SMITHSONIAN INSTITUTION.
UNITED STATES NATIONAL MUSEUM.

SPECIAL BULLETIN.

AMERICAN HYDROIDS.

PART I.

THE PLUMULARIDÆ,

WITH THIRTY-FOUR PLATES.

BY

CHARLES CLEVELAND NUTTING,
PROFESSOR OF ZOOLOGY, UNIVERSITY OF IOWA.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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ADVERTISEMENT.

This work (Special Bulletin No. 4) is one of a series intended to illustrate the collections belonging to, or placed in charge of, the Smithsonian Institution and deposited in the United States National Museum.

The publications of the National Museum consist of two series, the Bulletin and the Proceedings.

The Bulletin comprises complete technical works of considerable size, zoological monographs, handbooks of the Museum collections, records of scientific expeditions, etc. Most of the volumes hitherto published have been octavos, but a quarto form has been adopted for works like the present one, which, on account of the character of the illustrations, require a large page.

The Proceedings are intended primarily as a medium of publication for shorter technical papers, many of them of a preliminary character, containing newly acquired facts relating to biology, anthropology, and geology, new schemes of classification, descriptions of new forms of animals and plants, discussions of nomenclature, and the diaries of minor expeditions.

The Proceedings are issued annually to libraries in volumes of about 1,000 pages. A small edition of each paper is distributed in pamphlet form to specialists in advance of the bound volume.

Papers of more general popular interest are published in the appendix to the Annual Report.

Papers intended for publication in the Proceedings and Bulletin are referred to an advisory committee composed as follows: Frederick W. True (chairman), James E. Benedict, Otis T. Mason, Leonhard Stejneger, Lester F. Ward, and Marcus Benjamin (editor).

S. P. LANGLEY,
Secretary of the Smithsonian Institution.

WASHINGTON, D. C., July 15, 1900.

INTRODUCTORY NOTE.

The surprising wealth of plumularian life in American waters was unknown to the earlier investigators of the marine fauna of the New World, a fact due to the lack of exploration in the West Indian region, which has since yielded an unprecedented harvest, the result of the scientific work of those in charge of the vessels of the U. S. Coast and Geodetic Survey and the U. S. Fish Commission.

When, in 1862, the elder Agassiz wrote the fourth volume of his Contributions to the Natural History of the United States, only three species of Plumularidæ were included. Three years later his son, Alexander Agassiz, recognized six species in the second number of the Illustrated Catalogue of the Museum of Comparative Zoology. Two of these species, however, *Aglaophenia franciscana* and *Plumularia arborea*, probably belong to the genus *Hydrallmania*, and would therefore not be included in the Plumularidæ.

A very important contribution to our knowledge of this group was made by Professor Allman in 1877, when he published the results of his investigation of the material secured by Count Pourtalès in the Gulf Stream.[1] In that beautifully illustrated work no less than twenty-six species of plumularians are mentioned, twenty-four being new to science and hence carefully described and figured.

In 1879 Prof. A. E. Verrill published his Preliminary Check-List of the Marine Invertebrata of the Atlantic Coast from Cape Cod to the Gulf of St. Lawrence, in which seven species of Plumularidæ are noted. The material secured by the U. S. Coast and Geodetic Survey steamer *Blake* in 1877–78 was reported on by Dr. S. F. Clark,[2] who found three new species. The same vessel continued the work of dredging in the Southern waters during the remainder of 1878, 1879, and the summer of 1880, with the result that Dr. J. Walter Fewkes described twelve new species of Plumularidæ from the material secured.[3]

From 1871 to the present time an enormous amount of dredging has been done by the various vessels employed in the work of the U. S. Fish Commission and U. S. Coast and Geodetic Survey. As a result an unprecedented quantity of material has accumulated in the U. S. National Museum and the museum of Yale University, which has been a sort of repository for the U. S. Fish Commission collections, under charge of Prof. A. E. Verrill, who has done an almost incredible amount of labor in working up various groups. He has only incidentally given attention to the hydroids, however, and has described but few new species of Plumularidæ.

At the time of the inception of the present work it is doubtful if more than fifty species of Plumularidæ were known to occur in American waters. An examination of the wealth of material above referred to resulted in the discovery of the numerous new species described in the following pages. A careful scrutiny of the literature of the Hydroida also revealed a considerable number of species that should be added to our fauna.

It is now evident that the West Indian region is the richest in plumularian life of any area of equal size in the world. Not even the Australian region, hitherto regarded as by far the most prolific in these exceedingly graceful organisms, can equal our own Southern waters in profusion of genera and species.

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[1] Memoirs of the Museum of Comparative Zoology, V, No. 2, 1877.

[2] Report on the Hydroida collected during the exploration of the Gulf Stream and Gulf of Mexico by Alexander Agassiz, 1877–78. Bulletin, Museum of Comparative Zoology, V, No. 10, 1879.

[3] Report on the results of dredging, under the supervision of Alexander Agassiz, in the Caribbean Sea, in 1878–79, and along the Atlantic coast of the United States, during the summer of 1880, by the U. S. Coast Survey steamer *Blake*, Commander J. R. Bartlett, U. S. N., commanding. Bulletin, Museum Comparative Zoology, VIII, No. 7, 1881.

The material in the U. S. National Museum relating to the Hydroida had never been worked over when the present writer consented, at the request of the late Doctor Goode, Assistant Secretary of the Smithsonian Institution, to prepare a monographic account of the whole group. The author was persuaded that the time had come for a gathering together of our knowledge regarding the Hydroida, a review of the work done by other authors, a working over of the vast accumulations resulting from the various Government expeditions and the "Bahama expedition" from the University of Iowa, and a presentation of the whole subject in monographic form.

It was deemed best to publish the work in several sections for convenience in handling and a more prompt appearance of the results of study in certain groups, and the Plumularidæ was selected as the first group for discussion, because the amount of new material was probably greater than in other families, and for the further reason that it would take a greater amount of time to prepare any acceptable account of groups involving the investigation of the hydroid medusæ, perhaps the most intricate and perplexing class of forms embraced in the order Hydroida. It was hoped, moreover, that Dr. Alexander Agassiz would, in the mean time, complete his promised work on the Acalephæ, including the accession of knowledge which has been accumulating since the appearance of his "North American Acalephæ" in 1865. In this case it would be unnecessary to investigate the hydroid medusæ to any considerable extent in connection with this monograph.

Whatever of merit appears in the following pages is very largely due to the naturalists who have almost without exception responded to my great need for their generous aid. To mention all who have given assistance would involve the naming of nearly every living naturalist who has made a special study of the Hydroida. I can not, however, omit acknowledgment of the help rendered by the following: My thanks are especially due to Dr. Alexander Agassiz, who obtained for me the privilege of occupying the Harvard table at Naples; to Prof. A. E. Verrill, for much valuable material from the Yale Museum, and even more valuable advice; to Hon. J. J. Brice, former U. S. Commissioner of Fish and Fisheries, for placing at my disposal the facilities of the laboratory at Woods Hole, Massachusetts; to the late Sir William H. Flower, for permission to examine the *Challenger* Plumularidæ in the British Museum (Natural History); to the Rev. Canon A. M. Norman, for specimens and advice; to the veteran naturalist, the late Prof. G. J. Allman, for helpful suggestions; to the officers of the Marine Biological Association of the United Kingdom, and especially E. I. Allen, esq., for laboratory facilities at Plymouth; to Prof. Anton Dohrn, Prof. Paul Meyer, Prof. Hugo Eisig, and Dr. Salvatore Lo Bianco, of the Zoological Station in Naples; to Prof. William M. Bale, for specimens of Australian Plumularidæ and much excellent advice; to Prof. W. Baldwin Spencer, for literature and specimens; to Dr. Gottlieb Marktanner-Turneretscher, for his papers on the Hydroida; to Prof. Robert von Lendenfeld, for literature and correspondence, and to Dr. Walter Faxon, for facilities in examining the types in the Museum of Comparative Zoology.

AMERICAN HYDROIDS.

SECTION I.—THE PLUMULARIDÆ.

MORPHOLOGY OF THE PLUMULARIDÆ.

Only the more distinctive features of the Plumularidæ will be discussed here, the intention of the author being to reserve the presentation of the morphology of the Hydroida as a whole for the general introduction to this work, which will accompany the last section.

In pursuance of this plan the several structures more or less characteristic of the family Plumularidæ have been studied with special care. The most important of these are the nematophores, sarcostyles, and the assemblage of structures known as gonangia, phylactocarps, and corbulæ. The morphology, use, and homologies of these organs will be discussed at considerable length. The Plumularidæ have been regarded as of special interest by nearly all writers on the Hydroida, and their characteristic features have been carefully studied and described by a number of our ablest naturalists, of whom Hincks, Allman, and Bale should be particularly mentioned as most prominent among British writers. Continental naturalists also have contributed largely to our knowledge, especially Kirchenpauer, von Lendenfeld, Hamann, Jickeli, Merejkowsky, and Weismann. The works of these and other authors will be discussed and proper references given in the following pages.

My own investigations were carried on mainly in the Marine Biological Laboratory, Plymouth, England; the Naples Zoological Station, Naples, Italy; the Laboratory of the U. S. Fish Commission, Woods Hole, Massachusetts, and at Dr. Alexander Agassiz's private laboratory, Newport, Rhode Island. At all of these places material and equipment were abundant, and the facilities for studying living hydroids all that could be desired.

TROPHOSOME.

Among the Plumularidæ there is a greater number of simple nonbranching forms than in the other families of the Hydroida. The name Plumularidæ itself suggests the most common outline of the colony, which ordinarily consists of the single upright stem with laterally disposed ultimate branchlets, or "pinnæ," or "hydrocladia," as they are more commonly designated, the whole resembling in general form a plume or feather, which it fully equals in grace and symmetry. The main stem may arise from a tangled mass of filamentous rootlets, or from a creeping rootstock, which grows over algæ, stones, shells, or any other convenient base for support. A number of these delicate fronds may grow together, forming a plumose tuft resembling a miniature clump of ferns. Many species have a more or less pronounced branching habit, assuming various modes of ramification, dendritic, alternate, or opposite, the most common subdivision being in the form of pinnately disposed branches, giving the whole colony a flabellate outline. Those forms having simple nonfascicled stems are not apt to branch profusely, the greater portion of the decidedly branching species being characterized by the fascicled stem presently to be described. The most thoroughly dendritic species known to me is *Plumularia dendritica* from the Bahamas, which divides again and again into scores of branchlets and terminal twigs. Many species give forth

only one or two main branches springing from the proximal part of the main stem, a very common arrangement in the genera *Aglaophenia* and *Cladocarpus*. Others often give off a branch or two quite high up on the main stem, as is the case in *Aglaophenia rigida*. Some are very straggling in habit, resembling vines more than trees; for example, the northern variety of *Monostæchas dichotoma*. Of flabellate forms there are many, especially in the statoplean section of the family, as in the genera *Lytocarpus* and *Aglaophenopsis*.

In size some plumularians may well be regarded as giants among the hydroids, a height of 2 feet being attained by full-grown colonies of a number of species such as *Plumularia dendritica*, *Thecocarpus benedicti*, *Cladocarpus grandis*, and *Cladocarpus paradisea*, while a specimen of *Thecocarpus* in my possession from the bay of Naples attains a height of over 3 feet. Semper speaks of a plumularian which is "man high." This is probably the largest reported hydroid, with the exception of *Monocaulus imperator* Allman, a titanic nonbranched gymnoblastic form secured by the *Challenger*, which attains a height of nearly 8 feet.

But the Plumularidæ, although averaging larger than any other group of hydroids, are not all giants by any means, several species normally attaining a height of only about one-fourth of an inch; for example, *Plumularia filicaulis*, *Monotheca margaretta*, *Gattya humilis*, and *Aglaophenia perpusilla*. Whatever their size, however, these forms are always exquisitely graceful and beautiful, delighting not only the naturalist, but even the most unscientific observer who looks upon the plumularian as a very pretty form of "seaweed."

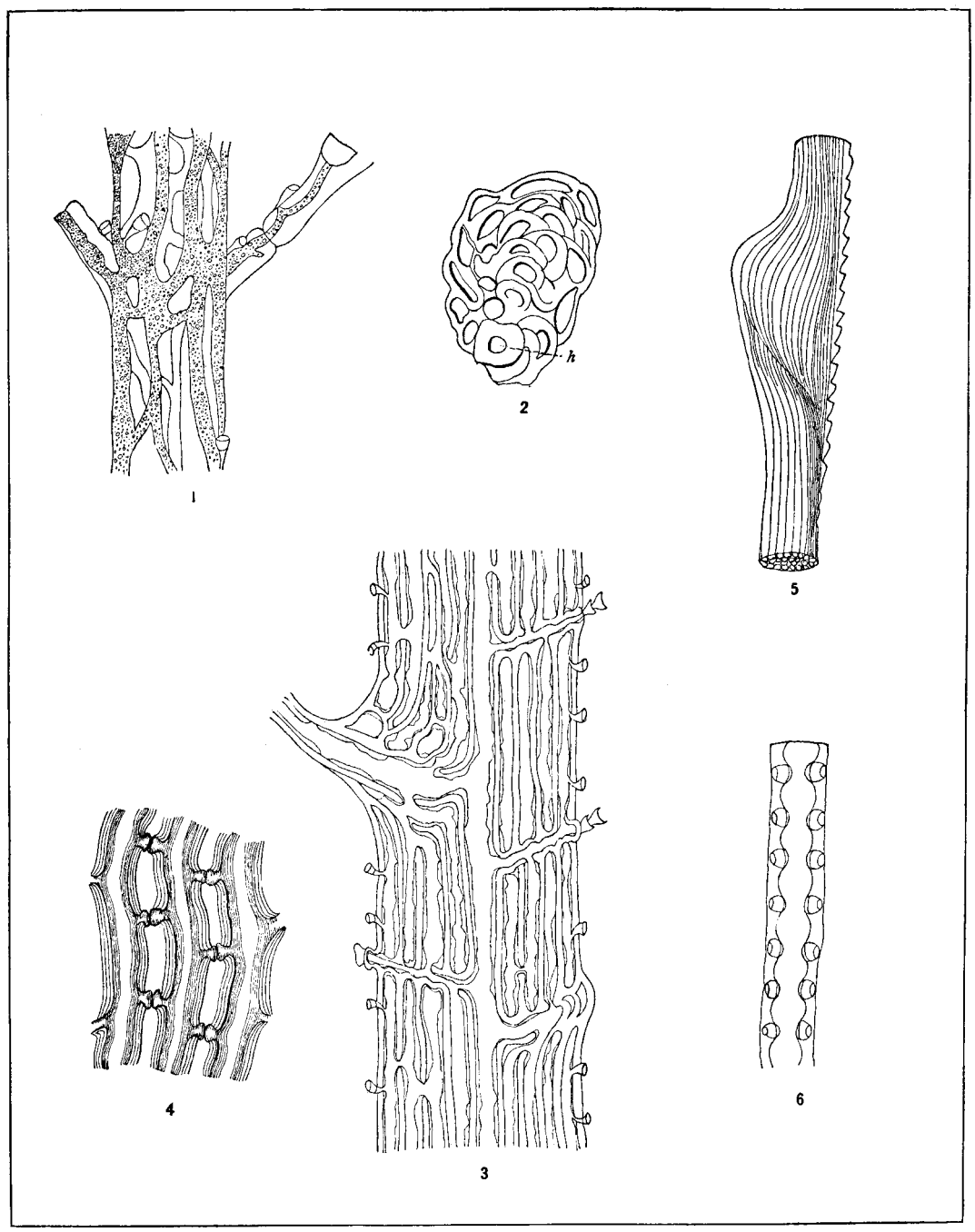
Stem.—This may be nonfascicled or fascicled. In the former case it consists of a single tube, which is ordinarily divided into regular internodes. It may be straight, or there may be sudden bends at the nodes, producing the geniculate stem. The branches, when present, are in most cases identical in structure with the stem. The proximal portion of the colony is usually devoid of hydrocladia and the stem is here straight, without outgrowths of any kind except nematophores. In a number of the smaller species of *Aglaophenia* which grow from a creeping rootstock there are peculiar twists in the stem below the pinnate portion, as if the stem had been pinched and twisted in one or more places. Some authors regard these as nodal marks, but I can see nothing to indicate this.

Those portions of the stem and its branches which bear hydrocladia are characterized by the fact that each internode bears a stout brace for the support of a hydrocladium, and usually two or more nematophores. Species with nonfascicled stems do not usually attain the great size reached by those with fascicled stems. Perhaps the largest simple-stemmed species among American forms are *Cladocarpus flexilis* Verrill, which attains a height of 9 or 10 inches, and *Halicornaria speciosa* Allman, a heavy plumose form with a thick stem reaching a height of 12 inches.

A very curious modification of the nonfascicled stem is characteristic of the genus *Antennularia*, and was first noticed by Professor Allman (fig. 1). The stem consists of a single strong tube of perisarc enclosing a series of cœnosarcal tubes, each surrounded by ectoderm and endoderm. These cœnosarcal canals, as they are termed, have a course which is in general parallel to the axis of the stem. The several tubes send off frequent branches or offsets, which form lateral connections with adjacent tubes, the whole forming a loose network of anastomosing tubes. Where branches or hydrocladia are given off from the main stem, one or two of these cœnosarcal canals will be diverted into the branch or hydrocladium. The main cavity or lumen of the stem is entirely empty so far as structural tissues are concerned, and is presumably filled with sea water during the life of the colony. It is not homologous with the central cavity of the ordinary nonfascicled stem, the whole structure resembling a polysiphonic or fascicled stem in which only a single outer layer of tubes remains, and in which the perisarc of the individual tubes is modified to form a single great tube inclosing the whole. This stem is divided into distinct internodes, each of which bears a circlet or whorl of hydrocladia. The canaliculated cœnosarc described above is found only in the genus *Antennularia*, and is a structure unique among the Hydroida.

The fascicled stem consists of a tube, which, from the fact of its bearing the hydrocladia, I will call the hydrocladiate tube, supported by a varying number of accessory tubes (fig. 2). The former, or hydrocladiate tube, can always be recognized by the fact that it bears either hydrocladia or the stumps of obliterated or metamorphosed hydrocladia, and is distinctly divided into

internodes in all species examined by me. It may run along the front of the stem and branches (Plate XVI, fig. 5) or be buried beneath the accessory tubes and occupy a central or axial position



CROSS ANATOMY OF PLUMULARIAN STEM.

Fig. 1.—Stem of *Antennularia tetrasticha*, showing canaliculated cœnosarc.
Fig. 2.—Cross section of fascicled stem, *h*, hydrocladiate tube.
Fig. 3.—Stem of *Plumularia procumbens*, showing immersed hydrocladiate tube (after Spencer).
Fig. 4.—Longitudinal section of fascicled stem, showing cross connection between tubes (after Allman).
Fig. 5.—Part of stem of same, showing "pinched place."
Fig. 6.—Single tube from stem of *Thecocarpus myriophyllum*, showing lateral processes.

in the stem (fig. 3). If the fascicled stem be boiled in a solution of potash, the component tubes can easily be separated and traced throughout their length. As a general thing the hydrocladiate

tube is anterior in the branches on the upper part of the stem and becomes immersed in the lower or proximal portion of the colony. In only one species, *Aglaophenopsis hirsuta*, could this tube in full-grown specimens be traced as a superficial tube clear to the origin of the stem.

There appears to be some difference of opinion as to the origin of the branches of the fascicled stem. Bale[1] says: "The branches spring not from the jointed stem [hydrocladiate tube], but from the supplementary tubes which grow up in contact with it." Prof. Baldwin Spencer, another Australian writer, in describing a new species, *Plumularia procumbens*, speaking of the tubes of the fascicled stem, says:[2] "The central one gives origin to all of the branches, passing out into the pinnæ and hydrocladia."

In order to obtain additional light on this question, I have made a number of dissections of fascicled stems of various genera, and find that the hydrocladiate tube gives origin to the branches in the following species: *Plumularia profunda*, *Calvinia mirabilis*, *Cladocarpus paradisea*, *Thecocarpus benedicti*, and *Antennopsis* species. In the two following species the accessory tubes give origin to the branches: *Plumularia dendritica* and *Lytocarpus clarkei*. Thus, out of seven species examined, five were characterized by branches which spring directly from the hydrocladiate tube and only two had branches formed entirely from accessory tubes. It seems, therefore, that there is no consistent arrangement, and that the branches may spring either from the hydrocladiate or accessory tubes; more frequently from the former among American species.

Professor Spencer says that the hydrocladiate tube in *P. procumbens* is not divided into internodes except in its distal free portion. In all of the American species examined the internodes could plainly be discerned throughout after the hydrocladiate tube had been dissected away from the others so as to admit of satisfactory examination.

The accessory tubes vary in number from one (*Aglaophenia longicornis*) to scores or even hundreds (*Plumularia dendritica*). The individual tubes are, in general, parallel to the hydrocladiate tube, but are often more or less sinuous, especially in the basal portions of thick and woody stems.

Each tube terminates distally in an open end, and it can often be traced downward where it is found to end in a rootlet or to become connected with the hydrocladiate tube at the point from which the original hydrocladia sprung. Ordinarily the accessory tubes communicate with each other by means of lateral tubular processes passing from one tube to the other. These cross communications are very prominent in some species of *Cladocarpus* (fig. 4) and *Thecocarpus*. They are minute in *Calvinia mirabilis*, and I am unable to make them out in *Plumularia dendritica*. In some species each of the superficial tubes bears a double row of cauline nematophores (*Cladocarpus paradisea*), while in others these nematophores are very minute (*Lytocarpus clarkei*), consisting of sarcostyles without sarcothecæ (*Plumularia procumbens*), or are absent (*Aglaophenopsis hirsuta*).

As to the homology of the accessory tubes, authorities seem to agree that they are modified hydrorhizal elements. Bale says on this point: "As regards the origin of the combined stem, it is obvious that the plumularia tubes are hydrorhizal elements. Monosiphonic species sometimes occur with a few irregular tubes, which, springing from the hydrorhiza, have attached themselves to the basal part of the stem instead of to a foreign body."[3] Spencer comes to the same conclusion.[4] Some of my own observations would seem to contradict these authorities. In dissecting the fascicled stem of *Cladocarpus paradisea* I found that the accessory tubes were sometimes given off from the hydrocladiate tube. Indeed, they seemed to grow from the old stumps of hydrocladia, which they had apparently replaced. The tubes originating in this way could in no wise be distinguished from the ordinary accessory tubes, and so, morphologically speaking, they must be regarded as modified hydrocladia. The same condition of affairs was found in *Plumularia dendritica*.

The best demonstration of the hydrocladial origin of the accessory tubes was afforded by a dissection of a gigantic specimen of *Thecocarpus* secured in Naples, in which, throughout the immersed portion of the hydrocladiate tube, the accessory tubes had their origin from the stumps of the old hydrocladia.

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[1] The Genera of the Plumulariidæ, with observations on various Australian Hydroids, Melbourne, 1886, p. 5.

[2] A New Family of Hydroida, together with a Description of the Structure of a New Species of Plumularia, Transactions of the Royal Society of Victoria, 1890, p. 133.

[3] The Genera of the Plumulariidæ, p. 5.

[4] A New Family of Hydroida, Transactions of the Royal Society of Victoria, 1890, p. 133.

The greater part of the tubes, however, in a number of species could be traced directly to the hydrorhiza, and formed in the aggregate almost, if not quite, the entire mass of root filaments. The apparent contradiction between previous writers and my own investigations may be reconciled if it can be demonstrated that the hydrorhizal elements and the hydrocladia are themselves homologically equivalent; that they are interchangeable terms in the life history of individual colonies.

Bale, as above stated, gives ample proof that the accessory tubes are true hydrorhizal elements. Professor Verrill, in a letter to the writer, says: "It has long been recognized that basal stolons are homologous with branches and hydrocladia." It would be difficult to point out any fundamental difference between stolons and hydrorhizæ, and indeed it seems to me proper to regard the former as merely modified elements of the latter.

Another fact bearing on this point was noted by me while studying at the Marine Biological Laboratory in Plymouth, England,[1] where I saw the entire process by which the fully matured hydrocladia of *Plumularia pinnata* were converted into stolons from which new colonies arose. We thus see that the hydrorhizal elements called stolons are converted into accessory tubes (for example, many species of *Cladocarpus*); that hydrocladia are converted into accessory tubes (*C. paradisea*); that accessory tubes are converted into branches and give rise to hydrocladia (many species, according to Bale); and, finally, that hydrocladia are converted into stolons from which new colonies arise (*P. pinnata*).

As a matter of fact, the subject of homology among Hydroida has been unnecessarily obscure because the whole group is so primitive that any one part is homologous with several others, or rather that the parts are not greatly or fundamentally differentiated. For instance, the creeping rootstock may properly be regarded as a portion of the hydrorhiza in many species; in many others it is considered a true stem, or hydrocaulus, which has adopted a procumbent habit; again, as we have just seen, it takes the guise of an accessory tube in a fascicled stem, which may in its distal portion adopt the further disguise of a branch or even a hydrocladium.

Each tube of the fascicled stem is made up of the ordinary elements of a simple stem. There is the outer layer of perisarc, within which is the cœnosarc, composed, as usual, of ectoderm and endoderm with the intervening stutzlamelle, and finally the central axial cavity lined with flagellate endoderm cells. In addition to the lateral communications between the accessory tubes, Spencer has found in *Plumularia procumbens* similar connections between the hydrocladiate and adjacent accessory tubes.

In many fascicled stems there are certain portions where the whole stem looks as if it had been violently compressed or pinched. This is notably the case in the genus *Thecocarpus* (fig. 5). I am unable to explain these curious structures, which Hincks[2] unhesitatingly declares to be arrested branches. "'On the back of it (the stem) at nearly equal distances are formed little regular arch-like risings which are compressed and hollowed in the middle' (Ellis). This is a very accurate description of these curious prominences, which have been supposed to mark the stages of growth. They are formed by an occasional divergence of a portion of the tubes from the ascending line of the stem, and are, in fact, arrested branches."

A careful dissection of a much-branched specimen of *Thecocarpus* (*Aglaophenia*) *myriophyllum* throws considerable doubt upon this. The facts ascertained are as follows: The hydrocladiate tubes of the stem give origin to the hydrocladiate tubes of the branches, part of the accessory tubes of the former accompanying the latter. This being true, the protuberances or pinched places should contain a branch from the hydrocladiate tube of the stem if the protuberances are suppressed branches. A close examination fails to disclose any such state of affairs. On the contrary, the protuberances are on the opposite side of the stem from the hydrocladiate tube, which is not at all diverted from its course, nor does it give origin to any branch at that point.

