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remote period as the commencement of the eleventh century; that we cannot bring it down to the middle of the seventeenth century (the only possible subsequent date on the above supposition) must be admitted.

That the peculiar period embraced in plates XX–XXIII may be located where any two cycles meet is certainly true, so far as the years are concerned, but judging by the symbols and extent of the period, certain signs which seem to indicate the 3d and 1st Ahau, and from the fact that the commencement of no other cycle, except that with which the grand cycle begins, coincides with the commencement of an Ahau, I am satisfied it marks the union of two of the greatest Maya periods.[1]

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THE SIPHONOPHORES.

III.—PHYSOPHORIDÆ (ANIMALS CLOSELY RELATED TO AGALMA).

BY J. WALTER FEWKES.

IN the two previous articles[2] in the NATURALIST, we have sketched in outline the anatomy and development of Agalma, which is regarded as the typical genus of a family of tubular jelly-fishes to which is given the name of Physophoridæ, in distinction from others yet to be mentioned, which are but distantly related to the type chosen. Before we go further a consideration of the different genera found in this family may be of interest to our readers.

All the genera now to be described agree in this particular, that they have a float, or air bladder, to support themselves in the water in which they live. Stem may fail, the attached nectocalyces, covering-scales and "tasters" be wanting, but the float always remains with the feeding-polyps, tentacles and sexual-bells represented in some form or other. To trace the different modifications in structure among the members of the group, and to show how now one part, and now another is modified, yet leading to no new plan of structure, is a most interesting and

[1] *Errata in the First Article.*—In second line from the bottom of page 631, after the words "17th day of the 2d" add "or 15th," so as to read "17th day of the 2d or 15th month." In third line from the top of page 636, for "governing" read "covering." In second line from the top of page 639, for "each period" read "each two periods."

[2] NATURALIST, September, 1880, March, 1881.

instructive study of these forms of life. Let us, therefore, consider in turn the more important genera allied to Agalma which constitute the so-called Physophoridæ.

One of the simplest members of the group is a genus in which we have present, as it were the mere skeleton of the Agalma, or simply the float and the stem. To this stem is added feeding polyps and sexual-bells, while all other appendages, as necto-calyces, covering-scales, "tasters" and the like, are wanting. It is, in fact, as if the Agalma had dropped all such as superfluous, and retained only those parts necessary for its life; polyps to eat for the community, a float to support the stem in the water, and sexual organs to reproduce new colonies. We are to consider a genus which is one of the simplest, and on that account can very properly be described in this place.

The name of the animal to which reference is made, is Rhizophysa, which is one of the rare Siphonophores of the Mediterranean and other seas. Its bizarre form and simplicity of structure gives to it an interest second to none of the Physophoridæ, and as is the case with a study of all aberrant forms, a few words about its general anatomy may do something to bring about a better understanding of the group of jelly-fishes, of which Agalma may rightly be regarded a representative. The body of Rhizophysa is a simple, flexible, transparent tube, at one end of which is a float (*a*), Fig. 11, filled with air to support it in the water. This tube, besides being extremely flexible, is highly muscular, and can be contracted into a shapeless snarl under the air bladder, or elongated into a straight, transparent, thread-like axis, as shown in the figure. Sensitive to the least touch of a foreign body, it is seldom quiet, contracting or expanding its length by muscular action of the stem walls. In no

