel horizontal striæ (Pl. XIX. *Fig.* 24), which have been pointed out in the last phase. In this case, they were seen in a natural state, and appear to be wider apart than when heretofore noticed. Where this wall is continued into the proboscis (Pl. XIX. *Figs.* 15, h^2 h^1 *h*, and 16, h^2 *h*), and constitutes its inner wall, the cellular structure is very easily discerned. In the pendent part of the proboscis (*Figs.* 15, *h* h^1, and 16, *h*), the cells are very large and transparent. In profile they are seen to vary in shape, according to the degree of contraction or expansion of the proboscis; sometimes having a broad cylindrical shape (*Fig.* 16, *h*), or, at another time, being prismatic and conical (*Fig.* 15, *h*), with the apex inward, forming the inner surface of the cavity of the proboscis, and the broader end lying next the outer wall (*Figs.* 15, *g*, and 16, *g*). When viewed in front, so that they seem standing side by side, they appear like a coarse net-work (*Fig.* 15, h^1), with thick meshes and irregularly polygonal interstices. At the end of the proboscis (*Fig.* 15, *k*) they are much smaller, and so, likewise, above, in the stomach (h^4), where they gradually diminish and grow fainter as this wall thins out and passes into the disk. The continuation of this wall into the tentacle, where it is the inner wall (Pl. XIX. *Figs.* 17, b^3, and 18, *h*), is a single layer of broad cylindrical, prismatic, transparent cells, resembling those of the proboscis. At the base of the tentacle they are very easily recognized, but toward the outer end (Pl. XX. *Fig.* 9) they are not to be seen.

The cells of the innermost wall of the disk and transverse septum are still more transparent, and more sharply polygonal than those of the outer wall, and have a much smaller, obscure mesoblast (Pl. XIX. *Fig.* 24, *a*). Alcohol brings them out clearly, but renders them circular in outline (*Fig.* 23). The continuation of this wall, as the outer wall of the proboscis (Pl. XIX. *Fig.* 15, *g*), is striated or furrowed lengthwise, but does not afford any trace of cellular structure, excepting the dense collection of lasso-cells at the end (*k*) of this organ, and occasionally one higher up, imbedded in the thickness of the wall.

The lasso-cells of the hydroid (Pl. XIX. *Figs.* 5 and 5^a) and of the medusoid (*Figs.* 6 and 6^a) are, to all appearances, identical in every respect. When in an extended state, with the lasso out (*Fig.* 5^a), they are most easily understood. In this state they are much smaller than when the lasso is still within its cell (*Figs.* 5 and 6). The wall of the oval cell is of even thickness throughout, and has perfectly clear contents *Fig.* 5^a, *e*). The base (*b*) of the lasso, forming a sort of bottle neck to the broader part (*a*), and about two thirds as long, is also hollow, but has thinner walls. The end of the neck is surrounded by three recurved barbels (*c* c^1), which are placed at equal distances from each other; and, without doubt, are hollow protrusions, communicating with the cavity of the neck. Just beyond these, the neck suddenly contracts, and tapers for a short distance (b^1), and then again contracts (d^1); from this point the lasso gradually thins out into a long and extremely slender thread (*d*). The hollow extension from the neck can only be traced to about one half the length of the lasso; the rest of the thread is so slender that it appears as a mere dark line. When only the neck and barbels are extruded (*Fig.* 6^a), the rest of the thread looks like a spiral mass (*d*) in the centre of the cell, connected with the edge of the mouth (Pl. XIX. *Fig.* 6^a, *f*) by a reverted hollow tube (*a*). In this state the lasso-cells give the tip of the tentacle (Pl. XIX. *Fig.* 3, *f*) of the hydroid, and the bunches (Pl. XX. *Fig.* 9, *b*) on the tentacles of the medusoid, a bristling appearance. In a closed state, the cell contents are very difficult to resolve. The axis is occupied by a columnar body, the more slender part of which (*Figs.* 5 and 6, *b*), being nearest to, and in direct connection with the opening (*f*) of the cell, corresponds to the neck of the expanded state; the lateral projections (*c*), nearer the centre, are the barbels in a non-everted condition; the thickest portion (b^1) is the same as the tapering base of the thread, and the spindle-shaped figure (b^2) is the hollow through which the whole mass of the thread (*d*) passes when it is everted. Nearer to the mouth of the cell the opposite walls of the neck (*b*) meet, and do not leave such a hollow channel as exists further inward. At the end of the cell, opposite to the mouth, the contents appear darker than elsewhere, and crescent-shaped. In profile the horns of this crescent (*Fig.* 5, *d*) may be traced along the sides of the cell, toward its mouth. The centre of the concave part is in direct connection with the broader end (b^2) of the axial column. By careful focusing within the range of the inner surface of the cell, a very faint set of bands are, with much difficulty, brought out, which run obliquely, or, rather, around the outskirts of the cavity, in a spiral direction (*Fig.* 6). The horns of the crescent, mentioned above, are here (*a*) the thickness of the spiral layer, which winds around the cell towards the mouth (*f*). Interpreting this spiral layer from what we know, positively, of the nature of a similar layer in the lasso-cells of Polyps, we have no hesitation in considering it to be the lasso-thread coiled up in its capsule.

Professor Clark has lately communicated to me the following observations, which relate to some points of the structure of the lasso-cells, which I had overlooked in my observations upon this subject:

"On the 19th of March, 1859, whilst studying the cellular structure of the outer wall of Coryne mirabilis, I detected that it was crowded with innumerable elongated lasso-cells (Pl. XI^c. *Fig.* 15), which laid in every possible position. These cells closely resemble those of Polypi; and all are elongated ovate, with the narrower end tapering, and slightly bent. The thread projects backwards from the broader end of the cell, where it forms its basal attachment, and trends in a nearly straight line (*b*) half way to the other end, keeping, at the same time, close to one side of the cell, and then bends upon itself and returns nearly to its base, and then, again recurving (*c*), passes back along the opposite wall, nearly to the first bend; and so it goes and returns, forming each time a coil (*d e*), until five, six, or seven of them are laid down between the two ends of the cell; and the thread terminates at the narrower end. Thus it will be seen that the part which is usually called the base (*b*) of the thread, does not stand within the coils (*c d e*), as heretofore observed in Polypi, but is entirely on one side of them, and close against the wall (*a*). These cells are excessively transparent, and much smaller and much more numerous than the form commonly observed, with the three recurved barbs. This is the first instance in which the relations and point of connection of the straight base, with the coil of any lasso-cell, whilst closed, has been observed. It was my good fortune, also, to discover this relation in similarly constructed lasso-cells of Polypi (Actinia marginata), on the 1st of the following August. More recently, May 27, 1860, I have made out, as I think satisfactorily, that the coil of the old form, the anchored lasso-cell, of Coryne mirabilis, is all on one side of the straight column (Pl. XIX. *Fig.* 6, *f* to *d*), and does not encircle it, as is represented in the figure quoted here; but the subject is so exceedingly difficult, that I must make further investigations before speaking definitely. This much, however, I will say, with certainty, that beside the three recurved barbels I have observed several much more minute barbels, toward the mouth of the cell, when the thread is out; and even these are to be detected in a closed cell."

The Egg.—The medusa of Coryne mirabilis comes to maturity as early as the middle of May, at which time the lower part of the proboscis is colored grayish blue by the multitude of eggs which are imbedded between its outer and inner walls. The largest eggs (Pl. XVIII. *Fig.* 19) have a bluish, minutely granular yolk (*y*); a hyaline Purkinjean vesicle (*p*), and a single Wagnerian vesicle (*w*), which contains a single large Valentinian vesicle (*vl*). In a little smaller egg (*Fig.* 20), a quadruple Valentinian vesicle (*vl*) was observed. In eggs half the diameter of the last, the yolk is much more transparent (*Fig.* 22, *y*), and more finely granulated; but the Purkinjean vesicle (*p*) is much larger in proportion to the whole egg; the Wagnerian vesicle (*w*) a little smaller, and there is a single Valentinian vesicle (*vl*) no larger than one of the four in the more advanced phase. When two thirds of this size, the eggs have a dark, but homogeneous yolk (*Fig.* 23, *y*), a much smaller Purkinjean (*p*) and Wagnerian vesicle (*w*), and no Valentinian vesicle. The yolk (*Fig.* 24, *y*) of an egg, half the size of the last, is very nearly clear, and perfectly homogeneous; the Purkinjean vesicle (*p*) contains a very small Wagnerian vesicle (*w*), which, to all appearances, has not been long developed. In one of the medusæ which was developed late in the season, and remained attached to the parent stem, an egg (which equalled in bulk, and in the size of its vesicles, one of those next to the largest mentioned above, though different in shape from it), contained very densely crowded, minutely granular, grayish yolk (*Fig.* 21, *y*), a hyaline Purkinjean vesicle (*p*), a granulated Wagnerian vesicle (*w*), and a single Valentinian vesicle (*vl*). In some other eggs of this size, taken from the same animal, there were two, or even three, Valentinian vesicles. In fact, there is no doubt that these eggs were just as normal, and as capable of developing young, as those in the free Medusæ.

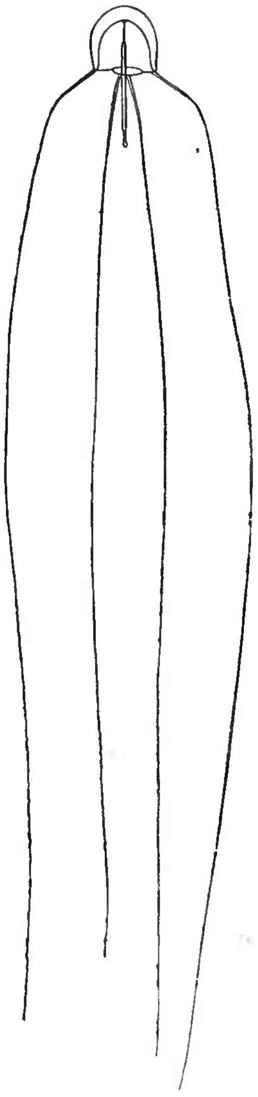
The Spermatic Particles.—In the male, the spermatic particles are situated, like the eggs, between the outer and inner walls of the proboscis. They are very small, and, like Cercariæ in form (Pl. XVIII. *Fig.* 25), and more closely resemble the human spermatic particles than any others. At one end there is a pear-shaped body (*Fig.* 25^a), from the broad part of which a very slender and long filament arises. The filament is about eight times as long as the pear-shaped part, and trails behind when the whole is swimming.

SECTION V

ADULT MEDUSA OF CORYNE (SARSIA) MIRABILIS.

The form of Sarsia mirabilis is very peculiar, and remarkably well adapted for its rapid movements. It is somewhat bell-shaped, or hemispherical; with the upper vault broad and flat, and the sides rather prolonged, assuming even, sometimes, in the relaxed state, a more or less cylindrical form; when contracted, the whole body has an almost hemispherical shape, and may, at times, really assume the appearance of a nearly globular mass. All these forms pass so rapidly from one into another, that it is exceedingly difficult to say which is the more natural. When pausing, motionless, in the midst of the water, these medusæ have the most regular hemispherical form; the four arms are then stretched at right angles with the lower margin of the animal, for a short distance, and their extremity hangs vertically downwards, for perhaps two or three times the length of the greatest diameter of the central mass. After remaining for a while immovable in that position, the walls of the body may relax, the arms elongate, the sides hang loosely downwards, and the whole body assume a more cylindrical form: when the arms hang straight downward in graceful undulations, and without forming any marked angle with the base of the animal. In this state of relaxation, the tentacles may elongate for three, four, and even more than five times the length of the bell-shaped part of the animal (wood-cut 30, p. 212). Sometimes they extend to an extraordinary length (wood-cut 28). But if, suddenly starting from this inactive position, the body contracts powerfully to move onward, it assumes an almost entirely spherical form, the thinner margins contracting more extensively than the main mass, and shutting almost entirely the lower opening of the body. The arms naturally follow, in their undulations,

Fig. 28.



the quick contractions, which press the water out of the main cavity with such force as to push rapidly the whole body forward in an opposite direction. After each contraction, and during the onward movement arising from it, the tentacles point directly backward. During each contraction they are considerably shortened, and elongate gradually in the progress of locomotion.

This animal seems very well to understand how to direct its course by its contractions, as it darts downward if it be near the surface of the water when starting, or moves sideways if it be near the walls of the jar, or rises upward if it be at its bottom. It may suddenly change its direction, if it meets with an obstacle, turn once or twice upon itself, in a revolving curve, and then dart again, suddenly, straight forward, in any given direction. Of course, the changes of form which it assumes, in these different movements, are almost endless.[1] What increases the variety of its aspects beyond the change of form of the main body, the shortening and elongating of the tentacles, and the shutting and opening of the main cavity, is the disposition of the proboscis, which is either entirely contracted within the main cavity, near its upper centre, or hangs down to the margin of the opening, or stretches out between the tentacles to two or three times the length of the body (wood-cut 29, *d*), in either a straight line, or variously bent in graceful undulations, or curved upon itself (wood-cut 30). Though the usual form of these animals is rounded, it may be seen at times to contract in such a manner as to assume a flattened shape in its lower part by the compression of its sides; and this is especially the case when the animal turns round upon itself, and changes its direction in its movements, or the bell elongates to such an extent as to become cylindrical and twice as high as broad (wood-cut 31). Again, when it pauses, and remains in a state of rest for a longer time, the lower margin is frequently seen to assume a square or quadrangular form; especially when it is perfectly immovable, and the tentacles are stretched out at right angles from the lower margin for a considerable length (Pl. XVIII. *Fig.* 17). On watching minutely its outline, it will be observed that the sides are not always circular, but from the contraction of the layers or bundles of motory cells, it assumes a quadrilobate appearance (Pl. XVIII. *Fig.* 18).

Fig. 29.

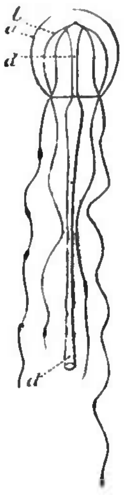


Fig. 30.

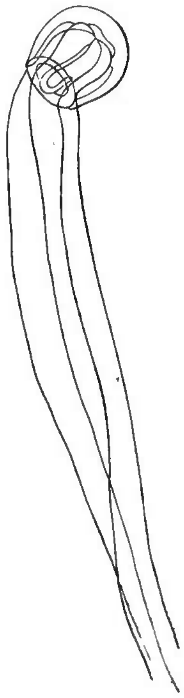
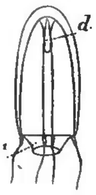


Fig. 31.



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[1] A very full description of this species may be found in my paper on Acalephs, in the 4th Vol. of the Memoirs of the Amer. Acad. of Arts and Sciences, 1860, with numerous figures.

The main bulk of the body consists of a gelatinous mass, forming the bell-shaped, central part of the animal. This is thickest above, in the central part of the swollen disk (wood-cut 29, *a b*); towards the sides it gradually tapers, and becomes very thin near the lower margin, about the origin of the tentacles, where it is suddenly turned inward, at right angles with its previous direction, and forms a transverse partition (wood-cut 31, c^1, and Pl. XVIII. *Fig.* 17, *a*), the so-called veil, between the main cavity of the body and the surrounding medium, a large hole, however, being left in the centre, through which the proboscis plays at ease.

At first, when watching the animal in its movements, it would seem as if the gelatinous mass itself were the cause of locomotion; but, upon close examination, it is easily found that it is merely an elastic support for the active apparatus of motion, which consists of layers and bundles of contractile cells, diversely arranged. There is an external system of these bundles, immediately under the epidermis, through the agency of which the contracted body is restored to its expanded form. Upon the inner surface there is another system, which contracts the sphere, acting in antagonism with the former. These two systems consist of bundles extending vertically from the upper portion of the vault downward. Within the inner vertical system, there is another one consisting of concentric transverse bundles, lining the cavity of the body, the direction of which tends to reduce the capacity of the space inclosed between the walls of the animal and the lower partition. A fourth system of circular concentric bundles is spread through the whole partition below. This last system, in its strongest contractions, may shut almost entirely the main cavity of the body, and, like the pupil of the eye, it opens and shuts constantly. In its less powerful contractions, it assists the inner transverse and vertical muscles in reducing the capacity of the inner cavity, and when deeply contracted, it helps, more fully than any other part of the contractile system, in forming the body into a sphere. Thus we have here four distinct motory systems: an external superficial system, an inner system, parallel to the former, a concentric system of the main cavity, and a concentric system of the partition below.

The nutritive system, with its ramifications, gives a peculiar aspect to this genus, and contributes greatly to its remarkable appearance. From the mere impression derived from the powerful movements and the great activity of the proboscis of this animal, we are at once led to infer that it is very voracious, the proboscis-like digestive cavity and the nettling appendages being well calculated to seize upon a living prey. This system begins with a central proboscis, of considerable size and length in proportion to the bulk of the body. It hangs down from the middle of the vault, and assumes the most diversified forms, in its various contractions, owing to the difference of structure of its different parts; the lower extremity, which is capable of the greatest dilatation, differing somewhat from the main body, and this again from the upper portion of the tube, which enlarges into a central cavity. This tube, or proboscis, when contracted, does not extend beyond half the depth of the main cavity of the body. It is even, at times, shortened beyond this limit. In its utmost state of contraction, the lower opening is rather widened, and the proboscis may then be compared, in some degree, to the mouth of other Medusæ, though its margin is not split into lobes. When relaxed, it either hangs straight downward or forms undulations in its course, and hangs then, generally, not only to the lower margin of the main cavity, but more or less beyond it. When greatly elongated, it may hang between the tentacles for three times the length of the body itself. The upper part of the tube, in the centre, is always thinner than the middle and lower portions. To this middle part the eggs are attached. From the central cavity, into which the proboscis empties, arise, at right angles with each other, four chymiferous tubes, communicating freely with the central cavity, as well as with the cavity of the proboscis. These four tubes, following the inner surface of the gelatinous disk, extend to its lower margin, where they are united with each other by a circular tube, of the same appearance and the same diameter, forming a continuous canal around the lower part of the disk. This circular tube communicates as freely with the vertical radiating tubes, as these communicate with the central cavity; so that digested materials, and the water in which the food is dissolved, and with which it is mixed in greater or smaller quantity, circulate freely, to and fro, in all the parts of this apparatus. It is astonishing how quickly an animal, swallowed by this little Medusa, is dissolved, and its particles circulated throughout the system. The digestion takes place above the mouth, which shuts over the food, or simply stretches upon the surface of the animal upon which it feeds, sucking its juices, and immediately after dropping its dead carcass. In that way our Sarsia swallows very quickly large numbers of small Medusæ, and especially other species of Hydroid Medusæ and the young of Aurelia flavidula, and also other soft animals and small Crustacea; I have, however, never seen it swallowing the hard parts of any of the latter, but only sucking their juices.

The liquid food thus secured is moved on, through the proboscis, in jerks, to and fro, under the contractions of the tubular proboscis. It takes, however, some time for the contents of the stomach or proboscis to pass entirely into the central digestive cavity, into which they are finally pressed, mingled with more or less water; as a constant process of regurgitation is going on, so that particles which were at one time near the upper end of the proboscis, are now and then suddenly pressed back into the lower end of that organ, the contractions of the mouth preventing, however, the food from escaping. After the nutritive fluid has made its way into the central cavity, it is circulated into the radiating tubes, and finally reaches the lower circular canal, moving to and fro in these canals, sometimes advancing from the centre towards the periphery, at other times rising from the periphery towards the centre, and flowing alternately one way or the other in the circular tube. There can be no doubt as to the irregularity of these movements, as the granules suspended in the more liquid food may enable any one, even with a low power, to trace the course of the nutritive fluid.

The tentacles, also four in number, arise from the lower margin of the disk, just at the point where the vertical chymiferous tubes unite with the circular canal, and at these points there is a sort of bulb, consisting of the swelling of the base of the tentacle in its connection with the chymiferous tubes, and also of a peculiar accumulation of cells, forming a rudimentary visual apparatus in the form of black eye-specks at the base of each tentacle. These tentacles are hollow, and the liquid which circulates in the circular tube penetrates into their cavity, up and down. They taper gradually, and are nearly cylindrical when extended, but rather thick when contracted. There is not the slightest indication of an aperture or puncture at their end, through which fluid might be absorbed, or refuse matter from the chymiferous system rejected, nor is there any such opening in any part of the circular tube, or of the other tubes through which the liquids are circulated. The external surface of the tentacles appears rough, granular, or rather tubercular; and, when elongated, these tubercles are sufficiently distinct to appear like rows of beads hanging loosely around a thread. But in their contracted state they come so close together, that the whole surface of the tentacle appears tubercular. Upon close examination, these tubercles are found to consist of heaps of minute epithelial nettling cells, arranged in the form of rosettes or mulberries, each of which contains within itself a thread coiled in a spiral, which may be thrown out like the threads of all nettling cells, and is provided, at its base, or at the upper portion of the bulb formed by the cell, with a double hook. See Pl. XIX. *Figs.* 6 and 6ª, and pages 208 and 209.

The sensitive bulb, or eye, as I may well call it, is placed, as already mentioned, at the junction of the marginal tentacles and the circular and vertical tubes, which pass into each other on their inner surface. It forms a marked projection, and is of an irregular triangular form, with rounded edges (Pl. XIX. *Fig.* 17). Seen from below, it is divided into two halves bulging sideways, between which the marginal tentacles arise. Seen in profile, the dark eye-speck appears still more prominent, in the shape of a hemispherical body projecting above the base of the tentacle. Seen from above and outside, it is more pear-shaped, the vertical tube above each eye-speck appearing like a continuation of its upper end. The circular tube opens into the vertical tube on the side of the bulb (*Fig.* 17, b^1), towards its lower margin, and so far behind its edge as scarcely to appear connected with it, when seen in front.

The free Medusæ of this species are very sensitive to the density of the medium in which they live, and the mere change arising from the difference in density between freshwater and salt-water is sufficient to kill them almost instantaneously. Taking up in a spoonful of sea-water a fresh Sarsia, in full activity, when swimming most energetically, and emptying it into a tumbler-full of fresh-water of the same temperature, the little animal will at once drop like a ball to the bottom of the glass, and remain forever motionless, killed instantaneously by the mere difference of density of the two media. This experiment, which I have often repeated, has led me to notice that the total disappearance of our small Medusæ uniformly coincides with heavy rainfalls, while the larger species survive. These little Medusæ occur in large numbers along our wharves, during the spring and summer, and as they swarm near the surface of the sea, they are particularly exposed to the action of rain-water. They move rapidly in all directions with the greatest freedom and energy. They are exceedingly voracious, and feed upon any kind of marine animals, not sparing their own species.

I have observed an interesting anomaly in this species, in the number of its parts. Though I have examined many thousand specimens of our Sarsia, I have always found it to present the most uniform arrangement of its parts, the specimens having, in every instance, shown four tentacles, four eye-specks, four radiating chymiferous tubes, and four main bundles of muscles. But, in one instance, two specimens were noticed, among many others, in which the parts were arranged in sixes; there were six tentacles, six eye-specks, six radiating chymiferous tubes, and six bundles of muscles. The specimens were somewhat larger than the common four-rayed specimens, the disk measuring about half an inch; and I for a moment suspected this to be a distinct species; but, upon close examination, I found that every part was so perfectly identical with the corresponding parts of the four-rayed individuals, that I failed to discover the slightest specific distinction. I would, therefore, view this case as a mere accidental modification of the number of parts, of no more importance than the accidental development of an additional spur on the foot of a cock, or an additional finger to the hand or paw of an animal. It was, perhaps, more striking here, as it ran through all the systems and influenced the general appearance of the whole body, but the six eye-specks were all identical in the details of their structure, and identical with those of the four-rayed ones. The connection between the circular tube and the radiating ones was the same, and the muscular bundles presented the same arrangement in relation to the lower margin, and intervening radiating tubes, as in common specimens.

This case of Medusæ with different numbers of rays is precisely parallel to the case of Star-fishes with a variable number of rays, such as have been described by the older Linck, who, unfortunately for himself and the progress of science, considered each variation, in this respect, as indicating generic distinctions; when he might easily have ascertained that several species vary greatly in this respect.

Since the genus Sarsia was first characterized by Lesson, several species have been added to it by Forbes, Busch, and McCrady; but I do not believe that these all belong to the genus Sarsia, and not even to the same family. The proliferous species described by Forbes and Busch, and the Sarsia turricula *McCr.*, resemble much more the free medusæ of certain Tubulariæ described in the sequel, than the true Sarsiæ arising from Syncoryne, and must, therefore, be referred to that family, to which, as we shall hereafter see, the genera Steenstrupia and Euphyra also belong. Oceania thelostyla *Gegenb.*, on the other hand, belongs to a distinct genus, lately characterized from a species discovered by my son on the coast of Massachusetts. This genus is closely allied to Sarsia, both in its hydroid and medusoid generation. Thus far it might have appeared that the genus Sarsia was confined to the two sides of the Atlantic Ocean, within the limits of the northern temperate zone; but, during his residence upon the Pacific coast of North America, my son has observed a genuine Sarsia, closely allied to the European S. tubulosa, the development of which, from a Syncoryne, he has also traced. This fact is of the highest importance, as showing that Medusæ which are generically identical, arise from Hydroids bearing identical generic relations.

CHAPTER SECOND.

THE GENERA CLAVA AND RHIZOGETON

SECTION I.

THE ADULT HYDROID OF CLAVA LEPTOSTYLA *AG.*

ALONG our shores, at low tide, one may frequently observe upon our common sea-weed, Fucus vesiculosus, little, red, moss-like bunches, which wave to and fro with the surges of the ocean. These bunches are, almost invariably, colonies of Clava leptostyla (Pl. XXI. *Fig.* 1).[1] The haunts of Coryne, Hydractinia, Tubularia, Tham-

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[1] References to the genus Clava *Gmel.*

Clava, Gmelin, in Linn. Syst. Nat., XIII., 1788, Vol. VI. p. 3131.
" Johnston, Brit. Zoöph., 2d ed., 1847, p. 29, Pl. I. *Figs.* 1–3.
" Leidy, Marine Invert., Journ. Acad. Nat. Sc., Philadelphia, 1855, Vol. III. Pl. XI. *Figs.* 33 and 34.
" Wright, Edinb. New Phil. Jour., 1857, Vol. VI. p. 79, Pl. II. *Figs.* 1–6.
" Wright, Edinb. New Phil. Jour., 1858, Vol. VII. p. 296.
Coryne, ? Pallas, Spic. Zool., 1774, p. 41, Pl. IV. *Fig.* 9, D *d* E.
" Lamarck, Syst. Ans. Vert., 1801, p. 364.
" Oken, Lehrbuch der Naturg., 1815, p. 50, Pl. I. 4, Zunft, 3.
" Lamarck, An. sans Vert., 1816, Vol. II. p. 61.
" Fleming, Brit. Animals, 1828, p. 553.
Coryne, Bosc, Hist. Vers., 2de éd., 1830, p. 279, Pl. XIV. *Fig.* 7.
" Ehrenberg, Corrallenthiere, Acad. Wissenschaft., Berlin, 1834.
" Oken, Allgemeine Naturg., 1835, Bd. 5, p. 73.
" Lamarck, An. sans Vert., 2de éd., 1836, Vol. II. p. 72.
" Johnston, Brit. Zoöph., 1st ed., 1838, p. 109, Pl. II. *Figs.* 1, 2, and 3.
" Van Beneden, Rech. Embr. Tubulaires, Nouv. Mem. Acad., Bruxelles, 1844, Vol. XVII. p. 60, Pl. V.
" Steenstrup, Untersuch. über Hermaphroditismus; aus dem Dänischen, MSS., übersetzt., 1846, p. 66, Pl. I. *Figs.* 17–21.
Hydra, Forskål, Icones Rerum Nat., 1776, Pl. XXVI. *Fig.* B, *b*.
" Müller, Zool. Danica, 1788, Vol. I. p. 3, Pl. IV.

nocnidia, Hybocodon, Parypha, Corymorpha, and Rhizogeton, are not frequented by Clava. It alone, among our Hydroids, though much less protected by a natural covering than several of the Tubularians, is subjected to the dashing of the breaking surf. A little force suffices to lift the whole colony from its foundation, to which it clings by the simple adhesion of its horny, stolon-like basis (*Fig.* 2, *e*). The creeping stems are usually so closely interwoven, and agglutinated to each other, by their horny sheaths, that, owing to the density of the mass, they cannot be easily distinguished as tubular bodies; but upon the outskirts of the group, where they are youngest, each one may be traced separately (*Fig.* 2, *e*). They appear, to the naked eye, as having about the diameter of a common horsehair. By actual measurement, they have an average diameter of $\frac{1}{125}$ of an inch. At intervals of from $\frac{1}{20}$ to $\frac{1}{12}$ of an inch, the bases (*d*) of the upright portions of the stems arise from the stolons, without expansion. About $\frac{1}{30}$ of an inch up the stem it increases in diameter, rather suddenly, to about three times that of its base, and, with this increase, it rises half an inch, in full-grown specimens, with a very slightly tapering outline (*Fig.* 2, A B).

The tip of each stem is terminated by an elongate oval head (*Fig.* 2, A *c*), which is scarcely greater in diameter than the region below, and is provided with long, round, slender, tapering, pointed tentacles, which are arranged in a close spiral, and are often not less than thirty-five in number. During the breeding season, the region just below the head is loaded with compound raceme-like bunches of medusoids (*b*), which sometimes occupy one third of the length of the stem (woodcut 32, p. 221), but more commonly are crowded at the upper part. The younger stems, up to an age when they have as many as twenty tentacles (*Fig.* 2, C E), do not bear medusoids. Of all the Tubularians, this genus has the most slender, and, in proportion to the size of the head, by far the longest tentacles. From the mouth (*Fig.* D, *c*) at the tip of the head, to the attachment of the slender base (*d*) of the stem, the whole upright body is highly contractile, and capable of assuming a variety of shapes. When very lively it is stretched to the utmost (*Fig.* 2, A), with elongated head (*c*), and extremely attenuated tentacles (*a*); at other times, every thing remaining as in the first instance, the head is depressed to a flat-topped disk (B, *c*), from which the tentacles (*a*) radiate nearly in one plane, like the spokes of a wheel; or the stem is contracted to one half its greatest height (H), and the tentacles of the flattened disk are reduced to one fourth or fifth of their greatest elongation; sometimes the region of the mouth (D, *c*) is much extended, whilst the head, tentacles, and stem are reduced by one half or more, and then in a moment the lips of the mouth (*Fig.* 8, g^1) are rolled outwards and backwards. When disturbed, the whole body assumes the most contracted condition (*Fig.* 2, F); the stem and head shorten, and the tentacles retract toward their bases, even to such an extent as to be only three times longer than thick (*Fig.* 9, *a*), whilst the inner surface of the chymiferous cavity (*Fig.* 2, F, *g*) becomes deeply plicated in obliquely transverse folds, which look like spiral semi-partitions. The depth of these folds varies considerably, under the same degree of contraction in the stem; sometimes they are slight and very oblique (H, *g*), or present a form intermediate (D, *g*) between this and the first-mentioned state. In extremely contracted states (*Fig.* 9) every thing is so compressed, crowded, and reduced, that the cells of the different layers are not distinguishable as cells, but appear like coarse granules more or less regularly disposed.

The creeping stem (*Fig.* 2, *e*) is covered by a dense, rigid, horny sheath, which rises a short distance, on the narrow bases of the upright stems, in the form of shallow cups, and then suddenly thins out into a mere film which vanishes at a little distance above. This leaves the whole upright stem, even to its slender base, full freedom to assume any shape it may choose. The whole extent of the colony is composed of two distinct, continuous layers. The outer layer or wall (*Figs.* 2, D F G H *f*, and 9, *f*) of the upright stem and head, is moderately thick, and very transparent. At the mouth (*Fig.* 9, *g*) it terminates abruptly, in the simple lip. On the tentacles (*Fig.* 8, *a*) it has the same proportionate thickness, without increasing, in this respect, at the blunt tips of these organs, and is still more transparent than on the stem and head. The inner wall (f^1) of the head and stem is about twice as thick, or a little more, than the outer wall, and much denser in appearance. This wall also terminates abruptly at the mouth (*Fig.* 9, *g*), on the same level with the outer wall. The interior surface of this wall is covered by brownish-red granules, which constantly become detached, and are carried away by the flow of the chymiferous fluid, which circulates backward and forward in the upright stems and the stolons. The remarkable oblique folds which appear in this wall, when the stem is contracted, have already been mentioned above; we have, however, to point out here, in addition, a few broad, longitudinal folds in the head, just below the mouth (*Fig.* 9, *g*). These vanish, however, at a short distance below. In the tentacles (*Fig.* 8, *a*) the inner wall of the body is continuous, as a solid axis, which is composed of a single row of very large transparent cells.

From the colony partially represented in Pl. XXI. *Fig.* 2, it is evident that the individuals united together by the creeping stem from which they arise, are very unequal in their development, some (E) having very few tentacles and no sign of medusæ-buds, while others (A) have their full number of tentacles and bear large bunches of medusæ. In their activity they show also a marked independence, some being fully expanded, while others are more or less contracted.

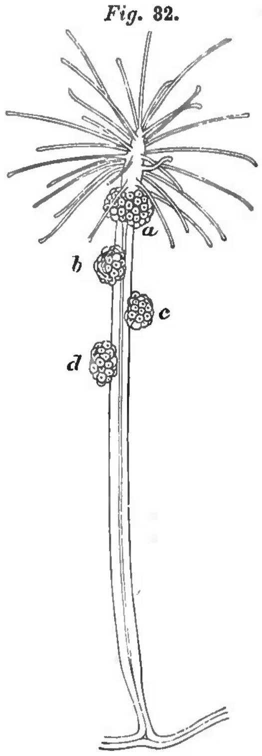
SECTION II.

THE MEDUSOID BUDS OF CLAVA LEPTOSTYLA.

The medusoids of Clava leptostyla are the most simple of all the Tubularians except those of Rhizogeton fusiformis, which are almost identical in the arrangement of their walls. (See Pl. XX. *Figs.* 17–21.) They are simple, rounded, and closed buds, attached to the main stem by a tapering pedicel, and may be compared to incipient Medusæ-buds of the types in which the buds become true Medusæ. But in this genus they are not freed, and do not assume the form of an open bell. In their most highly-developed state, there is only a single wall (Pl. XX. *Figs.* 11–15. a^1) in the spheroidal buds, and this is homological to the disk or umbrella of the spheroidal free Medusæ. This wall, when followed along its course, becomes continuous with the outer wall (a) of the pedicel and the body. It is of uniform thickness throughout, and equal, in this respect, to its continuation on the pedicel and body. The only point where the walls may be said to be double, is next the junction of the peduncle (a b), at what, homologically, is the top of the disk of a common Medusa. From the base of the proboscis (d) its own single wall dilates, and passes a short distance down the inner surface of the wall of the disk, and thus forms a narrow, sharp-edged ring (b^5), and, moreover, renders the disk double-walled at this point. The proboscis (d) projects through nearly the whole depth of the bud, and is almost uniform in breadth throughout, there being only a slight dilatation near its tip. It usually occupies from one fourth to one third of the transverse diameter of the cavity of the bud. Its single wall is as thick as that of the disk, and is uniform from tip to base, at which latter point it dilates, as we have described above. There is no mouth at the tip of the proboscis, nor any means of exit, for the circulating fluid, which bathes its inner surface, except to return backward through the way by which it entered. The cavity of the bud, in the males, is filled by the spermatic mass (*Fig.* 16, b^2), or, in the females, occupied by either two or three eggs (*Fig.* 11, b^3), or segmented masses (*Figs.* 12 and 13, b^3), or planulæ (*Figs.* 14 and 15, b^3), according to the age of the Medusoid. These imperfect Medusæ, which, from their relations to their Hydroids, are as truly Medusæ as the Sarsiæ arising from Syncoryne, exhibit the most striking resemblance to the so-called gonocalyx of the Siphonophoræ.

The pedicel, in connection with the medusoid, forms a pear-shaped figure, the former constituting the narrowing, inverted, conical portion. The greater bulk of this cone is formed by the inner wall (*Figs.* 11–15, b), which, at the base (b^5) of the proboscis, is several times thicker than the outer one (*a*), but gradually thins out, till, in the cylindrical part of the pedicel, the two are of equal thickness. Ten, fifteen, twenty, or twenty-five pedicels spring from a large, thick, and short peduncle (Pl. XXI. *Fig.* 8ª, *n*), which projects directly from the sides of the body. This form of grouping may be compared to a very short raceme, as the term is used in reference to plants. Usually these bunches are attached to the stem, nearly on the same level, and just below the tentacles (*Fig.* 2, A B D F H), but frequently the crowded groups extend downward, either continuously or in detached masses,[1] over one third of the distance toward the base (wood-cut 32). When the stem is contracted, these scattered groups are brought together so as to appear as if they originated nearly upon the same level (*Fig.* 2, G). After maturing their young within the cavity in which they arise, and casting them forth, the medusoids shrivel and die, without ever becoming free, or assuming a form at all resembling common free Medusæ.

Fig. 32.



SECTION III.

EMBRYOLOGY OF CLAVA LEPTOSTYLA.

According to our notes, the time of breeding is June and July, but whether it begins earlier and lasts later remains doubtful. The first individual of a new colony always originates as an egg, in the body of a medusoid (Pl. XX. *Fig.* 11, b^3). We have not investigated the mode of development of the egg, and can only say that, just before segmentation, it is situated in the cavity of the disk of the medusoid, and rests there, neither attached to, nor surrounded by, any membrane. Being crowded between the disk and the proboscis, the two or three eggs are more or less mutually flattened, and irregularly polyhedral. The yolk (b^3) is a dense, grayish, finely granulated mass, lighted up on one side by a large Purkinjean vesicle (b^4). The latter is equal, in diameter, to about one third of the egg.

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[1] A hydra of Clava leptostyla, similar to *Fig.* 2, A, Pl. XXI., to show the groups of medusæ (*b c d*) attached along the stem for some distance below the head; *a*, a group in the place where they have usually been observed. Drawn from nature by H. J. Clark.

After segmenting (*Figs.* 12 and 13, b^3), the young hydroid is irregularly globular in shape (*Fig.* 14, b^3), and appears to be composed of two dissimilar substances, namely, an outer, thick, transparent layer, which is about one sixth as thick as the whole body, and a very dark inner mass. Finally, the young assumes an elongated, pear-shaped form (*Fig.* 15, b^3). We have not been able to detect any vibratile cilia upon the planula while it was within the parent. After breaking through the confines of the disk, and entering upon the new relations of a free, planula-like hydroid (Pl. XXI. *Figs.* 10 and 10^a), the vibratile cilia may be seen covering the whole surface of the body, like short bristles, in a constant state of agitation. The length of these cilia is about equal to the thickness of the outer wall (f) of the body. The inner wall (*Fig.* 10^a, f^1), which has not been recognizable till now, is a little thicker than the outer one, and most distinct at the narrower end of the planula. After swimming about for a while, the planula settles down upon one end, loses its cilia, and its longer axis assumes a perpendicular position (*Fig.* 3). At this early stage a marked difference exists between the respective thicknesses of the outer and inner walls; the outer (f) is hardly half as thick as the inner one (f^1). In form, the young hydroid is perfectly cylindrical from the rounded top to the broad base. It retains this form until it has doubled its breadth, and is about six times longer than broad, and has, at least, five or six tentacles (*Fig.* 4, *a*). The tentacles originate one after the other, apparently from above downwards, and no two are ever on the same level. After this period, the body begins to broaden above (*Figs.* 5 and 6), and to assume a club-shaped form, while the number of the tentacles continues to increase. By comparing *Figs.* 5 and 6, it will be seen that there is considerable inequality in the development of the tentacles, the larger of two hydroids may possess fewer of these organs than the other, but those of the latter are much smaller. The contractions of the proboscis, and the wide gaping of the mouth (*Fig.* 6, g^1), sometimes reduce the head to such a degree that the tentacles are brought to nearly the same level, where they appear to be disposed in a single circle, as in Hydractinia, &c. This may be observed in older individuals (*Fig.* 7^a), where some of the tentacles are rolled inward to the borders of the widely-gaping mouth (g^1). The individual here alluded to (*Figs.* 7 and 7^a), although it has only nine tentacles, is yet twice as large as those we have compared above. Its upper part is as distinctly marked from the stem, as in the adult. The stem does not yet exhibit the remarkable slender base of the adult (Pl. XXI. *Fig.* 2, *d*).

As to the reproduction of the hydroid, by budding from adult forms, we can only say that the upright stem never branches nor produces any other buds, except medusoids, and, therefore, the prostrate stolonic portion is the basis of all increase in the number of individuals of the colony.

In the male medusoids the spermatic particles (Pl. XX. *Fig.* 16, b^2) are developed in a position which is homologous to the place where the eggs are developed in the females. As the wall of the disk recedes from the proboscis, the increasing space which lies between them is constantly kept filled by the growing mass of spermatic material. In the earliest stages, this mass is transparent, so that the medusoid, at first sight, appears to be empty (*Fig.* 16, B), but gradually it becomes granular, and the color changes to an orange tint, and finally, at maturity, to a deep, dull orange, and withal very opaque. The fully-developed particles keep up a constant and very lively agitation within the cavity of the medusoid, but do not appear to move from place to place. They escape from the medusoid through an aperture in the disk opposite the end of the proboscis. In shape, the head of the spermatozoa is ovate (*Fig.* 16^a), and, at its narrower end, a slender tail, about a dozen times the length of the head, is attached.

SECTION IV

RHIZOGETON FUSIFORMIS *AG.*

The Adult Hydromedusarium.— Among the pools left between the rocks by the receding tide on the promontory of Nahant, near Boston, red, velvet-like patches, varying in size from a mere point to several inches in breadth, may be found incrusting the stones beneath the surface of the water. Without close examination these may be mistaken for Hydractinia, which has an identical habitat, and can be found even upon the same stone.[1] The whole length and breadth of the colony is traversed by creeping tubes (Pl. XX. *Fig.* 17, *f*), from which arise two different kinds of individuals; the ones, thick cylinders (B), tapering to a blunt point (*m*)

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[1] He who would make a successful search after these delicate specimens, and discriminate carefully between them, must not be over fastidious in his examination of the puddles and tide-pools among the rocks. He must go prepared to lie down, sometimes to stand almost upon his head, to creep up and down through wet and slimy crevices, and over the surfaces of treacherous rocks, covered with sea-weed. It will not do to remove these Hydroids from their foundation, and transfer them to a bottle, in order to ascertain their nature, inasmuch as they contract and disguise their shape, to such an extent that one might bring home Hydractinia when he wanted Rhizogeton, and *vice versâ*, unless he had patience to wait until the animals expanded again. The only ready method of getting at these sensitive creatures, without disturbing them, is to observe them with lenses fixed in a long tube, that may be plunged into the water. The sliding tube of a common pocket telescope may be used, if one does not wish to have a special apparatus constructed.

at the upper part, and there provided with ten or twelve rather thick, cylindrical, tapering tentacles (*t*), about one third as long as the whole upright stem, which is a little over one eighth of an inch high; the other form varies in outline from elongate oval (A) to oval (*Fig.* 19), fusiform (*Fig.* 20), short cylindrical (*Fig.* 21) or long cylindrical (*Fig.* 22), and springs directly upwards, like the first, from the creeping tube. The interior is occupied by a long, cylindrical, hollow tube (*d*), which bears the same relation to the other parts of the body as the proboscis does to the disk of a Medusa. This is, therefore, the medusoid form; but instead of being attached to the upright hydroids of the colony, it bears the character of an independent individual, like the hydroid form (B). The uniformity of the red color of the group is broken by the varied colors of the medusoids, ranging from dead white and light orange, through all shades, to deep orange.

The Hydroids. — There is a very close resemblance between the hydroid form (*Fig.* 17, B) of this genus and that of Clava (Pl. XXI. *Fig.* 2), especially when the latter is devoid of medusæ-buds (C E); but the medusæ arise from the creeping stolon, and not from the upright hydroids, as in Clava. Besides this, the hydroids of the genus Rhizogeton taper uniformly from the base to the oral extremity (Pl. XX. *Fig.* 17, B *m*), there being no club-shaped swelling of the upper extremity, as in Clava, and a horny sheath (*c* c^1) extends up from the stolons to the base of the head. At certain seasons of the year it might be very difficult to distinguish the hydroids of these two genera from one another, especially if a colony of young Clava (Pl. XXI. *Figs.* 5, 6, and 7) should happen to be found by the side of a Rhizogeton; but this is not likely to occur, for the two have very different habits; the former is always found on rocks and stones in tide-pools, whilst the latter invariably clings to sea-weeds, and is very much exposed to the dashing of the surf. We have never observed more than ten tentacles in the hydra of Rhizogeton (Pl. XX. *Fig.* 17, *t*). These are very long and stout, quite unlike the graceful, slender tentacles of Clava, and are arranged spirally on the head, which comprises nearly one half of the whole height of the stem. They have a structure very similar to that of Clava, both in the proportionate thickness of the walls and in the cellular constituents; and the same may be said in regard to the whole body of the hydroid, as well as the stolon (*f*). In regard to the size of the latter we would say, however, that it is nearly as thick as the upright stems of the hydroids.

The Medusæ-buds. — We have never seen any other than the male colony of the genus Rhizogeton. As has been observed in the beginning of this section, the medusæ-buds of Rhizogeton arise from the stolons, and not from the upright stems of the hydroids. From the earliest period (*Fig.* 18), as far as we have seen, to the time when the spermatic particles are discharged, they are covered by a prolongation of the horny sheath (*Figs.* 17, A, to 21, *c*); but here it has much more consistence than in Coryne. Each medusa is elevated on a short stem (*Fig.* 17, A *a*), which elongates with age, until, by the time the spermatic particles are discharged (*Fig.* 21), it nearly equals the length of the medusa. This stem has a double wall (*a b*), like that of the hydroid, but the inner one (*b*) retreats from the outer one (*a*) at the base of the medusa, and projects freely into the disk, as a proboscis (*d*). In reality, although the form is altogether different, the structure of the medusa is the same as in Clava; the spermatic mass occupies a homologous position, and is developed in the same manner, and with a similar diminution in the size of the proboscis. The youngest medusa which we have observed, was nearly cylindrical in form (*Fig.* 18), being slightly swollen toward the base, and coming to a point rather suddenly at the end, where the wall was very thick. The cylindrical proboscis (*d*) traversed nearly the whole length of the disk, and was completely enveloped in the mass of deep orange-colored spermatic matter (b^2), which filled the cavity of the disk. With increasing age, the spermatic mass grows paler, and when fully matured, it is white (*Fig.* 20). After the discharge of the spermatic particles, the medusa becomes cylindrical (*Fig.* 21), whilst the proboscis dwindles down to a shrivelled, diminutive mass.

In other genera we have been accustomed to see the medusa wither and decompose, after it had matured and discharged its reproductive contents; but here an unusual and unexpected phenomenon takes place; *one and the same individual medusa, after discharging its reproductive organs, is metamorphozed into a hydra;* the same wall which formed the disk (*Fig.* 22, a^1) of the medusa grows upward (*a*), and forms a long, cylindrical body, within which an inner wall (b^1 *b*) develops, from the base of the still persistent proboscis (*d*), and completely lines the outer wall. We have traced this metamorphosis up to the time when the head of the hydra had begun to form, and its tentacles were just far enough advanced to give it a knotted appearance, but unfortunately the specimens died, and we have not been able to investigate the matter any further. The figure which we give here, representing this stage of growth, was taken from the animal when the basal part, or the original stem of the medusa, was so retracted that the base of the proboscis (*d*) was brought nearly down to the stolon. The spermatic particles have a broadly fusiform head (*Fig.* 23, A B), and a tail only four times longer than the head. This retrograde metamorphosis of a medusa into a hydra, is the most direct evidence, thus far obtained, of the structural identity of the free Medusæ and the Hydroids proper. It shows beyond the possibility of a doubt that the Hydroids themselves are not Polyps, but Acalephs, in the same way as Myriapods are Insects and not Worms, notwithstanding their many rings and elongated form.

CHAPTER THIRD

THE GENERA HYDRACTINIA AND HALOCHARIS.

SECTION I.

THE HYDROID FORM OF HYDRACTINIA POLYCLINA *AG.*

The first time that this species was met with, it was found upon the shells of Gasteropods, which served for the retreat of Hermit-crabs; but, subsequently, it has been discovered and collected in great abundance from rocks in tide-pools. In these latter habitats, it often covers several square feet with a rosy, velvet-like carpet, presenting a delicacy and vividness of tint which can hardly be described. The fact that it is often left by the tide, for five or six hours, in pools containing not more than a pailful of water, is enough to negative the assertion that the movable homes of Hermit-crabs are necessary to the welfare of the colonies of Hydractinia which settle upon them.[1] In order to examine the specimens without injuring them, a small pebble or shell on which a colony has developed should be selected, instead of placing the animals, piecemeal, under the microscope. Under such conditions it will be readily seen why the rosy tint of the colony

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[1] References to the genus HYDRACTINIA of VanBeneden, or Synhydra *Quatr.*

Hydractinia, VanBeneden, Bulletin Acad. Roy., Brux., Feb., 1841, p. 89, Pl. A, *Figs.* 1–4.

" VanBeneden, Mem. Acad. Roy., Brux., 1844, Tom. XVII. p. 62, Pl. VI.

" Johnston, Brit. Zoöph., 2d ed., 1847, p. 32, Pl. I. *Figs.* 4, 5, and 6. *Alcyonidium echinatum*, 1st ed.

Hydractinia, Leidy, Marine Invert. Fauna, Journ. Acad., Philad., 1855, Pl. II. *Fig.* 35.

" Wright, Edinb. New Phil. Jour., 1857, Vol. V. Pls. VIII. and IX.

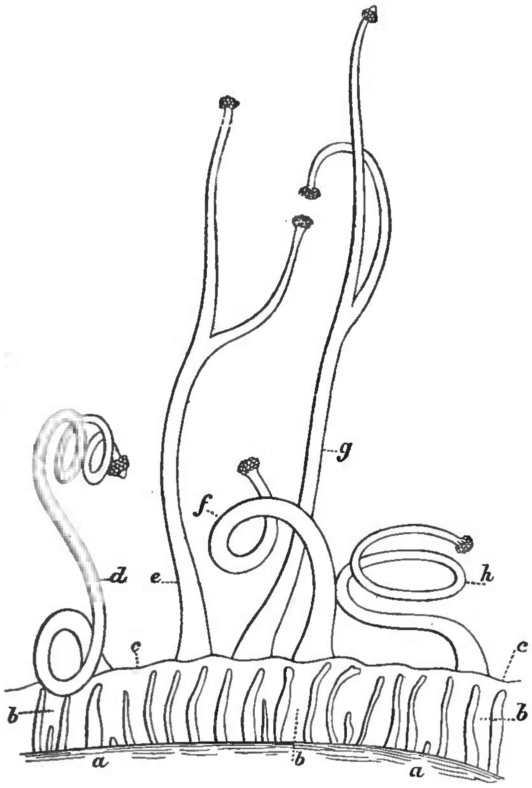
" McCrady, Proc. Elliot Soc., Charleston, S. Carolina, 1858, p. 65.

Echinocorium, Hassal, An. Mag. Nat. Hist., July, 1841, p. 371, Pl. X. *Fig.* 5.

Synhydra, Quatrefages, An. Sc. Naturelles, 1843, Tom. XX. p. 230, Pls. VIII. and IX.

is so equally disposed, for. upon plunging the focus to the base of the upright individuals, a uniform layer of fleshy substance (Pl. XVII. *Figs.* 1, K, 5, *a*, 5^a, *c*, 5^c, *a*, 6, *d*) is found to occupy the whole length and breadth of the group. It is neither in this layer, nor in its upward continuation, the outer wall of the individuals, that the rosy tint lies, but in the interior of the thick-walled, closely anastomosing channels (*Figs.* 5, *b*, 5^a, *e*, 5^c, *c*, and 6, *b*, and Pl. XXVI. *Fig.* 18, *b* b^1). Unlike the hydroids of other genera, those of Hydractinia are composed of no less than four different forms of individuals. Premising, what has been ascertained for some time, that the sexes are separate, all the individuals of one colony being either male or female, it may be said that each colony is trimorphous. Taking a female colony (Pl. XVI. *Fig.* 1) for example, we find, first, the reproductive form (A B C F), with a globular head (*h*), of short spherical tentacles, along whose stem the egg-bearing medusæ (*e*) bud; secondly, a form which is nothing more than an extremely elongated reproductive hydroid (E, and wood-cut 33), with much smaller heads than the generality of the first form and a stem which is frequently branched (*e g*). This form is only to be found on the outskirts of the colony. However, between this form and the reproductive one there are gradations, showing, as will be pointed out hereafter, that, after all, this form is hardly to be separated from the first. Lastly comes the sterile form (D G H I), with long, tapering tentacles, arranged in one row, and a short proboscis (*p*). The fourth form is found among the males (Pl. XVI. *Fig.* 2); it is the sterile hydroid (D E F G H I), with a long proboscis (*p*). Otherwise the males and females resemble each other. The degree of intermixture of the fertile and sterile individuals varies considerably; in some parts of a colony they are about equally distributed, whilst in others they are either nearly all fertile, or nearly all sterile. In all cases the hydroids are densely packed together.

Fig. 33.



The outskirts of a hydromedusarium of Hydractinia polyclina, to show the extremely elongated fertile hydræ which fringe the border. Magnified 25 diameters. From nature, by H. J. Clark.

a the edge of the shell (Natica) to which the colony is attached. —*b* parallel ridges of the horn-like network. —*c* edge of the horn-like layer. —*d f h* individual hydræ coiled into one, two, or three spiral turns. —*e g* two hydræ which are forked, and have two heads.

Underlying the whole colony is a layer of horny substance, either in the form of a network, or of a uniform layer, with ridges upon the upper surface, anastomosing so as to form a network. Here and there this network rises, bearing with it the overlying soft layers, as if pushed up from beneath, into more or less elevated pillars, of a cylindrical or conical shape (Pl. XVI. *Figs.* 1, *s*, 2, *s*, and 6), thus adding another diversity to the polymorphism of the colony. In some instances, where the colony is situated on Buccinum undatum, the spines are arranged in rows along the spiral ridges of the shell, with such perfect regularity that one might at first sight suppose he had a different species before him. There is considerable variation in regard to the proportionate size of the three different forms of a colony. In some colonies the reproductive hydroids (Pl. XVI. *Fig.* 1, A B) are nearly as tall as the sterile forms (D), and in others they are hardly one third as high (Pl. XVI. *Fig.* 2, B), but yet they bud as plentifully as the largest ones.

The hydroids, of all forms, are as closely crowded together as are the individuals of a colony of Bryozoa, among the Flustras and Lepralias, but not with any such regularity. We have observed an instance where a colony of Hydractinia had settled upon the calcareous habitation of a dead Flustra, and nearly every Hydroid had chosen a cell of the Bryozoan for a basement, into which it withdrew itself almost entirely when touched. This adaptation of our Hydroid to the nature of its habitat reminds one of a similar phenomenon which occurs among Oysters, and in the genus Crepidula among Gasteropods. Fossil Oysters, for instance, attached to Ammonites, frequently assume the form of the ornaments of the latter, along their growing edge; the Crepidula of our shores, when growing upon Pectens, becomes plicated; when growing upon Natica or Pyrula, it is smooth; and those which are attached to the outside of these shells are convex, while those growing upon the inside of empty shells become concave. These different forms have been described as distinct species.

The fertile Hydroid. — In general outline the fertile hydroid (Pl. XVI. *Figs.* 2^a and 2^b) may be compared to a club, gradually tapering from a broad, more or less globular head, to a slender base. In a contracted state (*Fig.* 1^g) the stem swells in the middle, so that, on the whole, it resembles a figure 8. When the stem is loaded with medusoids, it is almost invariably thicker at the point of attachment of these buds than elsewhere (*Figs.* 1, 2, and 3). This is not caused by a thickening of the walls, but by the expansion of the digestive cavity (*Fig.* 3, *d*). The head is as changeable in shape as that of the sterile form. In a natural state, or rather in that state in which it is seen most frequently, it is globular (*Figs.* 1, B C, *h*, 1^g, 2, C K, 3, 4^a, and 4^b, *h*), the whole spherical mass seeming to be composed of the conglomeration of the tentacles; but that this is not so, may be seen when, as frequently happens, the tentacles are spread apart at the extreme tip of the head, and a broad, thick proboscis (*Figs.* 2, A *p*, 2^a, *m*, 2, ^{b}, *m*, and 2^e, *p*) is protruded for a considerable distance. There can be no doubt that this is a proboscis, inasmuch as it has a mouth (*Figs.* 2^a, 2^b, and 2^e, *m*) which at times opens as widely (*Fig.* 2^a, *m*), and is as changeable in shape, as that of the sterile forms (*Figs.* 1^b, 1^c, 1^d, 1^e, and 2^d, *m*); and, in fact, considering the mobility and activity of particular parts of the mouth and proboscis, independently of other parts of the body, we have no hesitation in saying that it is as truly an organ for the prehension and reception of food, as is the proboscis of the sterile forms. Sometimes the tentacles separate, and simply disclose the mouth (*Fig.* 4^a, *m*), without protruding the proboscis. In such cases, the tentacles are usually arranged in two rows, those of one row alternating with those of the other, and forming, together, a depressed, turban-shaped mass (*Figs.* 1, A *h*, 1^g, *t*, 3, 4, *h*, and 4^a). The tentacles, as a usual thing, are globular, but now and then, during the dilatations of the head and proboscis, they stretch to a slight extent at the base, so as to stand out (*Fig.* 2^b, *t*) from the head on a short, thick pedicel (*Fig.* 2^f, *a*). It can hardly be said that this pedicel belongs to the tentacle, but is rather a lateral hernia of the walls of the head, with a hollow interior (*Fig.* 2^f, *d*), such as is never found in the tentacles, either of the sterile forms of Hydractinia, or among any of the marine Hydroids. They vary in size and number without any apparent reference to the age or size of the hydroid to which they respectively belong. Of two fully-grown hydroids, one (*Fig.* 1, A), for instance, may have numerous and small tentacles (*h*), and the other (*Fig.* 1, B) only a few large ones (*h*). The highest number of tentacles that we have ever been able to count on any one head is sixty (*Fig.* 2, K), and the lowest, only four (*Fig.* 1, F). In the latter case, they were larger than any we have ever observed upon older hydroids of the same species. When seen in an extended state (*Fig.* 2^f), it becomes evident that the tentacles are composed of two walls, the outer one of which (*a*) is continuous with the outer wall (*Fig.* 3, *a*) of the body, and almost entirely composed of densely packed lasso-cells (*Fig.* 11, *a b*), while the inner wall (*Fig.* 2^f, *b*) is continuous with the inner wall (*Fig.* 3, *b*) of the body.

The body of the hydroid, or that portion which is above the horizontal uniform layer, is composed of two walls. The outer one (*Fig.* 3, *a*) is so thin, when compared to the inner one (*b*), that it appears like an epidermis to the latter. It commences at the tip of the proboscis, and, including the thick, lasso-cell layer of the tentacles, extends to the base of the hydroid, where it becomes continuous with the uniform, horizontal layer (*Figs.* 5, *a*, 5^a, *d*, 5^b, *a*, 5^c, *a*, and 6, *d*), which forms the common basis of all the hydroids. When the hydroid is full of medusæ-buds, it is an easy matter to see that this outer wall (*Fig.* 3, *a*) is continuous with the outer wall (a^1) of the medusoids. (See, also, *Figs.* 7 and 8, *a b.*) There are but few lasso-cells in the outer wall, below the head, the great mass of them being congregated on the tentacles.

The inner wall (*Fig.* 3, *b*) is very thick, and constitutes the greater bulk of the body; it has the same extent as the outer wall, and is in more intimate connection with the active functions of the whole colony, forming the immediate lining of the digestive cavity (*d*), which receives the chymiferous fluid, in common with the other hydroids. Its inner surface is lined with an irregular layer of brownish-red, coarse granules, of the same nature as those (*Figs.* 5^a, *g*, and 5^c, *c*, wood-cut 34, b^1; Pl. XXVI. *Fig.* 18, b^1, Vol. IV.) seen in the ramifying canals and the sterile hydroids. The same may be said of the cells of this layer as of those of Coryne mirabilis (p. 205).

Fig. 34.

The retiform stolon of Hydractinia polyclina. From nature, by H. J. Clark.

a outer wall in profile, at the edge of the depressions (*d*). — *b* inner wall hollowed by the chymiferous canals. — b^1 granules circulating in *b*. — *c* cells of *a* in profile. — *d* depressions in the outer wall, which appear sometimes to be pierced.

From the 15th of December, 1855, to the 30th of April, 1856, the fertile hydroids on our coast were free from medusæ-buds, but from July to September, 1854, they were budding copiously. At Charleston, South Carolina, they were found budding from December, 1851, to February, 1852. During the unproductive season, we have found the sterile hydroids just as fully developed as at any other time. We have never known any instances in which the tentacles appeared to be resorbing, or indefinite in outline, except when the colony was attached to a shell which was cast ashore by the tide, or dragged about by the Hermit-crabs. In tide-pools, among the rocks to which they are attached, they flourish most luxuriantly, and do not exhibit any signs of unhealthiness. Each medusa-bud arises singly, in the form of a hernia, from the walls of its parent, either closely together, and nearly on the same level with each other (*Fig.* 2, A B C, 4, 4^a, and 4^b), or scattered along the length of the body (*Figs.* 1, A B C, and 3).

Excepting that they contain spermatic particles instead of eggs, the medusoids of the males do not differ from those of the females, but owe their dissimilarity simply to the fact that the fecundating mass, which fills them, is yellow, and uniformly diffused, whilst the eggs of the females are grayish, and present the appearance of several distinct masses. During this season the colony is much more crowded, and seems more densely packed than at any other time. Near the margin of the colony the reproductive hydroids are higher, and even equal the sterile forms in stature. Compare *Fig.* 1, A B, with D. Some of these have no buds on them (*Fig.* 1, E), but in other respects are not different from the gravid ones (Compare *Fig.* 1, E with A, and *Fig.* 2, A B C), not even in the apparently exclusive peculiarity which they possess, usually toward the outskirts of the colony, of frequently bending upon themselves till the head touches the base. On the extreme border of the colony they are not restrained in their contortions, and may be frequently seen coiled upon themselves, in one, two, three, or fourfold spirals (wood-cut 33, p. 228, *d e f g h*). Here, too, they reach their extreme height, one quarter of an inch or more, in many cases, especially in the branching individuals (wood-cut 33, *e g*, p. 228). Excepting in their great length, they are indentical with those which are full of medusæ-buds; the smaller heads of the latter being perfect counterparts, as to the proboscis, mouth, and tentacles, of the former. The fact that they do not bear medusæ, so far as we have been able to ascertain, does not prove, by any means, that they are forms of a truly definite nature, inasmuch as we find, everywhere throughout the colony, many of the reproductive hydroids totally destitute of buds, whilst the others are full of their broods.[1]

The sterile Hydroid. — Below the head there is no difference in the internal structure of the body of the sterile Hydroid, either in the male or female colonies, from that of the reproductive form, nor does their shape vary from that of the latter. The head, however, has a very different appearance, and even those of the male and female colonies are unlike, as we have already pointed out. A sterile Hydroid of either a male (*Fig.* 2) or female colony (*Fig.* 1), has long, slender, tapering tentacles (*Figs.* 2, H, and 1, D), disposed in a single row, like those of Tubularia or Campanularia. During the contractions and contortions of the head, the tentacles are sometimes displaced and rearranged, more or less alternatingly, in two rows (*Fig.* 2^c), one of which (*t*) stands out in a more spreading manner than the other (t^1), the latter being bent upward toward the mouth (*m*). However, this does not always happen; on the contrary, the tentacles oftentimes remain as distinctly in one row (*Figs.* 1^a, *t*, 1^f, *t*, and 2^g, *t*) as when fully stretched out. The base of each tentacle appears to be decurrent on the stem (*Fig.* 1, I), under certain conditions, and, on this account, it is oftentimes difficult to determine their exact relation to one another, and to ascertain whether a tentacle is above or below the one next to it, on each side.

When the tentacles are fully expanded, these difficulties are not in the way, and there can then be no doubt that they are truly uniserial in their arrangement. Unless under very favorable circumstances, the hydroids do not fully expand their tentacles in confinement, but keep them more or less contracted, in various shapes, either club-shaped at the ends (*Figs.* 2, D E F G I, and 2^c, t t^1)[2] or broadly

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[1] Dr. T. Strethill Wright has published an article in the Edinburgh New Philosophical Journal for April, 1857, on Hydractinia echinata, in which he, for the first time, has brought these peculiar modifications of the fertile hydroid into notice, under the name of "Ophidian, or Spiral Polyps." That they ought not to be considered as a distinct form of individuals, and still less as organs, as he regards them, we think will be sufficiently clear upon reading the results of our observations upon a species hardly distinct from that of Europe.

[2] Hassal, in the Annals and Magazine of Natural History, Vol. VII. p. 371, July, 1841, under the name of Echinocorium clavigerum, describes

cylindrical (*Figs.* 1, H, 1^a, *t*, 1^f, 2^d. *t*, and 2^g, *t*). The walls of the tentacles (*Fig.* 5, *t*) have the same relation to the walls of the body, as those of the reproductive individuals; the outer wall is much thinner, however, than that of the latter, but the inner wall is very thick and solid, like that of Coryne and Clava, and constitutes, as in these genera, a great proportion of the bulk of the tentacles.

The proboscis of the sterile male Hydroid (*Figs.* 2, D, 2^e, *m*, 2^g, *p*, and 2^h) is much longer than that of the female, being rather more than twice as long as the base is broad. It is composed of two walls (*Fig.* 2^h, *a b*), corresponding to the inner and outer walls of the body, below the head, and like it, its cavity is lined with a loose layer of brownish-red granules. The proboscis of the sterile Hydroid of the female colony (*Fig.* 1, D *p*, I *p*), is short and broadly conical, like that of the freshwater Hydra. Whether in individuals of a male or of a female colony, it has great distensibility, either swelling broadly into a great, hollow sphere, with a moderate aperture (*Fig.* 1^d, *m*) above, or assuming a deep, saucer-shaped form (*Figs.* 1^b and 1^c), with inrolled rim, the lip of the mouth (*m*) being contorted into a three, six, or seven-sided figure, or rolled outward and downward, till the bottom (*Figs.* 1^e, *m*, and 2^d, *m*) of its cavity is exposed.

That there is no horny tube, closely enveloping each hydroid, as obtains with Coryne, Tubularia, &c., is evident from the fact, that each individual can contract and shorten itself so much as to be little longer (*Fig.* 2^g), or no longer (*Fig.* 1^f), than broad. Nor is there a horny tube or cup around the hydroids, nor a secretion of any sort on the upper side of the uniform layer. If we follow the outer wall (*Figs.* 3, *a*, and 5, a^1) of either a reproductive or a sterile individual, from the base of each, we always find it terminating in a uniform, broadly spread, horizontal layer (*Fig.* 5, *a*), which extends through the length and breadth of the colony. Here it is much thicker, as a general thing, than the inner wall of the hydroid, except where it is elevated upon the bristling spines (*Fig.* 6), which arise from the horny network beneath, and there it varies from thick to thin, according as it covers the spinules (*c*), or plunges between them (*a*), even into the interior of the spine, through its lateral apertures. The inner wall of the hydroid (*Figs.* 3, *b*, and 5, *d*) continues below, in the form of a closely anastomosing network of tubes (*Figs.* 5, *b*, 5^a, *e*, 5^c, *d*, 6, *b* b^1; Pl. XXVI. *Fig.* 18, *b*), imbedded in the uniform layer which we have pointed out as continuous with the outer wall of the hydroid. A transverse section of one of these tubes (*Fig.* 5^c, *d*), with the surrounding uniform layer (*a*), will give the best idea of the relation of the former to the latter. The walls of these tubes are not absolutely so thick as in their upright

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the tentacles in this state, and, on this account, calls the species "*Clavigerum*." There can be no doubt that it is the common Hydractinia echinata of the British coast.

prolongation, but, in proportion to the diameter of the tubes they form, they may be said to be fully equal in this respect. They anastomose so closely, and have such small interstices occupied by the uniform layer, that, in reality, the latter fills much the smaller part of the whole bulk of the stolonic portion of the colony. At the edge of the colony, where the anastomosing tubes, budding laterally (*Fig.* 5^a, *f*), are progressing in growth, the uniform layer (*d*) is in preponderance, but only here. The chymiferous network not only covers the horny spines (*Fig.* 6), but also penetrates through their lateral apertures into the interior. This is not at all a different feature, however, from that observed in the horizontal parts of the horny layer, when it is young and forms as yet only a network of more or less elevated ridges, into the meshes of which these chymiferous tubes dip. The only difference is, that the latter is horizontal, whereas the spines are the same network much more elevated, as if pushed up from below. (See wood-cut 35, p. 238.)

This horny layer, already so frequently mentioned, varies according to age; at first it originates in isolated spots (*Fig.* 5, *e e*), which gradually dilate, horizontally, at the same time that they become elevated (*f*), till finally they coalesce and form a network. With age, the interstices of this network become filled up below, so as to cover completely the rock or shell, upon which the colony has settled, with a continuous layer. The upper side of this layer still retains its network form, the meshes constituting the elevated ridges, which give a dried specimen that honeycomb appearance so often noticeable. At pretty regular intervals, these ridges begin to be elevated, more than the rest of the network, and appear as low, conical, rough papillæ. When seen from above, these papillæ look like stellate excrescences on a retiform groundwork. As the papillæ grow higher, this stellate appearance becomes more conspicuous, and the rays of the star more prominent, till we may see that each ray corresponds to a single one of the several ridges which unite to form a papilla. Each of the ridges rises frequently into spinules, and these serve to render it bristling, and, when seen from above, give the arms of the star a more slender appearance. With increasing age, the papillæ grow higher and proportionally more slender, and frequently curved. In the latter stages of growth, they may more properly be described as spinous than papillate, especially the oldest ones, which are quite slender and pointed. We have already mentioned (p. 233) that there is no horny covering to the upper side of the stolonic layer, nor to the hydroids which arise from it; the whole horny mass is a foot secretion, just as truly as it is among the Gorgonioid Polyps.[1]

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[1] See Dana, on the foot secretions of Gorgoniæ, in his work on the Zoöphytes of the United States Exploring Expedition, p. 54, § 49. Philadelphia, 1846, 4to.

The Gorgonioid Polyps develop first a flat, horizontal, horny layer, as a basis, and this bears exactly the same relation to the Polyps as does the young, spineless, horny layer to the hydroids in a colony of Hydractinia; and when the horny stem begins to rise, in the form of a spine, it is still as essentially below the soft mass of the Polyps as is the fenestrated spine below the uniform layer of Hydractinia. The stolonic portion, in penetrating the lateral apertures of the spines, and filling up their interior with its chymiferous network, does not render the horny layer, in this manner of growth, any the less a foot secretion. Something like this happens with Gorgonia flabellum, and other fenestrated forms of that genus of Halcyonoids.

SECTION II.

REPRODUCTION OF HYDRACTINIA POLYCLINA.

There are, essentially, three modes of reproduction in Hydractinia, namely, the budding of the hydroid form from the common basis, the budding of the medusoid from the hydroid form, and the development from eggs.

The Hydroid. — As far as we have observed, the young hydroid always buds from the outskirts of the colony. The inner wall (Pl. XVI. *Fig.* 5^b, *b*) rises perpendicularly from the common basis, in the form of a hernia (b^1), and is covered by an outer wall (a^1) which is continuous with the uniform layer (*a*). In this state it does not differ from the young hydroid of Coryne mirabilis (Pl. XX. *Fig.* 3), as far as the relation of its walls to each other are concerned. The only difference between the further development of this Hydroid and that of Coryne mirabilis is, that here the tentacles arise all in the same plane, forming a single row; otherwise, in their mode of origin from the two walls of the body, there is a perfect similarity. The manner in which the network of chymiferous tubes is formed is very simple; horizontal herniæ (*Fig.* 5^a, *f*) are produced, in the direction of the growth of the uniform layer (*c*), which in time coalesce with each other, and, obliterating their walls where they come in contact, form a continuous channel of communication.