Of course it is possible that these protuberances indicate growth periods in the life of the colony. The regularity of their appearance would seem to indicate that they are normal struc-

[1] See Notes on the Reproduction of Plumularian Hydroids, American Naturalist, November, 1895; and Journal of the Marine Biological Association of the United Kingdom, IV, 1896, p. 152, where a detailed account of my observations on stoloniferous reproduction will be found.

[2] British Hydroid Zoophytes, London, 1868, p. 291.

tures; and perhaps the growth-period idea, an old one by the way,[1] is as likely to prove correct as any that has yet been suggested.

Hydrocladia.—Whatever may be the arrangement of the branches of the colony, whether the main stem soon breaks up into a cluster or tuft of erect branches, or gives off regular branches which again divide in a dendritic manner, or gives rise to regularly opposite or alternate branches, the ultimate hydrotheca-bearing branchlets or hydrocladia are, as a rule, regularly pinnate, rarely opposite, in their arrangement. The departures from this rule are as follows:

First.—The hydrocladia may spring direct from a creeping rootstock, in which case the rootstock may be regarded as a stem (Plate XVII, fig. 10). The hydrocladia would thus grow irregularly from the upper side of the creeping rootstock, as in *Antennella gracilis* and one form of *Plumularia filicaulis*. This unilateral arrangement is found again in the erect stem of *Streptocaulus pulcherrimus* (Plate XXXIV, fig. 1), one of the species secured by the *Challenger*. In this case, however, the stem itself is twisted so that the hydrocladia appear to be inserted along a spiral line ascending the stem, the hydrocladia jointly forming a helix with the stem as an axis. In the genus *Gattya* the hydrocladia spring directly from the creeping rootstock, but are borne on a jointed peduncle, and sometimes bear what may be called secondary hydrocladia, springing from their sides. In the genus *Monostæchas* Allman there is a unilateral arrangement of the hydrocladia in which the main stem is dichotomously branched, and the hydrocladia always grow on the upper side of each branch.

Second.—The hydrocladia are arranged in verticils around the stem, the verticils being composed of from three to eight or more hydrocladia. This arrangement is usually associated with a peculiar structure of the stem by which the cœnosarc forms a number of anastomosing tubes and is described as a canaliculated cœnosarc. All of the species of the genus *Antennularia* as here described are characterized by this verticillate arrangement of the hydrocladia, at least in the adult colonies (Plate IX, fig. 3).

Third.—The hydrocladia are scattered irregularly on all sides of the stem. This unsymmetrical arrangement is found only in the genus *Antennopsis* Allman. It sometimes happens that the proximal hydrocladia will be opposite and the distal hydrocladia scattered, as in young specimens of *Antennularia;* or the proximal hydrocladia may be alternate and the distal hydrocladia scattered, as in *Antennopsis annulata* (Plate XII, fig. 7). In almost all Plumularidæ the hydrocladia are divided into regular internodes. There are occasional exceptions, such as *Schizotricha dichotoma* and *Diplopteron grande*, in which the nodes are either absent or unrecognizable. Throughout the Statoplea each node is hydrothecate, but there are many eleutheroplean forms in which there are one or more intermediate internodes. In the latter case the hydrocladiate internodes are usually the longer. The nodal joints are ordinarily nearly at right angles with the axis of the hydrocladium, but in the "Catharina group" of the genus *Plumularia* the nodes are alternately at right and oblique angles with the axis.

The hydrocladia are ordinarily unbranched, the main exception being the genus *Schizotricha* (Plate XV, fig. 5) among the Eleutheroplea and *Nuditheca dalli* among the Statoplea.

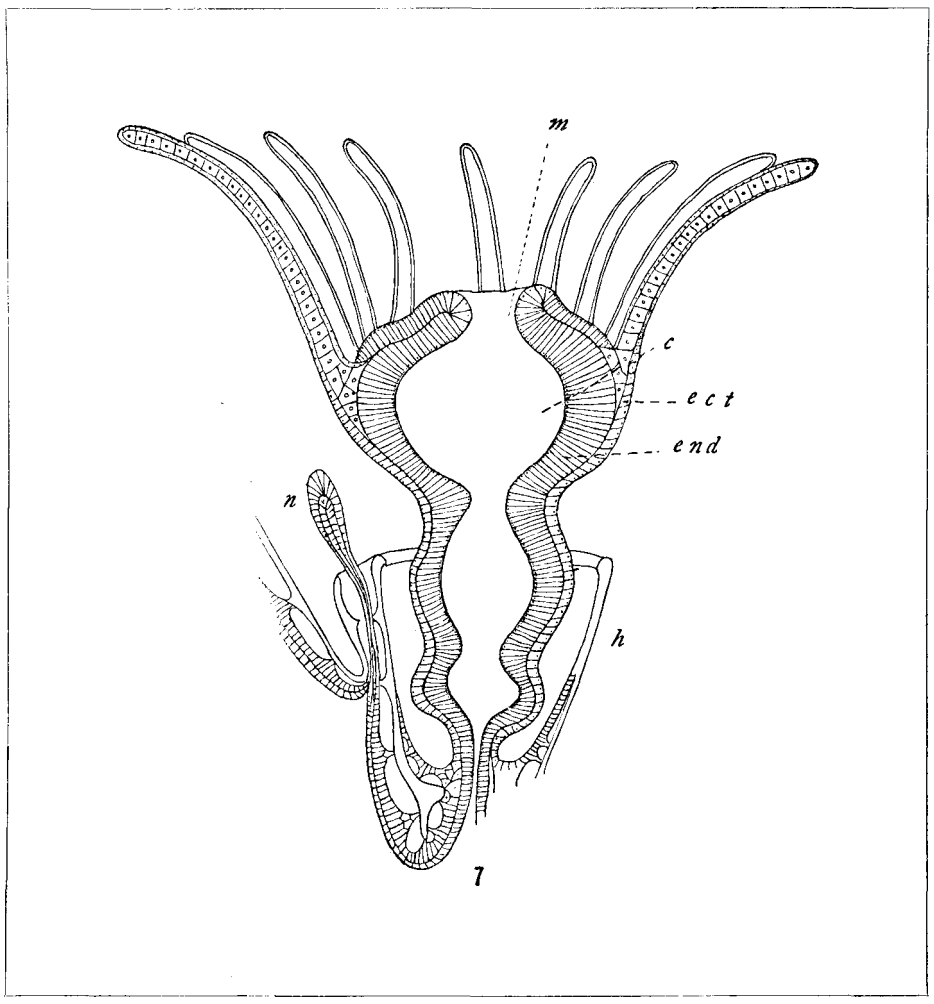
In a large number of species belonging to various genera the axial cavities of the hydrocladial internodes are partially divided by internal thickenings of the perisarc, which form raised circular ridges on the internal surfaces. These ridges, known as septal ridges, are found more frequently in the Statoplea, especially the genera *Cladocarpus*, *Thecocarpus*, and *Aglaophenopsis*, than in the Eleutheroplea, where they are seldom seen, except in the "Lagenifera group" of *Plumularia* and in one or two species of *Antennularia*. The office performed by the septal ridges in the economy of the colony is probably that of adding strength to the hydrocladia, although it is not unlikely that there is some other utility involved. It is often difficult to distinguish between septal ridges and nodes, and it is more than likely that the former have been mistaken for the latter, and descriptions thereby rendered inexact. The distinction between them is not difficult to understand if one bears in mind that the nodes are always indicated when there are external annular depressions in the perisarc when examined in profile, while the septal ridges are entirely internal and make no depression in the profile of the internode.

It sometimes happens that a normal hydrocladium loses its hydrothecæ, nematophores, and nodes; grows rapidly, and is transformed into a stolon or rootstock, from which a new colony

[1] George Johnston, A History of British Zoophytes, London, 1847, p. 100.

arises.[1] And again the hydrocladia become atrophied, lose their characters as hydrocladia, and become transformed into tubes which support the original stem from which they spring.

Hydranths.—Those of the Plumularidæ are of uniform structure throughout the group, so far as I have been able to ascertain. It should be noted, however, that they are usually absent or partially disintegrated in many alcoholic specimens, and of course in all dried material. The examination of living and expanded hydranths of numerous species has not resulted in the discovery of any considerable departure from the type ordinarily described in systematic works (fig. 7). The tentacles are always solid, filiform, arranged in a single whorl, usually of from eight to sixteen,



HYDRANTH OF PLUMULARIA TRIPARTITA.

Fig. 7.—(After von Lendenfeld) *c*, body cavity; *ect*, ectoderm; *end*, endoderm; *h*, hydrotheca; *m*, mouth; *n*, sarcostyle.

but sometimes as many as twenty-four. The proboscis is conical or dome-shaped. The hydranth usually has a more or less evident constriction which divides the body cavity into a distal and a proximal portion communicating broadly, otherwise the hydranths of this group can not be easily distinguished from many found among the Sertularidæ and Campanularidæ, with which they agree in arrangement of tentacles, general form, microscopic structure, and relation of histological layers. Where the hydrotheca has a pronounced intrathecal ridge, there is a bend in the body of the retracted hydranth to accommodate the latter to the ridge; but this does not seem to affect the contour of the expanded polyp.

The tentacles of the hydranth are armed with rather small nematocysts; but these do not seem to be as frequently brought into use as in other groups, perhaps on account of the special

[1] See discussion of the homology of the accessory tubes in the fascicled stems, p. 6.

protection often afforded by the sarcostyles. In expansion, the hydranths of the Eleutheroplea seem, as a group, to be capable of greater extension beyond the orifice of the hydrotheca than those of the Statoplea. They are seldom brilliantly colored. Indeed, I know of no American species which is at all notable in this direction. While working in Naples, however, I saw a species of *Antennularia* that was rendered quite striking by the brilliant rose-red color of the bodies of the hydranths. *Aglaophenia tubulifera* often displays a rather bright yellow color that extends to the hydranths. Several species of *Lytocarpus* are remarkable for having the cœnosarc of both stem and hydranths packed almost full of granular black bodies, which give a very dark color to these parts. I have been unable to determine the nature of these peculiar granules, but they seem to be confined to the species of this genus, and are found in all comparatively fresh specimens examined by me. The hydranths of several species of *Aglaophenia*, notably an undescribed species studied at Naples, are colored green from the innumerable unicellular algæ with which their tissues are packed. In a majority of plumularians, however, the polyps are either colorless or, rarely, have a brownish tinge when alive. Their size is not very great, averaging about the same as those of the Sertularidæ.

Hydrothecæ.—These are always sessile and usually have their posterior side partially or wholly attached to the hydrocladia. In *Aglaophenopsis hirsuta* (Plate XXIX, fig. 12) the proximal hydrothecæ are almost entirely free and the distal hydrothecæ largely adnate. In *Schizotricha tenella*, also, the hydrothecæ are nearly free, a condition often seen among Australian forms of *Plumularia*. As a rule, they are much more closely approximated in the Statoplea than in the Eleutheroplea, although *Plumularia dendritica* (Plate VIII, fig. 4), *Monostæchas quadridens*, *Diplopteron grande*, and *D. longipinna*, eleutheroplean forms, have the hydrothecæ as closely approximated as in the statoplean *Cladocarpus flexuosus*, *C. bispinosus*, and *Aglaophenopsis distans*. In form and comparative size the hydrothecæ of the Plumularidæ differ very widely. Among the Eleutheroplea many species are much wider than deep as in *Plumularia lagenifera* (fig. 8), *Antennopsis longicorna*, *A. nigra* (fig. 10), while they are more than twice as deep as wide in *Diplopteron grande* (fig. 9) and *Callicarpa gracilis*. Among the Statoplea almost as great divergence is found between *Halicornopsis avicularis* Kirchenpauer, on the one hand, and *Cladocarpus flexuosus* (fig. 25), on the other. In comparative size the divergence is still greater, as will be seen by comparing *Antennopsis nigra* (fig. 10) with *Diplopteron grande* (fig. 9) among the Eleutheroplea, and *Aglaophenia latirostris* (fig. 21) with *Cladocarpus grandis* (fig. 28) or *C. paradisea* among the Statoplea.

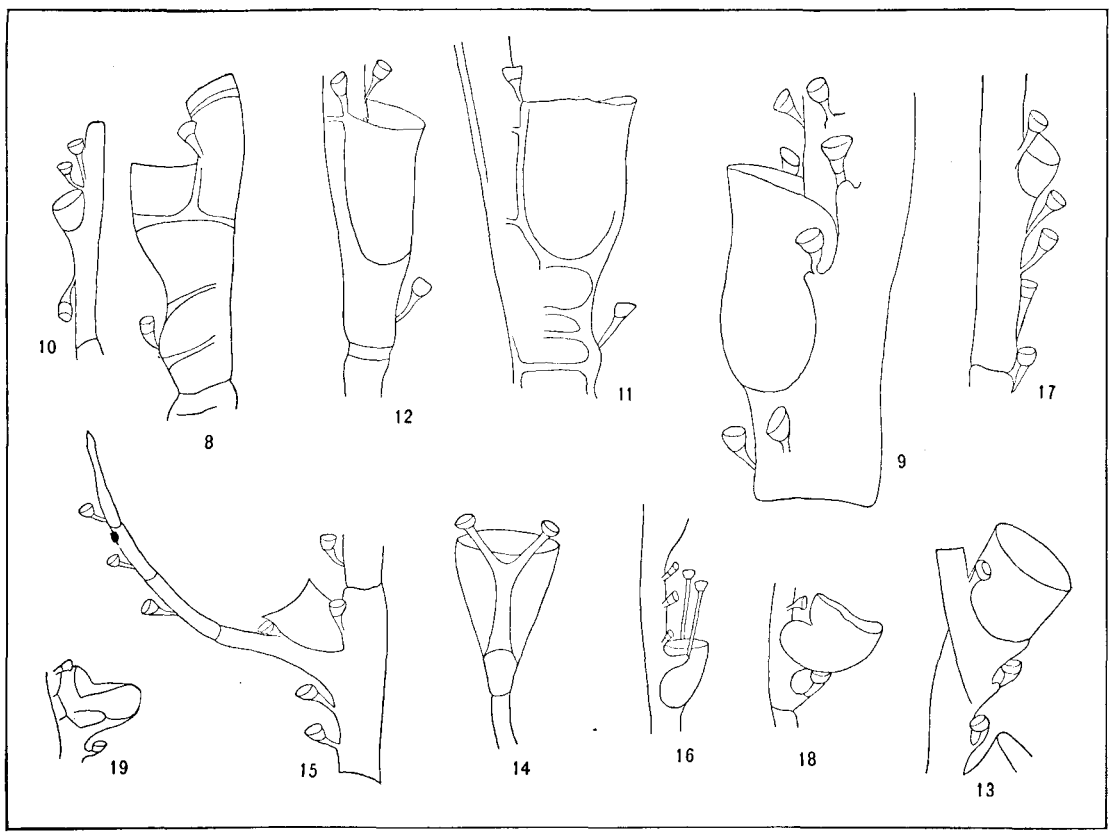
The aperture of the hydrotheca is often horizontal or at right angles with the hydrocladial axis. Sometimes, however, it is vertical, as in *Cladocarpus carinatus* (fig. 30) and *Aglaophenia sarignyana;* but ordinarily the opening is inclined between these extremes. In *Diplocheilus mirabilis* Allman the hydrothecal wall is rolled over, as it were, the margin forming thus a double wall throughout the upper part of the hydrotheca.[1] In a few species there is an anterior keel to the hydrotheca, as in *Halopteris carinata* (Plate XVII, fig. 8) and *Cladocarpus carinatus* (fig. 30). This structure is produced into a very conspicuous process reaching far beyond the hydrotheca in *Aglaophenopsis cornuta* (fig. 33).

The margin is almost always plain or destitute of teeth in the Eleutheroplea, the only exception known to me being *Gattya humilis* Allman (Plate XVII, fig. 10). This genus, however, is almost exactly intermediate in structure between the two great groups of the Plumularidæ, although agreeing more nearly with the Eleutheroplea. The margin of the hydrothecæ of this latter group, although always toothless, with the exception noted above, is often characterized by more or less pronounced sinuations, as in *Plumularia filicaulis* (fig. 18). The condition of affairs is exactly the reverse among the Statoplea, where a plain margin, as found in *Cladocarpus pourtalesii* (fig. 31), *Nuditheca dalli* (fig. 35), and a very few other species, is the exception. There are almost always either teeth or sinuations, the latter being especially characteristic of several species of *Halicornaria*. A few forms have one or two prominent anterior teeth varying considerably in shape. The most common arrangement among American species is that found in *Aglaophenia rigida* (Plate XVIII, fig. 3), which has nine even, conspicuous, pointed teeth. A number of Pacific coast species exhibit a departure from this in the direction of unequally developed teeth, some of which, usually the anterior, are bent abruptly inward or outward. *Lytocarpus furcatus* (fig. 36) is

[1] Bale says that this structure is merely a very great thickening of the distal portion of the hydrothecal wall.

almost unique in having the points of all the teeth curve abruptly inward. I know of but one other species exhibiting this peculiarity, and that is *Aglaophenia phyllocarpa* Bale—an Australian form.

The intrathecal ridge is a more or less extensively developed fold of chitine, which projects from the inner surface of the anterior or posterior wall of the hydrotheca and extends forward or backward in a horizontal or oblique direction toward the opposite side (fig. 22). The ridge may extend almost around the hydrothecal cavity, thus partially dividing the latter into two portions. The body of the hydranth seems to be capable of retracting itself into the chamber below the ridge, thus securing mechanical protection from the latter. When the hydranth is expanded its walls are indented by the ridge, which, if extensively developed, causes an abrupt bend in the axis of

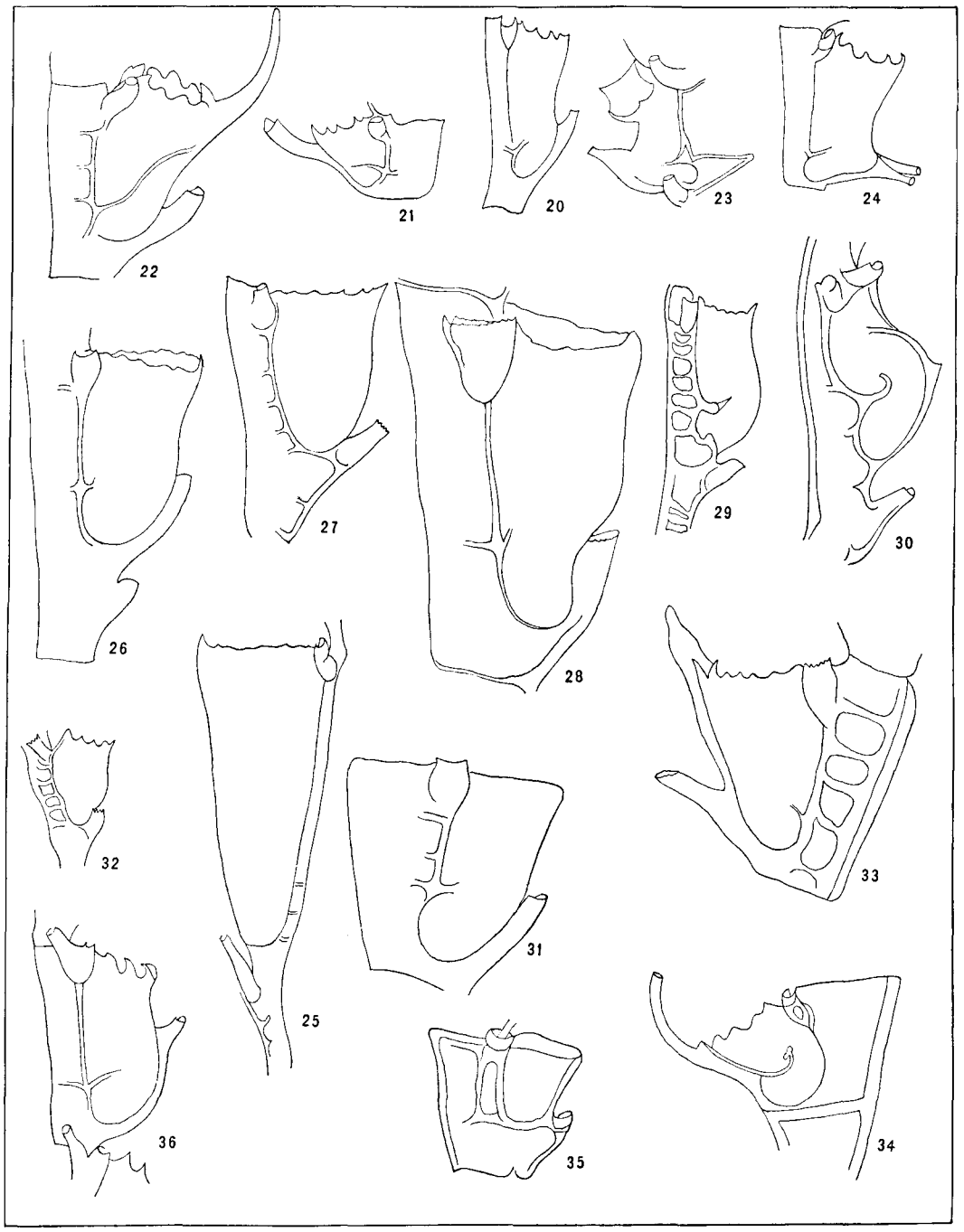


TYPICAL HYDROTHECÆ OF THE ELEUTHEROPLEA.

Fig. 8.—*Plumularia lagenifera.*
Fig. 9.—*Diplopteron grande.*
Fig. 10.—*Antennopsis nigra.*
Fig. 11.—*Plumularia caulitheca.*
Fig. 12.—*Antennopsis annulata.*
Fig. 13.—*Monostæchas quadridens.*
Fig. 14.—*Monotheca margaretta.*
Fig. 15.—*Calvinia mirabilis.*
Fig. 16.—*Diplopteron longipinna.*
Fig. 17.—*Polyplumularia armata.*
Fig. 18.—*Plumularia filicaulis* (after Bale).
Fig. 19.—*Plumularia goldsteini* (after Bale).

the hydranth. Bale explains both the use and origin of the ridge as follows: "The use of the intrathecal ridge is evidently to form a protective shield behind which the hydranth can retire; and if we consider its structure and origin it will be sufficiently obvious that whether it springs from the back or from the front of the hydrotheca its nature is essentially the same, and that it originates from a fold or constriction of the hydrothecal wall, which is more or less bent upon itself either towards or away from the hydrocladium, or in both directions alternately."[1] This author then shows how, in his opinion, the ridge can always be regarded as the mechanical result of the bending of the hydrotheca. This explanation appears to me to apply very well to the anterior ridge in many species; but I am inclined to regard the posterior ridge, which is by far the more common in American species, as strictly homologous with the septal ridges found so abun-

[1] The Genera of the Plumulariidæ, with observations on various Australian Hydroids, Melbourne, 1886, p. 4.



TYPICAL HYDROTHECÆ OF THE STATOPLEA. Enlarged.

Fig. 20.—*Aglaophenia elegans.*
Fig. 21.—*A. latirostris.*
Fig. 22.—*A. gracillima.*
Fig. 23.—*A. contorta.*
Fig. 24.—*A. bicornuta.*
Fig. 25.—*Cladocarpus flexuosus.*
Fig. 26.—*Thecocarpus normani.*
Fig. 27.—*Cladocarpus speciosus.*
Fig. 28.—*C. grandis.*
Fig. 29.—*C. septatus.*
Fig. 30.—*C. carinatus.*
Fig. 31.—*C. pourtalesii.*
Fig. 32.—*Aglaophenopsis hirsuta.*
Fig. 33.—*A. cornuta.*
Fig. 34.—*Halicornaria superba.*
Fig. 35.—*Nuditheca dalli.*
Fig. 36.—*Lytocarpus furcatus.*

dantly in the hydrocladia of many species of *Plumularia*, *Cladocarpus*, and other genera. These septal ridges can hardly be regarded as a result of the bending of the internodes in which they are found, but seem rather to be formed by annular thickenings produced by the addition of chitine—that is, the septal ridges are actually built up of new material and not formed by folds in the existing structures. In the same way, in the writer's opinion, the ordinary posterior intrathecal ridge is formed by the addition of a quantity of chitine, which constitutes an entirely new structure, and not by a fold in the existing hydrothecal wall. It is a fact worthy of notice in this connection that in many, indeed nearly all, species having both hydrocladial septal ridges and posterior intrathecal ridges the latter are situated immediately in front of the former and appear to be identical in structure. However this may be, it seems simplest and best to consider both the anterior and posterior ridges as intrathecal ridges, as does Bale, rather than to make a distinction and confine the term to the latter, as does Allman.[1] None of the American species of the Eleutheroplea have a recognizable intrathecal ridge, with the exception of *P. filicaulis* Kirchenpauer (fig. 18), where it is present in a rudimentary form (Bale). In the Statoplea, however, it is usually present in some form or other, the exception being *Aglaophenia crenata*, *Cladocarpus flexuosus*, *C. dolichotheca*, *Thecocarpus bispinosus*, and *Thecocarpus distans*.

The ridge is posterior in all American species of *Aglaophenia*, which undoubtedly belong to that genus; in all species of *Thecocarpus* and *Cladocarpus* that I have examined which have any intrathecal ridge at all; in *Aglaophenopsis*, except *A. distans;* and in *Lytocarpus*, except *L. philippinus*, where it is rudimentary.