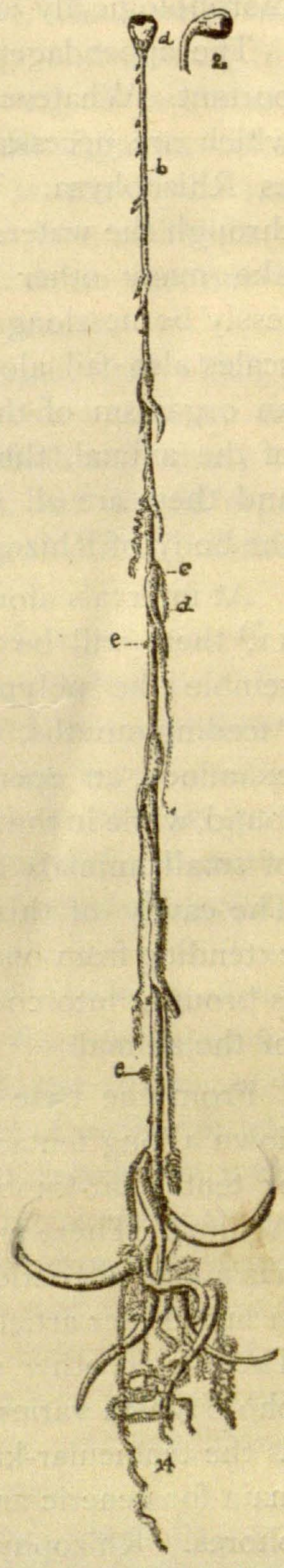

FIG. 11. — Rhizophysa.

respect does this axis differ from that of Agalma, with which it is morphologically identical.

The appendages to the axis are few in number, but very important. Whatever structures hang from its walls are those only which are necessary to the life of an animal so low in structure as Rhizophysa. There are no swimming-bells for propulsion through the water. It is a passive agent of wind and tide, and like many other pelagic animals, irrespective of itself is helplessly borne along hither and thither as they carry it. Covering-scales also fail along the stem, for they likewise are needless in an organism of this low kind. The organs necessary to the life of the animal, those of digestion and reproduction, cannot fail, and these are all which are to be found appended to the walls of the body of Rhizophysa.

At intervals along the stem, when expanded as shown in Fig. 11,[1] there will be noticed flask-shaped bodies, which closely resemble the polypites of the Agalma colony. These are the "feeding-mouths," and if the distal end of each of these bodies be examined, an opening through which the food is taken in will be found, while in the cavity of the polypite the half digested fragments of small animals betray at once the character of these bodies. The cavity of this polypite communicates with that of the body extending from one end to the other of the axis, through which it is brought into connection with the interior of every other organ of the animal.

From the base of each of these feeding-polyps, there hangs down a long tentacle, beset along its whole length with pendants or tentacular-knobs of a form very different from that of the Agalma. There are three kinds of these pendants, each of which has a characteristic shape which is very different from that figured in my former article, as of the tentacular-knob of *Agalma elegans.* There is no other structure in the organization of the Siphonophore which varies so much and assumes such a variety of form as the tentacular-knobs, and upon these differences we rely in the main for generic and specific characteristics among the Siphonophores. Rhizophysa has three kinds of these tentacular appendages, and in that respect differs from most other Siphonophores where only one form of pendant is found in the adult.

[1] Fig. 11 was taken from a paper by the author of this sketch in Proc. Bost. Soc. Nat. History, Vol. xx.

Midway between each pair of polypites on the axis of Rhizophysa, there will be noticed a small cluster (*e*), which when magnified will be found to have a botryoidal shape and to hang from the axis by a small slender pedicel. These organs are ovaries, and correspond with the sexual bells of the Agalma colony, although they never take on a bell shape as is true of the latter genus. How the egg is formed in these clusters, and what the character of the development of Rhizophysa is, no one has yet been able to make out with any degree of certainty.

In recapitulation, these then are the only structures which the skeleton-like Rhizophysa has : an axis *(b)*, with a terminal float *(a)*, polypites, or feeding-polyps, *(c)*, from which arise many tentacles *(d)*, closely set with tentacular knobs, and sexual organs *(e)* in the form of botryoidal clusters situated midway between each pair of feeding-polyps.

In Rhizophysa we have one of the simplest expressions of the group of animals of which Agalma has been taken as a type. There is but one simpler related animal, and that is a form in which the stem is wholly wanting, and nothing remains to indicate the affinities of the animal with the Physophoridæ except the float. We then have a well-known Siphonophore commonly figured as a representative of the group and called Physalia, or the Portuguese man-of-war.