The Medusoid. — The structure and mode of development of the medusoid of Hydractinia is so nearly identical in all the essential features, with those of Parypha crocea and Thamnocnidia tenella and spectabilis, that it would be superfluous to repeat the details which are given in another chapter, in regard to the latter genera. It will be sufficient to point out in what respect the medusoid of Hydractinia differs from that of these other genera, and refer to the description of the latter for further details. The young medusoid buds of the genus Hydractinia always arise singly, and directly from the upright stem of the parent (Pl. XVI. *Figs.* 1, A, *e*, B, *e*, F, *e*, 2, A, *e*, B, *e*, C, *e*, 3, 4, *a b*, 4^a, *a b c d e f g h i*, and 4^b), in the form of a double-walled, lateral protrusion (*Fig.* 7). The growth of these medusoids may be traced on the same parent stem, inasmuch as all stages of growth are to be oftentimes seen at one time (*Fig.* 4^a, *a–i*). At a very early age the female medusoid contains eggs (*Fig.* 3, *e*), which always lie loose in its cavity around the proboscis (*p*). We have never seen any thing but eggs in the female medusoids, even at the time the male medusoids were discharging their spermatic particles, and, on this account, cannot doubt that the segmentation of the yolk and the subsequent growth of the hydroid take place outside of the medusoid, in the open sea. The male medusoid (*Figs.* 4, *a b*, 4^a, *a–i*, 4^b, 8, and 9) does not retain the universally rounded form of the female, but varies from an elongate cylindrical (*Fig.* 14^a, *a*) to a perfectly globular form (*Figs.* 4^a, *c*, and 9). As fast as the spermatic particles are discharged, the walls of the medusoid shrink and become wrinkled (*Fig.* 4, *a b*), and at the same time the proboscis shrivels also, and the peduncular attachment constricts, till eventually the whole medusoid becomes a shapeless mass, with a very slight hold on the parent stem.

In this half-resolved state they fall from the parent hydroid and die. Till within a short time before the spermatic particles are discharged, their whole mass has a yellow tinge, but when they are fully developed, they have, altogether, a dead-white color. Neither the male nor female medusoids have any tentacles. The number of eggs which a medusoid may contain amounts to at least a dozen, and, perhaps, to sixteen or eighteen, since, sometimes, as many as eight or nine may be counted in one half of the parent, as it stands out in profile (*Fig.* 1, C). Oftentimes we have seen a young medusoid (*Fig.* 8) pretty thickly covered by lasso-cells (*l*), which gave it a bristling appearance, while at other times there are very few of these cells present (*Fig.* 3).

SECTION III.

HISTOLOGY OF HYDRACTINIA.

The Hydroid.—The outer wall of the young hydroid (Pl. 16, *Fig.* 5^b, a^1) is composed of very irregularly columnar, transparent cells, each one of which occupies its whole thickness. These cells are identical with those which enter into the composition of the outer wall (*a*) of the stolonic part of the colony. In the latter, they are not so conspicuous, but stand out isolately, as if they were imbedded in a homogeneous layer. In the older portions of this layer these cells are very irregularly arranged (*Figs.* 5^a, *d*, and 5^c, *b*), and appear like imbedded crystalline bodies. In a young hydroid with two tentacles (*Fig.* 5), the cells (a^1) of the outer wall are already very faint. The outer wall of the adult hydroid is so excessively transparent, that we have not been able to discover any thing more than a faint indication of large, broad cells; these are most satisfactorily seen in the proboscis (*Fig.* 2^h, *a*). The outer wall of the tentacles (*Fig.* 2^f, *a*) of the fertile hydroids, either male or female, is so thickly beset with lasso-cells that they appear to be the sole component of the layer in which they are imbedded. Lasso-cells, identical with these, are scattered all over the outer walls of the hydroids and the medusoids (*Figs.* 3, 7, *l*, and 8, *l*). The intimate structure of the long, cylindrical tentacles of the sterile form, has not been carefully investigated, but enough has been seen to warrant us in saying that they very closely resemble those of Clava. The inner wall (*Fig.* 5^b, b^1) of the young hydroid has a close resemblance to the outer one (a^1), but the cells are more regular and columnar. They, too, form but a single columnar layer, the inner ends abutting on the chymiferous channel (*c*). In the anastomosing chymiferous canals (*Fig.* 5^a, *e*; Pl. XXVI. *Fig.* 18, *a*) these cells are almost as irregular, both in shape and arrangement, as in the outer wall; still, their longer diameters have a greater trend toward the centre of the canal (Pl. XVI. *Fig.* 5^c, *d*, wood-cut 34, *a*, p. 231, and Pl. XXVI. *Fig.* 18, *a*, Vol. IV.). The inner wall (Pl. XVI. *Fig.* 3, *b*) of the adult hydroids has a columnar structure, like that represented in the proboscis (*Fig.* 2^h, *b*), consisting, through the whole length of the body, of broad columnar cells, each one of which extends from the outer to the inner surface of the wall.

The Lasso-cells.—There are two kinds of lasso-cells imbedded in the outer walls of the hydroids and medusoids, one of which is much larger than the other. The larger ones (*Fig.* 11, *a*, *b*) are very small, when compared with those of the Polyps, and when seen with a magnifying power of six hundred diameters, appear to the eye to be about one seventh of an inch long. They have an oblong-oval shape, slightly narrowed at the open end (*Fig.* 11, *a*). Professor Clark has ascertained that the interior contains a spiral coil of filament and a central thick column, which bears the same relation to the spiral coil as obtains in the lasso-cells of Cyanea, Aurelia, Coryne, and the Polyps generally.[1] When the lasso is extruded (*Fig.* 11, *b*, b^1, *c*) we see that it differs from that of any other hydroid, and has the character of that of the strobiloid Medusæ and of Polyps. The everted central column (*Fig.* 11, b^1) is elongate fusiform, and has about the same length as the cell from which it is protruded. It is endowed with a double spiral row of cilia;

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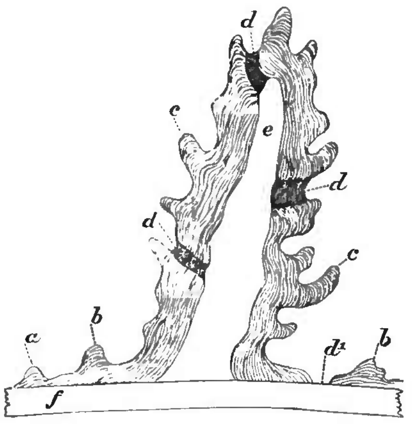
[1] See the remarks of Prof. Clark on this subject, and especially on the lasso-cells of Coryne, p. 209.

beyond these the thread gradually tapers into a long, slender, naked filament (*c*) which is ten or twelve times as long as the cell itself.

The smaller lasso-cells (*Fig.* 10, *a, b*) are excessively minute, and appear like mere threads (*a*) when observed by the side of the other kind (*Fig.* 11) under the same magnifying power; they are too small, in fact, to be delineated except by a line; — but as the eye can detect the form which is too minute to be drawn in its natural size, an exaggerated drawing (*Fig.* 10, *b*) must be used for illustration. When the lasso is out, the cell is pear-shaped, and to its narrower end an excessively long, naked thread (*b*) is attached. When the cell is closed, it appears as a mere oblong speck. These lasso-cells are most frequently seen upon the medusoids.

Fig. 35.



Longitudinal section of a horn-like spine of the stolonic basis of Hydractinia polyclina; to show the concentric layers, the apertures (*d* d^1), and the interior cavity (*e*). Magnified 200 diameters. Drawn from nature, by H. J. Clark.

a b processes from the horizontal layer. — *c* spinules. — *d* apertures leading to the central cavity (*e*). — d^1 hole through the horizontal layer. — *f* the shell to which the hydrarium is attached.

The Horny Basis. — We have already shown that this layer is a foot secretion, but have not described the manner in which it increases, and from being a simple, slightly uneven layer, becomes a very bristling coat of spines and anastomosing ridges. This horny substance is so transparent, that there is not the least difficulty in detecting its most intimate structure, without the necessity of making sections. At the thinnest portions of the layer (wood-cut 35, *a*) only one, two, or three layers may be seen, but as the projections grow higher, the layers become more numerous (*b*); in the large spines (*c*) they are most numerous. We hardly need say that these facts clearly point to a successive deposit of layers, by which the thickness of the horny mass is increased. When seen superficially, the layers show no trace of structure, nothing like fibres, but appear to be perfectly homogeneous.

The Egg. — The yolk, from the earliest period, has a transparent, grayish aspect, which becomes granulated, and, in consequence of this, denser and darker. (See *Fig.* 3^a, *y*.) The oldest eggs we have seen have a rather coarsely granulated yolk (*Figs.* 3^a, *y*), a large, clear, homogeneous, Purkinjean vesicle (*p*), a single, but less transparent, Wagnerian vesicle (*w*), occupying more than one third of the diameter of the Purkinjean vesicle, which is nearly filled by a very transparent, homogeneous, Valentinian vesicle (*vl*). In all essential characters, the mode of development of the egg and the phases through which it passes are the same as in Coryne mirabilis. See p. 210 and Pl. 18, *Fig.* 20 to 24.

The Spermatic Particles. — The male medusoids (Pl. 16, *Fig.* 2, A, B, C, *e*, *Fig.* 4^a, *a–i*, *Fig.* 4^b, *Fig.* 9) may be always recognized by their homogeneous contents, which, a short time before the spermatic particles are fully developed, have a tawny yellow color. The spermatic particles (*Fig.* 9^a) are very active at the time of their exclusion, fairly leaping the whole length of the head and tail at one bound. The so-called head (h) is oblong, with slightly converging sides, and about twice as long as broad. From the broader end, a long, slender part (t), the so-called tail, arises and extends to the length of from eighteen to twenty times that of the head.

SECTION IV

HALOCHARIS SPIRALIS *AG.*

Proles hydroidea. — A single group of Halocharis was discovered, attached to the tube of a Serpula, on the outer shore of Sullivan's Island, at the entrance of the harbor of Charleston, South Carolina. This locality is bounded by the open sea, and therefore untainted by the freshwater which flows into the harbor from the two rivers each side of the city. The group does not appear to be compound, but each stem or individual stands alone on a simple base. The usual form of the body is a slender cylinder (Pl. 20, *Fig.* 10), of equal calibre from top to base, and cannot be said to exhibit any such distinctions, as head and stem, as are seen in Coryne and Clava. It appears heavier at the top than below, because the tentacles are successively larger as we follow the stem upwards. The upper part sometimes becomes swollen to such an extent as to give the body a club-shaped outline (*Fig.* 10^b), and in this state it reminds one of Coryne. Having no horny sheath, it can contract, from top to bottom, so as to become a short, almost globular mass (*Fig.* 10^a), with several transverse folds overlying each other, and extending from the base at least half way up the stem. When the tentacles are contracted, also, the whole body resembles a warty excrescence. The color rests, as in many other Hydroids, in the yellowish-red, granular lining of the chymiferous cavity of the body. The tentacles (*Fig.* 10, t) have different proportions according to their position; at the top they are moderately slender, round, constricted slightly midway between base and tip, and terminated by a large globular mass of lasso-cells. From this point downwards, the tentacles gradually shorten, and thus are thicker in proportion to their length, till the lowest ones consist of nothing but a globular mass of lasso-cells. Their arrangement along the body is in a very marked spiral, belonging, apparently, to the category of $\frac{3}{8}$. They are capable of contracting into a very small mass, so as to be nearly globular (*Fig.* 10^a). The mouth (*Fig.* 10^b, d^1) is situated at the extreme upper end of the body, and is naked, being a simple perforation through the outer and inner walls, without any folds or appendages. From the mouth to the base of the body there is one uniform cavity (*d*) without fold or constriction, or any sign of a distinction between a stomach and a circulatory chamber. When the animal is in full activity and extension, the outer wall (*Fig.* 10, *a*) of the body is moderately thick and forms an even layer from the mouth to the base; but where it forms the outer wall of the tentacle it is very thin, and more like a delicate epidermis, excepting at the tip of these organs where it is very thick, and constitutes the bed of the lasso-cells. The inner wall (*Figs.* 10 and 10^b, *b*) is almost three times as thick as the outer one, and, like the latter, it forms an even layer from the top to the bottom of the body, the only diversion being its lateral projections into the axis (b^1) of the tentacles. When the body is in a swollen and partially retracted state (*Fig.* 10^b) the proportionate thickness of the walls changes considerably, but the foregoing description refers to the normal, and most frequent state. In the tentacles the inner wall occupies nearly their whole bulk, and there, as in the body, is composed of only a single layer of cells. (*Figs.* 10^b and 10^c, b^1.) We have not been so fortunate as to see the medusoid state of this animal.

Histology. — The cells of the outer wall have not been seen, nor does any thing in the wall indicate that it has an organic structure, except at the globular tip of the tentacles, where it is crowded with lasso-cells. The cells of the inner wall (*Fig.* 10^b, *b*) are disposed in a single layer; they have rounded ends outwardly and inwardly, and vary in breadth according to the degree of contraction of the body. In the tentacles they are also in a single layer (*Figs.* 10^b and 10^c, b^1) and have more or less of a truncate conical shape, the end of one serving, as it were, for the base of the next beyond. There are only three or four of these cells in each tentacle, a peculiarity not to be observed among any of the other Hydroids.

CHAPTER FOURTH

THE FAMILY OF TUBULARIDÆ.

SECTION I.

GENERAL REMARKS UPON THE TUBULARIANS.

The family of Tubularidæ,[1] as here circumscribed, embraces only two of the genera thus far referred to the Tubularians as first characterized by Lamouroux,

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[1] References to the true Tubularidæ.

Tubularia *Linn.* (restricted).

Tubularia (*indivisa*), Linnæus, Syst. Nat., 10th ed., 1758.
" Linnæus, 12th ed., 1767, p. 1301, No. 1.
" Pallas, Elenchus Zooph., 1766.
" Ellis and Solander, 1786, p. 30.
" Gmelin, Linn. Syst. Nat., 1788, 13th ed., p. 3830.
" Turton, British Fauna, Vol. I., 1807, p. 210.
Lamarck, Système An. s. Vert., 1801, p. 382.
" Müller, Zool. Danica, 1806, Vol. IV. p. 25.
" Lamouroux, Nouv. Bull. Soc. Phil., Paris, 1812, III. p. 1841.
" Lamarck, An. sans Vert., 1st ed., 1816, Vol. II. p. 108.
Tubularia, Lamouroux, Hist. Polyp. Flexibles, 1816, p. 225.
" Goldfuss, Handbuch der Zoologie, 1820, p. 89.
" Schweigger, Handbuch, 1820, p. 424.
" Lamouroux, Expos. Méthodique, 1821, p. 16.
" Fleming, Hist. British Animals, 1828, p. 552.
" Blainville, Dict. Sc. Nat., 1830, Vol. LX. p. 434.
" Bosc, Suites à Buffon, Hist. des Vers, 1830, 2nd ed., Vol. III. p. 84.
" Ehrenberg, Corallenthiere, Berlin Acad., 1834, p. 71.
" Lister, Phil. Trans. Roy. Soc. Lond., 1834, p. 366.
" Oken, Allgemeine Naturgeschichte, 1835, Bd. 5, p. 75.

namely, Tubularia and Corymorpha. These Hydroids are readily distinguished from all others by their large, bell-shaped head, standing upon a long stem, with many

Tubularia, Dujardin, in Lamrk., 2d ed., 1836, Vol. II. p. 124.
" Johnston, Brit. Zoöph., 1st ed., 1838, p. 113.
" Gould, Invertebrata of Massachusetts, 1841, p. 350.
" VanBeneden, Recherches sur l'Embryogénie des Tubulaires, Acad. Roy. Bruxelles, Vol. XVII., 1843.
" Dalyell, Remarkable Animals of Scotland, 1847, Vol. I. p. 2.
" Gegenbaur. Generationswechsel, 1854.
" Alder, Catal. Zoöph. Northumberland and Durham, 1857, p. 16.
" Mummery, Transact. Micr. Soc., in Micr. Journal, 1853, p. 28.
" Wright, Edinburgh New Phil. Jour., 1858, Vol. VII. p. 113.
Calamella, Oken, Lehrbuch, 1815, Theil 3, p. 55.
Vorticlava, Alder, An. Mag. Nat. Hist., 1856, XVIII. p. 353, Pl. XII. *Figs.* 1–4.
" Alder, Catalogue Zoöph., 1857, p. 10, Pl. I. *Figs.* 1–4. Very probably a young Tubularia.

THAMNOCNIDIA *Ag.*

Tubularia coronata, Abildgaard, Müll. Zool. Danica, Vol. IV., 1806, p. 25, Pl. CXLI.
" " VanBeneden, Mem. Acad. Brux., 1844, p. 49, Pl. I. *Figs.* 7–19.
Tubularia calamaris, VanBeneden, Excl. Syn. loc. cit., p. 46, Pl. I. *Figs.* 1–6.
Tubularia gracilis, Johnson, Brit. Zoöph., 2nd ed., p. 52, Pl. IV. *Figs.* 3, 4, and 5.

PARYPHA *Ag.*

Tubularia (sp.?), Kölliker, Zeitsch. für wiss. Zool., 1853, Vol. IV. p. 300.
Tubularia cristata, McCrady, Proc. Elliott Soc., Charleston, South Carolina, 1858, p. 54.

NEW GENUS, not yet described.

Tubularia Dumortieri, VanBeneden, Mem. sur les Tubulaires, Acad. Roy. Brux., 1844, XVII. p. 50, Pl. II.

CORYMORPHA *Sars.*

Corymorpha, Sars, Beskrivelser, 1835, p. 6, Pl. I. *Fig.* 3.
" Sars, Forhandl. i Vid. Selsk. i Christiana, 1859; transl. in Wieg. Archiv, 1860, and in An. Mag. Nat. Hist., Nov., 1861, p. 353.
" Forbes and Goodsir, An. Mag. Nat. Hist., 1840, V. p. 309.
" Johnston, British Zoöph., 1847, p. 53, Pl. VII. *Figs.* 3–6, and supplement, p. 463, *Fig.* 79, *b.*
" Alder, Cat. Zoöph. Northumb. &c., 1857, p. 18, Pl. VII. *Figs.* 7 and 8.
Amalthea, Schmidt (fide Sars), Handatlas der vergl. Anat., Tab. IX. *Fig.* 2.

STEENSTRUPIA *Sars.*

Coryne fritillaria, exclus. hydroid. (*Figs.* 41 and 42), Steenstrup, Generationswechsel, 1842, p. 19, Pl. I. *Figs.* 43, 44, and 45.
Steenstrupia, Sars, Wiegm. Archiv, 1860, p. 341. Transl. from Forhandl. i Vid. Selsk. i Christiana, 1859.— An. Mag. Nat. Hist., 1861, VIII. p. 357, transl. from Wieg. Archiv.
" Forbes, Brit. Naked-eyed Medusæ, 1848, p. 72.
" Forbes, An. Mag. Nat. Hist., 1846, XVIII. p. 287.

EUPHYSA *Forb.*

Euphysa, Forbes, Brit. Naked-eyed Medusæ, 1848, p. 71.

long tentacles, from the actinal side of which rises a long, tentaculated proboscis. The medusæ-buds arise upon the floor between the outer tentacles and the base of the proboscis; they may become free medusæ, or remain sessile and wither. The genera differ from one another, chiefly by the form and arrangement of the tentacles of the proboscis and the structure of the medusæ-buds. All the Tubularidæ have the same form, and constitute a very natural family.

SECTION II.

HYBOCODON PROLIFER *AG.*

Proles hydroidea. Adult. — We have never found Hybocodon elsewhere than in the purest sea-water, in clear pools at low-water level. Notwithstanding frequent explorations, it has not been discovered along our rocky shores where the tide dashes backward and forward, and on this account we are inclined to believe that it is, properly, a deep-water animal. The locality from which we are in the habit of collecting it, is a ledge of rocks at Nahant, lying at a short distance from the shore, and covered by ordinary tides; and it is only where the pools are protected by a great roof of rocks that this Hydroid flourishes. It is easily detected by its deep, orange-red color, and by its size, which is much greater than that of any other littoral Tubularians. In fact, the only Tubularian with which it may be compared, in size, is Thamnocnidia spectabilis (Pl. XXII. *Fig.* 16), and that is a brackish-water animal. It is seldom that more than three or four individuals are found together, and we have not been able to ascertain whether they are ever united by a common basis, as, from their position, the stems, to be secured, had, in every case, to be cut away from the rocks on which they rested, without any chance of tracing their relations to each other. However, it does not appear that this Hydroid has the habit of branching so intricately as the genera Tubularia, Thamnocnidia, and Parypha. The stem, which averages two inches in length (Pl. XXV. *Fig.* 1, *a*), is not thicker, at its base, than a common sewing needle, but from this point it gradually enlarges toward the head, at the base of which it has a diameter of one sixteenth of an inch. There is but one head on each stem, to which it is joined by a constricted portion just below the globose terminal expansion (*Fig.* 2, *b*). At times, the base of the head and the end of the stem are very much distended (*Fig.* 3), and the constriction is totally obliterated, so that it is impossible to tell where the stem terminates and the head begins. This is a condition which we have noticed only toward the end of the breeding season. The head has, in every respect, truly the character of all the Tubularidæ, but may be more closely compared to that of Parypha (Pl. XXIII. *Fig.* 1^b). At the height of the breeding season in January, the whole disk between the coronal tentacles (Pl. XXV *Fig.* 2, *t*) and the proboscis (t^1 t^2) is crowded with the medusoid progeny (*d e*), in all stages of growth, from the merest incipient buds to their fully-developed state (*d* d^1), in which they drop from the parent.

The horny sheath (*Figs.* 2 and 3, a^1) is a very notable feature in this genus, as it shows a tendency to form a permanent, turbinate terminal expansion, more or less deeply constricted at several successive points, so as to have the appearance of being ringed. The substance of the sheath, at the upper end, is rather filmy, and very delicate, yielding readily to the distension and flexure of the stem.

The free Medusa (*Figs.* 14, 14^a, 15, and 15^a) of our Hybocodon, bears a very close resemblance to that of Coryne fritillaria, as figured by Steenstrup in his work upon alternate generation (Pl. I. *Figs.* 41–45), but the Hydroid represented as the parent stock of the latter is a Coryne-like animal, if we may judge from the very small figure given by that author.[1]

Hereafter we shall give a full description of our Medusa; for the present we must return to the Hydroid, in order to present a more detailed account of its structure. The proboscis carries two rows of tentacles (Pl. XXV *Figs.* 2, 2^a, and 3, t^1 t^2), one of which (t^1) borders closely upon the mouth (*Fig.* 2^a, *p*), while the other is placed at a short distance below, in such a manner that the tentacles of this row alternate with those of the terminal circle. When the proboscis is strongly contracted the two rows are oftentimes brought, apparently, into one series (*Fig.* 3, t^1 t^2), but it may be readily seen that the one is concentric to the other. In the oldest hydroids we have counted as many as thirty-two buccal tentacles (*Fig.* 3), and, as they alternate with one another, there are sixteen in each row. They differ in nowise, as regards shape, from those of other Tubularidæ; but those of the terminal circle (*Figs.* 2 and 2^a, t^1) are only half as long as those of the second series (t^2); and the decurrent bases (*Fig.* 2^a, p^2) of the latter alone form the broad, parallel ridges, which lie closely, side by side, about the circumference of the proboscis. The rest of the head, the disk which bears the medusæ, and upon which the coronal tentacles are based, have the same general structure as in Parypha. The bunches of medusæ, which are present from January to April, are,

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[1] It is very questionable whether the Steenstrupia-like Medusa figured by Sars is truly the progeny of Coryne fritillaria, inasmuch as he found it floating in the open ocean, and refers it to this Hydroid because of a general resemblance to the medusoids which were attached to it. It is unfortunate that he did not give magnified figures of the latter.

however, very different from those of the latter genus, since they have no common peduncular axis of attachment. In Hybocodon the first medusa (*Fig.* 13) arises directly from the actinal area of the disk (*a b*), while from the marginal termination (b^4) of one of the radiating tubes (b^5) of this medusa numerous similar medusæ are developed, the latter again giving rise to other medusæ (c^1 c^2 h i^1 i^2), in the same manner, and from a corresponding place on their margin. In this way is produced a branching axis, which extends laterally as well as longitudinally, and, in the full breeding season, crowds the disk with its burden of medusæ (*Fig.* 2, d d^1 d^2 e).

The head of the hydroid, as we have before said, is joined to the stem by a constricted neck, which is capable of great distension, and when in this state (*Fig.* 3) the internal longitudinal rows (*a*) of orange-red pigment are very easily seen through the walls. But it is not the pigment lines alone which give rise to the ridged appearance of the stem, for upon making a transverse section of the walls (Pl. XXIII^a. *Fig.* 10) we find, that between every double pigment row (*Figs.* 10 and 11, *dd*) there is a ridge (g^4), or semi-partition, very similar to that described in Parypha (Pl. XXIII^a *Fig.* 7, g^4). It is transversely, broadly triangular, and projects more or less into the cavity of the stem, but the combined ridges never form a solid central core, as in Tubularia. In the oldest hydroids we have counted sixteen of these ridges at the upper part of the stem, but, passing downwards, they merge into each other, as in Parypha and Tubularia. The inner wall (*Fig.* 10, *d*), upon which the semi-partitions are based, is composed of a single layer of cells, and is about $\frac{1}{800}$ of an inch thick, or four fifths of the thickness of the outer wall (*b bb*). The whole interior surface, excepting where it is covered by the pigment cells (*dd*), is lined by vibratile cilia. The outer wall consists of a double layer of cells (*b bb*), and is $\frac{1}{1000}$ of an inch thick. Both of these walls are so transparent that it is possible to see the mesoblasts (*Fig.* 11, g^1) of the cells of the semi-partitions through the latter.

Proles medusoidea. — There is a close resemblance between the free medusa of this genus (Pl. XXV *Figs.* 14, 14^a, 15, and 15^a), at the time it drops from the parent, and that of Coryne mirabilis at a corresponding age (Pl. XVIII. *Fig.* 15^a), except in the number of their tentacles; in fact, a medusa of Hybocodon may be said to be a Coryne with only a single tentacle. Nor does the fact that the former produces medusæ from the base of its tentacle invalidate the comparison, for some of the Sarsiæ do the same. The proportions of the disk, or bell-shaped umbrella, its size, the relations of the outermost, the middle, and the innermost walls, the radiating and circular canals, the two walls of the proboscis, and the three walls of the transverse septum, are the same as in the medusa of Coryne, to which we refer the reader for full details of the structure of these parts. The side of the disk upon which the tentacle is attached (Pl. XXV *Figs.* 14 and 14^a, *n*) is a little larger than the rest of the bell, and, on this account, the medusa appears asymmetrical and gibbous, and hence its name.[1]

The base (*Figs.* 14 and 15, b^4) of the tentacle is broadly triangular, and quite thick, but varies in this latter respect when its cavity is more or less distended with the circulating fluid. Beyond the swollen, triangular portion, the tentacle is solid, and covered by a layer of coarse, loose cells, which appear as distinct groups, in rings, when the tentacle is extended (*Fig.* 15, g^1). The length of the tentacle varies from twice to three times the length of the bell. There are times when the hollow base stretches until it is two thirds as long as the height of the disk (*Figs.* 15 and 15^a, *g*), and then it may be distinguished from the solid portion (g^1) by the absence of the transverse rings of cells. At first sight the base of the tentacle may seem to be manifoldly lobed (*Figs.* 14, 14^a, and 15, $f\ f^2$) on the inner side; but closer inspection reveals the true nature of these seeming lobes. They are, in reality, medusæ, in various stages of development, the oldest of which seem to be identical with the one from which they bud.

There are five orange-red, granular bands (*Figs.* 15 and 15^a $k\ k^1\ k^2\ k^3\ k^4$), about as broad as the radiating canals, which extend from the base of the disk to, or near, its apex, on its exterior surface; two of them, starting from a broad, triangular base (*Figs.* 15 and 15^a, $k^1\ k^2$), suddenly narrow, and pass upwards, one on each side of the radiating canal which leads to the tentacle, and gradually converge in the direction of the apex (*Fig.* 15^a, k^4); the other three having a similar basis (k^2), opposite the point of junction of the circular and radiating canals, pass upward, each one over a radiating canal (*Figs.* 15 and 15^a, k^3) towards the apex, or, more correctly, to points opposite the junction of the canals with the digestive cavity (*d*). At the latter end of the breeding season in April, these bands were not so conspicuous as to attract attention, and, therefore, were not represented in the figures (*Figs.* 14 and 14^a) made at that time, and if they were really present, they have been mistaken for mere wrinkles in the epidermis. Early in the season they are so strongly marked as to be seen by the naked eye, although the medusa is not larger than $\frac{1}{12}$ of an inch in diameter. The difference in the season may also account for the fact that the later medusæ (*Figs.* 14 and 14^a) have so few, and so imperfectly developed buds, whilst on the earlier ones (*Figs.* 15 and 15^a) the young (*f*) are more numerous, and have quite long tentacles (f^2).

The close resemblance of our medusa to those described by Forbes as Steenstrupia and Euphysa leaves no doubt in my mind that these two genera are founded upon the free brood of some of the European species of the genus Tubularia,

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[1] ὕβος, hump, *κώδων*, a bell; Hybocodon.

even though direct evidence is wanting upon this point. I have already expressed my conviction (p. 217) that some of the Medusæ referred to Sarsia are likely to prove to be the offspring of Tubulariæ, rather than of Coryne; and if this is the case, it will appear, not only that Hydroids which are generically identical produce Medusæ exhibiting congeneric characteristics, but also that the genera of well-defined families agree, in their hydroid as well as in the medusoid state, with one another, in those structural relations which determine their form. A comparison of Tubularia and Corymorpha with the genera described in this chapter, under the names of Hybocodon, Parypha, and Thamnocnidia, shows them to agree in form, or, in other words, to belong to the same family, while they are generically distinct; and so do their free medusæ, as far as they are known. Tubularia Dumortieri forms another distinct genus, to which one of the American species belongs.

Embryology. — The mode of development of the medusæ, from the first budding of the double-walled hernia (*Fig.* 4) to the formation of the radiating tubes (*Fig.* 5, c c^1), and the subsequent appearance of the proboscis (*Fig.* 11, d), and the uniting of the radiating tubes to form the circular canal (b^2), is identical with that of Coryne (Pl. XVIII. *Figs.* 1–12), which we have described so fully in a previous chapter (p. 192). We will not repeat what has been there stated, but simply referring to it, proceed to point out the peculiarities of this genus. About the time that the radiating tubes have developed through four fifths of the depth of the disk (*Fig.* 6), one of their number pushes out laterally, and carrying the outer wall along with it, forms a hernia (c^2). This hernia continues to grow, until it projects so as nearly to double the transverse diameter of the disk (*Fig.* 7), and its walls (b^1 c^2) are fully twice as thick as in other parts of the body, when a second hernia (near c^1) begins to push out from the side of the first, at a point corresponding to the end of the radiating tube. The second hernia, developing in size (*Fig.* 8, b^2), forms a second sinus in the radiating canal, and then is soon followed by another hernia (*Fig.* 9, b^3), which rises between the primary one and the disk, and at the same time the first diverticulum (c^2) has more than doubled the transverse diameter of the disk. Soon a third (*Fig.* 10, b^2) and a fourth (a^1) hernia appear, successively, near to the disk, whilst the first one (c) becomes elongated into the fashion of a tentacle, which is solid at the distal half. As the first medusa continues to develop, the primary hernia, with its tentacle (*Fig.* 11, g), elongates at a corresponding rate, and the second, third, and fourth hernia show their medusoid character by the development of radiating tubes (f f^1), whilst other herniæ arise at the base of the primary one. Hardly have the second, third, and fourth medusa fairly formed their tubes before each one begins to exhibit a one-sided protrusion from the radiating canal, identical with that noticed in the first medusa (*Fig.* 6, c^2). Each of these secondary medusæ goes on developing its tentacular appendage (*Fig.* 12, *g*), exactly as did the parent (*e*), and in the same way secondary (c^1) and tertiary (c^2) herniæ, and so on, arise from the first hernia; whilst the tentacle of the primary medusa (*Fig.* 12) elongates to twice, and finally to thrice the length of the disk (*Fig.* 13, g^2). In such a state of development, there being no less than ten or a dozen medusæ attached to the base of its tentacle, the primary medusa soon drops from the head of the hydra, from which it has arisen, and enjoys a free life (*Figs.* 14, 14^a, 15, and 15^a). In this condition it is not unlike some of the Siphonophoræ. Indeed, no one can doubt that if such colonies of medusæ had been first observed in the ocean, in their free condition, away from the hydroids from which they originate, they would have been referred to the Siphonophoræ, and not to the Hydroids. In a discussion of the natural affinities of the Siphonophoræ, the genus Hybocodon cannot fail to appear as an important point of evidence of the close relationship which unites the Siphonophoræ and the Hydroids proper. For my own part, I have no doubt that the Siphonophoræ belong to the order of the Hydroidæ, in which they will be subdivided into a number of distinct families.

Histology. — The cells of the outer wall (Pl. XXIII^a. *Fig.* 10, *b bb*) are arranged in two layers, which, together, are about one one thousandth ($\frac{1}{1000}$) of an inch thick. The cell contents are perfectly homogeneous, and, although there is no trace of granulation, the wall appears darker than the inner wall (*d*). The cells are irregularly polygonal, and have very thin walls. The cells of the inner wall (*Figs.* 10 and 11, *d*) form but a single continuous layer, and are elongate in the direction of the length of the stem, having an irregular lozenge shape, when viewed from their inner face. They are about one two thousandth ($\frac{1}{2000}$) of an inch long, and from one third to one half as broad, and four fifths as thick as the outer wall. Their contents, as well as those of the semi-partitions (g^3 g^4), are perfectly hyaline, with the exception of a large, rather faint mesoblast (*Fig.* 11, g^1). The cells of the semi-partitions (g^3 g^4) are disposed in three or four layers. They are usually broader than those of the inner wall proper, being about half as broad as long, but about the same length as the latter. They vary considerably in thickness, according to whether the semi-partitions project more or less into the cavity of the stem. On each side of every semi-partition there is a collection of cells (*dd*), of moderate size, in one, or two, or three irregular rows; each cell contains a large, irregular, pigmentary, orange-red mesoblast, which occupies from one half to two thirds of its diameter. It is these mesoblasts which give the orange-red hue to the whole stem. With the exception of the space occupied by the pigment-bearing cells, the whole interior surface of the inner wall and semi-partitions is covered by vibratile cilia, which are about as long as the thickness of the cells to which they are attached. These cilia are quite conspicuous, and, in fact, may be seen through the walls of the stem, under favorable circumstances. The horny sheath (*Fig.* 10, *a*) has the same finely laminated structure as that of Tubularia.

SECTION III

PARYPHA CROCEA *AG.*

Proles hydroidea. Adult. — Parypha crocea grows in great luxuriance, attached to floating timbers in Boston Harbor. Here, when the tide is low, the water is very brackish, owing to the outflow of Charles River, and even when the tide is highest, it is far from being pure sea-water. On this account, it may be said to be an inhabitant of brackish water, especially as this Hydroid has never been found on the open coast where there is pure sea-water. It seems to prefer only partial sunshine, inasmuch as it is found most frequently, and in greatest luxuriance, on the under side of the logs to which it is attached. It grows in bunches (Pl. 23, *Fig.* 1), each bunch being the multiplied offspring, by budding, of a single hydroid, and forming either a male or female colony. The stems are very much contorted, irregularly branched, and densely intertwined at the base. From this entangled mass the stem of each hydroid rises singly, to the height of from two and a half to three and a half inches (*Fig.* 1^a), and is terminated by a broad and deep saucer-shaped head (*d*), which is surrounded by a coronet of slender, uniserial tentacles, and has a long proboscis. The whole length of the stems is enclosed in a horny sheath, which is wavy (*Fig.* 1^d, *a*) or slightly nodose or faintly ringed (*b*, *c*) at irregular distances; but this cannot be readily perceived except with a slightly magnifying power.

The head of the hydroid is attached by the base of the saucer-shaped part (*Fig.* 1^a, *d*) to a more or less globular expansion of the end of the stem (*Fig.* 1^b, d^1). From the edge of the saucer-shaped disk, or stomach, numerous slender and gradually tapering tentacles (t^1) stand out in a single row, like fringes, with their bases decurrent, on the under side of the head (*Fig.* 1^a, *d*), almost to its base. At its bottom, the proboscis (*p*) is as broad as the disk, arising at the upper side of the base of the tentacles, in the form of a convex cover to the saucer-shaped stomach. From the centre of the latter a cylindrical, columnar portion (*p*), about as thick as the stem, projects. This is, perhaps, more properly, to be called the proboscis, inasmuch as it is very flexible and bears an active part, with the tentacles (*t*) at its end, in catching the prey. It is strongly ribbed, by the decurrent bases (*Fig.* 1^e, t^1) of its tentacles (t), and expands slightly where the latter originate, and then suddenly contracts into a broad, conical or convex termination. At this point it is pierced by an aperture, the mouth (*Fig.* 1^c, m), which leads to the cavity (p^1, p^2) below. The tentacles of the proboscis, like those below, are in a single row, and in full-grown heads there may be twenty-four of them. These parts of the hydroid are present all the year round; but at certain seasons, in the summer and autumn, ten or twelve slender branches, covered with medusoids (*Fig.* 1^b, a, b, c), may be seen hanging down between the tentacles. The branches are attached at pretty regular intervals, around the base of the proboscis (p). They are usually arranged in two or three rows, but the largest are in one series. Whether those in each row become successively developed and attain a superior size to the others, we cannot say positively; but it would seem probable that they have such a systematic mode of growth, since the smaller branches bear young medusoids, whilst the larger ones, at certain times, bear full-grown medusoids, some of which have already set free their young, and are withering. The medusoids appear at a very early period in the growth of the hydroid, at a time when the head, from its base to the tip of the proboscis, is not more than one tenth of an inch long (*Fig.* 1, g). A full-grown head is five tenths of an inch long (*Fig.* 1^a).

Having thus alluded to the relation of the different organs to each other, we may now proceed to describe them in detail. There are as many as twenty-four tentacles (*Fig.* 1^b, t, *Fig.* 1^c, t) at the end of the proboscis of the largest hydroids. They are cylindrical, and tapering from the base to the tip, which is rounded off in an oblique manner (*Fig.* 1^e, c). At their bases they touch each other, and from thence are decurrent, in juxtaposed broad ridges, which give the proboscis (*Fig.* 1^b, p) a longitudinally ribbed appearance. The upper side of the bases of these tentacles project in approximated ridges (*Fig.* 1^c, t^2) to the very edge of the mouth (m), just in the same manner as obtains in Thamnocnidia spectabilis and tenella (Pl. 22, *Fig.* 18). This gives to the conical area around the mouth a radiated aspect, reminding one very forcibly of a similar appearance, in a homologous position, among Polypi. There are two walls (*Fig.* 1^e, a, b), or, perhaps, more properly speaking, two layers of different kinds of cells which enter into the composition of each tentacle. The outer wall (a), a continuation of the outer wall of the proboscis, and, in fact, of the whole body, is a comparatively thick layer, and closely embraces, like a sheath, the axial layer (b). The latter is a solid mass of cells, in direct prolongation from the inner wall of the proboscis. The tentacles have the appearance of being hollow on account of the dark pigment granules which are collected at the inner ends of the cells of the axis. The whole tentacle, from tip to base, is thickly covered by lasso-cells. In confinement, the tentacles are very seldom seen stretched to their fullest extent, but when the Hydroid is in its native habitat, with the water flowing past it rapidly, they equal in length the whole head, from the base to the mouth, and wave to and fro like slender threads, as if the animal had no control over them. In the various shapes which they assume, in connection with the proboscis, they agree with Thamnocnidia spectabilis and tenella (Pl. XXII.). The inner surface (Pl. XXIII. *Fig.* 1^c, p^1) of the proboscis is also ridged longitudinally at the upper part, but at the base these ridges (p^2) anastomose and form a raised network.

The branch, or peduncle, which carries the medusoids is a hollow, double-walled tube (*Figs.* 18, 18^a, 19, 19^a). The outer (*a*) and inner walls (*b*) are respectively continuous with the outer and inner walls of the proboscis. The outer wall (*a*) is thin and very transparent, and the inner wall (*Fig.* 19, *b*) is about three times as thick as the outer one. The cavity of the peduncle is in direct communication with the stomach, and in it a current of chymiferous fluid and granules is constantly passing backward and forward in the same way as occurs in the main part of the body. The same degree of sensibility and contractility obtains here as in the tentacles, and also the same flexibility under the influence of flowing water. Each branch is a single uniform stem, from the tip to the base, or very near it, as it sometimes happens that two branches arise from a short and thick single trunk. The pedicels to which the medusoids (*Fig.* 1^b, *a*, *b*, *c*) are attached are either single (*a*, *b*) or once (c^1) or twice (*e*) branched. At the tip of each branchlet a medusoid is attached. When the medusoids are most crowded, the whole mass is so dense as to hide the proboscis entirely, except at the extreme tip, allowing just room enough for the buccal tentacles to move and the mouth to open. When the head is held upright, with the mouth uppermost (*Fig.* 1^b), the bunches of medusoids hang down between the tentacles (t^1) of the lower series; but when the axis of the head trends horizontally (*Fig.* 1^a), then the bunches (*c*) are pendent between the tentacles of the lower side; and if the head hangs with the mouth downward, the proboscis is embraced by these pedulous bunches. When, however, the tide is flowing in or out very fast, then every thing is stretched out in the direction of the swift current. The larger tentacles (*t*) at the base of the head are as numerous, and have the same general form, as those of the upper row, when seen with the naked eye; and are tapering from the base to the tip, where they terminate bluntly. When observed closely, with the aid of a lens, it is easy to perceive that they are not cylindrical, but four-sided, so that in a transverse section (Pl. $XXIII^a$. *Fig.* 3) we have the upper (*a*) and lower (a^1) surfaces flat, and narrower than the lateral (c^2) flat or slightly concave sides. The proportions in the breadth of the upper and lower to the lateral surfaces vary gradually from the base to the tip of the tentacle; at the base the transverse diameter is not more than half of that which is included between the upper and the lower sides; but passing toward the tip this disproportion grows less and less, till the sides become nearly equal (Pl. XXIII^a. *Fig.* 3). At the base the sides are not so flat as toward the end, but curved in such a manner that a transverse section of the tentacle would show a wedge-shaped figure, with slightly convex sides, and the narrower end uppermost. At midway between the base and tip a transverse section (Pl. XXIII^a. *Fig.* 3) is parallelogramic, with the narrower ends alike, and corresponding to the upper and lower surfaces, the corners (b^3) are rounded, and the lateral longer sides (c^2) are slightly hollowed. Close to the end of the tentacle, just before it rounds off, the sides are more nearly equal and the corners more rounded than at the lower part. The sides of the tip of the tentacles are compressed, so that in a transverse section the figure would be broadly ovate. The end is blunt, and obliquely rounded off, from the upper toward the lower side, so that the extreme tip is nearer the inferior surface of the tentacle.

There are two layers, of different kinds of cells, in the tentacles; the one in the centre (Pl. XXIII^a. *Figs.* 1, *e*, and 2, *e*) is solid, and broader than deep (Pl. XXIII^a. *Fig.* 3, *e*), with four straight sides, in a transverse section, and occupies two thirds of the transverse diameter of the whole tentacle, and almost one half the diameter at right angles to this; the outer layer (*a*), which forms a sheath to the inner, is thinnest at the sides (*Fig.* 3, c^2), being about one sixth the thickness of the whole tentacle, and gradually thickens above and below; above (*a*) it is one quarter, and below (a^1) almost one third as thick as the whole mass of the two layers in this direction. In consequence of this arrangement, the tentacles appear unsymmetrical when seen in profile (*Fig.* 1), the greater portion of their central layer (*e*) being situated above the axis. The whole surface of the tentacles is thickly studded with lasso-cells, but on the under side (Pl. XXIII^a. *Fig.* 1, c^1) they are much more numerous than above (*c*), and at the tip still more crowded. The walls of the saucer-shaped disk (Pl. XXIII. *Fig.* 1^a, *d*), when the large digestive cavity which they enclose is taken into consideration, are comparatively thinner than those of the stem and of the upper part (*Fig.* 1^c. t^1) of the proboscis. The digestive cavity has a double convex shape, such as would be produced by putting two watch-glasses together face to face; above, there is a gradually narrowing opening which leads to the mouth, and below, another opening which leads to a suddenly expanding globular cavity (*Fig.* 1^b, d^1) at the end of the stem (*d*). The lower aperture of the digestive cavity corresponds to the constriction which divides the base of the head from the globular end of the stem. The end of the stem (*Fig.* 1^b, d^1) has a great deal of plasticity, and may assume an elongate, or very broad, flattened spheroid shape; but it is, usually, nearly spherical. It embraces a single, simple cavity, like that of the digestive cavity. At the neck of this expansion, where it joins the cylindrical portion of the stem, the chymiferous cavity loses its simplicity, and becomes complicated by the centripetal projection of several semi-partitions (Pl. XXIII^a. *Fig.* 7, g^3 g^4), varying in number from two or three to seven or eight, according to the age of the hydroid. These partitions arise from the inner wall (*Fig.* 7, d d^1); they are thicker than deep, and occupy more space, in a lateral direction, than the spaces (j) between them. They are most numerous at the top of the stem, and gradually decrease in number in a downward direction; at irregular intervals two of them anastomose, and continue as one, and so on, two more and two again, till at the base of the stem the last two run into a uniform, smooth, simple wall. They have a good deal of distensibility, and sometimes swell out so much as almost to meet in the centre of the stem. In this way they transform the interspaces into nearly closed tubes; but the centre never becomes permanently occupied by a solid cellular mass, connected with the inner wall by partitions, as occurs in Tubularia Couthouyi, and in T. indivisa of Europe. When seen from the outside, the stem appears striped longitudinally with alternately dark and light bands; the dark bands are the interspaces, and the light ones the semi-partitions. When light is transmitted through the stem, the reverse is the effect. The inner wall (Pl. XXIII^a. *Figs.* 4, *d*, 5, *d*, and 7, *d*) of the stem is quite thick, especially where it projects in the form of the semi-partitions (*Fig.* 7, g^3 g^4), and is lined by a loose layer of brownish-red, coarse and fine, granules (*Fig.* 7, *j*).

The outer wall (Pl. XXIII^a. *Figs.* 4, *b*, 5, *b*, and 7, *b*) is about two thirds as thick as the inner one; it is rendered papillate on the outer surface by the projecting rounded ends of the large cells, of which it is composed. At the lower part of the stem both these walls are much thinner; in fact, the base of the stem is hardly larger than at the time when the hydroid fixed itself, and the walls appear to have a corresponding thickness. The horny sheath (Pl. XXIII. *Fig.* 1^d; Pl. XXIII^a. *Figs.* 4, *a*, 5, *a* a^1, and 7, *a*) is not so tough as that of Tubularia Couthouyi, nor so thick, but is very flexible, and of a light yellow, or amber color. It embraces the outer wall of the hydroid, loosely, below; but above, it thins out and clings more closely, and even adheres to the globular expansion (Pl. XXIII. *Fig.* 1^b, d^1), in the guise of an excessively thin epidermis. There is no trace of this sheath on the head, as may be seen on that of Coryne and Corymorpha, but it terminates at the constriction where the latter joins the globose end of the stem. At this point it has all the appearances of an epidermic secretion, and may be seen to adhere closely to the curvature of the rounded ends of the cells of the outer wall.

Proles medusoidea. — There are neither radiating nor circular chymiferous tubes in the medusoids; but, when full-grown (Pl. XXIII. *Figs.* 12, 13, and 14), they have a simple single-walled proboscis (*d*), a double-walled disk (*a*), and from six to ten tentacles, very much compressed, laterally, crest-shaped, and hollow ($f\ f^1$). When full of young, ready to come out, they have a globular, or broad oval shape (*Figs.* 12 and 13), and the tentacles (*f*) are in the form of a low crest, which is hardly half so high as long; but when the young are nearly, or altogether set free, then the medusoids have an elongate, ovate shape (*Fig.* 14), and the cristate tentacles ($f\ f^1$) have almost twice the height of their centripetal diameter. In this condition they are very conspicuous (*Fig.* 1^b, *b*) among the other globular medusoids. The male medusoids (*Figs.* 2, 2^a, and 15) never have any tentacles, nor do they deviate from an almost perfectly spherical shape. As the details of the structure of the medusoids will necessarily be given in the history of their development, to avoid repetition, we only refer here to the next pages, relating to the embryology of this genus.

Embryology. Proles hydroidea. — We have never been able to find the least trace of eggs in the medusoids, though we have searched diligently for them. It is barely possible that they should have escaped our notice, when all stages of the growth of the medusoids have been closely scrutinized.

At first the medusoid is a simple, double-walled blind sac (*Fig.* 4, *a b*), which is in direct continuation with the walls ($a^1\ b^1$) of the branch to which it is attached; afterwards the two walls separate and leave a space (*Fig.* 5^a, *e*), which, from the moment of its formation, is filled by a very faintly granular, but excessively transparent substance. As the space between the walls increases in size, the transparent mass grows also, and at the same time becomes more coarsely and distinctly granular (*Fig.* 9, *e*), and deep yellow in color, but otherwise there is no internal change to be noticed. When the medusoid has attained to about one half of its adult diameter, the granular mass (*Figs.* 9, *e*, and 10, *e*) clings more closely to the proboscis (*d*), and has retracted from the region around the aperture of the disk, or, more properly speaking, has ceased to grow as fast as the still increasing cavity of the disk. Soon after this, the mass begins to be subdivided,[1] and, from time to time, throws off large spherical portions (*Fig.* 11, *e*). That which adheres to the proboscis still continues to grow, notwithstanding the process of self-division. The separated portions of the mass lose their yellow color, and, becoming semi-transparent, soon undergo a change, which, very early, indicates their destiny; each becomes flattened and angular (*Fig.* 21), with from six to eight sides, forming a polygonal disk. At first the angles are rounded, and not always equidistant (*Fig.*

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[1] The details of the process of subdivision will be found more fully illustrated in the section on Tubularia Couthouyi, in which this phenomenon was first traced.

21, *b* *c*), but this want of symmetry soon disappears. At this time a certain portion, at the exterior, becomes differentiated, and forms quite a thick layer (*Figs.* 21, *c*, and 21^a, *c*). Traces of this change may be seen earlier than this, while the separated mass is in a spheroid condition (*Figs.* 11, *e*, and 24, *c*); the parietal portion is then, to a considerable depth, more transparent than the central one; but a marked separation of an exterior thick layer does not occur till the angles appear at the edge of the disk. At the angles, and just below the thick layer, the granule-like cells (*Fig.* 21^a, a^1) are much more transparent than those along the sides, and more inwardly (*a*). Soon the sides become more equal, among each other, in length (*Fig.* 22), and quite concave, and the angles (*b*), consequently, more prominent, the exterior layer more transparent (*Figs.* 22, *c*, and 22^a, *c*), and the clear prominence (*Fig.* 22^a, a^1) of the interior still clearer. We have, thus far, sufficient evidence to show that this polygonal, free body, is a young hydroid, and on this account must consider the granular mass, of which it was once a portion, as the *germ-basis*. The exterior thick, transparent layer, is its exterior wall (*Fig.* 22, *c*), already evincing traces of large, broad, columnar cells (*Fig.* 22^a, *c*); the prominent angles, lying as one plane around the edge of the disk, are the tentacles (*b*) at the base of the head. The clear space (a^1) beneath the outer wall of the tentacles corresponds to the axial layer of these organs; and the interior mass (*a*) is the inner wall not yet hollowed out for the chymiferous cavity.

By the time the tentacles have grown to an elongate triangular shape (*Fig.* 23, *b*), and equal in length to one third the breadth of the discoid body (*a*), their axial layer (*Fig.* 23^a, a^1) has its characteristic double row of large cells (a^1 a^2); and they have considerable flexibility, not only up and down, but laterally (*Fig.* 23). After the tentacles have grown a little longer, and assumed an oblong shape (*Fig.* 13, e^3), the centre of the internal wall of the body becomes hollowed, and a large circular cavity (e^2) appears. The breadth of this cavity is about one half that of the body, but, in consequence of the flattened shape of the latter, the depth is much less. The young hydroid is concave on the side next the proboscis, and on the opposite side convex, and the tentacles (e^3) are curved slightly downward. For a considerable length of time after this, there is nothing new added to the organism, but the various parts of the body assume other proportions; the convexity of the body increases more and more (*Fig.* 12, e^1 e^2), the tentacles (e^3) become longer, more slender, and, as a general thing, curled under, toward the concave side of the body. By the time the tentacles (*Fig.* 14, *e*) have become globular at the tips (*g*), and three times as long as the diameter of the convex part of the body (c^1), and the latter has grown deeper than broad, its concave side has developed a large, broadly oval hernia (*c*), which projects in a straight line from the centre. Its walls (*c*) arise directly from the bases of the tentacles, and have the same thickness as those of the body (c^1). Its cavity does not open outwardly, but, at the base, communicates broadly with that of the convex portion. In this condition the young hydroid is set free, urging its way through the aperture of the disk between the cristate tentacles (f f^1).[1] The tentacles generally trail behind in the egress of the young, and very often, especially when there is but one highly-developed individual present, they occupy the region around the proboscis of the medusoid whilst the body presses against the opposite end. During the struggles of the young to push its way out, the medusoid becomes very much elongated in the direction of its axis. When once fairly freed from its parent, the young hydroid crawls about for a short time upon its long tentacles, and finally turns over and fixes itself by what we have hitherto spoken of as the convex portion of the body (c^1). We now recognize the latter as the basal side, or stem, of the individual; and are confirmed in this by the fact that it is covered by a thin, yellowish, glutinous film (*Fig.* 14^a, c), which acts as the medium of adherence to whatever the young animal may settle upon for a habitation. This glutinous film, the rudiment of the horny tube which encloses the stem of the hydroid, may be detected, without much difficulty, a short time before the exclusion of the young; but in order to see it satisfactorily, the hydroid must be cut out of its parent. We are able now to determine what organ the hernia is (*Fig.* 14, c) which developed from the concave side of the body; from its position above, and in the centre of the circle of long tentacles, there can be no doubt that it is the proboscis, although it has not yet the proboscidal tentacles. Very soon, however, the end of the proboscis is opened, and around this opening, or mouth, the buccal tentacles, five, six, or seven in number, develop rapidly. At this stage, the young hydroid appears identical, at least under a low magnifying power, with the young of Thamnocnidia spectabilis, of the same age (Pl. XXII. *Fig.* 15). There are often as many as nine or ten young hydroids, at one time, in a single medusoid (Pl. XXIII. *Fig.* 12), but not all in the same stage of development; there are those which have been very recently separated from the granular, yellow mass which clings around the proboscis, and have still a spheroidal form (e); others with tentacles just budding (*Fig.* 22, b), some half grown to the age of exclusion (e^1 e^2 e^3), and, finally, one or two just leaving the parent.

When the yellow granular mass has become quite thin, by repeated self-division and the casting off of young hydroids, it may at first sight be very readily mistaken for a second or outer wall (*Fig.* 17, a) of the proboscis, but its absence

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[1] The young resemble so much the small Acaleph-like animal described by Leuckart under the name of Pyxidium (Archiv f. Naturg., 1856, Vol. I. p. 31, Pl. II. *Fig.* 7), that I am inclined to consider this, also, as the free progeny of the sessile medusoid of some European Tubularia.

in those medusoids which have set free nearly all their young (*Fig.* 14), removes all possibility of mistake.

At birth, and for a short time before that period, the tentacles of the lower row are very differently proportioned from those of the adult, both in regard to the general contour, and in the relative thickness of their walls. In the adult stage, as we have shown on a former page (p. 251), the tentacles gradually taper to a rounded or slightly swollen tip, and are four-sided, but at birth they are round, and although they taper like those of the adult, yet, at the end, they terminate in a large globular expansion (*Fig.* 26, *c*), which is densely crowded with lasso-cells. This globular tip has nearly twice the diameter of that portion of the tentacle which is immediately below it. The outer wall (*a*) of the tentacles has about one sixth the thickness of the inner one (*b*), and is exceedingly transparent, so that it has not been possible, with the microscopic powers which we had at hand when these observations were made, to see the nature of its cellular structure.

Proles medusoidea.—The peduncle, which forms the basis of each group of medusoids, has hardly begun to bud from the convex upper walls of the stomach, before the young medusoids appear. At first, each medusa-bud is a low projection (*Figs.* 3 and 3ª) of the double wall (*a b*) of the peduncle, and embraces a broad cavity (*c*) which is in direct communication with the chymiferous channel of the latter. This prominence increases in height, until it is considerably higher than broad, before any change takes place in the relation of the outer and inner walls (*Figs.* 4 and 4ª). Then the outer wall grows faster than the inner one, and the two consequently become separated and leave, between them, a space (Pl. XXII. *Fig.* 1, *e*)[1] which is filled by a substance which, in the female, we have called the germ-basis,[2] and, in the male, the spermatic mass. The inner wall, in the meanwhile, becomes cup-shaped at the end, next the germ-basis, by rising in the form of a rim (*Fig.* 1, *b*) closely pressed against the outer wall (*a*). The edge of the cup rises very rapidly, so that its edge (Pl. XXIII. *Figs.* 5 and 5ª, b^2) nearly reaches the end of the medusoid before any other change occurs in the development of the embryo. In this way the germ-basis becomes almost completely enclosed in double walls (*Fig.* 5ª, *a b*). This new inner wall (*b*) is nearly twice as thick as the outer one (*a*), and comes to a sharp edge (b^2) at its outer end, where it forms the rim of the cup. Immediately after this the bottom (d^1) of the cup rises gradually, as if

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[1] There are certain phases in the development of the medusoids of Thamnocnidia spectabilis which resemble those of Parypha crocea, and on this account the figures of the former may be used to illustrate the latter.

[2] We have already described, on a previous page (p. 254), the nature of the substance which fills this space, and, subsequently (p. 255), shown why we have given it the name of the germ-basis.

pushed up from beneath. This forms a cone (*Fig.* 6, *d*) with a hollow interior (c^1) which is in direct and broadly open communication with the cavity (c) of the pedicel. Although this cone is at no time open at the end, and, consequently, food is never taken in through its instrumentality, yet it is in every respect, homologically, the proboscis of the medusoid. As the proboscis lengthens, its wall thickens, until, by the time the tip of the former has nearly reached the end of the medusoid, the latter (*Fig.* 7^a, *d*) has become as thick as the inner wall (b^1) of the pedicel. From this time the germ-basis, or the spermatic mass, ceases to grow as fast as the cavity of the disk enlarges. This at first makes itself evident near the end of the medusoid, where there is a space, which the germ-basis (*Fig.* 8, *f*) does not fill up. There is as yet only a single wall (*b*) which protects the space from the surrounding medium, the edge (*e*) of the cup-shaped inner wall (*c*) not being closed over. Simultaneous with this feature there appears another quite as noteworthy, in the comparatively much diminished size, and in the change of shape of the proboscis (*d*). Whereas heretofore it has occupied a very broad basis, nearly equalling the breadth of the medusoid, and also has filled a great portion of the cavity of the disk (*Figs.* 6, 7, and 7^a); it now projects into the axis of the disk, in the form of a slender cylindrical pillar (*Fig.* 8, *d*). Soon after this, both in the female (*Fig.* 9) and male (*Fig.* 15), the proboscis (d^1) forces its way through the germ-basis, or spermatic mass, and even projects through the recently formed opening (*Figs.* 9, *f*, and 15, *e*) of the disk. We have not made sure of the fact whether the inner wall closes over by uniting the edge of the cup mentioned above, or not; but in all probability it does not so happen, because the aperture in the disk is formed immediately after the vacant space is left between the outer wall and the germ-basis. In the male no further development, excepting an increase in bulk, takes place; but in the female a remarkable set of tentacles (*Fig.* 10, *f*) are formed. The time of their development is not always contemporaneous with certain other phases; sometimes they are largely developed before the germ-basis (*Fig.* 10, *e*) has begun to segment, and at others they have not appeared, although some of the young hydroids (*Fig.* 11, *e*) have already separated from their basis (*g*). The mode of formation of the tentacles is very simple: around the opening of the disk, the double walls become plicated in the direction of the axis of the medusoid, and these folds, varying from five or six to ten in number (*Fig.* 13, *f*), project outwardly in the form of low thin crests, the planes of which trend toward the axis of the medusoid. At first they are about as long, at the base, as high, and run out to a blunt point so as to form a triangle. After this, the fold extends toward the pedicel of the medusoid, and reaches sometimes along half the length of the disk, at the same time diminishing in height until finally it runs off into the walls from which it originates; and the highest part, which is nearest the aperture of the disk, assumes an arched contour (*Fig.* 10, *f*). In consequence of the mode of formation of the tentacles, their interior is hollow. If we look along the plane of one (through *a–c*, *Fig.* 12^{a}), a very narrow cavity (*Fig.* 12^{b}, *b*) may be seen, between the opposite double walls. In profile the double walls (*Fig.* 12^{a}, *d e*) are very readily detected; the outer one (*d*) is very thin, but the inner one (*e*) is extraordinarily thick, next the top of the crest.[1] Along the whole length of the base of the crest a narrow fissure (*Fig.* 12^{a}, b b^1 b^2) extends, and serves as a passage-way from the cavity of the tentacle into the interior of the disk. When the young hydroids are pretty far advanced in their development, and are numerous, the medusoid parent becomes spherical (*Fig.* 12) and the tentacles (*f*) higher in proportion to their length, and the transition into the disk is not so gradual. When most of the young have escaped from the parent, the latter becomes elongate (*Fig.* 14), and the tentacles (f f^1) assume a great height, equal to two thirds the length of the base, which now occupies much less extent. In this condition, when seen with a low magnifying power, they appear like cylindrical bodies (*Fig.* 1^{b}, *b*), and are very conspicuous among the other, globose or oval, medusoids. The proboscis, during these later periods, moves about with great freedom, and oftentimes projects far beyond the aperture of the disk, but as the medusoid approaches the end of its breeding season, and the young are nearly all discharged, the proboscis diminishes and retracts toward its base (*Fig.* 14, *d*), but yet retains its activity. When the germ-basis has almost separated from the proboscis, the part which remains (*Fig.* 17, *a*) oftentimes appears like an outer wall, but in later stages (*Fig.* 14, *d*), when the germ-basis is altogether developed, the proboscis is clearly single-walled.

Throughout the whole course of the development of the medusoid, there has not been the least trace of radiating or circular chymiferous tubes within the disk; and the only place where chyme has been seen to circulate was in the proboscis, which we have shown above to be in open communication with the canal of the pedicel. After the young are all excluded, the parent shrivels, dies, and falls off. The medusa-buds of Parypha thus appear to belong to the simplest forms of Acalephs. Morphologically, they are as genuine Medusæ as those which, being freed from their parent stock, assume an independent life, during which the reproductive organs are developed at a late stage of their life; but, as far as the complication of this structure goes, they do not rise above the level of ordinary Hydroids, being, like them, destitute of radiating and circular chymiferous tubes.

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[1] These two walls are so conspicuous, when seen in profile, as to give the tentacles the appearance of being margined, and, on this account, the genus has been called *Parypha*, from *Παϱῦφή*, a border or hem. Another species of this genus has been described by McCrady as Tubularia *cristata.*

These facts are highly important with reference to the appreciation of the various kinds of individuals found in the colonies of certain Siphonophoræ, in which a medusoid form is often found combined with the structure of a hydroid.

The spermatic particles. — During the earlier stages the mass of spermatic particles is perfectly hyaline, and, to all appearances, homogeneous; but when the medusoid is two thirds grown (*Fig.* 15), the mass (*c*) is yellow, and composed, in a great measure, of small cells (*Fig.* 15^a, *b*), each one of which is filled by three or four mutually compressed, rounded angular bodies. As the mass comes to maturity it assumes a dense yellow color, and the cells disappear, while their contents are scattered uniformly throughout the field. By this time these angular bodies have changed and become pear-shaped, and keep up a constant agitation among themselves. If the medusoid is opened and the mass torn, these lively bodies (*Fig.* 16, A, B) run out and swim about the field of the microscope by the help of a very long, slender, thread-like appendage (*b*), which is attached to the narrower end of the pear-shaped head (*a*) of the spermatic particle.

Histology. The adult Hydroid. — The cells, of which the tentacles of the lower row are composed, are remarkably conspicuous, and the walls are so distinct that they may be easily seen under a magnifying power of no more than one hundred diameters. Seen thus, they appear like coarse, polygonal granulations, closely packed together. Under a magnifying power of five hundred diameters their true nature is revealed. Their superficial ends (Pl. XXIII^a. *Fig.* 1, c c^1 c^2 c^3) are irregularly polygonal, with an average diameter of about $\frac{1}{2500}$ of an inch. They appear much darker at this point, at the surface of the tentacle, because, beside the numerous coarse, dark, angular granules, which are distributed throughout the body of the cell, each one has one, two, or three lasso-cells fixed just below the surface of the outer end. The lower side (*Fig.* 1, c^1) of the tentacle is much more thickly beset with lasso-cells than anywhere else. From this point, toward the upper surface, they diminish in numbers; at the sides (c^3) they are already, comparatively, very few, and above (*c*) they are least numerous. In a profile view these cells at once exhibit a marked difference, according to their position. At the lower side (*Fig.* 1, a^1 a^2) they are at least one quarter longer than those on the upper side (*a*), but not broader, whilst those at the sides (*Figs.* 1 and 3, c^2) are much shorter than anywhere else. Each cell occupies the whole thickness of the wall (*Figs.* 1, 2, and 3, from a^1 to a^2), and is wedge-shaped, with the broader end (a^1) outermost. The inner end (a^2) is quite sharply truncate, and presses closely upon the even surface of the inner layer (*e*). On this account the line of demarcation between the two walls is very sharply defined. The outer ends of the cells are variable in shape; when the tentacle is stretched to its fullest extent they are not in the least protuberant (*Fig.* 1, b b^1), but when the tentacle is less extended, they are more or less rounded, so that the surface of the wall appears papillate. If a piece of a tentacle is cut off, it soon disintegrates, and these cells assume a spherical shape (*Fig.* 1^a, A B C). In this condition their contents may be studied with great facility. When thus isolated, one can determine absolutely that the lasso-cells (*a b* b^2 *c d*) are within the cavity, or at least within the superficies of the cell. There is good reason to believe that the lasso-cells are not strictly within the cavity of the cell, but are imbedded in the thickness of the wall; but this is so extremely transparent that we have not been able to define its inner boundary with certainty. We have succeeded much better with the cells of the outer wall of the stem (*Fig.* 4, *b*), where the cell wall (*Fig.* 6, *c*) appeared to be quite thick, and, at the outer end, so incrassated (at *b*) as to include the whole length of the lasso-cell (*a*) which stood transverse to the surface. This thickening may not be, properly, a part of the cell wall, but a lining of it; on this point, however, we are much in doubt.

A larger part of the contents of the cells of the outer wall of the tentacles are coarse, irregular, granular, oily-looking bodies, some of which (*Fig.* 1^a, *e*) are as large as the lasso-cells. The lasso-cells belong to the same type as those found in Hydractinia polyclina (Pl. XVI. *Figs.* 10 and 11), to the description of which we will refer for the details in regard to these bodies. The inner, or axial layer of the lower tentacles, is composed of very peculiar cells (*Figs.* 1, *e*, 2, *e*, and 3, *e*). Upon taking a profile view of the tentacle, these cells, at first glance, appear to be irregularly and sharply polygonal (*Fig.* 1, *e*), but, by plunging toward the centre of the tentacle, we find that they have a much greater diameter transverse to the axis than along the same, and hence that they are four or five-sided prismatic bodies. They do not all converge toward a central line, but trend parallel with each other, and extend from a plane which is parallel to the flat side of the tentacle, to the plane of the axis. In a view from above or below (*Fig.* 2, *e*) the tentacle, their longer diameter is displayed, showing, in a more direct way, their elongate prismatic form, and also another peculiarity, not easily to be discovered from any other point, namely, that they all have a greater or less inclination toward the tip of the tentacle, so that the two rows of superimposed cells meet at an obtuse angle, in the perpendicular plane (e^1) of the axis. By taking advantage of the bending of a tentacle in its multiplied contortions, one may get a view of a most perfect transverse section (*Fig.* 3). The opposite sides of these cells are not often parallel with each other, one side making two or three curves in its course, while the other side makes but one or two curves, or sometimes is nearly straight; and again, the ends alternate irregularly, one end being broader or narrower than the opposite one. The walls are much thicker than those of the outer layer of cells, but we have never been able to see each one singly, so intimately united are the parieties of neighboring walls, even to the very extreme of the angle of the cell. Excepting a few coarse, dark granules, which lie at the end next the perpendicular plane (*Figs.* 2, e^1, and 3, e^1) of the axis, these cells are remarkably transparent, and very brilliant. The latter feature is probably owing to the peculiar refracting properties of the homogeneous contents.

The cells of the outer wall of the stem resemble, in a general way, those of the tentacles, but their relations to each other are quite different from these last. In the first place, the stem, being perfectly round, and this wall of equal thickness throughout, they are more nearly alike in shape and proportions. In a surface view, where only the outer ends of the cells (Pl. XXIII^a. *Fig.* 4, i^3) are seen, they appear irregularly polygonal, and thick-walled. In profile (*b c*) they have a broad cylindrical outline, with about equal transverse and longitudinal diameters, when the stem is in a medium state of extension, but when it is stretched to the fullest degree, these cells (*Fig.* 5, *b c*) have a transverse diameter at least twice as great as the longitudinal one. The outer ends are always more or less rounded, but the inner ends, where they abut on the inner wall (*d e*), are, on the contrary, flattened transversely to their longitudinal diameter, so as to form a perfectly smooth, even surface, over the whole extent of the wall which they form. The contents of each cell consists of a perfectly homogeneous, transparent substance, and one or two lasso-cells which are fixed at the outer rounded end. The peculiar relations of these lasso-cells to the wall of the cell, we have already described when speaking of the lasso-cells of the tentacles (p. 261). It is a remarkable fact, that, whilst these cells, which we have just described, are so conspicuous, the cells of the outer wall of some of the other Hydroids, such as Coryne, Halocharis, Clava, Hydractinia, and Rhizogeton, are only to be seen with the best magnifying powers which we can command.

The cells (*Figs.* 4, g g^1 g^2, and 5, g g^1 g^2) of the inner wall are as readily seen as those of the outer wall, and, in fact, the latter have such a strong resemblance to the former that one might easily be mistaken for the other, when both are seen endwise (i^3, g^2). When the stem is very much extended, there is a marked difference, at once recognizable; the cells of the inner wall (*Fig.* 5, g g^1 g^2), in such cases, are extremely elongated, in the direction of the axis of the stem. In a profile view (*Figs.* 4, *d e*, and 5, *d e*) we find the outer ends of the cells are flattened transversely, so as to form a smooth floor, which fits closely to the inner surface of the outer wall (*b c*). The inner ends (*e*) are rounded, with a tendency to sharpness when the stem is moderately extended (*Fig.* 4, *e*), but terminate with a long curve (*Fig.* 5, *e*) when the stem is very much stretched out. In the former case, the diameter of a cell, in a transverse direction, is hardly half of that from the outer to the inner end, but, in the latter case, the depth of a cell is reduced more than one half. We have here the most indisputable evidence that each individual cell elongates or shortens, and narrows or broadens according to the contraction or extension of the stem. We have seen this process repeatedly while the stem was under the microscope, and have even observed a single cell expand and contract quite independently of those around it; any one who will make a transverse section of the stem, and watch the movements of the cells on the edge (*Fig.* 7, g^1) of any one of the broad semi-partitions which extend along the chymiferous channel, may test the truth of this statement for himself. Sometimes a single cell expands until it nearly reaches the centre of the chymiferous channel; and so thin does its wall become at the time, that it could very easily be overlooked. The cells which enter into the composition of these semi-partitions (*Fig.* 5, g^3), may be very readily seen directly through the outer (i^3 i^4) and the inner (g g^1 g^2) walls, and are distinguishable from the cells of the latter by their relative position and their superior size. They are intimately united to the inner wall, of which they are, in fact, centripetal prolongations, as a transverse section (*Fig.* 7, g^3 g^4) shows. They are disposed in at least two layers (*Fig.* 7, g^3 g^4), the inner one (g^4) of which is narrower when the partitions are not expanded. The brownish-red granular substance (*Fig.* 7, j) which lines the surface of the chymiferous cavity of the stem, does not appear to be at all cellular in its nature, but, rather, concretionary. The granules are more or less angular, and of all sizes, from mere specks to apparently one sixteenth of an inch in diameter, as seen with a magnifying power of five hundred diameters. Those in the immediate neighborhood of the wall cling quite closely to it, but toward the centre of the cavity they are in constant agitation, and, frequently detaching themselves from their bed, rush along in the passing chymiferous current.

The cells, which constitute the outer and inner walls of the peduncles (Pl. 23, *Figs.* 18, 18^a, 19, and 19^a) of the medusoid bunches, have a close resemblance to those which we have just described, in the walls of the stem, but the former are much smaller. The cells of the outer wall (*Fig.* 19^a, a) cannot be seen unless the peduncle is contracted, because, when it is stretched out, this wall becomes excessively transparent and quite thin. These cells, when seen with a magnifying power of three hundred diameters, appear, in profile, to be about as broad as long, with rounded exterior and flattened or truncate interior ends. When the peduncle is stretched, all that can be seen of organization in this wall, are a few scattered lasso-cells (*Figs.* 18, 18^a, and 19), which give it a spotted appearance. The cells of the inner wall (*Figs.* 18, 18^a, 19, and 19^a, b), when the latter is in a strongly contracted state (*Fig.* 19^a, b), are three times as long as broad, and are rounded at the outer as well as at the inner ends. In this state the wall is very thick, and yet it is composed of but one layer of cells arranged so as to give it a columnar structure (*Fig.* 19^a, *b*). When the peduncle is extended (*Fig.* 19) the cells (*b*) of the inner wall are about as broad as long, with rounded outer, and flattened inner ends. They are, like those of the outer wall, very transparent. When viewed endwise, they show their polygonal shape (*Fig.* 18^a, *b*), and nearly equal-sided outline. As the peduncle contracts, these cells become flattened laterally and in the direction of the length of the wall, so that their polygonal outline elongates traversely (*Fig.* 18, *b*) to this.