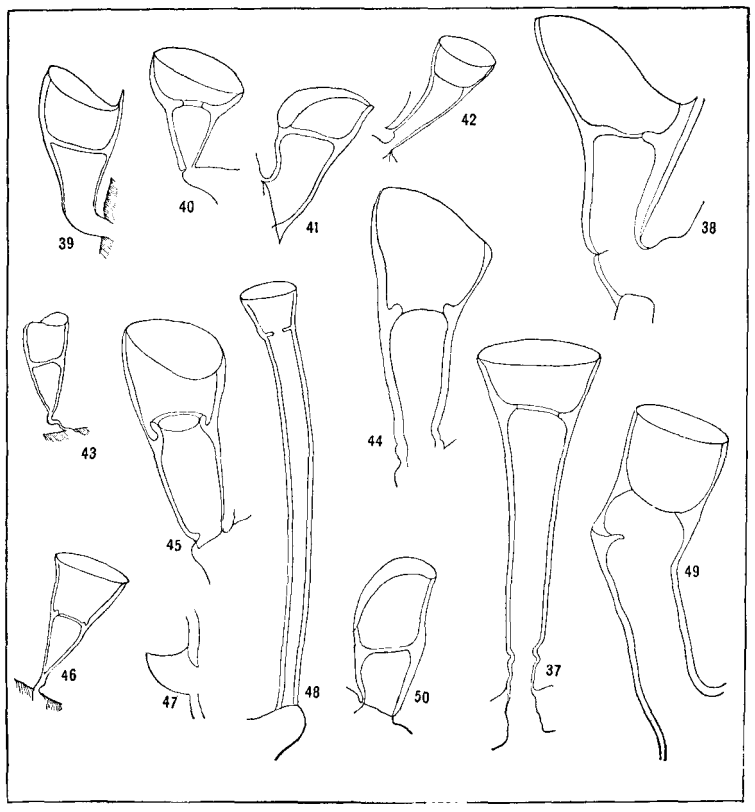
There are a few American species in which the ridge is anterior, as in *Cladocarpus carinatus* (fig. 30), *Lytocarpus philippinus*, and the American species of *Halicornaria* (Plate XXXIII, fig. 8). In the first two of these there is also a posterior ridge. Bale remarks that an opposite condition of affairs prevails among the Australian Plumularidæ, where the ridge is usually anterior and only exceptionally posterior. The ridge varies from a mere rudiment to a strong anterior shelf which completely encircles the hydrothecal cavity, as in *Aglaophenia minuta* (Plate XXI, fig. 1), or extends forward and upward clear across the hydrotheca in an oblique direction, as in *A. gracillima* (fig. 22). In no case that I have examined does the ridge extend forward and downward. In some species, for example *Cladocarpus septatus* (fig. 29), the ridge forms a single posterior shelf which ends in much more attenuated laterally projecting prolongations, forming an angle with the shelf. The anterior ridge in *Halicornaria* (fig. 34) is usually very strong, ending in a knoblike termination as viewed from the side. The anterior wall of the hydrotheca often contains an aperture, through which sarcodal processes from the sarcostyles penetrate into the hydrothecæ. This is particularly apt to be the case where the mesial nematophore has two openings.

Nematophores.—The name nematophore was first applied by Busk[2] to the entire structure which Hincks differentiated into two parts, sarcotheca and sarcostyle, the former designation being applied to the so-called sarcodal processes, and the latter to the chitinous receptacle into which they retract. As I have already suggested,[3] the more precise terminology would be to apply the name nematophore to the latter structure and use the words sarcostyle and sarcotheca as proposed by Hincks. The word nematophore has, however, become so fixed in the literature of the subject, especially in systematic works, as applied to the chitinous receptacle without reference to its contents, that it seems wise, on further consideration, to use but the two terms "nematophore" applied to the sarcotheca without necessary reference to its contents, and "sarcostyle" as applied to the "defensive zooid," "machopolyp," "protoplasmic process," "sarcodal process," etc., of various writers. Whether the term is an apt one or not is aside from the question now that it has become firmly intrenched in continuous use.

Nematophores have been divided by Allman into four classes, according to the position they occupy in the colony. Nematophores found in pairs at the side of, or immediately above the hydrothecæ are *supracalycine nematophores;* those found on the front of the hydrocladia, *mesial nematophores;* those on the main stem or branches are *cauline nematophores;* and finally, those attached to the gonangia or special protective branches of the gonosome are *gonosomal nematophores*. They

[1] Report on the Hydroida dredged by H. M. S. *Challenger* during the years 1873–76, Pt. 1, Plumularidæ, 1883, p. 5.
[2] Hunterian Lectures, manuscript, London, 1851.
[3] Journal of the Marine Biological Association of the United Kingdom, New Ser., IV, No. 2, 1896, p. 149.

have also been divided into two general classes, according to their attachment to the hydrocaulus. When joined to the latter by a slender pedicel which admits of more or less movement, they are called free nematophores, and are characteristic of the eleutheroplean plumularians; when they are firmly joined to the hydrocaulus by a broad rigid base they are called fixed nematophores, and are characteristic of the statoplean plumularians. Each of these groups is again divided into *monothalamic* and *bithalamic* nematophores, the former name being given to those without an internal circular ridge or shelf partially dividing the interior into two chambers; and the latter name being applied to those forms having this structure. The prevalent type in the Eleutheroplea is the bithalamic, while in the Statoplea the monothalamic nematophore prevails. There are exceptions, however, in both cases. *Plumularia similis* (fig. 47) and *Plumularia pinnata*, generally



TYPICAL NEMATOPHORES OF THE ELEUTHEROPLEA. Much enlarged.

Fig. 37.—*Plumularia megalocephala*.
Fig. 38.—*P. clarkei*, mesial.
Fig. 39.—*Monostæchas quadridens*, cauline.
Fig. 40.—*M. quadridens*, supracalycine.
Fig. 41.—*M. quadridens*, mesial.
Fig. 42.—*Calvinia mirabilis*.
Fig. 43.—*Schizotricha parvula*, mesial.
Fig. 44.—*S. dichotoma*, mesial.
Fig. 45.—*Diplopteron longipinnum*, mesial.
Fig. 46.—*Polyplumularia armata*, mesial.
Fig. 47.—*Plumularia similis*.
Fig. 48.—*Diplopteron quadricorne*, supracalycine.
Fig. 49.—*Halopteris carinata*, supracalycine.
Fig. 50.—*H. carinata*, mesial.

regarded as eleutheroplean species, have monothalamic nematophores, while *Nuditheca dalli* (figs. 71, 72), a statoplean, has plainly bithalamic nematophores. So far as I have been able to ascertain, no American eleutheroplean has monothalamic nematophores.[1] There are also a number of intergradations between the free and fixed nematophores. Indeed the monothalamic nematophores found in the genus *Plumularia* are all "fixed" in a literal way, and such species as *P. pinnata* and *P. similis* should probably be placed in Jickeli's genus *Kirchenpaueria*, as modified by Bale, characterized by an absence of the supracalycine nematophores and the presence of naked sarcostyles in their places. Both *P. pinnata* and *P. similis* are possessed of these characters and, in addition, their nematophores are monothalamic and fixed, in which they further

[1] Since writing the above I have found monothalamic nematophores on a new species, *Plumularia goodei*, from California. (See pl. VII, fig. 4.)

agree with the figures of *Kirchenpaueria*.[1] Although this group is statoplean, so far as its nematophores are concerned, it is allied by every other character both of trophosome and gonosome to the most typical eleutheroplean genus.

In many Eleutheroplea the mesial nematophore is fixed and not free; for example, *Plumularia clarkei* (fig. 38), *P. dendritica*, *Monostæchas quadridens* (fig. 41), and *Halopteris carinata* (fig. 50). According to Bale[2] this is true of at least half of the Australian species. Both the supracalycine and mesial nematophores of *Halopteris carinata* are fixed, and the species is therefore literally statoplean, although its relationship with the eleutheroplean forms is evident. In the remarkable genus *Gattya* Allman the single species has immovable mesial nematophores and movable supracalycine nematophores.

It will thus be seen that no hard and fast line can be drawn between the two great groups of Plumularidæ on the basis of the fixed or free condition of the nematophores. The monothalamic and bithalamic condition affords, perhaps, a better basis, although, as we have seen, it also has exceptions, which, however, would be reduced if those species properly belonging to *Kirchenpaueria* were placed in that genus, which Bale considers statoplean. The best character, perhaps, that has yet been suggested is the one mentioned by Bale, who says that, with a single probable exception, the supracalycine nematophores are attached to the hydrothecæ in the Statoplea and not in the Eleutheroplea.

The most common form of free nematophore is that found in *Antennularia*, *Antennopsis*, and most species of *Plumularia* (fig. 37). It is trumpet-shaped in outline, the small end of the trumpet being attached by a movable joint to the hydrocaulus, and the large end or "bell" being distal, the internal ridge being at the junction of the bell and the handle. The attachment is by means of an exceedingly slender pedicel in some species; for example, *Antennopsis distans*, *Schizotricha parvula* (fig. 43), and *Polyplumularia armata* (fig. 46). In such species the nematophores are apt to be broken off and lost. In nearly all cases where the supracalycine nematophores are trumpet-shaped, the mesial and cauline nematophores have the aperture oblique, so as to face more or less toward the hydrocladium or stem (fig. 44).

The variations in size and shape of the free nematophores can best be understood by consulting the accompanying figures made with the camera lucida, all being magnified to the same degree, unless otherwise noted in the explanation of the figures. It will be seen that the variation in size is very great, for example, between the nematophores of *Schizotricha parvula* (fig. 43) and *Schizotricha dichotoma* (fig. 44); and the difference in shape is equally remarkable, for example, between *Diplopteron quadricorne* (fig. 48) and *Plumularia clarkei* (fig. 38). So far as I have been able to ascertain, none of the free nematophores have more than a single external opening, and that is always terminal. It is also noteworthy that the hydrothecæ of the Eleutheroplea never have apertures on their anterior faces for the admission of the lengthened processes of the sarcostyles.

There is often a distinct difference between the supracalycine, mesial, cauline, and gonosomal nematophores in the same species; for example, referring to the nematophores of *Monostæchas quadridens* (figs. 39–41), we see that the supracalycine nematophore is bell-shaped, with a horizontal aperture; the mesial nematophore is curved, with an oblique orifice, and is firmly articulated to the hydrocladium by a broad base, and the cauline nematophore is longer, still more curved, with an oblique orifice and a much narrower base. The nematophores of *Plumularia clarkei* present a similar series of differences. In most cases the gonosomal nematophores resemble the cauline. The gonosome of *Sciurella indivisa* Allman is protected by a number of trumpet-shaped nematophores disposed in a semicircular manner, all borne on hollow lateral processes, springing from the distal end of the gonangium.

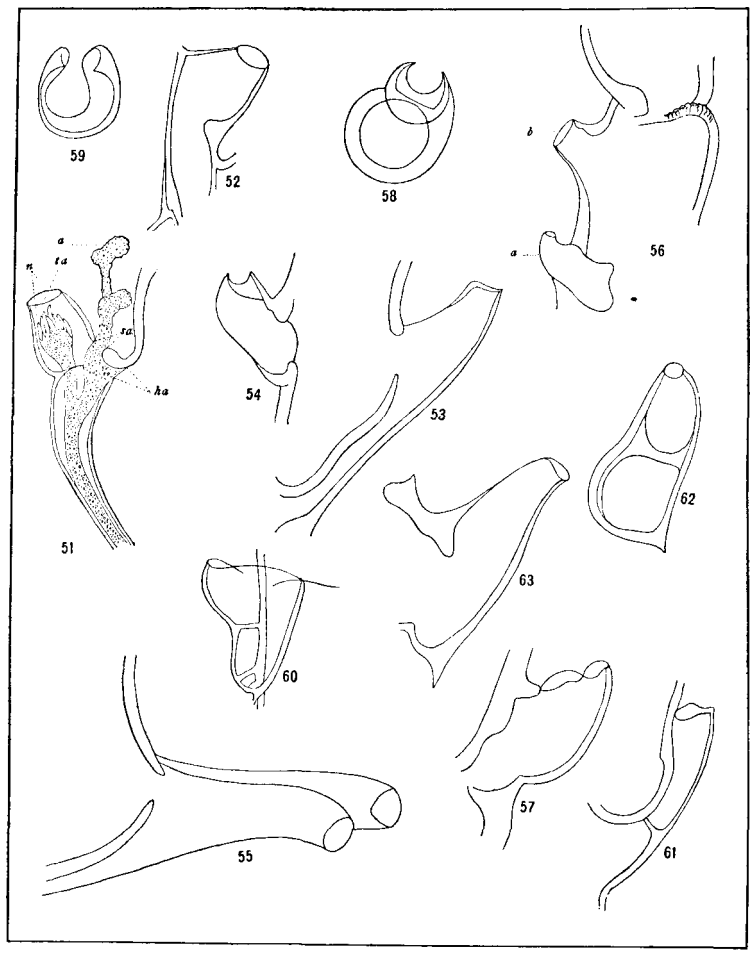
Although the nematophores may be accidentally absent, they are probably normal to all plumularians. The two classes, mesial and cauline, are present in all species known to me. The supracalycine pair is absent in the genus *Azygoplon*, and in those species of *Plumularia* which I have suggested should go into the genus *Kirchenpaueria*. Gonosomal nematophores are present in all Plumularidæ except certain species of *Halicornaria*.

[1] Further Notes on Australian Hydroids, with Descriptions of some New Species. Proceedings of the Royal Society of Victoria, 1893, p. 107, pl. VI, figs. 4–7.

[2] The Genera of the Plumulariidæ, with observations on various Australian Hydroids. Melbourne, 1886, p. 7.

Nematophores of the Statoplea.—In the Statoplea the nematophores are always fixed and almost always monothalamic, the only exception known to me being in the "minuta" group of *Aglaophenia* (fig. 51) and in *Nuditheca dalli* (fig. 72), where the nematophores, especially the mesial ones, exhibit internal ridges fully as pronounced as in many typical Eleutheroplea.

There is more diversity in the nematophores of the Statoplea than in the other group, and their size is, on the average, considerably greater; so much so that it was found inexpedient to represent them all on the same scale in the accompanying figures, where figs. 60, 61, and 74 are much less magnified than the others, the remainder being represented on the scale adopted for the



TYPICAL NEMATOPHORES OF THE STATOPLEA. Much enlarged.

Fig. 51.—*Aglaophenia minuta.* *a*, extensible process of sarcostyle; *ha*, hydrothecal aperture; *n*, nematocysts; *sa*, superior lateral aperture; *ta*, terminal aperture of nematophore.
Fig. 52.—*A. minuta*, supracalycine.
Fig. 53.—*A. lophocarpa*, mesial.
Fig. 54.—*A. lophocarpa*, supracalycine.
Fig. 55.—*A. bicornuta*, mesial.
Fig. 56.—*A. rhynchocarpa.* *a*, cauline; *b*, conical process.
Fig. 57.—*A. cristifrons*, cauline.
Fig. 58.—*A. mammillata*, cauline.
Fig. 59.—*A. aperta*, cauline.
Fig. 60.—*Cladocarpus paradisea*, supracalycine.
Fig. 61.—*Cladocarpus paradisea*, mesial.
Fig. 62.—*C. carinatus*, supracalycine.
Fig. 63.—*C. carinatus*, mesial.

eleutheroplean nematophores. The typical arrangement among the Statoplea is represented in *A. lophocarpa* (fig. 53), in which the supracalycine pair are small, monothalamic, slightly geniculate, even rimmed, and the mesial nematophore is rather short and spurlike, with a terminal aperture and a perforation between the adnate portion and the hydrotheca. In most species of *Cladocarpus* (fig. 60) the supracalycine nematophores are very broad above and constricted below. In others of the same genus their margins are distinctly denticulate, a condition of affairs quite characteristic of the genus *Aglaophenopsis*. In *Cladocarpus carinatus* (fig. 62) these structures are constricted at the distal end and have an aperture much smaller than the greatest internal

diameter of the nematophore, while in *Cladocarpus grandis* they have long, winglike, lateral expansions (fig. 28). In *Lytocarpus philippinus* they are long and tubular. In *L. clarkei* they have two openings, one terminal and one intero-lateral (fig. 67). In *L. furcatus* they are forked, each fork terminating in a round opening (fig. 68). In the genus *Kirchenpaueria* the supracalycine nematophores are entirely lacking; and in *Pentandra* (von Lendenfeld) there are two pairs of supracalycine nematophores, as the term is used in this work, which, in connection with the mesial nematophore, make five of these structures associated with each hydrotheca. According to von Lendenfeld's figure (fig. 74),[1] all of these are bithalamic.

The mesial nematophores are always present in the Statoplea, being usually more or less adnate to the front of the hydrotheca, and are never very distant from it. In several species of *Cladocarpus* they are distinctly separate from the hydrotheca, while in others they are very short and adnate. In some other species, for example, *Lytocarpus ramosus*, they are adnate to the entire front, while in others, for example, *Halicornaria longicauda* (fig. 73), they are adnate to the entire front and project far beyond and above the hydrotheca. In most species the basal portion of the mesial nematophore is adnate, while the distal end is free in the form of a short spur (*Lytocarpus furcatus*) or it may be a lengthened hornlike process as in *Halicornaria ilicistoma* Bale. A rare arrangement is illustrated by *Thecocarpus benedicti* (Plate XXV, fig. 3), which has two mesial nematophores in the median line below each hydrotheca, and a unique arrangement is found in *Aglaophenopsis hirsuta* where the nematophore is so broadly forked as to appear in front view to be double (fig. 64). Another unique form is represented in the "double-barreled" mesial nematophore of *Aglaophenia bicornuta* (fig. 55). There is much diversity also in the apertures of the mesial nematophores. Where they are short, or are not adnate to the hydrotheca, they are furnished with a single aperture which may be terminal and round (*Cladocarpus carinatus*, fig. 62), or terminal and posterior—that is, facing the hydrotheca—as in *Thecocarpus normani*. In *Aglaophenopsis* this is the case with each part of the forked nematophore, but here the margin is finely denticulate. So far as I am aware, there is no *Cladocarpus* in which this nematophore has two external openings, either both internal, or one external and the other leading into the hydrotheca. In many species of *Aglaophenia* there is a terminal opening which is, of course, external, and also an orifice connecting the adnate portion of the nematophore with the interior of the hydrotheca, for example, *A. lophocarpa* (fig. 53); in others of the same genus there appear to be three openings, one at the distal end, another, external, above and near the junction of the nematophore with the hydrotheca, and the third, internal, connecting the adnate portion of the nematophore with the hydrothecal cavity as in *Aglaophenia minuta* (fig. 51).

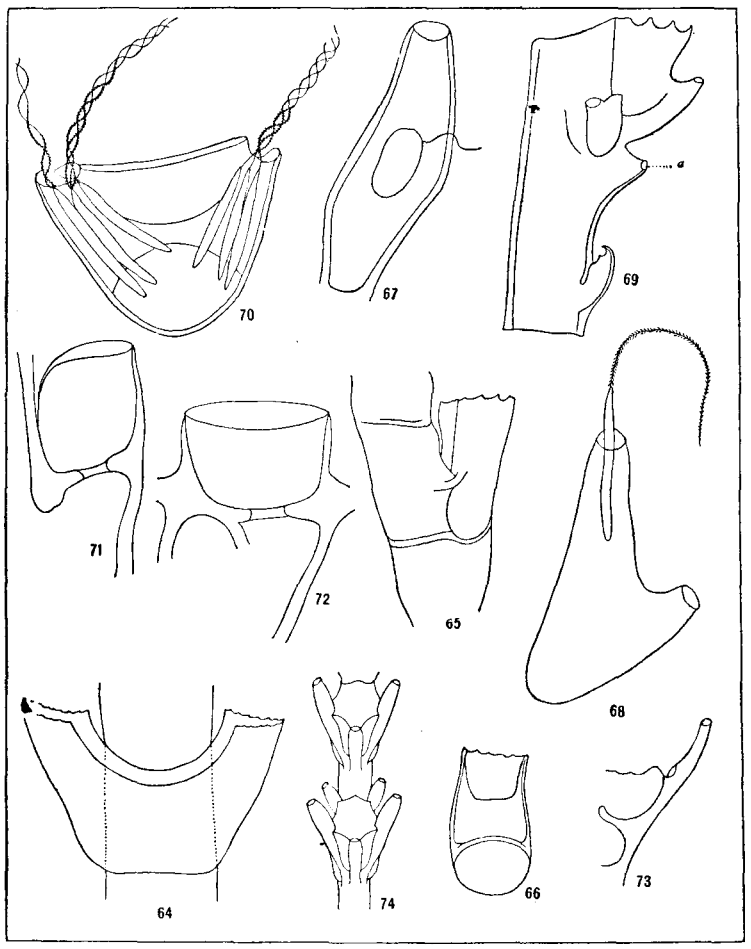
In a number of species of *Halicornaria* (for example, *H. longicauda*) with very long mesial nematophores these structures have two distinct external openings, one terminal, and the other just above and fronting the hydrothecal aperture (fig. 73). Mr. Bale, in a letter to the author, says: "I have noticed in *Halicornaria longirostris* that occasionally in parts of the polypidom the terminal aperture is wanting, the nematophore being closed at the end, but I imagine that this is temporary or abnormal."

The cauline nematophores are ordinarily small, spurlike processes with a terminal opening, adnate by their inner sides to the stem, the aperture being broad and oblique, partially facing the stem (fig. 57). They also communicate by a broad opening with the cœnosarc of the stem. One or two of these structures are almost always to be found at the base of each hydrocladium on the antero-lateral aspect of the stem and branches. In addition to these there is often a single nematophore on the front of each internode near its lower end. In the nonhydrocladiate part of the stem they sometimes occur in a linear series, for example, *Cladocarpus pectiniferus*, and where the stem is fascicled they may occur in numerous series, each corresponding to one of the component tubes of the stem, for example, *Thecocarpus* (*Aglaophenia*) *myriophyllum* and *Thecocarpus benedicti*.

The principal variations in size and shape of cauline nematophores among the American species of Statoplea are illustrated by the accompanying figures, all of which are drawn to the same scale with the exception of fig. 60. A typical form would be that found in fig. 57, from which the principal departures are, first, a constricted orifice (fig. 59), with a tendency to a separation of

[1] The Australian Hydromedusæ, Pt. 4, Proceedings of the Linnean Society of New South Wales, IX, Pt. 3, 1884, pl. XVI.

the terminal aperture from the part facing the stem; second, an elongation of the latter nematophore, with a plain (fig. 60) or crenulated (fig. 66) aperture; third, a notable broadening of the distal portion of the nematophore and a tendency toward the formation of two apertures at the upper corners (fig. 70). This latter type is carried to an extreme in *Aglaophenopsis hirsuta* (fig. 64), in which there appears to be a pair of nematophores, while in reality there is a single one which is forked and has two distal branches, each with a distinct aperture. The largest cauline nematophores are found in the portion of the genus *Lytocarpus* embraced in the genus *Nematophorus* of



TYPICAL NEMATOPHORES OF THE STATOPLEA. Much enlarged.

Fig. 64.—*Aglaophenopsis hirsuta*, mesial.
Fig. 65.—*A. hirsuta*, gonosomal.
Fig. 66.—*A. hirsuta*, cauline.
Fig. 67.—*Lytocarpus clarkei*, supracalycine.
Fig. 68.—*L. furcatus*, supracalycine.
Fig. 69.—*L. curtus*, cauline. *a*, perforated process.
Fig. 70.—*L. furcatus*, cauline, showing nematocysts.
Fig. 71.—*Nuditheca dalli*, mesial.
Fig. 72.—*N. dalli*, supracalycine.
Fig. 73.—*Halicornaria longicauda*, mesial.
Fig. 74.—*Aglaophenia* sp. (after von Lendenfeld). Much less magnified than the other figures.

Clarke. In some cases these are almost half as high as the hydrothecæ. *Aglaophenopsis cornuta* Verrill also has remarkably large cauline nematophores which are very beautifully crenulated around the margin.

In many species of both groups of Plumularidæ a careful examination at the base of the hydrocladium will reveal a more or less prominent conical, mammillate, or tubular projection with a round aperture at its summit. This is usually regarded as a nematophore. Allman, the first to call attention to the structures under consideration, in his description of *Aglaophenia perpusilla* speaks of the process as bearing a nematophore.[1] The best example of this structure is found in

[1] Report on the Hydroida collected during the Exploration of the Gulf Stream by L. F. De Pourtalès, Memoirs of the Museum of Comparative Zoology, V, No. 2, 1877, p. 48.

the genus *Nematophorus* of Clarke (fig. 69*a*), which is regarded in the present work as a part of *Lytocarpus*. Dr. Clarke, in discussing this in connection with *Nematophorus grandis*, says:

> The cœnosarc of the most proximal hydrotheca on each pinna finds its way to the cœnosarc of the main stem by passing directly through the cavity of the oval basal process, and from the size of the opening of the basal process I imagine that it must be used for the protrusion of protoplasmic processes like those from an ordinary nematophore. The process differs, however, from the ordinary nematophores in containing a portion of true cœnosarc, and to this extent it approaches the nature of a hydrotheca; that is, there exists a swollen, oval process of the perisarc, containing a process of the cœnosarc, and with (what in all probability is) a mesial nematophore upon its upper surface. It appears to be, then, a structure which we may look upon as a rudimentary hydrotheca.[1]

Later investigations have demonstrated that the nematophores contain true cœnosarc, and therefore the above distinction between the hydranth and nematophores breaks down. I have carefully examined a number of species exhibiting these processes and found nothing to justify the theory that they are rudimentary hydrothecæ. It appears to me that the processes themselves contain no cœnosarc, but that the cœnosarc of the hydrocladium is seen through the aperture of the process, the cavity of which communicates broadly with that of the hydrocladium. Neither have I been able to find the large nematocysts which are so conspicuous in the nematophores of the same species. In no case, moreover, have I found the sarcostyle projecting from the orifice. Another feature, which casts a doubt on the theory that we have here to deal with a nematophore, is the fact that in all species which I have examined the usual number of cauline nematophores is present in addition to the problematical process under consideration. Prof. W. Baldwin Spencer suggests a use for the conical processes which is worthy of consideration. In his discussion of *Plumularia procumbens*, he says:[2]

> In the axil of the pinnules there are present two nematophores— * * * (2) between these a curious structure formed of the perisarc, having the shape of a cone with the apex cut off. The space within the latter communicates by the narrow end with the exterior, and by the broader with the cavity of the pinna joint. Into it cells of the ectoderm may enter to a slight degree, but more usually it appears to be unoccupied (in spirit preserved specimens), and I am quite unable to attach any meaning to it, though it is a perfectly constant structure. * * * Possibly it may serve as a means of allowing of the ingress and egress of water to and from the perisarcal tubes. Any space between the ectoderm and the perisarc in the very numerous tubes which compose the colony must presumably be filled by liquid. The openings leading into the hydrothecæ and nematophores from the stem are small and narrow, and quite filled up by the soft parts. When sudden contraction takes place part of the soft portions must be withdrawn through these openings and occupy space within this perisarcal tube previously, presumably, occupied by fluid. If there be some means of expelling this fluid, then the sudden contraction of the polypes and machopolypes is rendered more easy. It may be that these openings serve this purpose. The openings are guarded, as it were, by two machopolypes.