In this curious animal there is no sign, whatsoever, of stem, swimming-bell or covering-scales, and the float is enormously developed into a bladder, which swims on the surface of the water, and acts in a way as a sail, to the spread of surface in which a raised crest also contributes. The colony of individuals is clustered on its under side, and in that position is borne along through the water. Physalia is, in some respects, the simplest possible form of Physophore and most distantly removed from the type, Agalma. Its close relation to Rhizophysa indicates that it is a true member of the group and not closely related to the floating hydroids Velella and Porpita, which I have already followed McCrady in separating from the Siphonophores.[1]

The genus Physophora or the "float-bearer," which has given the name of Physophoridæ to the group, is not perfectly normal, and differs in some respects from the type Agalma. Physophora has never been found in American waters, although quite com-

[1] Bull. Mus. Comp. Zool., Vol. VI, No. 7.

mon in the Mediterranean, and found likewise in the Atlantic near the Cape Verde islands. It is one of the most beautiful and graceful of all the group to which it belongs.

Physophora differs from Agalma and from all other Physophoridæ in this particular, that the polyp-stem to which is affixed polypites, covering-scales, tasters and sexual organs in Agalma, and which takes on the form of a long tube in this animal, becomes reduced in length in Physophora and inflated into a special bag, from the under side of which, in a definite spiral arrangement, structures similar to those of the polyp-stem in the Agalma, hang. It is precisely what would be expected if the portion of the axis of Agalma below the lowest nectocalyx were inflated into a sac, and the appended structures drawn into a spiral line over its under surface. The nectocalyces and the nectostem do not essentially differ in the type and in Physophora. The peculiar tentacular pendants of this animal I will not consider at length, since an account of them would draw me into a description too technical for these papers.

One genus of the Physophoridæ, closely related to the young of Agalma, remains yet to be mentioned. It will be remembered that we described the Agalma as passing through what was called an Athorybia stage. That form is permanently taken by the genus Athorybia, from which it was named. The resemblance of the two is, however, only a likeness in general shape, and is, in particulars, quite remote, for when we study the form of the covering-scales, the tentacular pendants and the fine anatomy of the float, we find very little resemblance between the two. The term "Athorybia stage" is a very convenient one to designate a well marked larval condition of the young even of other genera besides Agalma.

In the genus Athorybia there are no nectocalyces, and if any axis is developed, it is so small as to be practically wanting. In place of swimming-bells, the covering-scales are capable of quite extended motion, and arise directly under the base of the float, thus forming a crown or circlet which encloses that body. To the outline and arrangement of these structures, as well as the complete absence of nectocalyces, Athorybia owes its peculiar shape. It is probably an arrested embryonic condition resembling closely the young of Agalma, although differing from it in structural details.

There remains among the Physophoridæ, closely resembling in general outline the type Agalma, several genera which should be mentioned in this place. One of these is so well marked that it can be easily distinguished at a glance, and in one important particular is different from all the other Physophores. It will be remembered in my account of the arrangement of the swimming-bells of Agalma, published in the first article of this series, that I described these organs as arranged in two rows, the lines of the two series apparently opposite on the axis. As is true also of other genera, where nectocalyces occur, this appearance of being placed in two rows on different sides of the stem, is brought about by a twisting of the axis itself, and not by a formation of the bells on opposite sides. If the axis of Agalma has its fibers straightened, all the covering-scales, swimming-bells and the like, would be found one above the other in a line. Consequently the biserial arrangement of the swimming-bells is wholly distinct from their place of apparent origin on the axis, but dependent upon the twisting of the axis itself. In the genus Stephanomia,[1] instead of the section of the stem between the position of origin of two nectocalyces taking a turn through an angle of 180°, thus bringing the nectocalyces into two series; the stem between two adjoining swimming-bells is twisted at a smaller angle, even one less than a right angle, so that the openings of the bell cavity face on all sides. There still remains a serial arrangement of the bells, but in Stephanomia it is no longer biserial as in Agalma, but multiserial with the bells opening in all directions in a plane at right angles to the axis. The polyp-stem in this beautiful genus resembles that of an Agalma, but the feeding-polyps are mounted upon long peduncles, so that the tentacles seem to originate on the polypites midway between the stem and the mouth. Covering-scales of peculiar outline are also present, as well as "tasters," and male and female sexual-bells. In all of these structures, the genus is very characteristic, and if its whole organization be considered, is probably the highest member of the family. The arrangement of the swimming-bells, opening as they apparently do on all sides of the stem, make it possible for the whole colony to move rapidly through the water, and nothing can excel the grace with which these animals make their way through

[1] This genus was commonly called Foskalia by European naturalists; Stephanomia has a prior claim as its true name.