The young Hydroid. — When the germ-mass is nearly ready to begin the process of segmentation, its cellular structure is very distinct. The whole mass (*Fig.* 9, *e*, *Fig.* 9^a, *b*) is composed of small vesicles (*Fig.* 9^b), congregated without order. Each vesicle or cell consists of homogeneous contents (*a*), with a mesoblast (*b*) which is so large as to occupy three fifths of the diameter of the whole cell. This leaves between the cell wall and the mesoblast so little space, in the shape of a broad ring (*a*), that one might very easily mistake the ring for a thick wall, and the mesoblast (*b*) for the homogeneous contents. After a segment has separated (*Fig.* 11, *e*) from the germ-basis, a greater portion of its constituent cells (*Fig.* 24, *a*) retain for a short time the same structure as we have just described, but at the periphery of the segment the cells are very much changed; they are much smaller (*Fig.* 24, *c*) and more numerous, and densely crowded into a thick layer, which in profile appears like a semi-transparent margin. As the young hydroid begins to take on a polygonal shape (*Fig.* 21), this layer increases in transparency (*Fig.* 21^a, *c*) and the cells (*Fig.* 25, *c*), although augmented in size, become quite inconspicuous, except under the highest magnifying powers. There does not as yet seem to be any arrangement among them, but, on the contrary, they are packed together indiscriminately. The interior portion (*Fig.* 21^a, *a*) has undergone a considerable change at the corners (a^1), where the tentacles are now forming. This change consists in an increase of transparency of the cells at this place, and a diminution of their numbers. Soon after this, when the young hydroid has assumed a prominently polygonal outline (*Fig.* 22), the cells of the outer wall (*Fig.* 22^a, *c*) arrange themselves in a single layer. Each cell is about as broad as long, and the outer and inner ends form, respectively, the outer and inner surface of the wall. The contents of these cells are perfectly homogeneous and hyaline. The inner mass, in the region of the tentacles (*Fig.* 22^a, a^1), is still more transparent than in the last phase, but elsewhere, throughout the body, the cells (*a*) are still very conspicuous, so that, under a low magnifying power, they appear like coarse granulations (*Fig.* 22, *a*). By the time the tentacles have grown to a prominent triangular shape (*Fig.* 23, *b*), the cells of the outer wall (*Fig.* 23^a, *c*) have grown to a full and clear definition of their respective outlines. The inner mass, as far as it enters into the composition of the tentacles, has assumed an organic shape, and the cells (*Fig.* 23ᵃ, a^1 a^2) are disposed in two parallel layers, as in the adult (Pl. XXIIIᵃ. *Fig.* 2, *e*). Individually they are cylindrical, and about twice as long as thick. The remainder of the interior mass of cells (*a*) is the same as in the last stage, except that they are not so crowded. At the birth of the hydroid, the cells of the outer wall (Pl. XXIII. *Figs.* 26, 26ᵃ, and 26ᵇ, *a*) are too hyaline to be visible in a natural state. The only sign of organization that we have here, are the scattered lasso-cells (a^1 a^2) which give the wall a nodulated appearance. At the globular tip (*Fig.* 26, *c*) of the tentacles these lasso-cells are crowded so as to touch each other, and their projecting ends give the surface a papillate aspect, while the lasso-threads, frequently extended, render it bristling here and there. The interior wall (*b*) is very conspicuously cellular. The cells are, however, far less numerous than in the adult; toward the base of the tentacles they are the most frequent, forming at least three layers (b^1) between the upper and lower side, but in the vicinity of the tip there are only two layers (*b*). The outer ends of these cells are irregularly four-sided, excepting in some instances toward the base of the tentacles, where they have a strong tendency to be polygonal. In a view from above (*Fig.* 26ᵃ), the individual cells (*b*) — the two ranks which lie right and left — are opposite to each other, and as they are square, or at least parallelogramic, the walls of their coinciding and adherent ends form a thick partition (b^2), which has the appearance of being a solid column, running the whole length of the tentacle. The contents of these cells are perfectly homogeneous and hyaline. The horny sheath (*Fig.* 14ᵃ, *c*), which is developed just before the young escapes from its parent, is very transparent, faintly tinged with yellow, and, as far as we can see, structureless. We have a suspicion, that with improved lenses, a lamellar structure could be discovered.

The Medusoid. — In the beginning of the formation of the medusoid, the cells of the outer and inner walls are identical with those of the pedicel from which the bud springs. These characters they retain, for the most part, throughout the life of the medusoid, but there are one or two exceptions, where they undergo slight modifications. In the flat, thin tentacles (*Fig.* 12ᵃ), those which compose the inner wall (*e*) are enormously developed, both in length and breadth, to about thrice their original diameter, and are perfectly hyaline. In a half-grown medusoid a single row of them occupies about one half the height of the tentacle, and form a broad border, just within the thin strip of the outer wall (*d*). In the proboscis of a full-grown medusoid, the cells of the wall (*Figs.* 17, *b*, and 17ᵃ, *b*) are about half again as large as the original size, but otherwise very little changed.

SECTION IV

TUBULARIA COUTHOUYI *AG.*

Proles hydroidea. Adult. — We have always found this species in the same localities, and under the same conditions, as Parypha crocea and Thamnocnidia spectabilis, and never in pure sea-water, so essential to its very closely related European congener, the Tubularia indivisa. It is usually found in clusters of not more than four or five, and occasionally eight or ten, individuals, springing from a few closely tangled, knotty, root-like tubes. Each stem (Pl. XXIV *Fig.* 1, *a b c d*) bears a single head, and runs up from three to six inches, having, in the average, a diameter of one twelfth of an inch, but tapering a little toward the base, where it is connected with the diminutive, tangled, stolonic tubules. The whole stem, from the base of the head to the lower extremity, is covered by a horny sheath, which is more or less ringed, or jointed, sometimes very regularly, at intervals of an eighth of an inch, or constricted once or twice, and then again smooth throughout.

The head resembles very closely that of Parypha crocea, described page 249, except that the tentacles of the proboscis (Pl. XXIV. *Fig.* 1, D *p*), amounting to fifty, are disposed in three or four indistinctly defined series (*Fig.* 4, t t^3 t^2 t^1). In each series they are successively shorter than the next inner, or higher ones, and the outermost (t^1) are mere papillæ. The head is much larger than that of Parypha crocea or Thamnocnidia spectabilis, and so are also the stem and the medusoids (*b*); in fact, Tubularia Couthouyi has an average of double the diameter of these species, and its tentacles, when fully expanded, form a coronet measuring an inch and a half across.

The medusoids are present, and full of completely developed young, from March to December. It is not probable, however, that the same head bears full-grown medusoids all this time; on the contrary, at one and the same date, some of the largest hydroids bear only a few young buds, and others are crowded to the utmost with highly-developed medusoids casting their young. The branches which bear the medusoids are disposed in longitudinal rows, with three or four in each, so that, transversely, they form three or four circles around the base of the proboscis. The sexes are separate, on different stocks, and may be readily distinguished with the naked eye by the shape of the medusoids, the males being elongate oval, or pyriform (*Figs.* 2 and 3, *b*, and 5, *d*), and the females, globular or broadly oval (*Figs.* 1, *b*, and 1^B, 1^C, *d*).

As regards the details of the anatomy of this hydroid, what has been said of Parypha crocea (p. 250) might be repeated here, with a few modifications, which we will now point out. The proboscidal tentacles, not less than fifty, in the oldest hydroids, do not all take part in the formation of the converging ridges which run to the mouth, but only those of the uppermost series, while the bases of the others are merged into the proboscis lower down. The ridges which are formed by their decurrent bases project to a quarter or less distance down the proboscis, according to the size of the tentacles from which they originate (*Fig.* 4, *a*).

Below the terminal globose expansion of the stem, the interior wall has a very remarkable structure, which has no parallel in any other of the Hydroids. Upon making a careful transverse section with a very sharp scalpel, we were surprised to find that at least two thirds of the stem within the boundary of the outer wall is filled by a solid central mass, composed entirely of large polygonal cells (Pl. XXIII^a. *Fig.* 8, g^4). At the periphery of this mass, there are several longitudinal channels (j j^1), disposed at pretty regular intervals, and varying in number, according to the age of the hydroid, from fourteen downwards. One of these channels (j^4) is always much larger than the others, and is equal to one fourth the diameter of the whole cellular mass (d g^4), while the smaller ones (j) have one half this diameter. The larger channel is the only one present during the earliest period of growth of the young hydroid, and at that time constitutes the broad chymiferous cavity of the stem. Unlike the smaller channels, it extends for the whole length of the stem, in unbroken continuity, and has, in its course, no connection whatsoever with them; whereas the smaller channels fork, from time to time, as they pass upward, thus increasing in number according to the age and length of the stem. All these channels may be seen with the naked eye (Pl. XXIV. *Fig.* 1); but with a low magnifying power the difference between the larger channel (*Fig.* 1^B, a^1) and the smaller ones (a) becomes very apparent.[1] The large channel varies from cylindrical to broadly ovate, and in the latter case the broader diameter trends toward the axis of the stem. The smaller channels (Pl. XXIII^a. *Fig.* 8, j) are broader, in a direction trending toward the axis of the stem, than they are

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[1] We find the large, and the small channels also, in a very closely related species, the Tubularia indivisa of Europe. sent to us by Sars from the coast of Norway; and if the observations of Dr. T. S. Wright, which are published in the Edinburgh New Philosophical Journal for January, 1858, p. 113, Pl. III. *Figs.* 2 and 3, were made upon this same species, then his discovery, although very interesting, was only a partial one. It hardly seems possible that he could have noticed the channels, from the outside of the stem, without seeing also the single large one, which is very conspicuous, and thus have been led to inquire into the cause of this difference by a more careful section than the crushing blades of a pair of scissors, however sharp, would afford.

at right angles to this, so that the outline of a transverse section appears broadly ovate, with the broader end next the outer wall (*b*).

The cellular mass (g^4) terminates at the base of the globular terminal expansion (Pl. XXIV *Fig.* 1^B, *b*) of the stem, and the channels here empty into the broad open space. Within these channels a more or less brisk circulation is constantly kept up, apparently by means of vibratile cilia, but these are so excessively fine that we have not been able to detect them. The outer wall (Pl. $XXIII^A$. *Fig.* 8, *b*) is about as thick as one half the shorter diameter of the channels, has a smooth exterior surface, and is composed of numerous irregularly-disposed cells (*Fig.* 9, *b*), of moderate size. The horny sheath is variable in thickness, according to its height; at the top it thins out to a mere filmy, epidermoid covering, upon the globular expansion, and, passing downward, it gradually thickens, till, at the base, it is twice or thrice, and, in very old specimens, even four times as thick as the outer wall midway up the stem.[1]

Proles medusoidea. — A full-grown medusoid has a diameter about double that of Parypha or Thamnocnidia, and possesses as complete a system of chymiferous circulation as that of Coryne; it also closely resembles the latter in the disposition of its circular and radiating (Pl. XXIV *Figs.* 18 and 19, *e*; Pl. XXVI. *Fig.* 3, *e*) tubes (*c*), of which latter there are four, and sometimes five. Here, however, the resemblance ceases, for the medusoid of Tubularia has not the least trace of tentacles. There are the same double walls of the disk, and the single wall of the proboscis as in Parypha and Thamnocnidia; but, unlike the latter, the inner wall is channelled by the chymiferous system of tubes. As the medusoid never becomes a free animal, dependent upon its own exertions for subsistence, but, on the contrary, receives all its nourishment from the hydroid, it is not at all remarkable that the chymiferous system of tubes should be in some instances irregular in its persistence, as we have observed it to be. These tubes always develop completely, but here and there we find that the radiating tubes become obsolete, even before the medusoid has reached its maturity (*Figs.* 15, 16, and 17). Sometimes every trace of the chymiferous system has vanished long before the medusoid begins to wither (*Fig.* 15), or nothing but the areas of junction of the radiating and circular tubes are indicated by red spots, from one to five in number (*Figs.* 16 and 17, *c*), near the opening of the disk. By the time the hydroids are beginning to be set free, the proboscis (*Figs.* 21 and 23, *d*) becomes remarkably elongated; but instead of pushing itself out through the aperture of the disk, as does that of Parypha, it doubles upon itself. After all the young are developed and set free, the medusoids wither, and either drop off or are resorbed (Pl. XXVI. *Fig.* 4). When undergoing this process,

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[1] For further details upon the structure of these walls, see the paragraph upon histology (p. 270).

those partially resorbed (*Fig.* 4, *b c e*) might readily be mistaken for young, budding medusoids, did not the nearly obsolete chymiferous system, and the ragged looseness of the cellular tissue, indicate their true condition. Those which have just begun to wither may be recognized by their much diminished size (*Fig.* 4, *d*), shrunken proboscis (Pl. XXIV *Fig.* 25, *d*), and the great thickness of their walls (*Figs.* 25 and 25^a, a^1) when compared to those of the medusoids in full vigor (Pl. XXVI. *Fig.* 3).

Embryology. Proles hydroidea. — Tubularia shares with Parypha and Thamnocnidia the remarkable property of reproducing the hydroid form without the intervention of the egg phase. The genus Tubularia has recently received our special attention in regard to this point, and we can safely say that it is not possible to find any resemblance to an egg in the contents of the cavity of the medusoid buds. If the egg is present it must be under the disguise of an unusual form. Can it be possible that the Purkinjean vesicle does not appear until the yolk masses have separated from the germ-basis, at a time when they are so opaque as to hinder all ordinary chances of a view of their interior? We have investigated these masses at this stage, but have not been able to see any indication of that characteristic vesicle; so that, if present, it must have been quite small. The germ-basis (Pl. XXIV. *Fig.* 8, *f*) occupies the cavity of the disk from a very early stage, and originates in the same way as in Parypha and Thamnocnidia. When the medusoid has reached about two thirds of its size, the germ-basis (*Fig.* 14, *f*), which heretofore has been colorless, assumes a dingy yellow color, which, with increasing age, grows darker, until the germ-masses begin to separate from it (*Fig.* 15, $f\ f^1$). The manner in which these masses separate from the germ-basis is altogether different from the regular process of self-division, as may be seen from a sectional view (*Figs.* 15 and 17). At first, the furrows are few (*Fig.* 15), and, probably, always begin at the distal end of the basis; nor do they appear to trend in any particular direction, in preference to another, but take their course as often obliquely, as transversely or longitudinally with the proboscis. In time, the whole basis becomes cleft, to at least half its depth (*Fig.* 17), by numerous anastomosing furrows, and then it has all the appearance of a normally self-dividing, single germ (*Fig.* 16). The number of the resultant segment-masses amounts to at least fifteen or twenty, and, after the separation of these, a few more are produced by the residual basis; so that, in all probability, as many as thirty germs are successively developed in one parent medusa. The earliest separated germ-masses are the first to develop, but as they could not all grow, with like rapidity, to their full size, within the restricted cavity of the disk, it becomes a necessity which amounts to a law, that some one or two of them shall precede the others (*Fig.* 18, $f^1\ f^2$), and as these come to maturity (Pl. XXVI. *Fig.* 3), and leave the parent, to lead an independent life (*Figs.* 1 and 2), another set takes their place, and then another after these, and so on successively (Pl. XXIV. *Figs.* 19, 20, 21, 23, 24, and 22), till the whole of the germ-basis is exhausted, and the proboscis (*Fig.* 22, *d*) is left uncovered. As the germs leave the basis, they lose the yellow tint of the latter, and become colorless. Their mode of development is the same as we have described in Parypha (Pl. XXIII. *Figs.* 21, 22, 23, 24, 25, and 26, p. 254), and therefore need not be repeated here.

A short time before birth the young hydroid is endowed with a horny sheath, like that of Parypha (Pl. XXIII. *Fig.* 14^a, *c*); but in Tubularia we have been able to trace it, not only to the base of the head, but even to the tips of the tentacles of the crown (Pl. XXVI. *Figs.* 1 and 2, *b*) and of the proboscis (*c*). On the stem of the hydra, it is as thick as in Parypha (XXIII. *Fig.* 14^a, *c*); but at the base of the head it thins out suddenly, to a very thin, and yet distinct and measurable, film, in which state it covers the whole head and tentacles.[1] At birth there are from ten (Pl. II. *Figs.* 1 and 2, *b*) to fourteen tapering coronal tentacles, and from eight to twelve proboscidal tentacles (*c*); the latter are mere papillæ, and constitute nothing more than a crenulate edge to the mouth. The spermatic particles are similar to those of Parypha (Pl. XXIII. *Fig.* 16).

Proles medusoidea. — The mode of development of the medusa of Tubularia Couthouyi is, with one single exception, identical with that of Thamnocnidia spectabilis; we may, therefore, after pointing out the difference, refer the reader to the embryology of the latter genus for further details. In Thamnocnidia the inner wall (Pl. XXII. *Figs.* 1–8) rises as a solid layer, and, in time, forms a uniform lining (*Fig.* 8^a, *b*) to the inner surface of the outer wall (*Fig.* 8^a, *a*), whereas, in Tubularia Couthouyi, as the inner wall rises, it is channelled (Pl. XXIV. *Figs.* 8, 9, 10, 11, 12, and 13) in the same way, as we have fully described in Coryne mirabilis (Pl. XVIII. *Figs.* 4–12, p. 192). In the last period of the breeding season of Coryne, the male medusoids (Pl. XVII. *Fig.* 11, *n r*) of this genus bear a strong resemblance to the males (Pl. XXIV. *Fig.* 13) of Tubularia, and might easily be mistaken one for the other.

Histology. — All that we have to say of the histology of Tubularia has reference to the stem. The outer wall (Pl. XXIII^a. *Figs.* 8 and 9, *b*) is about one five hundredth of an inch thick, and consists of a mass of moderate sized, polygonal cells, which are disposed in an irregular manner throughout the thickness of the wall. On an average, they are about one four thousandth of an inch in

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[1] The alcoholic specimens of Tubularia indivisa sent to us by Sars, happen to be full of young, which, upon examination, we find to possess a horny sheath, to all appearances identical, both in proportions and extent, with that of our American Tubularia Couthouyi.

diameter, and perfectly clear and homogeneous throughout, even to the absence of a mesoblast. What may be, perhaps, called the inner wall proper (*Figs.* 8, *d*, and 9, *d* d^1), is a double layer of very large, irregularly polygonal cells, each one of which is nearly filled by a dense mass of dark granular matter (*Fig.* 9, *d* d^1). Their distal ends, in the exterior layer, are more or less flattened, and conform to the outlines of the cells of the outer wall (*b*); the proximal ends of those of the inner layer (*d*) conform to the outlines of the large cells (*g*), which fill the centre of the stem. These great cells are very different in appearance and contents from those of the double layer which we have just described; some of them, especially those nearest the centre of the stem, are one one hundredth of an inch in diameter; they are perfectly hyaline, and, adding to this their sharp polygonal outlines, they have a marked crystalline appearance. Each cell has a single, discoid, homogeneous mesoblast (g^1 g^3), which lies close against the wall.[1] The outlines of these cells are gently curved, and form a continuous smooth surface, from one to the other, where they border upon the longitudinal canals. The horny sheath (*Figs.* 8 and 9, *a*) possesses very fine concentric laminæ.

SECTION V

THAMNOCNIDIA SPECTABILIS *AG.*

Proles hydroidea. Adult. — The description already given of the habitat, the mode of life, the general form, the separate sexes, the head with its proboscis, the tentacles and the bunches of medusoids, the stems and their mode of branching, the horny sheath, the walls of the head and stem of Parypha crocea, apply equally to this Hydroid, with the following exceptions. The horny sheath (Pl. XXII. *Fig.* 16, b^1) is quite uniform and smooth as far as it covers the stem above its base, and is a very little narrower below than above; but the entangled mass of the base is perhaps more dense than in Parypha. The medusoids have been observed to be present as early in summer as those of Parypha, but they have been seen much later in the autumn. This difference, however, may be only apparent; perhaps because the two genera were not always collected at the same time; at least we have no notes indicating that they were. As the various shapes which the proboscis and its tentacles assume in Parypha were not described, but only stated to be identical in that genus and in Thamnocnidia, we will now give

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[1] The mesoblasts which are represented in this figure all belong to the cells nearest the eye.

a full account of them here.[1] The head of this Hydroid is capable of assuming a great variety of shapes; but most frequently, especially when the animal is in its native haunts, it assumes an extremely extended condition, with its crown of tentacles, the proboscis and buccal tentacles, and the bunches of medusoids stretched to the utmost (Pl. XXIII. *Fig.* 1^b).[2] The buccal tentacles, when fully extended (Pl. XXIII. *Fig.* 1^b, *t*), are as long as the proboscis (*p*) from the base to the mouth, and very slender and tapering; yet they may at another time be so contracted as to resemble mere protuberances, hardly, if at all, longer than broad (Pl. XXII. *Figs.* 19 and 23, t^2). Between these two extremes there are all grades of length and breadth, as may be seen by referring to our figures. The lower circle of tentacles presents as great a variety of attitudes as the upper one. When the tide flows rapidly, they are usually stretched out in the direction of the current, and seem to undulate with every passing ripple; in still water, however, they are more active, and more apparently under the control of the animal. At one time they are thrown upwards, with a sudden sweep, as if to embrace an intrusive animal (Pl. XXII. *Fig.* 22, *t*), and quickly contracted, and then concentrated about the mouth, along with the buccal tentacles (t^2). On such occasions they very frequently become globular at the tips, so that they might readily be supposed to retain this shape normally.[3] At the next moment, perhaps, the captured creature, proving to be unpalatable, is rejected with as much readiness as it was seized, by throwing back the crown of tentacles (*Figs.* 25 and 28, *t*), and disclosing the interior of the stomach (t^4), with a sudden and sometimes often repeated gaping. Sometimes the contractions of the proboscis (*Fig.* 26, p^1) are so vigorous, and the buccal tentacles (t^2) are laid together so evenly and compactly, that the whole is reduced to the smallest possible space, with nothing to indicate the presence of the tactile organs, but the longitudinal ridges, which extend nearly down to the disk. Again, the larger tentacles, retaining their taper points, simply shorten and thicken transversely (*Fig.* 20, *t*), and, turned either inwards or outwards (*Fig.* 19, *t*), retain a fixed position, while the proboscis swells up into a globular shape (*Fig.* 20, *a*), and at times constricts into two more or less distinctly-defined portions (*Fig.* 19, *a b*). In this last phase the hydroid appears to be in a highly irritated state,

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[1] The two species of Thamnocnidia, Th. spectabilis and tenella are identical in every respect, excepting size and the mode of branching, the latter species being considerably smaller than the former, and branching very openly and loosely, and therefore the illustrations of one will be used reciprocally for the other.

[2] The figure here referred to was drawn while the animal was in an upright position, in order to allow the bunches of medusoids to fall back from the proboscis.

[3] If thrown into alcohol in this condition, they would very naturally be described as club-shaped, if they were studied from preserved specimens alone, as may happen in case of specimens brought home from distant expeditions.

and the fluid contents of the stomach circulate very rapidly, a phenomenon which, owing to the transparency of the distended walls, may be seen very readily. As an opposite extreme to this, the proboscis stretches out till it equals in length the greatest extension of the discal tentacles (*Fig.* 16, p^1), and is as slender as the thickest part of the stem.

Proles medusoidea. — The full-grown medusoid is a very simple, double-walled body (Pl. XXII. *Fig.* 14), with a thick proboscis (*e*) projecting half way or less into its cavity, while at the opposite end, around the lower edge of the disk, are three or four solid, short, and rather unshapely tentacles (*f*). Excepting the tentacles, the whole structure of the medusoid is almost identical with that of Parypha crocea, even to the absence of radiating and circular chymiferous tubes. As it produces only two or three young, it is seldom distended in a lateral direction, as in the latter genus, but usually presents an elongated form (*Figs.* 13 and 14), produced by the efforts of the young to push their way out through the actinal opening of the disk.

Embryology. Proles hydroidea. — The description of the development of the young hydroids of Parypha crocea, up to the time when the tentacles have assumed an oblong shape (Pl. XXIII. *Fig.* 13, e^3), applies perfectly well to Thamnocnidia, and therefore needs not be repeated here. Beyond this, however, there are certain differences, not so much of structure as of form, in their relation to the parent body, which require special notice. Owing to the small number of the embryos, there being only two or three produced by each medusoid, and to the fact that they are developed consecutively, each young hydroid (Pl. XXII. *Fig.* 12, *st*) occupies a large proportion of the cavity of the disk. There is, however, one remarkable feature in regard to the position of the young in the parent, which at once distinguishes this genus from Parypha, namely, that from a very early period the young is frequently, if not always, fitted like a cap over the end of the proboscis (*Fig.* 12, *d* d^1), or rather over the germ-basis (*e*) which covers the proboscis. In this position the base (*st*) of the young hydroid occupies the region near the opening of the disk of the parent medusoid, and the tentacles (*te*) embrace the base of the proboscis (*d*). From this time forward, the development of the embryo is very rapid. The mass of the body forming the cap to the proboscis, becomes proportionally smaller (*Fig.* 13, *st*) and constricted just behind the base of the tentacles (*te*). This part constitutes the stem. The proboscis first appears in the form of a broad, conical protuberance (*te*), within the circle of tentacles, while the latter become simply elongate and tapering to a blunt end. In the mean while the proboscis of the medusoid, with its covering, the germ-basis (*e*), retracts from, or rather is pushed out of its cap-like socket by the protruding proboscis of the hydroid. After this the embryo seems actually to grow larger, while the stem (*Fig.* 14, *st*) becomes a little longer than broad, the proboscis

(p) more sharply conical, and the tentacles (te) at least three times as long as the transverse diameter of the base of the head, and slightly swollen at the tips. In this condition it escapes from the parent, and after creeping about for a while, settles down upon its stem, expands its tentacles (*Fig.* 15, t) and its hitherto unseen mouth (t^4), and five, six, or seven buccal tentacles (t^2). The number of discal tentacles, at the birth of the young hydroid, varies from seven or eight to eleven. At first, they are rather crooked and rough (*Fig.* 15, t), but very soon they assume the smooth contour of the adult, but retain their four-sided shape, as described in the young of Parypha (p. 254). In regard to the walls of the body and the tentacles, the details of the mode of escape from the parent, and the appearance of the last portion of the germ-basis, we may refer to Parypha crocea. There is a wide difference between the degree of development to which the several embryos, in one and the same parent, have arrived; one of them (*Fig.* 14, st) may be just escaping from the medusoid, whilst another is a mere irregular, spherical mass (e^1), without any traces of organs, and yet there still remains, clinging to the proboscis, enough of the germ-basis (e) to form a third individual.

Proles medusoidea.—We have already pointed out, on the preceding page, the identity in the mode of development of the earliest stages of the medusoids of Parypha and Thamnocnidia, and, therefore, need not repeat these descriptions here. After the inner wall (Pl. XXII. *Fig.* 2, b b^1) has become deeply cup-shaped, there arises a difference between these two genera, in their mode of growth. In Parypha the proboscis (Pl. XXIII. *Fig.* 6, d) arises from the base of the cup, before the edge of the latter has reached the extreme of the bud; whereas, in Thamnocnidia, the edge of the cup, having followed the inner surface of the exterior wall (Pl. XXII. *Fig.* 3, a), and finally arching over and uniting its constricting lip, has formed a continuous inner wall (b), as soon as the proboscis begins to rise in the guise of a broad, low papilla (d). In this way the germ-basis (e) is withdrawn from contact with the outer wall (a) and shut up within the interior wall (b) and its continuity, the single transverse wall (d) of the proboscis. Soon after this the medusoid begins to broaden (*Figs.* 4 and 4^a), and assumes a globular shape, and the proboscis (d) gradually pushes its way into the mass of the germ-basis (e), while the latter, at the same rate, assumes a deeper and deeper concavo-convex form, and becomes a cap to the former. Up to this time, the wall of the proboscis (d) has maintained a pretty uniform thickness, about equal to that of the inner wall (b); but subsequently it shows considerable variation in this respect, probably owing to the different degrees of contraction in which it may be at various times. Sometimes the wall (*Fig.* 5, d) swells till its cavity (c) is nearly obliterated, and soon, again, it extends its peripheric dimensions at the expense of its thickness (*Fig.* 6, *d*). After this, the inner wall (*Fig.* 8^a, *b*) of the disk, which hitherto has maintained a thickness equal to that of the outer wall, ceases to grow so rapidly as the latter (*Fig.* 8^a, *a*), and, about this time, the walls of the area, around the future aperture of the disk, rise in the form of papillæ (*Figs.* 8 and 8^a, *f*), varying from two to four in number. The papillæ are, homologically, the tentacles, although they do not ever seem to perform the office of such organs, even when most fully developed. In some medusoids unmistakable signs of a greater age than this may be discovered, and yet the tentacles have not begun to develop. Thus, in certain individuals, the germ-basis (*Fig.* 7, *e*) has changed to the characteristic yellow color of the later stages, but there are no tentacular appendages on the disk. The individual figured is an instance of the plasticity of the medusoid, which, at times, may be seen very much elongated, and then, again, concentrated upon itself in a globular form. The subsequent development of the medusoid consists in the elongation of the tentacles (*Figs.* 9–14, *f*) and the diminution of the thickness of the inner wall of the disk, until it appears like a mere filmy epidermis upon the interior of the outer wall, and, unless highly magnified, cannot be seen. On this account the disk appears to have only a single wall in the figures (*Figs.* 9–14) representing the later and last phases of growth. Owing to the dense red pigment granules, which collect in large numbers along the sides, and especially at the tip (*Figs.* 8, 9, and 10, *d*) of the chymiferous cavity of the proboscis, the whole medusoid is pervaded by a delicate pink tint, which, when seen in a certain light, combines with the yellow color of the germ-basis to form an orange hue. The mouth of the disk is formed very late, probably not until the young is just ready to leave the parent.

Thamnocnidia tenella *Ag.* *Proles hydroidea.* *Adult.* — Although this species agrees so closely, in nearly all its details, with T. spectabilis, it has a very different habitat; it is never found, with its congener, in brackish water, but always in the open ocean, among rocky pools. It is a very delicate, graceful animal, and much the smallest of our Tubularians, having about half the size of T. spectabilis or Parypha crocea. It branches very irregularly, loosely, and openly (Pl. XXII. *Fig.* 21), with a stem of uniform thickness throughout, about as large as a common sewing needle, or, to be more exact, one fiftieth of an inch in diameter. The medusoids have been observed in January, July, August, and December, but the young hydroids were only seen escaping from the parent during the months of July and August.

VanBeneden has given a very incorrect account of the reproduction of the Tubularians, in his paper on the Embryology of these Hydroids. According to his representation, the medusoids, after freeing themselves from their parent stock, attach themselves to submarine bodies, and grow up into new hydroids. This is contrary to all my observations. The medusoids actually produce a number of hydroids which become attached, but they themselves soon afterwards die.

SECTION VI.

CORYMORPHA PENDULA *AG.*

The hydroid.—This Hydroid is not found along our shores, as are the other Tubularians, but may be obtained by dredging in deeper water, on a sandy or muddy bottom. In some localities it is quite plentiful. It has been collected in three different places, all within Massachusetts Bay; namely, at Beverly, in September, 1847; off Nahant, by Mr. Wm. Stimpson, who says that it is very plenty about three quarters of a mile, due east, from East Point; and, within a few days, we have received two living males from Cape Cod. From these last, we have drawn all the details of structure mentioned in this section; those observed in 1847 having died while they were drawing.

The natural position of this Hydroid is an upright one, with its branching base buried in the sand. The prevalent color is a clear, bright pink. Like the European Corymorpha, our species always appears in single individuals, and never branches. It grows to a height of at least four inches, and the stem has a diameter of one quarter of an inch at the thickest part, and gradually tapers, both upwards and downwards. At the base it tapers to a point, but above it diminishes to about one half its greatest diameter, and then expands into the cup-shaped base of the head. The head, which is more or less pendulous, consists of a cupuliform base (Pl. XXVI. *Figs.* 8 and 8^a, b^1), from the edge of which arises a single row of uniformly tapering tentacles (t), above which projects a broad proboscidal organ (a), the terminal third of which is closely set with moderately long, tapering, indiscriminately arranged tentacles (t^1 t^2). At the base of the proboscis, there are groups of medusæ (d), arranged on branches, in the same manner as in Tubularia proper, and bearing a strong resemblance to those of the latter genus; in fact, with a low magnifying power the male medusæ of Corymorpha could hardly be distinguished from those of Tubularia (Pl. XXIV. *Fig.* 5, d), but when we study the details of their organism the resemblance ceases. In the younger stages of growth (Pl. XXVI. *Figs.* 7, 8, and 8^a), the coronal tentacles (*Fig.* 8^a, t t^3 t^4 t^5) are quite unequal in size; nor does this inequality cease altogether in the full-grown hydroid, but it does not prevail to so great an extent as in the earlier period of development of these organs. The horny sheath is quite conspicuous from the base upwards to about one third the height of the stem, but from this point it either disappears altogether, or exists as a mere film (*Fig.* 8, b^4 b^5) over the upper part of the stem and on the head. The lower, pointed base of the stem, is not so simple as might at first be supposed. The question naturally arises, whence are derived the numerous filamentary rootlets of the horny sheath? and, upon close examination, we find that the lower fifth of the stem is covered by small processes, varying from mere papillæ above, to extremely elongate filaments at the end of the stem. These processes excrete the filamentary rootlets of the horny sheath, and may be traced to the finest terminations of the latter. They are hollow, and are permeated by prolongations of the chymiferous tubes of the stem.

Before proceeding to describe the details of the different organs of this Hydroid, we would say a word in regard to the attitudes which it assumes from time to time. Owing to the flexible, plastic nature of the horny sheath, and also to its distensibility, the stem of this Hydroid is capable of assuming almost any form, without restraint. At one time we may see it swollen to its fullest extent, from top to bottom, with the head nearly erect, and, perhaps, in a few minutes, the whole aspect is changed, and the stem is contracted to one fourth, or even to one sixth, of its former diameter, when it is sometimes very much elongated, though it may also contract without elongating. At other times the upper part of the stem becomes quite slender and elongated, and the head droops to a greater or less degree (*Figs.* 7–17). The proboscis also shares largely in these changes, but, in this respect, it does not differ from the proboscis of other Tubularians, except, perhaps, in the extent of its changes; at one moment it has a globular form (*Fig.* 9), and soon afterwards assumes the opposite extreme, and hangs suspended by a slender neck (*Figs.* 13 and 14). Between these extreme limits of its plasticity it assumes, at intervals, numerous other forms, a few of which we have reproduced among our illustrations (*Figs.* 7–17).

An examination of the stem from the outside, already leads us to suspect that it has a structure similar to that of Tubularia; but we notice that, in addition to the longitudinal tubules (*Fig.* 8, b^4), about thirty in number, which extend along the whole length of the stem, there are, in the lower half, transverse communications from one tubule to the next on either side. These transverse channels are very simple about the middle region of the stem, but lower down they are irregular in their course, and communicate with each other as well as with the longitudinal tubules; and at the base of the stem the longitudinal tubules become very irregular in their course, and reduced in size, so that they cannot be distinguished from their transverse connections, with which they form an irregular network. Now, upon making a transverse section of the stem, we find that it consists of a spongy mass of very large cells, whose interstices are permeated, in every direction, by prolongations from the peripheric longitudinal tubules. The universal permeation of these irregular interstitial chymiferous lacunæ, among the enormous cells of the core, at once explains the great distensibility and contractility of the stem.

The medusoid. — The medusæ-buds of this Hydroid do not become free individuals, but, remaining attached, develop their generative material, and then wither and die. The form of the bunches of medusæ, and their manner of attachment to the base of the proboscis of the hydroid, is the same as in Tubularia (Pl. XXIV.); and the mode of development of the walls of the disk and proboscis, and of the radiating and circular tubes, is also the same as in that genus. The figures of the early stages of the medusoid of Tubularia, on Pl. XXIV., can hardly be distinguished, either in form or color, from those of our Corymorpha, and if we were to elongate one of the four corners of Pl. XXIV. *Fig.* 13, which represents the male medusa of our Tubularia, into a thick tentacle, about half as long as the disk, and place, on the outer surface of the bell, over each radiating tube, a narrow longitudinal band of enormously developed cells, we should have a medusa of Corymorpha pendula. The proboscis, in our specimens, which are males, is capped by an enormous, dusky yellow, spermatic mass, which completely fills the disk, and at times projects through the aperture to a considerable extent. When fully ripe, the spermatic mass has a dead white color, and the medusa is only a little more pointed than that of Tubularia, as represented in Pl. XXIV. *Fig.* 5.

SECTION VII.

THE PENNARIDÆ.

PENNARIA GIBBOSA *Ag.* — Though generally referred to the family of Tubularidæ, the genus Pennaria constitutes a distinct family,[1] to which a few other recently

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[1] References to the Pennaridæ.

Pennaria, Goldfuss, 1820, Handbuch der Zoologie, p. 89. (Pennaria, Oken, 1815. = Amathia, Lamx., 1812. = Serialaria, Lamk., 1816, a Bryozoön.)

" Milne-Edwards, in Lamk. An. Sans Vert., 2d ed., 1836, Vol. II. p. 161, note.

Pennaria, Kölliker, Zeitschrift fur Naturwissenschaft, 1853, Vol. IV. p. 303.

" McCrady, Proc. Elliot Soc., Charleston, S. C., 1858, p. 50.

" Sars, Nyt. Mag., 1856, p. 156.

" Ehrenberg, Corall. Königl. Akad. Wiss., Berlin, 1834.

described genera also belong. This Hydroid may be very readily recognized by its remarkable, feather-like form (Pl. XV *Figs.* 1 and 1ª). The main stem (*Fig.* 1, *a*) rises from its stoloniferous basis with a long and gentle curve (*Fig.* 1ª), which extends to its extreme, free end; it does not, however, trend strictly in the plane of the general curve, which it simulates, but follows it in a slightly transversely zigzag course, giving off a branch at every bend. Obliquely transverse to the plane of this curve, the branches (*c*) arise, alternately on each side, at regular intervals of about one twelfth of an inch, and bend in curves similar to that of the main stem, but more abrupt, and uniformly in the same plane. The angle at which these branches project from the main stem has a twofold relation; it subtends about fifty degrees from the main stem, on the convex side of its curve, and about forty-five degrees from the plane of this curve. Both the main stem and its branches taper gradually from base to apex. At regular intervals, of one twelfth of an inch, on the convex side of the branches (*Fig.* 2, a to a^2), and in one series, arise the peduncles (a^4) of the individual hydræ (C D E F G). Unlike the main stem and branches, each peduncle, being about one twelfth of an inch long, expands gradually, from the base upwards, and bears on its broadened extremity a single Tubularia-like hydra, each one of which, going from the base of the branch toward the tip, is successively smaller than the preceding (G F E D C). The tip (a^2) of the branch also expands, like the peduncles, and bears a single hydra (B), which is much larger than any of those on the peduncles. The same feature is very prominent at the extremity of the main stem (*Fig.* 1, *d*). By these characters the genus Pennaria may be distinguished from all others at a glance.

It remains now to describe each feature in detail, so far as we may be prepared to do so, by a few hours study of the living animals, and by the examination of

Sertularia pennaria, Cavolini, Mem. Polypi Marini, 1785, p. 134, Pl. V. *Figs.* 1–6.
" " Cavolini, Transl. Sprengel, 1813, p. 61, Pl. V. *Figs.* 1–6.
" " ? Linnæus, Syst. Nat., 1767, 12th ed., Tom. 1, p. 1313, No. 26.
" " Gmelin, Lin. Syst. Nat., 1788, p. 3856, No. 26.
" " Oken, Allgemeine Naturg., Bd. V., 1835, p. 77.
" " Bosc, Hist. des Vers, 1830, 2d ed., Vol. III. p. 119.
? *Aglaophenia*, Lamour., Bulletin Soc. Phil., Paris, 1812, p. 184.
? *Aglaophenia*, Lamour., Hist. Polyp. Flexibles, 1816, p. 167.
Plumularia, Blainville, Dict. Sc. Nat., 1830, Vol. LX. p. 442.—Manuel Actin., 1834, p. 477.
Globiceps, Ayres, Proc. Boston Soc. Nat. Hist., 1852, IV. p. 193. Name preoccupied, for an Hemipterous Insect, by Lepelletier and Serville, Encyc. Méthod., X., 1825.
Eucoryne, Leidy, Jour. Acad. Nat. Sc., Philadelphia, 1855, Vol. III. Pl. X. *Figs.* 1–5. Name preoccupied, for a Coleopterous Insect, by Schönherr, Disposit. Method., 1826.

alcoholic preparations brought home from Key West, in Florida, where our species is common upon the pillars of the wharves, in the harbor of that place.

The main stem, which is of a very dark brownish-purple color, rises to a height of at least four inches, and at its base is as thick as a common-sized pin. The root-like stolon is a little thinner than the main stem, and is perfectly smooth, but more or less contorted. The base of the stem is endowed with eight, ten, or twelve narrow rings, closely set together, without any intervals; and the two or three succeeding intervals, just above the origin of the branches, are ringed by several constrictions, but above these each interval has generally only three rings (*Fig.* 2, A^1). The branches (*Figs.* 1, *c*, and 2), which are about half as thick as the main stem, have from three (*Fig.* 2, *a*) to ten or twelve closely set rings at the base (just beyond the origin of each peduncle they have only three (a^1)), and finally terminate in a peduncle-like expansion (a^2), which is made up of from four or five to nine rings. The peduncles (a^4) of the hydræ are closely ringed from base to tip; each successive ring being larger than the preceding, and numbering in all from fourteen to twenty. The base of the peduncles is about one fifth as thick as the branches from which they arise, and the tip of the same has twice this diameter.

The hydræ, which terminate the ringed peduncles, the branches, and the main stem, are Tubularioid in character, but remind one of Coryne. Imagine the head of a Coryne, with its globe-tipped tentacles, contracted upon itself (Pl. XVII. *Fig.* 6), with a collar of a dozen tapering tentacles, strung around the base in a single row, and we have the hydra of Pennaria. The crown of tentacles, numbering twelve in all, arises from the tip of the peduncle, without any intervening disk, and spreads its tapering members (*Fig.* 2, *t*) equally, all around the base of the head. These tentacles do not come to a point like those of Clava and Hydractinia, but round off, very much in the same way as in Tubularia and other closely allied genera, with an obliquely rounded, slightly globular tip. The head (p p^1), which rises from the circle of tentacles, has a remarkable, elongate-ovate shape, bulging to such an extent, on the side (p^1) facing toward the main stem, as to render it strongly gibbous (B D E F G); a feature hitherto unnoticed among Hydro-medusæ. The oral end (*m*) tapers, very much after the fashion of a champagne bottle, and is covered by numerous short, globe-tipped tentacles, varying in number, according to the age of the individual, from three or four to thirty-two (D E F G B), and arranged in a spiral combination, similar to what we have described in Coryne. At the base of the gibbous head, and just within the collar of slender tentacles (*t*), the medusæ (d–d^4) bud forth, each one rising directly from the parent, on a short stem (*b*). We have not seen more than three or four of these, at one time, on any individual head.

The mode of growth of the main stem and branches is simply this; the main stem, carrying its great terminal individual (*Fig.* 1, *d*) continually onward from the beginning, gives off, alternately right and left, a branch, which, at first, bears only a single hydra of the largest kind (*Fig.* 2, B). The main stem continues to give off branches in this manner, while each branch, carrying outward its great terminal hydra, gives off, always on its upper side, and in one line, a succession of pedunculated individuals (G F E D C), in such a manner that the youngest is always next to the end of the branch. In consequence of this mode of growth, the lowest branches are the longest, and bear the greatest number of individuals, while those above are successively shorter; but it is very seldom, and owing to accidents, as examination of the branches shows, that a perfect specimen, illustrating the whole succession of individuals as they originally budded forth, can be found. We have counted as many as twelve individuals on one branch; but, inasmuch as the branch was broken off at the top, and, moreover, sprang from the main stem at the sixteenth interval from the base, we may safely infer that the lowest branch bore twenty or twenty-five individuals. The branches themselves give off secondary branches, as the third branch from the base in *Fig.* 1 shows; but how extensively this occurs, we have not ascertained. Since, however, the cases observed were isolated, the lower branches of the main stem remaining simple, we suspect that this sort of secondary ramification is only an occasional phenomenon.

The medusa. — The oldest medusa which we have observed had an oval oblong figure (*Fig.* 2, G, d^3), and measured about one twelfth of an inch in length. It had a large proboscis (f), similar in shape to itself, and was nearly half as long. At four equidistant places, a radiating chymiferous tube (h) diverged from the base of the proboscis, and terminated in a circular tube (e^2) at the edge of the disk. What seemed to distinguish this medusa from all other Medusæ, among the Tubularians, was the position of the ovaries (e e^1), which, instead of being on the proboscis, were near the peripheric, or outer end, of the chymiferous tubes; these organs were, however, not so far developed as to show their sexual character, and may be only specialized cells, as in Zanclea. They occupied about one third of the length of the tube, and had an elongate oval, or fusiform shape. There were also four globular, papillate tentacles (g), like those of Zanclea, one of which stood opposite the end of each radiating tube. The disk was perfectly transparent, and free from the red, granular, longitudinal lines, which ornament the surface of some of the Tubularioid medusæ.

In another chapter it will be shown, that the Hydroids described by Ayres and Leidy, under the names of Globiceps and Eucoryne, and by McCrady, under the name of Pennaria, are very closely allied, but not generically identical with Pennaria, though belonging to the same family.

CHAPTER FIFTH

THE GENUS EUDENDRIUM OF EHRENBERG

SECTION I

REMARKS ON THE HYDROIDS REFERRED TO THE GENUS EUDENDRIUM AND THEIR FREE MEDUSÆ.

I ASSOCIATE here a number of genera,[1] the free medusæ of which have been supposed to originate from Hydroids belonging to one and the same genus, called

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[1] References to Eudendrium, Lizzia, Hippocrene, Bougainvillia, and allied genera. The queries express doubts respecting the generic identity of the species quoted.

EUDENDRIUM *Ehr.*

Eudendrium, Ehrenberg (not VanBeneden), (E ramosum. = *Tubularia ramosa* Lin.; E. racemosum. = *Sertularia racemosa* Cavolini), Corallenthiere, Verhdl. Königl. Akad. Wiss., Berlin, 1834, p. 72.

" Johnston (E. rameum = *Tubularia ramea*, Pallas; E. ramosum = *Tubularia ramosa*, Linn.), British Zoöphytes, 2d ed., 1847, p. 45.

" Sars (E. racemosum = *Sertularia racemosa*, Cavolini), Nyt Mag. for Naturvid., 1856, p. 154.

Eudendrium, Alder (E. capillare = E. rameum [and ramosum?], Johnston), An. Mag. Nat. Hist., Nov., 1856, p. 355.

" Alder (E. rameum, ramosum, and capillare), Cat. Zoöph. North., 1857, p. 13.

" McCrady (E. ramosum), Proc. Elliot Soc., Charleston, S. C., 1858.

" Wright (E. rameum), Edinb. New Phil. Jour., 1859, Vol. IX. p. 108.

" Wright (E. rameum), An. Mag. Nat. Hist., 1861, VIII. p. 125.

Corallina tubularia gracilis, & ramosa, axillis rumulorum contortis, Ellis, Corallines, 1755, p. 31, Pl. XVII. *Fig. a*, A, (? Pl. XVI. *Fig. a*).

Tubularia ramosa, Ellis and Solander, Zoöphytes, 1786, p. 32. Ovaries placed in a circle round the lower part of the heads.

Eudendrium by Ehrenberg, but formerly united with Tubularia. It will, however, appear in the sequel, that there are marked differences, not only between these

Tubularia ramosa, Linn. (“ Ellis, Corall., 31, t. 16, *Fig. a*, t. 17, *Fig. a*, A”), Fauna Suecica, Ed. altera, 1761, p. 539, No. 2229.

“ *trichoides*, Pallas, Elenchus, 1766, p. 84, No. 41.

“ *ramosa*, Linn., Systema Nat., 1767, 12th ed., p. 1302.

“ “ Gmelin, Lin. Syst. Nat., 1788, p. 3831.

“ “ Turton, Brit. Fauna, 1807, p. 210.

“ “ Lamouroux, Bull. Soc. Phil., Paris, 1812, p. 184.

“ “ Lamouroux, Polypiers Flexibles, 1816, p. 231.

“ “ Lamarck, Animaux sans Vert., 1816, p. 110.

“ “ Fleming, British Animals, 1828, p. 552.

“ “ Bosc, Hist. des Vers, 2de éd., 1830, III. p. 89.

“ “ Blainville, Dict. Sc. Nat., 1830, Tom. 60, p. 435.

“ “ Blainville, Manuel d’Actinologie, 1834–1836 (see p. 687 for the date), p. 470.

“ “ Milne-Edwards, Lamk. An. sans Vert., 2de éd., 1836, II. p. 126.

“ *ramea* and *ramosa*, Johnston, Brit. Zoöph., 1st ed., 1838, p. 116.

ramosa, Gould, Report on the Invertebrata of Massachusetts, 1841, p. 350.

“ *ramea*, Dalyell, Rare and Remarkable Animals, 1847, Vol. I. p. 50, Pls. VI.–X.

Fistularia ramosa, Müller, Prodromus Zool. Danicæ, 1776, p. 254.

? *Fistulana ramosa*, Fabricius, Fauna Grœnland., 1780, p. 441.

Sertularia racemosa, Cavolini, Polipi Marini, Mem., 1785; and translated by Sprengel into German, 1813, Pl. VI. *Figs.* 1–7.

“ “ Gmelin, Lin. Syst., 13th ed., 1788, p. 3854.

“ “ Lamouroux, Hist. Polyp. Flexibles, 1816, p. 195.

“ *ramosa*, Blainville, Dict. Sc. Nat., 1830, Tom. 60, p. 445.

“ “ Blainville, Manuel d’Actinologie, 1834–1836 (see p. 687), p. 480.

Campanularia (*C. racemosa* = *Sertularia racemosa*, Cavolini), M.-Edwards, in Lmk. An. sans Vert., 2de éd., 1836, p. 134.

Calamella (*C. trichoides* = *Tubularia trichoides*, Pallas = *T. ramosa*, Linn.), Oken, Lehrbuch, 1815, III. p. 55.

? *Thoa* (*T. Savignii* = *Tubularia ramea*, Pallas, fide Lamx.), Lamouroux, Hist. Pol. Flex., 1816, p. 210, Pl. VI. *Fig. a*, B C. (*Thoa Halecina* = *Halecium*, Oken).

“ “ Lamouroux, Exposition Méthod., 1821, p. 14, Pl. LXVII. *Figs.* 5 and 6.

Corymbogonium (*Eudendrium capillare*, Alder), Allman, Annals and Mag. Nat. Hist., 1861, VIII. p. 171.

? *Corythamnium* (*Eudendrium bacciferum*), Allman, An. Mag. Nat. Hist., 1859, Vol. IV. p. 52.

HIPPOCRENE *Mertens*.

Hippocrene, Mertens, Brandt, Prod. Descrip. Anim., 1835, p. 29.

“ Mertens, in Brandt, Mém. Acad. St. Pet., 6th ser., II., 1838, p. 392.

“ Forbes, An. Mag. Nat. Hist., 1841, VII. p. 82, Pl. I. *Fig.* 2.

Hydroids, but also between the free medusæ described under the names of Lizzia, Hippocrene, Bougainvillia, etc., the origin of which has been traced to Hydroids

Hippocrene, Agassiz, Mem. American Acad., 1849, p. 250, Pls. I. II. III.
" McCrady, Proc. Elliot Soc.. Charleston, S. C., 1858, p. 61.
Bougainvillia, Lesson, Annales Sciences Nat., 1836, Vol. V. p. 262.
" Lesson, Voyage de la Coquille, Tom. 2, Part II. 2d Div., 1838 (*Cyanea Bougainvillii*, Pl. XIV. *Fig.* 3, Atlas du Voyage, 1826).
" Lesson, Hist. Nat. Zooph. Acal., Suites à Buffon, 1843, p. 290.
" Forbes, Brit. Naked-eyed Med., 1848, p. 61, Pl. XII. *Figs.* 1 and 2.
" Wright, Edinb. New Phil. Journal, 1859, Vol. IX. p. 108, Pl. I. *Figs.* 1 and 2.
Geryonia, Blainville, Manuel d'Actinologie. Nouvelles additions, p. 662, 1836 (for date see p. 687).
Medusa ocilia, Dalyell, Remark. Animals of Scotland, 1847, Vol. I. p. 66, Pl. XI. *Fig.* 10, &c.
Eudendrium, VanBeneden (non Ehrenberg) (*E. ramosum*, exclus. synonomy), Nouv. Mém. Acad. Bruxelles, 1844, XVII. p. 55, Pl. IV.
" (VanBeneden, non Ehr.) Gegenbaur (*E. ramosum*), Carus Icones Zoot., 1857, Pl. II. *Figs.* 3 and 4, and description.
Tubularia ramosa (non Linn.), Dalyell, Remark. Animals of Scotland, 1847, Vol. I. p. 64, Pl. XI.
Atractylis, Wright (*A. ramosa* = *Eudendrium ramosum*, VanB., non Ehr.), Edinburgh New Phil. Journal, 1859, Vol. IX. p. 108.
? *Perigonimus*, Sars, Fauna Littoralis Norveg., 1846, p. 8, Pl. I. *Figs.* 19, 20, and 21.
? *Fistulana* (*F. ramosa*), Fabricius, Fauna Grœnland., 1780, p. 441, No. 451. Compare "*Ramulos, &c., &c., longitudinaliter striatos*" with Sars' Perigonimus, "*Röhre, &c., &c., der Länge nach etwas wellenförmig gestreift.*"

LIZZIA *Forbes*, 1846.

Lizzia, Forbes, Annals Nat. Hist., 1846.
Forbes, Proc. Brit. Ass., 1847.
Forbes, Brit. Naked-eyed Medusæ, 1848, p. 64, Pl. XII. *Figs.* 3 and 4.
Gegenbaur, Generationswechsel, 1854, p. 22, Pl. II. *Figs.* 1–9.
" Gegenbaur, Sieb. and Köll., Zeitschrift, 1857, VIII. Pl. VII. *Figs.* 5–9.
" Claparède, Sieb. and Köll., Zeitscrift, 1860, X. p. 401, Pl. XXXII. *Figs.* 1, 2, and 3.
Hippocrene, Forbes, An. Mag. Nat. Hist., 1841, VII. p. 84.
Bougainvillea, Leuckart, Wieg. Archiv., 1856, I. p. 24, Pl. II. *Fig.* 2.
? *Podocoryne*, Sars, Faun. Litt. Norveg., 1846, p. 4, Pl. I. *Figs.* 7–18.
" Sars, Faun. Litt. Norveg., 1846, p. 7, Pl. II. *Figs.* 5–11.
" Sars, Nyt Magazin, 1856, Bd. 9, p. 144, Pl. II. *Figs.* 7–13.
" Krohn, Wiegm. Archiv, XVII Jahrg., Bd. I., 1851, p. 263.
" Allman, An. and Mag. Nat. Hist., 1859, 2d ser., IV. p. 50.
" Peach, Edinb. New Phil. Jour., 1856, IV p. 163.
" Peach, An. Mag. Nat. Hist., 1856, XVIII. p. 99, Pl. VIII.
Cytæis? (*octopunctata*), Sars, Beskrivelser, 1835, p. 28, Pl. VI. *Fig.* 14.
" " Sars, Wieg. Archiv, 1837. Bd. 1, p. 406.
" " Sars, Fauna Litt. Norveg., 1846, p. 10, Pl. IV. *Figs.* 7–13.
? *Dysmorphosa*, Philippi, Wiegm. Archiv, VIII Jahrg., Bd. 1, 1842, p. 37, Pl. I. *Fig.* 3.

belonging to the genus Eudendrium of Ehrenberg. In the first place, we may distinguish, under the name of Eudendrium, the type of these Hydroids, the proboscis of which is large and prominent, and the medusæ-buds permanently sessile; next the type with short proboscis, from which arise the free medusæ known as Bougainvillia and Lizzia, and, finally, a third type, embracing the free medusæ which I have described under the name of Nemopsis, the Hydroid of which McCrady has first ascertained to be a free locomotive form, allied to Acaulis of Stimpson. These three types constitute, I believe, three distinct families. For more details upon the Nemopsidæ I refer to the paper of McCrady upon the Hydroids of South Carolina. Representatives of the two other families are described in the following sections.

SECTION II.

EUDENDRIUM DISPAR *AG.*

For many years I have known two Hydroids, from the shores of Massachusetts, which I have for a long time considered as two distinct species, and described as such under Nos. I. and II., though they are now figured (Pl. XXVII. *Figs.* 10–21 and 22–26) as one and the same species, it having of late been ascertained that they are, respectively, the male and the female stock of the same kind of Hydroids.

No. I. *Proles hydroidea.* — This hydroid is a true deep-water animal, never being found on the shore, properly speaking. It may, however, be obtained in covered, rocky pools, on the ledges which lie far out in the ocean. It has a similar mode of branching, and is very nearly of the same size and color as the hydra of

?*Dysmorphosa*, Krohn, Wiegm. Archiv, XVII Jahrg., Bd. 1, 1851, p. 263.
Laomedea (*tenuis*). The medusa, Allman, An. Mag. Nat. Hist., 1859, IV. p. 367.
Coryne (*aculeata*), Wagner, Oken's Isis, 1833, p. 256, Pl. XI. *Figs.* 1–9.
" (*vulgaris*), Wagner, Icones Zoot., 1841, Pl. XXXIV. *Figs.* 16 and 17.
?*Eudendrium* (*confertum*), Alder, Annals and Magazine Nat. Hist., 2d ser., 1856, Vol. XVIII. p. 354, Pl. XII. *Figs.* 5–8.
?*Eudendrium* (*confertum*), Alder, Cat. Zoöph., 1857, p. 13, Pl. I. *Figs.* 5–8.
" " Wright, An. Mag. Nat. Hist., 1861, VIII. p. 126.
?*Dicoryne*, Allman, An. Mag. Nat. Hist., 2d ser., 1859, Vol. IV. p. 369.
" Allman, An. Mag. Nat. Hist., 2d ser., 1861, Vol. VIII. p. 168.
?*Cionistes*, Wright, An. Mag. Nat. Hist., 2d ser., 1861, Vol. VIII. p. 123.
?*Hydractinia*, Alder, Edinb. New Phil. Jour., 1862, p. 144.

Bougainvillia, though it is a little more slender, and has a more graceful aspect (Pl. XXVII. *Fig.* 10), on account of the greater length of its pedicels. It is also more strongly ringed throughout. and possesses eight or ten more tentacles, twenty-eight in all (*Fig.* 11), and tapering in form. The principal feature which distinguishes this hydra from that of Bougainvillia, is its long, simple proboscis (*Figs.* 10 and 11, *p*), in comparison with which the hydra of Bougainvillia (Pl. XXVII. *Fig.* 3) may be said to have none at all. The proboscis has all the flexibility and plasticity of that of the Campanularians, so often referred to by authors, and resembles it not only in form but also in the absence of tentacles around the oral apertures. The coronal tentacles agree also with those of the Campanularians in their occasional alternate depression and elevation. When the animal is in a quiescent state, the proboscis often assumes an elongate, pear-shaped form (*Figs.* 10, B C, and 11, *p*); but when searching for food it expands into the form of a trumpet (*Fig.* 13, *p*), with more or less dilated lips.

From May to September the heads are loaded with medusoid progeny (*Figs.* 10, 12, and 13, *md*), arranged in an irregular circle, just below, and parallel to, the tentacles. During this season this hydra may be distinguished from the very similar hydra of No. II., by its medusæ-buds, which are arranged in a moniliform series, attached to each other by twos or threes, end to end (*Figs.* 18 and 19, A B C), while No. II. produces single, scattered medusæ-buds. Unfortunately, we have never seen the medusæ with eggs; but, judging from the females of another species of this genus, figured by Dr. Wright in the Edinburgh New Philosophical Journal, Vol. IX. 1859, Pl. II. *Fig.* 2, *a*, and described at page 108, they are not moniliform but single. The structure of the medusa will be described in the next paragraph, along with its embryology.

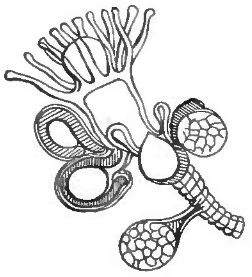
Proles medusoidea (Pl. XXVII. *Figs.* 12–19). — Like all Hydro-medusæ, the budding embryo commences as a protrusion of the two walls of the body of the hydra (*Fig.* 14, *a b*), in the form of a hernia, into which the digestive cavity (*c*) projects. This continues to increase, until it has assumed a pear-shaped form (*Fig.* 15), and has a breadth equal to the thickness of the stem of the hydra (see *Fig.* 12, *md*). At this age the cells of the outer wall (*Fig.* 15, *a*), which in the hydra are so exceedingly indistinct, and barely recognizable in the initiatory state of the medusa (*Fig.* 14), are very conspicuous, and, in fact, are the first to attract the eye, by their beauty and remarkable appearance. They form a single layer, and have a polygonal outline when seen from the outer end; in profile, they have a broad and short, cylindrical shape, with rounded exterior ends. Each cell contains a few granules, which are grouped around its centre. The inner wall (*Fig.* 15, *b*), which is about twice as thick as the outer one, is lined by reddish, or, rather, pink granules. Soon after this date, the outer and inner wall become separated (*Fig.* 16, a^1 *p*), the inner one retaining the form of a cone (*p*), and the hemispherical cavity (*ca*) thus left is filled by a homogeneous, transparent, faint yellow mass. The conical proboscis (*p*) extends through the whole depth of the cavity (*ca*), and within is occupied by a prolongation from the chymiferous cavity, which is thickly lined by reddish-brown granules and cells (*c*). The pedicel (*a b*) is a little longer than the medusa, and is pervaded by a broad chymiferous cavity, expanding into a still broader chamber (*c*), the digestive cavity proper of the medusa. Gradually the medusa, at the same time that it increases in size, becomes globular (*Fig.* 17, A), and the disk cavity (*ca*) assumes the form of a spherical chamber, through which the cylindrical proboscis (*p*) projects, from base to apex. The spermatic contents of the disk cavity (*ca*), which occupy the whole space about the proboscis, become denser, and more decidedly yellow. Here and there lasso-cells (*l*) are scattered through the outer wall, and seem to be fully developed; but we have not made any special investigation of their structure. The pedicellar portion (*a b c*) is about one half longer than the medusa, and the chymiferous cavity (*c*) has become very irregular in its outlines, on account of the highly increased development of the reddish-brown granules and cells, which line it as well as the proboscis (*p*). The two walls, the outer (*a*) and the inner (*b*), have the same thickness throughout, not only in the pedicel, but in the medusa, where the inner one forms the proboscis (*p*) and the outer one the disk (A). In the next stage (*Fig.* 18) we find that the pedicellar portion has nearly doubled its length, and that a second medusa (B) has begun to develop immediately below the first one (A), simply by a bulging and separation of the outer wall from the inner one (B p^2). This second medusa is separated from the primary one by a very short neck (*e*), no longer than the combined thickness of the outer and inner walls (c^1 *e*), which, at this point, are closely in contact with each other, the inner one (c^1) forming a partition, as it were, between the disk cavities (A *ca*, B *ca*) of the two medusæ. The primary medusa (A) has the form of a flattened sphere, of which the proboscis (*p*) forms the axis, and its spermatic contents (*ca*) are much denser than in the last phase, and of a dusky yellow color. The spermatic mass of the second medusa (B) is yellowish, like that in the last phase, and occupies a little less than two thirds of the transverse diameter of the disk, the axial portion (*p*), or, homologically, the proboscis, filling more than one third of the space. The terminal (c^1) and basal ends of this proboscidal axis, are expanded, so as to extend a short distance along the internal surface of the outer wall. Immediately below the secondary medusa (B) the pedicel (C) is slightly swollen, and in the act of forming a third medusa, as seen in *Fig.* 19, in which we have actually a third medusa (C) added to the group, and formed in the same way as the second, but as yet less advanced than the secondary medusa of the last stage. As the pedicel is not elongate, and shows no signs of preparation for the development of a fourth medusa, we conclude that three is the highest number on any one axis; we have, at least, never seen more than three. The terminal medusa of *Fig.* 19 is very nearly ripe, but not quite so, as may be seen by comparing the pear-shaped spermatic particles (*Fig.* 20, A B), which were taken from it, with those which were naturally discharged from a fully mature animal (*Fig.* 21, A B). From this period to maturity the spermatic contents have an opaque white color. The mature spermatic particle (*Fig.* 21, A B) has an elongated, guitar-shaped body, and from its narrower end a tail tapers away, and extends to about eight times its length. The anterior end suddenly narrows into a rounded prominence. We have searched in vain for female medusæ among this kind of Hydroids.

No. II. *Proles hydroidea.*—The hydra of this hydromedusarium (Pl. XXVII. *Figs.* 22–26) can in no way be distinguished from that of No. I., except by its yellow color; it has the same habitat, size, proportions, and mode of branching, and the structural details do not differ. In the breeding season, however, the differences are very obvious; then we find that the medusæ (*md*) are not only single, but scattered along the stem of the hydra for a considerable distance from the head. As these medusæ were observed in July, the middle of the breeding season of No. I., and the two appeared to be in the same stage of development, they could not be supposed to represent two different states of the same species; the less so since the medusæ of both seemed to be males, and the oldest of the second kind were very opaque and yellow, like the whole hydra. Unlike the Eudendrium ramosum figured by VanBeneden and others, the medusæ of our species do not free themselves, but are developed as simple, saccate, globular bodies, with what appears to be a broad proboscis (*Fig.* 22, md^1). The tendency to form branched bunches, as represented by one of the figures (*Fig.* 22, *a b*), indicates a close relation to the type of the true Eudendrium ramosum.

Recent observations have shown that, notwithstanding the extraordinary differences noticed between the two Hydroids described above, they belong to one and the same species; the first form being the stock which produces proliferous male medusæ only, and the second that which produces single, scattered, female medusæ; there is, besides, a marked difference in the color of the hydroids. This case shows, perhaps, more fully than any other, with what perseverance the Hydroids must be studied, in their various stages of growth, before correct results can be reached.

The buds of the female medusæ are usually scattered irregularly upon the calyx of the hydra; occasionally they are found at some distance from the head, along the stem. The wall of the bud, which, in the early stages, is of uniform thickness, bulges unequally, upon one side, near the base. This lateral bulging becomes gradually deeper, until the bud assumes the form of an urn-shaped body, attached by one of its edges (wood-cut 36), with its summit near the base. The contents of the buds, as they increase in bulk, become more and more disconnected from the wall, the lip opens, the wall is split laterally, and, with the increasing bulk of the contents of the bud, soon dwindles down to a band, passing like a hoop over the contents of the bud, which, at this period, appear to be a mass of yolk substance in process of segmentation. The wall soon disappears altogether, and the yolk substance remains a sphere, attached to the peduncle of the bud, fitting into a sort of socket formed by the remnant of the outer wall.

Fig. 36.



EUDENDRIUM DISPAR *Ag.* Female medusæ-buds in various stages of development.

The various shapes of the hydra (Pl. XXVII. *Figs.* 23, 24, and 25), as illustrated here, are characteristic of the habits of all the Eudendrioids. *Fig.* 26 shows very well the broad disk (*dc*), upon which the proboscis (*p*) arises, and also exhibits the true character of the tentacles (*t*). All Hydroids having taper-pointed tentacles are able to contract them into a club-shaped form, as we have represented them in some of the figures on this plate (*Figs.* 12, 22, 23, 24, and 25), but none of the truly clavate tentacles, such as those of Pennaria (Pl. XV *Fig.* 2, t^1), of the reproductive hydra of Hydractinia (Pl. XVI. *Figs.* 2^a, 2^f, 3, &c.), of Coryne (Pl. XVII.), and of Halocharis (Pl. XX. *Fig.* 10), can assume a pointed form.

On Pl. XXVII. this species is represented under the name of Thoa dispar. But I am now satisfied that the name Thoa cannot safely be retained for Eudendrium.

SECTION III

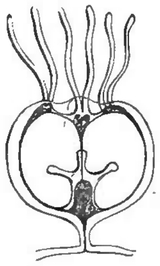
BOUGAINVILLIA SUPERCILIARIS *AG.*

Proles hydroidea. — The hydroid of this species has always been found in the purest sea-water, along the rocky shores of our coast. It grows in clusters, not more than two inches high, and is usually attached to some rock, or to the shell of a Mytilus, and seldom to sea-weeds. The hydrarium (Pl. XXVII. *Fig.* 1), the stem of which is about as thick as a cambric needle, has a deep red tint, and branches rather irregularly, though more or less alternately and spirally, and in like manner do the secondary branches arise from the primary ones. The base of every branch (*Fig.* 2, *a b c d e*), as well as every pedicel (*Fig.* 3, *c*) of the horny sheath, is marked, sometimes very strongly (*Fig.* 2, *a b e*) and at others rather faintly (*c d*). by rings, varying from five to ten in number. There are instances where the whole primary branch is at least wavy, if not completely ringed throughout. Each pedicel has an average length of one eighth of an inch, and is terminated by a single head. The horny tube, as it passes on to the head, thins out to a mere film, which disappears entirely at the base of the crown of tentacles. The head bears only a single row of slender, tapering tentacles (*Fig.* 3, *t* t^1), varying from fifteen to twenty in number. They have the appearance of being ringed, on account of the transverse rows of lasso-cells, which project from the surface like short bristles. This arrangement reminds one of the tentacles of the Campanularians. The proboscis (*m*) is very short, forming a mere conical papilla; in fact it cannot be said to have a greater prominence than the mouth region of the genus Hydra. Just below the head, during the summer months, the medusæ-buds (*Fig.* 2, A B) may be observed scattered along the pedicel in an irregular manner; each bud arising singly from the hydra walls, and protected by a filmy capsule (*Figs.* 5, 6, and 7, *i*), prolonged from the horny sheath of the stem. The outer wall (*Fig.* 3, *a* a^1) of the stem and head is moderately thick upon the proboscis (*m*) and over the head (*d*); but at the junction (c^1) of the pedicel it becomes quite thick, and then again grows thinner as it passes down the stem, until it is about one sixth as thick as the diameter of the two walls and the included chymiferous canal. Upon the tentacles (a^2) it has about the same relative thickness as in the last place mentioned; and the inner wall (b^2) occupies the remaining four sixths of the diameter of these organs. In the proboscis and head the inner wall (*b* b^1) varies from twice to three times the thickness of the outer one, but, lower down the stem, it decreases in this respect, until it is about as thick, on the average, as the outer wall. The digestive cavity (*d*) is densely lined by a layer of deep, purplish-red pigment-cells, which extend, in diminished quantity, throughout the whole length of the stem and branches.

Proles medusoidea.—I have not traced the embryology of the medusa through all its stages to the fully-developed state, but only just far enough to recognize the identity of its mode of evolution, at least in the earlier stages, with that of Coryne, and to ascertain the identity of these medusæ-buds with the free medusæ described many years ago by me, under the name of Hippocrene superciliaris. Professor Leidy has also observed its development, and forwarded to me an exquisite drawing of a Hydroid stock, bearing a number of well-advanced medusæ-buds. If we compare Pl. XXVII. *Figs.* 5, 6, and 7, respectively, with Pl. XVIII. *Figs.* 7, 6, and 10, it will readily appear, that the development of one of these Hydroids, the Coryne mirabilis, may serve to illustrate that of the other, Bougainvillia superciliaris; and that the principal value of the figures given on

Pl. XXVII. consists in showing the slight difference in their form. My son, however, has traced its further growth to its final development, and there is no doubt left now, that the Hydroid described above is the parent stock of the free medusa, described under the name of Hippocrene superciliaris[1] in my Contributions to the Natural History of the Acalephs of North America. The young medusa, when about to separate from the hydroid (wood-cut 37), is almost globular; it has a short digestive cavity, terminating in four slight knobs, in the prolongation of the lines of the chymiferous tubes, four pairs of tentacles, equalling in length the diameter of the bell, with a well-marked eye-speck at the base of each. The bulb at the base of the tentacles is not yet well separated from the circular tube. But, as the tentacles lengthen, which takes place very rapidly, as soon as the medusæ have become detached, the swelling of the tentacles appears more distinctly. The knobs at the four corners of the digestive cavity assume more the shape of a short branch. The general outline is more hemispherical. The opening of the veil increases, and the young medusa is a Bougainvillia superciliaris, with but two tentacles, and the oral bunches slightly developed (wood-cut 38), agreeing, in this respect, entirely with the mode of growth of the young of Margelis,[2] in which the oral bunches are still very little ramified, even when there are as many as six tentacles at the base of each chymiferous tube. The tentacles at the apex of the sensitive bulb are first developed, smaller tentacles being added, simultaneously, on each side of the original pair. The adjoining wood-cut, *Fig.* 39, of an adult specimen, shows to what extent the process goes on. For further details upon the full-grown medusa, I refer to my former paper.