The gonosomal nematophores of the Statoplea are quite constant in their general features, the most characteristic form being represented in *A. pluma*. They are oval in form, borne on the edges of the corbula leaves, and curved so that their apertures are directed nearly upward. They are monothalamic, although there is a downward projecting chitinous process on the interior of the side next the corbula leaf. In the genus *Aglaophenia* nematophores are borne on both edges of the corbula leaves, although in what is called the "closed" corbula there is apparently but a single row situated on the distal edge of the leaf, those on the proximal edge being concealed by the imbrication of the leaves. These nematophores vary considerably in size and shape, sometimes assuming the form of a tube (*Aglaophenia rathbuni*) and again being almost globular (*A. pluma*). There is often a very long, pointed or tubular nematophore directed forward from near the base of each corbula leaf (*A. lophocarpa*). In the genera possessing phylactogonia the nematophores are arranged in more or less regular rows along the protective branchlets. Sometimes there is a distinct arrangement in sets of three (*Lytocarpus*) which are supposed to represent the supracalycine and mesial nematophores of hydrothecæ which have been replaced by gonangia. In several species of *Aglaophenopsis* these phylactogonia are jointed, each joint bearing a nematophore on its outer surface; for example, *Aglaophenopsis hirsuta* (fig. 65).

Very long tubular nematophores are found on the gonosome of *Lytocarpus ramosus* (Fewkes), and they are further remarkable for having both a terminal and lateral aperture. In *Aglaophe-*

[1] Report on the Hydroida collected during the Exploration of the Gulf Stream and Gulf of Mexico by Alexander Agassiz, 1877–78, Bulletin of the Museum of Comparative Zoology, V, No. 10, p. 249.

[2] A New Family of Hydroidea, together with a Description of the Structure of a New Species of Plumularia, Transactions of the Royal Society of Victoria, 1890, pp. 132, 133.

nopsis the margins of the nematophores are finely crenulated. In most other forms the margins are even.

In *Nuditheca dalli* (Plate XXXIV, fig. 6) there is no protective branchlet, and in this case there are two *bithalamic* nematophores attached directly to the gonangia, as so commonly found in the Eleutheroplea. This arrangement is, I believe, unique among the Statoplea. In those species of *Halicornaria* the gonosome of which I have examined there are no gonosomal nematophores.

Sarcostyles.—As before intimated, the writer prefers to designate the sarcodal contents of the nematophores as sarcostyles, a name originally proposed by Hincks and synonymous with the "extensile process" of Hincks's earlier work; "protoplasmic process," "sarcodal process" of Allman; "wehrpolypen," "machopolyps," "wehrthier" of von Lendenfeld, Kirchenpauer, and others; "nematophores" of Merejkowsky, Hamann, and Weismann. The last three authors, however, seem to include both the sarcostyle and nematophore, as the terms are here used, under the common and original designation "nematophore."

It is doubtful if any structure found in the Hydroida has given rise to more discussion and incited to more careful investigation than this. From the time when Allman, in 1864, published his communication On the Occurrence of Amœbiform Protoplasm and the Emission of Pseudopodia among the Hydroida down to the most recent investigations no structure found in the plumularians has been so carefully and repeatedly studied. Perhaps the growth of our knowledge concerning the sarcostyles can best be understood by means of a brief summary of the principal discoveries, discussed in chronological order.

In 1863 Semper, in his Preliminary Narrative of the Philippines, speaks of a hydroid almost as high as a man, in which the three nematophores associated with each hydrotheca contains "nessel polyps." In his figure[1] of the latter, which are undoubtedly sarcostyles, we have the first representation of these structures that I have been able to find, and this figure represents the sarcostyle as being a true person with well differentiated endoderm and a *large body cavity*, thus coming considerably nearer the truth than most writers for the succeeding twenty years. The species in question seems to have been *Lytocarpus philippinus* (Kirchenpauer).

In 1864 Allman published the above-mentioned paper,[2] in which he described the contents of the nematophore as a soft granular mass which could send forth very extensible processes which could be very greatly produced and then so completely retracted as to apparently disappear. These processes have, moreover, the power of sending forth pseudopodia, as does the Amœba, and acting in many respects exactly as do certain Rhizopods. The author considers that the sarcostyles are composed of undifferentiated protoplasm in which nematocysts are sometimes immersed.

In 1868 Hincks[3] quotes from the above-mentioned paper of Allman and adds: "I have made similar observations on *Plumularia setacea* and *P. frutescens*. On a young specimen of the latter species obtained at Oban the nematophores were in a state of great activity, sending out long filamentary processes, which tended some upwards and some downwards, following the course of the stem and branches, and completely investing the zoophyte with a multitude of gossamerlike threads." This author does not regard the nematophores as weapons of offense, for the reasons that nematocysts are not always present and that they are not carried out with the pseudopodial processes. He suggests that they may have some connection with the nutrition of the colony. As to the histological structure of the sarcostyles, he regards these organs as "ectodermal offshoots somewhat less consolidated than the layer from which they originate." The ectoderm he describes as "of the simplest homogeneous texture, a structureless contractile substance not unlike 'sarcode' in any essential particular."

In 1871 Allman[4] reaffirms the structureless composition of the contents of the nematophores and says: "It differs in no respect from the sarcode matter composing the bodies of the Rhizopoda, and, like it, it is capable of emitting true pseudopodia." He says that the nematocysts are stationary, never being carried out by the sarcode or its processes.

[1] Zeitschrift für wissenschaftliche Zoologie, XIII, pl. XXVIII, fig. 4*a*.

[2] On the Occurrence of Amœbiform Protoplasm and the Emission of Pseudopodia among the Hydroida, Annals and Magazine of Natural History, March, 1864, p. 203.

[3] British Hydroid Zoophytes, London, 1868, pp. xvii, xviii.

[4] A Monograph of the Gymnoblastic or Tubularian Hydroids, Ray Society, London, 1870–1872, p. 115.

No further investigations of importance seem to have been carried on until eleven years later. In 1882 Hamann[1] brought to bear upon the sarcostyles for the first time the modern methods by which the efficiency of the microscope has been so immensely increased, and succeeded in discovering some of the most important points regarding the nature, both histological and homological, of these interesting structures. This author contributed the following points: The sarcostyle is composed of external ectoderm with an endodermal axis which is composed of nucleated cells, the two being separated by the stutzlamelle. There are a few nematocysts in the end of the sarcostyle in *Plumularia* and many in the same place in *Antennularia*. The extensibility of the sarcostyle is enormous, but is due to the action of muscle fibrillæ. The amœboid movements seen in the processes from the sarcostyle the author compares to the well-known "*pseudopodia cells*" in the foot of the common Hydra, and does not believe that we have here to do with amœboid protoplasm. Regarding the morphological significance of these structures, they are degenerated polyps or degraded persons of the colony, in which the mouth and stomach have been obliterated and the tentacles lost. The sarcostyles originate in a proliferation of ectodermal and endodermal cells of the stem, forming a process which finally breaks through the investing chitine, which has left a cup-shaped receptacle.

In the same year (1882) C. Merejkowsky published a very important paper entitled Structure et Développement des Nématophores chez les Hydroides.[2] It does not appear that this author was aware of Hamann's investigations, and hence the two works are the more valuable as independent contributions. The figures in Merejkowsky's work add greatly to its utility and constitute by far the best set of illustrations showing the morphology and development of nematophores that have yet appeared. The following is a condensed translation of the author's summary:

First. The nematophores are composed, not of sarcode, but of an endodermal axis and an ectodermal covering divided by a membrane, "stutzlamelles" (fig. 75).

Second. Ordinarily two parts can be distinguished, the fixed and the motile, the latter being composed of ectoderm alone, exhibiting amœboid changes of form.

Third. In the motile part the cells present a special histological type, in that *they are immersed in a contractile, structureless protoplasm* to which the movement of the organ is due, and from which pseudopodia are produced (figs. 76, 77). The author suggests that this intercellular protoplasm may be the aggregated "ectoplasm" of the individual ectoderm cells.

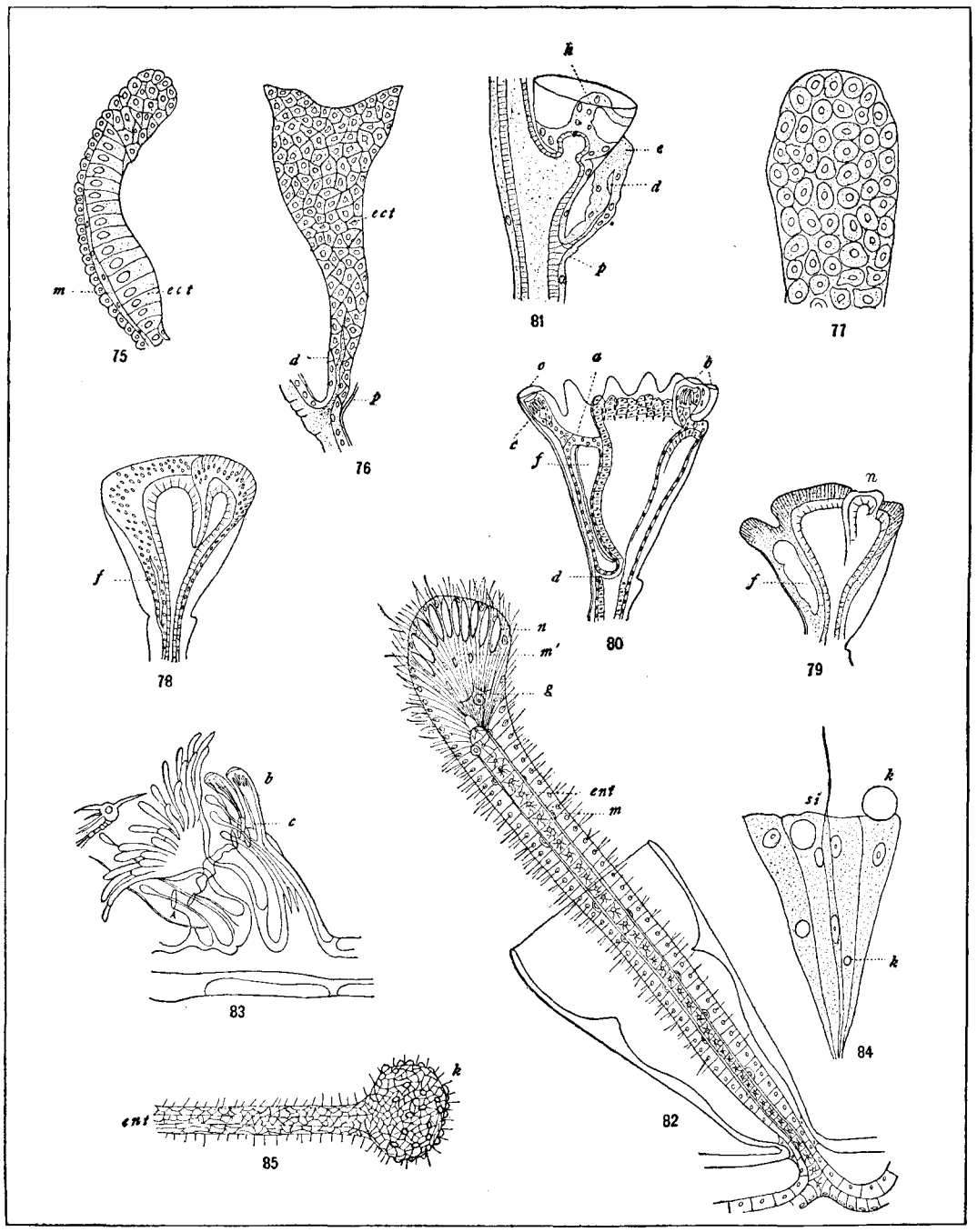
Fourth. The development of the nematophores takes place in two ways. In *Aglaophenia* a reduplication is formed in the ectoderm of the future hydranth, afterwards the endoderm enters the already formed sarcostyle (figs. 78–80). In *Plumularia* and probably in *Antennularia* the sarcostyle is formed by a process or swelling of the ectoderm, afterwards filled by an invagination of the endoderm. In regard to the part taken by this structure in the life of the colony, Merejkowsky thinks that they are not special organs to serve a certain function, but that they are individuals or degenerate polyps. Their structure is analogous to that of the hydranths, being formed of ectoderm and endoderm. The absence of a body cavity is due to degeneration. The presence of nematocysts demonstrates that they serve in the defense of the colony. The best proof that they are degenerate individuals lies in the fact that the hydranths, under certain conditions, are transformed into sarcostyles. Merejkowsky has seen this take place in specimens of *Plumularia halecioides* (fig. 81) which were left overnight in a vessel of running water. The tentacles and mouth disappeared, the whole body diminished in volume, and the entire structure presented a close resemblance to a sarcostyle. The ectoderm exhibited movements characteristic of nematophores, sending out long threadlike processes which continually changed form and even crept up the side of the hydrotheca.[3] The movement was weaker than in true nematophores. The author concludes by reasserting his belief in the fact that the nematophores are "*individus dégénérés.*"

In 1883 three important works appeared, each of which contained detailed accounts of the sarcostyles. I judge from the context that no one of these authors had the opportunity to con-

[1] Der Organismus der Hydroidpolypen, Jenaische Zeitschrift für Naturwissenschaft, XV, New Ser., VIII, 1882, pp. 17, 18, 65.

[2] Archives de Zoologie Expérimentale et Générale, X, 1882, pp. 583–610, pl. XXIX A, B.

[3] The writer saw a similar case in Naples, where a hydranth of an *Aglaophenia* became disgusted with its surroundings and began to degenerate, sending off very pronounced sarcodal processes from its ectoderm to the hydrothecal walls.



THE MORPHOLOGY OF THE SARCOSTYLES.

Figs. 75-81.—After C. Merekowsky. Figs. 82-85.—After R. von Lendenfeld.

Fig. 75.—Sarcostyle of *Plumularia* sp. in longitudinal section. *ect*, ectoderm; *m*, endoderm.

Fig. 76.—The same greatly expanded. *d*, endoderm; *ect*, ectoderm; *p*, perisarc.

Fig. 77.—Portion of same, showing ectodermal cells embedded in free protoplasm.

Fig. 78.—Young hydranth of *Aglaophenia* in longitudinal section. *f*, space formed by a fission in the ectoderm.

Fig. 79.—The same in a later stage of development. *f*, space formed by fusion of ectoderm. *n*, budding nematophore.

Fig. 80.—The same with nematophores fully developed. *a*, bridge of ectoderm uniting the hydranth and sarcostyle; *b*, supracalycine nematophore; *c*, mesial nematophore; *d*, ectoderm entering base of nematophore; *f*, the fissure which commenced as represented in figure 78; *o*, opening of mesial nematophore.

Fig. 81.—Hydrotheca containing the hydranth which is degenerating into a sarcostyle. *d*, endoderm; *e* and *k*, protoplasmic processes; *p*, perisarc.

Fig. 82.—Nematophore and sarcostyle of *Plumularia* sp. *ent*, endoderm; *g*, ganglion cells; *m* and *m'*, muscle striæ; *n*, nematocysts.

Fig. 83.—Sarcostyles of *Aglaophenia* sp. capturing a Zoea. *b*, nematocyst-bearing process, and *c*, adhesive process, of sarcostyle.

Fig. 84.—Portion of end of "adhesive polyp," highly magnified. *k*, adhesive globules; *si*, sense organ.

Fig. 85.—"Adhesive polyp;" *ent*, endoderm; *k*, knob at end containing adhesive globules.

sult the work of the others,[1] and only one of them had the advantage of consulting Merejkowsky's paper, and that was Weismann.

Weismann,[2] in his discussion of *Plumularia echinulata*, agrees with Hamann and Merejkowsky in describing the sarcostyles as composed of ectoderm cells surrounding a solid endodermal axis, the two layers being separated by the stutzlamelle. He considers the sarcostyles as degenerate polyps. He takes issue, however, with Merejkowsky concerning the free intercellular protoplasm in the sarcostyle. He thinks that the phenomena concerning the pseudopodial processes are similar to those frequently observed in the ectoderm of the stem, which greatly resembles free protoplasm in its appearance and movements while living, but proves strictly cellular when examined after staining and sectioning.

By far the most complete investigation of the sarcostyles that has yet appeared was published in that same year (1883) by von Lendenfeld.[3] He had an excellent opportunity to study the active sarcostyles of many living Australian Plumularidæ. The following is a condensed translation of the more important points ascertained by von Lendenfeld:

The author agrees with Hamann that the sarcostyle (Wehrthiere) is a modified polyp. He divides the sarcostyles into three classes, as follows:

First. *Sarcostyles with nematocysts* (fig. 82) characteristic of the genus *Plumularia*, consisting of a solid endodermal axis composed of cells much like the axial cells of the solid tentacles of the hydranths, and an ectoderm composed of two layers, epithelial and subepithelial. In the latter or subepithelial layer is a bundle of muscle cells. Between the ectoderm and the endoderm is a dividing membrane or stutzlamelle. The muscle cells combined constitute a cylinder embracing the distal part of the axis, but outside of the stutzlamelle. Several large ganglion cells are found in the subepithelial layer at the end of the axis. Large curved nematocysts lie in the endothelium, each being partly inclosed in a plasma investment with a flat nucleus. The distal end of the plasma layer of each nematocyst cell is produced into a long process. All of these processes are concentrated at the very spot where the ganglion cells lie. There are sometimes radial muscle cells in which are situated the thick handles of the cnidoblasts. The author regards some of the surface cells as sense cells. The expansion of these sarcostyles is much more rapid than their retraction, the movements being like that of a solid tentacle, but slower. The tentacles are of far older phylogenetic structure than are the sarcostyles. Transition between a Protohydra and a sarcostyle consists of a gradual pressing back (zuruckdrangen) of the digestive cavity, resulting first in solid tentacles and then in a growing together of the body walls. Sarcostyles are defensive weapons because they are most active when the colony is disturbed, but they are also employed in the capture of food. In all cases examined the nematocysts remain in the distal end of the sarcostyle, accompanying the latter in its movements.

Second. *Sarcostyles with adhesive cells* are found particularly in the mesial nematophores of *Aglaophenia*, but also in *Plumularia*. These sarcostyles are similar to the first kind, but have adhesive cells in place of nematocysts. These adhesive cells are considered to be identical with the snare threads (Fangfaden) or prehensile cells of Ctenophores. The "adhesive polyps" are very mobile, being capable of extending themselves into long fine threads, each ending in an enlargement, which is itself capable of considerable change of form (fig. 85). Surface cells, subepithelial muscle cells, ganglia, and an endodermal axis are present. The distal portion consists of crowded pyramidal cells (fig. 84) radially arranged, and with adhesive bodies in the shape of rounded highly refractive globules. The cells resemble glandular cells, and the globules originate in the narrow proximal part of each cell and migrate during their development toward the distal wider ends of the cells, finally protruding through the upper surface. These are the adhesive cells which occur in considerable numbers on the distal end of the sarcostyle. They differ from the similar structures in the Ctenophora in not having the thread spirally coiled. The author has seen these sarcostyles with an appearance of branching, due to the fact that one or more adhesive cells, having become attached to some foreign object, remain connected by a very fine thread upon the retraction of the sarcostyle.

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[1] Weismann includes Jickeli's work in his bibliography, but it evidently appeared too late to be consulted in the preparation of the text.

[2] Die Entstehung der Sexualzellen bei den Hydromedusen, Jena, 1883, pp. 175, 176.

[3] Ueber Coelenteraten der Südsee, III. Mittheilungen Ueber Wehrpolypen und Nesselzellen, Zeitschrift für wissenschaftliche Zoologie, XXXVIII, 1882, pp. 355–371.

Third. *Sarcostyles with nematocysts and adhesive cells* are exclusively found in the paired nematophores of *Aglaophenia*.[1] The lower pair of nematophores in *Pentandra* were the ones which appear to have been most successfully studied. These sarcostyles are composed of two parts—a distal, containing nematocysts, and a proximal, containing the adhesive cells and constituting the "adhesive polyp." The latter portion is developed from the former. The endodermal axis and stutzlamelle are wanting in the distal portion, but ganglion cells are found, together with radial muscle cells and other cells which the author considers sense cells. The proximal or adhesive portion is greatly extensible and contains an endodermal axis. The entire structure is merely a somewhat complicated single sarcostyle, and not two joined together, as might be supposed. The sarcostyles begin to develop long before the hydranth with which they are associated. At first they contain no adhesive cells, their places being taken by nematocysts, but later they are found developing in the supporting cells between the cnidoblasts, and increase, as it were, at the expense of the latter, which lose their plasma investment, the nematocysts themselves finally disappearing. Still later, when the adhesive cells are matured, there are yet a few single nematocysts on the adhesive part of the sarcostyle.

This author gives an interesting account of the action of living sarcostyles of this type. The Plumularian captures the embryos of crustacea (Zoea) as follows: The prey, coming in contact with a tentacle of the hydranth, is pierced by the tentacular nematocysts, which have a narcotizing effect. Next it comes in contact with one of the adhesive bodies at the end of the greatly produced sarcostyle. The adhesive cells adhere to the prey, and the body of the adhesive polyp quickly retracts, bringing the Zoea into contact with more of the globular adhesive masses, which hold it in spite of even the most violent struggles for liberty. It is thus brought again within range of the tentacles and devoured. The adhesive cells are finally cast off, remaining attached to the victim, and the sarcostyles again retract.

When a large animal, such as an Annelid, strikes the tentacle, the adhesive threads immediately retract, as do also the tentacles, and the batteries of nematocysts on the other part of the sarcostyles are brought into play to repel the attack (fig. 83).

The author regards the nematocysts and adhesive cells as homologous structures, and believes that they are not gland cells, but a secretion of gland cells, a product thrown off from the organism and of no further utility. Von Lendenfeld does not seem to have encountered anything like the intercellular protoplasm of Merejkowsky. It seems probable that the unicellular glands of the latter are much the same as the adhesive cells of von Lendenfeld.

Dr. Carl F. Jickeli, in his second paper on Der Bau der Hydroidpolypen,[2] discusses the sarcostyles more briefly than the other writers. He does not seem to have seen the works of Merejkowsky, Weismann, or von Lendenfeld. He concludes that the sarcostyle is homologous with the solid tentacle of the hydranth, with an axis composed of endodermal cells. He regards the tentacular organs of *Ophiodes* as sarcostyles, and considers them as homologous with the capitate tentacles of many hydroids, and thinks it possible to find the intergradation between scattered sarcostyles and the complete tentacle whorl of the Plumularian hydranth. He seems to regard the sarcostyle of *Aglaophenia*, with its distal defensive and proximal adhesive parts, as a two-tentacled sarcostyle, a suggestion with which no authority that I have consulted would be likely to agree.

This author finds an objection to regarding the sarcostyles as weapons of the colony in the fact that they are most abundant where, in his opinion, they are least needed—that is, in the vicinity of the hydranths, which are sufficiently protected by the nematocysts in the tentacles—and are wanting in the delicate twig terminations, where, he thinks, they would be most effective.

In 1888 the second part of the report of the *Challenger* collection of hydroids appeared, in which Professor Allman says:[3]

> We have, however, already seen that the ectoderm, in the modified condition which it often presents in the cœnosarc, may show an entire obliteration of cell boundaries and may throw out processes having many of the characters of true pseudopodia, and it needs but a further modification of this layer, consisting in a still lower grade of

[1] The species more especially studied by this author was *Pentandra parvula*, a form which von Lendenfeld at one time regarded as *Aglaophenia parvula* Bale. It is characterized by having two pairs of paired nematophores and a single mesial nematophore in connection with each hydranth.

[2] Der Bau der Hydroidpolypen, Morphologisches Jahrbuch, 1883, VIII, pp. 580-680.

[3] Report on the Hydroida dredged by H. M. S. *Challenger* during the years 1873-1876, Second Part, 1888, pp. xix, xx.

degradation towards the condition of undifferentiated protoplasm, in order that it may possess the faculty of emitting pseudopodia to the extraordinary extent which we meet with in the sarcostyles of the Plumularinæ; so that even though all the three body layers be present in the sarcostyles, we shall have in these appendages a portion which can scarcely be distinguished from undifferentiated protoplasm. If this portion be not free protoplasm, it must be sought for in the ectoderm.

It should be remembered in this connection that every observer, so far as I can discover, who has carefully studied properly prepared material for the investigation of sarcostyles has definitely announced that the extensible processes are made up of ectodermal cells. The one modification of this view is that of Merejkowsky, who announces that the cells were immersed, as it were, in intercellular protoplasm.

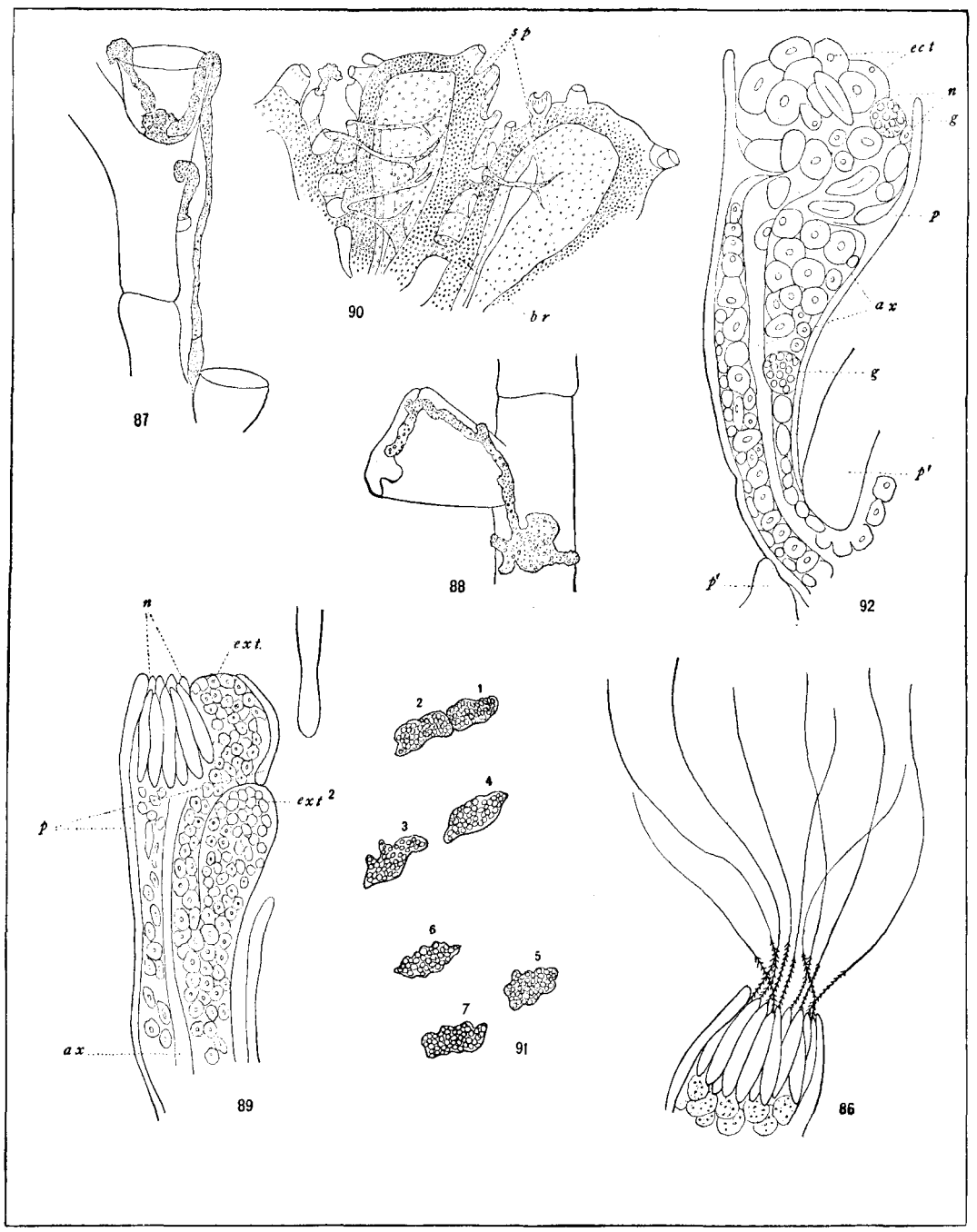
I know of no special investigations of the sarcostyles between 1888 and 1895, when the present writer spent some time in the study of these remarkable structures at the Marine Biological Laboratory in Plymouth, England, and the Zoological Station in Naples, Italy. As to the histological structures he confirmed the conclusions of the later writers in most points. The sarcostyles are composed of well-differentiated cells forming an ectoderm and an endoderm, separated by a stutzlamelle. The arrangement of cells in *Plumularia pinnata* corresponds with that of *Plumularia halecioides* as illustrated by Merejkowsky, the ectodermal cells on one side of the axis being very much larger than those on the other. Muscular fibrillæ were found in *Plumularia pinnata* and *Antennularia janina*. There are few nematocysts in the sarcostyles of the Eleutheroplea so far as examined, but adhesive cells seem to play an important part. In several species of *Aglaophenia* nematocysts were found forming formidable batteries just inside of the distal end of the nematophores (fig. 86).