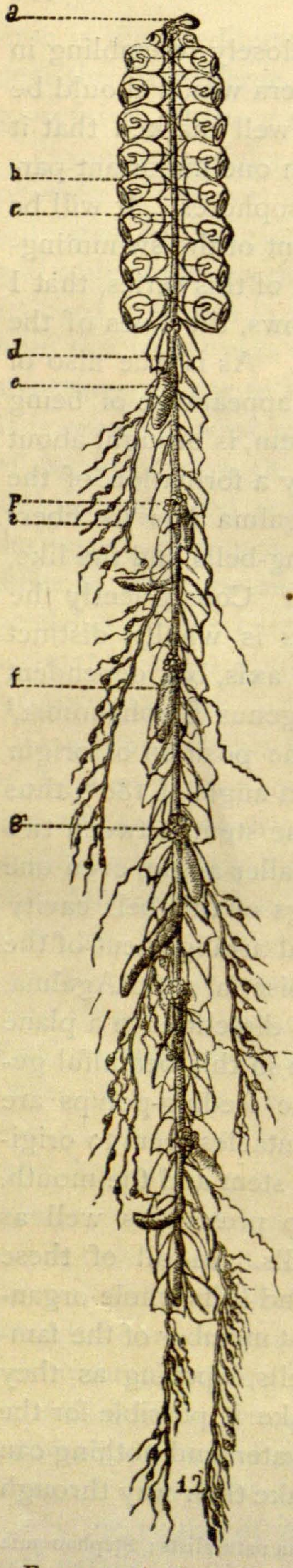

FIG. 12.—Agalmopsis.

their native element, when the combined movements of different series of bells impart a spiral motion to the whole colony. In truth, the grace of this animal is something marvelous, and when once seen is not soon to be forgotten.

There are two genera of Physophores closely resembling Agalma in external shape, but so well marked that they are commonly placed in different genera. They are known as Agalmopsis, and Halistemma. The likeness of the former of these animals to Agalma, as its name betrays, is very great (Fig. 12[1]). The most important difference between the two is in the structure of the tentacular-knobs, which in Agalmopsis (Fig. 13) have but a single terminal filament, while in Agalma, as has been already pointed out, there are two of these terminal filaments and an intermediate vesicle. In minor details also, as in the position of the sexual-bells upon the base of the "tasters," instead of midway between the feeding-polyps on the stem, Agalmopsis differs from Agalma, but as has been already said, the general outline of the two is much the same.

FIG. 13.—Pendant knob of Agalmopsis.

The genus called Halistemma, or "sea-tube," approaches very closely, in form, the type Agalma. The great difference between the two, as be-

[1] Figs. 12 and 13 are copied from my paper in the Bull. Mus. Comp. Zool., Vol. VI, No. 7.