Fig. 37.

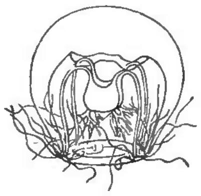


Bud of BOUGAINVILLIA SUPERCILIARIS, still connected with its Hydroid.

Fig. 38.

Young BOUGAINVILLIA SUPERCILIARIS, shortly freed from its Hydroid.

Fig. 39.



Adult BOUGAINVILLIA.

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[1] The name Hippocrene is now changed to Bougainvillia, for the obvious reason that Montfort's genus Hippocrene, among the Gasteropods, cannot be discarded, as it has been by most Conchologists of the present day.

[2] Margelis is the name proposed by Steenstrup for the European species of Bougainvillia, which, as McCrady has first pointed out, are generically distinct from the American species, and the latter agrees with the Pacific type.

CHAPTER SIXTH

THE CORALLARIA TABULATA AS HYDROIDS.

SECTION I.

MILLEPORA ALCICORNIS *LINN.*

The hydra. — Until now, the genus Millepora has been referred to the class of Polyps, and so long as the soft parts of the animals forming this kind of Corals remained unknown, there appeared no reason why they should not be associated with the Coral-builder, even after it had been ascertained that the Bryozoa belong to the branch of Mollusks. The opportunity I had while in Florida of observing Millepora alive, has satisfied me, however, that this genus has none of the characteristic features of the true Polyps, the main cavity of the body not being divided by vertical radiating partitions into chambers, as is the case in all the members of this class. Like the true Hydroids each individual has a simple, undivided cavity, with double walls. The individual hydræ (Pl. XV *Figs.* 4, 5, and 6) resemble very strikingly those of Halocharis (Pl. XX. *Fig.* 10), and, to some extent also, those of Coryne (Pl. XVII.), and even those of the fertile Hydractinia (Pl. XVI.). As in these genera, the mouth (Pl. XV *Figs.* 5 and 6, *d*) opens at the summit of the head, as a simple, round aperture, alternately opening and closing; the digestive cavity being a simple straight cylinder when empty (*Fig.* 6, *c*), and widening somewhat when full (*Fig.* 5, c^1). The outer wall (*a*) is much thinner than the inner wall (*b*), which consists of large cells (*Fig.* 7, *e*), stretching across the whole thickness of the wall. There are two kinds of hydræ (*Fig.* 4) in one and the same community; the large ones (*Figs.* 4, *d g h,* and 6), with very few, and generally only four or five, and seldom six, short tentacles, around the head, terminating in a more or less spheroidal knob (*Fig.* 6, *e f g*), supported by a short peduncle (*h*), are fewer in number; the smaller ones are much more numerous, and more active (*Figs.* 4, *i k l m n o*, and 5). The latter differ chiefly from the larger hydræ, in having tentacles scattered upon the whole length of the stem, like Halocharis; but instead of being gradually larger from base to summit, the reverse is the case with the tentacles of the small hydræ of Millepora, the lower ones (*Fig.* 5, *g i h f*) being the larger, and those near the summit growing gradually smaller and smaller (*k l m*). The knobs of all these tentacles are chiefly made up of larger lasso-cells (*Fig.* 5^{a}), the largest of which have a very long thread, remarkable for the enlargement of its spiral band, at a great distance (*c*) from the bulb (*a*).

Whether the difference in the size of the hydræ is connected with their fertility or not, could not be ascertained, as no medusæ-buds were observed upon either of them. A most interesting point in the history of this genus remains, therefore, still to be traced. It can, however, hardly be doubted that the hydræ must produce medusæ of some kind or other, as all the Hydroids do.

The Corallum. — It is seldom that in dried specimens of the corallum the natural smooth surface can be studied with confidence, on account of the extreme delicacy of the spongiform mass of most recent growth. It is impossible, even with the utmost care, to handle a specimen without abrading the slender, irregular spiculæ, whose points form the horizon over which the soft walls of the animal stretch in a uniform, smooth film. It is, therefore, necessary to study perfectly fresh specimens, in order to form a correct idea of the relations of the superficial, spiculate deposits of the animal basis. Under such conditions the whole corallum will appear dotted with round apertures, usually of two sizes (Pl. XV. *Fig.* 8, *a b*), in numbers and position corresponding to the large and small hydræ, which may be found retracted within their cells. Oftentimes the aperture of the cell is completely closed over by the contracted basal walls of the hydra, and in such cases the actual number of cells is disguised.

The only proper means of removing the fleshy part of the animal, in order to study the corallum, is a potash solution, after which operation it appears, to the naked eye, like a very fine sponge; but under a considerable magnifying power it presents a very ragged aspect (Pl. XV. *Fig.* 8), especially about the tips of the branches, where the jagged spiculæ are less intimately united with each other. From a superficial point of view, the cells of both the large and small hydræ appear to have radiate semi-partitions, which, in some instances, are quite regularly disposed, and in the largest cells amount to a dozen in number; but, upon closer inspection, it may be seen that the apparent lamellæ are very irregular, laterally flattened projections (*Fig.* 8, *f–m*), which have but little depth, and stand at various levels (*Fig.* 10, *c d e f*). In some cases a longitudinal section of a cell (*Fig.* 13) discloses a complete series of false partitions from mouth (*a*) to bottom (*b*), whereas, in other instances, the projections are but slightly developed (*Fig.* 9). The greatest care is necessary in making such sections, in order not to break these partitions, inasmuch as they are mostly very thin, oftentimes filmy, and brittle. A section made by simply breaking the branch across, holding it very steadily in the fingers, is much better than a cut by the section wheel. At the tips of the branches the cells can hardly be recognized as such, but appear more like irregular depressions of greater or less depth (*Fig.* 12, *b d e f*). Between these the corallum is very loose and spongy, each cell communicating with the others through large, irregular channels, penetrating even to the centre (*Fig.* 12, *a*) of the branch. In the specimen which we have figured (*Fig.* 12), the intercommunicating channels are less numerous than in many cases; for instance, a specimen now before me is so thickly channelled, that the solid, calcareous deposit occupies much less room than the open spaces. Passing down the branch, for half an inch, we come to a point where the cells have a definite outline (*Fig.* 10) and the bottom (*b*) of the cavity is clearly circumscribed. About the mouth (*a*), or entrance, and between it and that of the adjoining cells, the corallum is traversed by tortuous cavities (*i j*), some like channels (*i*), and others like lacunæ (*j*), all of which communicate freely with the cavity of the cell. Around the base (*b*) of the cell the corallum (*k*) is more solid, and the intercommunicating channels (*h*) are smaller and fewer; but around, and at the centre of the branch, we find, again, a spongiform structure, such as we have figured from a section lower down the branch (*Fig.* 11, *a*). Nor is this absent at any age, even in the oldest part of the corallum; at least we have found it at the centre of stems, from an inch to an inch and a half in diameter. Sometimes, such is the irregularity in the rate of development of the branch, that we find the cells quite deep at the distance of half an inch from the tip, and transversely divided into three or four superposed chambers (*Fig.* 9). The transverse partitions (*c*) which lie between these chambers are as thin and fragile as the false partitions, but they are more regular, and seldom, if ever, perforated. The same may be said for the oldest and deepest cells (*Fig.* 13). In fact there is very little change in the structure of the cell after it has acquired three or four transverse partitions; there are the same tortuous channels, both about the youngest (*Fig.* 10, *h i*), the more advanced (*Figs.* 9, *e f h*, and 11), and the oldest (*Fig.* 13); and beyond that, the corallum is, as we have described it in *Fig.* 10, *k*, nearly solid, with only here and there a narrow channel, until we approach the axis of the stem, where we always find a spongiform mass (*Fig.* 11, *a*). The form of the cell, at all ages, is cylindrical (*Figs.* 9, 11, and 13), and the transverse partitions are nearly uniformly arranged, at equal distances, one above the other, and at such heights, that each included chamber is from one quarter to one third broader than deep. The direction in which the cells trend is, more or less, along a curve, following an upward or a downward course, that is, trending toward the apex, or base of the stem; and occasionally a cell has a double curve, in a plane parallel to the axis, and also laterally (*Fig.* 13). The perpendicular curvature accounts for the fact, that in breaking a stem, the surface of fracture is usually curved, the stem naturally giving way along the line of least resistance.

A structure like this does not occur among the Corals of the class of Polyps; it is peculiar to the Tabulata, as a comparison with those of Pocillopora and Seriatopora, described in the following sections, unquestionably shows. I am, therefore, satisfied that the whole group of Tabulata must be referred to the class of Acalephs, in which they find naturally their place, among the Hydroids.

SECTION II.

POCILLOPORA DAMICORNIS *LMK.*

The Corallum. — The youngest cells (Pl. XV *Fig.* 14, *a*) of the corallum are about as strictly defined as the older ones; there is none of the uncertain, irregular limitation between the outlines of the cells and the spaces intervening, as we have observed in Millepora, but the corallum is deposited in a solid mass (*Fig.* 14^a, *c*), close up to the boundaries of the pits. The intervals, at first, are very thin and fragile, and crested by rather irregular, spiniform projections, which are arranged, generally speaking, in a single row. Similar spines, but shorter and more conical, are scattered all over the sides and bottom of the cells. In consequence of this close proximity of the cells, they are necessarily polygonal, and usually five or six-sided. After a cell has developed to a certain degree, and obtained a depth equal to one third its width (*Fig.* 14^a, *a b*), it loses its simple character, and becomes transversely partitioned, and, at the same time, excepting at the forks of the branches, where the hydroids are crowded to a certain extent, changes its contour, and becomes more circular; and, finally, the intervals widen, sometimes to such an extent, that, in the oldest part of the stem, they are as broad as the cells between which they lie. All the chambers which are shut off from the outermost or youngest division of the cell, are perfectly smooth, the intervals between the spinules being filled up by calcareous deposit, which, at the same time, thickens the intervening walls of adjacent cells to a greater or less extent. The transverse diaphragmic partitions are quite firm, and sometimes of considerable thickness, and are usually slightly arched across the cell, and imperforated (*Fig.* 14^b). In the oldest cells, three quarters of an inch deep, there are at least from thirty to thirty-five of these partitions. The general outline of the cells is cylindrical (*Fig.* 14^b), usually circular, but in certain cases prismatic. From the foregoing it will be seen that the hydræ have no lateral communication with each other, through the mass of the corallum, but that their relations are altogether superficial. A longitudinal section of the cells would seem to show that this is not so, when we find two cells (*Fig.* 14^b, *h e*) uniting below in one chamber (*m*); but we have found that this was only the case when the hydræ were down at that level, and consequently superficially related, whereas, at later periods, they were not only separated from the lower chambers by the transverse partitions, but, by the same means, from each other.

SECTION III.

SERIATOPORA SUBULATA *LMK.*

The intervals between the cells at the tip of the branches (Pl. XV. *Fig.* 15, *a b c*) are as distinctly marked out as in Pocillopora damicornis, and the calcareous deposit equally solid. The borders of the cells at this point are fringed by rather blunt spinules (*h*), arranged in an irregular row. At the very earliest stages of growth recognizable on the corallum, the young cell possesses a columellar projection, such as is so prominent in the older cells (*Fig.* 15, *j k*). Originally, then, these young cells have the form of inverted, truncated cones, which finally deepen and become parallel sided (*Fig.* 15^a), but as they do this the central columella rises, and at the same time, usually, four perpendicular partitions, at ninety degrees from each other, are thrown out from the axis to the periphery, in such a way as to produce four cavities (*Figs.* 15, *f i*, and 15^a, *d e*) around the axis. After the cell has attained a depth usually equal to its breadth, a transverse diaphragmic partition (*Fig.* 15^a, *f g*) is developed, and then another chamber, or rather a fourfold cavity is formed, to be eventually partitioned off like the preceding one, and so on until the end of the existence of the hydra. Throughout the whole corallum, we find the calcareous deposit solid and amorphous, so that it is not possible that the hydræ should have any lateral communication with each other, excepting at the surface of the colony. At the oldest part of the corallum the spinules are scattered, and have no trace of the serial arrangement which obtains in the younger parts of the branches.

From the peculiar characteristics of this genus, I infer that the Corallaria Rugosa of Milne-Edwards are more likely to have been Hydroids than true Polyps.

CHAPTER SEVENTH.

THE GENERA OF THE CAMPANULARIANS.

SECTION I.

CLYTIA (ORTHOPYXIS) POTERIUM *AG.*

Proles hydroidea. *Adult.*[1] — The habitat of this hydroid is wherever, among the rocky tide pools, the water is clear and cool; and almost invariably the animal

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[1] References to the Campanularians.

CLYTIA *Lamx.*, 1812.

Clytia, Lamouroux, Bulletin Soc. Philom., Paris, 1812, p. 184. (C. volubilis = Sertularia volubilis Lin.)
" Lamouroux, Histoire de Polypiers Flexibles, 1816, p. 20.
" Lamouroux, Expos. Méthodique, 1821, p. 13.
Campanularia (*C. volubilis*), Lamarck, An. sans Vert., 1816, p. 112.
Schweigger, Handbuch, 1820, p. 425.
" Fleming, Hist. Brit. Animals, 1828, p. 548.
" Cuvier, Règne Animal, 1830, 2de éd., Vol. III. p. 300.
" Blainville, Dict. Sc. Nat., 1830, Vol. 60, p. 437.
" Blainville, Manuel d'Actinologie, 1834–1836, p. 472.
Campanularia M.-Edwards, in Lamk. An. sans Vert., 2de éd., 1836, p. 131.
" Johnston, Brit. Zoöph., 1838, p. 154.
" Johnston, Brit. Zoöph., 1847, 2d ed., p. 107.
" Dalyell, Remark. Animals of Scotland, 1847, Vol. I. p. 211.
" VanBeneden, Nouv. Mém. Acad. Roy. Brux., 1844, XVII. p. 31.
" VanBeneden, Bull. Acad. Roy. de Belgique, 1847, XIV. p. 457.
" Hincks, An. Mag. Nat. Hist., 1852, X. p. 85.
" Gosse, Devonshire Coast, 1853, pp. 296 and 300.
" Hincks, An. Mag. Nat. Hist., 1852, XI. p. 178.
" Hincks, An. Mag. Nat. Hist., 1855, XV. p. 130.
" Alder, Catal. Zoöph. Northumb., 1854.

is attached to sea-weeds (Pl. XXVIII. *Fig.* 1) or to the stem of other Hydroids, such as the Tubularians, and never, as far we know, to the solid rock or any

Campanularia (*C. volubilis*), Gegenbaur, Generationswechsel, 1854, p. 13.
“ Alder, An. Mag. Nat. Hist., 1856, XVIII. p. 358.
“ Sars, Nyt Magazin, 1856, p. 156.
“ Wright, Edinb. New Phil. Jour., 1858, VII. p. 286.
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Sertularia, Linnæus, Syst. Nat., 12th ed., 1767 (*S. volubilis*, *&c.*).
“ Pallas, Elenchus Zooph., 1766.
“ Fabricius, Fauna Grœnlandica, 1780, p. 444.
“ Ellis and Solander, Zooph., 1786, p. 51.
“ Gmelin, Lin. Syst. Nat., 13th ed., 1788, p. 3844.
“ Turton, British Fauna, 1807, p. 212.
“ Oken, Lehrbuch, 1815, III. p. 92.
“ Goldfuss, Handbuch, 1820, p. 88.
“ Bosc, Hist. des Vers, 1830, 2de éd., p. 94.

LAOMEDEA *Lamx.*

Laomedea, Lamouroux (= Sertularia dichotoma Lin. = Ellis Corallines, p. 21, No. 18, Pl. XII. *a* A), Bulletin Soc. Phil., Paris, 1812, p. 184.
“ Lamouroux, Hist. Polyp. Flexibles, 1816, p. 204.
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“ Blainville, Dict. Sc. Nat., 1830, Vol. LX. p. 458.
“ Blainville, Manuel d'Actinologie, 1834–1836, p. 473.
“ Johnston, British Zoöph., 1838, p. 150.
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“ Sars, Nyt Magazin, 1856, p. 159.
“ Alder, An. Mag. Nat. Hist., 1856, XVIII. p. 440.
“ Alder, Catal. Zoöph. Northumb., 1857, p. 32.
“ Wright, Edinb. New Phil. Jour., 1858, VII. p. 108.
“ Wright, Edinb. New Phil. Jour., 1859, IX. p. 112.
“ Allman, An. Mag. Nat. Hist., 1859, IV. pp. 137 and 367.
Campanularia, Lamarck, Animaux sans Vert., 1816, p. 113.
“ Fleming, British Animals, 1828, p. 548.
“ Meyen, Nova Acta Acad. Nat. Cur., 1834, XVI., Suppl., p. 193.
“ Lister, Phil. Trans. Roy. Soc., 1834, p. 372.
“ Lovèn, Vetensk. Acad. Handl., 1835; transl. in Wieg. Archiv., 1837, p. 249.
“ Steenstrup, Generationswechsel, 1842, p. 27.
“ VanBeneden, Mém. Acad. Roy. Brux., 1844, XVII. p. 33.
“ Schultze, Müller Archiv., 1850, p. 53.
“ Gegenbaur, Generationswechsel, 1854, p. 35.
Monopyxis, Ehrenberg, Corallenthiere, Verh. Akad. Wiss., Berlin, 1834, p. 73.
Sertularia, Linnæus, Fauna Suecica, 1761, ed. altera, p. 540.
“ Linnæus, Syst. Nat., 1767, 12th ed., Tom. 2, p. 1306.
“ Pallas, Elenchus Zooph., 1766, p. 106.

immovable substance. Oftentimes it is found attached to the antennæ of the spider-crab (Libinia canaliculata). The main stem (*Fig.* 2, *d*) never rises to an erect position, but always creeps, stolon-like, over the body to which it is attached, while the pedicels (*a*) of the sterile hydræ stand up like the stems of the Tubularians. These pedicels are always simple, varying from three, to four sixteenths of an inch in height, and are faintly ringed from top to bottom. The rings are not so strongly marked as in some other species, but are, more properly, slight waves (*Fig.* 3, c^2). At the top of the pedicel there is, however, one well-developed ring (c^3), upon which the calycle rests. The calycle (c^1) is deeply campanulate, has a smooth edge, and its depth is to the breadth as four to three. The wall of the cup is very thick, in fact three or four times as thick as the wall of the pedicel; it thins out suddenly at the edge, but at the lower part it abruptly doubles its thickness, to form a diaphragm (*c*). This diaphragm, or transverse semi-partition, is altogether different from that of any of the upright and branching forms of the Campanularians; in profile it has the form of an equilateral triangle, of which one side is based upon the calycle, and the other two sides are free, one facing toward the mouth of the cup, and the other, obliquely, toward its base. The free edge is rounded, and the inferior face is concave, so that it embraces a spherical cavity.

The reproductive hydræ (*Fig.* 2, *b*) do not seem to have any systematic arrangement upon the creeping stem, but arise indiscriminately with the pedicels of the hydræ. Their calycles have an oval cylindrical shape, and are about twice the length of the calycles of the hydræ. They are more or less wavy in outline, and frequently have the appearance of being ringed (Pl. XXIX. *Fig.* 5). Their aperture (Pl. XXVIII. *Fig.* 16, k^1) is truncate, and smooth, and occupies nearly the whole breadth of the calycle. The base of the calycle tapers into a short pedicel (*Figs.* 15, 16, and 19, *a*), which rises immediately from the creeping main stem. The wall of this calycle is of a uniform thickness throughout (*Fig.* 15, *k*; Pl. XXIX. *Fig.* 2), and, in this respect, agrees with the pedicel upon which it is based.

The sterile hydræ (Pl. XXVIII. *Figs.* 2, *a*, and 3, *a*) have twenty-four tentacles, exhibiting the same proportions and structural elements as most Campanularians. Compare Pl. XXXIII. *Fig.* 5, and Pl. XXX. *Figs.* 4 and 5. It must be borne in mind, however, that the hydra of this species bears somewhat different relations

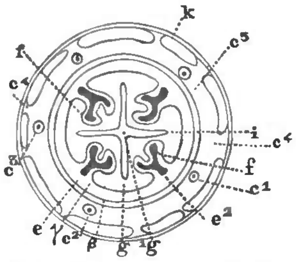
Sertularia, Gmelin, Linn. Syst. Nat., 1788, p. 3844.
" Abildgaard, in Zool. Danica, 1789, III. p. 61.
" Turton, British Fauna, 1807, p. 212.
" Olivi, Zool. Adriatica, 1792, p. 288.
Sertularia, Oken, Lehrbuch der Naturgeschichte, 1815, III. p. 92.
" Bosc, Hist. Nat. des Vers, 1830, III. 2de éd., p. 94.

to its calyx, on account of the peculiar form and proportions of the latter. The reproductive hydræ (Pl. XXVIII. *Fig.* 2, *b*) bring forth planulæ (*Figs.* 17 and 17^a), which are developed within a very low form of medusa. Each calycle contains but one medusa, either male (Pl. XXVIII. *Figs.* 13, 13^a, *i*, 14, *i*, and 19, *i*; Pl. XXIX. *Figs.* 2, *e f g*, 3, *i*, 4, *i*, and 5, *h i*) or female (Pl. XXVIII. *Figs.* 15 and 16, *i*), and in each colony the medusæ are either all males or all females. The relations of the medusa to the axis or axes of the reproductive calycle, can be better understood in connection with the process of development of this part of the hydromedusarium; and, therefore, we will merely state here that there are more frequently two, three, four, or five axes, than one, and that the medusa develops either from one side of the axis, whether single (Pl. XXVIII. *Fig.* 14, *c*) or multiple (*Fig.* 13, *c*), or arises from within the circle of axes, at their point of branching (*Figs.* 15, 16, and 19; Pl. XXIX. *Figs.* 2, 3, 4, and 5).

Embryology. Proles medusoidea.—The young reproductive calycles (Pl. XXVIII. *Figs.* 2, *c* c^1, 11, and 12) have a broad, pyriform contour, being mere hernia-like expansions of the stem, with double walls (*Fig.* 11, β γ). In the very earliest stage they seem to be perfectly identical with the young sterile hydra-buds (*Fig.* 4); and have very thick outer (*a*) and inner (*b*) walls, which press closely against the horny covering (*c*). As development goes on, the terminal portion (*Fig.* 11, *d*) always presents a broad outline, and uniformly adheres to the horny sheath (*k*), which, by the way, it constantly secretes from its exterior surface. At a certain period, however, that part of the axis which is already well developed, retracts from the sheath, and occupies a central position; and as fast as this occurs, the cellular structure, which is so conspicuous in the terminal portion (*d*), becomes obscure. Almost immediately after this, the medusa (*i*) begins to bud from the axis, and usually near its base. In its incipient condition it is a slight lateral divergence of the double walls of the axis; but it soon increases to much larger dimensions, and assumes, by degrees, a broad, cylindrical form (*Fig.* 12, *i*), with a rounded end. At this stage, the terminal growth of the axis (*d*) is considerably broader than in the previous phase, and the free portion of the axis immediately below it is bent to one side; but what is, perhaps, most noteworthy here, is that the outer wall (β) has increased to an enormous thickness, and fills the entire space of the calycle not occupied by the medusa. At a later period (*Fig.* 13) we find the medusa (*i*) possessing four radiating chymiferous tubes (*f*), which appear to be excavated within the thickness of the inner wall, after the manner of the earlier stages in the medusa of Tubularia Couthouyi (Pl. XXIV. *Fig.* 11, *c*). In the specimen which we have represented (Pl. XXVIII. *Fig.* 13) the axis is quadruple (*c* c^1 c^2), the original and single axis (*a*) having diverged in four directions during the process of development. At the actinal end, where the axis is still growing, the four channels terminate in the single chymiferous cavity (*d*). The medusa (*i*) is so crowded in the calycle, that it is hardly possible to see its connection with the axis unless the whole horny sheath is removed (*Fig.* 13^a), and then we find that only one of the axial canals (*c*) is in direct communication with the radiating tubes (*f*), the single channel (e^1) of the peduncle being the medium between the two. The whole cavity of the disk is filled by the reproductive material, either eggs or spermatic particles.

From this period onward, the medusa, already recognizable as such, grows comparatively very rapidly, and, in size, soon surpasses the whole axial portion of the hydra (*Fig.* 14). The radiating tubes (*f*) become more distinct, and the outer wall increases considerably in thickness. Up to the period when the medusa has reached two thirds of its growth, the radiating tubes are simple channels (*Fig.* 14, *f*), but soon after this we find them sending forth, from each side, a row of blind sacs (*Fig.* 19, *f*), so that each canal (e e^1 e^2) has a pennate appearance. In the males (*Fig.* 19) these diverticles (*f*) are most frequently opposite each other on any one channel, but in the females (*Fig.* 15) they are disposed more or less alternately (*f*) so as to correspond to the intervals among the eggs (*i*); and they project not only laterally but obliquely toward the interior, as if to form supports for the reproductive mass. Frequently the different channels of the compound axis of the reproductive hydra branch above the point of common divergence, as in *Fig.* 15, where a short branch (c^1) diverges from one of the main channels (c^2), near its termination. There is considerable difference among these hydræ in regard to the age at which the diverticles of the radiating tubes of the medusæ begin to form; sometimes, in a comparatively young hydra (Pl. XXVIII. *Fig.* 19, and Pl. XXIX. *Fig.* 2), the diverticles (*f*) of the medusæ are quite long, while, in a much older hydra (Pl. XXIX. *Fig.* 4, *f*), the diverticles are not more than half as long; or in another (*Fig.* 3), nearly as old as the last, they are not developed at all, and the radiating tubes (*e*) are as yet simple channels. The length of some of these diverticles is remarkable, projecting, as they do (Pl. XXIX. *Fig.* 2, *f*), nearly half way across the reproductive mass, and also occasionally branching. In the more highly-developed male medusæ the reproductive mass is internally divided lengthwise, by a furrow (Pl. XXIX. *Fig.* 2, *g*), into as many lobes as there are radiating canals, and each lobe is penetrated by the diverticles from a single radiating tube. Whether the reproductive mass is covered by an internal wall, which corresponds to the innermost, or lining wall of the disk of the Hydroid-medusæ, we are not able to say, but incline to believe there is none, inasmuch as the calycles were subjected to prolonged and careful investigation. The woodcut on the next page, representing an ideal section of *Fig.* 2, Pl. XXIX., with corresponding letters, will assist in the understanding of the relation of the various walls and channels of the reproductive calycle. In this wood-cut (*Fig.* 40), the branches of the compound axis, extending from base to summit, are represented by simple rings (c^1, c^2, c^3) around the medusa (β γ), and the chymiferous tubes of the latter (e e), with their blind sacs, appear furcate.

Fig. 40.



Section through the reproductive hydra of CLYTIA (Orthopyxis) POTERIUM. Drawn by H. J. Clark.

c^1 c^2 c^3 branches of the compound axis of the reproductive hydra. — c^4 c^5 wall of hydra. — e e radiating tubes. — f f blind sacs of radiating tubes. — g g furrows dividing the reproductive mass. — i spermatic mass. — k the calycle. — β outer wall. — γ inner wall of the medusa.

At maturity the medusa fills the calycle from base to top (Pl. XXIX. *Figs.* 3 and 4, i), while the axis occupies but a small space, being crowded to one side and compressed by its swelling progeny. Under such conditions the channels of the axes are collapsed, and the walls appear like wrinkled bands (*Figs.* 3 and 4, c c^1), running longitudinally over the medusa. So great is the pressure caused by the enormous swelling of the medusa, that, oftentimes, when the calycle opens to allow the egress of the planulæ, they are forced out in a body (Pl. XXVIII. *Fig.* 16, i^2), carrying along with them the actinal end of the medusa. In this way there is produced the semblance of an exterior development of a medusa, even to the formation of radiating tubes (e^3). The exit of the planulæ is made through an opening between the ends of the compound axes, so that the latter has the appearance of an exterior medusa. This similitude is more fully carried out in the male (Pl. XXIX. *Fig.* 5), where the medusa (h) opens at its end, and the spermatic mass (i i^1) streams out through the central aperture (d^1) of the disk-like, common termination of the channelled axes; and the latter, at the same time, gradually contract toward the base of the calycle as the mass of the medusa grows smaller. The planules are finally released by the disintegration of the medusa, and they commence an independent life as oval, or more or less ovate solid bodies (Pl. XXVIII. *Figs.* 17 and 17^a), and move about by means of vibratile cilia, with which they are covered. The planula is not a homogeneous body at this time; but consists of a very thick outer wall (*Fig.* 17), which is composed of irregularly round cells (*Fig.* 18, A), and a central clearer portion which is made up of much smaller cells (*Fig.* 18, B), that appear like mere granules beside those of the outer wall. In an end view (*Fig.* 17^a) of the planula it appears circular.

A short time before maturity the spermatic particles are broad, flask shaped (Pl. XXVIII. *Fig.* 20, C), and do not possess any filamentary appendage. The fully-developed spermatic particles (*Fig.* 20, A B) are elongate, flask shaped, with a moderately long filamentary appendage attached to the broader end.

Proles hydroidea. — In the development of the hydra, by the budding process, the proportionate growth of the walls, the mode of formation of the tentacles, and the changes in the cellular constituents, are essentially the same as in other Campanularians; but there are some features which are peculiar to this type, in regard to the formation of the calycle. At first the calycle is a thick-walled, pear-shaped, terminal expansion (Pl. XXVIII. *Fig.* 4, *c*) of the horny tube, and is completely filled by the hydra. As the hydra increases in size, the wall of the calyx thickens most rapidly at a point not far above the base, and projects inwardly (*Fig.* 5, *c*) so as to seem to constrict the hydra. Next, we find this thickening prolonged sharply toward the axis of the calycle, in the form of an acute, triangular-edged, semi-partition (*Fig.* 6, *c*), which still further constricts the base of the hydra, and forms a more or less globular space below it, while above, toward the actinal end, the wall very rapidly decreases to a moderate thickness. There is some variation in the degree of progress of the development of this semi-partition (*c*), for we find, at much older periods (*Figs.* 7 and 8) than the last (*Fig.* 6), that the edge is not so sharp, nor prominent, although, as a whole, it is much thicker. Still later, again, we observe that the edge of the semi-partition (*Fig.* 9, *c*) is quite as sharp as in *Fig.* 6, *c*, but the space below it is comparatively more extended, and perfectly globular. From the fact, that in a hydra which has reached four fifths of its normal size (*Fig.* 9) the walls are retracted from a larger proportion of the calycle, and yet the thickness of the latter is far inferior to that of the adult, we infer that, notwithstanding this separation, the hydra has the power to renew, at will, the secreting process, in order to bring the walls of the calycle up to the required thickness. Even at the period when the hydra, being fully developed, pushes off the convex cap (*Fig.* 10, *d*) of the calyx, and emerges from its hitherto embryonic state, we frequently find the semi-partition apparently no more highly developed than in some of the much younger stages; but this is merely owing to the fact that it does not project at so sharp an angle from the sides of the calyx as it does in other individuals. The cap of the calycle which is pushed off, as the hydra protrudes for the first time, has the form of a watch-glass, whose edge is attached to the margin of the calyx at the point where the wall suddenly comes to a thin, revolute border.

We may here mention, also, a curious monstrosity, produced by an injury and the consecutive regeneration of a sterile hydra. Pl. XXIX. *Fig.* 1, represents a single hydra which possesses two calycles (a a^1), the inferior one of which forms the basis from which the pedicel of the upper arises. It would seem that the termination of the pedicel of the inferior calycle, having lost the head of its hydra, instead of directly budding a new head, first proceeded to grow onward, as a pedicel, and at the same time secreted a horny sheath (a^1), which was made continuous with the diaphragm (a) at the base of the old calycle, and, of course, concentric to the same; so that there is the curious anomaly of a calycle whose diaphragm is seemingly prolonged till it equals the length of a pedicel, and then a new calycle is developed, with a regenerated hydra head.

SECTION II.

CLYTIA (TROCHOPYXIS) BICOPHOBA *AG.*

Proles hydroidea. Adult. — The habitat of this species is the same as that of C. poterium, but it is not so abundant as the latter. It may be found from Grand Menan Island, at the extreme eastern coast of Maine, all along the New England coast, to Vineyard Sound, south of Cape Cod. The main stem (Pl. XXIX. *Fig.* 6, *g*) is stolonic, and either smooth or tortuous, while the pedicels (A–G), which arise from it at right angles, are more or less distinctly ringed, from base to apex. At some points the rings are twice as broad as deep (*Fig.* 7, c^2), at others they are equal in breadth and depth, and so on in all intermediate proportions. Occasionally the pedicels are branched, not only once (*Fig.* 6, B), but twice and three times (F *a b c*); but as this is not a common occurrence, and, moreover, since now and then a gemmiferous calycle (E, *d*) arises from the pedicels, we are inclined to look upon the branching pedicels in the light of erect stolons, if such a distinction can be made.

As regards size, this species is, on the average, a little smaller than C. poterium, but the most luxurious specimens (*Fig.* 6) fully equal the latter. The calycle (*Fig.* 7) of the sterile hydra is deeply campanulate, and the depth compares to the breadth as three to two (*Fig.* 6). When the hydra is retracted, the sides of the calycle are more or less collapsed (*Fig.* 7), and then the proportions between its depth and breadth are more nearly as two to one. The edge of the calycle is deeply indented (*Figs.* 7 and 7^b, c^7), or scalloped, into twelve or fourteen divisions, and broad triangular teeth (c^6) alternate with the sinuses (c^7). When the calycle is entirely empty, or the hydra is fully expanded (*Fig.* 6, F), the outline of the edge is circular; but when the hydra is contracted, the calycle becomes folded longitudinally (*Figs.* 7, 7^a, and 7^b) in such a manner that the teeth (c^6) correspond to the broad furrows, which are depressed inwardly, whilst the sinuses (c^7) project sharply outward, along with the ridges which bound the furrows; and thus, in a view from the end of the calycle, the teeth form the sides of a spherical polyhedron, and the sinuses constitute the projecting angles. At the base, the wall of the calycle is about as thick as that of the pedicel, but it gradually thins out toward the edge. The semi-partition (*Fig.* 7, *c*) is no thicker than the wall from which it arises, and the space below it and the base of the calycle is about one third broader than deep. The reproductive calycles (*Fig.* 6, *d e*) usually arise from the stolons (*g*), but occasionally from the pedicels (E). They are twice as long as the sterile calycles, and one third wider, and present an elliptical outline; the mouth is slightly narrowed, and smooth; the contour is varied by six or seven equidistant transverse ridges, with broad furrows between them; and the pedicel is very short, consisting of only three or four rings.

The sterile hydræ have twenty-four tentacles, and, in all respects, resemble those of C. poterium (Pl. XXVIII. *Fig.* 2, *a b c*), excepting that in this species the diaphragm (Pl. XXIX. *Fig.* 7, *c*) is very different. As for the reproductive hydræ (*Fig.* 6, *d e*), they are remarkable for their parallel constrictions, giving them a ringed appearance; but we have never been so fortunate as to see them alive, although this species has been collected by us in September, December, January, March, and April, during which months it was found to be destitute of these parts. We are obliged, therefore, to limit our remarks to a few observations made upon alcoholic specimens, collected incidentally in August, 1849, in Vineyard Sound, south of Cape Cod, and in August, 1857, at Grand Manan Island, off the most eastern shore of Maine. We cannot say positively whether these calycles produce free medusæ or medusæ-buds bearing planulæ, but are inclined to believe, from appearances, that they produce medusæ. At any rate, the breeding season is during the summer, certainly in August, and, probably, also in May, June, and July.

Proles hydroidea. Embryology.—The hydra of this species follows the same mode of development as C. poterium (Pl. XXVIII. *Figs.* 4–10); but the calycle is a simple, thin-walled case, until at least two thirds grown, when the diaphragm begins to develop, in the form of a thin, sharp ridge (Pl. XXIX. *Fig.* 8, *c*), which eventually projects straight across the lower part of the calycle, without increasing its thickness beyond that of the wall from which it arises. When the hydra is fully developed, and ready to escape from its embryonic confinement, we find that the calycle, along the elevations of the teeth (*Fig.* 9, c^6), and the depressions of the sinuses (c^7), suddenly thins, from within outwardly, to an oblique obtuse edge, which, consequently, corresponds to the outer surface of the calycle (see c^4 and c^7). At this border the cap (d d^1) is attached, and follows all the sinuosities; but it is, unlike the calycle, a very thin, filmy body, and divided into two regions, one of which, just above the edge of the calycle, is puffed outwardly, at regular intervals (d^2 d^3), which correspond to the sinuses (c^7) between the teeth; and the other portion is a smooth arch (d), like a watch-glass, which joins the first along a straight line (d^1), trending exactly transversely to the axis of the calycle.

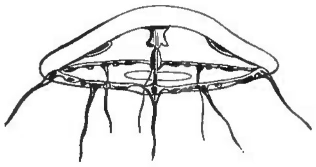
CLYTIA INTERMEDIA *Ag. Adult.*—As we have not seen the reproductive calycles of this species, we can characterize it only by the sterile hydra. The stolonic main stem (Pl. XXIX. *Fig.* 10, *g*), the pedicel (*Fig.* 11, c^2) of the hydra, and the diaphragm (*c*) of the calycle, are identical with the same parts in C. poterium (Pl. XXVIII. *Fig.* 3, $c\ c^2\ c^3\ c^4$); but the contour of the calycle (Pl. XXIX. *Fig.* 11, c^8), the thickness of its wall, and its border (c^6), with from twelve to fourteen teeth, agree with C. bicophora. On the whole, this species is a little smaller than the two others, the characteristics of which it combines. It is about as frequent as C. bicophora, but is likely to be overlooked, on account of its strong resemblance to the latter.

SECTION III.

CLYTIA (PLATYPYXIS) CYLINDRICA.

Proles medusoidea.—The newly-born medusa (Pl. XXVII. *Figs.* 8 and 9) of this hydra has the form of a hollow sphere, from which a segment, equal to one third of its diameter, has been sliced off. From the centre of the bell hangs a simple tubuliform proboscis (*d*), and from the base of this, four slender, radiating, equidistant, chymiferous tubes (*e*) descend along the inner face of the dome to its edge, where they join a circular tube (*b*) which is continuous throughout the circumference of the disk. The four canals have a uniform breadth from apex to base, and the circular tube has a similar uniformity, but is a little broader. About half way between the apex and base of each radiating canal, there projects from the face of the dome a slight, oblong swelling (e'), which is about twice as long as, and a little broader than, the diameter of the tube. These swellings represent the incipient, reproductive organs. From each of the four points of junction of the radiating and circular canals, hangs a single tentacle (*c*), which has a triangular hollow base (c^2), narrowing rapidly into a cylindrical, solid, slender organ of prehension. As these organs are habitually coiled up spirally, it is not easy to determine their length accurately, but they seem to be capable of extending several times the length of the bell. Midway between every two tentacles, the edge of the disk bears a slight granulated swelling (c^1), which is open interiorly and in direct communication with the circular canal (*b*), precisely in the same way as do the incipient tentacles of Tiaropsis (Pl. XXXI. *Fig.* 10), and on this account we infer that it is a similar organ; in fact, from what we have observed in regard to the eyes, we have every reason to believe that this medusa is closely allied to Tiaropsis. Just below and within the edge of the disk, and half way between every tentacle and the next tentacle-bud, on each side there is a hollow, globular, ocular vesicle (Pl. XXVII. *Figs.* 8 and 9, *f*), which stands out from the disk, and is attached by one side. Each of these eight vesicles contains a single, highly refractive, spherical body. Across the lower side of the disk there is a septum or veil, which has an opening (*a*) in its centre equal to about one half the breadth of the whole. The four rudimentary tentacles, which are at first mere swellings, soon become conical, their tip lengthening more and more, till we have four short tentacles, similar in all other respects to the first four tentacles seen at the base of the chymiferous tubes when the Medusa escapes from the calycle. Soon after the rudiments of eight additional tentacles (wood-cut 41) appear, which, as the Medusæ grow older, are probably further developed. The ovaries increase slightly in size, hanging like pouches from the chymiferous tubes. The chymiferous cavity shortens as the lobes of the actinostome are more deeply cleft. The opening of the veil grows larger and larger, and the spherosome more depressed, with increasing size.

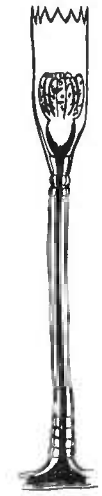
Fig. 41.



Free medusa of CLYTIA CYLINDRICA with eight eyes and eight tentacles, and as many more rudimentary ones.

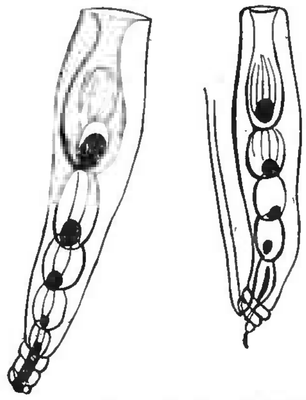
Proles hydroidea. — The sterile hydræ have sixteen tentacles; the stems of the single individuals are either connected by a creeping base, or ramify two or three times. The bell is deep, and has ten teeth along its edge; it equals in length half the length of the stem (wood-cut 42), which is straight, rather stout, with three or four rings near its base, and two at the base of the bell. In the only specimen in which reproductive calycles were found, they were placed at the base of a branch; they are smooth, increasing in breadth (wood-cut 43) from the base, with a slight constriction near the extremity; when seen edgewise (wood-cut 44), they are very much flattened, and uniform in breadth. There are three rings at the point of attachment of the fertile calycle, the flat side of which is turned towards the main stem. The calycles contained only five medusæ-buds.

Fig. 42.



Sterile hydra of CLYTIA CYLINDRICA.

Figs. 43 and 44.



Reproductive calycle of CLYTIA CYLINDRICA, seen, *Fig.* 43, from the flattened, and *Fig.* 44 from the narrow side.

Conclusions. — The Campanularians, thus far described, have all been referred to the genus Clytia *Lamx.*, in order to remind the reader of their systematic position, according to the present state of our knowledge of the Hydroids. A comparison of the preceding descriptions cannot fail, however, to show that we have here three different generic types, two of which produce medusæ differing as widely in their development as the genera distinguished above among the Tubularidæ, and one of these medusæ, that of Clytia cylindrica, resembles so closely the genus Tiaropsis, that I have, for many months, supposed it to be the young Tiaropsis, until this was, also, finally obtained. There can be no doubt now that the naked-eyed medusæ, with free eyes between their tentacles, arise from the creeping Campanularians, referred by Lamouroux to the genus Clytia, and by Johnston to the genus Campanularia proper. We shall see in the sequel that the branching Campanularians, now mostly referred to the genus Laomedea, bear medusæ with similar eyes, but attached to the base of the tentacles, and that the type of Campanularia dumosa, which belongs to the genus Lafœa of Lamouroux, produces Medusæ without eyes at all, one of which has been described as Atractylis repens by Mr. Wright. My son has lately traced the development of a species of Hydroids from our coast, which I have identified with Lafœa cornuta *Lamrx.*, the type of the genus, originally found in Newfoundland. This establishes, beyond a doubt, the fact that there are several families among the Hydroids thus far referred to the genus Campanularia.

SECTION IV

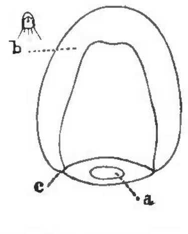
TIAROPSIS DIADEMATA.

This medusa is already minutely described in my first paper on the Acalephs of Massachusetts; I will, therefore, limit myself here to adding a few observations upon the structure of the eyes and reproductive organs, which are not satisfactorily represented in that paper. The form of the black pigment spot (Pl. XXXI. *Figs.* 12, 13, 14, and 15, *e*) which is at the base of the pedunculated eye, is only recognizable when viewed from above, in a line parallel to the axis of the disk (*Fig.* 13, *e*), and then its broad conical outline is apparent; and then only may we see that it occupies the centre of a thickening of the inner wall (*b*), of the edge of the disk, which, with the outer wall (a^1), forms a broad, rounded prominence above the eye peduncle. The ocular apparatus proper (*Figs.* 12–15, a^2) hangs from the under side of the disk and just within its edge. When seen from above (*Fig.* 12) or below (*Fig.* 14), it has the form of a battle-door without a handle, and in an end view (*Fig.* 15) it is transversely oval; in fact, it is a thick, transversely oval body, attached to the disk by a short and broad pedicel. The outer wall (*Fig.* 12, a^2) is in direct continuation with the outer wall (*a*) of the disk; it consists of a single layer of large, hyaline, broad, sharply polygonal cells, which appear like a net-work covering (*Figs.* 13, 14, and 15). These cells are visible as far as the pigment spot (*Fig.* 14, *e*), but within the range of this field they are so excessively transparent as to escape the powers of an ordinary microscope. The inner wall (*Fig.* 12, b^1) of the eye fills the whole length, breadth, and depth of its thickness, and is a direct prolongation of the inner wall (*b*) of the disk; and as in the latter, its cells are too transparent to be seen with an ordinary objective. The optical apparatus proper consists of a row of highly refractive, globular bodies (*c*), arranged in the form of a crescent, which lies parallel to the extreme border (a^2) of the eye, and half way between the upper and lower surface, as we may see by an end view (*Fig.* 15, *c*). Each lens of the coronet is enclosed by a cell wall, in fact, it is the whole content of a cell. We have counted as many as fourteen lenses (*Fig.* 12, *c*) in one coronet, of which the central ones are the largest, and those on each side successively smaller. The circular tube (*f*) has no communication whatever with the eye, nor with the pigment spot.

The generative organs are represented on Pl. XXXI. *Figs.* 9 and 9^a. In the region occupied by these organs, the radiating tube has the form of a deep oblong pouch (*Fig.* 9, a^1), which, when the edge of the disk is rolled inwardly, may be seen, in a sectional view (*Fig.* 9^a), to be broadest above (*a*) and narrowed by one half to a rounded bottom (a^1), in such proportions as to be one third deeper than the greatest breadth. The innermost, or lining wall (*Fig.* 9, 9^a, *b*) of the disk, is prolonged over the pouch, and becomes a thicker layer (b^1) than in any other part of the disk. Between this and the wall (a^1) of the radiating tube, the eggs, or spermatic particles, are developed. As the eggs increase in size, the outer surface of the ovary becomes papillated by their prominence, and the color gradually changes to a dark bluish-grey. The chymiferous fluid circulates as freely in the pouches as in the rest of the tubes, and rather more actively, and with a greater variety of passing and repassing currents.

Embryology. — On the 31st of March, 1855, we discovered the youngest Tiaropsis diademata which we have ever had the good fortune to investigate. At that time the disk was deep bell-shaped (wood-cut 45), and about one twelfth of an inch in diameter; the thickness of the parieties (*b*) nearly uniform, and, on the average, one fifth that of the diameter of the bell, with a slight diminution toward the lower edge (*c*), where it rounded off abruptly; and the aperture (*a*) in the veil one third the marginal diameter of the disk. There were nine diversely developed tentacles (wood-cut 46, *a b d*) on every quarter of the disk, making, with the four primary ones (*e*), opposite the four radiating canals, forty in all. The four tentacles (*a*), intermediate to the four canals (*g*), were two thirds the length of the primary ones (*e*) and the

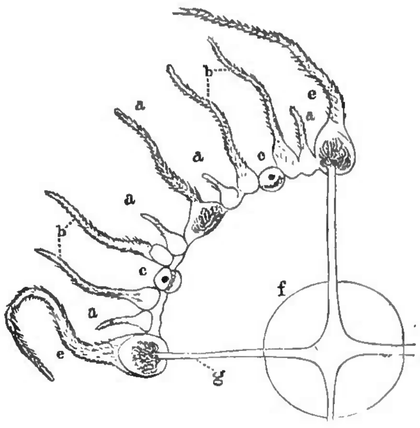
Fig. 45.



Youngest TIAROPSIS observed, with forty tentacles, and magnified disk.

a opening in the veil. — *b* wall of the bell. — *c* its lower edge.

Fig. 46.

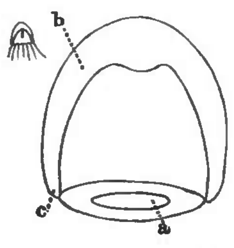


Quarter segment of a very young TIAROPSIS.

a b d secondary tentacles. — *e e* primary tentacles. — *g* chymiferous tubes. — *c* compound eyes. — *f* opening of the veil.

base, as in the latter, had a large cavity communicating with the circular tube. On both sides of, and in immediate juxtaposition to, each eye (*c*), there was a tentacle (*b*) nearly as far advanced as the secondary ones (*a*), but the base was as yet only slightly swollen, and contained scarcely any pigment cells within its cavity. Of these, the third group, there were sixteen, two for each of the eight compound eyes (*c*). The fourth, and youngest group (*d*), amounted to sixteen, one on each side of every primary (*e*) and secondary (*a*) tentacle. They were scarcely more than one third as long as those of the third group, and had perfectly transparent bases, which, however, were very nearly as broad as the bases of the third group. All the tentacles of the first, second, and third groups, bristled with well-developed lasso-cells, and, in the fourth group, these bodies were in a rudimentary state, just far enough advanced to appear like minute specks in the walls of the tentacles. The highly refractive corpuscules of the eyes (*c*) numbered no less than six or seven in each eye, and were arranged parallel-wise to the edge of the disk. There was also a pigment spot at the base of each eye, which was already so dense as to be more conspicuous than the refractive corpuscules. It thus appears that, after the first, the others, secondary tentacles, follow regularly in pairs. The mode of development of tentacles is very simple, and may be comprehended at a glance by inspecting the figures which we have given (Pl. XXXI. *Figs.* 10 and 11), to illustrate this process. The outer wall (*Fig.* 10, a^1) of the edge of the disk, together with the inner one (b^1), protrude in the form of a double-walled papilla (*a b*); this papilla continues to grow for a while by the same process with which it commenced; and in this way a hollow, double-walled (*Fig.* 11, *a b*), broad cone is produced. From this hollow base the solid portion, or tentacle proper, is developed; but we have not traced its cellular growth, and therefore cannot point out any thing beyond the general increase in proportions, size, and appearance, as we have done above for the medusa with forty tentacles. As the animal increases in size, the bell gradually broadens, as may be seen in our figures of a specimen one eighth of an inch in diameter (wood-cut 47). It has fifty-two tentacles, twelve between every two of the primary ones; the upper, or abactinal half (*b*) of the disk, is still as high as one fifth the transverse diam-

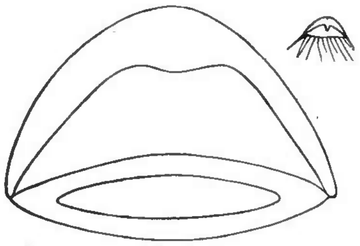
Fig. 47.



Young TIAROPSIS with fifty-two tentacles, and magnified disk.

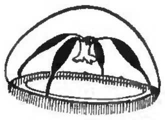
eter of the whole bell; but it thins out toward the actinal end (*c*), where it terminates in a rather blunt edge; and the aperture (*a*) of the veil occupies a little more than one half the whole lateral extent of the actinal end of the disk. The oldest medusa, still in the progress of growth, which we have studied, was one fifth of an inch across the actinal margin (wood-cut 48), and bore eighty variously-developed tentacles, of which four were primary, and nineteen secondary, in every quarter segment of the disk. The shape of the disk had approached near to that of the adult (wood-cut 49), which is a deep saucer form, and the veil was reduced to about the same proportions as in the adult, being one eighth the breadth of the actinal end of the disk.

Fig. 48.



TIAROPSIS with eighty tentacles.

Fig. 49.



Adult TIAROPSIS DIADEMATA.

SECTION V

LAOMEDEA AMPHORA *AG.*

Proles hydroidea. *Adult.*—This hydromedusarium (Pl. XXX. *Figs.* 1, 2, and 3) may be found in any of the rocky tide-pools along our coast, attached either to sea-weeds or to the shells of stationary mollusca. It is one of the most hardy of the Campanularians, but we cannot say that we have ever seen it left out of the water entirely, and only covered, like Dynamena, with dripping Fucus pendent from the sides of rocks and boulders. It usually grows to a length of three or four inches, but occasionally may be found five or six inches long. The orientation of the branches is the same as in Obelia commissuralis, excepting that the branches do not diverge nearly at a right angle, as in that species, but at about thirty-five or forty degrees. The rings at the base of the branches are often more numerous than in the above-mentioned species, but the most marked difference is in the middle of each internode (*Fig.* 11, c^3), where it bulges laterally, and directly in a line with the point of insertion of the branch or pedicel below it. The pedicels are ringed throughout, and the older ones (*Fig.* 14, c^2) are very deeply constricted. The calycle of the hydra is campanulate, and from one third to two fifths deeper than broad, and the edge is slightly polyhedral, usually twelve-sided (*Fig.* 6^a). The wall is very thin; at the base it has the same thickness as that of the pedicel, but thins out to a mere film at the edge. The partition

(*Figs.* 6, *a b*, and 7, *a b c*) near the base of the cup appears to be a separate layer from the wall on which it rests, and is composed of two strata; the upper one of which extends from the edge of the median aperture to the wall of the calycle, and (c^1) along the inner face of the same, toward its mouth, while the lower, or abactinal side of the semi-partition, projects from the edge of the central aperture, in the form of a narrow rim (*b*), toward the base of the calycle, and also extends along the inner face (c^2) of the latter into the pedicel. In an empty calycle (*Fig.* 6) there may be observed, with a low power, a row of dots (*a*) along the outer edge of the partition; these, when more highly magnified (*Figs.* 6^b and 7, *a*), prove to be the papillæ of a fringe which projects from the exterior margin, and is a direct continuation of the same. It is quite evident that these papillæ have to do with the attachment of the hydra to the calycle, although they would not seem to be absolutely necessary, as they are not present in Obelia commissuralis and some other allied species. The space between the partition and the base of the calycle is twice as broad as deep, and but little broader than the proximate point of the pedicel.

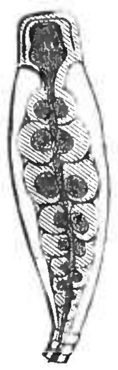
The reproductive calycle stands on a four or five-ringed pedicel (*Figs.* 15 and 18, *k*), which rises from the base of each hydra pedicel, just without the fork; its shape, when mature (*Fig.* 18), is elongate oval, and opens by an aperture no larger than the entrance from the pedicel at its base. It is about four times longer, and one half broader than the calycles of the hydræ. The wall is of the same thickness throughout, and equal to that of the base of the hydra calycle. The sterile hydra (Pl. XXX. *Figs.* 4 and 5) has at least thirty tentacles, and it appears to be essentially the same in structure with that of the genus Obelia. The axis (*Fig.* 15, β γ) of the reproductive hydra bears the same relations to the calycle (*k*) as in Obelia and Eucope, but the medusæ (h^1), although developing in exactly the same manner, do not become so highly complicated, nor are they ever freed, to live an independent life, but reproduce their kind through planulæ, and then wither.

Embryology. Proles medusoidea.—The highest degree of development to which the medusa attains, corresponds to the very early stage of those medusæ which become free; in fact, the medusa of this species is nothing more than a double-walled hernia (Pl. XXX. *Figs.* 15, h^1, 16, and 17, h^1 h^2; Pl. XXXI. *Figs.* 2, 5, 5^a, 6, 6^a, 7, and 8, h^1 h^2), with a space between its outer and inner walls, in which either the egg (Pl. XXX. *Figs.* 15 and 16, *ae*) or the spermatic particles (*Fig.* 17, *ae*) are developed. In the female medusa (*Fig.* 15, h^1) the egg (*ae*) begins to develop before the inner wall of the medusa has risen above the level of the axis. Presently, however, the inner wall also projects, and forms an elevated floor upon which the egg rests (see the upper *ae*, *Fig.* 15); and, finally, the two walls, rising together and constricting at their base, form a globular sac with a short and moderately thick peduncle. In the mean while, the space between the walls has gradually increased in size, but is constantly filled by the egg, which develops at the same rate, until the medusa has matured (*Fig.* 16), when the egg occupies about four fifths of the whole bulk of the projecting body. In this state the inner wall (*Fig.* 16, *h*) is inverted upon itself, and constitutes a shallow, saucer-shaped basis for the egg. The chymiferous cavity (h^4) penetrates to the extreme edge of the saucer, where, in profile, it appears like an incipient stage of the radiating chymiferous system. In later stages, when the segmentation of the yolk is going on, the saucer gradually diminishes, and finally becomes a mere disk (Pl. XXXI. *Figs.* 5, 5^a, 6, and 6^a, *h*) or truncate termination (*Figs.* 7 and 8, *h*) of the interior wall, and, at the same time, the yolk mass gradually fills the space left by the retreating saucer, and, finally, becomes a globular mass (*Fig.* 8, *ae*).

The egg (Pl. XXXI. *Fig.* 2, *ae*) is always more or less flattened, even at maturity (Pl. XXX. *Fig.* 16, *ae*), when upon the point of undergoing segmentation. It consists of a dense mass of minute yolk granules (Pl. XXXI. *Fig.* 2, *ae*), and a large, tough, clear Purkinjean vesicle (*Figs.* 2, *p*, and 2^a), which contains several irregular, scattered mesoblasts, and, within each of the latter, one, two, or three very minute granular entoblasts. The process of segmentation is very easily traced, on account of the moderate degree of opacity of the yolk; it commences by forming a furrow (Pl. XXXI. *Figs.* 3, 3^a, and 3^b, a a^1 a^2) across the yolk on that side which lies next to the peduncle of the medusa, that is, on the abactinal side. The division proceeds very rapidly; in fact, it could actually be seen, for, in one hour, not only had the yolk separated into two, but each half had divided again into two (*Fig.* 4, *b c d e*), by furrowing transversely (*f g*) to the primary constriction (a a^1). That the segment masses are not always of equal size among themselves, may be seen in two of our figures (*Figs.* 5 and 5^a), which were drawn carefully to illustrate this point, and lettered correspondingly with *Fig.* 4. It will be noticed that the first and second constrictions (*Fig.* 4, a, a^1–f, g) pass through the yolk in planes which are parallel to the axis of the medusa, but at right angles to each other. In the next stage, each of the four segments divides in a direction either directly (*Fig.* 6, b c, b^1 c^1) or obliquely transverse (*Fig.* 6^a, d e, d^1 e^1) to the axis of the medusa, so as to form eight segments. As the self-division goes on, the yolk gradually becomes less opaque, so that, by the time it is separated into thirty-two masses (*Fig.* 7, *ae af ag*), the granular contents (*Fig.* 7^a) of each segment may be seen without difficulty. Here, too, as in former stages, the segment masses vary considerably in size; some of them (*ag*) being fully one third greater in diameter than others (*ae*). It is, also, a very notable fact that the yolk, as a whole, diminishes in bulk, as segmentation proceeds (compare *Figs.* 6, 7, and 8) and the wall of the medusa presses more closely upon the contents. In the oldest phase which we have observed, the yolk was divided into innumerable masses (*Fig.* 8, *ae*), each of which was from one fourth to one sixth the diameter of those of the last stage. The planula, when fully developed, has an oblong form, like that of Clytia (Orthopyxis) poterium.

The male medusa (Pl. XXX. *Fig.* 17, A B C D, and wood-cut *Fig.* 50) does not have a peduncle like the female, and yet, in one respect, it attains to a higher degree of development than the other sex, inasmuch as it becomes possessed of a proboscidal actinostome (*Fig.* 17, D h^5), which projects at least through three quarters of the axial diameter. As in the female, the reproductive material of the male occupies the space between the outer and inner wall of the medusa, from the beginning of its development (*Fig.* 17, A, *ae*). The medusa develops for a while merely by the gradual separation of the outer wall (β) from the inner one (γ), while the spermatic mass (*ae*) keeps the growing interspace constantly filled. Gradually, however, the inner wall begins to rise above the level of the axis; but instead of forming a saucer-shaped body, it projects pointedly, at first, like a broad, conical papilla (C, h^5), and, finally, becomes, at maturity, a broad cylindrical actinostome (D, h^5). The spermatic mass always fills the medusa to its extreme border, and, consequently, runs out to quite a sharp edge at its base, where the outer (h^1) wall of the medusa meets that of the axis (γ), and, therefore, in a mature state (D), it is more or less broadly and inversely bell-shaped when the medusæ are few; when crowded, they assume a more rounded form (wood-cut, *Fig.* 50). The spermatic particles (Pl. XXXI. A B) have a guitar form (*a*), with a very slender filament (*b*), twelve to fourteen times longer than the body, prolonged from the broader end. We have often found the whole mass of the axis and its medusæ crowded together at the mouth of the calycle (Pl. XXX. *Fig.* 18, *k*), and partly extruded, in a globular mass (A). At first sight, this appearance reminds one of the well-developed female medusæ which Lovèn saw growing at the end of the axis, outside of the calycle of Campanularia (Laomedea) geniculata;[1] but, in our animal, it is merely a breaking loose of the reproductive bodies after they have completed the term of their office.

Fig. 50.



Fertile Hydra of LAOMEDEA AMPHORA, showing how the male medusæ are arranged around the axis of the hydra.

Proles hydroidea. — The mode of development of the hydra of this species is essentially identical with that of Obelia. The representations of the two given

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[1] Wiegmann's Archiv, 1837, Tab. VI. *Figs.* 12 and 13; and translated in the Annales des Sciences Naturelles, 1841, Vol. XV. Pl. VIII. *Figs.* 12 and 13.

in Pls. XXXIII. and XXX. complete each other; some figures of L. amphora reproducing stages intermediate to those figured for Obelia. As the description of the plate will sufficiently elucidate their character, we may simply enumerate them in the order of their relative state of development. Thus, the youngest is Pl. XXXIII. *Fig.* 3^a; then Pl. XXX. *Fig.* 8, the base of a branch; Pl. XXXIII. *Fig.* 3, a branch and the base of a pedicel; Pl. XXX. *Fig.* 9, a calycle half grown; Pl. XXXIII. *Fig.* 4, a calycle three quarters developed; Pl. XXX. *Fig.* 10, just before the tentacles begin to form; Pl. XXX. *Fig.* 11, somewhat contracted, and *Fig.* 12, the calyx fully shaped out, and the rim, from which the tentacles arise, quite sharp, and *Fig.* 13, the same as the two last figures, showing the calyx broadened at the base by the strongly-retracted hydra; Pl. XXXIII. *Fig.* 7, the tentacles just beginning to develop, *Fig.* 9, tentacles further advanced, and, finally, *Fig.* 8, the tentacles complete, and the operculum of the calyx upon the point of falling off.

SECTION VI.

OBELIA COMMISSURALIS *McCR.*

Proles hydroidea. Adult. — The hydrarium of this species is a littoral animal, and may be found at low tide along the rocky shores of the Atlantic Ocean, from Nova Scotia to Charleston, South Carolina, attached to stones, or sea-weeds of various sorts. It rises from its base to a height of at least five or six inches (Pl. XXXIII. *Fig.* 1), but is certainly in an adult state even when not more than an inch high (*Fig.* 2), inasmuch as, at that age, it bears medusæ, in the proper season. In its mode of branching it comes nearer to Laomedea dichotoma of the European shores, as figured by Johnston in his "British Zoöphytes," 2d ed., Pl. XXVI. *Figs.* 1 and 2, p. 102, than to any other species thus far described. Van-Beneden's figure of the European species, under the name of L. geniculata, Mém. Acad. Brussels, 1844, Vol. XVII., is better than that of Johnston's. The most closely-allied species, however, is that described by Cavolini, "Memorie, &c., &c., polipi marini, Naples, 1785, Tab. 8, *Figs.* 1, 2, 3, and 4," under the name of Sertularia geniculata;[1] for, in this species, not only are the reproductive calycles identical

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[1] McCrady has already described our species without, however, giving a full account of its development. He was, nevertheless, right in restoring the name of Obelia *Pér.* and *LeS.* to this type, and I have no doubt that the Obelia sphærulina figured by Slabber, and quoted by Péron and LeSueur, is the free medusa of the Hydroid described by Johnston and VanBeneden.

with those of the American species, even to the constricted truncate aperture (Pl. XXXIV. *Fig.* 11, k^1), but they bear also free medusæ. The branches spread nearly at right angles (Pl. XXXIII. *Fig.* 11), and the whole appearance of the hydromedusarium reminds us of that little Caryophyllaceous plant, the Spergularia rubra. In the earlier stages of growth (*Fig.* 2) the stem is very simple; the branches arise, at intervals of about one tenth of an inch, in a spiral, and, in progress of growth, each branch gives off other branches, which are arranged in the same way. Every interval of the chitinous stem, between any two branches, is gently curved (*Fig.* 6, β), and the outlines are parallel; at the base of each there are four or five rings (ε); and so is it with every branch, whether it be primary, secondary, or tertiary. Each branch pursues a zigzag course, every internode trending at an angle of forty-five degrees from the previous one.

The pedicels of the hydra calycles (*Figs.* 6 and 11, C) are ringed (c^2), from base to apex, and, when fully developed, are nearly as long as the intervals of the branches. Those hydræ which terminate the branches (*Fig.* 6, C^1) are usually not completely developed, at least the pedicels are not as long as the others, and, being in direct continuation with the branches, appear as if partially ringed, whereas the smooth portion belongs to the branches proper. The calycle of the sterile hydræ varies in shape from a narrow (*Fig.* 5, c^3) to a broadly campanulate (*Fig.* 12, c^3) outline, but its form is more or less dependent upon the contraction or expansion of the hydra. When the calyx is empty, and left to itself, it assumes a broad campanulate form (*Fig.* 12). The rim (c^6) is even, but polyhedral (*Fig.* 12^a), and each of the twelve sides (c^6) is slightly curved inwardly. This peculiar figure is confined to the terminal fifth of the cup, whereas the remaining portion is perfectly circular in outline. At a short distance above the base of the calyx, equal to the height of one of the rings, a semi-partition (c) projects into the cavity of the bell. It is as thick as the wall of the calyx, at its margin, but thins out to a sharp edge at the border of the central hole, which occupies one fourth of its breadth. The cavity thus formed below the semi-partition, is half as deep as broad. The wall of the calyx is thin at the base, where it bears the same proportion to the whole that the shell of a fowl's egg bears to the whole egg, but it thins out gradually to the margin, where it is a mere film, and very frail and flexible. During the breeding season, the reproductive calycles (*Fig.* 11, A B) occupy the forks of the branches and of the pedicels; each one is borne on a short peduncle, consisting of three or four rings, and, when fully developed, broadens gradually upwards, and, attaining a height double that of the hydra calycle, it suddenly constricts (Pl. XXXIV *Fig.* 11) to one third of its previous breadth, and then terminates in a slightly expanding short neck (k^1), which is about as long as two of the rings of the peduncle. The breadth of the calycle is the same as that of the hydra. The wall (k) of this calycle is of uniform thickness throughout, and, in this respect, is equal to that of the peduncle. The microscopic structure of the horny sheath of the hydrarium does not differ from that of other Hydroids; it being merely a concentric series of fibrillated lamellæ (Pl. XXXIII. *Figs.* 13 and 14, c^2). The transverse striæ, which appear here and there in the thickness of the sheath, are inexplicable features, which have all the appearance of minute anastomosing vessels in another genus (Pl. XXXIV. *Fig.* 1, a^1 a^2). There is no essential difference in the hydra from that of Laomedea amphora (Pl. XXX. *Figs.* 4 and 5), except that, perhaps, the latter has more tentacles, but of this we are not certain. Every calycle contains a single hydra, consisting of a digestive cavity (Pl. XXXIII. *Fig.* 5, g), which is based upon the semi-partition mentioned above (Pl. XXXIII. *Fig.* 12, c), and terminated by a single coronet of slender, tapering tentacles (Pl. XXX. *Fig.* 5, A B), with an extremely dilatable simple proboscis (pr) rising in the centre of the circlet. As peculiar to all Campanularians, the tentacles are here, also, alternately elevated (B) and depressed (A) when fully expanded, although their bases are, strictly, in one row. The double walls of the stem (Pl. XXXIII. *Fig.* 5, a^1 b^1), the digestive cavity (a b), the tentacles (a^2 b^2), the proboscis (a^3 b^3), the reproductive calycle (Pl. XXXIV. *Fig.* 11, β γ), and even the medusæ-buds (β'' γ'), are continuous with each other throughout the hydromedusarium. The inner wall is generally twice as thick as the outer one, except, perhaps, in the reproductive calycles, where the two (Pl. XXXIV. *Fig.* 11, β γ) are nearly alike. The flexibility of the semi-partition (Pl. XXXIII. *Figs.* 12 and 12^a, c) allows the passage of the double walls (*Fig.* 5, a^1 b^1) of the pedicel into those of the digestive cavity (a b), without sensible constriction. The lasso-cells are arranged not only in transverse but also in longitudinal rows (Pl. XXXII. *Fig.* 5^b, l), the transverse rows corresponding to the transverse walls of the axial cells (b^2). There are at least six longitudinal rows of these prehensile organs, and there are no other Hydroids in which the individual lasso-cells project so far from the surface as in this species, and in all the Campanularians. The figure which we give here (*Fig.* 5^b) represents two of the lasso-threads wound about an Infusorium (α), which was caught while we were examining the tentacle.

As we have said before, the walls of the reproductive calycles are double, and in direct prolongation of those of the stem. They are supported by processes (Pl. XXXIV. *Fig.* 11, β''') from the outer wall, and by their terminal attachment (β γ) to the end of the calycle (k^2 k^3). The outer surface of the exterior wall is exceedingly transparent, and, being elevated in longitudinal ridges (β'), has the appearance, in profile, of a third wall; and, moreover, being very plastic, it doubles over the medusæ and seems to form an exterior sheath or veil. The medusæ (A–G) occupy the whole length of the axis, and are present in the younger stages of growth (Pl. XXXIII. *Fig.* 6, B) a long time before the calycle is fully developed (Pl. XXXIV *Fig.* 10), but are not set free until the latter is mature.

Embryology. Proles medusoidea. — The first steps in the development of the medusa are precisely the same as in Coryne mirabilis (p. 192); the outer (Pl. XXXIV. *Fig.* 11, G, β'') and the inner (γ') wall push out from the axis and form a hernia; the hernia continues to grow until it becomes pear-shaped (Pl. XXXIV *Fig.* 16, A), and then the radiating tubes (*Fig.* 16, B, h) and the proboscis (p) begin to form; the radiating tubes, extending their extremities, finally reach the actinal end of the disk (*Fig.* 13, 13^a, h); at the same time the tubes, or rather the inner wall in which they are developed, includes, as it were in a cup, a prolongation (*Fig.* 13, h^1) of the outer wall exactly as in Coryne.

There are differences in the proportions of the embryos of these two genera, which, however, do not clash with the typical mode of development of the Hydromedusæ; at a period not long before the radiating tubes unite laterally to form the circular tube, the embryo gradually changes from a globular to a broadly discoid form (*Fig.* 17), and the radiating tubes (h) are correspondingly broadened, but, in subsequent phases, become proportionately narrower. By the time the embryo is two thirds grown the tentacles (*Fig.* 11, C, t) begin to bud, appearing like broad papillæ when seen in profile; and the proboscis (p) projects prominently beyond the outlines of the disk. As the tentacles are developed, they curl inwardly upon themselves, so that, to the very last moment before birth, they appear externally as broad crenulations (*Fig.* 11, A, B, t). Some time before birth the mouth assumes its four-cornered, characteristic (*Fig.* 10, A, m) form. Finally, the embryo breaks loose from its attachment with convulsive, systolic contractions, and finds its way out of the calycle between the walls of the axis and the edge of the aperture. In the very act of extrusion, it expands its disk and unrolls the tentacles, so that by the time it has freed itself from the embrace of its parent, it is already fully expanded, and at once commences the diasystolic movements of the act of swimming. It has, at birth, sixteen tentacles (Pl. XXXIV. *Fig.* 18, t, t^1) and four broad radiating tubes (f^1), and a circular tube (f) equally broad, which are quite conspicuous, and render the observation of its movements very easy. When in a state of rest it usually retains the diastolic state, the tentacles are thrown upwards, and their ends droop in graceful curves, in a contrary direction to the concavity of the reverted disk, while the proboscis, hanging below, adds to the resemblance of a broad vase, with herbage pendent from its edge. Suddenly it reverses its position, and then the proboscis hangs from the centre of a broad concavity, the tentacles curving in the same direction, when the medusa has altogether a drooping appearance. From one of these extremes to the other, it passes, during the act of swimming, with various degrees of rapidity; and, at times, the tentacles are thrown more strongly upward, so as to be nearly parallel with the axis of the proboscis, or, in the systolic act, they are, as well as the disk, strongly curved downwards, and form a deep bell-shaped cavity about the proboscis. The proportions of the disk are like those of an old-fashioned bull's-eye watch-glass, thickest in the centre, and thinning out to an edge. The centre is occupied by a four-sided digestive cavity (*Fig.* 12, h^4), from which a simple, trumpet-shaped quadrate proboscis (p) hangs down, to a depth which, in full extension, equals the semidiameter of the disk. The four corners of the proboscis correspond to the four corners of the digestive cavity. From the digestive cavity (h^4) four radiating canals (f^1) extend from its four corners to near the edge of the disk, where they connect with a circular canal (f) which passes through the whole circuit of the margin. Within these canals a constantly circulating current is kept up by means of large vibratile cilia (*Figs.* 20 and 21, f, f). Of the sixteen tentacles, there is one opposite the termination of each radiating canal, and three, arranged at equal distances, in every quarter segment between the canals.