In the Eleutheroplea the nematophores seem always to be of the simpler type, not being divided into nematocyst-bearing and adhesive parts. In the Statoplea the ordinary arrangement seems to be to have both these parts well developed and differentiated.

I was not able to demonstrate the sense cells and ganglion cells of von Lendenfeld nor the intercellular protoplasm of Merejkowsky. I do not consider, however, that this negative evidence should weigh with any considerable force against the positive statements of such men as Hamann, Weismann, and the others quoted above. I am inclined to seriously doubt the existence of the intercellular protoplasm, however, from the fact that the discovery of Merejkowsky is not confirmed by either of the three careful observers who immediately succeeded him, and is denied positively by Weismann. Hamann's comparison of the pseudopodia of the cells of the foot of the hydroida with those of the sarcostyles seems to me to be an apt one. I have myself seen the living ectodermal cells of the somewhat protruded sarcostyle of *Aglaophenia pluma* send out perfectly characteristic pseudopodia. It may be observed in this connection that under a high power and careful manipulation of light it is sometimes possible to plainly distinguish the limitations of the cells in the living sarcostyles. It would seem then that the ectodermal cells are themselves amœboid and capable of conjointly exhibiting the wonderful extensibility so often described.

A careful study of living and active sarcostyles yielded some results worthy of mention. Those of *P. pinnata* proved particularly active in the vicinity of degenerating hydranths and mutilated gonangia (fig. 88). They advanced with a creeping motion over the sides of the hydrothecæ and gonangia, and into their cavities so as to suggest the idea that they might be acting as scavengers for the colony. It could plainly be seen that the sarcostyles were adhesive, particularly at the ends of the extensible processes, which would apparently cling to any object to which they became attached. Then when the sarcostyles were contracted these ends would adhere until their resistance would be suddenly overcome and the entire process retract with a jerking motion, the whole structure behaving much like a rubber band attached by an adhesive end to some object and then torn away by a pull on the rubber. The mesial sarcostyle of *Aglaophenia helleri* (fig. 89) seems to be divided into three parts; one containing a battery of nematocysts and situated just inside of the distal end of the nematophore; another, adhesive, which projects into the hydrotheca through an opening leading from the adherent part of the nematophore; and a third, also adhesive, which projects out from the top of the hydrotheca, crowding the nematocyst battery to one side.

In studying the young gonosomal sarcostyles of *Aglaophenia pluma* it appeared that a new function was here exercised. The corbula under examination was in a very early stage of development and the corbula leaves had not yet become adherent to each other along their edges, as is



STUDIES OF LIVING SARCOSTYLES.

Fig. 86.—Mesial nematophore of *Aglaophenia* sp., showing battery of nematocysts with threads extruded.

Fig. 87.—Sarcostyle of *Plumularia pinnata* entering the hydrotheca containing disintegrating hydranth.

Fig. 88.—Sarcostyle of *Plumularia pinnata* entering a gonangium in which the gonophores have been destroyed.

Fig. 89.—Mesial nematophore of *Aglaophenia helleri*. *ax*, axial cavity of sarcostyle; *ext*, the terminal extensible process; *ext*^{2}, the extensible process which projects into the hydrotheca; *n*, battery of nematocysts.

Fig. 90.—Corbula leaves of *Aglaophenia pluma*, showing the sarcostyles holding the edges together. *br*, bridge formed between adjacent corbula leaves; *sp*, sarcodal processes.

Fig. 91.—Amœboid cells found in the axial cavity of *A. pluma*, showing successive changes in outline during a period of two minutes.

Fig. 92.—Mesial nematophore of *Antennina janini* in optical section. *ax*, axial cavity of sarcostyle; *ect*, large ectoderm cells; *g*, gland cells (?); *n*, nematocysts; *p*, perisarc; *p'*, perisarc of stem.

the case in older specimens, and the sarcostyles were exceedingly active, stretching across from one leaf to the next, to which they became attached by their adhesive ends and remained in that position for a considerable time (fig. 90).

It appeared as if these sarcostyles served as a temporary attachment to hold the edges of the leaves together, while the edges themselves were connected by trabeculæ of cœnosarc, which rapidly formed a stronger and permanent connection. The perisarc of the edges of the leaves seemed exceedingly thin and in places appeared to be wanting. A contact having been established between the edges of the adjacent leaves the permanent attachment was soon formed, and the cœlomic cavities of the leaves established connections at these points. A little later currents of water bearing granules were seen to flow in active streams from one leaf to the other.[1]

After this connection was strongly effected the sarcostyles retracted suddenly within their nematophores. The design of the arrangement and the function of the sarcostyles seemed so evident that I have little doubt that we here have a hitherto unnoted use for these sarcostyles.

In a study of the mesial sarcostyle of *Aglaophenia* species at Naples, I witnessed an apparently conclusive proof that the structure possesses an axial cavity corresponding to the body cavity of the hydranth.[2] When examining a living sarcostyle under a one-twelfth oil immersion lens I could distinctly see the so-called endodermal axis, which was sharply divided off from the ectoderm by the stutzlamelle. The axial endodermal cells were not distinctly outlined in the live specimen. While trying to distinguish these cells I saw, much to my astonishment, a granular amœboid cell quickly pass along the exact axis of the nematophore. This cell had very much the appearance of an amœba, with the exception of the fact that the granules were much more numerous and sharply outlined. The cell was constantly changing form and putting forth pseudopodia with as great rapidity as the most active amœba (fig. 91). My attention having once been attracted to these strange cells, there was no difficulty in seeing that they were in nearly every sarcostyle examined. Sometimes several were found together in the same sarcostyle. They appeared to be engaged in traveling back and forth along the axial line of the sarcostyle, and none were observed to pass to the ectoderm nor to the cavity of the hydrocladium. Their progress was too rapid and uninterrupted to admit of its being explained as a mere working of a passage between the loose aggregation of endodermal cells, and the conviction was strong that they were traversing an axial cavity of the sarcostyle. It appeared as if the walls of the cavity were ordinarily in contact but not adherent; as if it were, in effect, a collapsed tube (fig. 89). When the amœboid cells were passing along the very thin walls of the tube could be seen to be parted immediately above and below the cells. The cavity could not be seen in stained preparations, although a careful search was made for it. This may be due to the fact that the thin walls are collapsed at all times except when forced apart by the passage of the cells. These latter reminded one very strongly of the leucocytes in the human blood. They were afterwards found in abundance in the endoderm of the hydranths and more sparingly in the endoderm of the stem. They were most abundant of all in the rapidly growing terminations of the stems in an undescribed species of *Aglaophenia*.[3]

In these positions, however, they were not seen to move definitely from place to place, although the sending forth of pseudopodia was frequently observed.

As before stated, Semper, who, it seems, was the first to figure the sarcostyles, represented them as having a distinct body cavity. No author has heretofore confirmed this idea, and indeed they seem conclusively proved to be solid when stained and cleared specimens are examined. But the living sarcostyles tell a different story, at least in *Antennularia janini* (fig. 92), where it evidently has a narrow axial tube. In this latter species the endoderm of the sarcostyles was, in some cases, packed with unicellular algæ, as was that of *Aglaophenia pinnata*. In some cases these algæ appeared to be in an axial cavity, where the thin walls of the tube could be seen parting immediately above and below them, as in the case of the amœboid cells.

The nematocysts in the sarcostyles of the Eleutheroplea are not numerous, nor do they present any striking features whereby they can be distinguished from those in other parts of the

[1] C. C. Nutting, Notes on Plymouth Hydroids, Journal, Marine Biological Association, New Ser., IV, No. 2, February, 1896, p. 153; reprinted in Natural History Bulletin, State University of Iowa, IV, No. 1. May, 1896.

[2] This discovery was announced in a paper entitled The Sarcostyles of the Plumularidæ, read before Section F of the American Association for the Advancement of Science at the Detroit meeting and afterward printed in the American Naturalist, April, 1898, p. 223.

[3] This species is the one mentioned by me in Notes on the Reproduction of Plumularian Hydroids, American Naturalist, November, 1895, p. 969.

colony. In most of the Statoplea, however, the sarcostyles are provided with nematocysts which are very large, long, and slightly arcuate, differing greatly from those found elsewhere. They are arranged in a regular bundle just inside of the opening of the nematophore, from which they are seldom, if ever, protruded to any considerable distance. When the thread is extended it is seen to be extensively barbed in its proximal portion, the remainder consisting of an exceedingly delicate filament of great length (fig. 86). It is hard to see the utility of barbs situated as these are, or to understand how they can be brought into play to aid the penetration or lacerating action of the threads when used, as the supposition is, for the defense of the colony.

The most formidable nematocysts that I have seen among the Plumularidæ occur in the genus *Lytocarpus* (fig. 70), several species of which are capable of causing severe irritation to the human skin, which is not usually pervious to the attack of the nettling cells of the Hydroida, with the exception of the millepores which probably find their rightful place in this group.

The researches of Hamann, Jickeli, and others seem to demonstrate with a fair degree of certainty that the nematocysts are not strictly histological cells, but an accessory part or product of cells. The latter writer goes so far as to regard them rather in the light of a secretion.[1]

As to the morphological significance of the sarcostyles, all of the more recent authorities, except Jickeli,[2] regard them as degenerate individuals of the colony, or as "fighting persons."

That they are individuals or "persons" is a matter hardly admitting of doubt; but it may well be questioned whether they are *degenerate* persons or not, and an argument might be constructed which would go to show that instead of being degenerate individuals they are in fact very highly specialized persons. Specialization is indicated when the structure has departed from the original type in order to become adapted to more definite and exclusive function. It would seem that the sarcostyles have done this very thing—departed from the original type (*Protohydra?*), and become morphologically differentiated into individuals having the definite function of defense, in most cases, and of prehension by means of adhesive cells in others.

Defensive persons are more widely distributed among the hydroida than is usually supposed. They are, as we have seen, universally found among the Plumularidæ, and they are also to be met with in *Ophiodes parasitica* Sars, *Ophiodes mirabilis* Sars, *Lafoëina tenuis* Sars, *Oplorhiza parvula* Allman, *Perisiphonia filicaulis* Allman, *Diplocyathus dichotomus* Allman, *Halecium gorgonide* Sars, and *Hydractinia echinata* Fleming.

An interesting new family of hydroids was described by Prof. W. Baldwin Spencer,[3] which, among other novel features, is characterized by numerous cylindrical tubes inclosing defensive zooids which consist of a solid endodermal axis surrounded by an ectodermal layer. The distal end forms a round knob with a number of large nematocysts which greatly resemble those of the Plumularidæ. The whole structure appears to be almost identical with the sarcostyles of *Lafoëina tenuis* Sars.

This family (Hydroceratinidæ) shows distinct relationship to the Hydrocorallinæ in the arrangement of the cœnosarcal tubes and their connection with the hydranths.

Finally, there are many points of resemblance between the sarcostyles of the Plumularidæ and the dactylozooids of the Milleporidæ. A fairly satisfactory line of intergradation between the former and the latter may be traced through *Lafoëina parasitica*, *Halecium gorgonide*, *Hydractinia echinata*, and *Clathrozoon wilsoni*, the only known species of Hydroceratinidæ.

So far as I am aware, none of the defensive zooids in other groups exhibit the great extensibility and the pseudopodial movements found in the sarcostyles of the Plumularidæ, and it is doubtless true that these latter form in themselves a very distinct type of defensive zooids, a type which differs more from any other known form than the remaining types do from each other. It must be remembered, however, that only part of these latter have been studied with care and the use of modern facilities, and there is thus a possibility that a more perfect intergradation between the sarcostyles of the plumularians and the defensive zooids of other groups may yet be demonstrated.

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[1] The author hopes to present a discussion of the nematocysts in connection with the introductory part of this work.

[2] As before mentioned, this writer seeks to establish a homology between the sarcostyles and the tentacles.

[3] A New Family of Hydroidea, together with a Description of the Structure of a New Species of Plumularia; Transactions of the Royal Society of Victoria, 1890. Professor Spencer very kindly furnished the author with a specimen for study.

Allman has come to the conclusion that the nematophores of the Plumularidæ are homologous with the denticles of graptolites. Not having had an opportunity to study these structures with care, I here give Allman's argument, or the most important part of it, in his own words:

> The remarkable bodies known as nematophores, and which are characteristic of the Plumularidæ, have been already described. Among these nematophores there is one form which consists of simple chitinous offsets from the main tube of the hydroid filled with the protoplasmic matter which constitutes the characteristic contents of all the nematophores. The mesial and lateral nematophores of *Aglaophenia* are of this nature, and a comparison of them with the denticles of a graptolite will show how complete is the resemblance. * * * It has been already shown that the toothlike processes which project from the edges of the hollow leaflets, which form the walls of the corbula in *Aglaophenia*, are bodies of an entirely similar kind, and the resemblance between these and the toothlike processes of many graptolites is complete.
>
> Now, it is not alone in general form that the nematophores of *Aglaophenia* resemble the denticles of a graptolite. The mode in which their chitinous sheaths are seen to open into the common canal of the perisarc after the destruction of all the soft parts, is entirely similar to the mode of communication between the denticles and the common canal in the fossil—in those cases at least in which the graptolite has afforded facilities for examination such as to leave no doubt as to the structure of the parts in question—and quite different from that in which the proximal extremity of the hydrotheca is connected with the common tube of the chitinous perisarc in the existing hydroid.
>
> I can not help believing that this is the true view to take of the morphology of graptolites. If so, the graptolites would admit of an approximation through an unexpected channel with the Plumularidæ. They would then be morphologically plumularidans in which the development of hydrothecæ had been suppressed by the great development of the nematophores, probably the mesial ones; while, on the other hand, the existing plumularidan, with well-developed hydrothecæ, would present in its nematophores the last traces of the structure of its ancient representative, the graptolite.[1]

The idea that the nematophores and not the hydrothecæ are homologues of the denticles of the graptolites receives considerable support from the fact that the nematophores are, judging from embryological evidence, older structures than the hydrothecæ, being developed in most, if not all, cases before them in the history of the individual colony. Although this evidence is by no means conclusive, it at least suggests that the hydranth is more modern than the sarcostyle. Almost nothing seems to be known of the living parts of the graptolites, and it is hardly possible to come to any definite conclusion regarding the relationships of these forms which have apparently by common consent been included among the hydroids by several modern writers, notably von Lendenfeld,[2] who places them between the sertularians and plumularians.

GONOSOME.

This term, originally introduced by Allman, is used to designate all those parts of a colony which are concerned directly in the reproductive process (that is, the gonophores and their contents), and also those structures destined for the protection of the gonophores. In the latter category would come the gonangia, corbulæ, and phylactocarps of every description, from the most complicated structures found in *Lytocarpus* and *Aglaophenia* to the simple protective branchlets of certain species of *Cladocarpus*.

Gonophores.—The gonophores of the Plumularidæ are without exception protected by gonangia. When reduced to their fundamental plan they are simple hernialike protuberances from the blastostyle, which are made up of the two histological layers, the endoderm and the ectoderm, the two layers being separated by a thin, apparently structureless membrane, the "*stutzlamelle*" of German writers (fig. 93, *st*). The generative elements, when mature, are found between the stutzlamelle and the ectoderm. The endoderm, with its included axial cavity, forms the spadix, which is surrounded by a mass of spermatozoa in the male, and is pressed to one side by the developing ova in the female.

The blastostyle is itself a diverticulum from the cœnosarc of the hydrocaulus, from which it arises in the same way that the gonophore arises from the blastostyle. The distal or upper part of the blastostyle in many calypteroblastic forms, including the Plumularidæ, is developed during the growth of the sperm masses or ova into a structure which acts as a thick plug in the end of the gonangium, composed largely of ectoderm cells and called "Deckenplatte" by Weismann (fig. 93, *n*).

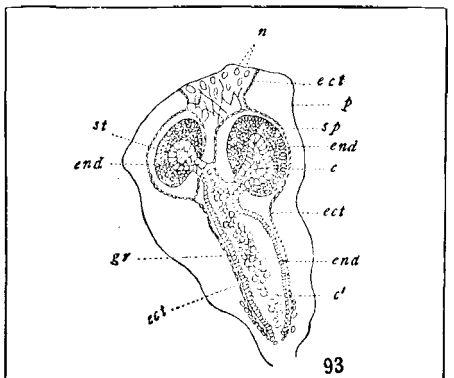
Allman regards the blastostyle as a modified hydranth, and there is little doubt of the correctness of this view, which seems to be demonstrated in the case of certain gymoblastic forms (for example, *Eudendrium*) in which the hydranth loses its character as a hydranth, the tentacles become

[1] A Monograph of the Gymnoblastic or Tubularian Hydroids, Ray Society, London, 1871, p. 179.

[2] Ueber Cœlenteraten der Südsee, V, Mittheilung. Zeitschrift für wissenschaftliche Zoologie, XLI, p. 634.

aborted, and the mouth seems closed, while the ova are developing. In this case the gonophores spring directly from the body walls of the hydranth, the latter being thus a true blastostyle.

Reasoning from analogy, we are justified in regarding the blastostyle of the plumularians as degenerate persons, although this view can not be demonstrated by direct observation. There are reasons, however, for believing that a gonophore itself, in this group, as in many others, is really a degenerate medusa, or "planoblast," as Allman would call it.



HISTOLOGY OF THE GONOPHORES OF PLUMULARIDÆ.

Fig. 93.—Vertical section of the gonangium of *Plumularia pinnata*. *c*, cavity of gonophore; *c'*, cavity of blastostyle *ect*, ectoderm; *end*, endoderm; *gr*, floating granules in cavity of blastostyle; *n*, "deckenplatte" of Weismann; *p*, perisarc; *sp*, sperm cells; *st*, "stutzlamelle."

Fig. 94.—Diagram in longitudinal section of hydroid medusa in a gonangium, to show arrangement of histological layers. Lettering as in fig. 95.

Fig. 95.—Partial transverse section of the gonophore of *Plumularia halecioides; ciz*, ovum; *ekt*, external ectodermal layer of gonophore; *ekt'*, endoderm of bell; *ekt''*, subumbrellar ectoderm layer of the medusa; *ekt'''*, external ectodermal layer of bell of medusa; *ent*, endoderm; *entl*, ectoderm of manubrium; *st*, stutzlamelle.

Weismann found in his investigations of the origin of the sex cells of *Plumularia halecioides* and *Antennularia* that the arrangement of the cell layers in the gonophores of these species was such as to strongly suggest that of the cell layers of the planoblast.[1] In the former species, which was the first studied, he found that there were four layers of ectoderm, instead of one, outside of the ova. These four layers he regards as an equivalent of the three ectoderm layers and one endoderm layer which would be found in making a cross section through one side of the bell and manubrium of a medusa, within a gonangium, the section ending at the place where the ova are situated in the planoblast; that is, between the stutzlamelle and the ectoderm of the manubrium. A comparison of Weismann's figure (fig. 95) with a diagram of a medusa within a gonangium showing the plane of the hypothetical section will make Weismann's ideas plain (fig. 94). It will be noticed that the order in which the several layers occur in his figure, counting from without inward, is *ekt*, *ekt'*, *entl*, *ekt''*, *ekt'''*, which stand respectively for the external ectodermal layer of the gonophore, the external ectodermal layer of the bell of the medusa, the endoderm of the bell, the subumbrellar ectoderm layer of the medusa and the ectoderm of the manubrium. There is also a space between *ekt''* and *ekt'''* which Weismann regards as the space between the bell and the manubrium. The parallelism is therefore exact and goes far to prove the correctness of his idea regarding the homology existing between the gonophore and the planoblast.

Weismann does not show in his figure that the layer *entl* differs histologically from the others. In the text, however, he says: "There can be no more doubt that the present plumularians descend directly or remotely from the medusa-bearing hydroids, and it is not impossible that, at present, plumularians exist with medusa broods."

A single blastostyle may bear a single gonophore, as in the genus *Aglaophenia*, or several, as in many species of *Plumularia*. In *Plumularia echinulata* two or more gonophores are borne in succession upon the same part of the blastostyle. All of the cases that I have been able to find in which there are more than one gonophore on a single blastostyle have been eleutheroplean forms, and I have seen no statoplean with more than one gonophore to a blastostyle.

Ordinarily the colonies are unisexual, but there are a few cases such as *Antennularia* and *Plumularia catharina* in which both sexual products will be found in the same colony. When mature, the sexes can easily be determined, if the gonophores are removed from the gonangia, by the fact that in the male the spadix is surrounded by a

[1] Die Entstehung der Sexualzellen bei den Hydromedusen, Jena, 1883, p. 185, pl. XXIV, fig. 12.

globular mass of sperm cells, while in the female the ova are all on one side of the spadix. In the male the spadix may break up distally into several lobular diverticula which penetrate the mass of sperm cells.

Gonangium.—This is to the blastostyle what the hydrotheca is to the hydranth and the nematophore is to the sarcostyle, being purely protective in its nature, inclosing the reproductive individual in a chitinous capsule, the distal end of which appears to be closed in almost all cases by a chitinous cap, which is finally ruptured by the passage of the sexual products.

The gonangia in the Eleutheroplea are found most commonly along the front of the hydrocladiate portion of the stem and rather frequently on the hydrocladia, where they are usually placed just below the hydrothecæ. More rarely they spring from the hydrorhiza (*Plumularia echinulata*), although I know of no American form which exhibits this peculiarity. When growing on the front of the stem they are most frequently situated in the axils of the hydrocladia although they are at times thickly crowded along the entire front of the stem (*Plumularia pinnata*). In the Statoplea the gonangia are borne rather exceptionally on the stem, as in *Cladocarpus septatus* and several species of *Halicornaria*, and commonly on a modified hydrocladium, as in *Aglaophenia*, *Cladocarpus* (in part), and *Aglaophenopsis*. Rarely they are borne on unmodified hydrocladia, as in *Nuditheca dalli* and *Halicornaria saccata*. In some cases they are borne on nematophorous appendages to the hydrocladia, as in *Cladocarpus paradisea*. In many cases they appear to replace hydrothecæ, as in several species of *Lytocarpus*, and in others they are thought to take the place of mesial nematophores, as in certain species of *Aglaophenopsis*.

In form the gonangia are typically ovate, but there are many more or less important modifications. As illustrating these departures from the type form in the Eleutheroplea, the following may be mentioned: The cylindrical gonangium of *Antennopsis annulata* (Plate XII, fig. 7), with an apparently truncated end. The gonangia of *Schizotricha tenella* (Plate IV, fig. 4) in the shape of a robust horn or cornucopia, the tip of the horn being attached to the hydrocaulus and the large end containing the aperture; the oblong-ovate form found in *Plumularia elegantula*, with a cruciform depression on the distal end; the oblong ovate form with lunate latero-terminal aperture shown in *Antennularia americana* (Plate IX, fig. 3); the spinulose gonangium found in *Plumularia echinulata*, which has the upper portion armed with long, strong, hornlike spines; the greatly elongated gonangia with distal ends produced into slender necks found in *Plumularia setacea* (Plate I, fig. 1); the obovate form found in *Plumularia altitheca* (Plate II, fig. 1); the globular form characteristic of *Schizotricha dichotoma* (Plate XV, fig. 4); the obovate structure with a pronounced operculum of *Plumularia stylifera* Allman; the annulated gonangia of *Plumularia halecioides*; and the obconical gonangia with the very wide shelflike rim around the top and branched nematophorous processes shown in the remarkable species *Sciurella indivisa*. The gonangia of the Eleutheroplea are in general larger than in the Statoplea, and show considerable more divergence in form. They are very generally armed with two or more nematophores placed on or immediately above the peduncle.

In the Statoplea the gonangia show but little diversity in form, probably on account of the greater proportion of protected gonangia found in that group. In *Aglaophenia* the oblong-ovate form is, so far as I know, universal. In *Cladocarpus* the latero-terminal lunate aperture prevails. The gonangia are flattened and obcordate in outline in several species of *Lytocarpus* (Plate XXXI, fig. 6). In *Nuditheca* they are exceedingly large and elongated, with thick chitinous walls. Finally there are the inverted cones characteristic of *Halicornaria* (Plate XXXIII, fig. 10).