Agalma, lies in the form and arrangement of the pendant tentacular-

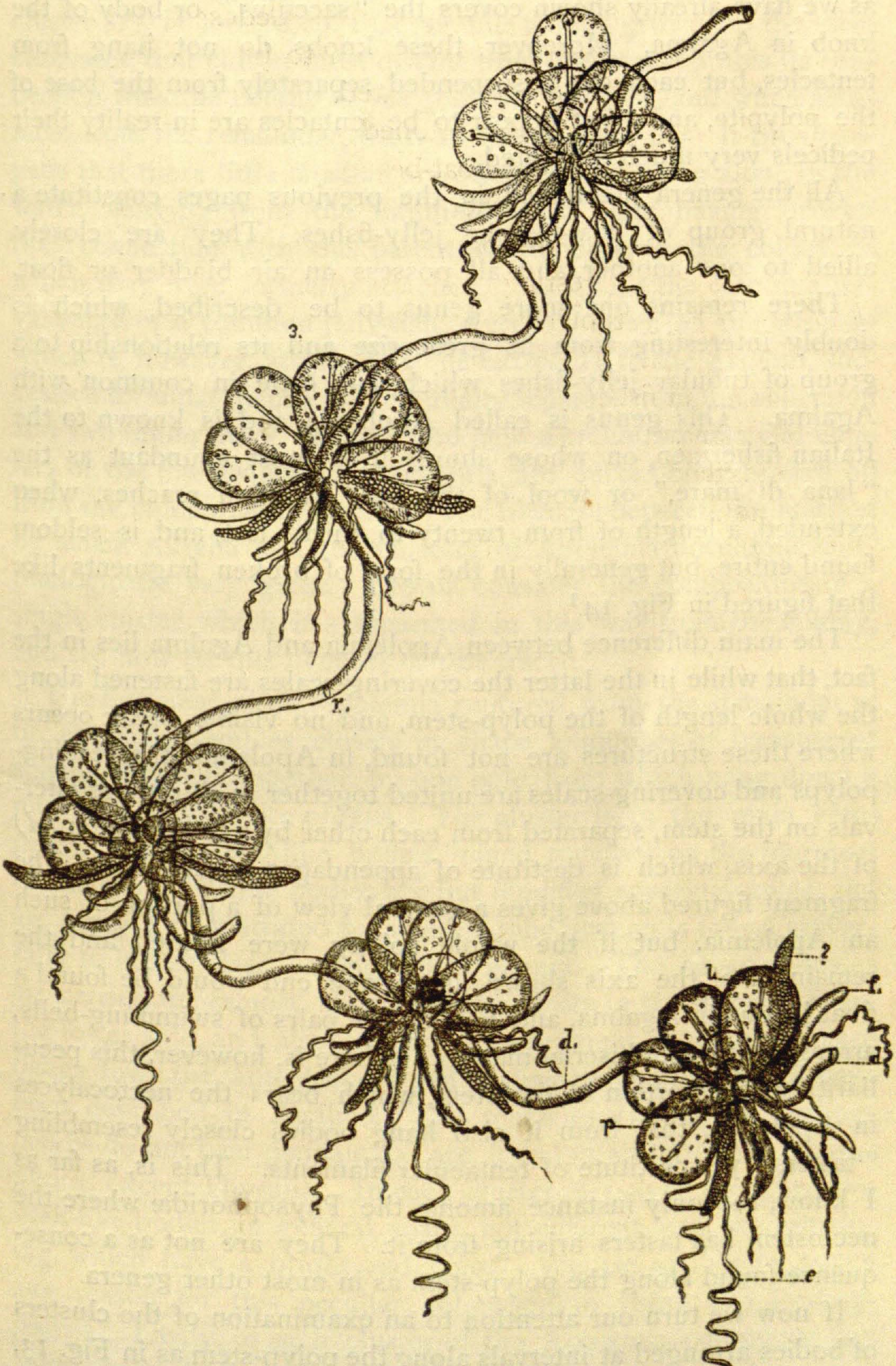

FIG. 14.—Apolemia.

knobs. In Halistemma as in Agalmopsis, there is but a single

terminal filament on each knob, but there is no involucrum such as we have already shown covers the "sacculus," or body of the knob in Agalma. Moreover, these knobs do not hang from tentacles, but each one is suspended separately from the base of the polypite, and what appear to be tentacles are in reality their pedicels very much elongated.

All the genera mentioned in the previous pages constitute a natural group of float-bearing jelly-fishes. They are closely allied to one another, and all possess an air bladder or float.

There remains one more genus to be described, which is doubly interesting from its great size and its relationship to a group of tubular jelly-fishes which has little in common with Agalma. This genus is called Apolemia, and is known to the Italian fishermen, on whose shores it is most abundant, as the "lana di mare," or wool of the sea. It often reaches, when extended, a length of from twenty to thirty feet, and is seldom found entire, but generally in the form of broken fragments like that figured in Fig. 14.[1]

The main difference between Apolemia and Agalma lies in the fact, that while in the latter the covering-scales are fastened along the whole length of the polyp-stem, and no visible break occurs where these structures are not found, in Apolemia the feeding-polyps and covering-scales are united together in clusters at intervals on the stem, separated from each other by a bare portion *(d)* of the axis, which is destitute of appendages of any kind. The fragment figured above gives a general view of a portion of such an Apolemia, but if the whole colony were figured and the remainder of the axis shown, upon one end would be found a float just as in Agalma, and four or five pairs of swimming-bells, arranged in a like biserial manner. There is, however, this peculiarity of the portion of the stem, which bears the nectocalyces in Apolemia, that from it also hang bodies closely resembling "tasters," yet destitute of tentacular filaments. This is, as far as I know, the only instance among the Physophoridæ where the nectostem has tasters arising from it. They are not as a consequence found along the polyp-stem as in most other genera.