Seen from above, every tentacle seems to taper gradually from the base to the apex (*Fig.* 20), but, upon looking deeper, its actinal end appears enlarged into a broad swelling (γ), which, however, when observed more closely and from below (*Fig.* 21, γ), proves to be a two-fold lobe of the edge (a) of the disk, embracing the base of the tentacle. The outer wall (*Fig.* 12, a^1) of every tentacle is continuous with the outer wall of the disk (a), and the inner wall (b^1) of the same is a prolongation of the middle wall (b) of the disk. The base of each tentacle has a broad and rounded prolongation (*Figs.* 12 and 20, β), which projects toward the centre of the disk, and across the actinal side of the circular canal. The eight eyes (*Fig.* 12, α) are affixed to the actinal side of the base of the eight tentacles which stand, one on each side of the radiating canals. Each eye is a globular body (*Fig.* 21, α), containing, at its centre, another globular body (α') about one quarter its diameter, and possessing highly refracting properties. The eye stands out from the surface, and, in profile (*Fig.* 18^a, α), is a very conspicuous object. The transverse veil (*Fig.* 12, v), which borders the margin of the disk, is about one eighth the diameter of the latter, more or less wavy at the edge, and very transparent and thin. The proboscidal actinostome (*Fig.* 12, p) is double-walled, as in other Hydroids; the outer wall (p) is thin and continuous with the innermost or lining wall (g^2, and *Figs.* 20 and 21, g, g^1) of the disk, and the inner wall (p) is very thick and continuous with the middle wall in which the radiating and circular canals are hollowed out (*Figs.* 20 and 21, f, f^1). The arrangement of the lasso-cells on the tentacles is peculiar; in a view from the abactinal side (*Fig.* 20), we see a single row along the middle, and a double row on each edge; whereas, on the actinal side (*Fig.* 21) there is no central row. Each lasso-cell is opposite the walls of the axial cells (*Figs.* 20 and 21, b^1), which are arranged end to end in a single series, and none are opposite the cells themselves, so that, as a natural consequence, they are not only arranged in longitudinal, but also in transverse rows or circlets. The proboscidal actinostome exhibits very clearly the changes which the component cells undergo during its contraction and expansion. During contraction they are more nearly equilaterally polygonal (*Fig.* 14^a), and do not seem to have any method in their arrangement; but in expansion (*Fig.* 12, *p*) they are disposed in rows, radiating from the centre, and are elongated (*Fig.* 14) in the same direction. Even with a magnifying power of five hundred diameters they appear small, but yet very well defined in outline. The cells of the lower, or actinal, surface of the disk (*Fig.* 15) are a little larger than the last, and differ in having finely granular contents. In the double, bulb-like protrusions (*Figs.* 21, γ, and 21^a) of the edge of the disk, at the base of each tentacle, the cells are much smaller than those of the actinostome, but, nevertheless, sharply polygonal.

Proles hydroidea. — Whenever a new branch, or a new pedicel begins to bud, the cells of the outer and inner walls of the old branch become quite conspicuous at that point (Pl. XXXIII. *Fig.* 3^a, a^1, b^1), and to some distance above and below it (ε), whereas, on the opposite side, they are not more prominent (α, β) than usual. In a later stage (*Figs.* 3 and 4, 4^a), we will describe the peculiarity of these cells. It will be noticed that the wall of the bud (*Fig.* 3^a, a^1, b^1) and of the old stem near it (ε), are considerably thickened, and press closely against the chitinous sheath; and that the latter is torn open and cast aside (c^2) by the protruding bud, which bears a new sheath (c^3) of much thinner and more delicate structure. From the beginning, the bud has a tendency in the direction of its future line of growth, and even overlaps (δ) the main stem (ε) to a considerable extent. As the stem or peduncle grows, it assumes at each point the form which it ever after retains, as may be seen by the examination of our figures. *Fig.* 3 represents a young branch which, at the lower part, has all its adult characteristics, as regards the general proportions (α, β, γ, ε); while at the end it is still growing, and, as it proceeds in this way, the rings are developed by a deposition from the exterior surface of the outer wall (a^1). As fast as the chitinous tube is completed, the outer wall withdraws from it, in a greater or less degree, leaving here and there isolated projections (γ) still adhering to the sheath. The completion of this tube corresponds, also, to the obscuration of the cellular structure of the outer and inner walls, in fact, the amount of development of the stem may be estimated by the degree of faintness of the cells of these walls. The chymiferous cavity does not follow the terminal growth of the stem very closely, as the tip of the inner wall of the young part of the pedicel is solid

(b^1) to a considerable distance beyond. The circulation of the chymiferous fluid is very active in this part of the hydrarium, and there seems to be an unusual amount of granular matter brought to these parts. The hydra (*Fig.* 4) is developed by an expanding terminal growth of the pedicel. The outer (a) and inner (b) walls have the same characteristics as those of the growing stem (*Fig.* 3, a^1, b^1), and, as in the latter, the cells are arranged transversely to the thickness of the walls, and in a single layer. The cells of the outer wall (*Figs.* 3 and 4, a, a^1) are much more slender and transparent than those of the inner wall; they are prismatic and sharply angular (*Fig.* 4^a), and have an average transverse diameter of one five thousandth ($\frac{1}{5000}$) of an inch. The cells of the inner wall (*Figs.* 3, b, and 4, b) are nearly twice as broad as those of the outer wall, and are much darker and have thicker walls. Their inner ends are thickly coated with ragged brown pigment cells, which are detached, from time to time, and carried away by the circulating fluid. After the calycle is complete, the broadest part of the top-shaped hydra becomes the seat of the development of a circle of papilliform protuberances (*Figs.* 7 and 9, t), which are formed by the combined protrusion of the outer and inner walls. These rapidly grow into well-formed tentacles (*Fig.* 8, t), but are confined in their extension by the calycle. The relative proportions, in thickness, between the outer and inner walls of the adult hydra, are assumed as fast as these walls are developed; so that they are comparable to those of the adult (compare *Figs.* 7 and 5, a, b) at the time the tentacles have begun to form (*Fig.* 7, t). Just before the hydra issues from its retreat for the first time, it retracts from the parietes of the calycle, and offers a better view of the structure of the latter, especially of the margin (*Fig.* 8, c^6, c^7) and the opercle (d). The margin is identical in form with that of the older adults, and rather more distinctly polygonal. The opercle (d) does not meet edge to edge with that of the calycle, but its rim is bent, at a sharp angle, inwardly, and forms a narrow transverse shelf (d^1). A very noticeable feature in the outer wall of the stem and pedicels is the enormous development of lasso-cells, which make their appearance just in proportion as the cells of the growing wall become obscure (compare *Figs.* 3 and 4). In the adult they roughen the wall like the teeth of a farrier's file (*Fig.* 13, a^1).

SECTION VII

EUCOPE DIAPHANA *AG.*

Proles hydroidea. Adult. — The habitat of this Hydroid is either below low-water mark, or else in deep pools which are not left more than an hour or two uncovered by the sea. It evidently needs all the advantages of the open ocean in order to thrive, and we find it very difficult to keep it alive, unless the water in the jar is made icy cold. It is most frequently attached to the fronds of Laminaria, but may be found on other sea-weeds. Its true characteristics are very much disguised unless it has a broad surface like that of Laminaria to creep over, when its stolons pursue nearly straight courses, giving off, occasionally, a branch to the right or left (Pl. XXXIV *Fig.* 9), and, at regular intervals, an upright stem. A colony of such Hydroids resembles a long row of trees vanishing in the distance. Fronds of Laminaria, thrown up from deep water, frequently bear the most perfect examples of this peculiar mode of branching. It is a remarkable fact, that the upright stems lean toward the direction of the growth of the stolon, so that between each upright stem and the stolon from which it springs, there is an acute angle (Pl. XXXIV *Fig.* 9) of about sixty-five or seventy degrees. The upright stem is not more strongly zigzag than that of Obelia commissuralis, or related species, but by reason of the great thickening of the horny sheath (Pl. XXXIV *Fig.* 5, e^1) on alternate sides of the successive joints, the appearance of a zigzag is produced, whereas the course of the chymiferous cavity of the hydrarium is only slightly sinuous. In dried specimens, the zigzag appearance becomes exaggerated by the unequal contraction of the corneous tube. Each intermode (*Fig.* 5, e^1) is twice as long as its greatest breadth, and the point of its greatest thickening is always in the same plane, and corresponds to the direction of the stolon. In this plane, also, the pedicels which bear the calycles have a general trend, and, therefore, have a distichous arrangement, but lean a little to either one or the other side of it, all having the same direction, in this respect, on the same stem (*Fig.* 8); but whether the pedicels of every stem, of any one stolon, all lean to the right or all to the left, we are not certain, although it seems to be so. The lowest pedicel of every stem, arising from any one stolon, originates on the same side; either all are on the side toward which the stems lean, and, consequently, in the acute angle, or all are on the opposite side, and in the obtuse angle. From the thickest side of an internode, the tube of the main stem gradually thins out laterally, as may be seen in an oblique view (*Fig.* 2, *e*^{1}), until at right angles to the plane of greatest thickening the two opposite sides are alike (*Fig.* 6, *e*, *e*). From the latter point of view, the outline is elongate pear-shaped, whereas on the thickest side (*Fig.* 5, *e*^{1}) the contour is arched inwardly, and on the side opposite to this (*e*) the outline is an outward curve. Just below the constriction (*Fig.* 5, *f*) of each joint, and immediately above the point of greatest thickening (*e*), the pedicels arise, at an average angle, to the main stem, of about thirty or thirty-five degrees.

The diversion of the chymiferous tube from the main stem begins exactly where the corneous tube is thickest, and, as it were, rests upon this point, the thickening, therefore, forming a part of the pedicel, yet thinning out so rapidly that the second ring is not affected by it, but has an equal thickness on all sides; and so is it with the rest of the pedicel up to the base of the calycle, while, at the same time, the calibre gradually lessens, and the rings become successively thinner. The number of rings varies from eight to twelve, but usually there are not more than five to eight, the higher number apparently arising from an injury and the renewal of the lost part; in which case, as often happens among Hydroids, the tendency is to a distortion in form, or an exaggeration in number. The calycle (*a*, *a*^{1}) has the form of a cup, whose sides diverge at an angle of thirty or thirty-five degrees, and whose depth is to its greatest breadth as six is to five. The margin, which is perfectly smooth, is slightly oblique to the axis of the pedicel, the slant trending toward the stem, and, consequently, the outline, as seen from above (*Fig.* 5^a), is broadly ovate. The wall of the calycle (*Fig.* 5, *a*, *a*^{1}) is much thicker than that of the pedicel, and even varies on different sides; on the side furthest from the main stem, and directly above the great thickening in the joints of the latter, the wall is twice as thick (*a*^{1}) as that of the pedicel, but passing around to the opposite side (*a*) it gradually diminishes to half this amount. At the margin the wall thins out to a sharp edge rather suddenly, and with like rapidity the base diminishes as it passes into the pedicel. The transverse perforated septum (*Figs.* 5 and 7, *k*), which projects into the inferior part of the cavity of the calycle, is also very thick, and, in a transverse section, has the form of an isosceles triangle, one of whose longer sides (*l*) rests against the inner face of the calycle, while the other long side, which is free, faces obliquely toward the mouth of the cup, and the short side, also free, trends at right angles to the last, and faces obliquely toward the base of the calycle. The median third of the partition is occupied by an aperture, formed by the very abrupt termination of the edge. From the lower margin of the truncate edge there hangs a very thin and transparent tube (*m*), with an irregular opening (*n*) at the lower end. This tube is, perhaps, one third longer than its transverse diameter, but owing to its extreme frailty, it is often carried away by the decomposing hydra. In a fresh state it is so closely applied to the wall of the chymiferous cavity, that it has not been recognized.

The reproductive calycles so closely resemble those of Obelia commissuralis (Pl. XXXIV. *Fig.* 11). described in the preceding section, that one figure may serve for both. They arise singly from the base of the pedicels of the hydra; not in the fork, between the latter and the main stem, but immediately above the great thickening of the stem joint, and, alternating on successive joints, they project at right angles to the plane in which the hydra-pedicels trend; so that in a view from above we would have a cross, formed by the alternating hydra-pedicels on one hand, and at right angles to this the two limbs formed by the alternating reproductive calycles. The pedicels of the latter are very short, and consist of three or four rings; and the angle between them and the joints from which they arise is not so great as that of the hydra-pedicels. Sometimes we have found a reproductive calycle on each side of one and the same pedicel, and this may be repeated four or five times on the same stem; but, in such cases, there was a strong tendency to branching, or throwing out stolon-like processes, or the stem was actually branching. This Hydroid does not usually branch, but when it occurs, the trend of the hydra-pedicels and of the reproductive calycles is at right angles to that of the main stem, so that the hydra-pedicels of the main stem trend in the same plane as the reproductive calycles of the branch, while the reproductive calycles trend in a plane which, although at right angles to that of the pedicels, cuts that of the branch-pedicels at a sharp angle, equivalent to the angle between the stem and the branch.

In every part of the hydrarium, the corneous sheath is composed of fibres, arranged longitudinally (Pl. XXXIV *Fig.* 1), not only visible in profile (a, a^1, a^2), but also in a face view (b); moreover distinct fibres (c) may be torn off. Transverse to these fibres, and most conspicuous in the thickening of the joints of the stem, are very irregular branching and anastomosing lines, which have the appearance of cellular tissue, but in a view perpendicular to the surface (b), they are simply transverse to the fibres. We have not been able to satisfy ourselves as to the nature of these lines. They are most frequent in old stems.

Owing to the peculiarity of the joints of the stem, the common chymiferous channel of the hydrarium alternately approaches the thinner side of each successive internode with a slightly sinuous course, and alternately diverges, immediately above the great thickening of each joint, into the pedicels, and terminates in a hydra, or, at the base of each pedicel, passes into the reproductive calycles, where, in time, it produces medusæ-buds from its double walls.

The hydræ (*Figs.* 3 and 4) have thirty-five tentacles, and, as in other Campanularians, are disposed in a single row around the base of a simple proboscidal actinostome. As an instance of the far-reaching power of the tentacles, by means of their lasso-cells, we would mention having seen an Infusorium, which was swimming in the vicinity of one of the hydræ, suddenly stopped in its course, and drawn violently to a tentacle, which rolled around it and conveyed it into the expanded mouth, the other tentacles remaining stationary. The mouth expanded rapidly several times, thus causing an inward current, and then closing, the tentacle was drawn out in close contact with the lips, as if to rub off, or prevent the escape of the Infusorium. The disposition of parts in the reproductive calycle, as far as the hydrarium proper is concerned, is the same as in that of Obelia commissuralis (Pl. XXXIV. *Fig.* 11), but the medusæ, at the time they are freed, have twenty-four (*Fig.* 9^a), instead of sixteen tentacles, and the reproductive organs (*Fig.* 9^a, f^1) begin to develop before birth.

The adult medusa of this species has already been described in my Contributions to the Natural History of the Acalephs of North America, under the name of Thaumantias diaphana.

Embryology. — The breeding season of Eucope diaphana is during the spring and summer months, while from December to April, in some years at least, the reproductive calycles are absent; but there would seem to be either some variation as regards time, or else those specimens found along shore, in the deep pools close to low-water mark, are not so fertile as those which live in deeper water, or may be retarded in their growth by the changes of alternating tides. We are led to this belief by the fact that, on the sixteenth of April, 1855, we found some free medusæ (Pl. XXXIV. *Fig.* 9^a) which were identical, in every respect, with those which were taken from the reproductive calycles in September, 1854. The anatomical details of the medusa and its mode of development are, with one or two exceptions, identical with those of Obelia commissuralis, and, therefore, the illustrations of the latter may serve for the former. The only differences between the two are, that the medusa of Eucope diaphana, while attached to the column of the reproductive calycle, develops twenty-four tentacles at once, and that, at the same time, the ovarian pouches (*Fig.* 9^a, f^1) become so far advanced as to be quite conspicuous, and extend from the base of the actinostome half way to the margin; while Obelia has only sixteen tentacles at first, and no sexual pouches. The eyes (α) are on the second tentacle from the radiating tubes.

SECTION VIII.

DYNAMENA PUMILA *LAMX.*

All the Hydroids of our coast, described in the preceding pages, exhibit such distinct specific differences from their European representatives, that they may readily be distinguished. Not so with our most common Dynamena. After repeated comparisons with dried specimens from the shores of Europe, I could find no difference. Not satisfied, however, with this evidence, I requested my friend, Captain James Anderson, to bring me living specimens of the European Dynamena pumila, which he obtained through the kindness of Mr. Thomas Moore of Liverpool, and brought safely to Cambridge, where I compared them anew with specimens from the Bay of Boston. The result of this renewed comparison was, however, the same. I can perceive no constant difference between them.

Proles Hydroidea. Adult.[1]—There is no Hydroid on the coast of New England so common as this; from high to low-water line, wherever the common olive Fucoids grow, Dynamena pumila flourishes in the greatest profusion upon them, and among them upon the rocks. From September to April, through the cold months, the hydræ alone are to be found (Pl. XXXII. *Fig.* 1), but from May to July, the reproductive and sterile forms are alike abundant. When attached to the flat fronds of sea-weeds, the horizontal creeping stolon (*Fig.* 1) is quite conspicuous,

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[1] REFERENCES TO DYNAMENA *Lamx.*

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and the origin of the upright stems, which bear the hydræ, may be readily traced; but when these animals grow upon the narrow branches of the more slender Fucoids, the stolons cross and recross each other, in such an inextricable mass, that it is next to impossible to distinguish one hydrarium from another. The creeping stolonic stem has the appearance of being more slender than the upright stems, but in reality it is quite as thick as the latter, which only seems more stout, because it is bordered on two opposite sides by the calycles of the hydræ.

The upright stems vary in height, from half an inch to an inch and a half, according to the position in which they grow; those nearest low-water mark being usually the most luxuriant, and more or less branching, while those at higher levels are quite simple, as our figure represents them (*Fig.* 1). Some specimens in my possession are an inch and a half high, and tripinnately branched, but by far the greater number of those collected between high and low-water are, at most, an inch high, and branch only once. The stolonic portion of the colony is about as thick as common sewing-thread, and clings very closely to the surface upon which it creeps. At irregular intervals, varying from one twelfth to one sixth of an inch, the upright stems arise from the stolon, and in such a way that the opposite cells (*Fig.* 3, *op*, *op*) of the hydræ stand transversely to its trend. The upright stem is straight; it has, at least, no abrupt turns, but may be, as a whole, gently curved from base to tip. At pretty regular intervals, usually equal to the breadth of the stem, the calycles (*Fig.* 2, 3, 6^a, 12) stand in pairs above one another; they are not exactly opposite, but converge slightly toward one side of the stem, and that side faces toward the younger part of the colony; the same is the case with the branches, the calycles of which, standing transverse to those on the stem, converge toward the upper side. This is carried out with the most perfect regularity, even to the second and third branching, and, moreover, the reproductive calycles, which, like the branching ones, usually arise from, or just below, the bases of the sterile calycles (*Fig.* 10^a, A), all converge in the same direction as the latter. The first, or lowest pair of calycles, is situated about the depth of a cell from the base of the stem; the latter rises with a slight constriction, and then expanding, transversely to the trend of the stolon, into a V-shaped form (*Fig.* 6^a), suddenly contracts to its former breadth, and then proceeds, with a slight and gradual widening, a short distance, varying from one half to twice the distance across the V-shaped portion, and finally contracts to the same thickness which it has at the base. On that side toward which the calycles converge, the stem, which lies between them (*Fig.* 2), appears quite narrow, when compared with the other side (*Fig.* 12) from which the calycles diverge. Upon each of the two arms of the V, and against the gradually widening portion rising immediately above it, a calycle is placed in such a manner that for about two thirds of its depth it is attached, while the remaining third is free, and bent outwardly. In this way, the whole series of calycles is arranged along the stem, from base to apex, at such regular distances, that the base of any one is about double the depth of a calyx from the base of the next one above or below it. At the base of each calycle, there is an annular projection from its interior face, which forms a diaphragmic semi-partition (*Figs.* 2, *d*, and 12, *c′*, *d*), through which the hydra (*Fig.* 2, *a*, *b*) connects with the main stem of the hydrarium, but without any, or with very slight constriction; but the lateral portion of the calycle is entirely closed up; in fact, as we shall show hereafter, when describing its growth, it has one and the same wall with the stem (*Fig.* 15, *m*), or rather the walls of the two are soldered together. The general outline of the hydra-cells is cylindrical, but not very regular, and the free, or actinal end, is more or less curved outwardly, and slightly narrowed, so that the two opposite calycles, and the included stem, form an equilateral, inverted triangle (*Fig.* 3). The aperture of the cell is prolonged into two broadly triangular lips (*Figs.* 2, *m*, and 14, *m*), one on each side of the plane through the two opposite cells, as if the cylinder had been sliced obliquely across from two opposite directions, one cut facing toward the main stem, and the other, the broader one, facing outwardly, and slightly to that side toward which the cells converge. The base of a branch (*Fig.* 3, *i*) arises just below the semi-partition of a hydra, and trends in a direct line with the plane of opposite calycles, and, as we have mentioned above, the opposite calycles (*k*) of a branch, or of a branchlet, always stand at right angles to these, on the stem from which the branch arises.

The reproductive calycles (*Figs.* 7, 8, 9, 10, and 10^a) are oval in outline, and terminate with a slightly flaring, truncate aperture (*g*), while below they taper away into a pedicel (*e*), which is a little smaller than the main stem, and more or less curved in the same direction, toward which the sterile calycles converge. Oftentimes we meet with a reproductive calycle, taking, as it were, the place of a branch, the latter being present on the opposite side; but most frequently they occupy both sides, or one side is destitute of any lateral growth. Occasionally we find two or three reproductive calycles (*Fig.* 10^a), arising from one joint.

The soft part of the hydrarium, or the hydra proper, is double-walled throughout (*Figs.* 2, *a*, *b*, 12, *a*, *b*, 8, 9, and 10, *a*,^{1} *c*); the stolonic part is a uniform, smooth cylinder; in the upright stems it arises directly, and at right angles, from the stolon, and proceeds with uniform thickness to a point just below the calycles, where it expands upon two opposite sides, and gives off from each a single uniform tubule (*Fig.* 2, *c*, *c*^{1}), which, passing through the diaphragmic semi-partition (*d*), traverses the calycle, and terminates in a simple, short, conical proboscis (*p*), around which a single row of slender, tapering tentacles, usually sixteen in number (*t*), is disposed in a uniform series. Immediately beyond the bases of the calycles, the main stem suddenly contracts to its original thickness, and proceeds to the base of the next pair of calycles, where it diverges in two opposite directions as before, and so it traverses the whole length of the stem to its apex. Wherever a branch arises (*Fig.* 3, *i*), its base is a prolongation from the distal side of the expansion of the main stem, just below the calycles; and the same relation obtains, where a branchlet arises from a branch. When extended from its calycle, the hydra (*Fig.* 2, *c p t*) has no thicker outer wall (*a*) than the main stem, but the inner wall (*b*) is at least twice as thick, whereas, in the stem, it scarcely more than equals the outer one in this respect. When retracted within its calycle (*Fig.* 2, *m*), the outer wall (*a*) is sometimes very thick, but at other times it is comparatively thin (*Fig.* 3). The outer wall is not altogether free from the chitinous sheath, which envelops the whole hydrarium, but here and there film-like prolongations (*Figs.* 2, *a′*, and 12, *a′*) from the wall attach it to the inner face of the sheath. In the younger stages of development, these processes are quite numerous (*Fig.* 15, *a′*), but, with increasing age, the greater part of them are retracted. In the reproductive calycles, not only the outer wall, but the inner one also, enters into the composition of these props, and, moreover, the chymiferous cavity pervades them to a considerable extent (*Figs.* 10 and 10^a, *h*). As regards the reproductive calycles, it is noteworthy that the diverticula arising from their axis (*Figs.* 10, a^1, and 10^a, *j*), originate from, or near the terminal portion (*g*) of the axis, and branch more or less, as they project toward the base and down the sides of the calycle.

Proles medusoidea. — It is only during the breeding season, from May to September, that the reproductive individuals (*Figs.* 7, 8, 9, 10, and 10^a) are present. A fully-developed calycle contains a prolongation of the stem of the hydrarium, and a medusoid which buds from it; the first extends, as a uniform, double-walled tubule (a^1 *e*), from the base to the apex of the chitinous calycle, at the latter point expanding into a disk (*g*), which completely fills the aperture; and the second, the medusoid, a double-walled sac (*b* b^1), with a central, single-walled, prosbosciform body (*l*), occupies nearly the whole available room within the calycle, the axial prolongation (a^1 *e*) of the hydrarium being pushed aside against the chitinous investment. The two walls (*b* b^1) of the medusoid are directly prolonged from the tubular axis (a^1 *e*), and are about as thick as those of the latter, and totally devoid of radiating or circular chymiferous canals. The prosbosciform, axial prolongation (*l*) of the actinostome is a duplicature of the inner wall (b^1) of the medusoid; arising from a point (l^1) just within the junction of the latter with the tubular axis, it forms a sac within a sac, and is the immediate investment of the chymiferous cavity, which is prolonged from the stem into the medusoid.

Between this and the inner wall of the disk, the reproductive material, the spermatic (*sp*) or the ovarian mass (*ov*), is deposited.

Embryology. — Although the breeding season commences in May, it is not until June that any of the ovarian or spermatic bodies have attained maturity; at the latter date, we have secured and figured (*Figs.* 11, *a b c*, and 16, A B C) the ripe spermatic particles, and the egg. The egg consists of a very thin, vitelline sac (*Fig.* 16, B *v*); a perfectly homogeneous, or uniformly and minutely granular, dark yolk (*y*), the granules appearing as mere dots (A), under a magnifying power of five hundred diameters; a clear, Purkinjean vesicle (B *p*, C *p*); and a thick-walled, homogeneous, Wagnerian vesicle (*w*). In a fully-developed medusoid, the eggs are so crowded upon each other, as to be irregularly polyhedral, but upon being set free, they assume perfectly curved outlines, almost, or quite spherical. The spermatic particles fill the male medusoid (*Fig.* 8) in one uniform mass (*sp*); they are comparatively very minute, so that, as seen with a power of five hundred diameters (*Fig.* 11, *a*), it is impossible to represent their proper form, and, therefore, we have drawn them on a diagrammic scale (*Fig.* 11, *b c*), and in two positions, showing that from one side they are pear-shaped (*b*), and from the side at right angles to the latter they are oval, and have a slender filament, about four times as long as the body, appended to the narrower end.

Budding. — The main stem increases in length by terminal growth (*Fig.* 12, *g*); the extreme apex (*h*) is constantly developing new cells, and a chitinous sheath, which gradually become lateral by the onward progress of the newer portions. At certain points, corresponding to the bases of the hydra-calycles, the stem broadens as it grows, the walls become extremely thick, especially the outer one (*Fig.* 14^a, *a*), and the inner walls become three-lobed (e e^2 e^3). At the lower part of the bud, the cellular structure of the outer wall (*a*) is barely intimated by fine transverse striæ; but above, the cellular structure is quite evident, seeming to be a congeries of coarsely granulated, oval cells, arranged end to end in rows which traverse the thickness of the wall. Those cells which lie in the youngest part, or terminal portion of the bud, have a transparent, thin wall (*Fig.* 13, *a b c*), which is thickly lined by a layer of globular particles (*d*); others, from this neighborhood, but a little older (*Fig.* 13, *e f g h i*), appear to have thick walls (*f*), and homogeneous, highly refractive contents, and are rather elliptical than oval in outline. The inner wall (*e*) shows more of its cellular nature, in the older portions, than the outer wall. The chitinous sheath (*c*) is very thick below, and very clearly shows the superposed lamellæ, of which it is composed; but it thins out quite rapidly, and is a mere film across the end of the bud. In the next stage which we have to present, the slight triple lobulation of the last, has become fully three-parted (*Fig.* 17, f f^1 f^2), reminding one very much of a three-toed, webbed foot, the middle lobe, or the main stem (f^1), being slightly in advance, and the two lateral ones (f f^2) communicating with it only through their bases (e^1). Each lobe is entirely distinct from the others from its base upwards, and besides, it is capped by a thin, chitinous layer (b b^1), which, however, is distinct from that of the next lobe, only at the base (b), where it forms a single coating to the outer surface of the adjoining walls (a^1 a^2), but toward the end (b) fuses with its neighbor, and, finally, with the terminal, general envelop (c). It is impossible to say what is the definite thickness of the walls, because of the great degree of contraction and expansion which they exhibit; but they may, in general terms, be said to be twice as thick as the fully-developed walls in the oldest part of the stem. The cellular elements are the same as in the last phase. At a later stage (*Figs.* 6 and 6ª), in which the hydræ (f f^2) are just upon the point of developing the free terminal portion, the variable thickness in the walls is represented in our figure, especially in the inner wall (e e^3). It will be noticed that the outer wall (a) separates from the chitinous investment very early; but that it is a permanent separation, it is not possible to say. The whole surface of the bud is so loosely connected with its investment, that it is not a difficult matter to detach it by pressure, and force it out through the basal end, if the stem be cut across a short distance below. By this process, we may get a clear and connected view of the sheath (*Fig.* 18), and of the position of the partition walls (a b c). In the figure, the broader side of the stem is next the eye, and, in the distance, the narrower side; so that the inner sides (a) of the partitions face obliquely toward the observer. As a further step in development, the hydræ push out, from the hitherto consolidated, budding mass, one on each side of the main stem, like the upper limbs of the letter Y (*Fig.* 15, l); each limb bearing its own sheath (l). When the hydra has completed its longitudinal growth, as in the figure, and is about to develop its tentacles, its apex is obliquely truncate (l b), or asymmetrically roof-like. The walls (a b), at the upper part, are closely pressed against the sheathing calycle (l), and present a pretty uniform thickness in this region; but below, they are retracted and much thinner; still the outer wall adheres, by prop-like processes (a^1), to the calycle. Finally, the hydra is completed by the scalloping of its distal end, the lobes of the scallop eventually elongating into tentacles (*Figs.* 3 and 12), and the body retracts altogether from the calycle, after having completed the formation of a bivalve-like operculum (*Figs.* 2, 3, 4, and 4ª, *op*). At or about the same time, the semi-partition (*Fig.* 2, *d*) is constructed. When the hydra protrudes from its calycle for the first time, it pushes aside the operculum (*Figs.* 4 and 4ª, *op*), yet the latter may remain adherent for some time, but evidently for no particular purpose.

The reproductive calycles usually originate just beneath the hydra (*Fig.* 10ª), but occasionally they arise at a point nearer to the main axis (*Fig.* 14), but always on that side toward which the twin hydræ calycles converge. At first, one of these reproductive bodies (*Figs.* 5, 5ª, and 14, *a*) resembles the incipient stage of a pair of hydræ (*Fig.* 14ª), and, in fact, the process of the development of the walls is the same in both. Primarily the organ in question is turbinate, and strictly circular in a transverse section (*Figs.* 5, 5ª, and 14); the outer wall (*Fig.* 5ª, *a* a^1) is very thick, and composed of very distinct, columnar cells; whereas the inner wall (*d e*), although it has a very well-marked contour, exteriorly appears like a confused mass of dark brown cells. The cavity contains granules, apparently detached from the inner wall, which are in a constant state of circulation around its sides, and backwards and forwards through the pedicel, in direct communication with the common canal of the main stem. Before the axis of the reproductive body has completed its terminal growth (*Fig.* 10, *g*), the outer wall (a^1) detaches itself from the now oval calycle (*c*), and begins the development of its medusa (*b* b^1). At this time, the outer wall (a^1) of the axis is no thicker than in the main stem; but the inner one (*e*) has a much greater depth, and the cellular structure is quite recognizable. The medusa commences, as a mere lateral hernia (*b* b^1) of the outer and inner walls of the axis, and, eventually, by a process similar to the mode of development in the medusa of Hydractinia (Pl. XVI. *Figs.* 7, 8, and 9), Thamnocnidia (Pl. XXII. *Figs.* 1–7), and Parypha (Pl. XXIII. *Figs.* 3–8), becomes a double-walled sac (Pl. XXXII. *Fig.* 8, *b*, b^1), the disk proper, in the axis of which a probosciform, single-walled, actinostome (*l*) projects, as we have described more fully on a previous page (p. 329). In the mean time, the axis (a^1) increases in length, by the further development of the solid mass (*g*), which fills the mouth of the calycle, and, when mature (*Fig.* 8, a^1), is attached terminally to the thin edge of the calycle and its operculum (*g*).

CHAPTER EIGHTH

SIPHONOPHORÆ.

SECTION I.

SIPHONOPHORÆ IN GENERAL.

MODERN zoölogists generally consider the Siphonophoræ as one natural group of Acalephs, which they have subdivided in various ways, into families or tribes. When closely compared, it appears, however, that they differ widely, in a morphological point of view; while the characteristics by which they are held together, are of the most trifling nature, consisting chiefly in the fact that they are free, moving animals, and not attached to the ground. Kölliker has, nevertheless, insisted upon that feature as essential, and on that account called them Polypi nechalei. In attempting to classify them, I have kept in view the prominent difference pervading the whole class of Acalephs, in which individuals assume either the characteristics of attached Hydroids or of free Medusæ, with every degree of approximation to one or the other of these extreme forms. In Siphonophoræ the hydroid type is prevalent, but already raised above the ordinary condition of Hydroids, in being free; and the medusoid element is lowered, in so far as most Medusæ, budding from the colonies, are deprived of some of the characteristics of the higher Acalephs. Moreover, hydroids and medusæ, budding from one another, invariably form polymorphous communities, from which various parts are cast off to continue a short, precarious existence, as independent beings. The connection of all these isolated members of the Siphonophoræ, has only recently been traced in a satisfactory manner. Upon the prevalence of the hydroid or medusoid elements, and their various combinations among these Acalephs, aided by what is already known of their development, I venture to subdivide the Siphonophoræ into four sub-orders: the Porpitæ of Goldfuss, or Chondrophoræ of Chamisso and

Eysenhardt; the Physaliæ, as limited by Lesson;[1] the Physophoræ of Goldfuss, excluding Physalia (Arethusa); and the Diphyæ of Cuvier. These sub-orders may be characterized as follows: —

1. Porpitæ *Goldf.* — The community of these Acalephs buds from a primary hydra, which is provided with many tentacles, and retains its individuality. The secondary hydræ arise between the tentacles of the primary hydra and its proboscis; they are small, club-shaped, and without tentacles. From these small hydræ arise medusæ-buds, which are cast off and become free sexual Medusæ, long known under the name of Linuche, and recently described anew as Chrysomitra.

2. Physaliæ *Less.*[1] — Physalia starts from a primitive hydra, which attains gigantic dimensions, and, losing its individuality, becomes a floating apparatus for the whole community. The secondary hydræ all arise from one and the same side of the primitive hydra, in bunches; they vary in size and development from one another, some being closed at the actinal end, while others have a gaping mouth; some have one long, lateral tentacle, starting from their base, and attached to their side, and others none. By the side of these arise large bunches of small, fertile medusæ-buds, with four radiating chymiferous tubes and a circular tube, but without tentacles. These Medusæ wither upon the stock from which they arise. The mode of combination of the hydræ and medusæ, in different species of this type, may afford generic characters to subdivide them.

3. Physophoræ *Goldf.*[2] — Community budding around a slender tentaculated hydra, the abactinal end of which terminates in an air cyst. From the abactinal sides of this primary, egg-born hydra, arise sterile sessile medusæ, without tentacles and proboscis, arranged in two or more vertical rows; and from the actinal side, one or two kinds of secondary hydræ, with or without compound or simple tentacles. Between the secondary hydræ, small sessile male and female Medusæ bud

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[1] Lesson is the first author who has isolated the Physaliæ, as a separate group, from all other Acalephs. He considers them only as a family, but they really constitute a distinct sub-order. Leuckart, Quatrefages, and Huxley, have published the most recent accounts upon this type. See their papers, quoted above. The way in which McCrady has divided the Siphonophoræ, and his attempt to incorporate them in one and the same sub-order with the Tubularians, does not seem to me to be justifiable. In the first place, the mode of growth of his Endostomata and Exostomata is not so characteristic as he supposes, as a comparison of the medusæ-buds of Coryne and Obelia, described above, pp. 192 and 318, may show. In the second place, the Diphyidæ arise in a totally different manner from the other Siphonophoræ, as the observations of Gegenbaur upon the reproduction of Diphyes have shown. Their community is not built up from a hydra, but from a medusa. Again, the primitive hydra of the Siphonophoræ is never pedunculated; that of the Tubularians always is.

[2] For this type, see the papers and works of Kölliker, Leuckart, Vogt, Gegenbaur, and Huxley, quoted above, Vol. III. p. 27; also Chapter II. Vol. III. p. 73.

forth, with a proboscis, four radiating chymiferous tubes, and a circular tube. These fertile Medusæ are either scattered between the secondary hydræ, or gathered in bunches.

4. Diphyæ *Cuv.* — Compound community of combined twins, arising from an egg-born Medusa. The community consists of twin sterile Medusæ, without tentacles or proboscis (Ersæa or Aglaisma, when young), from which arise a string of compound, heteromorphous twins, one of which is a hydra, the other a fertile medusa, either male or female, without tentacles but with proboscis, becoming free together (Eudoxia or Cuboides).

SECTION II.

THE GENUS PHYSALIA, AND OUR PHYSALIA ARETHUSA.

Although for many years past I have had ample opportunities of investigating the North American Siphonophoræ, this volume has already attained dimensions, which forbid that I should dwell upon them for the present. I will, therefore, limit myself to a few remarks upon one of their most remarkable representatives, from which the mode of combination of the heterogeneous individuals, forming this kind of communities, may best be appreciated. By far the most prominent part of the compound body is a large, oblong, pear-shaped bag, full of air, of a bright, bluish tint, varying to rose-color, floating lightly upon the surface of the ocean, so that it is altogether raised above the level of the water. An elegant, comb-like, crenulated crest, edged with a rose-colored rim, and traversed by similar bands, forms a sort of sail above the float, from the lower surface of which hangs a most extraordinary variety of appendages, appearing, at first sight, like bunches of varied tentacles. These appendages are all clustered upon one and the same side of the air-bag, and crowded toward its broader end, while the tapering end has none of them. A more careful inspection readily discloses the heterogeneous nature of these appendages, some of which are simple, elongated hydræ, with or without tentacles, and others medusæ-buds. Unless we compare these hydræ among themselves, and ascertain their mode of combination, we can have only a very imperfect idea of their extraordinary diversity. In the first place, it should be noticed that the largest hydræ are all arranged along the windward side of the animal, and that they are provided with the longest and most complicated tentacles. (Pl. XXXV *Fig.* 1.) As I have seen these Physalia by thousands, in every kind of weather, I have noticed that they always present the same side to the wind, that is, the one from which hang the longest tentacles; and when the breeze is fresh and the animal is driven before the wind, these tentacles are stretched to a most extraordinary length, varying, according to circumstance, from twenty to thirty, forty, and even fifty feet, and forming as many anchors upon which it rides, without being cast adrift. I have observed them in stormy weather struggling in that way against the elements, in order to avoid being thrown ashore. It is curious to see how, under these circumstances, they change their position, by raising the pointed end of their air-bag and throwing themselves suddenly upon the opposite side; but I have never seen them emptying their bag and sinking under the surface of the water. These large hydræ form small bunches of two, three, or four, budding from a common hollow stem, which communicates with the chymiferous cavity extending between the inner and outer wall of the air-bag. (Pl. XXV. *Fig.* 3.) Bunches of similar hydræ in larger numbers, but of a uniformly smaller size, alternate with these and occupy a position on their lee. All these hydræ have nothing to do with nourishing the colony, and their actinal end is closed; they are, evidently, simply locomotive individuals. When the whole colony is at rest, they hang down loosely.

The feeding hydræ are also of two kinds, large and small ones, and, like the locomotive hydræ, their difference of size seems to be primitive, and not the consequence of a more or less advanced development. These individuals never have tentacles; but they are clustered in bunches, budding in greater or smaller numbers from a common hollow stem, and, like the preceding, communicate with the chymiferous cavity. All these bunches of feeding hydræ are scattered along the lee-side of the floating bag. (Pl. XXV. *Fig.* 2.) I have seen them gorged with food almost to bursting, but I have never seen undigested food in any other kind of individuals. Neither the locomotive, nor the feeding hydræ, ever produce medusæ-buds. These always arise from a third class of very small hydræ, forming very large clusters, suspended between the clusters of feeding hydræ. These prolific hydræ resemble the locomotive hydræ most in general form, but, like the nutritive hydræ, they are destitute of tentacles. The medusæ-buds themselves, of which there are males and females, arise singly, either from the base of the prolific hydræ or from the stems and branches which unite the latter. These medusæ-buds are very similar to those of Tubularia proper, and wither without dropping from their parent stock. As soon as it is understood that the Physaliæ are compound communities, and not single individuals with very diversified organs, the idea is at once suggested that the floating air-bag must be a large primary hydra, assuming the special function of a floating apparatus, and the observations of Huxley upon very young Physaliæ fully supports this view. I must abstain from further details, from want of room, but shall resume my communications, upon this subject, on another occasion.

CHAPTER NINTH

CLASSIFICATION OF THE HYDROIDÆ.

SECTION I.

TABULAR VIEW OF THE WHOLE ORDER OF HYDROIDÆ.

In order not to introduce questionable information in this synopsis, I have only quoted such references as relate to the most trustworthy accounts now at hand upon this type, and condensed these to the utmost, sometimes to the mere names of the genera and species, as the special papers on this subject, already enumerated in preceding sections, must necessarily be consulted by all those who propose to investigate the Hydroids and their alternate generations.

Order of HYDROIDÆ *Johnst.* (So extended as to include the majority of the naked-eyed Medusæ and all the Siphonophoræ.) — Lithophyta and Zoophyta (pro parte) *Lin.* — Zoophyta (p. p.) *Pallas*, *Ellis* and *Sol.*, *Flem.*, *Dana.* — Polypi (p. p.) *Cuv.*, *Lamx.*, *Lmk.*, *Milne-Edw.* — Anthozoa (p. p.) *Ehrenb.* — Radiaires anomales and médusaires (p. p.) *Lmk.* — Medusæ (p. p.) *Pér.* and *LeS.* — Siphonophoræ *LeS.* — Acalèphes libres (p. p.) and Ac. hydrostatiques *Cuv.* — Æquoreæ, Physophoræ, and Porpitæ *Goldf.* — Vesiculares, Medusæ (p. p.), Chondrophoræ, and Anomalæ *Cham.* and *Eysenh.* — Papyracea, Hydrostatica, and Cyclomorpha (p. p.) *Latr.* — Discophoræ cryptocarpæ (p. p.) and Siphonophoræ *Esch.* — Polypiaria (p. p.), Physograda, Pulmograda (p. p.), and Cirrhograda, *DeBl.* — Siphonophoræ and Discophoræ (p. p.) *Oken.* — Discophoræ (p. p.) and Siphonophoræ *Brandt.* — Medusæ (p. p.) and Diphyidæ, Polytomæ, Physophoræ, Physaliæ, Velellæ, and Porpitæ *Less.* — Gymnophthalmata *Forbes.* — Hydroidæ *Agass.* — Coralliaria Tabulata and Rugosa, and Hydraria *Milne-Edw.* and *Haime.* — Hydromedusæ (p. p.) and Siphonophoræ *Vogt.* — Hydroidea and Hydromedusida *Köll.* — Hydroidea, Medusida Craspedota (p. p.) and Siphonophora *Gegenb.* — Hydroidæ *McCr.* (exclud. Æginidæ). — Hydrozoa *Huxl.*

1st Sub-order. RUGOSÆ. — Coralliaria Rugosa *Milne-Edw.* and *Haime*; with four families: Stauridæ, Cyathaxonidæ, Cyathophyllidæ, and Cystiphyllidæ; all extinct, and mostly belonging to the earliest geological periods, for the enumeration of which I refer to the elaborate works of Milne-Edwards and Haime. Evidently the Hydroid elements prevailed in the structure of these animals, and they probably never produced Medusoid buds. How far the living types of Hydra and Lucernaria may be related to them still remains to be ascertained.

2d Sub-order. TABULATÆ. — Coralliaria Tabulata *Milne-Edw.* and *Haime*; with four families: Milleporidæ, Seriatoporidæ,[1] Favositidæ, and Thecidæ, for the characteristics of which I refer to the papers of Milne-Edwards and Haime. The Tubulosa *Milne-Edw.* and *Haime*, seem to me to be low forms of Tabulata. Should Millepora prove to produce medusæ-buds, I would not hesitate to unite this sub-order with the following.

3d Sub-order. TUBULARIÆ.[2] Alternate generations. Hydra always pedunculated, and mostly attached, head more or less club-shaped, without distinct horny bell; Medusa, either free or sessile, deep bell-shaped, with few hollow tentacles, all, or at least the most prominent of which, are in the prolongation of the radiating chymiferous tubes; eyes never independent of the tentacles. Reproductive organs always connected with the proboscis, and never limited to the radiating chymiferous tubes.

1st Family. CLAVIDÆ *Mc Crady.*[3]

Clava *Gmel.* — See p. 218.

C. multicornis *Johnst.* — Clava parasitica *Gmel.* — Coryne squamata *Lmk.*, *VanBen.* — *Mediterranean* (Forskål); *British Channel* (Pallas).

C. leptostyla *Ag.*, Pl. 21. — *Massachusetts Bay* (Agassiz).

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[1] I have shown, p. 296, that in Seriatopora the same tendency to a quadripartite division of the cells prevails, as among the Rugosa, which indicates a closer relation between the Tabulata and Rugosa than Milne-Edwards seems to admit.

[2] Lamouroux, ignorant of the mode of growth and reproduction of these animals, included only Hydroids in this group, to which many free Medusæ are now also referred. It is highly important to notice the close affinities which bind together the Medusæ of this sub-order, and the Hydroids from which they arise. We shall see that these relations are most intimate in all the minor natural groups of these Acalephs, the Medusa and Hydra of which are equally well known.

[3] The simple, uniform tentacles, scattered upon a club-shaped head, and the sessile medusæ-buds, characterize this family. The extraordinary changes which the proboscis assumes (Pl. XXI.), show that the peculiar arrangement of the tentacles, in the Tubularidæ, belongs to the same series. The Tubularians present, in fact, a beautiful gradation of forms, indicating a large number of distinct families. In Clavidæ, the head of the Hydræ is simply club-shaped, and all the Hydræ of a community are alike, and so are they in Sarsiadæ;

Syncoryna *Ehr.* (restricted).[1] — Cordylomorpha *Allm.*

S. parasitica *Ehrenb.* — *Mediterranean* (Cavolini).

S. lacustris *Ag.* — Cordylomorpha lacustris *Allm.*, Phil. Trans. R. S., 1853, Pl. 25, fig. 1. — *Dublin, Ireland* (Allman). — Professor Leidy has discovered another species in *Newport Harbor, R. I.*

2nd Family. HYDRACTINIDÆ *Ag.*[2]

Hydractinia *VanBened.* See p. 227.

H. echinata *Johnst.* — Hydr. rosea and H. lactea *VanBen.* — *Scotland* (Fleming); *British Coast* (Johnston); *German Ocean* (VanBen.).

H. polyclina *Ag.* — *North America, Atlantic coast* (Agassiz).

3d Family. SARSIADÆ *Forbes* (restricted).[3] See pp. 184 and 217.

Coryne *Gärt.* — Hydra: Coryne *Gärt.*, Syncoryne *Ehr.*, Stipula *Sars*, Hermia *Johnst.* — Medusa: Sarsia *Less.*, Sthenyo *Dujar.*[4]

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but in the former the tentacles are simple, and only sessile medusæ-buds are produced, while the latter produce free medusæ, and have knobbed tentacles. In Cladonemidæ the clavate tentacles are arranged in worls and cross-wise. In Hydractinidæ there are two kinds of Hydræ, each kind with different tentacles. In Bougainvillidæ and Eudendroidæ the tentacles encircle a well-defined crown, and the apex of the Hydra assumes, in the latter, the form of a distinct proboscis. In Tubularidæ proper the proboscis has tentacles also, but of the same kind as the crown, while in Pennaridæ the coronal tentacles are simple, and those of the proboscis clavate. In Nemopsidæ the Hydroid community is free and locomotive, and in Nucleiferæ the medusæ-buds arise from a creeping stolon, and not from the pedicel, nor from the head of the Hydra, as in the other families.

[1] Syncoryna, *Ehrenberg*, Corallenthiere, Vert. Akad. Wiss., Berlin, 1834, p. 70. "Huc *Sertulariam parasiticam* Cavolini referrem: *Syncoryna* parasitica." The three other species belong to the genus Coryne *Gaert.*

Cordylophora, Allman, Proc. Brit. Assoc., 1843.
" Allman, Annals and Mag. Nat. Hist., May, 1844, XIII., p. 328.
" Allman, Philos. Trans. Roy. Soc., 1853, p. 367.
Corydendrium, VanBeneden, Bullet. Acad. Roy., Bruxelles, p. 313, Nov. 1844.
" Dana, Zoöphytes, 1846.
" Dana, Synopsis Zoöph., 1859, p. 148.
Sertularia (parasitica), Cavolini Mem. Polypi Marini, 1785, Pl. VI. *Figs.* 8–13, and Sprengel's transl., 1813, p. 83.

[2] This family is very peculiar and distinct from all other Tubularians. The communities consist of two kinds of Hydræ, equally developed, the ones sterile with simple tentacles, the others fertile with knobbed tentacles. Medusæ sessile, the males and the females budding from different colonies. McCrady is mistaken in stating that the medusæ-bearing Hydræ are not tentaculated.

[3] Forbes refers, also, the genera Bougainvillia, Lizzia, Modeeria, Euphysa, and Steenstrupia, to this type; but they belong to different families. As here restricted, the Sarsiadæ embrace only those Acalephs the hydræ of which are Coryne-like, and the medusæ deep bell-shaped, with four long tentacles in the prolongation of the four chymiferous tubes, and a long simple proboscis, upon which the eggs are developed.

[4] It is to be hoped that henceforth zoölogists will refrain from giving names to Hydroids, the development of which they have not traced, since this genus shows to what complication of the nomenclature the prevalent practice has led. A true

C. pusilla *Gärt.*, *Johnst.*, Pl. 2. — Oceania tubulosa *Sars.* — Sarsia tubulosa *Less.*, *Forbes*, Nak. Med., Pl. 6, fig. 2. — Comp. p. 201, note.[1] — Sthenyo *Duj.*, An. Sc. Nat., 1845, Vol. IV Pls. 14 and 15, B. — *British Channel* (Gärtner); *Coast of Norway* (Sars); *Zetland Islands* (Forbes).

C. mirabilis *Ag.*, Vol. III. Pls. 17 and 18. — Sarsia mirabilis *Ag.*, Mem. Am. Ac., IV Pls. 4 and 5. — *Boston Bay* (Agassiz).

C. Rosaria *A. Ag.* — *Gulf of Georgia* (A. Agassiz).[2]

Sarsia macrorhynchos *Busch*, Pl. 3, fig. 7, from Falmouth, belongs certainly to this genus, and, may be, to Coryne pusilla.

Syndictyon *A. Ag.* — Hydra: Coryne-like.

S. reticulatum *A. Ag.* — *Nahant* (A. Agassiz).[3]

S. thelostylum *Ag.* — Oceania thelostyla *Gegenb.*, Pl. 8, fig. 9. — *Messina* (Gegenbaur).

Sarsia ocellata *Busch*, Pl. 2, fig. 1, from Triest, probably belongs to this genus.

Corynitis *McCr.* — Hydra: Halocharis *Ag.*,[4] Vol. IV p. 239, Pl. 20, fig. 10.

C. Agassizii *McCr.*, Pl. 9, fig. 2. — *Charleston Harbor, South Carolina* (McCrady).

Candelabrum *DeBl.* — Myriothela *Sars.* — Spadix *Gosse.*

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regard for science ought to lead us all to imitate the entomologists, who raise the larvæ of Insects before naming them.

[1] The European zoölogists have described many species belonging to this genus, but it now remains to be seen how far they are distinct, since I have shown how greatly one of the American species varies at different seasons.

[2] C. Rosaria *A. Ag.*; resembles the English C. pusilla very closely; it has a long, light-brown proboscis, hanging below the level of the veil, with a marked constriction at the point of attachment. Tentacular bulb small; eye-speck very minute; tentacles moderately long, expanding about twice the length of the spherosome. Height of the bell half an inch, length of the proboscis three quarters of an inch, diameter across the circular tube one quarter of an inch. — *Straits of Rosario, Washington Territory* (A. Agassiz).

[3] Syndictyon *A. Ag.* Spherosome goblet-shaped; digestive trunk shorter than in Sarsia proper; tentacular bulb large, with large eye-speck; tentacles hollow, short, the surface crowded with clusters of large lasso-cells; whole surface of spherosome covered with a net-work of clusters of lasso-cells.

S. reticulatum *A. Ag.* Thickness of bell uniform, from abactinal pole to circular tube; digestive cavity with a constriction near the base, and another near the actinal end; clusters of lasso-cells increasing in size towards the end of the tentacles; lasso-cells of surface of bell arranged in concentric lines made up of clusters of small cells parallel to the circular tube, with clusters of larger lasso-cells scattered irregularly; height one eighth of an inch; of a light metallic-blue color. — *Nahant, near Boston, July* (A. Agassiz).

[4] This is the Stauridioid genus to which McCrady makes a reference in his paper, p. 46

C. phrygium *DeBl.* — Lucernaria phrygia *Fabr.*[1] — *Greenland* (Fabricius); *Grand Manan, Bay of Fundy* (W. Stimpson).

C. arcticum *Ag.* — Myriothela arctica *Sars.* — Spadix purpurea *Gosse,* Ann. and Mag. Nat. Hist., 1855, p. 125; Mar. Zool., p. 19, fig. 25. — *Norway* (Sars); *English Coast* (Gosse).

Dipurena *McCr.*[2]

D. strangulata *McCr.,* Pl. 9, fig. 1. — *Charleston Harbor* (McCrady).

D. cervicata *McCr.* — *Charleston Harbor* (McCrady).

D. conica *A. Ag.* — *Naushon, Buzzard's Bay* (A. Agassiz).[3]

Slabberia *Forbes.*

S. halterata *Forbes,* Nak. Med., Pl. 6, fig. 1. — *Cornwall* (Forbes).

4th Family. CYTÆIDÆ *Agass.*[4]

Cytæis *Esch.* (not Sars).

C. tetrastyla *Esch.,* Pl. 8, fig. 2; *Eyd.* and *Soul.,* Bonite, Zooph., Pl. 2, figs. 4–15. — *Atlantic Ocean, Equator* (Eschscholtz).

C. pusilla *Gegenb.,* Pl. 8, fig. 8. — ? Bougainvillia mediterranea *Busch.* — *Messina* (Gegenbaur).

5th Family. CLADONEMIDÆ *Gegenb.,* Zeit. w. Zool., 1856.

Cladonema *Duj.*—Medusa: Stauridia *Wright.*—Hydra: Stauridia *Duj.*

C. radiatum *Duj.,* Ann. sc. nat., 1845, Pls. 14 and 15, C. — *British Channel* or *Mediterranean* (Dujardin).

Eleutheria *Quatr.* — Hydra: Clavatella *Hincks,* Ann. and Mag., 1861, Vol. VII. Pl. 7.

E. dichotoma *Quatr.,* Ann. sc. nat., 1842, Pl. 8. — *Isles Chausey* (Quatrefages).

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[1] Mr. W. Stimpson has called my attention to the generic identity of Lucernaria phrygia *Fabr.* and Sars' Myriothela, which is unquestionable. I have compared a specimen collected by Mr. Stimpson at Grand Manan with the descriptions of the European species, and find that they agree in their generic characters. The name first proposed by DeBlainville for this genus must, therefore, be retained. The medusa is not yet known.

[2] According to Forbes' statement, the ovaries of Slabberia are upon the radiating tubes: in Dipurena they are upon the proboscis. This seems to indicate either an incorrect observation or different affinities.

[3] Dipurena conica *A. Ag.* Spherosome conical; thickness of disk tapering rapidly from abactinal pole to circular tube; digestive trunk elongated, with a slight constriction at the base and another near the middle, tapering towards extremity, does not quite extend to the level of the veil; the four marginal tentacles with large bulbs at the base, and very marked eye-specks, surrounded by reddish pigment-cells; terminal bulb of tentacles about twice the diameter of the tentacle itself; height of spherosome and diameter across the circular tube one eighth of an inch. — *Naushon, Buzzard's Bay, September* (A. Agassiz).

[4] This family differs, chiefly, from the Sarsiadæ, by the presence of tentacles at the end of the proboscis. The species referred to Cytæis by Sars, belong to the family of Bougainvillidæ.

6th Family. EUDENDROIDÆ *Ag.* See p. 282. No free Medusæ.

Eudendrium *Ehrenb.* — Calamella *Oken.* — Thoa *Lamx.*

E. ramosum *Ehrenb.* — Tubularia ramea *Dalyell,* Pl. 6. — *Northern Europe* (Linnæus).

E. dispar *Ag.* — Thoa dispar *Ag.*, Vol. 4, Pl. 27, figs. 10–26. — *Massachusetts Bay* (Agassiz).

7th Family. TUBULARIDÆ *Johnst.* (restricted).[1]

Tubularia *Linn.* (restricted).

T. indivisa *Linn., Dalyell,* Pls. 1–4; *Johnst.,* Zoöph., Pl. 3, fig. 1. See p. 241. — *Northern Europe* (Linnæus).

T. Couthouyi *Ag.*, p. 266, Pl. 24. — *Massachusetts Bay* (Agassiz).

Thamnocnidia *Ag.*

T. coronata *Ag.* See p. 242. — Tubularia coronata *Abild.* — *Northern Europe* (Abildgaàrd and VanBeneden).

T. calamaris *Ag.* See p. 242. — Tubularia calamaris *VanBen.* — Tubularia gracilis *Johnst.* — *German Ocean* (VanBeneden).

T. spectabilis *Ag.*, p. 271, Pl. 22, figs. 1–20. — *Boston Bay, Nahant* (Agassiz).

T. tenella *Ag.*, p. 275, Pl. 22, figs. 21–30. — *Nahant* (Agassiz).

Parypha *Ag.* — Pyxidium *Leuck.* ?

P. cristata *Ag.* — Tubularia cristata *McCr.* — *Charleston* (McCrady).

P. crocea *Ag.*, p. 249, Pl. 23. — *Boston Bay* (Agassiz).

Pyxidium truncatum *Leuck.*, Arch. Nat., 1856, Pl. 2, fig. 7. — *Nice* (Leuckart).[2]

Ectopleura *Ag.*[3]

E. Dumortieri *Ag.* See p. 242. — Tubularia Dumortieri *VanBen.* — *German Ocean* (VanBeneden).

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[1] As here limited, the Tubularidæ embrace only those Hydroids the head of which has a wreath of simple coronal tentacles, and a proboscis with simple tentacles around the mouth; producing either sessile or free medusæ, more or less one-sided, budding from the floor between the coronal tentacles and the proboscis.

[2] Kölliker has described a Tubularia which belongs to the genus Parypha (see p. 242), and may be the parent of Leuckart's Pyxidium. The eminent anatomist uses expressions in this description, which require our special attention. What he calls sexual organs are unquestionably medusæ-buds, and the hollow cone of these organs is the proboscis of the medusa. The parts of these so-called sexual capsules are, in fact, homologous to the parts of the free medusæ, in all their details; and this shows them to be distinct individuals, for an organ homologous to a whole animal, in all its parts, would be a singular anomaly.

[3] Ectopleura *Ag.* In this genus are included those species formerly referred to Sarsia, having a short digestive trunk, not provided with movable lips; and in which the pigment cells of the sen-

E. pulchella *Ag.* — Sarsia pulchella *Forbes*, Nak. Med., Pl. 6, fig. 3. — *British Seas* (Forbes).

E. turricula *Ag.* — Sarsia turricula *McCr.*, Pl. 8, figs. 6–8. — *Charleston, South Carolina* (McCrady).

E. nodosa *Ag.* — Sarsia nodosa *Busch.*, Pl. 2, fig. 6. — *Cornwall* (Busch).

E. ochracea *A. Ag.* — *Naushon, Buzzard's Bay* (A. Agassiz).[1]

Corymorpha. *Sars.* — Ellisia *Forbes.*

C. nutans *Sars.* See p. 242. — *German Ocean* (Sars); *British Seas, Orkney Islands* (Forbes).

C. pendula *Ag.*, p. 276, Pl. 26, figs. 7–17. — *Bay of Massachusetts, Nahant* (Agassiz).

Steenstrupia *Forbes.* See p. 242.[2]

S. fritillaria *Ag.* — Coryne fritillaria *Steenst.*, Generationsw., Tab. I. — *Iceland* (Steenstrup).

S. rubra *Forbes*, Nak. Med., Pl. 13, fig. 1. — *British Seas* (Forbes). — S. flaveola *Forbes*, Nak. Med., Pl. 13, fig. 2, is, perhaps, only another state of S. rubra.

S. lineata *Leuck.*, Arch. Nat., 1856, Pl. 2, fig. 6. — *Nice* (Leuckart).

Euphysa *Forbes.*

E. aurata *Forbes*, Nak. Med., Pl. 13, fig. 3. — *British Seas* (Forbes).

Hybocodon *Ag.*

H. prolifer *Ag.*, p. 243, Pl. 25. — *Massachusetts Bay* (Agassiz).

Sarsia gemmifera *Forbes*, Nak. Med., Pl. 7, fig. 2, and Sarsia prolifera *Forbes*, Nak. Med., Pl. 7, fig. 3, may also belong to this genus, or form another distinct group.

sitive bulb are not concentrated in one mass, but scattered through the whole swelling at the base of the tentacles. There are also two rows of lasso-cells on the surface of the spherosome, commencing at the base of the chymiferous tubes, and running, one each side of it, towards the abactinal pole.

[1] Ectopleura ochracea *A. Ag.* Spherosome of uniform thickness from the circular tube to the base of the digestive trunk. From this point the outline tapers very gradually towards the abactinal pole, giving a great thickness to this part of the spherosome. The tentacles are short, carried tightly curled, lasso-cells very numerous, and scattered irregularly over their surface. There is an accumulation of light-yellow pigment-cells near the base of the digestive trunk, which is itself of a delicate pink color. The pigment-cells of the sensitive bulb are of a purplish-orange upon a yellow ground. Height one quarter of an inch. — *Naushon, Buzzard's Bay, September* (A. Agassiz).

[2] By misprint the genus Steenstrupia bears the authority of Sars, on p. 242, when it should be Forbes. I suspect a mistake on the part of Steenstrup in referring the free Medusa, represented in the "Generationswechsel," Pl. I. figs. 43, 44, and 45, to the Hydroid represented fig. 41. His free Medusa has the closest affinity with Hybocodon prolifer, which truly belongs to the Tubularidæ, while his Hydroid cannot be referred to this family, as it has no coronal tentacles.

8th Family. PENNARIDÆ *Mc Cr.*[1] (restricted).

Pennaria *Goldf.* (non *Oken*). See p. 278.

P. distycha *Goldf.* — Sertularia pennaria *Cav.*, Pl. 5, figs. 1–6. — *Mediterranean* (Cavolini).

P. gibbosa *Ag.*, Vol. III. Pl. 15, figs. 1 and 2. — *Florida* (Agassiz). Euphysa globator *Leuck.*, Wiegm. Arch., 1856, Pl. 2, fig. 4, is probably a Pennaria.

Globiceps *Ayres.* — Eucoryne *Leidy.* Both names preoccupied.

G. tiarella Ayres. — Eucoryne elegans *Leidy.* — Pennaria tiarella *Mc Cr.* — *Massachusetts : Buzzard's Bay* (Ayres); *N. Jersey* (Leidy); *Charleston, South Carolina* (McCrady).

Zanclea *Gegenb.* — Microstoma *Less.* (preoccupied).

Z. costata *Gegenb.*, Pl. 8, figs. 4–7. — *Messina* (Gegenbaur).

Z. ambigua *Ag.* — Microstoma ambiguum *Less.* — *Waigiou* (Lesson).

Z. gemmosa *Mc Cr.*, Pl. 8, fig. 4. — Gemmaria *Mc Cr.* — *Charleston, South Carolina* (McCrady).

9th Family. BOUGAINVILLIDÆ *Lütk.*, *Gegenb.* — Hippocrenidæ *Mc Cr.*

Bougainvillia *Less.* — Hippocrene *Mert.* — Hydra: Eudendrium-like, with short proboscis. — See p. 283.

B. macloviana *Less.* — Cyanea Bougainvillii *Less.*, Coq. Zooph, Pl. 14, fig. 3. — *Falkland Islands* (Lesson).

B. Mertensii *Ag.* — Hippocrene Bougainvillei *Br.*, Pl. 20. — *Behring Straits* (Brandt); *Gulf of Georgia* (A. Agassiz).

B. superciliaris *Ag.*, Mem. Am. Ac., IV. Pl. 1; see also this volume, p. 283. — *Bay of Boston, Nahant* (Agassiz).

Margelis *Steenst.* — Medusa: Bougainvillia *Forb.*, Hippocrene *Mc Cr.* — Hydra: Eudendrium-like, with short proboscis.

M. principis *Steenst.* — *Faröe Isl.* (Steenstrup).

M. carolinensis *Ag.* — Hippocrene carolinensis *Mc Cr.*, Pl. 10, figs. 8–10. — *Charleston Harbor* (McCrady); *Naushon* (A. Agassiz).

M. ramosa *Ag.* — Tubularia ramosa *Dalyell*, and Medusa ocilia *Dalyell*, Pl. XI. — Bougainvillia britannica *Forbes*, Nak. Med., Pl. 12, fig. 1. — *Zetland Islands* (Forbes).

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[1] McCrady refers also Willia and Cladonema to this family, but the hydræ of Cladonema and Eleutheria, which are closely allied, differ as much from those of the true Pennaridæ, as their free medusæ. The Pennaridæ differ from the Tubularidæ by the mode of branching of the Hydroid, and by the structure of the proboscidal tentacles, which are clavate, while the coronal tentacles are simple. The Cladonemidæ have only one kind of tentacles, arranged in worls, and they are clavate.

M. nigritella *Ag.*—Bougainvillia nigritella *Forbes,* Nak. Med., Pl. 12, fig. 2.—*Zetland Islands* (Forbes).

Lizzia *Forbes.* See p. 284.

L. octopunctata *Forbes,* Nak. Med., Pl. 12, fig. 3.—Cytæis octopunctata *Sars.*—*Norway* (Sars); *Zetland Islands* (Forbes).

L. blondina *Forbes,* Nak. Med., Pl. 12, fig. 4.—*Zetland Islands* (Forbes).

Rathkia *Br.* Ac. St. Pet., 1838, p. 353, note.

R. Blumenbachii *Br.*—Oceania Blumenbachii *Rathke,* Ac. St. Pet., 1835, Pl. (no number).—*Crimea* (Rathke).

Köllikeria *Agass.* Differs by its eight bunches of tentacles.

K. fasciculata *Ag.*[1]—Melicerta fasciculata *Pér.* and *LeS.*—Lizzia Köllikeri *Gegenb.,* Pl. 7, fig. 5; *Leuck.,* Arch., 1856, Pl. 2, fig. 2.—Bougainvillia diplectanos *Busch,* Pl. 2, fig. 9, may be the young.—*Nice* (Péron and LeSueur); *Messina* (Gegenbaur).

10th Family. NEMOPSIDÆ *Agass.*[2]

Nemopsis *Ag.* The Hydra has been described by McCrady.

N. Bachei *Ag.*—Nemopsis Gibbesi *McCr.,* Pl. 10, figs. 1–7.—*Vineyard Sound* (Agassiz); *Naushon* (A. Agassiz); *Charleston Harbor, South Carolina* (McCrady).

Acaulis *Stimp.* The free medusa is not known.

A. primarius *Stimp.,* Pl. 1, fig. 1.—*Grand Manan, Bay of Fundy* (Stimpson).

11th Family. BERENICIDÆ *Esch.*—Willsiadæ *Forbes.*[3]

Berenix *Pér.* and *LeS.*—Berenice *Cuv.*

B. euchroma *Pér.* and *LeS.*; *Cuv.,* Règn. An., Ill. ed., Pl. 53, fig. 2.—*Equatorial Atlantic Ocean* (Péron and LeSueur).

B. Thalassina *Pér.* and *LeS.*—*West Coast of New-Holland* (Péron and LeSueur.

Cuvieria *Pér.* and *LeS.*

C. carisochroma *Pér.* and *LeS.*; *Cuv.,* Règn. An., Ill. ed., Pl. 53, fig. 1.—*New-Holland* (Péron and LeSueur).

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[1] There can be no doubt that Lizzia Köllikeri *Gegenb.* is identical with Melicerta fasciculata, *Pér.* and *LeS.* The description agrees fully, and the origin is the same. Is not Lizzia dibalia *Busch* also a Köllikeria or a Rathkia?

[2] This family differs from the Bougainvillidæ, by the peculiar prolongation of the genital apparatus of the free Medusa, which extends from the proboscis to the radiating tubes, along which it projects, like curtains, into the cavity of the bell.

[3] I see no reason why the Willsiadæ of Forbes should be separated from the Berenicidæ of Eschscholtz, founded upon the species drawn by LeSueur, and described by Péron and LeSueur. The genus Eudora is evidently drawn from imperfect Acalephs.

Eudora *Pér.* and *LeS.* (not Lesson).

E. undulosa *Pér.* and *LeS.*; *Cuv.*, Règn. An., Ill. ed., Pl. 54, fig. 5. — *De Witt's Land* (Péron and LeSueur).

Proboscidactyla *Br.* — P. flavicirrhata *Br.*, Pl. 19. — *Petropolawsky* (Mertens); *Gulf of Georgia* (A. Agassiz).

Willia *Forbes.*[1] (Spelled Willsia by Forbes.)

W stellata *Forbes*, Nak. Med., Pl. 1, fig. 1; Gosse, Devon., Pl. 20, figs. 1–5. — *Bay of Oban and Penzance* (Forbes).

W. ornata *McCr.*, Pl. 9, figs. 9–11. — *Charleston Harbor, South Carolina* (McCrady); *Naushon, Massachusetts* (A. Agassiz).

12th Family. Nucleiferæ *Less.* — Oceanidæ *Esch.* (p. p.), *Gegenb.*, *McCr.*

Conis *Br.* — C. mitrata *Br.*, Mém. Acad. St. Petersb., 1838, Pl. 2. — *Bonin Islands* (Mertens).

Turris *Less.* — Oceania (Auct. p. p.).[2] — Hydra: Clavula *Wright.*

T. papua *Less.*; *Eyd.* and *Soul.*, Bonite, Zooph., Pl. 2, figs. 1–3. — *Waigiou* (Lesson).

T. digitalis *Forbes*, Nak. Med., Pl. 3, fig. 1. — Medusa digitalis *O. F. Müll.* — Melicerta digitalis *Pér.* and *LeS.* — Eirene digitalis *Esch.* — Turris borealis *Less.* — *German Ocean* (O. F. Müller); *British Seas* (Forbes).

T. neglecta *Less.*; *Forbes*, Nak. Med., Pl. 3, fig. 2. — Clavula Gossii *Wright*, Edinb. Phil. Journ., 1859, Vol. X. p. 105; *Gosse*, Devon., Pl. 13, figs. 6–10. — *British Seas* (Forbes).

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[1] Dedicated to Dr. Will, by Prof. Forbes, and should, therefore, be written Willia, and not Willsia.