Structures for the protection of the Gonangia and their contents.—In many of the eleutheroplean genera and in most of the Statoplea there are special contrivances always supplied with numerous nematophores, which are evidently designed to guard the important structures contained within the gonangia. The term "*Phylactocarp*" has been used by Allman[1] to designate any structures obviously intended to serve this purpose, and it has been of great convenience in the discussion of these highly diversified and interesting features of the Plumularidæ. The same writer has divided the family into two groups on the basis of the presence or absence of phylactocarps, those species possessing these structures being called "*phylactocarpal*," while those not possessing them are "*gymnocarpal*."

[1] Report on the Hydroida dredged by H. M. S. *Challenger* during the years 1873-1876, p. 10, Pt. 1, Plumularidæ, 1883, p. 10.

Among the Eleutheroplea the genera *Schizotricha*, *Diplopteron*, *Polyplumularia*, *Hippurella*, and *Callicarpa* are here regarded as phylactocarpal, the remaining genera—*Plumularia*, *Monotheca*, *Antennularia*, *Antennopsis*, *Calvinia*, *Antennella*, and *Monostæchas*—being gymnocarpal.

Although it is contrary to the position taken by previous writers, several of these genera, such as *Schizotricha*, *Diplopteron*, and *Polyplumularia* are, as above indicated, regarded as phylactocarpal. The reason for this is as follows: In examining a series of *Schizotricha dichotoma* collected in the West Indies, I found evidence sufficient, in my opinion, to show that the branching of the hydrocladia is a character directly associated with reproduction; in other words, it is temporary, often connected more intimately with the gonosome than with the trophosome, and is designed for the protection of the gonangia (Plate XV, fig. 1). In mature specimens the hydrocladia are bifurcated near their bases, one portion, which I regard as the hydrocladium proper, continuing unchanged with regularly disposed hydrothecæ and nematophores. The other portion, which I regard as an accessory branch or phylactogonium, is bifurcated a short distance above its origin and one of the resulting branches is again bifurcated, making three ultimate branchlets to the phylactogonium. Upon the first, or nonbifurcated part, the gonangium is borne and some of the hydrothecæ are replaced by nematophores, while on the bifurcated part there are no gonangia and one fork has all but the terminal hydrotheca suppressed and replaced by numerous nematophores. In a specimen with obviously matured gonangia the hydrocladia with their phylactogonia are directed forward so that those from opposite sides almost touch each other. Thus the gonangia are clasped, as it were, between the protective phylactogonia from opposite sides where they are more or less protected by a great number of nematophores. A specimen with immature gonangia has the hydrocladia directed laterally, as usual among plumularians, while a colony without gonosome from the same place and identical with the last in every other respect has the hydrocladia unbranched and directed laterally, so that the specimen would, without doubt, be placed in the genus *Plumularia* had not other colonies with gonosomes been found.

It seems evident, therefore, that the branching of the hydrocladia is a character associated with the maturity of the colony, and that we have here a structure which represents in the Eleutheroplea the protective branchlets of the genus *Cladocarpus* among the Statoplea, the main difference being that the hydrothecæ are entirely suppressed in the latter case and only partially so in the former. The fact that the hydrocladia are directed forward in sexually matured colonies only is of considerable interest, and I am inclined to think that the same thing is true in certain of the "Catharina group" of *Plumularia*, for example, *Plumularia geminata* Allman. It is altogether probable that the accessory ramuli or branchlets with which the hydrocladia in *Schizotricha* are furnished, are of the nature of gonosomal structures, and I therefore include this with the following forms among the phylactocarpal Eleutheroplea.

In *Diplopteron grande* (Plate XVI, fig. 2) we find a phylactocarp greatly resembling that frequently met with in *Cladocarpus*. In this case the gonangia are borne on accessory ramuli springing from the hydrocladia and composed of three branches, each bearing numerous nematophores and an occasional hydrotheca. This form of phylactocarp shows the intergradation between that structure in *Cladocarpus* and *Schizotricha*. In *Cladocarpus* there are no hydrothecæ on the phylactogonia, in *Diplopteron* there are a few, in *Schizotricha dichotoma* there are a still greater number, while in *S. parvula* these accessory ramuli are apparently unmodified branches of the hydrocladia. We thus find what appears to be a satisfactory demonstration of the homologous nature of branched hydrocladia and phylactogonia. It must be borne in mind also that hydranths and sarcostyles are homologous structures and often seem to be interchangeable in the economy of the colony, so that the replacing of hydrothecæ by nematophores in the more differentiated phylactogonia is, after all, a simple and natural process.

Dr. J. Walter Fewkes discovered among the material secured by the *Blake*, in 1878–1880, two other remarkable genera of phylactocarpal Eleutheroplea. In *Hippurella* (Fewkes not Allman) (Plate XVII, fig. 3) the distal end of the branch is highly modified for the protection of the gonangia, the hydrocladia on this portion of the colony being apparently modified into a great number of nematophorous branchlets arranged in whorls and curving upward over the gonangia placed in their axils. These branchlets or ribs are true phylactogonia and are without hydrothecæ although they are, in all probability, modified hydrocladia.

A still more specialized phylactocarp was discovered by Dr. Fewkes, and formed the basis of

his new genus *Callicarpa* (Plate XVII, fig. 6), which consisted of special branches which do not bear hydrocladia, but are profoundly modified for the protection of the gonangia. The whole structure somewhat resembles a spike of barley consisting of the central axis, from which arise branched ribs arranged in verticils of three, each rib being divided into four branchlets and each terminal branchlet being armed with a row of nematophores. The gonangia are borne in the axils of the ribs. This is the most elaborate structure yet found among the Eleutheroplea for the protection of the reproductive zooids.

In the Statoplea there are only two genera, *Nuditheca* and *Halicornaria*, that are gymnocarpal, all of the remainder being possessed of more or less specialized contrivances for the protection of the gonangia. The phylactocarps in this group may eventually be divided into three classes:

First, those which are, morphologically, modified hydrocladia.

Second, those which are, morphologically, modified branches.

Third, those which are, morphologically, appendages to hydrocladia.

In the first group would be included the most conspicuous and the largest known form of phylactocarp, the *corbula*, found in the genera *Aglaophenia* and *Thecocarpus*. The corbula is strictly a highly modified hydrocladium, the proximal part bearing one or more hydrothecæ which may be either normal, or more or less modified. It seems to be a general rule that when there is only one hydrotheca between the corbula and the stem, it is normal, as in most species of *Aglaophenia* (Plate XX, fig. 4), but where there are several hydrothecæ between the corbula and the stem, they are apt to be more or less modified, as in *Thecocarpus*. A better idea can be gained concerning the appearance of these exquisite structures by an examination of the plates accompanying this work than can possibly be conveyed by description, however elaborate. In general it may be said that the corbula consists of an axial stem, or rachis, which is homologous with the hydrocaulus of the ordinary hydrocladium, and a number of corbula leaves. This stem often shows indications of divisions into regular internodes, each of which bears one of the corbula leaves or ribs. The leaves often appear to be borne in pairs and are generally so described in technical language, especially in systematic works. As a matter of fact, however, they are alternate, as are the hydrocladia themselves. Each leaf curves outward, upward, and then inward, the leaves on one side meeting those of the other side above, the whole forming a pod-shaped receptacle, within which the gonangia are protected. Ordinarily each leaf, in the mature corbula, is attached by its distal edge to the one immediately in front, which it often overlaps slightly. When there is a definite space between adjacent leaves, the corbula is called "open," and when the leaves are adherent along the edges they form a "closed" corbula. On account of the overlapping of the leaves mistakes have arisen in descriptive works regarding the presence of nematophores along the proximal edge of each leaf. I have dissected a number of corbulæ of different species and have found, without exception, that the distal edge of each leaf is armed with a regularly disposed row of large gonosomal nematophores which often produce a very striking and beautiful external ornamentation. In addition to this there is always, so far as the species dissected are concerned, a row of nematophores on the proximal or inner edges of each leaf, the nematophores projecting into the cavity of the corbula. This latter row is often concealed by the imbrication of the leaves, and thus it comes about that corbulæ are described as having leaves with a single row of nematophores, when, in fact, each leaf has two rows, one of which is internal and concealed.

As to the homology of the corbula-leaves, they are, in the opinion of Allman, "the greatly modified mesial nematophores of the suppressed hydrothecæ, complicated by the development on them of secondary nematophores, and thrown alternately to the right and left in accordance with their new protective function."[1] In my opinion, it is perhaps not possible to decide in every case whether we have here a modified nematophore, or hydrotheca, or simply the modification of a structure originally produced to protect what might be called an indefinite person, an individual that might, under other circumstances, have eventually become either a sarcostyle or a hydranth. In this view of the case attempts to homologize the leaves with nematophores or hydranths are unnecessary.

[1] Report on the Hydroida dredged by H. M. S. *Challenger* during the years 1873-76, Pt. 1., Plumularidæ, 1883, p. 11.

In several species—for example, *Aglaophenia tubulifera* Hincks and *A. insignis* Fewkes (Plate XIX, fig. 7)—there is an accessory leaf hanging downward and outward from near the base of the proximal leaf. Its significance is not known, but it is interesting in that it shows the two rows of nematophores normally present, the proximal one of which is hidden, in the other leaves, by the imbrication of adjacent leaves.

In all gonosomes with true corbulæ the gonangia are borne at the bases of the leaves, there being normally as many gonangia as there are individual leaves. There is usually in each leaf a longitudinal transparent strip, sometimes widening into a broad band or oval space. It is so perfectly transparent in some cases as to lead one to believe that it is an open space cut out of the leaf. By a proper management of the light, however, or by staining, it can always be demonstrated to be a thin plate of chitine. It is of interest as suggesting a means by which light may be admitted to the growing planulæ within the corbula. It is hard to conceive any other use for these delicate windows in the corbula-leaf.

In the genus *Thecocarpus* a true corbula, although a distinctly different one from that just described, is found, in which the corbula-leaves are very narrow, saber-shaped, and widely separated, each bearing a row of nematophores along one edge and a hydrotheca on its basal portion (Plate XXIV, figs. 15 and 16). The hydrotheca has its anterior side applied to the modified corbula-leaf, and behind it is a small tubular structure, representing the cauline internode, and two supracalycine nematophores in their normal position. Professor Allman considers this form of corbula a beautiful demonstration of his theory that the corbula-leaves are merely immensely developed mesial nematophores, and indeed no one could study these structures without being strongly impressed with this view. As already indicated, however, my own impression is that hydranths and sarcostyles are homologous, or, as it were, interchangeable structures. Indeed, we might go still farther and suggest that all "persons" of the hydroid colony are fundamentally homologous and often interchangeable; that the hydranth, sarcostyle, and blastostyle are each to be considered as a special modification of the primitive hydroid polyp. There are many facts which indicate that each of these may be converted into either of the others. For example, the hydranth may become a nematophore, as observed by Merejkowsky in *Plumularia halecioides;*[1] the hydranth may be converted into a blastostyle, as in *Eudendrium* and other gymnoblastic forms; a given structure may serve as both blastostyle and hydranth body at the same time, as in the remarkable hydranth-bearing gonophore of *Halecium halecinum;* and hydranths may apparently be replaced by blastostyles, as in the genus *Synthecium* of Allman. Nor does this remarkable power of interchanging of persons in the different parts of the hydroid organism end here, for I have seen the terminations of hydrocladia in *Plumularia pinnata*, which, as in all plumularians, bear developing hydranths, change into rapidly growing stolons, which ultimately develop new colonies.[2] In view of such facts it would seem, as I have already suggested, unnecessary to devote much time to attempt to homologize these various parts with the corbula-leaves of *Thecocarpus.*

Phylactocarps which appear to be modified branches are met with among the Statoplea in the genus *Lytocarpus.* Dr. J. Walter Fewkes, in working over the *Blake* material, found specimens which were characterized by the possession of a sort of pseudo-corbula which differed from the true structure in the fact that it was a modified branch instead of a modified hydrocladium. For this form he instituted the genus *Pleurocarpa.* In the present work I have deemed it necessary to include this form, with several allied ones, in the genus *Lytocarpus.* The pseudo-corbula is formed by the hydrocladia on a certain portion of a branch being replaced by nematophorous appendages which are borne alternately on the rachis and curve outward, upward, and inward, so as conjointly to form a structure looking much like an open corbula (Plate XXXII, fig. 2). The long tabular nematophores are arranged regularly in sets of three and are supposed to represent the supracalycine and mesial nematophores of suppressed hydranths. There is a hydrotheca at the base of each of these appendages which has all three nematophores, and above this one or more gonangia are found, each with three nematophores around its point of origin on the protective branchlet, thus giving evidence that the gonophores here replace hydranths (Plate XXXII, figs. 3, 4). The distal portion of the branch is unmodified, bearing regular hydrocladia. In some specimens which I have examined there is evidence that the protective appendages are actually metamorphosed

[1] Archives de Zoologie Expérimentale et Générale, X, 1882, p. 607. [2] American Naturalist, November, 1895, p. 966.

hydrocladia, as in the young pseudo-corbula, with ordinary hydrocladia alternating with the protective branchlets—a condition not found in the fully developed structures of the species examined (*L. clarkei*). In *Lytocarpus spectabilis* Allman this seems to be the normal state of affairs, the hydrocladia and protective branchlets being intermingled along the stem.[1] In all species of *Lytocarpus* the phylactogonia are morphologically hydrocladia and not appendages to hydrocladia. When these are aggregated together on one portion of the branch to the exclusion of the true hydrocladia, a pseudo-corbula is formed; but when they are not thus aggregated the gonangia are protected by the individual phylactogonia to which they are attached.

Phylactocarps which are, morphologically, appendages to the hydrocladia are found in the genera *Cladocarpus*, *Aglaophenopsis*, and *Streptocaulus*. In *Cladocarpus* this appendage springs from the hydrocladium immediately below and to one side of the proximal hydrotheca. Two very distinct types of phylactogonia are found in this genus. In one, typified by *C. flexilis* Verrill (Plate XXVI, fig. 12), the gonangia are borne on the stem near the phylactogonium which is branched much like a stag's horn and arches over the front of the stem, those from opposite sides alternating, but still interdigitating to a certain extent, so as to conjointly form an excellent protection for the gonangia over which they extend. The number of branchlets into which the individual phylactogonium is divided varies from two to five or six. The other type is well shown in *Cladocarpus paradisea* (Plate XXVIII, fig. 7). Here the phylactogonium consists of a straight central shaft, which usually shows indications of internodes, each of which gives off a short branchlet and bears a gonangium. In *C. pourtalesius* there are no branchlets, the phylactogonia consisting of straight stems divided into internodes bearing nematophores and gonangia (Plate XXIX, fig. 2).

In *Aglaophenopsis* the phylactogonium is supposed to be a greatly produced mesial nematophore of the proximal hydrotheca. For reasons already stated it is impracticable to insist in all cases on such homologies. In the three species of this genus furnishing sufficient material for investigation, the phylactogonia have one or more hydrothecæ on their distal ends or throughout their extent. This is, I believe, unique among the Statoplea, and if consistent would prove an excellent generic character. The gonangia in this genus, as in *Cladocarpus*, are borne on the stem in some species (*A. hirsuta*, Plate XXIX, fig. 12) and on the phylactogonia in others (*A. verrilli*, Plate XXX, fig. 3).

The remaining phylactocarpal genus of the Statoplea is *Streptocaulus*. The gonosome was unknown to the original describer of this genus (Allman), but was afterwards found by Quelch in specimens taken from the cable off the Cape Verde Islands.[2] In the single species known the phylactogonia spring from the side of the mesial nematophore of the proximal hydrotheca and resemble greatly the structure in *Cladocarpus pourtalesius*, being straight, unbranched, jointed, and bearing nematophores and a gonangium on each internode.

This author has the following to say concerning phylactocarpal and gymnocarpal forms:[3]

> *Schizotricha* has been referred by Prof. Allman to the section *Gymnocarpa* of the Eleutheroplea, and *Cladocarpus* to the section *Phylactocarpa* of the Statoplea; and, judging on the point of function as to whether the reproductive appendages of the hydrocladia on which the gonothecæ are placed are or are not protective, the genus *Streptocaulus* must be removed from the Phylactocarpal Statoplea, among which it was temporarily placed, to the section *Gymnocarpa*. On the other hand, since the reproductive appendages and segments which bear the gonothecæ seem in the three cases to be strictly homologous, and thus but rudimentary or varying forms of the phylactocarp, it seems necessary, if the terms *Gymnocarpa* and *Phylactocarpa* are to be retained with any definite meaning, that all three genera should be placed among the phylactocarpal forms.

The present writer agrees entirely with the latter part of this quotation. Form is of greatly more importance than function in systematic work, and while it is doubtless true that the phylactocarpal appendages of *Streptocaulus* and several other forms afford little, if any, protection to the gonangia, their morphology is such that they must be regarded as structures associated more closely with the gonosome than with the trophosome, and they can be most conveniently discussed by using the terms phylactocarpal and gymnocarpal, as originally suggested by Allman.

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[1] Report on the Hydroida dredged by H. M. S. *Challenger* during the years 1873-76, Pt. 1, Plumularidæ, 1883, pl. xv, fig. 4.

[2] On some deep-sea and shallow-water Hydrozoa, Annals and Magazine of Natural History, 5th ser., XVI, 1885, p. 1.

[3] Idem., p. 13.

DEVELOPMENT OF THE PLUMULARIDÆ.[1]

Origin of the sex cells.—All of the earlier writers supposed that the sexual products of the hydroids originated within the gonophores. Latterly, however, it has been demonstrated by several authorities that this is not the case. A very complete and masterly discussion of this subject is presented by Weismann in his splendid monograph, Die Entstehung der Sexualzellen bie den Hydromedusen, 1883, a work which has already become classic and is a model of careful and exact scientific research. The following account is practically a condensed translation of Weismann's description of the origin of the sex cells in *Plumularia echinulata*. I had the pleasure, while in Naples in 1895, of following to a certain extent in the footsteps of this master and verifying in most details the account which he gives, working at the same place and with the same species. Previous to this I had independently made some studies of the origin of the sex cells of *Plumularia pinnata* and found that the main phenomena were identical with those presented by *P. echinulata*.

The male sex cells arise as follows: Upon examining a colony which bears gonangia on the lower part of the stem it will be found that the joints above the upper gonangia contain groups of germ cells situated in the endoderm and usually pressing against the stutzlamelle (fig. 96). These sex cells may be traced in their development by examining first the distal internodes of the stem and working downward. At the top of the colony there is no discernible difference between the individual ectodermal and endodermal cells. In the eighth or ninth internode from the top a number of deeply stained cells will be seen in the endoderm. These cells, the "plasmareiche Zellen," are large and appear to be undergoing rapid cell division, the resulting cells being smaller, deeply stained, and with distinct nuclei.

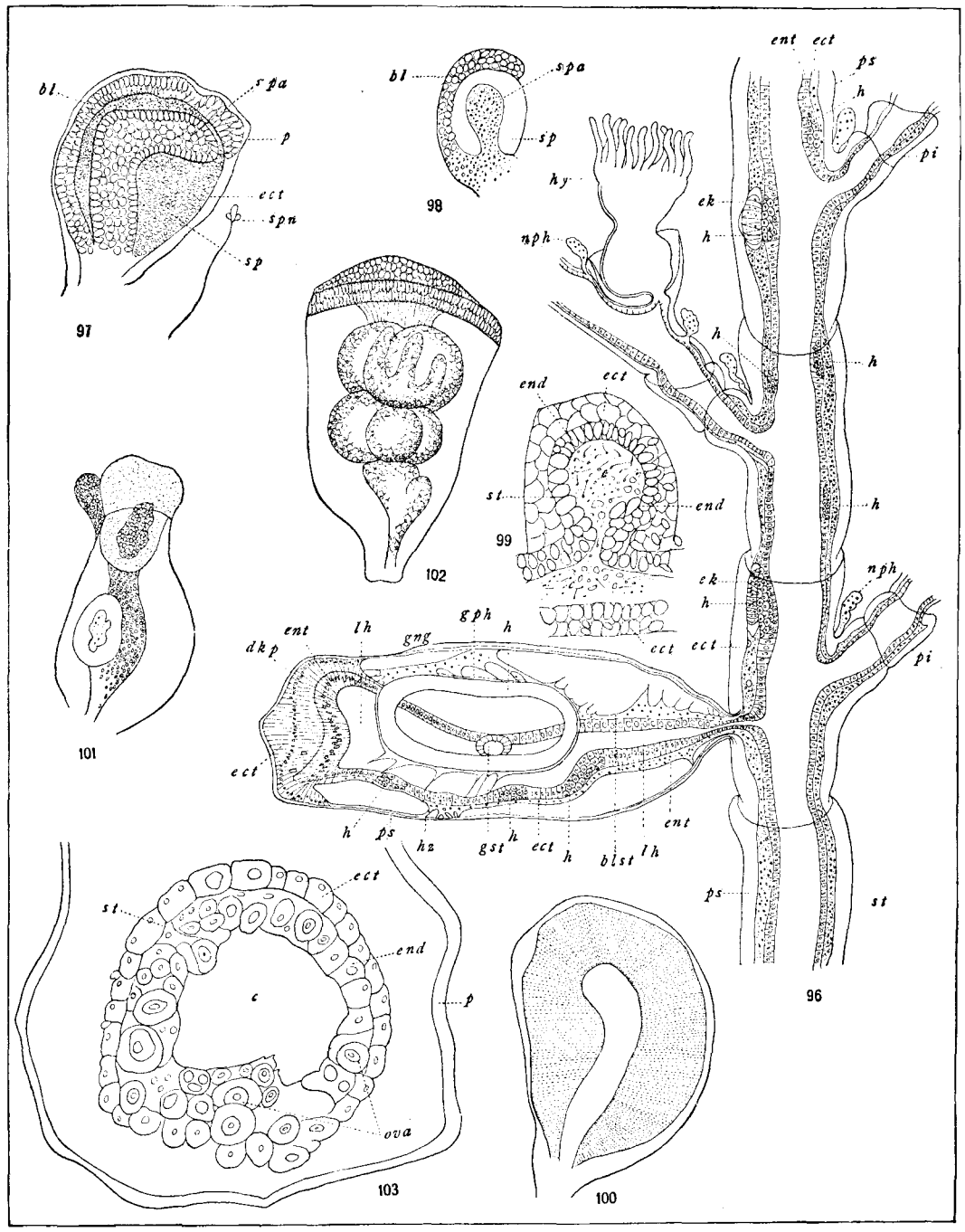
These latter are the spermatoblasts. A little farther down these spermatoblasts are aggregated into well-defined groups or masses called testicles, which lie in the endoderm awaiting their migration into the gonangia, which will be described presently.

Turning now to the development of the gonangium, which is the next event in course of time; the first change takes place in the ectoderm which intervenes between the mass of spermatoblasts and the perisarc. Here the ectodermal cells, which are ordinarily small and polygonal, become elongated in a horizontal direction, and eventually form a rounded cap of long cells which occupies the whole thickness of the ectoderm, resting almost upon the mass of spermatoblasts, from which it is separated by the stutzlamelle. This ectoderm is an important structure, designed to penetrate the thick perisarc of the stem, a performance which would apparently be impossible by any purely mechanical process. In reality the process is not mechanical, but in all probability chemical. According to Weismann, the cells of the cap have the power of excreting a substance capable of dissolving the chitine, which is thus cut away, as it were, from in front of the growing ends of the ectoderm cap which gradually advances through the thick perisarc of the stem without exerting any mechanical pressure whatever. One fact maintained by Weismann in this connection is almost beyond comprehension, and that is that the youngest, inner, and most delicate layer of perisarc is not dissolved by this action, but is pushed out through the remaining layers by the ectoderm cap. It is therefore necessary to believe that the dissolving secretion passes through one layer of chitine without injuring it, and then *completely dissolves the remaining harder and immensely thicker layers of the same substance!*

However this may be, the penetration appears to be affected without obvious pressure, and, in spite of the difficulties, Weismann's idea of chemical solution seems the only conceivable method.

After the penetration of the perisarc by the ectodermal cap the endoderm again takes part in the process. At first a prominence appears opposite the center of the mass of spermatoblasts which presses against the stutzlamelle and forms a concavity on the inner side of the endodermal cap. The endodermal layer then pushes into the ectoderm cap, which, being liberated from the confining perisarc of the stem, expands rapidly, the result being a hernia-like protrusion formed of ectoderm, stutzlamelle, and endoderm, covered with a chitinous investment, a structure imme-

[1] Under this heading, as under Morphology, there will be no attempt to discuss matters which are not more or less peculiar to the Plumularidæ, reserving a more complete treatment of the subject for a future part of this work.



ORIGIN OF THE MALE SEX CELLS IN THE PLUMULARIDÆ.

Fig. 96.—Optical section of part of a male colony of *Plumularia echinulata*. After Weismann. *blst*, blastostyle; *dkp*, plug closing end of gonangium; *ect*, ectoderm; *ek*, cap of ectoderm over primary testes; *ent*, endoderm; *gng*, gonangium; *gph*, gonophore; *gst*, peduncle of gonophore; *h*, testes; *hy*, hydranth; *hz*, ectoderm processes; *lh*, cavity of blastostyle; *nph*, nematophore; *pi*, origin of hydrocladium; *ps*, perisarc; *st*, stem.

Fig. 97.—A very young male gonangium of *Aglaophenia* sp., viewed with transmitted light. *bl*, blastostyle; *ect*, ectoderm; *p*, perisarc of gonangium; *sp*, mass of sperm cells; *spa*, spadix; *spn*, spermatozoon.

Fig. 98.—A similar specimen viewed as an opaque object. Lettering is the same.

Fig. 99.—A still younger gonophore in optical section. *c*, cavity of blastostyle; *ect*, ectoderm; *end*, endoderm; *st*, stutzlamelle.

Fig. 100.—A mature sporosac showing the arrangement of sperm cells in lines radiating from the spadix.

Fig. 101.—Gonangium of *Plumularia pinnata*, showing a gonophore passing out of the top.

Fig. 102.—Gonangium of *P. pinnata* with six gonophores.

Fig. 103.—Cross section of blastostyle of *Plumularia echinulata*, showing ova in the endoderm. *p*, perisarc; other lettering as in fig. 99.

diately recognizable as a young gonangium (fig. 99). At first, strangely enough, the endoderm layer does not carry the spermatoblasts with it into the young gonangium. Afterwards the spermatoblasts migrate *en masse* with a flowing motion, passing through the opening in the perisarc and up into the blastostyle. Weismann believes that this movement is due, in part at least, to the activity of the individual spermatoblasts, from the fact that they become scattered during the operation.

The gonangium itself (fig. 102) is formed primarily by the delicate inner pellicle of perisarc which is pushed out by the growing ectoderm cap. Later this appears to be reenforced by a secretion from the peripheral ectodermal cells, appearing as a clear transparent fluid, which evidently hardens into chitine. After attaining a definite thickness, which it does very soon, it does not further increase in thickness, although the gonangium attains a much greater size before it reaches maturity.