If now we turn our attention to an examination of the clusters of bodies arranged at intervals along the polyp-stem as in Fig. 13, we find each cluster of peculiar shape, differing greatly from

[1] The figure (Fig. 14) was copied from the Bull. Mus. Comp. Zool., Vol. VI, No. 7.

what we have already studied. The stem, half way between each cluster *(r)*, is jointed so that as the animal grows, or the stem elongates, that cluster most distant from the float ruptures its connection with the colony at the joint in the axis, and when separated from the remainder, leads an independent life. It thus happens that these little clusters are often found floating alone in the water, hanging from the fragment of the stem, having broken their connection with the parent, or rather with the colony, to which they were formerly attached. As is also the case in a larval stage of a common jelly-fish, Aurelia, known as the strobila, which is, however, attached at one extremity to the ground, successive terminal members continually separate from the collection and swimming away, develop into new Aureliæ, so terminal clusters of the free-swimming Apolemia are successively broken off from the colony as it matures. The likeness between the method by which Aurelia and the clusters of Apolemia develop is morphologically very great. Let us consider the composition of a single cluster which has separated in this way from the colony, and see how far this likeness can be traced.

The fragment of an Apolemia ruptured from the remainder of the colony, resembles closely in shape a number of transparent spheres fastened together by one pole, from which hang down a number of polyp-like organs. The cluster is, in the main, composed of many jelly-like bodies joined together on the fragment of the stem. These bodies are but modified covering-scales, and are generally penetrated by a single tube, just as is found universally to be the case among other genera. The covering-scales are carried uppermost as the cluster floats in the water. From the lower side, and also attached to a segment of the axis, there hangs down the same flask-shaped feeding-polyps *(f)*, which have been described in Agalma. The tentacles *(c)* of the feeding-polyps do not bear pendants as are found in all the other Physophores except Physalia. In each cluster of polyps there are two flask-like bodies, in general shape not different from the remaining, which have a bright red color. We are unable to assign any reason for this peculiar coloration in these two feeding-polyps. Lastly, in each cluster of the Apolemia colony we find sexual-bells, male and female, which fill out the complement of organs necessary for the independent life of the cluster.

On account of this independence of life in each cluster, when

separated from the colony, it is evident that we have a condition of life in this instance very different from that usually met with among lower animals, especially among the jelly-fishes. Apolemia is, without question, a colony composed of many members, which in younger stages are attached together in the form of a Siphonophore, but as it grows older, each colony breaks up into many fragments, each of which lives wholly independent of its neighbor. The growth of a fragment after it has been separated from its connections, has never been traced, and it is not known how long or short that life may be, but in other genera belonging to a group of Siphonophores, quite unlike the Physophoridæ, the whole history of the growth of such a fragment has been followed. Apolemia is very interesting from its relationship to this form known as Diphyes, the type of a large family of Siphonophores called the Diphyidæ. The anatomy of this animal will be pointed out in a paper to follow the present, after which its curious relatives can be better understood, and the reasons why they are not placed in the group with Agalma better appreciated.

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THE LOESS IN CENTRAL IOWA.

BY R. ELLSWORTH CALL.

ON the 16th of May last, the writer discovered unmistakable loess under and around the city of Des Moines. Following are the details of the discovery, and such notes thereon as may be of general interest.

It might be well to remark that this formation has hitherto been known only in Western and Southwestern Iowa, as has been reported by the various surveys and explorations sustained by the General and State Governments; and in Southeastern Iowa, as reported on to the Muscatine Academy of Science, by Professor F. M. Witter, formerly of that city. He found the loess under certain portions of Muscatine, with its characteristic fossils, a list of which, if my memory serves me, he reported with his paper. A reference is made (White's Geology of Iowa, Vol. I, p. 114, foot note) to a deposit of the loess near the source of one of the branches of the Raccoon, east of the great water-shed of the State, but which of the three branches of the Raccoon is meant, or the locality of the deposit, is not indicated.