[2] As characterized by the French naturalists, the genus Oceania does not at all correspond to the genus Oceania of Forbes and the modern German zoölogists. Eschscholtz does not seem to have observed a single species himself, and adopts nearly the same limits for it as Péron and LeSueur. So does also DeBlainville. Moreover, Péron and LeSueur unite the Oceaniæ of modern writers with the species which Lesson has retained in this genus, after restricting it so as to exclude the Forskalian species. The result of all this is, that the Lessonian Oceaniæ are united with some of the Æquoridæ of Eschscholtz, even though Eschscholtz had already proposed the name Oceanidæ for a family which is entirely different from the Æquoridæ. As there are types of several distinct families united at the outset under the name Oceania, by Péron and LeSueur, the question now is, for which that name ought to be retained, if retained at all. Lesson perceived the confusion, and took the first steps towards remedying it; but he did it very imperfectly. I see, however, no reason why the name Nucleiferæ, which he proposed for the old Forskalian type, should not be retained for this family, and the name Oceania and Oceanidæ applied specially, as Lesson has done, to Oceania phosphorica, which Péron and LeSueur place in the first section of the genus. This section corresponds to the genus Thaumantias of modern writers. The second section answers to the genus Oceania, as limited by Forbes; but since Lesson had previously divided the genus in a different way, Forbes' arrangement cannot be adopted. The third section corresponds to Geryonopsis.

Tiara *Less.* — Oceania *Forbes.* — Pandea *Less.* (p. p.).

T. pileata *Ag.* — Medusa pileata *Forsk.* — Oceania pileata *Pér.* and *LeS.*; *Leuck.*, Arch. Nat., 1856, Pl. 2, fig. 1. — Tiara papalis *Less.* — Oceania coccinea *Leuck.* (male). — *Mediterranean* (Péron and LeSueur); *Nice* (Leuckart).

T. conica *Ag.* — Dianæa conica *Q.* and *G.* — Oceania conica *Esch.*, *Gegenb.*, Pl. 7, fig. 1. — Pandea conica *Less.* — Oceania sedecimcostata *Köll.* — *Mediterranean* (Guoy and Gaimard).

T. octona *Ag.* — Oceania octona *Forbes*, Nak. Med., Pl. 2, fig. 1. — Oceania saltatoria *Sars*, O. turrita and O. episcopalis *Forbes*, Nak. Med., Pl. 2, figs. 2 and 3, are probably different stages of growth of the same species. — *British Seas* (Forbes).

Pandea *Less.* (restricted).

P. flavidula *Ag.* — Oceania flavidula *Pér.* and *LeS.*; *Gegenb.*, Pl. 7, fig. 4. — Oceania rotunda *Q.* and *G.* — Oceania armata *Köll.* — *Nice* (Péron and LeSueur).

P. globulosa *Ag.* — Oceania globulosa *Forbes*, Nak. Med., Pl. 3, fig. 3. — *British Seas* (Forbes).

Turritopsis *McCr.*

T. nutricola *McCr.*, Pls. 4 and 5, and Pl. 8, fig. 1. — *Charleston, South Carolina* (McCrady); *Naushon* (A. Agassiz).

Modeeria *Forbes.*

M. formosa *Forbes*, Nak. Med., Pl. 7, fig. 1. — *Hebrides* (Forbes).

Stomotoca *Ag.* — Saphenia *Forbes* (not *Esch.*).[1]

St. dinema *Ag.* — Saphenia dinema *Forbes*, Nak. Med., Pl. 2, fig. 4, (not *Esch.*). — Saphenia Titania *Gosse*, Devon., Pl. 26, figs. 7–9. — *British Channel* (Forbes). — Syncoryna Cleodoræ *Gegenb.*, Generat., Pl. 1, fig. 3, appears to be the Hydra of a Stomotoca.

St. apicata *Ag.* — Saphenia apicata *McCr.*, Pl. 8, figs. 2 and 3. — *Charleston* (McCrady).

St. atra *A. Ag.* — *Gulf of Georgia, W. T.* (A. Agassiz).[2]

Rhizogeton *Ag.* See p. 224.

R. fusiformis *Ag.*, Pl. 20, figs. 17–23. — *Nahant* (Agassiz).

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[1] This name must be changed, since the genus Saphenia *Esch.* is well founded, but embraces entirely different species from those referred to it by Forbes, and belonging to a different family, the Geryonopsidæ. I propose to call it Stomotoca.

[2] Stomotoca atra *A. Ag.* Spherosome rounded at abactinal pole. Peduncle long, ovaries of dark brown color, occupying the lower half of it, and extending to the level of the veil; digestive cavity terminating in four simple folds, hanging below the

4th Sub-order. SERTULARIÆ.[1] Alternate generations or direct development.[2] Hydra always pedunculated and attached, protected by a horny sheath, forming a distinct cup around the head. Medusa either free or sessile, mostly flat, sometimes, however, deep bell-shaped, with numerous tentacles, not more prominent in the prolongation of the radiating chymiferous tubes, than in the intervals between them, along the circular tube;[3] with or without independent eyes and marginal cirrhi. Reproductive organs always along the radiating chymiferous tubes, and never upon the proboscis.

1st Family. AGLAURIDÆ *Ag.* See note 2, p. 352.

Aglaura *Pér.* and *LeS.*, *Esch.*, *DeBl.*, *Less.*, *Gegenb.* (non *Oken*).

A. hemistoma *Pér.* and *LeS.* — Aglaura Peronii *Leuck.*, Arch. Nat., 1856, Pl. 1, fig. 5; *Gegenb.*, Pl. 8, fig. 3. — *Niee* (Péron and LeSueur); *Messina* (Gegenbaur).[4]

Lessonia *Eyd. et Soul.*

L. radiata *Eyd. et Soul.*, Bonite, Zooph., Pl. 2, fig. 16. — *South Sea* (Eydoux et Souleyet).

2d Family. CIRCEIDÆ *Forbes.* See note 2, p. 352.

Circe *Mert.*, in Brandt's paper, Mém. Ac. St. Petersb., 1838.

C. camtschatica *Br.*, Pl. 1. — *Coast of Kamtschatka* (Mertens).

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level of the circular tube. About eighty rudimentary tentacles between the two large ones. Spherosome of a light blue color; folds of actinostome, dirty yellow; tentacles, light brown. Height, three quarters of an inch. — *Gulf of Georgia, Washington Territory* (A. Agassiz).

[1] This sub-order corresponds to the groups of Hydroids generally designated under the names of Sertularians and Campanularians, but, since many of them are now known to produce free Medusæ, it is evident that all the naked-eyed Medusæ which have the same structure as these, must be associated with them, even though the origin of a majority of them remains at present unknown.

[2] It remains doubtful whether some naked-eyed Medusæ, such as the Trachynemidæ *Gegenb.*, which are known to undergo a direct development from eggs, should remain in this sub-order. But when I consider the difference in the development of Pelagia and Cyanea, notwithstanding their close affinity, I am inclined to believe that a regular succession of generations, without the interposition of an hydroid form, is no objection to the association of these naked-eyed Medusæ with those, the eggs of which produce Hydræ from which free Medusæ arise.

[3] When young, some of these Medusæ have four tentacles, and for some time, while still growing, the tentacles in the prolongation of the chymiferous tubes are larger than those placed in the intervals; but in course of time this difference gradually vanishes.

[4] The Aglaura penicillata *DeBl.*, Pl. 33, fig. 4, belongs to the genus Polyorchis; it is figured twice, and appears under two different names in the Manuel d'Actinologie. It is the Melicertum penicillatum *Esch.*, and is also figured under that name by DeBlainville on Pl. 38. See Polyorchis, p. 349.

C. impatiens *A. Ag.*—*Gulf of Georgia* (A. Agassiz).

C. Anais *Less.*, Pl. 5, fig. 1.—Circe elongata *Less.*, Pl. 5, fig. 2 (the same contracted).—*Seas of Africa* (Rang).

C. rosea *Forbes*, Nak. Med., Pl. 1, fig. 1.—*British Seas* (Forbes).

Persa *Mc Cr.*

P. incolorata *Mc Cr.*, Pl. 12, fig. 3.—*Charleston* (McCrady).

Mitra *Less.*

M. Rangii *Less.*, Pl. 6, fig. 5.—*Seas of Africa* (Rang). The long tentacles indicate an affinity with Tiara *Less.*

3d Family. POLYORCHIDÆ *A. Ag.* See note 2, p. 352.

Polyorchis *A. Ag.*[1]—Melicertum *Esch.* (p. p.).—Aglaura *DeBl.* (p. p.).

P. penicillata *A. Ag.*—Melicertum penicillatum *Esch.*, Pl. 8, fig. 4.—Aglaura penicillata *DeBl.*—*California* (Eschscholtz).—*Gulf of Georgia and San Francisco* (A. Agassiz).

4th Family. MELICERTIDÆ *Ag.* See note 2, p. 352.

Melicertum *Oken.*—Melicerta *Pér.* and *LeS.* (p. p.).—Campanella *Less.* (non *Bl.*).

M. campanula *Pér.* and *LeS.*—Medusa campanula *Fab.*—Campanella Fabricii *Less.*—*Greenland* (Fabricius); *Massachusetts Bay* (Agassiz).

M. pusillum *Esch.*—Actinia pusilla *Swartz*—Melicertum campanulatum *Ehrenb.*, Pl. 8, fig. 7 (non *Cham.* and *Eysenh.*).—Stomobrachium octocostatum *Forbes*, Nak. Med., Pl. 4, fig. 1.—Oceania octocostata *Sars.*—Æquorea octocostata *Less.*—Thaumantias Milleri *Landsb.*—*German Ocean* (Swartz); *England* (Forbes).

M. campanulatum *Esch.* (non *Ehrenb.*).—Medusa campanulata *Cham.* and *Eysenh.*, Act. Nov., X. Pl. 30, fig. 1.—Campanella Chamissonis *Less.*—*South Sea* (Chamisso and Eysenhardt).

M. georgicum *A. Ag.*[2]—*Gulf of Georgia* (A. Agassiz).

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[1] Polyorchis *A. Ag.* Spherosome bell-shaped. Ovaries suspended as independent pouches near the base of the digestive cavity; digestive cavity cylindrical, very flexible, terminating in simple lips. Chymiferous tubes sending off numerous branches at right angles with the main stems; tentacles forming a knee upon themselves, and having the tentacular bulb at a distance from the circular tube. No ocelli or sensitive capsules.

[2] Melicertum georgicum *A. Ag.* Spherosome somewhat pointed towards abactinal region; tentacles much fewer in number than in the species of the New England coast, with large tentacular bulbs; digestive cavity longer, terminating in four lips. Ovaries not extending to the base of the chymiferous tubes. Digestive cavity, ovaries, and tentacular bulbs of a yellowish-brown color.—*Gulf of Georgia, Washington Territory, July* (A. Agassiz).

Gonionemus *A. Ag.*[1]

G. vertens *A. Ag.*[2]—*Gulf of Georgia, Washington Territory* (A. Agassiz).

5th Family. LAODICEIDÆ *Ag.* — Thaumantiadæ *Gegenb.*[3]

Laodicea *Less.*[4] — Cosmetira *Forbes.* — Thaumantias *Gegenb.* (non *Esch.*).

L. cruciata *Ag.* — L. crucigera *Less.* — Medusa cruciata *Forsk.*, Pl. 33, fig. A. — Oceania cruciata, in Wagner's Icones Zoot., Pl. 33, fig. 2. — Oceania cacuminata *Esch.* — Thaumantias Mediterranea *Gegenb.*, Pl. 8, figs. 1–3. — Thaumantias corollata *Leuck.*, Pl. 1, fig. 11. — *Mediterranean* (Forskål).

L. stauroglypha *Ag.* — Æquorea stauroglypha *Pér.* and *LeS.* — Thaumantias (Cosmetira) pilosella *Forbes*, Pl. 8, fig. 1. — *British Channel* (Péron and LeSueur).

L. cellularia *A. Ag.*[5] — *Gulf of Georgia, W. T.* (A. Agassiz).

L. calcarata *A. Ag.*[6] — *Naushon, Buzzard's Bay* (A. Agassiz).

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[1] Gonionemus *A. Ag.* Spherosome conical, ovaries in alternate folds along the chymiferous tubes. Digestive cavity flexible; tentacles attached to the circular tube by a peduncle, not numerous.

[2] Gonionemus vertens *A. Ag.* Spherosome rather conical, with rounded apex, chymiferous tubes making a sharp bend above the commencement of the ovaries, which are dark violet, as well as the tentacular bulb, and a spot of the same color near the extremity of the tentacles; the tentacles themselves are reddish brown, short, sickle-shaped (when the Medusa is in motion), with a bulb which is not immediately at the base of the tentacle: they can expand to twice the diameter of the Medusa. There are fifteen between every two chymiferous tubes, and one opposite each. The lasso-cells are arranged in rings around the tentacles. The digestive cavity, hanging like a long bag, with four-lobed lips round the actinostome. Vertical diameter nine tenths of an inch, actinal diameter eight tenths of an inch. — *Gulf of Georgia* (A. Agassiz).

[3] As the genus Thaumantias *Gegenb.* does not correspond to that of Eschscholtz, while it is synonymous with Laodicea *Less.*, this name cannot be retained for the family.

[4] By a strange mistake the name of Laodicea is introduced among the synonyms of Aurelia, p. 159. It was copied from a memorandum made to compare Medusa cruciata *Forsk.*, which is a Laomedea, with Medusa cruciata *Bast.*, which is an Aurelia.

[5] Laodicea cellularia *A. Ag.* Digestive cavity very short; lips of actinostome narrow, with frilled edges, at least five times as long as the diameter of the digestive cavity. Ovaries extending the whole length of the chymiferous tubes, with a slightly lobed outline. Tentacles very contractile, with a large swelling at the base. Ovaries and digestive cavity of a light violet color; the tentacular bulb of a darker shade; the whole spherosome with a light violet tinge. Diameter, across the circular tube, one and one fifth of an inch. Height, three quarters of an inch. Surface of spherosome covered with large, polygonal epithelial cells. — *Gulf of Georgia, Washington Territory, July to September* (A. Agassiz).

[6] Laodicea calcarata *A. Ag.* Spherosome perfectly transparent; ovaries hanging in folds from the base of the digestive cavity to a short distance from the circular tube. Digestive cavity short, with four thin, wavy lips, equalling in length the diameter of the digestive cavity. The tentacles are exceedingly numerous, and placed close together; from the narrow intervals between them protrude small, solid, club-shaped tentacles, and thread-like cirrhi. The large tentacles have a conical spur, equalling in length the diameter of the tentacular bulb, which is of a dirty yellow color, with a dark

Staurophora *Br.*

St. Mertensii *Br.*, Pls. 24 and 25. — *Norfolk Sound* (Mertens).

St. laciniata *Ag.*, Mem. Amer. Acad., IV. Pl. 7. — *Massachusetts Bay* (Agassiz).

Laphœa *Lamx.* — Atractylis *Wr.* (p. p.). — Campanulina *VanBened.*

L. cornuta *Lamx.*[1] — *Newfoundland* (Lamouroux). — *Naushon, Buzzard's Bay* (A. Agassiz).

L. dumosa *Ag.* — Campanularia dumosa *Flem.*, *Johnst.*, Zoöph., p. 114, fig. 20. — Atractylis repens *Wr.*, Edinb. Phil. Journ., 1859, Pl. 1, fig. 5. — Campanulina tenuis *VanBened.*, Bull. Ac. Belg., 1847. — *British Seas* (Fleming); *Ostende* (VanBeneden).

Trichydra *Wright.*

T. pudica *Wright*, Ed. Phil. Journ., 1858, Vol. VII., Pl. 3, fig. 1.

6th Family. EUCOPIDÆ *Gegenb.* (restricted). See note 2, p. 352.

Obelia *Pér.* and *LeS.* — Hydra: a branching Campanularia.

O. sphaerulina *Pér.* and *LeS.*; *DeBl.*, Actin., Pl. 41, fig. 3. — Campanularia geniculata *Van-Ben.*, Pl. 3, figs. 1–6. — *Holland* (Péron and LeSueur); *Ostende* (VanBeneden).

O. leucostyla *Ag.* — Thaumantias leucostyla *Will.* — Pl. 2, fig. 16. — *Trieste* (Will).

O. commissuralis *McCr.* — *Charleston* (McCrady); *Naushon* (A. Agassiz); *Massachusetts Bay* and *Grand Manan* (Agassiz).

Eucope *Gegenb.* — Hydra: a branching Campanularia.

E. polystyla *Gegenb.*, Pl. 8, fig. 18. — *Messina* (Gegenbaur).

E. plana *Ag.* — Thaumantias plana *Sars*, Beskr., Pl. 5, fig. 13. — *Norway* (Sars).

E. lucifera *Ag.* — Thaumantias lucifera *Forbes*, Pl. 10, fig. 2, under the name of Th. lucida. — *Zetland* (Forbes). — Laomedea geniculata *Gosse*, Devon., Pl. 4, and Campanularia gelatinosa *Van-Ben.*, Pls. 1 and 2, may be the young of this species.

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violet pigment spot. The ovaries and digestive cavity are of the same color as the tentacular bulb. Diameter across the circular tube one inch, height, half an inch. — *Naushon, Buzzard's Bay* (A. Agassiz).

[1] Laphœa cornuta *Lamx.* The free Medusa resembles that of Atractylis repens of Wright. Tentacles shorter, lasso-cells arranged in spirals along the two long tentacles. Large white pigment-cells at the base of the tentacles and at the base of the digestive cavity. Hydræ creeping upon stems of Dynamena. Sterile hydræ alternating upon the stem, moderately close together; calyx curved at the base. Reproductive calycle very large, egg-shaped, smooth, containing, in an advanced state of development, one Medusa only. Height of the Medusa, one sixteenth of an inch. — *Naushon, Buzzard's Bay, September* (A. Agassiz). The knowledge of this Medusa gives a clue to the position of Trichydra.

E. diaphana *Ag.*, p. 322, Pl. 34, figs. 1–9.—Thaumantias diaphana *Ag.*, Mem. Amer. Acad., IV p. 300, figs. 1 and 2.—*Nahant* (Agassiz); *Naushon* (A. Agassiz).

Laomedea *Lamx.*[1] — Campanularia *Lmk.* (p. p.).

L. amphora *Ag.*, p. 311, Pl. 30.—*Massachusetts Bay* (Agassiz).

7th Family. OCEANIDÆ *Esch.*[2] (So restricted as to exclude the Nucleiferæ *Less.*, and the Geryonopsidæ *Ag.*).—Eucopidæ *Gegenb.* (p. p.).

Oceania *Pér.* and *LeS.* (restricted).—Thaumantias *Esch.*—Callichroma *Dujard.*—Epenthesis *Mc Cr.*—Phialidium *Leuck.*

O. phosphorica *Pér.* and *LeS.*—Thaumantias cymbaloides *Esch.*—T. hemisphærica *Esch.*, *Forbes*, Nak. Med., Pl. 8, fig. 2.—*English Channel* (Péron and LeSueur).—Thaumantias inconspicua *Forbes*, Pl. 8, fig. 3, *Hebrides*,—T. punctata *Forbes*, Pl. 10, fig. 1, *Isle of Man*,—T. lineata *Forbes*, Pl. 11, fig. 1, *Zetland*,—T. pileata *Forbes*, Pl. 11, fig. 2, *North Ireland*,—T. sarnica *Forbes*, Pl. 11, fig. 4, *Guernsey*,—are probably different stages of growth only of T. hemisphærica.—Oceania ampullacea *Sars*, belongs also to this series.

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[1] Without a renewed comparison, it is impossible for me to refer to their proper genus, the many species of Campanularia and Laomedea already described, since it is known that among them there are types of different genera; belonging even to different families.

[2] Compare note 2, p. 346. It is far more difficult to define correctly the families of this sub-order, than those of the Tubularians, for the simple reason that comparatively few free Medusæ of this type can be referred with certainty to the Hydroids from which they arise, and the medusæ-buds of a large number of the Hydroids, have not been observed at all. Under these circumstances, the attempt at a classification, here presented, should be considered as containing hints, rather than mature results. Starting, however, from principles which have proved a safe guide, whenever the data on hand were sufficient, I have considered as belonging to distinct families all those free Medusæ and Hydroids which have distinct patterns. Thus, the Aglauridæ are separated on account of the flat-topped bell, and the position of their reproductive organs, even though their mode of reproduction is unknown. To the characters assigned to the Circeidæ by Forbes, I would add their elongated, cylindrical form. The Polyorchidæ are quite remarkable for their branching, chymiferous tubes, and their pendent, reproductive organs; the Melicertidæ for their eight radiating tubes, their lobed, reproductive organs, and their wide and short actinostome; the Laodiceidæ for their flat form, the extensive lobes of their actinostome, and their peculiar marginal appendages. The free medusa of Lafœa cornuta *Lamx.*, lately observed, and the peculiarities of this Hydroid, show that this family cannot be united with the Oceanidæ proper, and still less with the Geryonidæ with which Forbes associates them. Gegenbauer has appreciated their difference correctly; but he has given them a name which cannot be retained. All these families are destitute of eyes, and have only an accumulation of pigment upon the base of the tentacles, or cirrhi alternating with them. The Eucopidæ and Oceanidæ, on the contrary, have distinct eyes; but in the Eucopidæ they are at-

Oceania folleata *Ag.* — Epenthesis folleata *McCr.* — *Charleston, South Carolina* (McCrady).

O. languida[1] *A. Ag.* — *Nahant* and *Naushon* (A. Agassiz).

O. gregaria[2] *A. Ag.* — *Gulf of Georgia, W. T.* (A. Agassiz).

Phialidium viridiscens *Leuck.*, Arch. Nat., 1856, from *Nice*, belongs to this genus.

Thaumantias convexa *Forbes*, Pl. 11, fig. 6, *Zetland*, may also be a distinct species. — T. Thompsoni *Forbes*, Pl. 11, fig. 5, seems to be the adult of Obelia sphærulina. See p. 351.

Thaumantias gibbosa *Forbes*, Nak. Med., Pl. 11, fig. 3, *Hebrides*, constitutes, probably, a distinct genus.

Eucheilota *McCr.*

E. ventricularis *McCr.*, Pl. 11, figs. 1–3, and Pl. 1, fig. 12. — *Charleston* (McCrady); *Naushon* (A. Agassiz).

E. duodecimalis *A. Ag.*[3] — *Naushon, Buzzard's Bay* (A. Agassiz).

tached to the base of the tentacles, while in the Oceanidæ they are free, and occupy, along the circular tube, a position which seems independent of the arrangement of the tentacles. As I now know the young Medusa of four genera of this family, I am able to add to the family character that, in their early stages of growth, these Medusæ have only four tentacles, one in the prolongation of each of the four radiating tubes, and two eyes in each interval; while the Eucopidæ are hatched with at least sixteen or twenty-four tentacles, with eyes attached to two of the tentacles in each quarter segment. The Laodiceidæ are born with two or four tentacles only, placed, like those of the Oceanidæ, in the prolongation of the radiating tubes, but they have no eyes at all. As many of these Medusæ have a large number of tentacles in their adult condition, it follows that the specific distinctions which have been based upon the relative number of tentacles are not trustworthy; and yet the reduction of the species hinted at above, should merely be looked upon as approximative, since I had no means of tracing the transformations of the European species, and could only infer their specific identity from what I have observed in the American species.

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[1] Oceania languida *A. Ag.* Spherosome a segment of a sphere, somewhat less than a hemisphere. Tentacles thirty-two in number, with large swelling at the base. Two or three sensitive capsules, with one granule in each, between every two tentacles; digestive cavity with short lips; ovaries linear, light brown, extending from the circular tube nearly to the base of the digestive cavity. One inch in diameter, half an inch high. — *Nahant and Naushon* (A. Agassiz).

[2] Oceania gregaria *A. Ag.* Four pale-yellow, linear ovaries, extending from the circular tube along one half the length of the chymiferous tubes. Thirty-six short tentacles, not capable of great expansion. Lips of actinostome very thin, convoluted. Three quarters of an inch in diameter. — *Gulf of Georgia, from May to September* (A. Agassiz).

[3] Eucheilota duodecimalis *A. Ag.* Spherosome thin, of uniform thickness; ovaries short, elliptical, commencing from the circular tube; four tentacles, with lateral cirrhi, one opposite each chymiferous tube. Twelve sensitive capsules, one in the middle of the space between two tubes, and one on each side of the four tentacles. Digestive cavity short, bottle-shaped, colorless; one quarter of an inch in diameter. — *Naushon, September* (A. Agassiz).

Clytia *Lamx.* — Calicella *Hincks.* — Trochopyxis *Ag.* — Hydra: a Campanularia of the type of C. volubilis.

C volubilis *Lamx.* See p. 297. — *Northern Europe* (Lamouroux).

C. bicophora *Ag.* See p. 304. — *Massachusetts Bay* (Agassiz).

Campanularia noliformis *McCr.*, Pl. 11, fig. 4, from *Charleston, South Carolina,* — Campanularia Gegenbauri *Sars; Gegenb.*, Generat., Pl. 1, fig. 1, from *Messina,* — and Campanularia Johnstoni *Hincks; Wright*, Ed. Phil. Journ., 1858, Vol. VII. Pl. 7, fig. 3, from the *British shores*, belong also to this genus.

Platypyxis *Ag.* See p. 306.

Pl. cylindrica *Ag.*, Pl. 27, figs. 8 and 9. — *Massachusetts Bay, Nahant* (Agassiz); *Buzzard's Bay, Naushon* (A. Agassiz).

Thaumantias octona *Forbes*, Pl. 9, fig. 2, *Tarbet, Scotland,* — T. quadrata *Forbes*, Pl. 9, fig. 2, *Tarbet,* — T. aeronautica *Forbes*, Pl. 9, fig. 3, *Brassay, Zetland,* — T. maculata *Forbes*, Pl. 9, fig. 4, *Zetland,* — T. globosa *Forbes*, Pl. 10, fig. 4, *Zetland,* — T. melanops *Forbes*, Pl. 10, fig. 3, *Zetland,* — and Eucope thaumantoides *Gegenb.*, Pl. 9, fig. 9, *Messina*; E. campanulata *Gegenb.*, Pl. 9, fig. 8, *Messina*; E. affinis *Gegenb.*, Pl. 9, fig. 12, *Messina*, which are, probably, the males and females of the same species, at different stages of growth, belong either to this genus or to the preceding and following genera.

Geryonia planata *Will*, Pl. 2, figs. 13 and 14, *Trieste* (Will), belongs also to this family, and may be the type of a distinct genus, if its eyes really alternate with the tentacles, as Will's figure and description indicate.

Wrightia *Ag.*[1] — Hydra: a Campanularia of the type of C. Syringa.

W Syringa *Ag.* — Sertularia Syringa *Lin.* — *Northern Europe* (Linnæus). To this genus belong also the Laomedea acuminata *Alder; Wright*, Ed. Phil. Jour., 1858, Vol. VII. Pl. 1, and the Laomedea lacerata *Wright*, Ed. Phil. Jour., 1859, Vol. IX. Pl. 3. Some of Forbes' species of Medusæ, quoted above, may, perhaps, belong to this genus rather than to Platypyxis.

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[1] The genus Wrightia differs from Clytia proper in having the eyes near the tentacles, instead of occupying the middle of the space between them. We have an undescribed species upon the shores of Massachusetts, and another genus closely allied to this, the Hydra of which has only ten tentacles. Campanulata verticillata and Hincksii belong also to distinct genera, for the first of which the name Campanularia may be retained. I shall describe their American representatives on another occasion.

Tiaropsis *Agass.*

T. diademata *Ag.* See p. 308. — *Nahant, Massachusetts Bay* (Agassiz).

T. multicirrhata *Ag.* — Thaumantias multicirrhata *Sars*, Beskr., Pl. 5, fig. 12. — *Norway* (Sars).

Orthopyxis *Ag.* — Clytia *Lamx.*, see p. 297. — Silicularia *Meyen*?

O. poterium *Ag.*, Pl. 28. — *Massachusetts Bay* (Agassiz).

Campanularia volubiliformis, *Sars; Gegenb.*, Generat., Pl. 1, fig. 8, and Laomedea integra *Johnst.*, Pl. 28, fig. 2, belong also to this genus.

Hincksia *Ag.*[1] — Campanularia *Hincks.*

H. tincta *Ag.* — Campanularia tincta *Hincks*, Ann. and Mag. Nat. Hist., 1861, Vol. VII. Pl. 12. — *Australia* (Hincks).

8th Family. SERTULARIDÆ[2] *Johnst.*

Dynamena *Lamx.*[3] (restricted). — Sertularia *Lin.*, *Lmk.*

D. pumila *Lamx.* See p. 326. — *On the European and American shores of the Atlantic* (Ellis, Agassiz).

Diphasia *Ag.*[4] — Dynamena *Lamx.* (p. p.). — Sertularia *Lmk.* (p. p.).

D. rosacea *Ag.* — Sertularia rosacea *Lin.*, *Johnst.* — *Europe* (Ellis).

Sertularia fallax *Johnst.*; S. tamarisca *Lin.*; S. pinaster *Ellis* and *Sol.*; S. margareta *Hass.*; S. pinnata *Pall.*; S. nigra *Pall.*; S. fusca *Johnst.*; belong also to this genus.

Amphisbetia *Ag.* — Dynamena *Lamx.* (p. p.). — Sertularia *Lmk.* (p. p.).

A. operculata *Ag.* — Sertularia operculata *Lin.* — *Europe* (Ellis).

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[1] The genus Hincksia is characterized by its one-sided, ringled, fertile hydra. Bimeria vestita *Wright* = Manicella fusca *Allm.*, seems to belong to this family; while Reticularia immersa *Thomps.* (Campanularia serpens *Hassall* = Thalia prætenuis *Allm.*), and Coppinia arcta *Hassall*, appear more closely related to Trichydra, p. 351, and through this to Lafœa. Campanularia fruticosa is unquestionably closely allied to Lafœa. Thus all the known types of Campanularians are now referred to known types of Medusæ; they prove to belong to three different families of Medusæ, and they represent three different types of Hydroids. See p. 307.

[2] Hydræ in two rows, on opposite sides of the main stem and branches; calycles always sessile, more or less flask-shaped or tubular, with a tendency to a bilabiated aperture. It is superfluous to fill the references to the works of Ellis and Johnston, which must be in everybody's hands who would study this family.

[3] See p. 326. As here limited, the genus Dynamena embraces those species the sterile hydræ of which are opposite one another, in successive pairs, with distinctly bilabiate calycle, and the fertile hydræ fusiform, with simple aperture. In the genus Diphasia the fertile hydræ are deeply dentated; in Amphisbetia the sterile hydræ are slender, the outer edge extending to a prominent point, and the fertile hydræ fusiform, with simple aperture.

[4] The American representatives of this and the following genera, which are about as numerous as the European ones, will be described on another occasion.

Sertularia *Lin.*[1] (restricted).

S. cupressina *Lin.*, *Lmk.*, *Johnst.*, *Van Ben.* — *Europe* (Ellis).[2]

S. argentea *Ellis* and *Sol.*, belongs also to this genus, and, probably, also S. abietina *Lin.*, S. filicula *Ellis* and *Sol.*, and Plumularia falcata *Lmk.*

Amphitrocha *Ag.* — Sertularia *Lmk.* (p. p.).

A. rugosa *Ag.* — Sertularia rugosa *Lin.* — *Europe* (Ellis).

A. picta *Ag.* — Sertularia picta *Meyen.* — *Terra del Fuego* (Meyen).

A. cincta *Ag.* — *Massachusetts Bay* (Agassiz).

Cotulina *Ag.*[3] — Sertularia *Lin.* (p. p.).

C. polyzonias *Ag.* — Sertularia polyzonias *Lin.* — *Europe* (Ellis). — Also S. Ellisii *Milne-Edw.*

Lineolaria *Hincks.*[4]

L. spinulosa *Hincks*, An. and Mag. Nat. Hist., 1861, Vol. VII. Pl. 13. — *Australia* (Hincks).

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[1] SERTULARIA *Lin.*, *Lamx.*

Sertularia, Linné, Systema Naturæ, 1767, p. 1306.
" Linné, Fauna Suecica, 1761, p. 540.
" Fabricius, Fauna Grœnland., 1780, p. 442.
" Ellis and Solander, Zoöph., 1786, p. 32.
" Gmelin, Linn. Systema Nat., 1788, p. 3844.
" Turton, British Fauna, 1807, p. 212.
" Lamouroux, Bull. Soc. Phil., Paris, 1812, p. 184.
" Lamouroux, Hist. Polyp. Flex., 1816, p. 182.
" Lamouroux, Expos. Méthodique, 1821, p. 12.
" Schweigger, Handbuch der Naturg., 1820, p. 426.
" Goldfuss, Handbuch der Zool., 1820, p. 88.
" Fleming, Brit. Animals, 1828, p. 542.
" Blainville, Dict. Sc. Nat., 1830, LX. p. 444.
" Blainville, Manuel d'Actinologie, 1834–1836, p. 480.
" Bosc, Hist. des Vers, 1830, p. 94.
Sertularia, Johnston, Brit. Zoöph., 1838, p. 121.
" Johnston, Brit. Zoöph., 1847, 2d ed., p. 61.
" Alder, Catal. Zoöph., Northumb., &c., 1857, p. 21.
" Hincks, An. Mag. Nat. Hist., 1861, VIII. p. 252.

[2] As here limited, the genus Sertularia embraces those species the sterile hydræ of which alternate on opposite sides of the stem, with a tendency to a combination in pairs; fertile hydræ two-horned. This peculiarity has an important morphological meaning, and seems to indicate that the calyx consists of two connate hydræ, homologous to an undeveloped pair of hydræ, as observed in Dynamena. In Amphitrocha the sterile hydræ are more loosely scattered on opposite sides, and the fertile hydræ flask-shaped, the calycles of both being ringled.

[3] This genus differs from the other Sertularidæ in having the alternate calycles of the sterile hydræ dentate; the fertile ones are ventricose and slightly ringled, with contracted aperture.

[4] The sessile hydræ show this genus to belong to the Sertularidæ, and not to the Campanularidæ, to which Hincks refers it.

Thuiaria *Flem.*[1] — Sertularia *Lin.* (p. p.).

Th. Thuia *Flem.* — Sertularia Thuia *Lin.* — *Europe* (Ellis). — Also Th. articulata *Flem.*

Halecium *Oken.*[2] — Thoa *Lamx.* — Sertularia *Lin.* (p. p.).

H. halecinum *Oken.*[3] — Thoa halecina *Lamx.* — Sertularia halecina *Lin.* — *Europe* (Ellis).

Grammaria *Stimp.* and Cryptolaria *Busk,* appear to be related to Halecium.

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[1] THUIARIA *Fleming,* 1828.

Thuiaria, Fleming, British Animals, 1828, p. 545.
“ Johnston, Brit. Zoöph., 1838, p. 137.
“ Johnston, Brit. Zoöph., 1847, 2d ed., p. 83.
“ Alder, Catalogue Zoöph. Northumb., &c., 1857, p. 27.
“ Hincks, An. Mag. Nat. Hist., 1861, VIII. p. 255.
Biseriaria, Blainville, Dict. Sc. Nat., 1830, LX. p. 446.
“ Blainville, Manuel d'Actinologie, 1834–1836, p. 482.
Cellaria (*C. thuia*), Lamarck, An. sans Vert., 1816, p. 139.
Sertularia, Linnæus, Systema Naturæ, 1767, 12th ed., p. 1308.
“ Fabricius, Fauna Grœnland., 1780, p. 444.
“ Solander and Ellis, 1786, p. 41.
Corallina vesiculata, caule angulato rigido, ramis dense stipitatis et bifurcatis, terminantibus denticulis cauli appressis. Ellis, Corallines, 1755, p. 10, Pl. 5, fig. *b,* B.

[2] HALECIUM *Oken,* 1815. The short, simple, symmetrical calycles of the sterile hydræ, which are too small to allow the animal to retreat in them, and the one-sided fertile calycles, seem to indicate a distinct family.

Halecium, Oken, Lehrbuch, 1815, III. p. 91.
“ Schweigger, Handbuch, 1820, p. 426.
“ Johnston, Brit. Zoöph., 1847, 2d ed., p. 58.
“ Alder, Catal. Zoöph. Northumb., &c., 1857, p. 20.
Halecium, Alder, An. Mag. Nat. Hist., 1859, III. p. 354.
“ Hincks, An. Mag. Nat. Hist., 1861, VIII. p. 251.
“ Hincks, Proc. British Association, 1858, p. 128.
Thoa, Lamouroux, Hist. Polyp. Flexibles, 1816, p. 210.
“ Lamouroux, Exposition Méthodique, 1821, p. 14.
“ Johnston, British Zoöph., 1828, 1st ed., p. 119.
“ Blainville, Dict. Sc. Nat., 1830, LX. p. 452.
“ Blainville, Manuel d'Actinologie, 1834–1836, p. 488.
“ Milne-Edwards, in Lamk. An. sans Vert., 1836, 2d ed., p. 147.
Sertularia (*halecina*), Linnæus, Fauna Suecica, 1761, p. 540.
“ “ Linnæus, Syst. Nat., 1767, 12th ed., p. 1308.
“ “ Solander and Ellis, Zoöphytes, 1786, p. 46.
Corallina erecta, tubulosa, pennata, halecis spinæ facie. Ellis, Corallines, 1755, p. 17, Pl. 10.

[3] Halecium Beanii *Johnst.*, and H. muricatum *Johnst.*, seem to me to be generically distinct from H. halecinum, but I have not the means of ascertaining their true characters. If they constitute distinct genera, the characters now assigned to the genus will require modifications. VanBeneden has figured the animal of H. halecinum, Bull. Acc. Belg., 1847, Vol. XIV. p. 462. The fertile hydra is double-headed and tentaculated.

9th Family. PLUMULARIDÆ *Ag.*[1] — Sertularidæ *Johnst.* (p. p.).

Aglaophenia *Lamx.*,[2] as restricted by McCrady. — Plumularia *Lmk.* (p. p.). — Sertularia *Lin.* (p. p.).

A. Pluma *Lamx.* — Sertularia Pluma *Lin.* — Plumularia cristata *Lmk.* — *Europe* (Ellis).

A. trifida *Ag.* — A. cristata *McCr.* (non *Lmk.*). — *Charleston, South Carolina* (McCrady and Agassiz).

A. pennatula *Lamx.*, A. myriophyllum *Lamx.*, A. tricuspis *McCr.*, and A. arcuata *Lamx.*, belong also to this genus.

Plumularia *Lmk.*, as restricted by McCrady.

Pl. quadridens *McCr.* — *Charleston* (McCrady).

Pl. setacea *Lmk.* — *Europe* (Ellis).

Pl. pinnata *Lmk.*, Pl. frutescens *Lmk.*, Pl. Catharina *Johnst.*, belong to this genus, and probably also Laomedea obliqua *Sanders.*

Nemertesia *Lamx.*[3] — Antennularia *Lmk.*

N. antennina *Lamx.* — Antennularia antennina *Lmk.* — *Europe* (Ellis). Also N. ramosa *Lamx.*

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[1] Hydræ sessile, on one side of the stem. Two kinds of sterile hydræ, large ones and small ones, the small ones either in the intervals between the large ones or clustered around them; besides these, fertile calycles, either simple or compound. The tentacles of the hydræ assume a more or less bilateral symmetry. McCrady has already hinted at the propriety of separating this family from the Sertularidæ. Having observed several of these Hydroids alive, I feel justified in carrying out this suggestion.

[2] AGLAOPHENIA *Lamx.*, 1812.

Aglaophenia, Lamouroux (*Sertularia pluma* Linn.), Bull. Soc. Phil., Paris, 1812, p. 184.
" Lamouroux, Hist. Polyp. Flex., 1816, p. 164.
Lamouroux, Exposition Méthodique, 1821, p. 11.
Plumularia, Lamarck, Animaux sans Vert., 1816, II. p. 123.
" Fleming, Brit. Animals, 1828, p. 546.
" Blainville, Dict. Sciences Nat., 1830, LX. p. 441.
Plumularia, Blainville, Manuel d'Actinologie, 1834–1836, p. 477.
" Milne-Edwards, in Lmk. An. sans Vert., 2d ed., 1836, p. 158.
" Johnston, Brit. Zoöph., 1838, p. 140.
" Johnston, Brit. Zoöph., 2d ed., 1847, p. 89.
" Sars, Nyt Mag., 1856, p. 163.
" Alder, Catal. Zoöph. North., 1857, p. 28.
Sertularia, Linnæus, Fauna Succica, 1761, ed. altera, p. 540.
" Linnæus, Syst. Nat., 1767, p. 1306.
" Pallas, Elenchus, 1766.

[3] NEMERTESIA *Lamx.*, 1812.

Nemertesia, Lamouroux (*Sertularia antennina* Ell.), Bulletin Soc. Phil., Paris, 1812, p. 184.
" Lamouroux, Hist. Polyp. Flexibles, 1816, p. 161.
" Lamouroux, Exposition Méthodique, 1821, p. 10.
Antennularia, Lamarck, An. sans Vert., 1816, p. 122.
" Milne-Edwards, in Lmk., An. sans Vert., 1836, 2d ed., p. 155.

10th Family. ÆQUORIDÆ *Esch.* (restricted).

Æquorea *Pér.* and *LeS.*

Æ. Forskålea *Pér.* and *LeS.* — Medusa Æquorea *Forsk.*, Pl. 32. — Æquorea Forskålina *Esch.* — *Mediterranean* (Forskål).

Æ. ciliata *Esch.*, Pl. 9, fig. 1. — *North-west Coast of N. America, Lat.* 41°–51° *N.* (Eschscholtz).

Æ. violacea *M.-Edw.*, in *Cuv.* Règne An. Zooph., Pl. 42, and Ann. Sc. Nat., 2d ser., Vol. XVI. — *Cette* (Milne-Edwards).

Æ. cyanea *Pér.* and *LeS.*; *DeBl.*, Actin., Pl. 32, fig. 2. — *New Holland, Arnheim* (Péron and LeSueur).

Æ. albida *A. Ag.* — *Naushon* (A. Agassiz).[1]

Æ. eurodina *Pér.* and *LeS.* — *Strait of Bass* (Péron and LeSueur).

Æ. allantophora *Pér.* and *LeS.* — *English Channel.*

Æ. atlantica *Pér.* and *LeS.* — Medusa Æquorea *Lin.* — *Atlantic* (Löffling).

Æ. danica *Pér.* and *LeS.* — Medusa Æquorea *Müll.* — *German Ocean* (O. F. Müller).

Æ. amphicurta *Pér.* and *LeS.* — *New Holland, De Witt's Land* (Péron and LeSueur).

Æ. bunogaster *Pér.* and *LeS.* — *New Holland, Arnheim* (Péron and LeSueur).

Antennularia, Goldfuss, Handbuch der Zoöl., 1820, p. 89.
" Schweigger, Handbuch der Naturg., 1820, p. 427.
" Fleming, British Animals, 1828, p. 546.
" Blainville, Dict. Sc. Nat., 1830, LX. p. 450.
" Blainville, Manuel d'Actinologie, 1834–1836, p. 486.
" Johnston, British Zoöphytes, 1838, p. 139.
" Johnston, British Zoöphytes, 1847, p. 85.
" Alder, Catalogue Zoöph. Northumb., &c., 1857, p. 27.
Sertularia, Linnæus, Fauna Suecica, 1761, editio altera, p. 540.
" Linnæus, Syst. Nat., 1767, XII. p. 1306.
" Ellis and Solander, Zoöph., 1786, p. 45.
Corallina astaci corniculorum æmula, Ellis, Corallines, 1755, p. 15, Pl. 9, fig. A, *a*.

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[1] Æquorea albida *A. Ag.* Spherosome slightly concave near the abactinal pole, diminishing very gradually in thickness towards the circular tube. Chymiferous tubes exceedingly numerous, extending in a regular curve from the circular tube to the digestive cavity, the diameter of which is about one third the diameter of the disk. Narrow linear ovaries extending along the whole length of the tubes. Marginal tentacles numerous, three to four between every two chymiferous tubes. No prominent swelling at the base of the tentacles, which taper gradually from the circular tube to their extremity; large patches of lasso-cells scattered irregularly over the surface; two marginal capsules for every large tentacle, with from three to four granules clustered in the centre of each. The spurs are placed at the base of the large tentacles. Ratio of actinal to polar diameter as two to one and one half. Actinal diameter two and one half inches. — *Naushon, Buzzard's Bay* (A. Agassiz).

Æ. purpurea *Pér.* and *LeS.*; *M.-Edw.*, in *Cuv.* Règn. An. Zooph., Pl. 43, fig. 3.— Polyxenia purpurea *Esch.* — *New-Holland, Endracht* (Péron and LeSueur).[1]

Crematostoma *A. Ag.*[2]

C. flava *A. Ag.*[3] — *Gulf of Georgia, W. T.* (A. Agassiz).

Mesonema pileus *Less.*, Pl. 6, fig. 1, belongs to this genus.

Melicerta *Less.*[4]

M. morchella *Less.*, Pl. 6, fig. 4. — Geryonie morille, Pl. 6, fig. 4. Origin unknown.

Mesonema *Esch.*

M. Coelum pensile *Esch.* — M. coerulescens *Köll.* — Medusa *Forsk.*, Tab. 28, B. — Æquorea mesonema. *Pér.* and *LeS.* — Æquorea Rissoana *Delle Ch.*, Pl. 73, figs. 1 and 2. — *Mediterranean* (Forskål).

M. macrodactylum *Br.*, Pl. 4. — *Pacific, Equator* (Mertens).

M. abbreviata *Esch.*, Pl. 11, fig. 3. — *Sunda* (Eschscholtz).

Zygodactyla *Br.* — Rhacostoma *Agass.*

Z. coerulescens *Br.* — Mesonema coerulescens *Br.*, Pl. 5. — *Pacific Ocean, Lat.* 35° *N.*, *Long.* 144° *W.* (Mertens).

Z. dubia *Ag.* — Mesonema dubium *Br.*, Pl. 26. — *Conception Bay and Coast of Chili* (Mertens).

Z. groenlandica *Ag.* — Æquorea groenlandica *Pér.* and *LeS.* — Medusa Æquorea *Fab.* — Medusa globularis *Mod.* — Rhacostoma atlanticum *Ag.* — *Greenland* (Fabricius); *Coast of Maine, Bay of Fundy*, and *Massachusetts Bay* (Agassiz).

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[1] Judging from the figure of LeSueur, published by Milne-Edwards, this species belongs to a different genus.

[2] Crematostoma *A. Ag.* Digestive cavity hanging down below the level of the circular tube; lips of actinostome large, lanceolate, fimbriated, and as numerous as the chymiferous tubes, of which there are from sixty to eighty. One large marginal tentacle opposite the base of each of the chymiferous tubes, without intermediate ones.

[3] Crematostoma flava *A. Ag.* Spherosome very heavy, of a slight blueish tinge. Chymiferous tubes broad, extending down the projection of the disk into the cavity of the bell. Tentacles with a broad base, dark yellow, as well as the chymiferous tubes; the ovaries extend from the circular tube to the base of the digestive cavity. The digestive cavity is almost colorless, but the lips of the actinostome are of the same color as the base of the tentacles. Ratio of actinal to polar diameter as three to one and three quarters; from three to four inches in diameter. — *Gulf of Georgia, Washington Territory* (A. Agassiz).

[4] The name Melicerta or Melicertum has been applied to two very different genera, among Acalephs. It is to be retained for the type to which Medusa campanula *Fabr.* belongs, and for which Lesson proposed the name Campanella, unfortunately already preoccupied; see p. 349. Melicerta *Less.* must be changed, but I forbear to do it, as this Medusa is little known. Melicerta Perla *Pér.* and *LeS.* seems to be a young Pelagia.

Z. cyanea *Ag.*[1] — *Florida: Key West* (Agassiz).

Z. vitrina *Ag.* — Æquorea vitrina *Gosse*, Devon., Pl. 23. — *Devonshire* (Gosse).

Rhegmatodes *A. Ag.*[2]

R. tenuis *A. Ag.*[3] — *Buzzard's Bay: Naushon* (A. Agassiz).

R. floridanus *Ag.*[4] — *Florida: Key West* (Agassiz).

R. Forbesianus *Ag.* — Æquorea Forbesiana *Gosse*, Devon., Pl. 24. — *Devonshire* (Gosse).

R. globosa *Ag.* — Æquorea globosa *Esch.*, Pl. 10, fig. 2. — *Pacific Ocean, near the Equator* (Eschscholtz).

Stomobrachium mirabile *Köll.* — *Messina* (Kölliker), belongs to this genus.

Stomobrachium *Br.*[5] (non *Forbes*).

St. lenticulare *Br.*, Pl. 3, fig. 7. — *Falkland Islands* (Mertens).

St. tentaculatum *Ag.*[6] — *Massachusetts Bay, Nahant* (Agassiz).

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[1] Zygodactyla cyanea *Ag.* Spherosome of a light blue color; this species can at once be distinguished from the Z. grœnlandica by the greater thickness of the spherosome, the shorter digestive cavity, with a large actinostome surrounded by innumerable small fimbriated lips, and the greater radius of the digestive cavity, which is more than half that of the spherosome itself. Actinal diameter three inches, polar diameter two inches. — *Key West, Florida* (Agassiz).

[2] Rhegmatodes *A. Ag.* Spherosome flat; chymiferous tubes numerous; digestive cavity short, of small diameter compared to that of the spherosome; lips of actinostome scarcely fimbriated. Large tentacles, twice as numerous as the chymiferous tubes, and not always placed opposite them; rudimentary tentacles between the larger ones.

[3] Rhegmatodes tenuis *A. Ag.* Specimens measuring between three and four inches have been found at Naushon. Ratio of actinal to polar diameter as one to three and a half; in young specimens as one to one and a half; in large specimens there were thirty chymiferous tubes, extending along the bulging of the disk into the cavity of the bell. Digestive cavity very short, lips of actinostome resembling a piece of catgut tied near the end. The ovaries do not extend to the circular tube, but hang down in two pouches from the chymiferous tubes. Spur placed opposite the base of the large tentacles. Two marginal capsules for each large tentacle, two granules in each marginal capsule, placed opposite one another, near the circumference. Disk colorless. — *Naushon, Buzzard's Bay* (A. Agassiz).

[4] Rhegmatodes floridanus *Ag.* resembles the young of Rhegmatodes tenuis at the time when it has from sixteen to twenty-four chymiferous tubes. This species has three large tentacles between every two chymiferous tubes, and one opposite each. Ovaries extending only along the middle portion of the chymiferous tubes; from three to five marginal capsules between the large tentacles, with two, or even three granules in each.

[5] This genus differs chiefly from the other Æquoridæ, by the structure of its actinostome, which is distinctly divided into four lobes.

[6] Stomobrachium tentaculatum *Ag.* The tentacles between every two chymiferous tubes are from thirty to forty in number. The ovaries extend along the greater part of the chymiferous tubes, except a small portion of the actinal and abactinal ends. The lobes of the actinostome are only four in number. The disk is colorless. — *Massachusetts Bay, Nahant* (Agassiz).

11th Family. GERYONOPSIDÆ *Agass.* — Geryonidæ *Esch.* (p. p.).

Eirene *Esch.*[1] — Geryonopsis *Forbes.* — Phortis *McCr.* ?

E. viridula *Esch.* — Oceania viridula *Pér.* and *LeS.* — Geryonopsis delicatula *Forbes.* — Thaumantias cymbaloidea *Forbes* (on Pl. 9, fig. 1). — *British Channel* (Péron and LeSueur); *Coasts of Dorset and Devon* (Forbes).

E. coerulea *Ag.*[2] — *Florida: Key West* (Agassiz).

Phortis gibbosa *McCr.* — *Charleston, South Carolina* (McCrady) — belongs either to this or the following genus.

Tima *Esch.* — Eirene *Esch.* (p. p.). — Dianæa *Delle Ch.*

T. flavilabris *Esch.*, Pl. 8, fig. 3. — *Atlantic Ocean: Azores* (Eschscholtz).

T. gibbosa *Ag.*[3] — Oceania gibbosa *Pér.* and *LeS.* — Eirene gibbosa *Esch.* — Dianæa lucullana *Delle-Ch.*, Pl. 74, fig. 1. — Geryonia pellucida *Will.*, Pl. 2, fig. 8. — Geryonopsis pellucida *Forbes.* — Tima pellucida *Gegenb.* — *Nice* (Péron and LeSueur); *Naples* (Delle-Chiaje); *Messina* (Gegenbaur).

T. Bairdii *Forbes*, Pl. 5, fig. 1. — *St. Andrews, Scotland* (Forbes).

T. formosa *Ag.*[4] — *Massachusetts Bay* (Agassiz).

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[1] The genus Eirene, as characterized by Eschscholtz, contains species of three distinct genera; all of which, however, belong to the same family. Instead of rejecting it altogether, as most writers have done, I have here limited it to the type first described by Péron and LeSueur.

[2] Eirene coerulea *Ag.* Spherosome hemispherical; proboscis tapering rapidly, not extending to the level of the veil. Lips of actinostome short; ovaries commencing some way from the circular tube, and extending to the digestive cavity. From thirty to thirty-five short tentacles between every two chymiferous tubes. Diameter across the circular tube one and a quarter inches, height of spherosome one inch, base of proboscis half an inch above the veil. Of a light steel-blue color. — *Key West, Florida, April* (Agassiz).

[3] We have here a species, accurately described by the first naturalists who have most extensively known the Acalephs, redescribed twice, as new, by later observers, and referred to not less than six genera. This does not speak well for the criticism bestowed upon the nomenclature of these animals. Eschscholtz, himself, has overlooked its generic identity with Tima, though he himself first characterized the latter genus.

[4] Tima formosa *Ag.* Spherosome greater than a hemisphere, with actinal edges slightly receding from the axis near the circular tube. Proboscis broad, tapering very gradually, and reaching slightly beyond the level of the veil; ovaries convoluted, extending from the circular tube along the whole length of the chymiferous tubes nearly to the digestive cavity, which is short. Actinostome surrounded by four long, lanceolatel ips, with exceedingly fine frills, colorless. Veil heavy, with small opening. Diameter across the circular tube two and a half inches; height of spherosome two inches; distance from circular tube to base of proboscis, one inch and a quarter. In specimens of this size there are seven large tentacles between every two chymiferous tubes, and one opposite; between every two large tentacles, five small rudimentary tentacles, and from four to six marginal corpuscles, with eight to nine granules arranged in a circle in each. — *Massachusetts Bay, March to May* (Agassiz).

Eutima *McCr.*

E. mira *McCr.*, Pl. 11, fig. 8. — *Charleston, South Carolina* (McCrady).

E. variabilis *McCr.* — *Charleston, South Carolina* (McCrady).

E. limpida *A. Ag.*[1] — *Buzzard's Bay: Naushon* (A. Agassiz).

E. pyramidalis *Ag.*[2] — *Florida: Key West* (Agassiz).

Orythia *Pér.* and *LeS.*;[3] DeBlainv. (p. p.). — Phorcynia *Pér.* and *LeS.*[4] — Eirene *Esch.* (p. p.).

O. viridis *Pér.* and *LeS.*; *DeBl.*, Pl. 34, fig. 1. — Dianæa endrachtensis *Q.* and *G.*; *DeBl.*, Pl. 34, fig. 2. — Eirene endrachtensis *Esch.* — *New Holland* (Péron and LeSueur).

Saphenia *Esch.* (not *Forbes*). — Dianæa *Q.* and *G.*[5] — Plancia *Forbes.* — Goodsirea *Wright.* — Geryonia *Pér.* and *LeS.* (p. p.).

S. balearica *Esch.* — Dianæa balearica *Q.* and *G.*, Zool. Uran., Pl. 84, fig. 3. — Dianæa bitentaculata *Q.* and *G.*, Ann. Sc. Nat., Vol. X. Pl. 6, fig. 9. — Saphenia bitentaculata *Esch.* — *Coast of Valencia* and *Gibraltar* (Quoy and Gaimard).

S. dinema *Esch.* (non *Forbes*). — Geryonia dinema *Pér.* and *LeS.*; *Milne-Edw.*, in *Cuv.* Règn. An. Zooph., Pl. 54, fig. 1. — Goodsirea mirabilis *Wr.*, Ed. Phil. Journ., 1859, Vol. X. Pl. 9, fig. 1. — *British Channel* (Péron and LeSueur).

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[1] Eutima limpida *A. Ag.* Gelatinous proboscis not projecting more than the length of the diameter of the bell below the level of the veil. Digestive cavity long, terminating in a quadrangular flat disk, which may be folded into four simple lips. Genital organs narrow, extending one third of their length along the proboscis, and the remaining two thirds along the chymiferous tubes towards the circular tube, which they do not reach. Two marginal capsules between every two chymiferous tubes, and from twelve to thirteen granules, arranged in a semicircle, in each. Walls of the four large tentacles tapering gradually from circular tube; lateral cirrhi small, one on each side of the large tentacles; rudimentary tentacles numerous. Tentacles, digestive cavity, and ovaries perfectly colorless. Polar diameter half an inch; actinal diameter one and one eighth of an inch; length of proboscis two inches. — *Naushon, Buzzard's Bay* (A. Agassiz).

[2] Eutima pyramidalis *Ag.* Spherosome hemispherical; base of the gelatinous proboscis very broad, tapering rapidly; the digestive cavity is short, terminating with four rounded leaflets with scalloped edges. The four larger tentacles are short, colorless. Polar diameter half an inch; actinal diameter seven eighths of an inch. — *Key West, Florida* (Agassiz).

[3] The genus Orythia is only known from the description of Péron and LeSueur, and the later figure of Quoy and Gaimard, in the Voyage of the Uranie, who represent the same species, with its tentacles. Both are reproduced in DeBlainville's Actinologie.

[4] The genus Phorcynia is founded upon decayed specimens, probably belonging to this genus.

[5] The genus Dianæa *Lmk.* is worthless. It embraces Medusæ of at least eight different families, most of which had already been referred to separate genera by Péron and LeSueur, before Lamarck named it, and no one of which could be considered as the type of a new genus. Later authors, who have adopted the genus, have only made matters worse by adding other heterogeneous species.

12th Family. GERYONIDÆ *Esch.* (restricted).

Geryonia *Pér.* and *LeS.* (non *Less.*), restricted. — Liriope *Less.* (non *Gegenb.*).

G. proboscidalis *Esch.* — Medusa proboscidalis *Forsk.*; *M.-Edw.*, in *Cuv.* Règn. An., Pl. 52, fig. 3. — Geryonia hexaphylla *Pér.* and *LeS.* (non *Br.*). — *Mediterranean* (Forskål).

G. hexaphylla *Br.*, Pl. 18 (non *Pér.* and *LeS.*). — *Bonin Islands* (Mertens).

13th Family. LEUCKARTIDÆ *Agass.*[1] — Geryonidæ *Esch.* (p. p.).

Leuckartia *Ag.* — Geryonia *Leuck.* (non *Auct.*).

L. proboscidalis *Ag.* — Geryonia proboscidalis *Leuck.* (non *Auct.*), Arch. Nat., 1856, Pl. 1, fig. 1. — *Nice* (Leuckart).

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[1] After having satisfied myself that the bitentaculated Medusæ thus far referred to the genus Saphenia belong to two different families, Saphenia *Forbes* to the Nucleiferæ, and Saphenia *Esch.* to the Geryonopsidæ, it occurred to me that, among the proboscidal Geryonidæ, there might also be representatives of different families. I was led to this supposition by the great diversity of types included in that family by earlier naturalists, and even by Forbes. The result of my comparisons are here submitted to the criticisms of those who may have an opportunity of testing the value of my suggestions. That the Geryonopsidæ differ from the Leuckartidæ I have no doubt, having had an opportunity of examining several representatives of the two families. But there does not occur, along the American coast, a representative of the Geryonia proboscidalis of Europe, so that my inference upon this type are solely based upon a careful comparison of the descriptions and figures of Forskål, Mertens, Milne-Edwards, Gegenbaur, and Leuckart. On comparing the figures of this species published by Forskål and Milne-Edwards, it may at once be noticed, that, while they agree in every prominent feature, they differ strangely from that of Leuckart. Gegenbaur's minute description of the same type differs equally from the description given by Leuckart. Gegenbaur says distinctly, "the proboscis is characterized by the absence of distinct canals," "its interior forms a large cavity," and "from the circular tube arise centripetal, cæcal appendages." In Leuckart's Geryonia proboscidalis there are no "centripetal appendages;" moreover, it appears to agree in every respect with the other species described by him under the name of Geryonia exigua, of which he says, that the "stomach is small, about a line long." He says distinctly, that above the stomach there is "no funnel-shaped cavity," and that "the radiating canals arise immediately from it." We have thus Geryonidæ, with flat, heart-shaped dilatations of the radiating tubes, as genital organs, which agree with the Geryonopsidæ in the structure of their chymiferous system and its ramification, and others which do not. The latter are Gegenbaur's type, long known from Forskål's description and figure, and for which the name of Geryonidæ must be retained; for the other, first accurately described by Leuckart, I propose the name of Leuckartidæ, and to the latter family the genus Liriope *Gegenb.* (not *Less.*) also belongs. It will be noticed that the form of the genital organs of the Leuckartidæ is the reverse of that of the Geryonidæ; the heart-shaped genital organs of the genuine Geryonidæ pointing toward the circular tube, and those of the Leuckartidæ toward the stomach, while in Geryonopsidæ they extend evenly along the chymiferous tubes, as in the Oceanidæ. If I am not mistaken, the true Geryonidæ should be referred to the Discophoræ haplostomeæ, while the Leuckartidæ are genuine Hydroids.

Liriope *Gegenb.* (non *Less.*). — Geryonia *Less.*; *Esch.* (p. p.) (non *Pér.* and *LeS.*). — Dianæa *Q.* and *G.* — Eurybia *Esch.* (see p. 169), and Eurybiopsis *Gegenb.*, are only the young of this genus.

L. exigua *Gegenb.* — Dianæa exigua *Q.* and *G.* — Geryonia exigua *Leuck.*, Arch. Nat., 1856, Pl. 1, fig. 1. — Liriope mucronata *Gegenb.* — Eurybiopsis anisostyla *Gegenb.*, Pl. 8, fig. 12. — *Gibraltar* (Quoy and Gaimard); *Messina* (Gegenbaur); *Nice* (Leuckart).

L. appendiculata *Gegenb.* — Geryonia appendiculata *Forbes*, Nak. Med., Pl. 5, fig. 2. — *British Seas* (Forbes).

L. catharinensis *F. Müll.*,[1] Wiegm. Archiv, 1859, Pl. 11. — *Brazil* (Fritz Müller).

L. scutigera *McCr.* — *Charleston, South Carolina* (McCrady).

L. tenuirostris *Ag.*[2] — *Key West, Florida* (Agassiz).

L. rosacea *Gegenb.* — Geryonia rosacea *Esch.*, Pl. 11, fig. 2. — *South Sea, under the Equator* (Eschscholtz).

Xanthea *Less.*, are eight-tentaculated Liriope.

X. agaricina *Less.*, Pl. 6, fig. 3. — Origin unknown.

X. tetraphylla *Ag.* — Geryonia tetraphylla *Cham.* and *Eysenh.*, Pl. 27, fig. 2. — *Sunda Straits* (Chamisso and Eysenhardt).

14th Family. TRACHYNEMIDÆ *Gegenb.*

Trachynema *Gegenb.* — Its embryology in *Gegenb.*, Generations-Wech., p. 50, Pl. 2, figs. 17–23.

T. ciliatum *Gegenb.*, Pl. 9, fig. 6. — *Messina* (Gegenbaur).

Tholus *Less.* — Sminthea *Gegenb.* (p. p.).

T. funerarius *Less.* — Dianæa funeraria *Q.* and *G.*, Ann. Sc. Nat., Vol. X., Pl. 6, figs. 10–15. — Sminthea eurygaster *Gegenb.*, Pl. 9, fig. 14. — Sminthea leptogaster *Gegenb.*, Pl. 9, fig. 11. — *Straits of Gibraltar* (Quoy and Gaimard); *Messina* (Gegenbaur).

Sminthea *Gegenb.* (restricted).

S. globosa *Gegenb.*, Pl. 9, fig. 1. — *Messina* (Gegenbaur).

S. tympanum *Gegenb.*, Pl. 9, fig. 18. — *Messina* (Gegenbaur).

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[1] The elaborate paper of F. Müller upon this Medusa, recently published in the Archiv für Naturgeschichte, is one of the most important modern contributions to the Natural History of Acalephs. It appears from Müller's observations, that the genus Eurybia *Esch.*, and Eurybiopsis *Gegenb.*, were established upon the young of Liriope. Liriope catharinensis, however, may be the Geryonia bicolor *Esch.*, Pl. 11, fig. 1, in which case the name of Liriope catharinensis should be changed to L. bicolor.

[2] The great length and narrowness of the proboscis at once distinguish this species from any other of the genus. Actinal and polar diameters half an inch, length of the proboscis two and a half inches. — *Key West, Florida* (Agassiz).

Rhopalonema *Gegenb.*—Calyptra *Leuck.* (preoccupied among Mollusca).

R. velatum *Gegenb.*, Pl. 9, figs. 1–5. — Calyptra umbilicata *Leuck.*, Pl. 1, figs. 9 and 10.—*Nice* (Leuckart); *Messina* (Gegenbaur).

Hypsonema *Ag.* — Cytæis *Will.*

H. polystyla *Ag.* — Cytæis polystyla *Will.*, Pl. 2, fig. 5. — *Adriatic: Trieste* (Will).

Gossea *Ag.* — Thaumantias *Gosse* (p. p.).

G. Corynetes *Ag.* — Thaumantias Corynetes *Gosse*, Devon., Pl. 21; fig. 1, Pl. 22, may be the young. — *Devonshire Coast* (Gosse).

5th Sub-order. PORPITÆ *Goldf.*[1] — Chondrophoræ *Cham.* and *Eysenh.*

1st Family. VELELLIDÆ *Esch.* (restricted). This family is readily distinguished by its oblong form and crested disk.

Velella *Lmk.* — Holothuria *Forsk.* — Phyllodoce *Br.* — Armenistarium *Costa.* — Rataria *Esch.* (young). — The free Medusæ: Chrysomitra *Gegenb.*, and Linuche *Esch.* — For the development of the Hydra, see Huxley, p. 114, and Pl. 11.

V spirans *Esch.* — Holothuria spirans *Forsk.*; *Köll.*, Pl. 11; *Vogt*, Pl. 1 & 2; *Leuck.*, Pl. 13, fig. 22. — *Mediterranean* (Forskål).

V. mutica *Bosc; Ag.*, pp. 83 and 110. — *Gulf of Mexico* (Brown, Bosc); *Coast of Florida* (Agassiz).

2d Family. PORPITIDÆ *Guild.* — Velellidæ *Esch.*, (p. p.). — Form circular, no crest.

Porpita *Lmk.* — Holothuria *Forsk.* — Polybrachionia *L. Guild.* — Ratis *Less.* — Acies *Less.*

P. mediterranea *Esch.*; *Köll.*, Pl. 12. — Holothuria denudata *Forsk.* — *Mediterranean* (Forskål).

P. linnæana *Less.* — Polybrachionia linnæana *L. Guild.* — *Antilles* (Guilding); *Florida* (Agassiz); *Charleston* (McCrady).

6th Sub-order. PHYSALLÆ *Less.* — Thus far only one family, PHYSALIDÆ *Br.*, with a single genus:

Physalia *Lmk.* — Holothuria *L.* — Salacia *L.* — Arethusa *Br.* — Thalia *Brug.* — Cystisoma *Less.* — Young Hydra in *Huxl.*, Pl. 10.

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[1] In characterizing this and the following sub-orders, p. 334, I have purposely avoided the special nomenclature, devised by the German naturalists to describe the Siphonophoræ, and reproduced in an hellenic garb by Huxley, in order the more directly to show the close affinity of these animals with the Hydroids. It is a fact constantly recurring in our science, that special names are required to designate the parts of animals, the homologies of which are not fully ascertained; but as soon as their structural identity ceases to be doubtful, it seems to me best to discard such technicalities, and I believe the time has come when the Siphonophoræ may be described in the same words as other Acalephs.

Ph. Arethusa *Til.*;[1] *Ag.*, Pl. 35. — Ph. aurigera *McCr.* — *Gulf of Mexico* (Brown, Sloane); *Charleston, South Carolina* (McCrady).

7th Sub-order. PHYSOPHORÆ, *Goldf.*[2] — Phosophoridæ *Esch.* (p. p.).

1st Family. PETHOSOMEÆ *Less.* (p. p.). — Hippopodidæ *Köll.*

Gleba *Forsk.*, *Otto.* — Hippopodius *Q.* and *G.* — Protomedea *DeBl.* — Stephanomia *Q.* and *G.* — Elephantopus *Less.*

Gl. Hippopus *Forsk.*;[3] *Leuck.*, Arch. Nat., 1854, Pl. 12, figs. 1–5. — Hippopodius lutens *Q.* and *G.*, Ann. Sc. Nat., Vol. X. Pl. 4, Zool. Astr., Pl. 2, figs. 13–21; *Vogt*, Pl. 13. — H. neapolitanus *Köll.*, Pl. 6, figs. 1–5. — *Mediterranean* (Forskål).

Vogtia *Köll.*

V pentacantha *Köll.*, Pl. 8. — *Messina* (Kölliker).

2d Family. PHYSOPHORIDÆ *Esch.* (restricted), *Huxl.* — Physophoræ *Less.* — Discolabæ *Less.* — Angelæ *Less.*?

Physophora *Forsk.*[4] — Cupulita *Q.* and *G.*

Ph. hydrostatica *Forsk.*, Pl. 33, fig. *E*; *Vogt*, Pls. 3–6; *Gegenb.* Neue Beitr., Pl. 31. — Physophora Philippii *Köll.*, Pl. 5. — *Mediterranean* (Forskål).

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[1] The species of this and the preceding sub-orders, thus far described, are most fully enumerated by Lesson; but it remains to be seen which are truly distinct.

[2] Instead of discarding altogether the species described by Quoy and Gaimard, in the Zoölogy of the Astrolabe, most of which are figured from imperfect specimens, I have here attempted to classify them according to the method so successfully applied in the study of fossil remains, comparing the parts preserved and illustrated by the French zoölogists, with corresponding parts of the European species, now fully known by the extensive researches of Milne-Edwards, Kölliker, Leuckart, Vogt, Gegenbaur, and Huxley. From the observations of these naturalists, it is now evident that all the representatives of this sub-order arise, like Physalia, from a primary hydra. But there is this essential difference between the Physaliæ and the Physophoræ, that in the first, the primary hydra produces no secondary sterile medusæ, and that the fertile medusæ arise from secondary hydræ; while in Physophoræ, the abactinal sides of the primary hydra produce more or less numerous sterile medusæ, and the fertile medusæ arise directly from the primary hydra. Again, the primary hydra of the Physophoræ is reduced to the function of an axis, around which the two kinds of secondary medusæ and the secondary hydræ arise; while in Physaliæ, the primary hydra remains the most prominent individual of the community, even though it is not the most highly organized. The Rhizophysidæ seem to be the only family in which there appear no secondary sterile medusæ. Whether Discolabe Stephanospira has any or not remains doubtful.

[3] While Kölliker, Leuckart, and Vogt's figures and descriptions of this type agree fully with one another, and with Forskål's, those of Quoy and Gaimard's differ so strikingly, that I am strongly inclined to believe in the existence of two closely-allied genera observed by different authors, and more or less mixed up by Delle-Chiaje and Lesson; but I have no means of settling the difficulty. Leuckart has at one time considered them as distinct, and afterwards again identified them.

[4] The European species alone is satisfactorily described; those from other parts are very imperfectly known.

Haplorhiza *Ag.* — Physophora *Q.* and *G.*

H. alba *Ag.* — Physophora alba *Q.* and *G.*, Zool. Astr., Pl. 1, figs. 1–9. — *Southern Atlantic* (Quoy and Gaimard).

Discolabe *Esch.* — Stephanospira *Gegenb.* — Rhizophysa *Q.* and *G.* — Rhodophysa *DeBl.*

D. mediterranea *Esch.* — Rhizophysa discoidea *Q.* and *G.*; Ann. Sc. Nat., Vol. X. Pl. 5; Zool. Astrol., Pl. 1, figs. 22–24. — Rhodophysa discoidea *DeBl.* — Stephanospira insignis *Gegenb.*, Neue Beitr., Pl. 33. — *Mediterranean* (Quoy and Gaimard).

Angela *Less.*

A. cytherea *Less.*, Acal., Pl. 9, fig. 1. — *Senegal* (Rang). ?

3d Family. AGALMIDÆ *Br.*[1] — Agalmæ *Less.* — Stephanomiæ *Less.* — Stephanomidæ *Leuck.*, *Huxl.*

Agalma *Esch.* (non *Köll.*, *Leuck.*, *Vogt*). — Pontocardia *Less.* ?

A. Okenii *Esch.*, Acal., Pl. 13, fig. 1. — *North Pacific* (Eschscholtz).

Crystallomia *Dana.*

Cr. polygonata *Dana*, Mem. Amer. Acad., Vol. VI. p. 459, Pl. 1. — *Pacific Ocean*, 30° *N. Lat.*, *and* 179° *E. Long.* (Dana).

Temnophysa *Ag.* — Stephanomia *Q.* and *G.*

T. alveolata *Ag.* — Stephanomia alveolata *Q.* and *G.*, Zool. Astr., Pl. 3, figs. 19–23. — *Off Cape Verd* (Quoy and Gaimard).