The gonophore now develops rapidly, the first indication of its location being an aggregation of the spermatoblasts in a definite locality, where they form a protuberance in the endoderm of the blastostyle. Next the spermatoblasts pass through the stutzlamelle and take their place between that structure and the ectoderm (fig. 97). This appears to occur very early in the history of the structure.

The present writer found in his study of *Plumularia pinnata* that the spermatoblasts underwent a certain amount of cell division before penetrating the stutzlamelle.

Afterwards the gonophore is formed by a budding from the blastostyle very much as the latter was formed from the cœnosarc of the stem, although in the former case there is no ectoderm cap formed, as there is no perisarc to be penetrated. The gonophore, then, is a two-layered sac composed of ectoderm and endoderm separated by the stutzlamelle, but with the rapidly increasing mass of sperm cells between the ectoderm and stutzlamelle. The cavity of the blastostyle communicates with that of the spadix or central core of the gonophore, and in living specimens a great activity is seen, rapidly moving currents being constantly swept to and from the cavity of the gonophore (fig. 99).

Weismann says that the histogenesis of the semen cells has not been followed. My own observations show that there is a further and often-repeated division of the spermatoblasts after they have penetrated the stutzlamelle, the ultimate result of these divisions being spermatozoa which at first have large heads and short tails, but gradually reverse these proportions until the typical form is reached. As the spermaries reach maturity, the cap of elongated ectoderm cells occupies the end of the gonangium, and, extending downward, meets the endodermal layer, the whole structure forming a sort of plug which fills the distal end of the gonangium (fig. 96, *d k p*). This plug seems to be partly absorbed when the spermatozoa reach maturity; and when the spermaries break, the plug is in some way penetrated by the spermatozoa which finally escape to the outer world through an aperture in the end of the gonangium.

In *Plumularia pinnata* I found that the entire gonophore would at times break through at the top of the gonangium, appearing much like an acrocyst such as is found in *Sertularia pumila*, although, of course, it was very different homologically (fig. 101). It is not impossible, however, that the gonophores may have been accidentally forced out of the gonangia by external pressure, although care was taken in the handling of the specimens. In mature gonophores the spermatozoa seem to be arranged in numerous lines radiating from the spadix (fig. 100).

In *P. echinulata* a second gonophore is formed, the only difference being that in this case the "Hoden" are formed in the blastostyle instead of in the stem. In *P. pinnata* as many as a half dozen gonophores may be seen on the same blastostyle (fig. 102). In one case Weismann found that the mass of spermatoblasts while still in the internode of the hydrocladium became developed into a gonophore of thin perisarc, and thus the internode performed the rôle of the blastostyle.

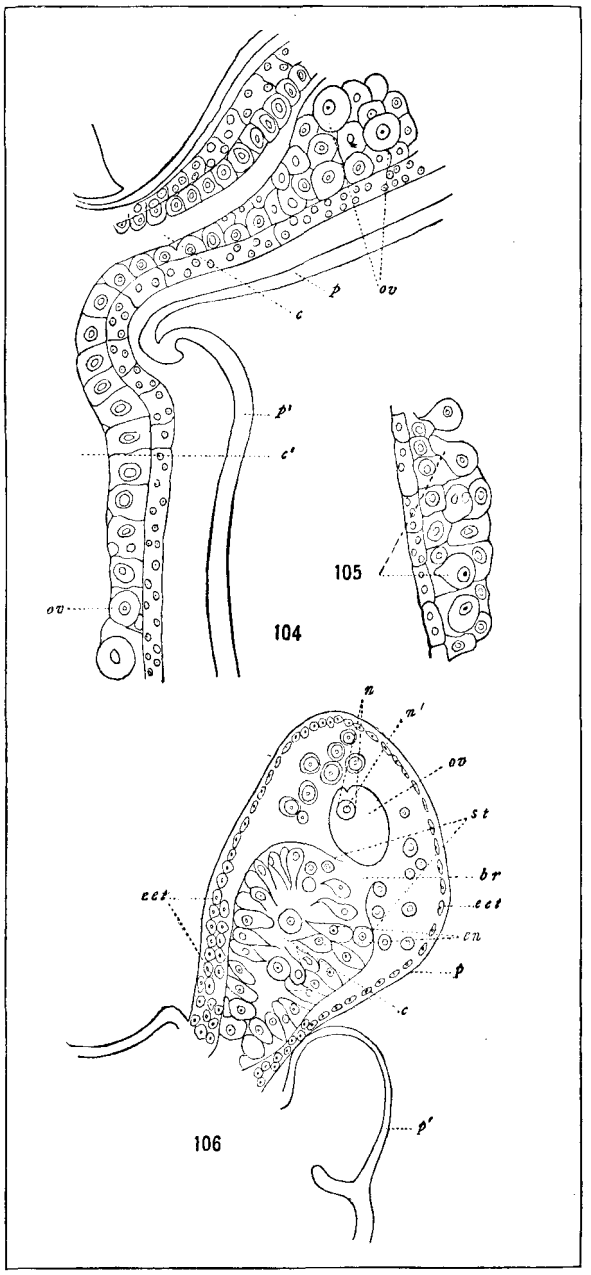
The origin of the female sex cells is quite similar to that of the male elements. The cells originate in the endoderm of the stem and basal internodes of the hydrocladia; the "Keimzone" is here, as in the male colony, immediately above the developed gonangia. In the upper internodes of this zone appear "Keimzellen," such as are found in the male, of irregular outline and size. Instead of repeatedly dividing and decreasing in size, however, these cells grow larger and eventually become well-marked ova, which often exhibit amœboid movements and contain

each a distinct nucleus and nucleolus. The ova become aggregated in certain portions of the internodes immediately below the places where the gonangia are to appear, but are, of course, much larger and less numerous than the spermatoblasts in the male colony (fig. 104). The gonangia originate as already described. After the young gonangium has pierced the perisarc and has been followed by the ectoderm, stutzlamelle, and endoderm, the ova migrate with definite cell movement into the blastostyle[1] (fig. 104), after which they reassemble, as it were, in the developing gonophore. While in this position they actually diminish in number, many of them being apparently reabsorbed. Next the ova penetrate the stutzlamelle and take their position between it and the endoderm. The present writer was so fortunate as to obtain a section showing an ovum which had just broken through the stutzlamelle, the fracture still being evident (fig. 104). It seems, however, that the stutzlamelle was already undergoing repair, as there was an indication of an exceedingly delicate membrane forming over the fractured spot.

During the maturing of the ovum the cover plate of the gonangium diminishes, and is finally penetrated by the escaping planula. A second gonophore is often formed, the ova making their appearance in the blastostyle, and not migrating from the stem joints. In *Antennularia* there is but one gonophore in each gonangium and a single ovum in a gonophore.

The following species of Plumularidæ have been investigated with the view to determining the origin of the sex cells, and in all cases these elements appear to originate in the stem. De Varenne, however, reports finding them in the body of the hydranth. *Plumularia echinulata*, *Plumularia halecioides*, *Antennularia antennina*, and *Aglaophenia pluma* were studied by Weismann; *Plumularia fragilis* and probably other species were studied by Hamann; *Plumularia echinulata* was studied by De Varenne;[2] *Plumularia echinulata*, *Plumularia pinnata*, *Plumularia halecioides*, *Plumularia similis*, *Antennularia janini*, *Aglaophenia pluma*, and *Aglaophenia helleri* were investigated by the present writer.

Development of the corbula.—Weismann is the only one, so far as I know, who has described the very beginning of the development of the corbula, although the later stages have been investigated by others. According to the first-mentioned writer, the sex cells arise in the



ORIGIN OF THE OVA IN PLUMULARIDÆ.

Fig. 104.—Longitudinal section of part of stem and base of gonangium of *Plumularia echinulata*, showing ova in the endoderm of the stem and of the blastostyle. *c*, cavity of blastostyle; *c'*, cavity of stem; *ov*, ova; *p*, perisarc of gonangium; *p'*, perisarc of stem.

Fig. 105.—Another part of same section, showing ova in endoderm of stem.

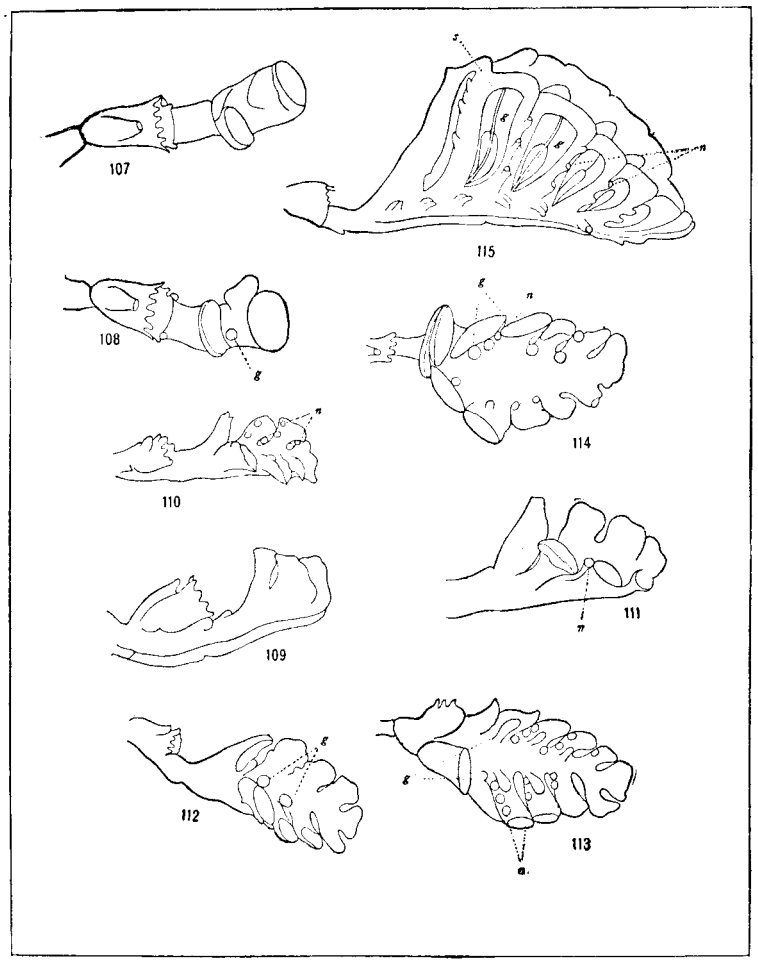
Fig. 106.—Oblique section across the base of the blastostyle of *Aglaophenia helleri*, showing an ovum which has apparently just broken through the stutzlamelle at *br*. *c*, cavity of blastostyle; *ect*, ectoderm; *en*, endoderm with developing ova; *n*, nucleus; *n'*, nucleolus; *ov*, ovum; *p*, perisarc; *p'*, perisarc of corbula; *st*, stutzlamelle.

[1] Hamann says that this movement resembles that of amebæ. (Der Organismus der Hydroidpolypen, Jenaische Zeitschrift für Naturwissenschaft, XV, 1882, p. 30.)

[2] Récherches sur la Reproduction des Polypes Hydraires, 1882, p. 19.

endoderm of the stem and finally become aggregated under the points of insertion of little buds or stumps, which are the beginnings of the corbulæ. These stumps make their appearance early in the life of the colony, and remain quiescent in a rudimentary state during the growth of the hydrocladia above them. Afterwards these stumps grow larger and are filled with the sex cells. According to Weismann's figure, a nematophore is born on a very young corbula stump.

The later development has been studied by Allman,[1] who gives a careful description of the development of the corbulæ of *Aglaophenia pluma*. While at the Marine Biological Laboratory in Plymouth, England, I had an excellent opportunity to study the same species and to sketch the various stages of growth (figs. 107–115). The succession of events is as follows:



DEVELOPMENT OF THE CORBULA OF AGLAOPHENIA PLUMA.

Figs. 107–115 are arranged in their proper sequence to show the progressive development of the corbula. *g*, gonophore; *n*, nematophore; *s*, septum of corbula leaf.

First, the corbula stump produces a hydranth with hydrotheca and the three sarcostyles with their nematophores. I was unable to determine whether the hydranth or sarcostyle made its appearance first. The distal end of the growing twig in front of the hydrotheca appears to be an unclosed tube slightly swollen near its extremity. About halfway between its end and the margin of the hydrotheca the bud of the first corbula leaf appears in the form of a broad oval process from the twig with an oval, apparently open end directed somewhat laterally. The second leaf appears between the first and the open end of the twig and is directed toward the side opposite the first. At this stage the bud of the first gonophore appears in front of the base of the first leaf. Other leaves now appear in alternate succession. The six-leaved corbula (fig. 110) shows that the

[1] A Monograph of the Gymnoblastic or Tubularian Hydroids, Ray Society, London, 1871, p. 60.

leaves have become palmate or lobate, their ends no longer being open, and the distal end of the corbula twig is also closed. Two or three budding nematophores are now seen on the inner proximal edge of some of the leaves, but they can not at this stage be distinguished from the budding gonangia except by their position.[1] In the ten-leaved corbula (fig. 114) the gonangia have so increased in size that they can readily be distinguished from the nematophores. Up to the time when about twelve corbula leaves have been acquired (fig. 113) the individual leaves are thick, fleshy lobes filled with cœnosarc, except in their central cavities, which are apparently homologous with the central cavity of the stem, lined with endodermal ciliated cells which cause rapid currents of water to pass to and fro. Shortly after this stage the leaf becomes much flatter and thinner, the central part is solidified by the increased deposition of chitine, which is partially opaque and finely punctate in appearance, and the cœnosarc is pushed away from the center to the edges, where it forms a flattened tube of ectoderm with an open central cavity running around the periphery of the leaf and connecting with the sarcostyles. In the latter large nematocysts have appeared, the nematophores are completed, and the defensive zooids are functional.

In the plate of chitine which now occupies the oblong oval space in the middle of each leaf there appears a longitudinal streak near the posterior edge of the plate (fig. 115, *s*). This streak, called the "septum" by Allman, is perfectly clear and transparent, being composed of a structureless chitine, and may serve the purpose of strengthening the leaf by the hard flexible rod.[2]

From this time on the leaves are vascular along their edges. As they grow the edges meet and their distal ends curve over toward the center of the rachis until they meet above. The coalescence of the corbula leaves along their edges is, as has already been described, aided by the sacrostyles, which send forth processes from one leaf to another, thus holding the edges together until a permanent connection of chitine and sarcode is established, and the cœlomic cavities of the tubes of adjacent leaves are united, and currents are established running from one to the other. During all this time the gonangia are growing and the sexual elements reach maturity shortly after the corbula is completed.

At an early stage in the history of the gonangia the sex cells migrate from the corbula twig or rachis into the blastostyle, where the gonophores are formed, as already described.

Embryology.—The embryology of the Plumularidæ has not been very extensively studied. The following facts, however, seem to be well established: In speaking of the development of the ovum in hydroids which produce planulæ, including, of course, the Plumularidæ, Allman says:[3]

> In such cases the ovum, which is mostly destitute of vitellary membrane, after passing through a regular or nearly regular segmentation in accordance with the usual binary law of embryonal development, becomes transformed into a solid spherical mass of cells (bastosphere), from which a peripheral layer soon becomes separated by a process of delamination. The embryo now as a rule becomes more or less elongated, and the central cavity makes its appearance in it.
>
> At this stage the embryo is in the form of a hollow oviform body whose walls are composed of two layers, an external or ectoderm, and an internal or endoderm. It is by delamination, never by invagination, that the two germinal layers, ectoderm and endoderm, are formed. The embryo has now usually escaped from the confinement of the gonophore, and its ectoderm becomes clothed with vibratile cilia, by the aid of which it moves about as a free larva in the surrounding water. It would seem to be about this time that the mesosarc shows itself as a very fine structureless membrane between the endoderm and the ectoderm. To the larva thus formed Dalyell, by whose observations it was first made known, has given the name of Planula [fig. 116].
>
> The planula is still a completely closed sac. After enjoying for a time its free locomotive life it loses its cilia and fixes itself by one end—the aboral pole. A delicate chitinous pellicle, the foundation of the perisarc, is excreted over a greater or less extent of its surface; the free or oral pole becomes perforated by a mouth round which a circle of tentacles has become developed. The larva may now be recognized as the primordial hydranth of the colony, and it only remains for this to become complicated by the budding of other hydranths and of the sexual zooids in order that it may attain the condition of the fully developed dendritic colony.

Hamann[4] agrees with Allman regarding the important point involved in his declaration that the separation of the embryonal layers is by delamination, and states that he has examined various species of *Aglaophenia* and *Plumularia* and finds the same to be true in all cases. In *Aglao-*

[1] This refers to their external appearance; satisfactory sections were not secured.

[2] The analogy between this structure and the rod found in graptolites is quite suggestive.

[3] Report on Hydroida dredged by H. M. S. *Challenger*, during the years 1873-76, Pt. 2, 1888, p. xxxvi.

[4] Der Organismus der Hydroidpolypen, Jenaische Zeitschrift für Naturwissenschaft, XV, 1882, p. 31.

phenia helleri the present writer found the two layers to be formed by delamination, as described above.

Reproduction.—As in all other hydroids, the common method of propagating the species is by means of a true sexual reproduction involving ova and spermatozoa. With rare exceptions, for example, *Antennularia*, each colony is unisexual; that is, all of the gonophores of a given colony will contain sexual elements of one kind only.

When the spermatozoa have reached maturity they go forth in countless numbers from the male gonophore, pass through an aperture in the top of the gonangium in a compact stream of rapidly moving bodies lashed along in their course by the vigorous movements of the flagella, the heads moving from side to side as they progress in what appear to be definite directions. How long the spermatozoa are capable of living this free life in sea water we do not know. A few fortunate ones find their way into the gonangia of a female colony and succeed in impregnating the mature ova while the latter are still within the gonophores. I do not know that the cytological phenomena immediately following the impregnation of the plumularian ovum have ever been carefully worked out. What is known of the segmentation and succeeding events has already been described under the head of Embryology.

STOLONIFEROUS REPRODUCTION.[1]

Plumularia pinnata is the most abundant plumularian at Plymouth, affording ample material for satisfactory study. The first specimens with young gonangia were brought to the laboratory on May 2. Ten days before this I noticed that several fresh specimens were peculiar in having a number of the hydrocladia greatly produced into thread-like extensions ending in a clavate enlargement (fig. 117). Neither hydranths nor nematophores grew upon these processes, although the usual number were found in their normal position on the unmodified portions of the hydrocladia.

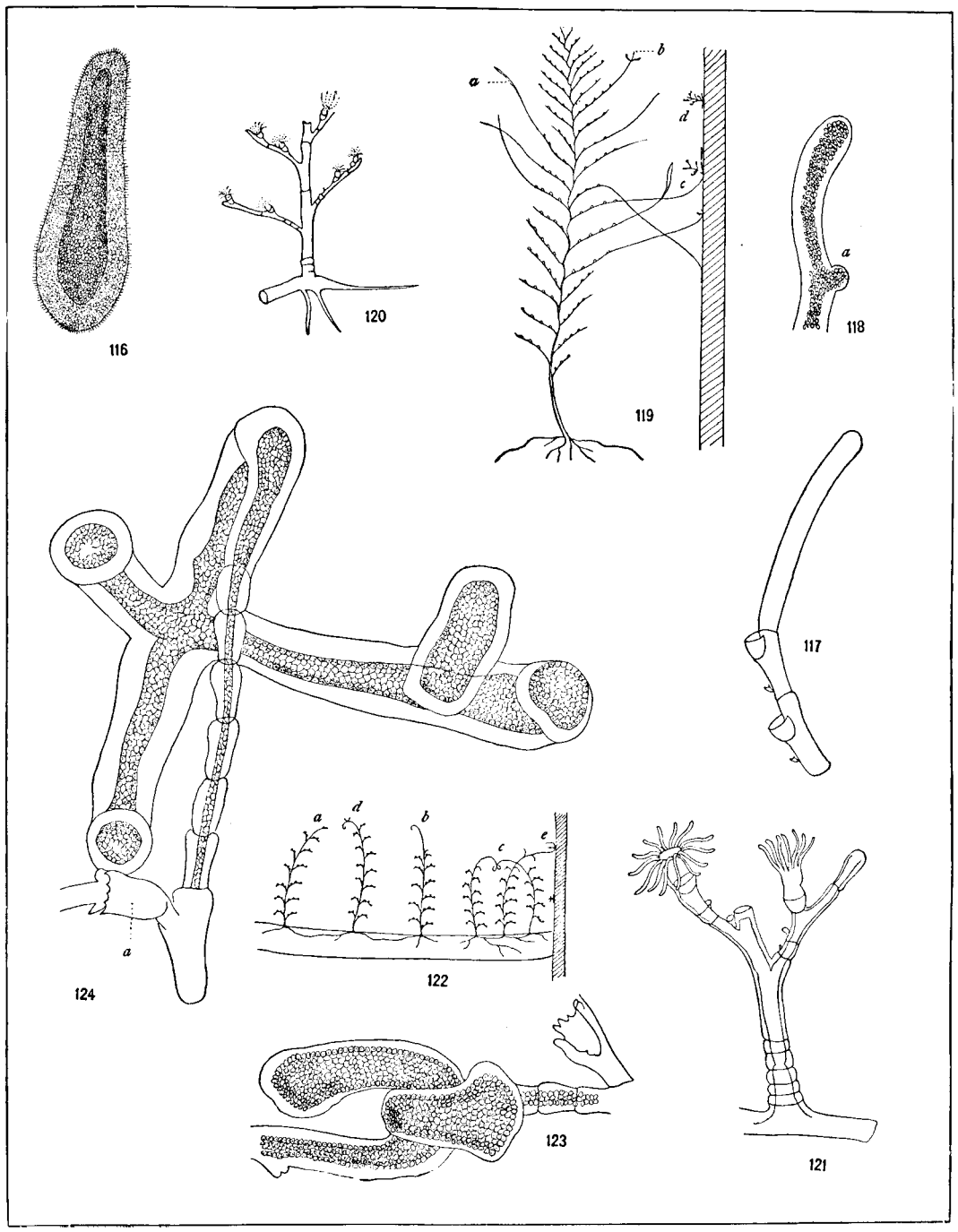
These specimens were kept alive in a separate jar, and three days later it was found that the curiously lengthened hydrocladia had continued their abnormal growth, and that some of the enlarged ends had become forked. A microscopic examination showed that the hydrocladial extensions were almost or entirely destitute of nodes, the whole structure being a simple tube, with perisarc, ectoderm, and endoderm, inclosing the axial cavity in which the life currents were moving in unusual activity. The most notable histological feature was the surprising number of nematocysts embedded in the cœnosarc. The colony seemed in good condition, the hydranths being fully expanded and active.

Four days later I noticed some delicate, thread-like lines adhering to the inside of a jar containing living colonies of *P. pinnata* (fig. 119). Upon moving a piece of stone, it was found that these lines were the long, thread-like processes or continuations of hydrocladia noticed several days before. Upon close investigation hydranths were seen fully expanded arising from these processes attached to the glass, and one small colony with the pinnate branching of *Plumularia* had advanced so far as to show seven hydranths on branches (fig. 120). The original process from the hydrocladium of the parent colony had become a creeping stolon attached to the glass. It was sending up the new colony on the one hand, and giving forth delicate rootlets on the other. A single hydranth growing on the stolon a little to the right of the incipient colony already described seems to indicate the starting of a second colony. Several other stolons (derived in the same way from greatly elongated hydrocladia) were giving off little colonies. There had been no other plumularians in this jar, and the original colonies were without gonangia.

These new colonies were kept alive for a week longer, by which time their connection with the parent stocks had been destroyed by atrophy of the hydrocladial extensions from which the new colonies arose, and the daughter colonies had attained considerable size and all the characteristic features of *P. pinnata* (fig. 121).

In another jar a colony showing the hydrocladial extensions was purposely placed so that they could reach neither the side of the jar nor any other point of support. This did not interfere with the asexual reproduction, however, as the processes became forked at their distal ends, and from

[1] The description under Stoloniferous Reproduction is from an article by the author in the American Naturalist for November, 1895. The observations described were made at Plymouth, England.



REPRODUCTION OF PLUMULARIDÆ.

Fig. 116.—Planula of *Aglaophenia helleri*.
Fig. 117.—Enlarged process at end of hydrocladium of *Plumularia pinnata*, showing first stage of stoloniferous reproduction.
Fig. 118.—The process branching at (*a*).
Fig. 119.—Colony showing several processes: (*a*) Enlarged end of process; (*b*) a process forking; (*c*) a process the end of which is attached to side of jar and which is giving origin to a new colony; (*d*) a new colony which was formed as above, but is now separate.
Fig. 120.—A new colony formed as above, enlarged.
Fig. 121.—Colony still more enlarged.
Fig. 122.—Colonies of *Aglaophenia* sp.: (*a*) Enlarged tip of main stem; (*b*) the tip becomes hooked; (*c*) the hooks of two colonies clasped together; (*d*) a tip hooked and forked; (*e*) a tip which has become attached to side of jar and from which a new colony is springing.
Fig. 123.—The clasped hooks of two colonies, enlarged.
Fig. 124.—A tip of main stem which is greatly enlarged and branched; (*a*) basal hydrotheca of last hydrocladium of colony.

these forks arose incipient colonies. After a week had elapsed the parent colony died and the main stem became withered and dropped to the bottom of the jar, carrying with it the daughter colonies, which were then able to attach themselves and proceed with their development as would any other colony.

After a careful search through the literature of the subject, I am unable to find any account of this mode of reproduction either among hydroids or any other of the metazoa, and I propose for it the name *Stoloniferous reproduction* on account of the great similarity which it bears to that process among plants.[1]

Asexual multiplication has long been known to exist among the hydroids, where it usually presents itself in some form of gemmation. Fission has been found to occur in a medusa, *Stomobrachium mirabile* Kölliker, but the most remarkable case heretofore recorded is described by Allman in a campanularian named by him *Schizocladium ramosum*.[2] The process is, in brief, as follows:

An ordinary ramulus, instead of bearing a hydranth on its distal end, elongates and the cœnosarc ruptures the chitinous investment at the tip and protrudes naked into the water. A constriction takes place by which this naked cœnosarc is divided off and finally separated from the parent stem. "The detached segment is now the $\frac{3}{100}$ of an inch in length, and strikingly resembles a planula in all points except in the total absence of vibratile cilia. It attaches itself by a mucous excretion from its surface to the walls of the vessel, and exhibits slight and very sluggish changes of form. After a time a bud springs from its side, and it is from this bud alone that the first hydranth of the new colony is developed."