Sphyrophysa *Ag.* — Physophora *Q.* and *G.* — Agalma *Huxl.* (p. p.).

Sph. intermedia *Ag.* — Physophora intermedia *Q.* and *G.*, Astr., Pl. 1, figs. 10–18. — *Atlantic Ocean*, 7° *N. Lat.* (Quoy and Gaimard).

Sph. brevis *Ag.* — Agalma breve *Huxl.*, Pl. 7. — Origin not stated.

Stephanomia *Pér.* and *LeS.*; *Huxl.* (non *Milne-Edw.*).

St. amphitritis *Pér.* and *LeS.*, Voy. Terres Austr., Pl. 29, fig. 5; *Huxl.*, Pl. 6. — *Australia*, *Pacific* (Péron and LeSueur).

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[1] Upon a closer comparison of the genera referred to this family, it will appear that the true Agalmidæ, of which the genus Agalma *Esch.* is the type, may form a distinct family, including also the genera Chrystallomia and Temnophysa, characterized by the wedge-shaped secondary actinal Hydræ; while the Stephenomiadæ, including Stephenomia, Agalmopsis, and Forskålia, may be separated on the ground of the thin, flat, secondary actinal Hydræ; and the Chamissonidæ *Ag.*, restricted to the type of Cuneolaria, the sterile abactinal Medusæ of which, resemble the actinal ones of the true Agalmidæ. It should not be overlooked in this connection, that Agalma *Esch.* is not generically identical with the European species generally referred to this genus, while Chrystallomia *Dana*, and Temnophysa *Ag.*, are closely related to it. Again, Quoy and Gaimard have figured several Cuneolariæ, under the names of Stephanomia triangularis, etc., which exhibit a totally different combination of their sterile Medusæ. Phyllophysa may belong to the true Stephenomiæ, or form another family by itself. The decision of this question must depend upon the structure of the secondary Hydra which are not satisfactorily represented.

Forskalia *Köll.* — Stephanomia *Milne-Edw.* — Apolemia *Vogt* (non *Esch.*). — *Less.* (p. p.).

F. contorta *Leuck.* — Stephanomia contorta *Milne-Edw.*, Ann. Sc. Nat., 1841, Vol. XVI. Pls. 7 and 8. — Apolemia contorta *Vogt*, Pl. 13. — *Mediterranean* (Milne-Edwards).

F. Edwardsii *Köll.*, Pl. 1. — *Messina* (Kölliker).

F. ophiura *Leuck.*, Arch. Nat., 1854, Pl. 13, fig. 18. — Stephanomia ophiura *Delle-Ch.*, Pl. 50, fig. 7. — *Naples* (Delle-Chiaje); *Nice* (Leuckart).

Agalmopsis *Sars* (non *Leuck.*). — Agalma *Köll.*, *Leuck.* (non *Esch.*).

A. elegans *Sars.* — Fauna littor. Norv., Pls. 5 and 6. — *Coast of Norway, Floröe Islands* (Sars).

A. Sarsii *Köll.*, Pl. 3.; *Leuck.*, Arch. Nat., 1854, Pl. 12, figs. 21–27. — *Messina* (Kölliker); *Nice* (Leuckart).

A. clavatum *Leuck.*, Arch. Nat., 1854, Pl. 13, figs. 2–7. — *Nice* (Leuckart).

Halistemma *Huxl.* — Agalma *Vogt* (non *Esch.*). — Agalmopsis *Köll.*, *Leuck.*

H. rubrum *Huxl.* — Agalma rubra *Vogt*, Pls. 8–11. — Agalmopsis rubra *Leuck.*, Arch. Nat., 1854, Pl. 12, figs. 12–20. — *Nice* (Vogt).

H. punctatum *Ag.* — Agalmopsis punctata *Köll.*, Pl. 4. — *Messina* (Kölliker).

Phyllophysa *Ag.* — Stephanomia *Q.* and *G.* — Sarcoconus *Less.*

Ph. foliacea *Ag.* — Stephanomia foliacea *Q.* and *G.*, Zool. Astr., Pl. 3, figs. 8–12. — *New-Guinea* (Quoy and Gaimard).

Cuneolaria *Eysenh.* — Sarcoconus *Less.* — Stephanomia *Q.* and *G.*

C. incisa *Eysenh.*, Act.-Nov. Acad. Nat. Cur., Vol. X. Pl. 32, fig. 5. — Sarocconus Eysenhardtii *Less.* — *Sandwich Islands* (Chamisso).

C. triangularis *Ag.* — Stephanomia triangularis *Q.* and *G.*, Zool. Astr., Pl. 3, figs. 1–7. — *Off Cape Verd* (Quoy and Gaimard).

C. heptacantha *Ag.* — Stephanomia heptacantha *Q.* and *G.*, Zool. Astr., Pl. 3, figs. 16–18. — *Molucca Islands* (Quoy and Gaimard).

C. imbricata *Ag.* — Stephanomia imbricata *Q.* and *G.*, Zool. Astr., Pl. 3, figs. 13–16. — *New-Zealand* (Quoy and Gaimard.)

4th Family. APOLEMIÆ *Less.* — Apolemiadæ *Huxl.* — Stephanomidæ *Leuck.* (p. p.).

Apolemia *Esch.* — Stephanomia *LeS.* — Agalma *Vogt* (non *Esch.*).

A. Uvaria *Esch.*; *Gegenb.*, Zeitsch. w. Zool., 1854, Pl. 18, fig. 1; *Leuck.*, Arch. Nat., 1854, Pl. 12, figs. 8–11; *Köll.*, Pl. 6, figs. 6–9. — Agalma punctata *Vogt*, Pl. 12. — *Mediterranean* (LeSueur).

5th Family. ANTHOPHYSIDÆ *Br.* — Athorybiæ *Less.* — Athorybides *Vogt.* — Athorybiadæ *Huxl.*

Athorybia *Esch.* — Physophora *Forsk.* (p. p.). — Rhizophysa *Q.* and *G.* (p. p.). — Anthophysa *Br.* — Rhodophysa *DeBl.*

Ath. rosacea. — *Esch.*; *Köll.*, Pl. 7; *Huxl.*, Pl. 9. — Physophora rosacea *Forsk.*, Tab. 43, Fig. B. — *Mediterranean* (Forskål).

Ath. melo. *Esch.* — Rhizophysa melo *Q.* and *G.*, Ann. Sc. Nat., Vol. X. Pl. 5, C. — Stephanomia melo *Q.* and *G.*, Zool. Astr., Pl. 2, figs. 7–12. — *Mediterranean* (Quoy and Gaimard).

Ath. helianthea *Esch.* — Rhizophysa Helianthus *Q.* and *G.*, Ann. Sc. Nat., Vol. X. Pl. 5, A. — Stephanomia Helianthus *Q.* and *G.*, Zool. Astr., Pl. 2, figs. 1–6. — *Mediterranean* (Quoy and Gaimard).

6th Family. RHIZOPHYSIDÆ *Br.*, *Leuck.*, *Huxl.* — Rhizophysæ *Less.*

Rhizophysa *Pér.* and *LeS.* — Physophora *Forsk.* (p. p.). — Epibulia *Esch.*

Rh. filiformis *Lamk.*; *Gegenb.*, Zeitsch. w. Zool., 1854, Pl. 18, fig. 5; *Huxl.*, Pl. 8, figs. 13–20. — *Mediterranean* (Forskål).

8th Sub-order. DIPHYÆ *Cuv.* — Calycosphoridæ *Leuck.* (p. p.).

1st Family. PRAYIDÆ *Köll.* (restricted so as to exclude Galeolaria). — Sphæronectidæ *Huxl.*[1]

Praia *Q.* and *G.*, *DeBl.*, *Less.* — Prayia *Köll.*, *Leuck.*, *Gegenb.*, *Vogt.* — Rosacea *Q.* and *G.* — Cucuballus *Q.* and *G.* — Rhizophysa *Vogt.* — Diplophysa *Gegenb.*

P. dubia *Q.* and *G.*, in *DeBl.* Act., Pl. 3, figs. 34–36. — *Australia, off Kangaroo Islands* (Quoy and Gaimard).

P. Diphyes *Less.* (non *Köll.*, *Gegenb.*, *Vogt*). — Diphyes prayensis *Q.* and *G.*, Vol. Astr., Pl. 3, figs. 37 and 38. — *Cape Verd Islands* (Quoy and Gaimard).

P. Köllikeri *Ag.* — Praya Diphyes *Köll.*, Pl. 9; *Gegenb.* (non *Less.*, *Vogt*). — *Messina* (Kölliker).

P. cymbiformis *Leuck.*, Zool. Unt., Pl. 1; Arch. Nat., 1854, Pl. 11, figs. 19–24. — P. maxima *Gegenb.*, Zeitsch. w. Zool., 1854, Pl. 17, figs. 1–4. — P. Diphyes *Vogt.*, Pls. 16 and 17 (non *Less.*, *Köll.*, *Gegenb.*). — *Messina* (Gegenbaur); *Nice* (Vogt, Leuckart).

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[1] Huxley's Sphæronectidæ seem hardly distinct from the Prayidæ. Praya dubia is closely allied to it, more so than to the other species of the genus thus far described; it may, however, constitute a distinct genus, judging from the drawings of Quoy and Gaimard, or rather, it is the type of the genus Praya, and if generically distinct from the others, these will require a new generic name.

Sphæronectes *Huxl.*

Sph. Köllikeri *Huxl.*, p. 30, Pl. 3, fig. 4. — *Indian Ocean, East Coast of Australia and Torres Straits* (Huxley).

2d Family. DIPHYIDÆ *Esch.*[1] (restricted).

Diphyes *Cuv.*, *Esch.* — Eudoxia *Esch.* — Ersæa *Esch.* — Cucullus *Q.* and *G.* — Eudoxoides *Huxl.*

D. dispar *Cham.* and *Eysenh.*; *Huxl.*, Pl. 1, fig. 1. — *Pacific Ocean* (Chamisso and Eysenhardt).[2]

Muggiæa *Busch* (extended; see note 3, below). — Ersæa *Will.*[3]

M. pyramidalis *Busch*, Beob., p. 48, Pl. 4, fig. 6. — Diphyes Kochii *Will*, Hor. Terg., Pl. 2, figs. 22 and 23. — *Adriatic: Trieste* (Will).

Huxleyia *Ag.* — Diphyes *Auct.* (See note 3, below.)

H. biloba *Ag.* — Diphyes biloba *Sars*, Faun. litt. Norv., Pl. 7, figs. 16–21. — *Coast of Norway: Floröe Islands* (Sars).

Galeolaria *DeBl.*, *LeS.* — Sulculeolaria *DeBl.*, *LeS.* — Physophora *Delle-Ch.* — Beroides *Q.* and *G.* — Epibulia *Vogt.* — Diphyes *Gegenb.*

G. filiformis *Leuck.*, Arch. Nat., 1854, Pl. 11, figs. 14–16. — Physophora filiformis *Delle-Ch.* — Sulculeolaria quadrivalvis *LeS.* — Epibulia aurantiaca *Vogt.* — Galeolaria aurantiaca *Vogt.*, Pls. 18 and 19. — Diphyes quadrivalvis *Gegenb.*, Zeit. w. Zool., Pl. 16, figs. 8–11. — *Naples* (Delle-Chiaje); *Nice* (Vogt, Leuckart); *Messina* (Gegenbaur).

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[1] For this type see the papers and works, quoted above, of Kölliker, Gegenbaur, Leuckart, and Huxley. For the embryology, especially the paper of Gegenbaur on Diphyes turgida, Zeits. w. Zool., 1834, p. 332, and for the budding, the work of Huxley, especially Pl. 5. The Calycophoridæ *Leuck.* do not constitute a natural division, since the communities of the Hippopodidæ have not the same organic complication as the Diphyidæ, while the Prayidæ have. The Abylidæ differ from the two latter families, by the great inequality, angular form, and position of the twin sterile Medusæ.

[2] To this genus belong also D. Boryi *Q.* and *G.* — D. campanulifera *Esch.*; *Gegenb.*, Neue Beitr., Pl. 30, figs. 23–26. — D. angustata *Esch.*, Ac., Pl. 12, fig. 6. — D. regularis *Meyen*, and D. Steenstrupii *Gegenb.*, Neue Beitr., Pl. 29, figs. 27–29.

[3] It is my impression that D. appendiculata, *Esch.*, Ac., Pl. 12, fig. 8; *Huxl.*, Pl. 1, fig. 2. — D. Sieboldii *Köll.*, Pl. 11, figs. 1–8 (with which D. gracilis *Gegenb.*, Zeit. w. Zool., Pl. 16, figs. 5–7, and D. acuminata *Leuck.*, Zool. Unters., Pl. 3, figs. 11–19, are synonymous), and D. Kochii *Will*, belong to another genus for which the name Muggiæa *Busch* may be retained. D. biloba *Sars*; D. Sarsii *Gegenb.*, Neue Beitr., Pl. 30, figs. 30 and 31; D. turgida *Gegenb.*, Zeitsch. w. Zool., 1854, Pl. 23, formerly D. Sieboldii *Gegenb.*, and D. truncata *Sars*, Faun. litt. Norv., Pl. 7, figs. 1–15, form a third genus, for which I propose the name of *Huxleyia*. The generic relations of the many species of this family have not yet been sufficiently considered, nor is it easy, when the young and adult and the secondary buds differ so widely.

3d Family. ABYLIDÆ *Ag.* — Diphyidæ *Auct.*

Abyla *Q.* and *G.*, *Esch.* (p. p.). — Amphirhoa *LeS.* — Cymba *Q.* and *G.* — Enneagonum *Q.* and *G.* — Microdiphyes *Less.* (p. p.). — Heterodiphyes *Less.* (p. p.).

A. trigona *Q.* and *G.*, Ann. Sc. Nat., Vol. X. Pl. 2, B; Vogt. Pl. 20, figs. 4–7; *Gegenb.*, Neue Beitr., Pls. 27 and 28, figs. 9–12. — Diphyes Abyla *Q.* and *G.*, Zool. Astr., Pl. 4, figs. 12–17. — Salpa polymorpha *Q.* and *G.*, Zool. Uran., Pl. 73, figs. 4 and 5. — *Mediterranean* (Quoy and Gaimard).

Calpe *Q.* and *G.* — Abyla *Esch.* (p. p.). — Eudoxia *Esch.* (p. p.). — Cuboides *Q.* and *G.* — Aglaisma *Esch.* — Aglaismoides *Huxl.* — Tetragonum *Q.* and *G.* — Pyramis *Otto.*

C. pentagona *Q.* and *G.* — Abyla pentagona *Esch.*; *Leuck.*, Zool. Unters., Pl. 3, figs. 1–10, Arch. Nat., 1854, Pl. 11, 1–10; *Köll.*, Pl. 10; *Gegenb.*, Neue Beitr., Pl. 29, figs. 17 and 18; *Huxl.*, Pl. 2, fig. 2. — *Mediterranean* (Quoy and Gaimard).

Bassia *Q.* and *G.* — Calpe *Less.* (p. p.). — Sphenia *Huxl.* — Sphenoides *Huxl.*

B. quadrilatera *Q.* and *G.*, in *DeBl.* Actin. — Diphyes bassensis *Q.* and *G.*, Zool. Astr., Pl. 4, figs. 18–20; *Huxl.*, Pl. 2, fig. 1. — *Bass Straits* (Quoy and Gaimard.)

B. perforata *Ag.* — Abyla perforata *Gegenb.*, Neue Beitr., Pl. 31, figs. 20 and 21 — *Coast of Guinea* (Gegenbaur).

SECTION II.

GEOGRAPHICAL DISTRIBUTION OF THE HYDROIDÆ.

Our knowledge of these Acalephs is limited to those of so small areas of the surface of our globe, that it is impossible to characterize the faunæ into which they may be divided; nevertheless, from the fragmentary information on hand, it already appears that these Hydroids are localized within narrow boundaries, with as much precision as the higher orders of the class. The Diphyidæ alone seem to make an exception; but I suspect that in this family, closely allied representative species have been mistaken as identical. There are in the Museum of Comparative Zoölogy at Cambridge, a great many undescribed Hydroids from various parts of the world, which, when published, may lead to some general results respecting the mode of association of these animals with the higher Acalephs, and the representatives of other classes in their respective zoölogical provinces.

PART V.

HOMOLOGIES OF THE RADIATA.

HOMOLOGIES OF THE RADIATA.

SECTION I.

GENERAL HOMOLOGIES.

In order to compare the different systems of organs in animals whose natural attitudes in the surrounding elements may be extremely diversified, we must first bring them all into the same position; or, in other words, we must discriminate between their natural attitude and their normal position. No branch of the animal kingdom exhibits so great a diversity of attitudes as the Radiates. Some of them are always found mouth upwards, others mouth downwards, or lying upon one or the other side; and before they have been placed in a corresponding position, no accurate comparison between them can be instituted. It is, in my opinion, a mistake to place them, for such a purpose, in the position in which we are accustomed to describe animals of other branches. The very plan of their structure, characterized by radiation, forbids this. The main axis of their body is not a longitudinal axis, as in Vertebrates, but a vertical axis, around which the primary elements of their structure are symmetrically arranged. Most of them, moreover, assume in nature an attitude corresponding to this view of the subject. An attempt to place a Polyp, or a Jelly-fish, or a common Echinus on one side, with the mouth forward, does not modify the plan of their structure, and bring it in any way nearer to that of bilateral animals, with a distinct anterior and posterior end, an upper and a lower side, a right and a left. In whatever position a Radiate may be found, its structural elements retain their radiating arrangement around the main axis, and taking the bulk of the representatives of this type as our guide, that axis must be considered as a vertical axis. It remains so even in those Radiates which, like the Holothurians, move mouth forward, resting upon one side; for that side bears the same primary relations to the main axis, as in those which move or stand mouth upward or downward. The so-called dorsal or ventral side of an Holothuria, a Spatangus, or a Starfish, are neither homologous among themselves, nor do they correspond to the back or lower side of any Vertebrate, or Articulate, or Mollusk. Holothuria and Spatangus rest upon sides which are homologically opposite to one another, while the back of a Starfish corresponds to the posterior extremity of an Holothuria. To bring, therefore, all the Radiates into a uniform normal position, we must place them in that attitude of their main axis, which will indicate prominently their peculiarity as a primary division of the animal kingdom; and that attitude is the vertical, as it is, also, the natural attitude of a large majority of them.

To facilitate our generalizations, we may well assume that all the Radiates are spheroidal. Those that have not really that form, may readily be reduced to it, by slight changes of their different diameters, and without altering any of the primary relations of the plan of their structure.

The essential elements of the structure of these spheroidal bodies are spherical wedges, arranged symmetrically around a vertical axis. Of course, we have not to deal here with mathematical figures, but with the elements of a living sphere, loaded in every direction with those structural differentiations which determine the peculiarities of organic structures. In consequence of this unequal weight of the different diameters of the body, we find that the opposite poles of our organic sphere are provided with parts of a different nature, and perform different functions. The sides also present similar differences, in consequence of the unequal development of alternate zones, extending from pole to pole, and of similar inequalities along the same zone. The so-called mouth is always placed at one of these poles, and from it radiate the most prominent organs, in consequence of which I have called this side of the body the oral, or *actinal area*, and the opposite side the aboral, or *abactinal area.* This mode of designating these regions applies in every case, and we thus get rid of the difficulty arising from the inverse position of many of these animals. The zones, extending from pole to pole, differ chiefly in the differentiation of the substance, and the position of different systems of organs alternating with one another at the periphery of the body. Thus, in Sea-urchins, we have the ambulacral system alternating with the genital organs, while the digestive cavity occupies the centre; in Polyps, the radiating partitions to which the genital organs are attached, alternate likewise with the radiating chambers leading into the tentacles. For this reason I have adopted the names of *ambulacral* and *interambulacral zones,* to designate the alternating structural regions prominent upon the surface of all the Radiates. I have selected these names, not because they are the most appropriate, but because they recall the familiar structure of the Echinoderms, and may facilitate the comparisons between the different classes of these animals. The differences in the structure of one and the same zone, may best be determined with reference to the actinal and abactinal pole.

SECTION II.

SPECIAL HOMOLOGIES OF THE CLASSES.

This may give a general idea of the plan of structure of Radiates in general. The three classes of this type differ only in the mode of execution of this plan; and if I succeed in showing that the whole structure of Echinoderms is strictly homological to that of the Acalephs and Polyps, I shall have proved that these three classes belong to one and the same branch, and that it is unnatural to separate the Echinoderms as a distinct type. The structure of the Polyps, as a class, is characterized by the great uniformity of their spheromeres, which may be considered as hollow, spherical wedges, on the actinal side of which the cavity is prolonged externally into a tentacle. The wide cavity of their spheromeres represents the ambulacral system of the Echinoderms, and the radiating partitions the interambulacral system. The ambulacra of the Polyps differ only in being open along the vertical axis, to form the main cavity of the body; but the peripheric part of this system is even more complicated in some Polyps than in Synapta. In Actinia, for instance, we have a row of distinct pores, opening into the chambers, which extend from the tentacles to the foot, and frequently assume the form of distinct papillæ or rudimentary tentacles; while the genital organs hang from the free margin of the radiating partitions. The distinctive character of the Polyps consists, therefore, in the great width of their open ambulacral system, and the narrow interambulacra, projecting as partitions into the main cavity of the body. The number of these spheromeres, the form and number of their tentacles, the presence or absence of solid deposits in their tissues, the mode of branching of the compound communities, affect in no way these homologies. But there are two points in the structure of the Polyps which are of special interest with reference to their homologies: the stomach and the small holes on the actinal side of the radiating partitions, through which adjoining chambers communicate with one another. These holes are homologous to the marginal circular tube of the Acalephs, and are actually to be considered as short tubes through narrow walls, leading into wide radiating chambers; as in Acalephs, they are comparatively long tubes through thick walls, leading into narrow radiating tubes. The manner in which the radiating tubes of the Æquoridæ open into the main cavity proves that we have here homological organs. The so-called stomach of the Polyps in no way corresponds to the digestive cavity of the Acalephs; it is strictly homologous to the so-called arms of the Jelly-fishes, only that instead of projecting beyond the main cavity, it is inverted into it, the outer surface assuming digestive functions. We may compare this part to the neck of a bottle, which in Polyps would be turned inside, while in Acalephs it is turned out and divided into a number of distinct lobes. In this connection, it is essential to notice that the genital apparatus, extending in Polyps along the free edge of the radiating partitions, is double; so that there is nothing extraordinary in the position of these organs along the radiating chymiferous tubes of the Acalephs. This does not indicate a different position, but is the result of the great thickness and width of the interambulacral zones of these animals, in consequence of which the genital organs are divided into two rows, one on each side of an interambulacrum, while they appear to be in pairs on each side of an ambulacrum.

The class characters of the Acalephs are as distinct as their homologies with the other classes of Radiates are intimate. The bulk of the body is a continuous mass, traversed by narrow tubes arising from a central cavity, the opening of which forms a more or less prominent proboscis. Even the most Polyp-like Hydroids have no trace of radiating partitions. The central cavity corresponds to the main cavity of the body of Polyps, and the radiating tubes to the radiating chambers. As in Polyps, the primary tentacles are in the direct peripheric prolongation of the ambulacral system; but, in consequence of the great development of the interambulacra, the genital organs are more differentiated, and often assume an extraordinary development, in connection with a system of special interambulacral radiating tubes, as exist, also, in some Echinoderms. The periphery of the ambulacral system becomes connected, either by a marginal circular tube, or by a network of anastomoses, which are also to be found in many Echinoderms. The proboscis, when it assumes the shape of a tube, and the so-called arms, around the mouth, which are only a special mode of development of the proboscis, are homologous to the inverted neck of the Polyps, suspended in their main cavity. As the special homologies of the different orders of Acalephs have already been discussed in this volume, I need only say here, that, whether the members of this class are as simple as the Hydroids and naked-eyed Medusæ, or as complicated as the highest Discophoræ and Ctenophoræ, the same homologies may be traced among them all, with corresponding class differences. It does not matter, for instance, whether the radiating tubes are simple or branching; whether their course is limited to the ambulacra or extends to the interambulacral zones; whether they trend in the same plane, or branch up and down in the direction of the actinal and abactinal areas; whether tentacles exist only in the prolongation of the ambulacral tubes, or are also scattered along the circular tube; even their presence or absence, and the presence or absence of eyes upon or between them, are of subordinate importance, as are also the preponderance of the actinal over the abactinal area, and the degree of complication of the proboscidal and of the genital apparatus. All these complications constitute only characteristic features of the subordinate divisions of the class, and in no way influence the homologies. The polymorphism of the Hydroids and Siphonophoræ, rightly considered, sets this question completely at rest.

The character which at first sight distinguishes the Echinoderms from the Acalephs and Polyps is the individualization of all their systems of organs, connected with a striking histological differentiation. This, in a measure, obliterates the impression of similarity which binds them closely together; in the same way as, for a time, the presence or absence of a shell among Mollusks prevented naturalists from perceiving their closer affinities. But as soon as we can free ourselves from the belief that histological complication and structural differentiation are positive tests of homological relationship, and as soon as we allow due weight to embryological evidence, the close affinities of the Echinoderms and the other classes of Radiates become self-evident. A comparison of a Synapta with a Beroid is most likely to remove at once the impression of a typical difference between these animals. Here we have, in both cases, a cylindrical body, with radiating tubes extending from pole to pole, connected by a circular tube, but without ambulacral suckers. In both, these ambulacral zones alternate with more or less developed interambulacra. In none of the members of these types is the body-wall remarkable for its solidity or rigidity. And if the Beroids do not afford direct means of extending the comparison to the tentacles, we need only recall some other Acalephs to show that their marginal tentacles are strictly homological to the feelers which in Holothurians surround the mouth, while some other Echinoderm may show us that, as in Radiates generally, the genital organs alternate with the ambulacral system, and occupy an interambulacral position. The only important differences between the Echinoderms and Acalephs consist in the isolation of the digestive apparatus from the main mass of the body, forming its outer wall, and the corresponding isolation of the ambulacral and genital systems; but these differences are only class characters; they have no reference to the plan of structure.

This once settled, the special homologies of the Echinoderms are easily traced. The chief difficulty rests with the ambulacral suckers and so-called gills and lantern of the Sea-urchins, and with the position of the eyes in Starfishes, when compared to Echini. These difficulties are, however, readily removed, when the differentiation of the body-wall is taken into consideration. In Crinoids and Starfishes, the abactinal area is very extensive and made up of solid plates, entirely different from those of the actinal area, which consists of the well-known ambulacral and interambulacral plates, occupying nearly the whole surface of the body in Echini, so that their abactinal area is very small, and limited to the narrow space intervening between the ocular and ovarian plates. The great extension of the abactinal area in Starfishes, at once explains the position of their eyes at the end of the so-called arms, which correspond to the summit of the ambulacra in the Echini. If, on the other hand, we start from the simple ambulacra of the Synaptoids, and compare them with the genuine Holothuriæ, the presence or absence of ambulacral suckers appears only as a further complication of one and the same apparatus; and, however diversified this system may be, it remains homologous to the simplest radiating chymiferous tubes of the Acalephs, and is, therefore, also homologous to the radiating chambers of the Polyps. The presence of a simple tube extending over the eye, in our common Starfishes, in the prolongation of the main ambulacral tubes, shows further that the position of the eyes in Echinoderms is identical with that of the Acalephs, in which the eyes are also in the prolongation of the radiating chymiferous tubes, at the base of the primary tentacles. The complication of the ambulacral system of the Echinoderms is very remarkable in some of their types, assuming at times the form and function of gills on its actinal side, and forming ornamental rosettes, of the most diversified patterns, toward its abactinal side. But everywhere the ambulacra preserve their primary relations to the whole plan of structure. Even the most complicated feelers of Cuvieria and Psolus are only actinal modifications of the ambulacra, performing the functions of tentacles. As to the lantern of the Echini, we need only compare it with the chewing apparatus of Solaster endeca, or Echinaster solaris, or Paulia horrida, to remain satisfied that it consists of a combination of the interambulacral plates nearest to the mouth, movably articulated upon the next immovable plates of the corresponding interambulacral zones.

A glance at the mode of development of the Radiates may assist in making these comparisons more precise. Every naturalist now knows how very similar young Polyps and young Hydroids are, and, if in connection with this we take into consideration the fact that the young Aurelia is only a transverse section of the body of a Scyphostoma, the internal identity of these animals must be granted. We have here, therefore, the most direct evidence that young Discophoræ are Polyp-like. If we further consider the Acalephian character of the Pluteus-like larvæ of Echinoderms, we connect also this class with the other two classes upon embryological evidence. But that evidence amounts to a demonstration of their structural identity, when we compare the twin individuals of a Diphyes-chain with the Pluteus-like larvæ of an Echinoderm, in which the Echinoderm has begun its development. In the twin Diphyes, one individual has the structure of a sterile Hydroid, while the other is a genuine sexual Medusa, just as a Pluteus, with its young Echinoderm emerging, is a twin, one individual of which is a sterile Acalephoid, and the other a sexual Echinoderm. The embryological development of the three classes of Radiates shows that they belong to one and the same type.

EXPLANATION OF THE PLATES.

PLATE XX.

CORYNE MIRABILIS, HALOCHARIS SPIRALIS, CLAVA LEPTOSTYLA, RHIZOGETON FUSIFORMIS.

[Figs. 11 to 16a, drawn from nature by A. Sonrel; the others by H. J. Clark.]

Figs. 1 to 9. Coryne mirabilis *Ag.*

Fig. 1. The end of a hydra stem rejuvenating. *a* the horn-like sheath; *b* the stem of the hydra; b^1 the expanded end of *b*, attached to *a*. 200 diameters.

Fig. 2. The stem of a hydra one half of an inch below the tentacles, to show the numerous lasso-cells in the outer wall (*a*), where they cannot possibly perform any prehensile function, as they are covered by the thick, horn-like sheath (*c*). *b* the inner wall; *d* chymiferous canal. 400 diameters.

Fig. 3. Two young hydræ budding from opposite sides of the stem. *a* outer, and *b* inner wall of the bud; a^1 outer, and b^1 inner wall of the parent stem; *c* the horn-like sheath, which, at c^1, covers the buds; *d* the chymiferous canal. 200 diameters.

Fig. 4. A young hydra, with two incipient tentacles (*t*), budding from an old hydra stem (*d*). *c* horn-like sheath of *d*; d^1 mouth of the young hydra. 100 diams.

Fig. 5. A young hydra with four tentacles (*t*). Letters as in fig. 4. 100 diameters.

Fig. 6. A young hydra with eight tentacles, strongly contracted. *a* outer, and *b* inner wall of the head; a^1 outer, and b^1 inner wall of the stem; *c* horn-like sheath, which, at c^1, covers the head; *d* digestive cavity; *t* tentacles. 300 diameters.

Fig. 7. Proboscis of a young medusa, not long free, to show the replication of the walls. *a* the inner wall folded outward; *b* the outer wall of the second plication; *c* base of the proboscis. 400 diameters.

Fig. 8. A papilliform tentacle of the medusa of fig. 13, Pl. XVII. a^1 the outer wall of large hyaline cells; b^1 inner wall; d^1 chymiferous cavity. 500 diameters.

Fig. 9. End of the tentacle of a young medusa not long free. *a* papillate bodies on the surface; *b* groups of lasso-cells; *c* outer wall. 400 diameters.

Fig. 10. The hydra of Halocharis spiralis *Ag.*, with its Corynoid tentacles (*t*) developed from base to apex. *a* outer, and *b* inner wall. 100 diameters.

Fig. 10^a. The same as fig. 10, strongly contracted. 100 diameters.

Fig. 10^b. The upper part of fig. 10, more highly magnified. *a* outer, and *b* inner wall of the body; a^1 outer, and b^1 inner wall of the tentacle; *d* digestive cavity; d^1 mouth. 200 diameters.

Fig. 10^c. A tentacle of fig. 10^b, with the same letters. 200 diameters.

Figs. 11 to 15. From a bunch of female medusæ of Clava leptostyla *Ag.* All magnified 200 diameters.

Fig. 11. A medusa containing two eggs. *a* outer, and *b* inner wall of the pedicel; a^1 outer and only wall of the disk; b^3 eggs; b^4 Purkinjean vesicle; b^5 end of the inner wall; *d* the proboscis; *e* cavity of *d*.

Fig. 12. A medusa containing a segmenting, mulberry-like mass (b^3).

Fig. 13. Medusa similar to that of fig. 12, but the segmenting mass, b^3, more minutely divided.

Fig. 14. A medusa containing two or more very young, irregularly spherical planulæ or young hydræ (b^3). *d* the proboscis.

Fig. 15. A medusa whose planulæ (b^3) are elongate pyriform, and about to escape. e^1 chymiferous canal of the pedicel; the other letters as in fig. 11.

Fig. 16. A group of male medusæ of Clava leptostyla *Ag.* A A have discharged their spermatic particles; B a half-grown medusa; the other two full-grown. *a* wall of the medusa; b^2 spermatic mass; *d* the proboscis. 200 diameters.

Fig. 16^a. Spermatic particles from fig. 16. 800 diameters.

Figs. 17 to 23. Rhizogeton fusiformis *Ag.*; the male; all but fig. 23 magnified 100 diameters. All the figures have corresponding letters. *a* and a^1 the outer wall of either hydra or medusa; a^2 the thickened oral end of the disk: b and b^1 inner wall of the same; b^2 the spermatic mass: c and c^1 the horn-like sheath; d proboscis of the medusa; e and e^1 chymiferous canal or cavity; f stolon; m mouth of the hydra; t tentacles.

Fig. 17. A hydra (B) and a young medusa (A) arising from the same stolon.

Fig. 18. A very young medusa, with a large proboscis.

Fig. 19. A half ripe medusa, with the proboscis expanded.

Fig. 20. A ripe medusa, with a shrivelled proboscis.

Fig. 21. A medusa which has discharged its spermatic particles.

Fig. 22. A medusa metamorphozing into a hydra.

Fig. 23. Spermatic particle of the medusa of fig. 20. A is magnified 500 diameters; B is exaggerated, to show the form.

PLATE XXI.

CLAVA LEPTOSTYLA *Ag.*

[Figs. 1, D, and fig. 3, from nature, by H. J. Clark; the others by A. Sonrel.]

All the figures are lettered correspondingly. a the tentacles; b the medusæ; c the head of the hydra; d the slender base of the hydra; e the stolon; f the outer, and f^1 the inner wall; g the digestive cavity or chymiferous canal; g^1 the mouth; n the pedicel of the bunch of medusæ; p the proboscis of the medusæ.

Fig. 1. A hydromedusarium attached to a sea-weed. Natural size.

Fig. 2. A hydromedusarium, magnified to show the various forms and attitudes of the individual hydræ, A to H. 25 diameters.

Fig. 3. A young hydra, just commencing to bud. 60 diameters.

Fig. 4. A young hydra, with very few tentacles. 60 diams.

Fig. 5. A young hydra, transversely wrinkled by contraction. 60 diameters.

Fig. 6. A young hydra, having nine or ten tentacles, with the mouth wide open. 60 diameters.

Fig. 7. A young hydra, with no more tentacles than that of fig. 6, but much larger. 60 diameters.

Fig. 7^{a}. View of fig. 7 from above, the mouth wide open. 60 diameters.

Fig. 8. Mouth and upper tentacles of a full-grown hydra, showing the proboscis reverted. 80 diameters.

Fig. 8^{a}. A single bunch of medusæ from fig. 8. 80 diameters.

Fig. 9. The same as fig. 8, but strongly contracted. 200 diameters.

Figs. 10 and 10^{a}. The young hydra or planula, just escaped from the medusa, and swimming about by means of vibratile cilia. 200 diameters.

PLATE XXII.

Figs. 1–20, THAMNOCNIDIA SPECTABILIS *Ag.*; Figs. 21–30, T. TENELLA *Ag.*

[Figs. 1-15 and 17, drawn by H. J. Clark; the others by A. Sonrel.]

In figs. 1 to 14, a outer wall of the medusa; a^1 outer wall of the pedicel of the medusa; b inner wall of the medusa; b^1 inner wall of the pedicel; c chymiferous cavity; d proboscis; d^1 proboscis seen through the young hydroid; e germ basis; e^1 young hydroids; e^2 cavity of the disk; f tentacles; st basal end of the hydroid; p proboscis of the hydroid; te tentacles of the hydroid.

These figures (1–15) represent the origin and mode of growth of the medusa and the hydroids which it contains. Figs. 1, 4, 6, 6^{a}, 7, 8, 9, 10, 11, 12, 13, and 14, are magnified 100 diameters; figs. 2, 3, and 5, 300 diameters; figs. 4^{a} and 8^{a}, 200 diameters; fig. 15, 60 diameters. August, 1851.

In figures 15 to 30, excepting when stated otherwise, a is the base of the proboscis; b the oral end of the proboscis; b^1 the top of the stem; c the inner margin of the open mouth; d the medusæ; d^1 young medusæ-buds; e medusiferous branches; p proboscis; p^1 decurrent bases of proboscidal tentacles; t coronal tentacles; t^2 proboscidal tentacles; t^3 branching coronal tentacle; t^4 aperture of proboscis.

Fig. 15. A young hydroid just set free. 60 diameters.

Fig. 16. Hydromedusarium of T. spectabilis. Natural size.

Fig. 17. A bunch of female medusæ, in different stages of growth. 25 diameters.

Fig. 18. End view of the proboscis.

Fig. 18^{a}. Profile view of fig. 18.

Fig. 19. Birds-eye view, showing the gaping mouth and the constricted proboscis.

Fig. 20. The proboscis enormously distended.

Fig. 21. Hydromedusarium of T. tenella. Natural size. a the new branches; b the stems of the individual hydroids.

Figs. 22 to 30. Magnified 25 diameters.

Fig. 22. Shows the coronal tentacles, contracted so as to appear globose at the tip.

Fig. 23. Birds-eye view, to show the circle of medusiferous branches around the proboscis.

Fig. 24. A young hydromedusarium.

Fig. 25. Birds-eye view, showing the interior of the broadly expanded mouth.

Fig. 26. The buccal tentacles, so laid together as to resemble a solid ribbed mass.

Fig. 27. The medusiferous branches turned toward the mouth, so as to show their basal connection with the disk of the hydra.

Fig. 28. The buccal tentacles retracted, and the mouth wide open.

Fig. 29. A young hydroid, partially contracted.

Fig. 30. A young hydroid, contracted as in fig. 22.

PLATE XXIII.

PARYPHA CROCEA *Ag.*

[Figs. 1, 1b, and 1c, drawn by A. Sonrel; the others by H. J. Clark.]

Figures 2^a, 3, 4^a, 5, 7, 8, 9, 10, 11, 12, 12^c, 13, 14, 15, 21, 22, and 23, are magnified 100 diameters; figs. 1^e, 9^a, and 14^a, 200 diameters; figs. 3^a, 4, 5^a, 7^a, 18, 18^a, and 19, 300 diameters; figs. 6, 12^a, 12^b, 19^a, 21^a, 22^a, 23^a, and 24, 400 diameters; figs. 9_b, 15^a, 16^B, 17, 17^a, 25, 26, 26^a, and 26^b, 500 diameters.

Fig. 1. A group of immature hydroids. *a* a^1 a^2 a^3 branches and stolons; *b c d e f g* the heads in different stages of growth.

Fig. 1^a. A full-grown hydromedusarium. *a b* the stem; a^1 the stolon; *c* the medusæ bunches; *d* base of the head; *e* proboscidal tentacles.

Fig. 1^b. The head and top of the stem of a hydromedusarium, from fig. 1. *a b c* c^1 the medusæ; *d* the stem; d^1 top of *d*; *e* e^1 branchlets of the medusiferous branch; *p* the proboscis; *t* buccal tentacles; t^1 coronal tentacles. 25 diameters.

Fig. 1^c. The proboscis of fig. 1^b opened longitudinally. *m* mouth; *p* the walls; p^1 p^2 internal folds; *t* buccal tentacles; t^1 decurrent base of buccal tentacles; t^2 centripetal bases of buccal tentacles.

Fig. 1^d. The chitinous sheath. 3 diameters.

Fig. 1^e. The end of a buccal tentacle. *a* outer, and *b* inner wall; *c* dense accumulation of lasso-cells. 200 diameters.

Fig. 2. A bunch of male medusæ, *a b*; *c* the branch from which they arise. 25 diameters.

Fig. 2^a. A male medusa. *a* pedicel; *b* disk; *c* spermatic mass; *d* proboscis.

Figs. 3 to 26^b represent the development of the medusa and its young.

Figs. 3 to 7 are lettered alike. *a* outer wall of the medusa; a^1 outer wall of the branch or pedicel; *b* inner wall of the medusa; b^1 inner wall of the branch or pedicel; b^2 edge of the inner wall; *c* c^1 chymiferous cavity; *d* d^1 proboscis; *e* germ-basis.

Fig. 8. A male medusa. *a* inner wall of pedicel; *b* outer wall of disk; *c* inner wall of disk; *d* proboscis; *e* edge of inner wall; *f* spermatic mass.

Fig. 9. A partially developed female medusa. *a* disk; a^1 outer, and b^1 inner wall of pedicel; *c* chymiferous cavity; *d* proboscis; d^1 tip of *d*; *e* germ-basis; *f* tentacles beginning to bud.

Fig. 9^a. A portion (*b*) of the germ-basis. *a* walls of the disk.

Fig. 9^b. Cellules of fig. 9^a, *b*, isolated. *a* wall of the cell; *b* contents.

Fig. 10. A female medusa. *a* disk; a^1 outer wall of pedicel; *b* inner wall of pedicel; *c* chymiferous cavity; *d* proboscis; d^1 tip of *d*; *e* germ-basis; *f* tentacles.

Fig. 11. A female medusa. *a* a^1 *b c d* as in fig. 10; *e* a young hydroid; *f* the cavity of the disk; *g* the germ-basis.

Fig. 12. *a* a^2 *b c d* d^1 *f* as in fig. 10; *e* e^1 e^2 e^3 young hydroids.

Fig. 12^a. One of the tentacles of fig. 12, seen in profile. a^1 the disk; *b* b^1 b^2 the entrance to the cavity of the tentacle; *d* outer wall; *e* inner wall.

Fig. 12^b. Edgewise view of fig. 12^a, looking along the line *a* . . . . *c*. *a* the disk; *b* cavity of the tentacle; *e* corresponds to *e* in fig. 12^a.

Fig. 12^c. The edge of the disk of a female medusa with ten tentacles *c* c^1. *a* walls of the disk; *b* aperture of the disk.

Fig. 13. The lettering as in fig. 12, excepting e^2, the digestive cavity of a young hydroid, and e^3, tentacles.

Fig. 14. A medusa upon the point of discharging a young hydroid. *a* disk; a^1 outer, and b^1 inner wall of pedicel; *c* proboscis of the hydroid; c^1 stem of of the hydroid; *d* proboscis of the medusa; d^1 chymiferous cavity; *e* tentacles of the hydroid; *f* f^1 tentacles of the medusa; *g* globose tips of *e*.

Fig. 14^a. The stem of the hydra of fig. 14, to show the horny sheath, *c* c^1 c^2. *a* outer, and *b* inner wall; *d* chymiferous cavity.

Fig. 15. A male medusa. Letters as in fig. 2^a, and *e* aperture of the disk; d^1 proboscis projecting through *e*.

Fig. 15^a. A portion (*b*) of the spermatic mass of fig. 15. *a* the walls of the disk.

Fig. 16. Spermatic particle from a mature medusa. *A*, diagrammic, to show its form; B as seen with 500 diams.

Fig. 17. The proboscis of fig. 12. *a* remains of the germ-basis; *b* wall of the proboscis; *c* chymiferous cavity.

Fig. 17^{a}. The same as fig. 17, contracted, and the germ-basis wrinkled and having the appearance of an outer wall.

Fig. 18. A portion of a medusiferous branch, partially contracted. *a* outer, and *b* inner wall; *c* chymiferous channel.

Fig. 18^{a}. The same as fig. 18, but uncontracted.

Fig. 19. The same as fig. 18, in a sectional view.

Fig. 19^{a}. The same as fig. 19, contracted.

By mistake there is no figure 20.

Fig. 21. A young hydroid, just beginning to develop its tentacles, *b*. *a* the inner mass or wall; *c* outer wall.

Fig. 21^{a}. A portion of fig. 21. *a* inner wall; a^1 inner wall of the tentacle; *b* an incipient tentacle; *c* outer wall.

Fig. 22. A young hydroid with quite prominent tentacles (*b*). *a* inner, and *c* outer wall.

Fig. 22^{a}. A portion of fig. 22. Letters as in fig. 21^{a}.

Fig. 23. A young hydroid with tentacles already flexible. *a* inner wall; a^1 *b* tentacles.

Fig. 23^{a}. A portion of fig. 23. Lettered as in fig. 22^{a}. a^1 and a^2 axial cells of the tentacle.

Fig. 24. A portion of the young hydroid in fig. 11, *e*. *a* inner wall; *c* outer wall.

Fig. 25. A portion of fig. 21^{a}, more highly magnified.

Fig. 26. The end of the tentacle of a hydroid, just issuing from the parent; lateral view. *a* outer wall; a^1 a^2 lasso-cells in *a*; *b* b^1 inner wall; *c* globular tip, crowded with lasso-cells.

Fig. 26^{a}. The same as fig. 26, but more extended; seen from the actinal side.

Fig. 26^{b}. The same as fig. 26^{a}, but the lasso-cells more prominent.

PLATE XXXIII^{a}.

Figs. 1–7, PARYPHA CROCEA *Ag.*; Figs. 8 and 9, TUBULARIA COUTHOUYI *Ag.*; Figs. 10 and 11, HYBOCODON PROLIFER *Ag.*; Fig. 12, CORYNE MIRABILIS *Ag.*

[Drawn from nature by H. J. Clark.]

Figs. 1, 1^{a}, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, magnified 500 diameters; Fig. 8 magnified 40 diameters.

Fig. 1. A lateral view of a coronal tentacle in a highly extended state. *a* a^1 a^2 cells of the outer wall, in profile; *b* b^1 b^2 b^3 b^4 general view of the cells of the outer wall, in outline; *c* c^1 c^2 c^3 superficial view of the outer wall, c^3 lasso-cells; *d* cells of the inner wall or axis, seen through the outer wall; *e* the same as *d*, seen isolately.

Fig. 1^{a}. Cells from the disintegrated outer wall. *a–d* lasso-cells; *e* granular contents.

Fig. 2. View from below at the surface of the axis of a coronal tentacle. *a* a^1 a^2 as in fig. 1; a^3 lasso-cells; *e* the two rows of cells nearest the eye, which meet along the line e^1.

Fig. 3. Transversely sectional view of fig. 1. *a* cells of the actinal side; a^1 cells of abactinal side; a^2 corresponds to a^2 in fig. 1; b^1 b^3 correspond to b^1 b^3 in fig. 1; *e* e^1 same as in fig. 2.

Fig. 4. A combined profile and general view of a portion of the stem, just below the head. *a* the horny sheath; *b c* outer wall, in profile; b^1 lasso-cells; *d e* inner wall, in profile; *f* f^1 f^2 f^3 f^4 inner wall in profile, seen through the cells nearest the eye (*g*); g^1 g^2 end view of the cells of the inner wall, seen through those of the outer wall (*i*); *h i* i^2 i^3 general view of the outer wall.

Fig. 5. The stem of a young hydra, at the upper third, stretched longitudinally. The lettering as in fig. 4; in addition, g^3 cells of the semi-partition, corresponding to g^3 g^4 in fig. 7.

Fig. 6. A cell of the outer wall of fig. 4. *a* lasso-cell; *b c* wall of the cell; *d* cavity of the cell.

Fig. 7. Transverse section of the stem, a little below the head. The lettering as in fig. 5; in addition, *j* is the loose pigment layer.

Fig. 8. A transverse section of the stem of Tubularia Couthouyi *Ag.* *a* horny sheath; *b* outer wall; *d* inner wall; g^3 g^4 the solid cellular mass which fills the axis of the stem; *j* the longitudinal channels; j^1 the primary channel.

Fig. 9. A portion of fig. 8, more highly magnified. *a* lamellate sheath; *b* outer wall; *d* d^1 inner wall; *g* cells of the solid central mass; g^1 mesoblast of the cells (*g*); g^2 outline of cells like *g*, but in the distance; g^3 mesoblast in profile.

Fig. 10. A portion of the transverse section of the stem of Hybocodon prolifer *Ag.* *a* the lamellate sheath; *b bb* outer wall; *d* inner wall; *dd* pigment cells; g^3 g^4 the semi-partition.

Fig. 11. Inner face of a semi-partition of fig. 10, with the same letters, and g^1 a mesoblast.

Fig. 12. A transverse section of the stem of Coryne mirabilis *Ag.* *a* the horny sheath; *b c* cells of the outer wall; b^1 a mesoblast; *d, e* cells of the inner wall; *dd* pigment cells.

PLATE XXIV

TUBULARIA COUTHOUYI *Ag.*

[Figs. 1–5, drawn by A. Sonrel; the others by H. J. Clark.]

Figs. 6–13 magnified 200 diameters; figs. 14–18 and 24–26, 100 diameters; fig. 19, 60 diameters; figs. 20–23, 40 diameters.

Fig. 1. A group of female hydroids, natural size. *a* the stem; *b* the medusæ; *p* the proboscis; *t* the coronal tentacles.

Fig. 1, B. A lateral view of the head of a hydromedusarium, magnified 5 diameters. *a* the stem; a^1 the largest tubule; *b* the terminal expansion of the stem; *c* the base of the head; *d* d^1 the medusæ; *e* the medusiferous branches; *t* coronal tentacles.

Fig. 1, C. The same as fig. 1, B, seen from the under side.

Fig. 2. A male hydroid, with the proboscis (*p*) spread wide open. The letters as in fig. 1.

Fig. 3. Another male hydroid, the head hanging downward. Letters as before.

Fig. 4. The proboscis of a male hydra. *a* the base; *t* t^1 t^2 t^3 the tentacles. 5 diameters.

Fig. 5. The broadly-expanded proboscis and a medusiferous branch of a male hydromedusarium (*d e*). *a* the base of the proboscis; *b* the decurrent bases of the tentacles (t t^1); *d* the oldest, *e* the youngest medusæ. 5 diameters.

Fig. 6. A medusa-bud, just beginning to form. *a* outer, and *b* inner wall; *d* chymiferous cavity.

Fig. 7. A, a double-walled hernia-like medusa. a^1 outer, and b^1 inner wall; *d* chymiferous cavity. B, a far advanced bud. a^1 outer wall; *c* ends of the radiating tubes; *d* the proboscis; *e* base of the radiating tubes; *f* germ-basis.

Fig. 8. A little younger than fig. 7, B. The letters the same.

Fig. 9. An exterior view, a little younger than fig. 7, B. The letters the same.

Fig. 10. An interior view, showing three of the radiating tubes (c c^1). The letters as in fig. 7, B.

Fig. 11. A little older than fig. 7, B, and with the same letters.

Fig. 12. The circular tube is formed. *a b c* as before; a^1 outer wall of the disk; b^1 inner wall containing the radiating tubes; *d* base of the radiating tubes and proboscis (d^1).

Fig. 13. A male medusa, a little older than the last, with corresponding letters, and also c^1, junction of radiating and circular tubes, seen in the distance, and *g*, spermatic mass.

Fig. 14. A nearly mature female medusa. *c* remains of the circular tube; *d* proboscis; *e* radiating tube; *f* germ-basis.

Fig. 15. The chymiferous tubes obliterated, and the germ-basis (f f^1) beginning to divide. a a^1 b b^1 d as in fig. 12; b^2 the base of the proboscis. Drawn as a sectional view.

Fig. 16. The germ-basis, still further divided. a b f f^1 as in fig. 15; *c* as in fig. 14.

Fig. 17. A sectional view of a medusa of the same age as that of fig. 16. The letters as in fig. 15, and *c* as in fig. 14.

Fig. 18. The germ-basis nearly all divided off into hydræ (f^1 f^2). *a* outer, and *b* inner walls of the pedicel; *c* junction of circular and radiating (*e*) tubes; *d* proboscis.

Fig. 19. Similar to fig. 18, but not so far advanced. *f* germ-basis.

Figs. 20, 21, 22, and 23. Similar to figs. 18 and 19, with the same letters.

Fig. 24. The hydroids have escaped, but more of the germ-basis remains. Letters as in figs. 18 and 19: also a^1 the wrinkled disk.

Figs. 25 and 25^a. Lateral and end view of an empty medusa. Letters as in fig. 24.

Fig. 26. A male medusa. *a* outer, and *b* inner wall of the pedicel; *c* as in fig. 14; *f* spermatic mass; *g* disk cavity.

PLATE XXV.

HYBOCODON PROLIFER *Ag.*

[Figs. 1, 2, 15, 15a, and 15b, drawn by A. Sonrel; the others by H. J. Clark.]

Fig. 1 natural size; figs. 2 and 3 magnified 10 diameters; figs. 2^a, 14, 14^a, 15, 15^a, and 15^b, 40 diameters; figs. 4, 5, 6, 7, 8, 9, 200 diameters; figs. 10, 11, 12, 13, 100 diameters.

Fig. 1. A single hydra. *a* the stem; *t* the coronal tentacles.

Fig. 2. A profile view of the upper part of an individual, loaded with medusæ-buds. *a* the stem; a^1 the horny sheath; *b* the top of the stem; *c* the base of the head; d d^1 d^2 e medusæ; *t* coronal tentacles; t^1 t^2 proboscidal tentacles.

Fig. 2^a. The proboscis of fig. 2. *p* the mouth; p^1 the intervals of the exterior row (t^2) of tentacles; p^2 the decurrent bases of t^2; t^1 inner row of tentacles.

Fig. 3. A much older head than fig. 2, with the coronal tentacles (*t*) cut off near the base. *a* the stem; a^1

the horny sheath; a^2 the expansion of the sheath at the base of the head; d d^1 the medusæ; t^1 t^2 the inner and outer rows of proboscidal tentacles.

Fig. 4. A young medusa-bud, just rising from the disk of the hydra. *a* outer, and *b* inner wall; *d* chymiferous cavity.

Fig. 5. A medusa-bud from the hydra disk. *a* outer, and *b* inner wall; c c^1 radiating tubes; *d* digestive cavity.

Fig. 6. A medusa-bud from the hydra disk, already one-sided. a b c c^1 d as in fig. 5; c^2 the incipient tentacle.

Fig. 7. A little older than fig. 6, but from the base of the tentacle of figs. 14 and 14^a. a b c c^1 c^2 as in fig. 6; b^1 inner wall of c^2.

Fig. 8. A little older than fig. 7. From the hydra. The letters the same; b^2 an incipient primary medusa.

Fig. 9. Considerably older than fig. 8. From the hydra. a b b^2 c c^1 c^2 d as before; a^1 horny sheath; b^3 a secondary medusa-bud; d^1 chymiferous cavity.

Fig. 10. A medusa with four medusa-buds, a^1 b b^1 b^2. *c* the tentacle. From the hydra.

Fig. 11. A medusa in which the circular tube (b^2) is already developed. From the hydra. *a* outer, and *b* inner wall; b^1 the radiating tubes; b^2 circular tube; *c* the incipient bud of a secondary medusa; c^2 the tentacle of *c*; *d* outer, and d^1 inner wall of the proboscis; d^2 digestive cavity; *e* disk cavity; f f^1 secondary medusæ; *g* tentacle of the primary medusa.

Fig. 12. A medusa nearly ready to break loose from the hydra. *a* outer, and *b* inner wall; *b* junction of radiating (b^3 b^5 b^6) and circular (b^2) canals; b^4 hollow base of the tentacle (g^2); *c* a primary medusa; c^1 a secondary, and c^2 a tertiary medusa; *d* digestive cavity; d^1 proboscis; *e* disk cavity; *f* an incipient group of medusæ; g g^1 tentacle of *c*; g^2 tentacle of the parent medusa.

Fig. 13. A medusa a little older than fig. 12: looking toward the inner face of the tentacle. The letters as in the last: also f^1 f^2 h the same as *f* in fig. 12; *i* a primary medusa, a little younger than *c*; i^1 i^2 secondary and tertiary medusæ of *i*; g^3 tentacle of *i*.

Fig. 14. A medusa just set free, seen with the tentacle in profile. *b* the radiating canal; b^2 circular canal; b^4 the hollow base of *g*; b^5 the canal opposite the tentacle (*g*); d^1 the proboscis; d^3 the remains of the pedicellar attachment; f^2 medusæ-buds; *g* the tentacle; *l* aperture of the veil (l^1); *n* the prolonged edge of the disk.

Fig. 14^a. View of fig. 14, from the side opposite to the tentacle, and obliquely from below. Letters as in fig. 14; also *d*, the digestive cavity.

Fig. 15. A medusa, drawn about twenty-four hours after it dropped from the hydra: the tentacle next the observer. The letters as in figs. 14 and 14^a: also g^1 the solid part of the tentacle; *k* the pair of pigment bands on each side of the odd radiating canal; k^1 base of *k*; k^2 base of the other bands (k^3).

Fig. 15^a. View from above of fig. 15, with the same letters. Also k^4, the ends of the pair of pigment-bands.

Fig. 15^b. The proboscis of fig. 15, elongated. *a* outer, and *b* inner wall; *c* mouth; *d* the base.

PLATE XXVI.

Figs. 1–6, **Tubularia Couthouyi** *Ag.*; Figs. 7–17, **Corymorpha pendula** *Ag.*; Fig. 18, **Hydractinia polyclina** *Ag.*

[Figs. 1–5 and 18, drawn by H. J. Clark; fig. 6 by J. H. Richard; figs. 7–17 by Wm. Tappan.]

Fig. 1. A hydra just escaped from the parent. *a* the stem; *b* the coronal tentacles; *c* the buccal tentacles; *d* the base of *b*. 100 diameters.

Fig. 2. The same as fig. 1, in an expanded state, with the same letters.

Fig. 3. The medusa with the hydra of fig. 1, before it escaped. *a* outer, and *b* inner wall of the pedicel; *c* point of junction of the circular and radiating (e e^1) tubes; *d* the proboscis of the medusa, seen through the hydra (f^1); e^2 base of *e* and e^1; f^2 tentacles of *f*. 100 diameters.

Fig. 4. A branch of withering medusæ. *a* the branch; *b c d e* the medusæ in various stages of decadence. 100 diameters.

Fig. 5. A part of a medusiferous branch, to show the relations of its walls to those of the medusa. *a* the outer, and *b* the inner wall of the branch; a^1 the outer, and b^1 the inner wall of the branchlet; c c^1 the chymiferous cavity; *d* the radiating tubes of the medusa; *e* the proboscis. 60 diameters.

Fig. 6. The hydræ a short time after birth, attached to the stem of the parent (T). *p* the proboscis; *s* the stem; s^1 the base of *s*; *t* coronal tentacles. 40 diameters.

Figs. 7 and 9–17. Hydromedusarium of Corymorpha, in various attitudes. *a* the proboscis; *d* the medusæ. Natural size.

Fig. 8. A hydra, with the upper third of the stem very much extended, and pendulous. *a* the proboscis; b^1 the base of the head; b^3 the stem; b^4 the horn-like

sheath; b^5 the terminal expansion of b^4; *d* the medusæ; *r* the branching base of the stem; *t* the coronal tentacles; t^1 t^2 the buccal tentacles. 8 diameters.

Fig. 8^a. View of the abactinal side of the head of a hydra. b^1 b^3 *d* as in fig. 8; *t* t^3 t^4 t^5 coronal tentacles in various stages of growth. 8 diameters.

Fig. 18. The retiform stolonic basis of the hydra of Hydractinia polyclina. *a* the outer wall at the edge of the depressions (*d*); *b* inner wall; b^1 granules circulating in the channels; *c* cells of *a*, in profile; *d* depressions in the outer wall, which sometimes appear to be open spaces. 400 diameters.

PLATE XXVII.

Figs. 1–7, Bougainvillia superciliaris *Ag.*; Figs. 8 and 9, Clytia cylindrica *Ag.*; Figs. 10–26, Thoa (Eudendrium) dispar *Ag.*

[Figs. 1, 8, 9, 10, 11, 12, 13, 22, 23, 24, 25, 26, drawn by A. Sonrel; the others by H. J. Clark.]

Fig. 1. A hydromedusarium. Natural size.

Fig. 2. A portion of fig. 1. *a–d* rings of the stem; A B medusa-buds. 25 diameters.

Fig. 3. The head of a hydra and the upper part of a branch of fig. 1. *a* outer, and *b* inner wall of the head; a^1 outer, and b^1 inner wall of the proboscis; a^2 outer, and b^2 inner wall of the tentacles; *c* the horn-like sheath; c^1 the termination of *c*; *d* digestive cavity; *m* mouth; *t* t^1 tentacles. 200 diameters.

Fig. 4. A young head of a hydra, almost ready to burst its envelope. *a* outer, and *b* inner wall; a^1 outer, and b^1 inner wall of the proboscis; a^2 outer, and b^2 inner wall of the tentacles; *c* c^1 the horn-like sheath; *d* digestive cavity. 300 diameters.

Fig. 5. A medusa-bud and the pedicel. *a* outer, and *b* inner wall of the pedicel; *c* inner wall of the medusa, containing the radiating tubes; *i* the horn-like sheath. 300 diameters.

Fig. 6. A bud considerably older than fig. 5. *c* c^1 horn-like sheath; *l* base of *c*. 300 diameters.

Fig. 7. A medusa-bud in which the circular tube (*l*) is nearly complete. *a b c* d^1 *i* as above; *l* circular tube; *n* the proboscis. 300 diameters.

Fig. 8. The medusa of Clytia cylindrica, seen from below. *a* the edge of the opening in the veil; *b* the circular tube; *c* the tentacles; c^1 the tentacles budding; c^2 the base of *c*; *d* the proboscis; *e* the radiating tubes; e^1 the genital organs; *f* ocular organs. 40 diameters.

Fig. 9. The same as fig. 8, seen obliquely from below. *g* the disk.

Fig. 10. A branch of Thoa dispar: the male. A A young head; B heads destitute of medusoids; C medusiferous heads. 25 diameters.

Fig. 11. A head from fig. 10. *p* the proboscis. 25 diams.

Fig. 12. A head from fig. 10, bearing young medusæ. *md* medusæ; *p* the proboscis; *t* the tentacles. 40 diams.

Fig. 13. Similar to fig. 10, C. *d* base of the medusa pedicel; d^1 the digestive cavity; *md* medusæ; *p* the proboscis. 40 diameters.

Fig. 14. An incipient medusa-bud from fig. 10. *a* outer, and *b* inner wall; *c* chymiferous cavity. 300 diameters.

Fig. 15. A little older than fig. 14, with the same letters. 300 diameters.

Fig. 16. From fig. 10: the primary medusa. *a* outer, and *b* inner wall of the pedicel; a^1 disk; *ca* disk cavity; *p* proboscis. 300 diameters.

Fig. 17. A medusa much older than fig. 16. Letters as in fig. 16, and *l* lasso-cells. 300 diameters.

Fig. 18. The primary (A) and secondary (B) medusa, far advanced, the tertiary medusa (C) just forming. *a* outer, and *b* inner wall; c^1 the inner, or axial wall; *ca* disk cavity containing the spermatic mass; *e* constriction between A and B; e^1 constriction between B and C; *p* proboscis; p^2 the homologue of *p*. 300 diameters.

Fig. 19. An exterior view: the primary medusa (A) nearly mature, the secondary (B) and tertiary (C) far advanced. The letters as in fig. 18. 300 diams.

Fig. 20. A, an immature spermatic particle from fig. 19, A: 500 diameters. B, diagrammic, to show the form.

Fig. 21. A, a mature spermatic particle: 500 diameters. B, a diagrammic figure, to show the form.

Fig. 22. A head and branch of a female hydromedusarium. *a b* the young medusæ; *md* md^1 nearly mature medusæ; *p* the proboscis; *t* coronal tentacles. 25 diameters.

Figs. 23, 24, and 25. The same as fig. 22, with corresponding letters. 40 diameters.

Fig. 26. A view from above of fig. 22. *dc* the disk; *m* the mouth; *p* proboscis; *t* coronal tentacles. 60 diameters.

PLATE XXVIII.

Clytia poterium *Ag.*

[Figs. 1 and 2, drawn by A. Sonrel; the others by H. J. Clark.]

Figs. 3, 4, 5, 6, 7, 8, 9, 10, 13, 13^a, 15, and 19, are magnified 100 diameters; figs. 11, 12, and 14, 200 diameters; fig. 16, 60 diameters; figs. 17, 17^a, 18, and 20, B C. 500 diameters; fig. 20, A, diagrammic.

Fig. 1. A male hydromedusarium attached to a seaweed. Natural size.

Fig. 2. A portion of fig. 1. *a* the pedicels of the hydræ; *b* the reproductive calycles; c c^1 the young hydra-buds; *d* the stolon. 15 diameters.

Fig. 3. A sectional view of a hydra pedicel (c^2) and head. *a* outer, and *b* inner wall of the head; *c* the semi-partition; c^1 cavity of the calycle; c^2 pedicel; c^3 top of c^2; c^4 the stolon; *g* digestive cavity; *t* two opposite tentacles.

Figs. 4, 5, 6, 7, 8, 9. Progressive stages in the development of the hydra. *a* the outer, and *b* the inner wall of the head; a^1 outer, and b^1 inner wall of the pedicel; *ab* the tentacular region; *c* the semi-partition; c^1 cavity of the calycle; c^2 chitinous sheath; *d* the opercle; *e* point where the walls adhere to the calycle; *g* digestive cavity.

Fig. 10. A hydra just emerging from its embryonic state. *d* the opercle; *t* the tentacles.

Fig. 11. The bud of a fertile male hydra. β outer, and γ the inner wall; *b* chymiferous cavity; *d* the growing terminus; *i* a medusa-bud; *k* the calycle.

Fig. 12. The same as fig. 11, but much further advanced. The letters the same: also *a*, the chymiferous cavity.

Fig. 13. A male reproductive hydra. *a* the single chymiferous channel; c c^1 c^2 the multiple chymiferous channels; *d* the common terminal cavity; *f* radiating tubes of the medusa; *i* the spermatic mass.

Fig. 13^{a}. The hydromedusa of fig. 13, taken from its calycle, and allowed to expand so as to show the point of connection (e^1) of the medusa to one channel of the multiple axis.

Fig. 14. A two thirds grown hydromedusa, removed from its calycle. *a* base of the channel of *c*; *b* junction of the medusa with *a*; *c* channel of the axis; *d* expanded terminus of *c*; *f* radiating canals; *i* spermatic mass.

Fig. 15. A female hydromedusa. *a* the main channel; *b* neck of the medusa; c c^1 c^2 c^3 c^4 the multiple channels arising from *a*; *d* common cavity into which c–c^4 empty; e e^1 f f^1 radiating tubes of the medusa; *h* actinal side of the medusa; i i^1 the planulæ; k k^1 the calycle.

Fig. 16. A mature female hydromedusa. a b c c^1 c^2 d e e^1 f i i^1 k k^1 as in fig. 15; e^3 radiating tube; *h* a portion of the medusa protruded from the calycle; h^1 neck of *h*; i^2 planulæ.

Figs. 17 and 17^{a}. A lateral and end view of a planuloid hydra from fig. 15.

Fig. 18. A the outer cells of fig. 17; **B** the interior cells of the same.

Fig. 19. A male hydromedusa, two thirds grown. a b c c^1 d e e^1 e^2 f f^1 k as in fig. 15; also *i*, the spermatic mass.

Fig. 20. B, spermatic particles; A, a diagrammic figure of A; C, immature spermatic particle.

PLATE XXIX.

Figs. 1–5, CLYTIA POTERIUM *Ag.*; figs. 6–9 C. BICOPHORA *Ag.*; Figs. 10 and 11, C. INTERMEDIA *Ag.*

[Drawn by H. J. Clark.]

Fig. 1. A hydra which has developed from the head of another hydra. *a* the base of (a^1) the pedicel of the upper hydra; a^2 the semi-partition; *b* the terminal ring of the lower pedicel; b^2 terminal ring of the upper pedicel. 100 diameters.

Fig. 2. A male hydromedusa. *a* main chymiferous channel; *b* base of the multiple channels (c^1 c^2 c^3); c^4 c^5 outer wall of the hydra; *d* common chymiferous cavity; e e^1 e^2 radiating tubes of the medusa; *f* branches of *e*; g g^1 furrow in the spermatic mass. 150 diameters.

Fig. 3. A mature male hydromedusa. Letters as in fig. 2; also *i*, the spermatic mass. 100 diameters.

Fig. 4. Similar to fig. 3, and with the same letters.

Fig. 5. A mature male hydromedusa, discharging its spermatic particles, the multiple axis partially retracted. *a* main channel; *b* base of the multiple channels (c c^1 c^2); *d* end of the axis; *h* the medusa; i i^1 the current of spermatic particles; *k* the calycle; k^1 the mouth of *k*. 100 diameters.

Fig. 6. A hydromedusarium of Clytia bicophora. A–G the hydra; a b c f the base of the branch of a hydra; d e the reproductive hydra; *g* the stolonic sheath; *h* the channel of the stolon. 40 diameters.

Fig. 7. A hydra from fig. 6. *c* the semi-partition; c^2 the terminal ring of the pedicel; c^6 the teeth; c^7 the sinuses between c^6. 100 diameters.

Fig. 7^{a}. End view of fig. 7, with the same letters.

Fig. 7^{b}. A portion of the calycle of fig. 7, with the same letters. 100 diameters.

Fig. 8. The calycle of an immature hydra. *b* the terminal ring of the stem; *c* the semi-partition; *d* the filmy opercule. 200 diameters.

Fig. 9. The margin of the calycle of a mature hydra just before it emerges. c^3 c^4 c^6 the teeth; c^5 the decurrent angles of the intervals (c^7) of the teeth c^6); *d* the opercule; d^1 line which divides the smooth from

the scalloped part of the opercle; d^2 d^3 the puffs of d. 470 diameters.

Fig. 10. The hydra of Clytia intermedia. g the stolon. 40 diameters.

Fig. 11. A single hydra of fig. 10. c the semi-partition; c^2 the top ring of the stem; c^3 the calycle; c^6 the teeth; t the tentacles. 100 diameters.

PLATE XXX.

LAOMEDEA AMPHORA *Ag.*

[Figs. 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, drawn by A. Sonrel; the others by H. J. Clark.]

Fig. 1. A group of young hydra, attached to a sea-weed. Natural size.

Fig. 2. A full-grown bunch of hydræ. Natural size.

Fig. 3. A portion of a branch of a hydromedusarium. 8 diameters.

Fig. 4. A hydra, seen from above. A B the tentacles alternately elevated and depressed. 40 diameters.

Fig. 5. A hydra in profile. A B as in fig. 4; c^1 the calycle; c^2 the rings of the pedicel; g the intra-calycine axis; pr proboscis. 100 diameters.

Fig. 6. A hydra calycle. a the border, and b the aperture of the semi-partition. 100 diameters.

Fig. 6^a. End view of fig. 6.

Fig. 6^b. The papillate margin of the semi-partition of fig. 6. 400 diameters.

Fig. 7. The base of a hydra calycle. a the papillæ along the margin of c; b aperture of c; c the semi-partition; c^1 actinal prolongation of c; c^2 abactinal prolongation of c. 300 diameters.

Fig. 8. The terminal development of a branch. a b the youngest portion; c^1 the horn-like sheath; g the chymiferous channel. 100 diameters.

Fig. 9. A partially-developed hydra. ab the head; g^1 the axis of the pedicel; g^2 processes from the outer wall of g. 100 diameters.

Fig. 10. A nearly mature hydra. a outer, and b inner wall of the head; c^2 rings of the pedicel; g digestive cavity. 100 diameters.

Fig. 11. A hydra a little older than fig. 10. c^2 c^3 c^4 the pedicel and branchlet; d the calyx; g^1 the axis. 100 diameters.

Fig. 12. A hydra a little older than the last. a outer, and b inner wall; c^1 the calycle; c^2 the terminal ring of the pedicel; g the digestive cavity. 100 diams.

Fig. 13. Similar to fig. 12, but the head is retracted. 100 diameters.

Fig. 14. The pedicel of a hydra, to show the very prominent rings (c^2). 100 diameters.

Fig. 15. A female hydromedusa. β outer, and γ inner wall of the axis; ae the egg; d the end of the axis; h^1 the medusæ; k the calycle; k^1 rings of the pedicel. 100 diameters.

Fig. 16. A medusa from fig. 15. ae the egg; h the discoid termination of the inner wall; h^1 the disk; h^2 the pedicel; h^4 the chymiferous cavity. 300 diams.

Fig. 17. The inferior end of the axis of a male hydromedusa. A–D the medusæ; β the outer, and γ the inner wall of the axis; ae the spermatic mass; h^1 the disk of the medusa; h^5 the proboscis of the medusa. 300 diameters.

Fig. 18. A male reproductive calycle. A B, the medusæ emerging in one mass; k the wall of the calycle. 60 diameters.

PLATE XXXI.

FIGS. 1–8, LAOMEDEA AMPHORA *Ag.*; FIGS. 9–15, TIAROPSIS DIADEMATA *Ag.*

[Drawn by H. J. Clark.]

Fig. 1, A. A spermatic particle, from fig. 18, Pl. 30. 500 diameters. B a diagrammic figure.

Fig. 2. A medusa from a mature hydromedusa. ae the egg; af outline of the egg, next the inner wall; h the discoid termination of the inner wall (h^3); h^1 the disk; h^2 outer wall; h^3 inner wall; h^4 digestive cavity; p the Purkinjean vesicle. 400 diameters.

Fig. 2^a. The Purkinjean vesicle of fig. 2. 500 diameters.

Fig. 3, 3^a. Views from two opposite sides of a segmenting egg. a a^1 a^2 the dividing furrow; b e the two halves of the segmenting mass. 300 diameters.

Fig. 3^b. An end view of fig. 3^a.

Fig. 4. A quadrated mass. a a^1 as in fig. 3; b c d e the four segments; f g the secondary furrow.

Fig. 5, 5^a. An unequally quadrated mass; letters as in figs. 2 and 4.

Fig. 6. A surface view of a mass, divided into eight segments. b b^1 c c^1 the four segments nearest the eye; h h^1 h^2 as before.

Fig. 6^a. The same as fig. 6, by transmitted light. b b^1 c c^1 correspond to those in fig. 6; d d^1 e e^1 the four segments in the distance; h h^1 h^2 as before.

Fig. 7. A mass divided into thirty-two segments (ae af ag). h h^1 h^2 as before.

Fig. 7^a. One of the segments of fig. 7, isolated.

Fig. 8. A minutely divided mass (*ae*). h h^1 as before.

Fig. 9. An ovary of Tiaropsis diademata, seen obliquely from above. a a^1 a^2 a^3 the median wall of the medusa; b b^1 the innermost wall. 100 diameters.

Fig. 9^a. A transverse, sectional view of fig. 9. The letters as above.

Fig. 10. An incipient tentacle. a outer, and b inner wall of the bud; a^1 outer, and b^1 median wall of the disk; c circular canal. 400 diameters.

Fig. 11. A young tentacle. a outer, and b inner wall; b^1 the base. 400 diameters.

Fig. 12. An ocular coronet, seen obliquely from above. a outer, and b median wall of the edge of the disk; a^1 outer wall of the tentacle; a^2 outer wall of the coronet; b^1 inner wall of the coronet; c the semicircle of refractive bodies; d the boss-like edge of the disk; e the pigment spot; f circular canal. 400 diameters.

Fig. 13. The same as fig. 12, but seen strictly from above, so that the disk (h) partly overshadows it; the same letters; also g the innermost wall of the disk.

Fig. 14. The same as fig. 12, seen from below, with similar letters.

Fig. 15. An edgewise view of fig. 12, with similar letters.

PLATE XXXII.

DYNAMENA PUMILA *Lamx.*

[Figs. 1, 4, and 4a, drawn by A. Sonrel; the rest by H. J. Clark.]

Fig. 1. A hydrarium creeping over a sea-weed. Natural size.

Fig. 2. Two pairs of hydra calycles; the hydræ of the upper ones are omitted. a outer, and b inner wall; a^1 outer wall of the upper pair; c c^1 base of the hydra where it passes through the semi-partition (d); m aperture of the calycle; op operculum of an immature hydra calycle; p the proboscis; t tentacles. 100 diameters.

Fig. 3. A pair of hydræ, and the bases of two branches, seen from the convex side. i the branch; k a calycle of the branch; op as in fig. 2. 100 diameters.

Fig. 4. A hydra emerging for the first time from its calycle (b). Letters as in fig. 2. 100 diameters.

Fig. 4^a. The same as fig. 4, just before emerging.

Fig. 5. An oblique end-view of a young, reproductive hydra. 125 diameters.

Fig. 5^a. The same as fig. 5, in profile. a, a^1 the outer wall; d e the inner wall; c the calycle. 300 diameters.

Fig. 6. A pair of young hydræ. a a^1 a^2 the outer wall; b the fold of the horn-like sheath, at the base of the calycles; b^1 the sheath in process of formation; c the exterior portion of the sheath; d the inner wall of the matured stem; e e^1 e^3 inner wall of the young hydra; e^2 inner wall of the growing stem; f f^1 f^2 the three divisions of the triple bud. 300 diameters.

Fig. 6^a. The top of the branch from which figure 6 was taken. 40 diameters.

Fig. 7. A female hydromedusa. a the axis; g the growing portion of the axis; h ramifications of the axis; ov the eggs. 60 diameters.

Fig. 8. A mature male hydromedusa; a^1 the outer, and e the inner wall of the axis; b the outer, and b^1 the inner wall of the medusa; c the calycle; g the terminal expansion of the axis; l the proboscis of the medusa; l^1 the base of l; sp the spermatic mass. 100 diameters.

Fig. 9. A mature female hydromedusa. Letters as in fig. 8; also ov the eggs. 100 diameters.

Fig. 10. A young hydromedusa. A the main stem; a^1 e b b^1 c g h as in figs. 7, 8, and 9. 80 diams.

Fig. 10^a. A group of hydromedusæ. A the main stem; B C D the three calycles; h the branches decurrent from the axial, chymiferous canal; i point of junction of C and D; j the axis. 60 diameters.

Fig. 11, a. A spermatic particle from fig. 8. 500 diameters. b c diagrammic figures of a.

Fig. 12. A sectional view of a pair of hydræ, and the terminal development of the main stem. a outer, and b the inner wall of the stem and the hydra; a^1 the the processes from a; c the aperture of the semi-partition (d); g the chymiferous channel; h the flat end of the stem. 100 diameters.

Fig. 13, a e. Cells from the outer wall of fig. 14^a. 500 diams. b c d f g h i diagrammic figures of a e.

Fig. 14. Profile view of figs. 5 and 5^a. a the hydromedusa; m the mouth of a hydra-calycle; A the stem. 125 diameters.

Fig. 14^a. A pair of hydræ, just beginning to bud from the main stem. a the outer, and d the inner wall; c the horn-like sheath; e^2 the end of the inner wall of the stem; e e^3 the inner wall of the hydræ. 300 diams.

Fig. 15. A hydra just before the tentacles develop. The letters as in fig. 12; also m the chitinous sheath, between the hydra and the main stem; l the rooflike end of the calycle. 300 diameters.

Fig. 16. An egg removed from the medusa, like that in fig. 9. A the yolk, 500 diameters; B the egg,

of which p is the Purkinjean vesicle; w the Wagnerian vesicle; y the yolk; v the vitelline sac, 400 diameters; C the Purkinjean vesicle (p), seen isolately; w Wagnerian vesicle. 500 diameters.

Fig. 17. A pair of young hydræ, a little younger than fig. 6, with the same lettering. 300 diameters.

Fig. 18. The horn-like sheath of fig. 6. a b c the partition between the hydræ and the main stem. 150 diams.

PLATE XXXIII.

Obelia commissuralis *McCr.*

[Figs. 1 and 2, drawn by A. Sonrel; the others by H. J. Clark.]

Fig. 1. A hydrarium, full grown, and natural size.

Fig. 2. A hydromedusarium, attached to a sea-weed. Natural size.

Fig. 3. A growing branch and pedicel. a the outer, and β the inner wall of the branch; γ the processes from the outer wall; ε the rings of the horn-like sheath; a^1 the outer, and b^1 the inner walls of the young pedicel; c^2 the horn-like film over a^1; g^1 the end of the chymiferous channel. 500 diameters.

Fig. 3^a. The main stem, from which a branch is beginning to bud. a β γ as in fig. 3; δ the upper edge of the bud, overlapping the outer wall (ε) of the stem; a^1 outer, and b^1 inner wall of the bud; c^2 the old horn-like sheath, thrown off by the expanding bud; c^3 the new sheath of the bud. 500 diameters.

Fig. 4. A half-developed hydra. a outer, and b inner wall of the head; a^1 outer, and b^1 inner wall of the pedicel; c^1 cavity of the calycle; c^2 uppermost ring of the pedicel; c^3 the calycle; g the digestive cavity. 500 diameters.

Fig. 4^a. An end view of the polygonal cells of the outer wall (a) of fig. 4. 500 diameters.

Fig. 5. A sectional view of an adult hydra. a outer, and b inner wall of the head; a^1 outer and b^1 inner wall of the pedicel; a^2 outer, and b^2 inner wall of the tentacles; a^3 outer, and b^3 inner wall of the proboscis; c^1 cavity of the calycle (c^3); c^2 rings of the pedicel; g the digestive cavity; g^1 cavity of the proboscis (pr); t tentacles. 200 diameters.

Fig. 5^a. Looking into the mouth (m) of the proboscis of fig. 5.

Fig. 5^b. A tentacle of fig. 5. a^2 and b^2 as before; l lasso-cells; a an infusorium, encircled by lasso-threads. 500 diameters.

Fig. 6. A portion of the branch of a hydromedusarium. β the branch; γ the top of β; δ the branchlet; ε rings of the horn-like sheath; ζ rings of the pedicel of B; B the hydromedusa; C C^1 hydræ; C^2 the rings of the pedicel of C. 60 diameters.

Fig. 7. A hydra, with budding tentacles. Letters as in fig. 5; also c the point of attachment to the semi-partition. 60 diameters.

Fig. 7^a. The end of a tentacle of fig. 7. 500 diams.

Fig. 8. A young hydra, just upon the point of emerging from the calycle. c the attachment to the semi-partition; c^6 the sides, and c^7 the angles of the polyhedral aperture of the calycle; d the opercle; d^1 the inflected edge of d; t tentacles. 125 diams.

Fig. 9. A hydra a little older than fig. 7. 125 diams.

Fig. 10. A hydra similar to fig. 8. d the opercle depressed. 125 diameters.

Fig. 11. A branch of a hydromedusarium. A B the reproductive hydræ; C the hydræ. 11 diameters.

Fig. 12. The calycle of a hydra in profile. c the semi-partition; c^1 the cavity of the calycle (c); c^2 the pedicel; c^6 the sides, and c^7 the corners of the polyhedral aperture. 300 diameters.

Fig. 12^a. The same as fig. 12, looking into it; c c^1 c^6 c^7 as before.

Fig. 13. A portion of the pedicel of a hydra, beset with lasso-cells (a^1); c^2 the concentric layers of the horn-like pedicellar sheath. 500 diameters.

Fig. 14. A portion of the main stem in a state of decomposition. a^1 inner, and b^1 outer wall; c^2 the lamellated, horn-like sheath. 500 diameters.

PLATE XXXIV.

Figs. 1–9^a. Eucope diaphana *Ag.*; Figs. 10-21, Obelia commissuralis *McCr.*

[Figs. 4 and 9, drawn by A. Sonrel; the others by H. J. Clark.]

Fig. 1. A portion of the stem of a hydrarium. a a^1 a^2 a profile of the concentric laminæ; b the inner face exposed; c loosened filaments or shreds. 400 diameters.

Fig. 2. The calycle and its pedicel, obliquely in profile. a a^1 the thick wall of the calycle; e e^1 the thickness of the stem; f the basal attachment of the joint above; g–h one joint of the stem; k the semi-partition. 100 diameters.

Fig. 3. A hydra with partially contracted tentacles (b b^1). a the calycle; d the proboscis. 125 diameters.

Fig. 4. A birds-eye view of a hydra; b d as in fig. 3.

Fig. 5. A calycle, pedicel, and a joint of the stem, in sectional profile. a a^1 the thickness of the calycle walls (a is one third too thick); e e^1 the thickness of the sheath; f–g upper and lower ends of the joint of the stem; h the base of the pedicel; k the semi-partition; m the deflected edge of k. The arrows are explained in figs. 5^a and 6. 100 diameters.

Fig. 5^a. An end view of fig. 5, seen as if along the arrow 2, a little oblique to the axis. a the edge; c corresponds to a in fig. 5; b the tentacles; d the outskirts of the proboscis.

Fig. 6. A view of a terminal hydra, its pedicel and the last joint of the stem, seen as if along the arrow 3 of fig. 5. a the calycle; b cavity of a; d the proboscis; e the horn-like sheath of the stem; g the base of the joint; h the next joint below g; i outer wall of the stem; k semi-partition.

Fig. 7. The base of a calycle. k l m n various parts of the semi-partition. 500 diameters.

Fig. 8. A stem viewed so that the hydræ (A–F) project toward, and directly from, the eye. 40 diameters.

Fig. 9. A hydrarium creeping over a sea-weed. Natural size.

Fig. 9^a. A view of one quarter of the medusa. a the eyes; β the base of the tentacles; γ the lateral swellings of the tentacles; f the circular canal; f^1 the genital organ; h^4 the base of the proboscis (p); t tentacles; v the veil. 200 diameters.

Fig. 10. The terminal half of an immature hydromedusa. β outer, and γ inner wall of the axis; A A^1 the medusæ; c the chymiferous channel; d the undeveloped end of the axis; k the calycle; k^1 the opercle; k^3 the edge of k^1; m mouth of A; t tentacles of A. 400 diameters.

Fig. 11. A mature hydromedusa. β outer, and γ inner wall of the axis; β' β''' processes from β; β'' outer, and γ' inner wall of the young medusa (G); A–G the medusæ; a the axis; d^1 the chymiferous channel; k the calycle; k^1 the aperture of the calycle; k^2 the depressed base of the neck; k^3 the edge of the depression (k^2); p the proboscis of the medusa; t the tentacles of the medusa. 400 diameters.

Fig. 12. A quarter of a medusa, at the time of birth. a the eyes; β base of the tentacles; γ lateral swellings of t; a outer, and b middle wall of the disk; a^1 outer, and b^1 inner wall of the tentacles; f circular tube; f^1 radiating tube; g^2 wall of f^1; h^4 mouth of the proboscis (p); t t^1 the tentacles; v the veil. 400 diameters.

Fig. 13. A young medusa-bud in profile; h the radiating tubes, or inner wall; h^1 the disk. 300 diameters.

Fig. 13^a. An end view of fig. 13. h as before.

Fig. 14, 14^a. Cells from the outer wall of p, fig. 12. 500 diameters.

Fig. 15. Cells from the lower surface of fig. 12. 500 diameters.

Fig. 16. Two medusæ (A B) from fig. 11. h h^1 as in fig. 13; h^2 outer, and h^3 inner wall of the pedicel. 400 diameters.

Fig. 17. A medusa from fig. 11, in profile; h h^1 h^2 h^3 as in fig. 16; h^4 chymiferous cavity. 300 diameters.

Fig. 18. A medusa just escaped from the calycle; seen from above. Letters as in fig. 12. 300 diameters.

Fig. 18^a. A tentacle of fig. 18, a in profile, to show the prominence of the eye (a).

Fig. 19. The natural size of fig. 18.

Fig. 20. A tentacle from fig. 18, seen from above. a outer wall of the disk; b^1 axial or inner wall of the tentacle; f circular tube; f^1 radiating tube; g g^1 innermost wall of the disk; l lasso-cells; β centripetal projection of the axial wall of the tentacle; γ lateral swelling of the base of the tentacle. 500 diams.

Fig. 21. An oculiferous tentacle, from fig. 18, seen from below. a b^1 g^1 f γ as in fig. 20; a the eye; a' the lenticular body of a; v the veil.

Fig. 21^a. The lateral swelling, γ, fig. 21, seen isolately.

PLATE XXXV.

PHYSALIA ARETHUSA *Til.*

[Drawn from nature by A. Agassiz and A. Sonrel.]

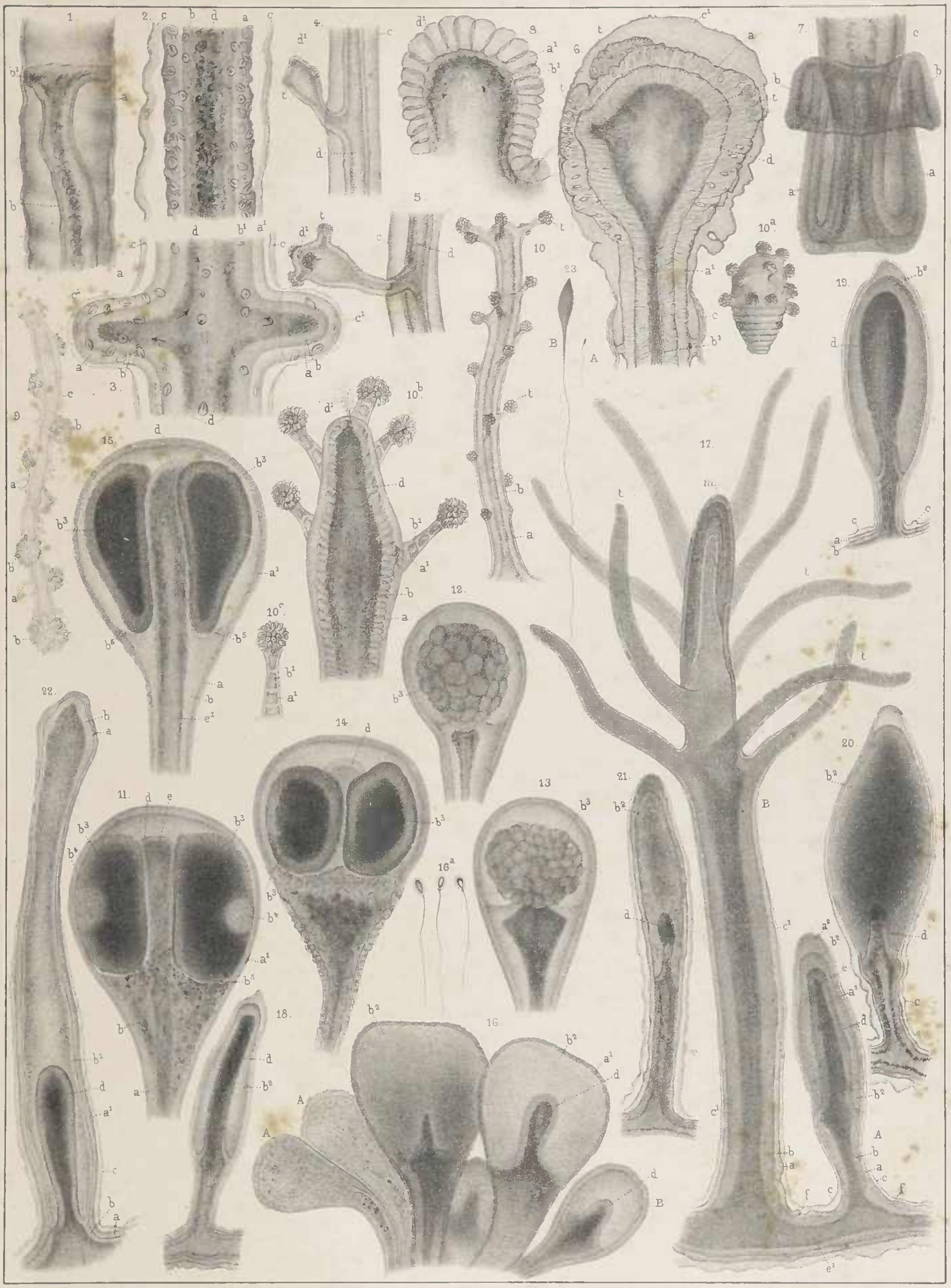
Fig. 1. Specimen floating quietly upon the surface of the water, with tentacles drooping loosely, seen from the windward side.

Fig. 2. The same specimen from the opposite side.

Fig. 3. Transverse section of the floating hydra, to show the relations of the secondary hydræ and clusters of hydræ and medusæ.

Obliged, on account of my eyes, to depend, in a great measure, upon others for the revision of my proofs, I request the reader to excuse the mistakes that may have been allowed to pass unnoticed in this volume.

CAMBRIDGE, May 1, 1862.



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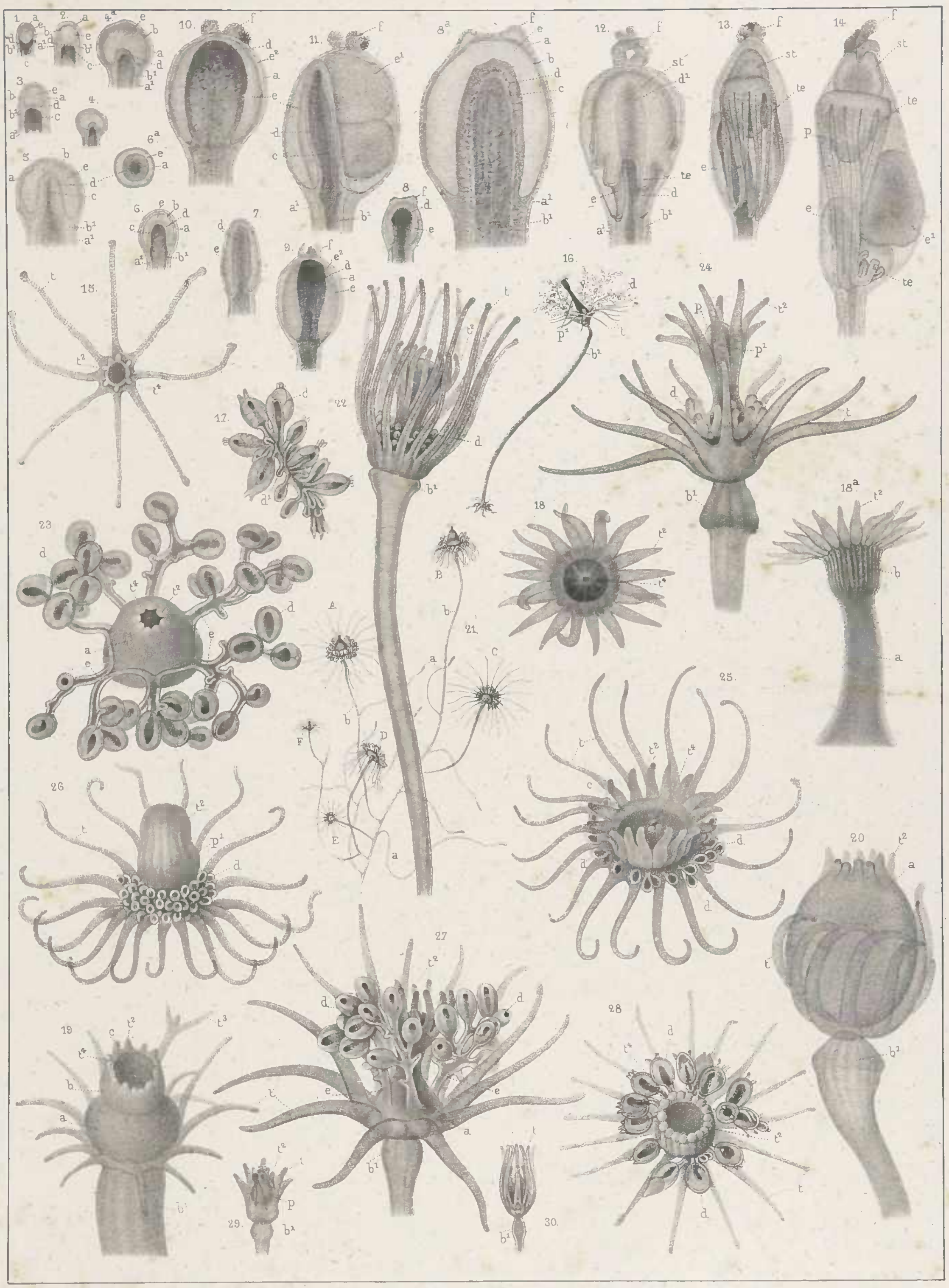

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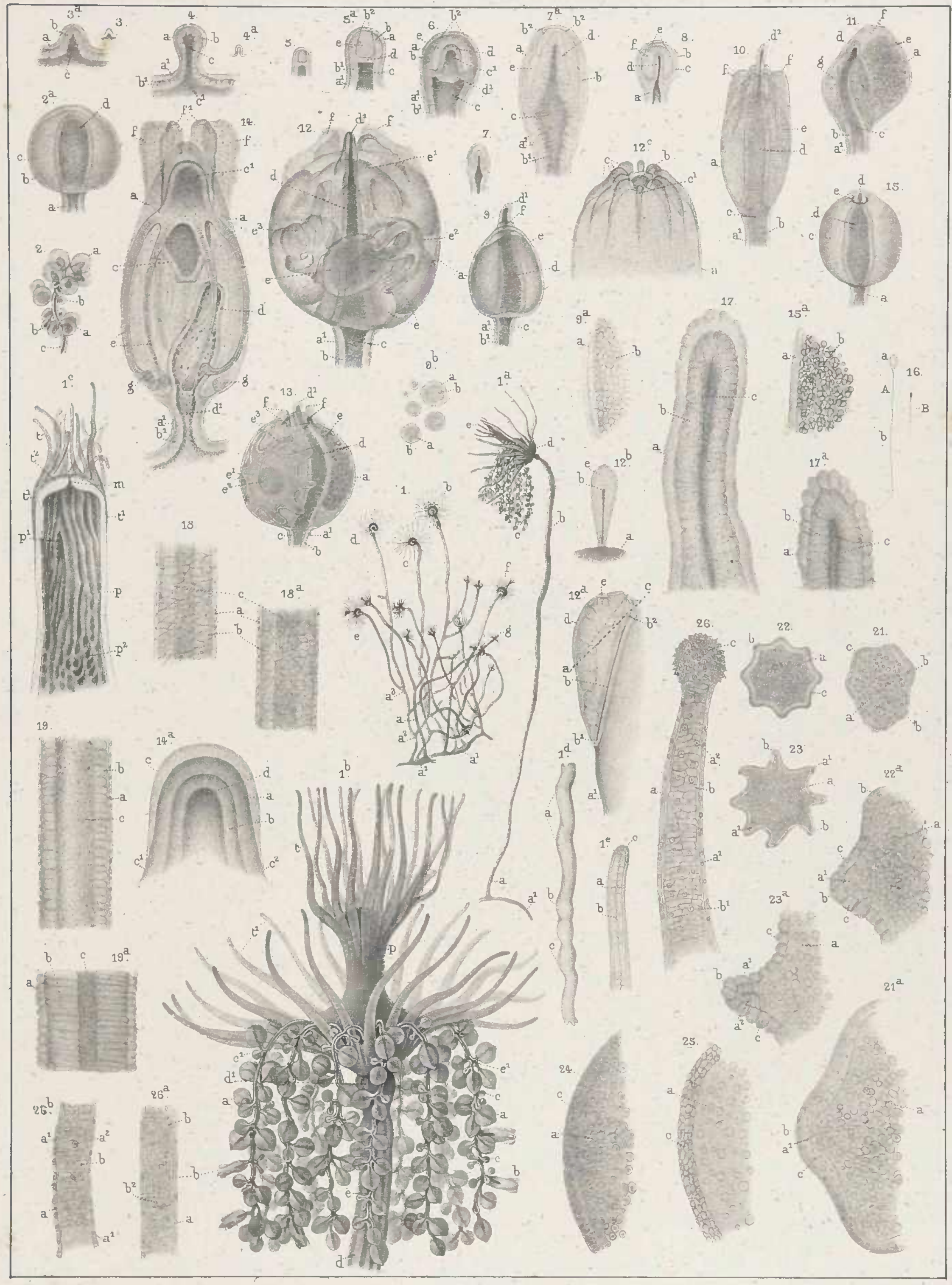

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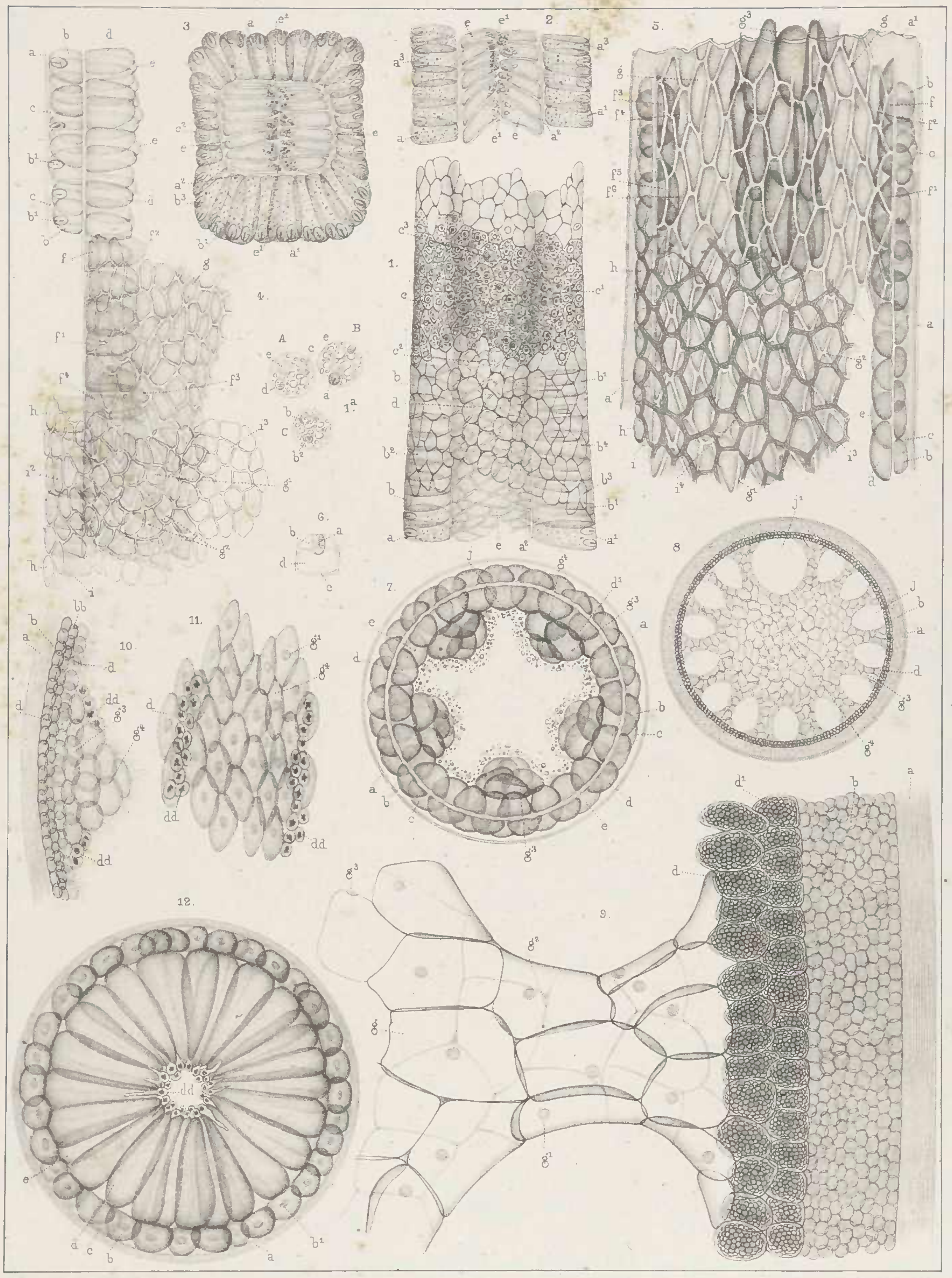
PARYPHA CROCEA Ag.



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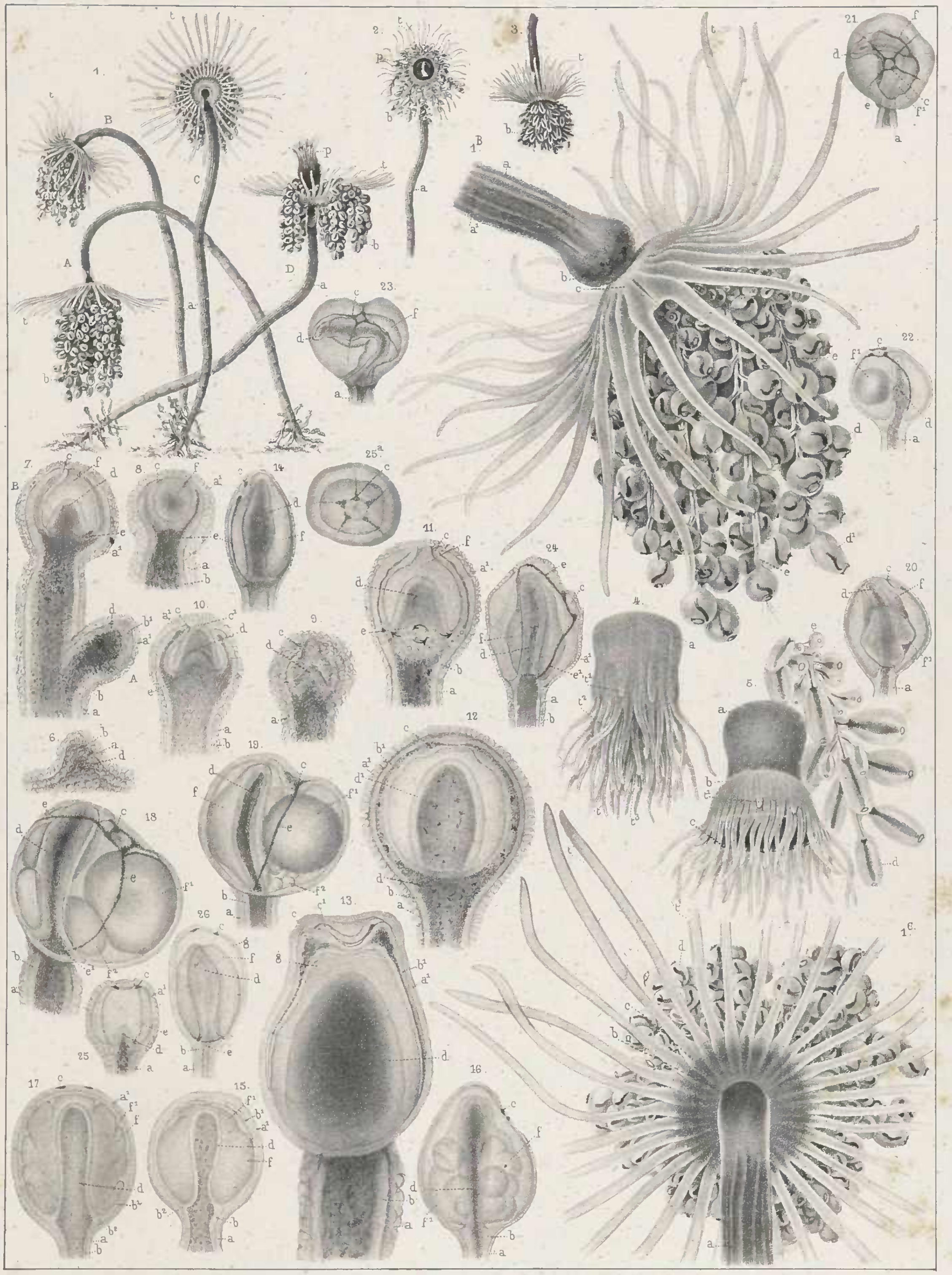
1 - 7 PARYPHA CROCEA Ag' — 8, 9. TUBULARIA COUTHOUYI. Ag' — 10, 11 HYBOCODON PROLIFER Ag'
12. CORYNE MIRABILIS Ag'

Pl. XXIV.



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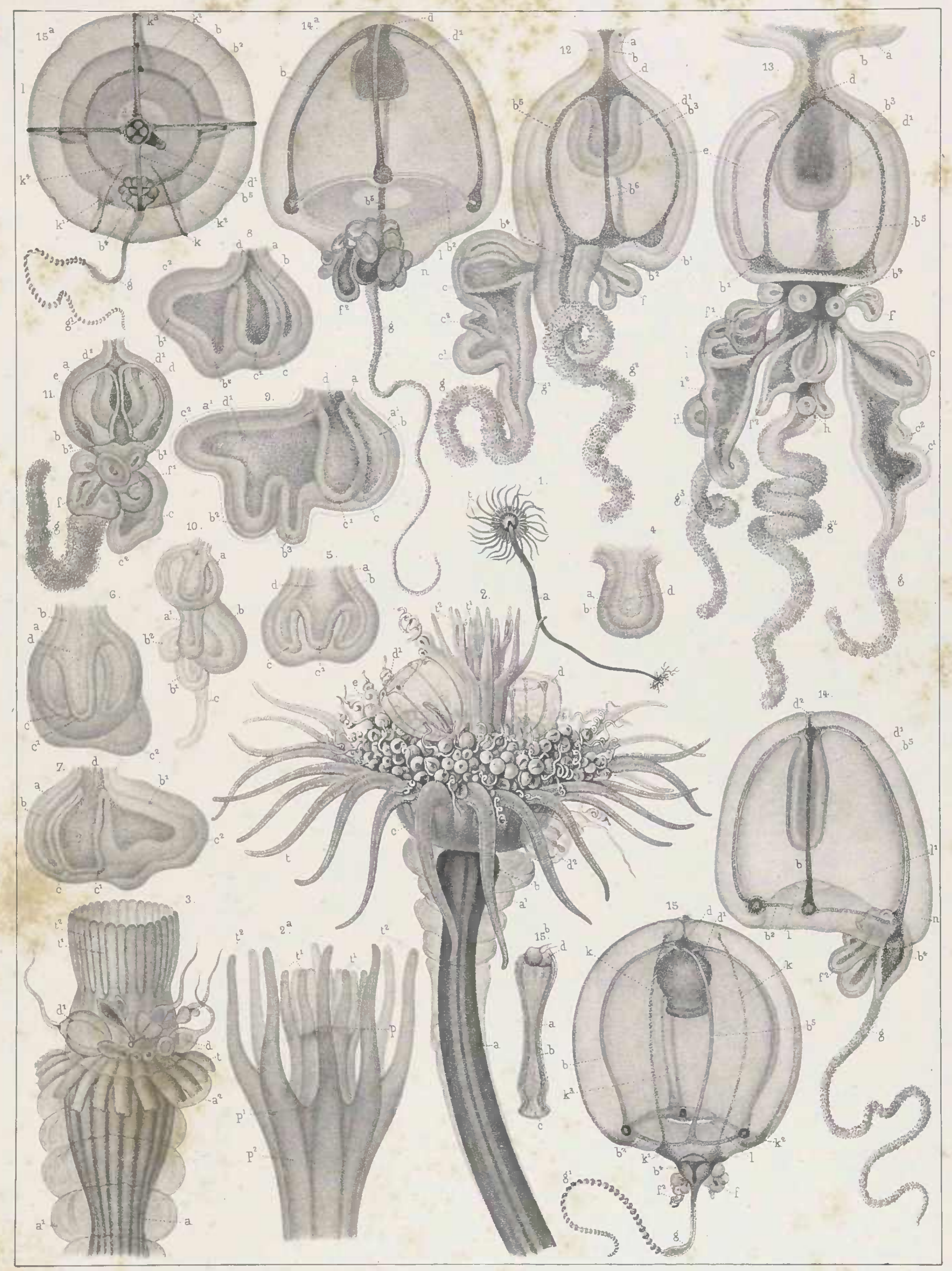

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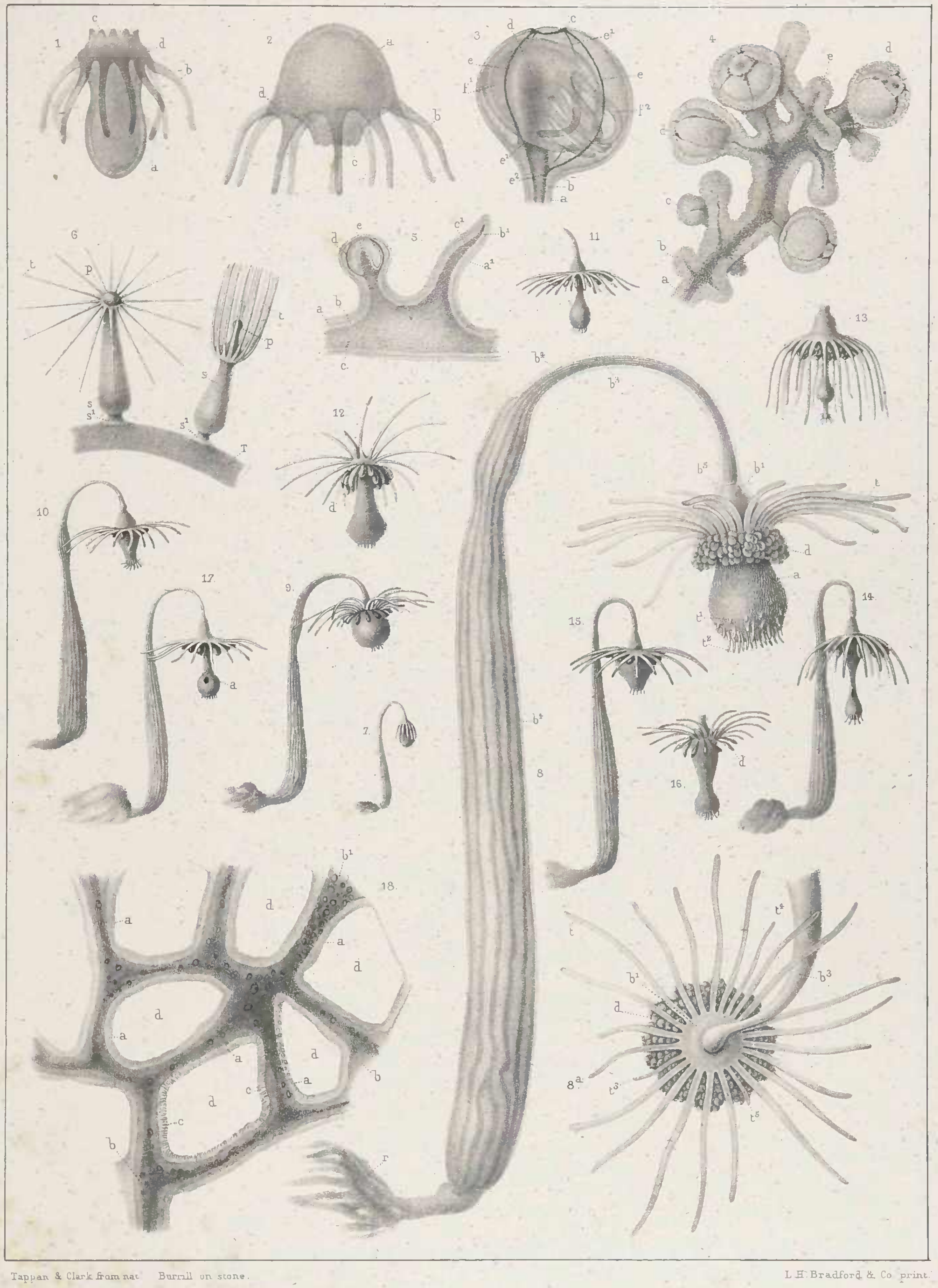

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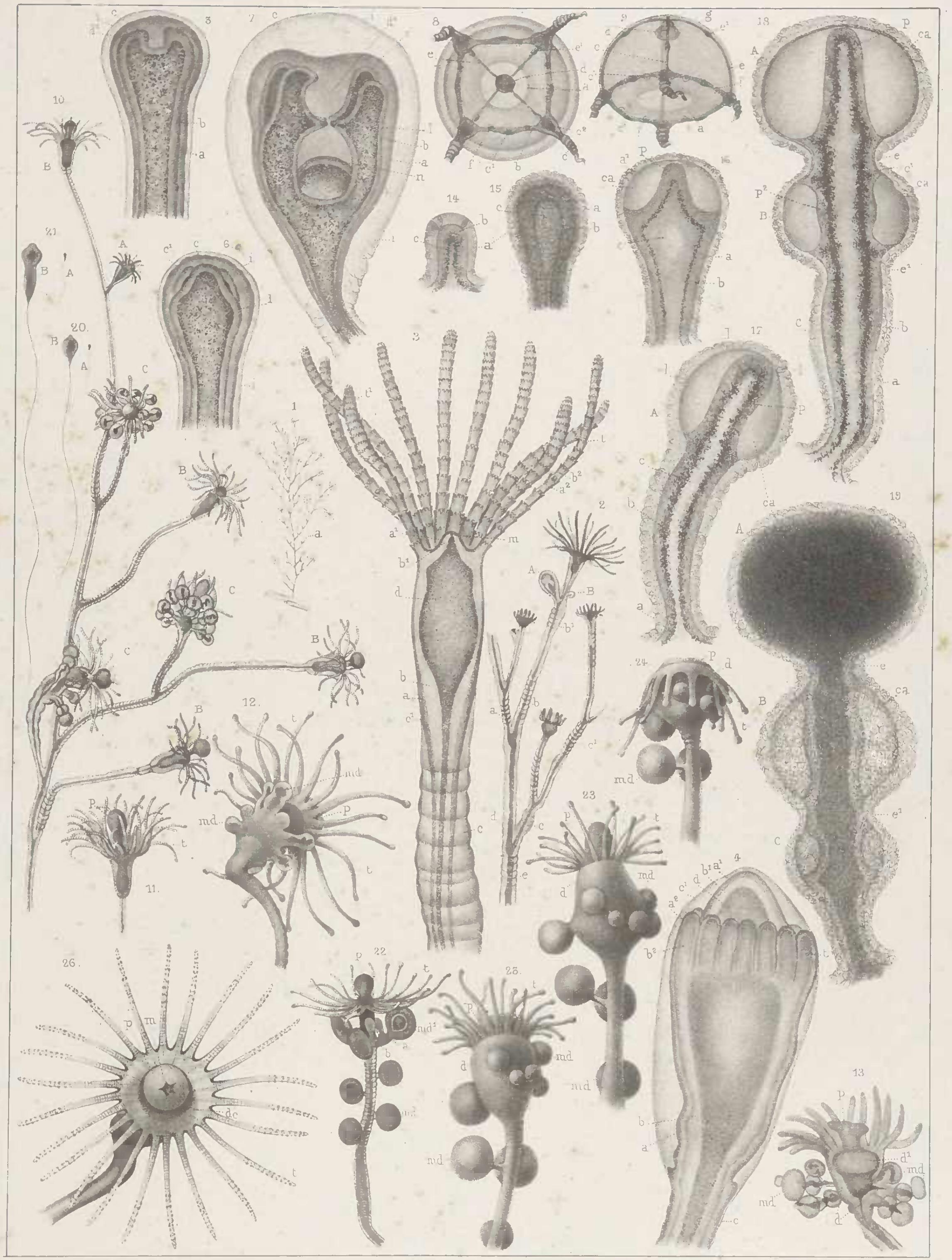

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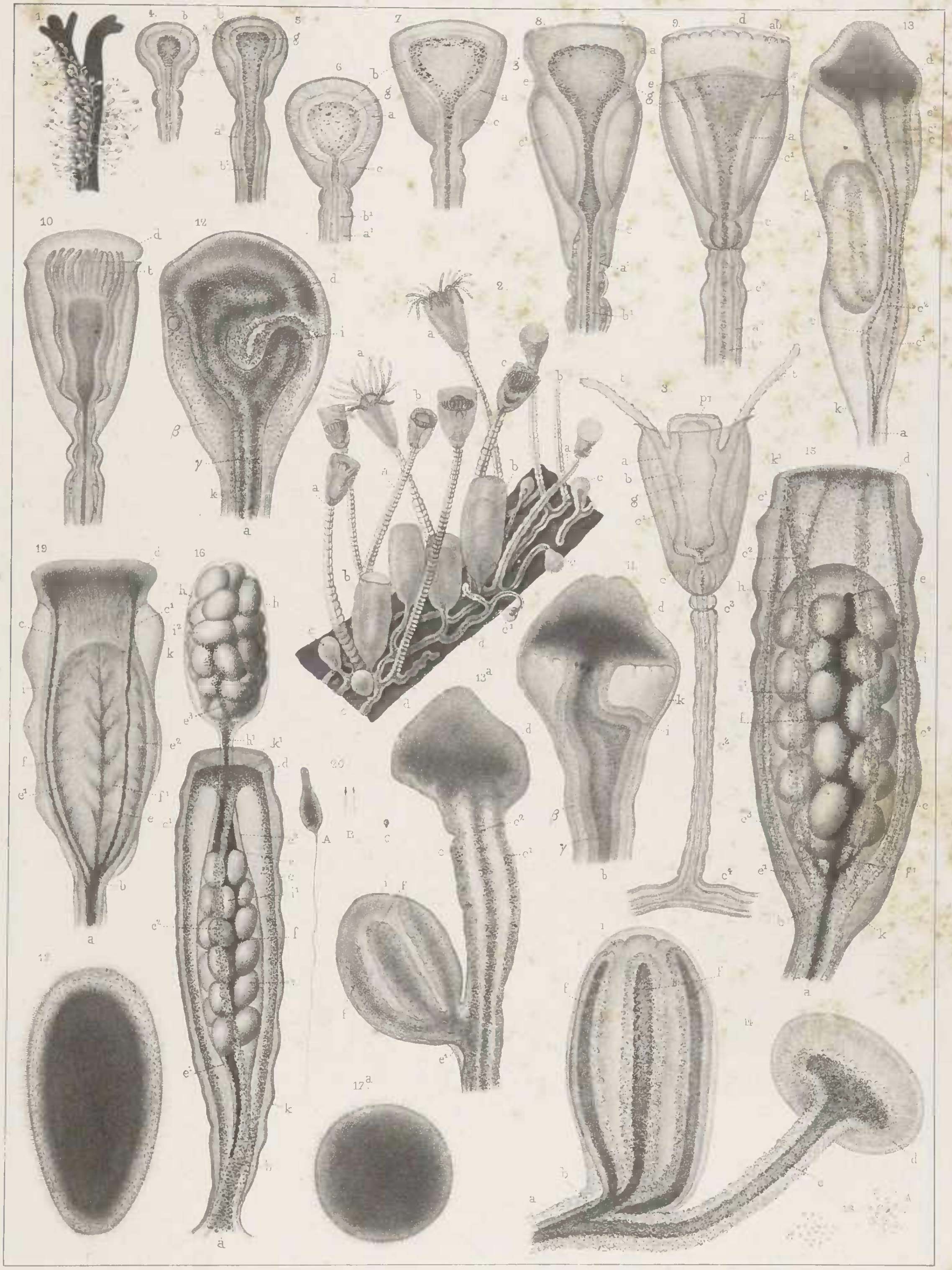

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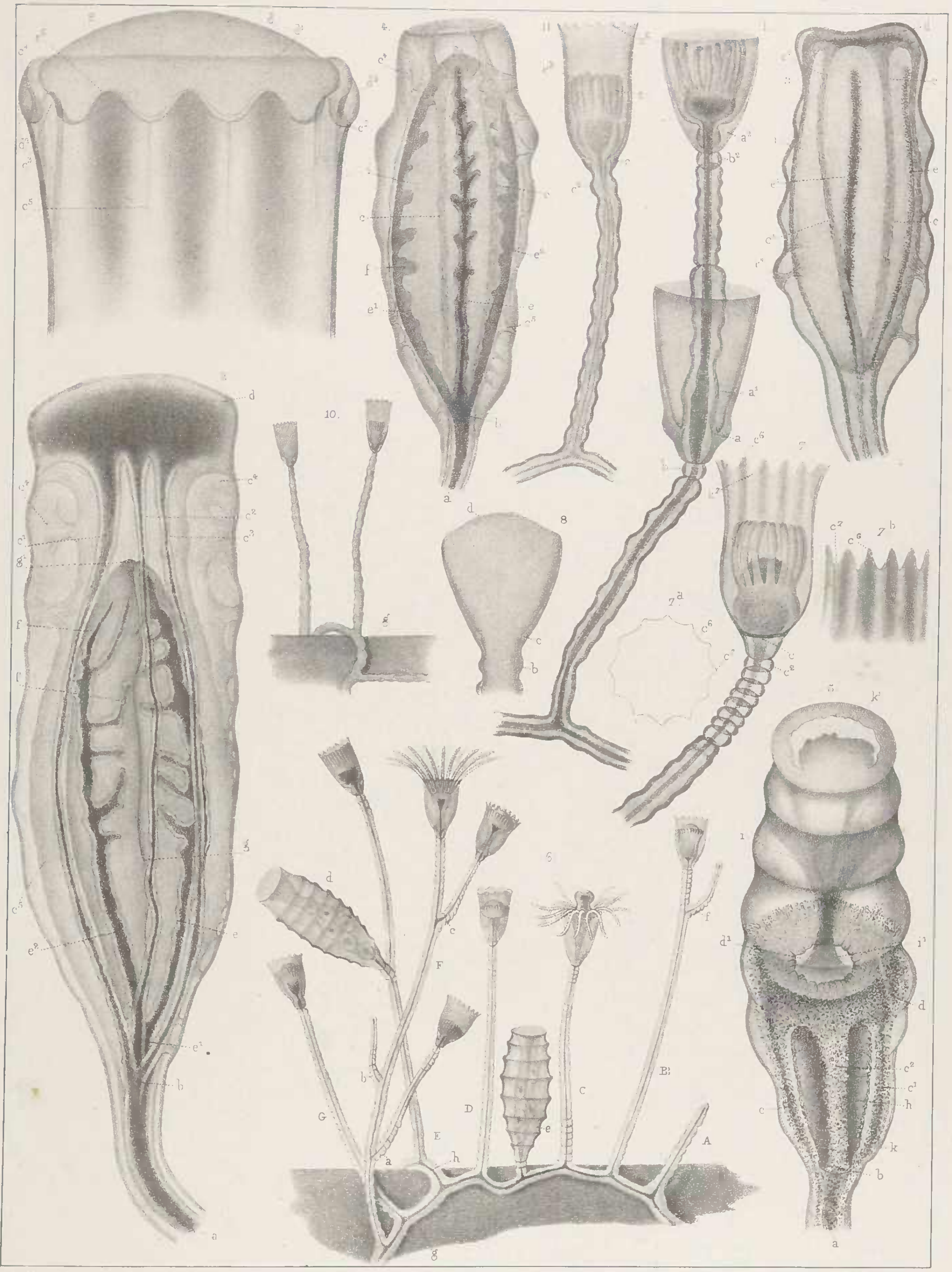

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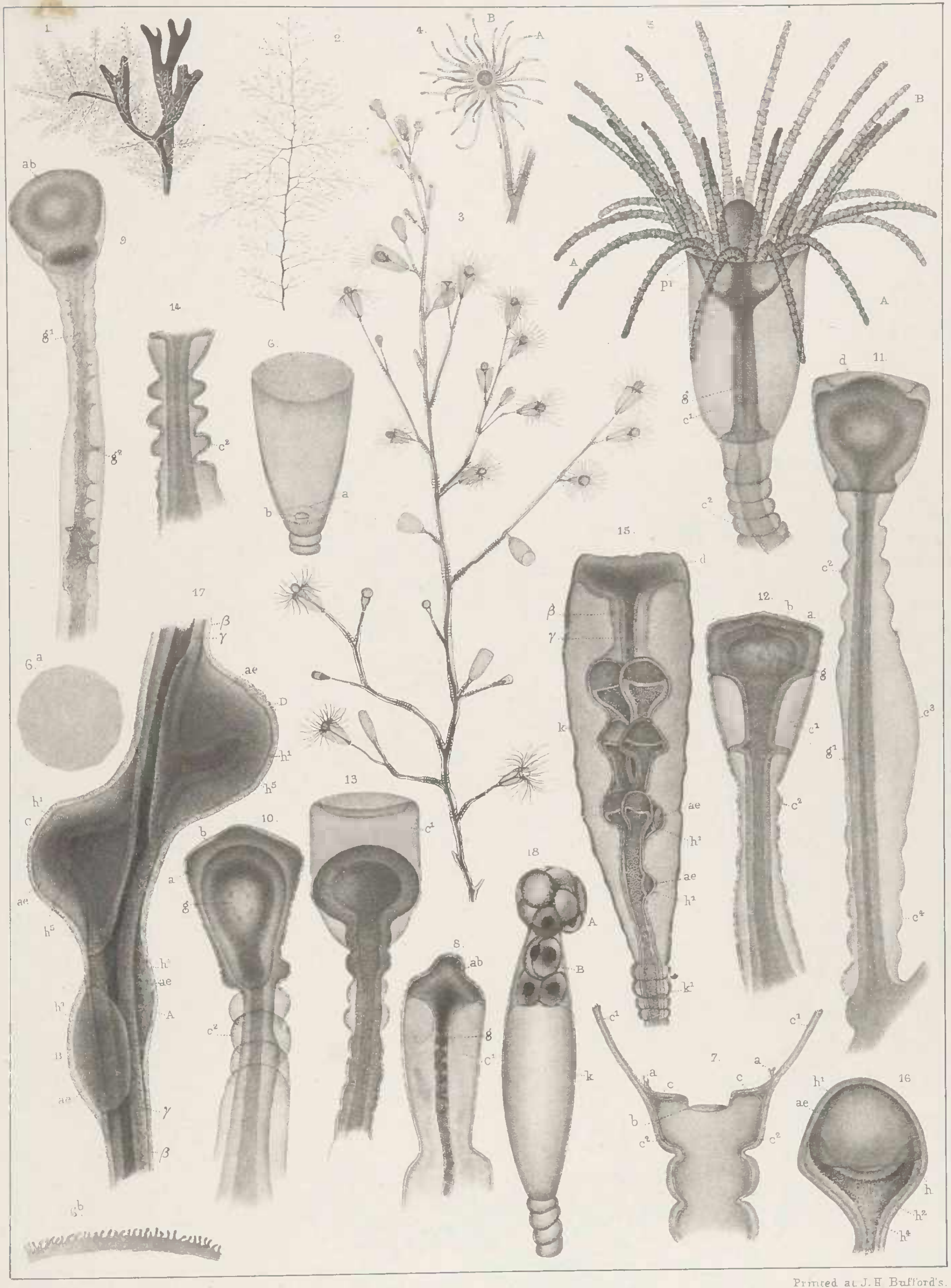

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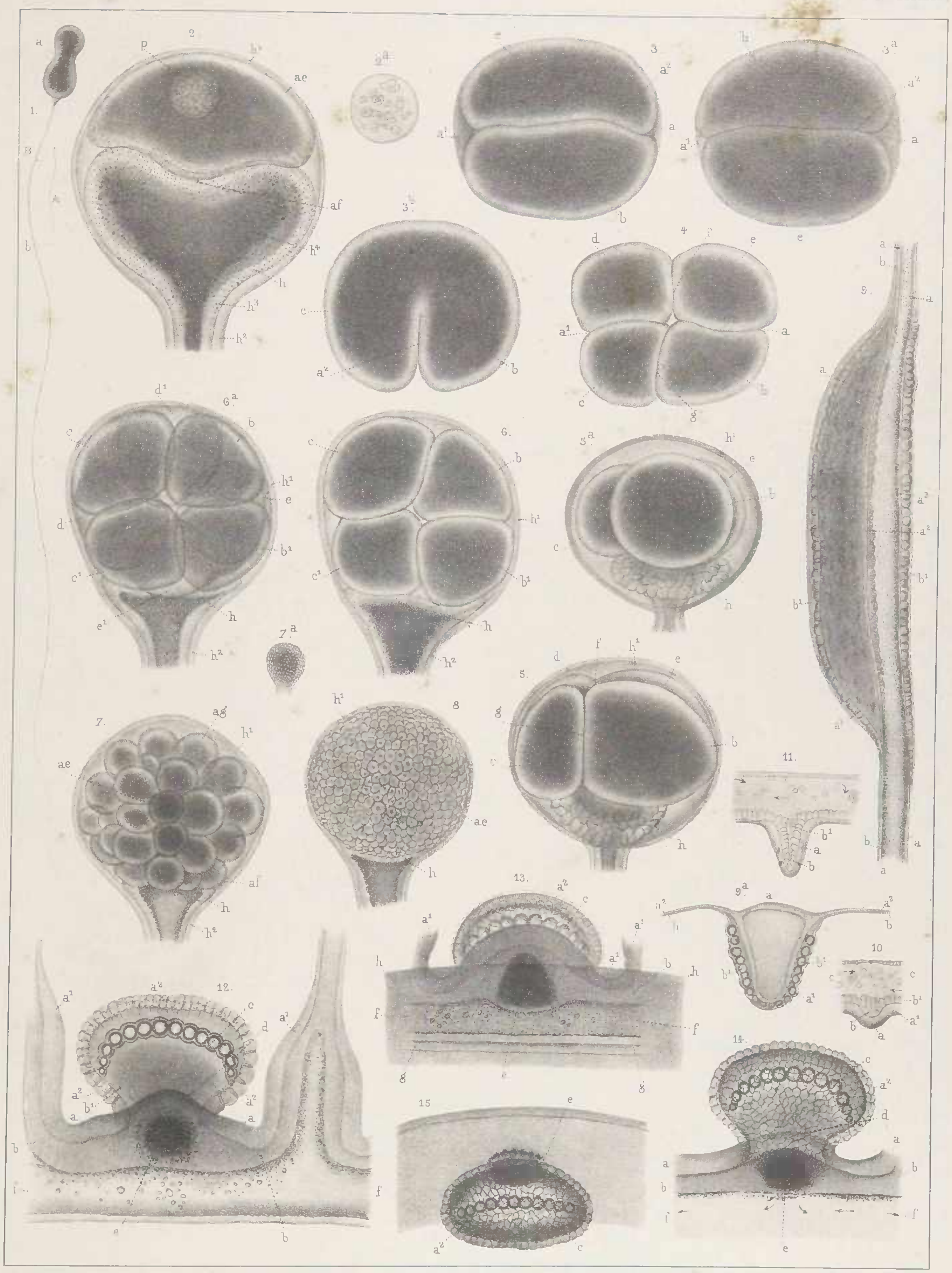
LAOMEDEA AMPHORA Ag.

Pl. XXXI



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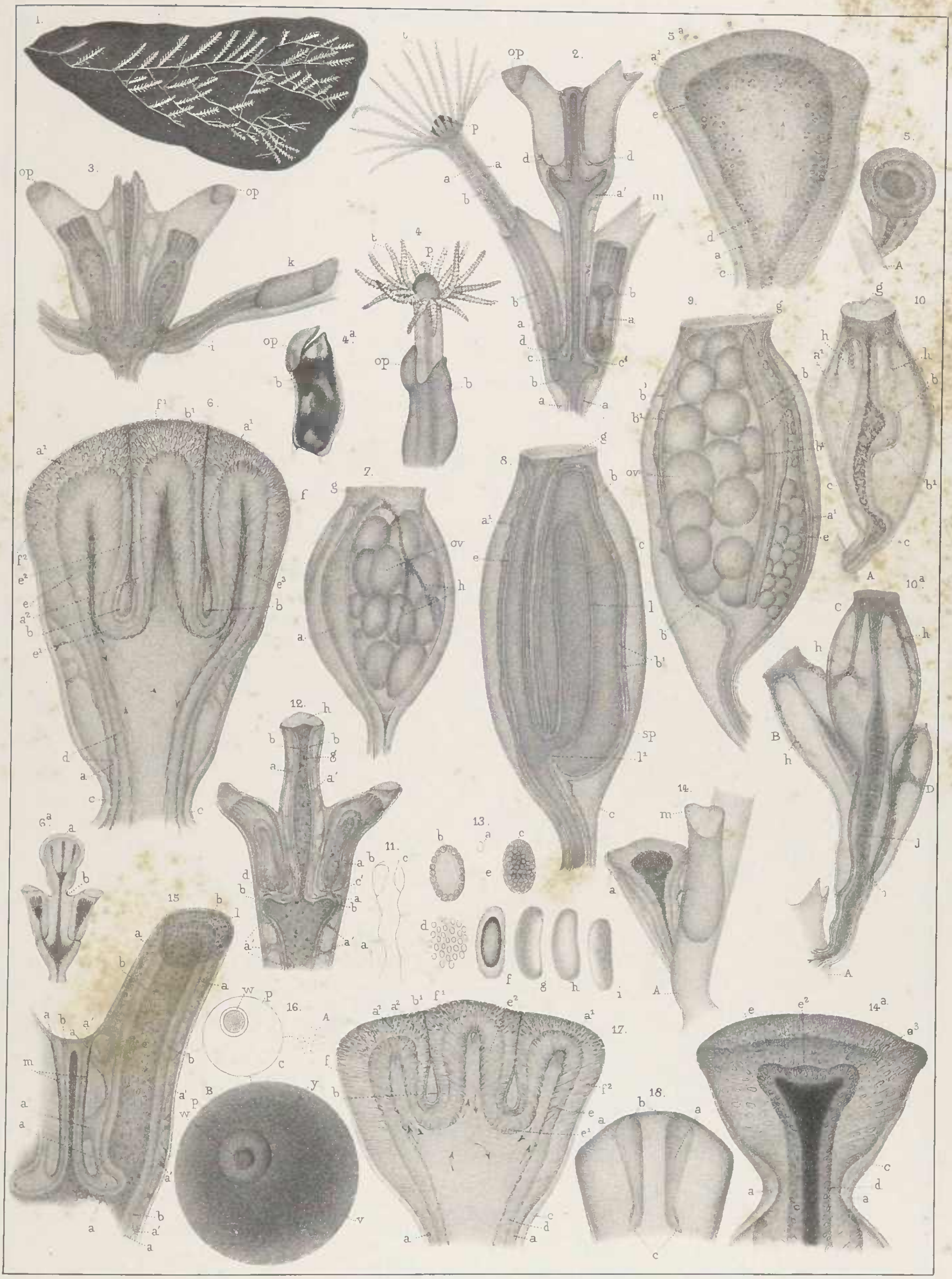

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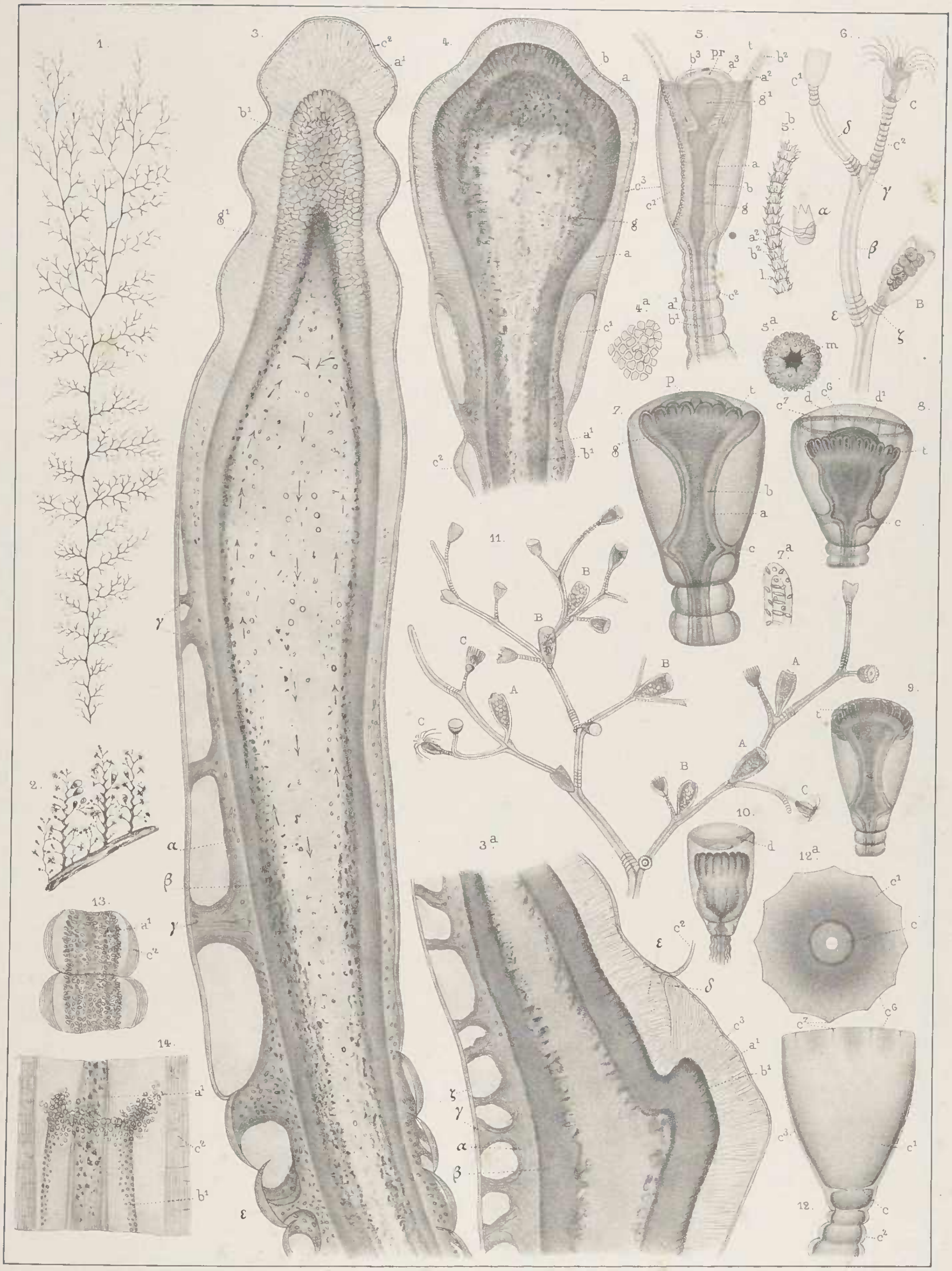

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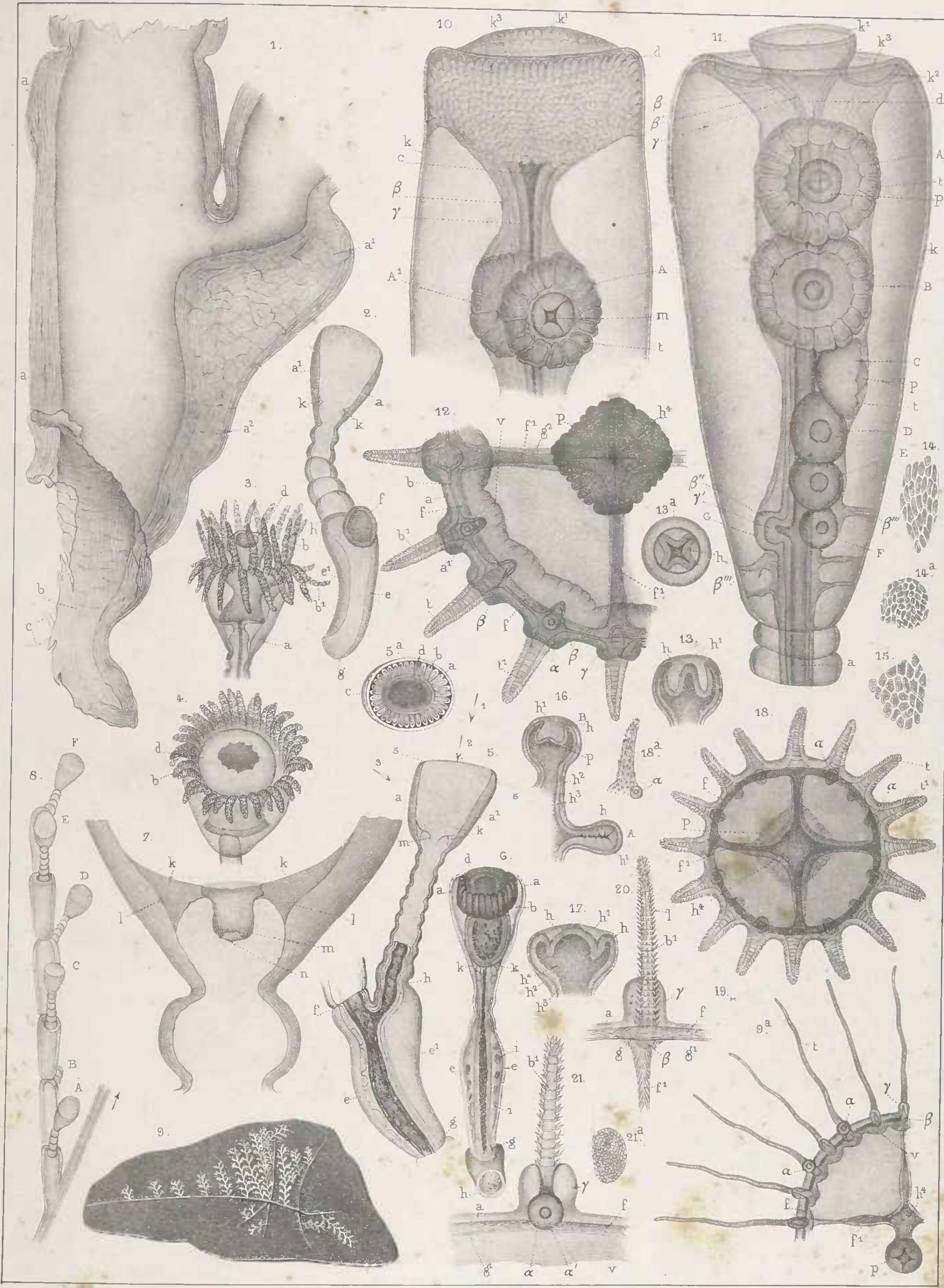
OBELIA COMMISSURALIS McCr.



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