Although this process resembles the stoloniferous multiplication of *Plumularia pinnata* in the formation of a new colony from a modified branch termination, it differs greatly in the fact that in *Schizocladium* the divided portion or "frustule," as Allman calls it, becomes entirely separated from the parent stock before the new colony begins to develop, while in *P. pinnata* there is a vital connection by means of the greatly elongated hydrocladium.

The stoloniferous multiplication must not be confounded with any of the many modes of branching heretofore found among the hydroids, which do not give rise to separate colonies having independent hydrorhizæ; neither is it equivalent to the multiplication often effected by mutilation. There is no mutilation in this case, unless we may so regard the spontaneous atrophy of the connection between the old and the new colonies.

That this stoloniferous multiplication is normal is indicated by the fact that specimens fresh from the sea exhibited the greatly elongated and forked hydrocladia.

It may be well to note that *P. pinnata* seems to have reproductive powers greater than those of any other plumularian known to me. At the proper season that part of the stem from which the hydrocladia spring is fairly packed with gonangia which may even be crowded out on to the hydrocladia. In some instances it seemed as if the reproductive potentiality demanded some other outlet, and long processes, exactly like the hydrocladial processes described above, were seen springing from the interior of the gonangia themselves.

THE POSSIBILITY OF CONJUGATION AMONG THE PLUMULARIDÆ.[3]

During the months of June, July, and August, 1895, a small species of *Aglaophenia* was brought almost daily to the Naples Zoological Station. It grows on a long ribbon-like alga in shallow water and bears a general resemblance to *A. pluma* Linnæus, from which it differs in exhibiting a frequent intercalation of intervening internodes on the distal half of the stem, in the more distant hydrocladia, and in having, as a rule, not more than three hydrothecæ to each internode.

In June it was noticed that a large proportion of the colonies had the end of the main stem

[1] "Stolons are trailing or reclining branches above ground which strike root where they touch the soil, and then send up a vigorous shoot which has roots of its own, and becomes an independent plant when the connecting part dies, as it does after awhile." Gray, School and Handbook of Botany, p. 37.

[2] Reports of the British Association, 1870, and Gymnoblastic Hydroids, pp. 151, 152.

[3] The description that follows the heading referred to is from an article by the author in the American Naturalist, November, 1895. Figs. 117–123 are from the same source.

greatly elongated and enlarged, the proximal part of this extension being divided into a great number of short internodes, while the distal portion was abruptly bent over so as to form a nearly closed hook (fig. 124). In many cases the ends of two colonies would be hooked together, clasping each other so tightly that they could not be separated without mutilating the specimens (fig. 122, *c*). This state of affairs was so common at this time that one could not regard the attachment as accidental or abnormal, and further developments were awaited with great interest.

In July this attachment was seldom seen, although the enlarged stem terminations were still common. These latter appeared to be shedding their perisarc, which was often seen to be partly peeled off.

About the middle of August I observed that these enlarged ends were *forking* just as did the produced hydrocladia of *P. pinnata* (fig. 124). Still later, immediately before my departure from Naples, I found some of these enlarged ends attached to the sides of the jar and budding, although the buds had not yet developed into hydranths. There is practically no doubt that we have here a case of stoloniferous reproduction in the genus *Aglaophenia*.

Although I was unable to demonstrate the use of the clasping hooks at the ends of the stems it was impossible to escape the constantly recurring suggestion that they might possibly signify a mode of *conjugation* such as is found among the Protozoa (for example, *Paramecium*) and the Algæ (for example, *Spirogyra*).

That these hooked ends are for some definite purpose can be confidently assumed, and there are but two explanations which appear plausible.

First. These terminal hooks may aid directly in the stoloniferous reproduction by attaching themselves to some adjacent object upon which the new colonies can grow.

Second. They may be clasping organs for use in conjugation. As a matter of fact they may serve both purposes. My observations strongly indicate that they are useful as a means of attachment, and the following considerations indicate a strong possibility that conjugation may take place.

First. They were seen so often in a position favoring conjugation, that is, with the ends of two colonies clasped in a close embrace, as to indicate a normal function.

Second. It was after this supposed conjugation that the stoloniferous multiplication was observed to be under way.

Third. These enlarged ends of the stems were found to contain a number of amœboid cells which were unusually active, sending out pronounced pseudopodia. I could not decide definitely whether these cells were in the ectoderm or endoderm, on account of the unfavorable position of the living colony under inspection.

Stained sections of these hooks failed to throw much additional light on the subject, the only noticeable histological feature being an appearance of great activity in cell multiplication and the presence of an unusual number of nematocysts. These sections were of value, however, in demonstrating that the enlargement of the stem termination was *not* due to the presence of a parasite, as is sometimes the case among hydroids, for example, *Syncoryne eximia* and *Coryne mirabilis*.

The clasping of the hooks is probably effected mechanically by the undulations of the ripples passing along the alga which supports the hydroid colonies.

Conjugation is essentially the union of two individuals of a species during which an interchange of protoplasm is effected without the intervention of ova or spermatozoa. So far as I have been able to discover, this process has not heretofore been found among the metazoa,[1] and the observations recorded above must be regarded as merely an indication of the possibility of conjugation among hydroids.

It is now a well established fact that the sex cells, both male and female, of the Plumularidæ originate in the endoderm of the stem; and any process which would enable the contents of the endodermal cells of one stem to mix with the contents of the endodermal cells of the stem of another colony would render conjugation possible so far as the purely mechanical part of the question is concerned. This would be effected in the case under consideration by the solution of

[1] The permanent union of individuals which results in *Diplozoon* can not be termed conjugation in the sense here used, because in the *Diplozoon* the intervention of ova and spermatozoa occurs.

the contiguous walls of the hooks when clasped as already described. While this solution was not actually seen in any of the specimens described by me, it was found that the perisarc was usually thinner in the region of contact than elsewhere.

It must be remembered, moreover, that in the normal reproduction of most hydroids a solution of the perisarc of the stem is effected, probably by chemical action, whenever a gonangium is formed,[1] and therefore no new principle would have to be invoked to accomplish this end in the case under discussion.

In passing from below upward in the stem of a plumularian examined just before the appearance of the gonangia, we find that the sex cells intergrade perfectly with the ordinary endodermal cells, many of which are themselves destined to become sex cells. The endoderm then, in the distal part of the stem, contains that which will ultimately become ova or spermatozoa, or it contains what might be called the undifferentiated sex elements. A given colony of *Aglaophenia* is always unisexual. That is, all the gonangia contain sex cells of one kind, and both ova and spermatozoa are never found in one colony.

Now it is evident that the hooking together of a male and a female colony by the upper parts of their stems, accompanied by a dissolving of those portions of the perisarc which are in contact, would leave only the thin ectoderm between the endodermal layers of the two colonies, and a communication between the undifferentiated sex cells would be an easy matter; for Weismann found that the undifferentiated sex cells exhibited pronounced amœboid movements,[2] and such movements would, of course, greatly facilitate conjugation. The amœboid cells observed by me in the clasping hooks may be of significance in this connection. Not only did these cells exhibit activity in sending forth pseudopodia, but they also moved bodily from place to place among the surrounding cells.

Since the foregoing material was published I have received a number of communications concerning the matter of asexual reproduction. Several of my correspondents, as Professor Verrill and Professor Bale, announce that they have observed lengthened processes such as I found in *Plumularia pinnata* in several other species. Professor Verrill considers the process as simply a modification of the well-known growth of new colonies by basal stolons. Of course the homology of hydrorhizae and hydrocladia has already been insisted upon in this work. The stoloniferous reproduction, however, differs essentially from reproduction by basal stolons in the fact that in the former case true hydrocladia with hydranths and sarcostyles are actually metamorphosed into stolons, by which reproduction is effected, the new colony being entirely cut off from the parent stem shortly after the development of the first hydranth.

In regard to the possibility of conjugation among hydroids, the attitude of several correspondents is well represented by that of Professor J. Playfair McMurrich, of the University of Michigan, who writes: "Is not the process of conjugation *a priori* unlikely?"

I frankly admit that the process of conjugation among hydroids is, *a priori*, very unlikely, and it was in view of that fact that I have been most guarded in my language in the above paper, which was intended to announce simply the evidence of the possibility of conjugation, giving the facts in full in order that readers might judge for themselves. There are considerations, however, which increase the *a priori* possibility of this process. Part of these considerations have already been given, but it might be well to mention in addition the fact that if any primitive methods are carried over from the protozoa to the metazoa they would most likely be found in the hydroids or perhaps in the sponges. Hydroids are exceedingly low in their organization and exhibit in several respects the appearance of loosely aggregated assemblages of cells which are individually much like protozoa. The ectoderm cells, for example, are in many cases strikingly amœboid both in appearance and conduct, as are the endoderm cells in other cases, as, for example, the undifferentiated sex cells. The wonderful facility with which lost parts can be replaced has astonished the world ever since the classical researches of Trembly, and indicates an exceedingly undifferentiated condition of the tissues involved. Not less remarkable is what might be called the interchangeability of parts already insisted upon in this work, whereby one person or organ can be directly metamorphosed into another. All of these facts indicate a high degree of plasticity on the part of the organism

[1] Dr. August Weismann, Die Entstehung der Sexualzellen bei den Hydromedusen, 1883, p. 182.

[2] This fact was repeatedly observed by the present writer.

and the retention of what might be called protozoan characters on the part of the individual cells. This being true, it is certainly possible, indeed not exceedingly improbable, that in some instances the protozoan method of reproduction should still be potentially retained and brought into activity under certain combinations of circumstances which would render it of marked benefit to the colony.

SYSTEMATIC DISCUSSION.

Family PLUMULARIDÆ Louis Agassiz.[1]

Trophosome.—The hydranth with a conical proboscis and a single verticil of filiform tentacles. Hydrothecæ, found on one side only of their supporting ramuli (hydrocladia), and always more or less adnate to the latter. Nematophores always present, three being usually associated with each hydrotheca and others variously situated on the hydrocaulus.

Gonosome.—Gonophores always inclosed in gonangia, which may be either unprotected, protected by special nematophorous branchlets, or inclosed in corbulæ which are highly modified hydrocladia. Free medusæ are never formed, the ova developing into ciliated planulæ within the gonangia. Colonies almost always unisexual.

Previous to the great work of the elder Agassiz, three genera—*Plumularia*, *Antennularia*, and *Aglaophenia*—all of the plumularians then known, were included with other calypteroblastic forms in the family Sertulariadæ. McCrady, in his "Gymnophthalmata of Charleston Harbor," 1857, had already pointed out the desirability of separating these forms from the others, a suggestion carried out finally by Louis Agassiz, in which he was followed by Hincks, Allman, and indeed practically all the more prominent writers up to the present time. Several British writers, for example, Hincks[2] and Bale[3], have written the word "Plumulariidæ," but the original spelling of Agassiz is here retained, in which the present writer agrees with Kirchenpauer[4], Allman[5], and von Lendenfeld.[6] Allman[7] constituted a "legion" Plumularinæ, in which arrangement he is followed by Marktanner-Turneretscher.[8] This legion is coextensive with the previously named family Plumularidæ.

The present writer is inclined to adhere, so far as possible, to the zoological arrangement most affected by his countrymen, in which the groups are arranged in classes, orders, families, genera, and species; and to avoid other terms as well as the use of subfamilies, subgenera, and subspecies, which often tends to confuse the student rather than to render him any real service.

The Plumularidæ constitute a perfectly well defined group of the Calypteroblastea, related on the one hand to the Sertularidæ, and on the other to the Hydroceratinidæ, a family recently instituted by Prof. W. Baldwin Spencer to accommodate a remarkable Australian hydroid, *Clathrozoon wilsoni*, which, although widely different from the Plumularidæ in many respects, resembles it in having what seem to be true nematophores containing true sarcostyles. The relationship is still more close to the family Zygophylacidæ instituted by Mr. John J. Quelch[9] to accommodate a new form found on the Atlantic cable off the Cape Verde Islands, characterized by a trophosome greatly resembling Allman's family Perisiphonidæ, and having a pair of structures which are apparently nematophores at the base of each hydrotheca.[10]

It is probable that over one-fourth of all the hydroids of the world belong to this group, and quite possible that the proportion may reach a third. Deep-sea investigations tend to raise the proportion of Plumularidæ. In the *Challenger* collection about 28 per cent of all the hydroids belong in this group. Taking the two regions in which the hydroid fauna has been most thoroughly

[1] Contributions to the Natural History of the United States, IV, p. 358.
[2] British Hydroid Zoophytes, p. 279.
[3] Australian Hydroid Zoophytes, p. 120.
[4] Ueber die Hydroidenfamilie Plumularidæ (title).
[5] Memoirs of the Museum of Comparative Zoology, V, No. 2, p. 29.
[6] The Australian Hydromedusæ, Pt. 4, p. 472.
[7] *Challenger* Report, Hydroida, Pt. 2, p. lii.
[8] Die Hydroiden des k. k. naturhistorischer Hofmuseums, p. 249.
[9] Annals and Magazine of Natural History, July, 1885, p. 4.
[10] I have myself found structures greatly resembling nematophores in another species of this family, *Lafoëa convallaria* Allman.

explored, Great Britain and Australia, we find that in the former only about 8 per cent of the hydroids are plumularians, while in the latter region that group is represented by about 40 per cent of the known species. Marktanner-Turneretscher's work, describing a collection that may fairly be regarded as cosmopolitan,[1] includes about 162 species of hydroids, 30 per cent of which are plumularians. The American hydroids have not been thoroughly worked over since the immense accretions were secured by the *Albatross*, but it is extremely probable that at least 30 per cent of all the species found in American waters belong to the Plumularidæ.

Taking the average of the proportions of plumularians to other hydroids as shown by a study of the *Challenger* report, Hincks's work on British Hydroid Zoophytes, Bale's Catalogue of Australian Hydroid Zoophytes, Marktanner Turneretscher's work, and a rude estimate of the American species, we find that about 28 per cent of the hydroids treated of in these larger works are plumularians.

Valuable as have been the results of the *Challenger* expedition, we are not justified in depending upon the apparent distribution of the Plumularidæ as indicated in the table (p. lxviii), according to which only one species of plumularian was found in the West Indian region. This table, like many of those included in the present work, does not indicate the number of hauls made with the dredge in each zoogeographical region, and where only a few casts were made so much depends upon the particular conditions attending each that it is impossible to derive any very reliable quantitative results regarding the fauna. Where a more limited area is carefully worked over, these sources of error are almost eliminated, at least greatly reduced. Over 3,000 hauls of the dredge, tangles, etc., have been taken by the vessels engaged in the work of the United States Fish Commission and the United States Coast Survey, and by the Bahama expedition from the State University of Iowa. These expeditions have worked almost exclusively along the Atlantic coast of the United States and in the West Indian and Nova Scotian regions as defined by Allman in his *Challenger* report. In these regions the *Challenger* made about 55 hauls of the dredge, with the astonishingly meager result of only one plumularian (*Streptocaulus pulcherrimus*), a result probably due to the fact that most of the work done in this region was in water of great depth and beyond the continental slope.

A more thorough working of this same region by the various United States expeditions resulted in the discovery of over 100 species of Plumularidæ, indicating in all probability the richest plumularian fauna yet discovered in any part of the globe.

As mentioned above, over 300 species of Plumularidæ have been described. About 33 per cent of these are found in the West Indies and off the Atlantic coast of the United States; about 23 per cent in the Australian and East Indian region; about 13 per cent in the Mediterranean and European region; the remaining 31 per cent being scattered over other parts of the globe. It is worthy of note that over half of the plumularians are found in the two widely separated regions, the West Indian and the Australian. Professor Allman points out a curious coincidence between the distribution of the bats and that of the Plumularidæ, each having its most notable centers in the East and West Indies.

As a whole, it may be said that the Plumularidæ reach their maximum development in species and individuals as well as in diversity of form and size of colonies in the warmer seas of the globe, in which, as just noted, there are two well-marked centers, the one in the East Indian and Australian region and the other in the West Indian. From these centers they are carried by currents and spread along the bottom in various directions, reaching as far north as Alaska, Norway, and Greenland.[2] It will be noted that in each of these cases, except possibly Greenland, the far northern shores are bathed by warm currents from tropical regions. In one case a species of this group has found its way as far south as the Straits of Magellan.[3] In an account of the hydroida of Spitzbergen,[4] Marktanner-Turneretscher enumerates 73 species of hydroids, among which there is not a single plumularian.

In both the East and West Indies the physical conditions are especially favorable to a luxu-

[1] Die Hydroiden des k. k. naturhistorischer Hofmuseums.

[2] I have a specimen of *Aglaophenopsis cornuta* Verrill from Canon Norman's collection (originally from the Copenhagen Museum), that came from Greenland.

[3] *Aglaophenia patagonica.*

[4] Zoologische Jahrbücher, VIII, Abtheilung für Systematik, 1895, pp. 437, 438.

riant marine fauna. Both are extensive archipelagoes with numerous islands, between which strong, warm currents are forced by the winds and tides—a very important factor, as Alexander Agassiz has pointed out. Both are characterized by extensive coral reefs with their attendant profusion of marine organisms of many kinds, and both contain great areas of comparatively shallow seas, affording what are probably the most favorable conditions for the Plumularidæ. It also seems likely that the presence in these regions of land masses of considerable magnitude is a factor which is favorable to the production of luxuriant marine life.

Representatives of this family have been found in considerable abundance down to nearly 300 fathoms, and not unfrequently to 500 fathoms. They have occasionally, however, been found at greater depths, as follows: *Plumularia attenuata* Allman, 576 fathoms, *Blake; Cladocarpus formosus* Allman, 775 fathoms, *Challenger; Cladocarpus pectiniferus* Allman, 900 fathoms, *Challenger; Cladocarpus flexuosus* Nutting, 940 fathoms, *Albatross; Aglaophenia lophocarpa* Allman, 1,181 fathoms, *Albatross; Aglaophenia crenata* Fewkes, 1,242 fathoms, *Blake; Aglaophenopsis verrilli* Nutting, 1,497 fathoms, *Albatross; Aglaophenopsis verrilli* Nutting, 1,742 fathoms, *Albatross.*

In the bathymetrical tables given by Sars[1] and others the zones are of unequal vertical thickness. Sars divides the depth down to 300 fathoms into the following zones: 0–10, 10–20, 20–50, 50–100, 100–150, 150–200, 200–300.

This method is useful where a limited number of species and comparatively few dredging stations are included, and I have adopted a similar arrangement for the bathymetrical distribution of genera in this work. When, however, a considerable number of species is included and a sufficient number of stations occupied at various depths to allow of an attempt at adducing conclusions concerning the general subject of bathymetrical distribution, it is better to have the zones more numerous and of equal vertical thickness. For this reason the tables for the whole groups of Eleutheroplea and Statoplea are founded on equally dividing the whole depth down to 500 fathoms into ten zones of 50 fathoms each.

The data upon which the following table is constructed seem sufficient to furnish at least a reliable indication of bathymetrical distribution down to 500 fathoms. In general it may be said that there is an apparent decrease in the number of species with the increase in depth. There are two exceptions to this rule, one in the Statoplea, where five species are found at a depth of from 350 to 400 fathoms and seven species at a depth of from 400 to 450 fathoms; the other is in the Eleutheroplea, where seven species are found at a depth of from 200 to 250 fathoms and thirteen species between 250 and 300 fathoms. In both cases, however, it will be noted that not more than one species was found in the next zone, indicating possibly an insufficient or unfortunate exploration of these latter zones, or particularly rich hauls in the preceding zones. It will also be noted that these breaks are not at the same depth for the two groups, which would also indicate that the departure from the rule given above was due to accidental causes.

[The abbreviations are used as follows: N. Atl., North Atlantic coast of America from Charleston northward. W. I., Atlantic coast of North and Central America south of Charleston, and the West Indies. S. Atl., South Atlantic, counting south of the Isthmus of Panama. Eu., European shores of the Atlantic. N. P., North Pacific southward to Panama. S. P., South Pacific south of Panama. Aus., Australian and East Indian region.]

Bathymetrical distribution of American Plumularidæ.

ELEUTHEROPLEA.

Species.	Zone. 1 to 50 fathoms.	50 to 100 fathoms.	100 to 150 fathoms.	150 to 200 fathoms.	200 to 250 fathoms.	250 to 300 fathoms.	300 to 350 fathoms.	350 to 400 fathoms.	400 to 450 fathoms.	450 to 500 fathoms.	Over 500 fathoms.	Province.
Plumularia setacea	?											N. Atl., W. I., Eu., N. P.
megalocephala	14							352				W. I.
oligopyxis	?											S. P.
altitheca						280						W. I.
filicula		88	107			273		352	440			W. I.
helleri	?									458		Eu., S. P.
floridana	?											W. I.
filicaulis	?											S. P., Aus.
catharina	?	60				270						N. Atl. Eu.
geminata		76	120			276		352				W. I.
clarkei				175	200							W. I.

[1] Bidrag til Kundskaben om Norges Hydroider, 1873, pp. 44–48.

Bathymetrical distribution of American Plumularidæ—Continued.

ELEUTHEROPLEA—Continued.

Species.	Zone. 1 to 50 fathoms.	50 to 100 fathoms.	100 to 150 fathoms.	150 to 200 fathoms.	200 to 250 fathoms.	250 to 300 fathoms.	300 to 350 fathoms.	350 to 400 fathoms.	400 to 450 fathoms.	450 to 500 fathoms.	Over 500 fathoms.	Province.
Plumularia alternata	?											W. I.
plumularioides	8											N. P.
inermis	?											W. I.
caulitheca	?					273			416			W. I.
goodei	?											N. P.
attenuata			195								576	W. I.
corrugata	30											S. Atl.
palmeri	?											N. P.
lagenifera	?											N. P.
virginiæ	?											N. P.
macrotheca										450		W. I.
profunda						273			440			W. I.
dendritica	13											W. I.
paucinoda			121									W. I.
Antennularia antennina	?											N. Atl., Eu.
americana			120					373				N. Atl.
simplex	35	70	124		201			373				N. Atl., W. I.
rugosa	46											N. Atl.
geniculata						273		352	440			W. I.
pinnata		86	100									N. Atl.
Monotheca margaretta	?											W. I.
Antennopsis annulata			107		229	283						W. I.
hippuris			195		229	263						W. I.
distans			115									W. I.
longicorna					204							W. I.
nigra			121									W. I.
Monostæchas quadridens	12	70		194		283						N. Atl., W. I.
Antennella gracilis	18	60	?	?								N. Atl., W. I.
Calvinia mirabilis						270	352			440		W. I.
Schizotricha gracillima	?	50			200							N. Atl., Eu.
tenella	1											N. Atl.
dichotoma					200							W. I.
parvula								352				W. I.
Diplopteron quadricorne				?								W. I.
grande						273						W. I.
longipinna				200								W. I.
Polyplumularia armata						270						W. I.
Hippurella longicarpa			124									N. Atl., W. I.
Callicarpa gracilis												W. I.
Halopteris carinata	13											W. I.
Gattya humilis												?
Total number of species	26	8	13	5	7	13	1	7	4	3	1	
Percentages[1]	50%	15%	25%	10%	13%	25%	2%	13%	8%	6%	2%	

[1] The percentages indicate the per cent of the total number of species of Plumularidæ found in each bathymetrical zone; for instance, there are 52 species of Eleutheroplea in the table, 26 or 50 per cent of which are found in the 1 to 50 fathom zone.

STATOPLEA.

Aglaophenia rhynchocarpa	3		150	169	250							W. I.
rigida	45	77	116									N. Atl., W. I.
dubia	24	96	150									W. I.
lophocarpa	32			200							1,181	W. I.
apocarpa	62	100	116	194								W. I.
flowersi			116									W. I.
elegans		80										W. I.
insignis						262						W. I.
aperta				194	200							W. I.
cristifrons				163								W. I.
contorta	5½											W. I.
minuta	?											N. Atl., W. I.
pelagica	?											N. Atl., W. I.
perpusilla	34											W. I.
mammillata	15											N. Atl.
minima	13											W. I.
fewkesi	?											W. I.
simplex	?											W. I.
ramosa	42											W. I.
robusta		88										W. I.
rathbuni	?											S. Atl
latirostris												N. P., S. Atl.
struthionides	?											N. P.
ramulosa		94										W. I.
octocarpa	?											N. P.
gracillima		96										W. I.
patagonica	?											S. Atl.
crenata											1,242	N. Atl.
trifida	?											N. Atl.
tricuspis	?											N. Atl.
constricta	30											S. Atl.
savignyana	?											W. I.
bicornuta			150									W. I.
calamus	20											S. Atl.
Thecocarpus myriophyllum	40											N. Atl., Eu.
distans						283			440			W. I.
normani									440			W. I.
benedicti						277			440			W. I.
bispinosus				156	200							W. I.

Bathymetrical distribution of American Plumularidæ—Continued.

STATOPLEA—Continued.

Species.	Zone. 1 to 50 fathoms.	50 to 100 fathoms.	100 to 150 fathoms.	150 to 200 fathoms.	200 to 250 fathoms.	250 to 300 fathoms.	300 to 350 fathoms.	350 to 400 fathoms.	400 to 450 fathoms.	450 to 500 fathoms.	Over 500 fathoms.	Province.
Cladocarpus sigma	22	.....	116	.....	.....	276	.....	352	.....	.....	.....	N. Atl., W. I.
compressus	.....	.....	114	.....	.....	.....	.....	.....	.....	.....	.....	W. I.
ventricosus	.....	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	W. I.
flexilis	.....	65	134	167	.....	.....	.....	.....	.....	.....	.....	N. Atl., W. I.
obliquus	.....	.....	.....	.....	200	.....	.....	.....	.....	.....	.....	W. I.
septatus	48	85	132	.....	.....	.....	.....	.....	430	.....	.....	N. Atl.
dolichotheca	.....	.....	107	.....	.....	.....	283	.....	.....	.....	.....	N. Atl., W. I.
flexuosus	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	940	W. I.
tenuis	.....	.....	101	.....	.....	.....	.....	.....	.....	.....	.....	W. I.
grandis	.....	.....	.....	.....	.....	.....	270	352	440	.....	.....	W. I.
paradisea	.....	.....	123	174	.....	.....	270	352	440	.....	.....	W. I.
speciosus	.....	.....	.....	.....	200	.....	.....	.....	.....	.....	.....	N. Atl.
pourtalesii	.....	90	133	.....	.....	270	300	.....	.....	.....	.....	N. Atl.
carinatus	.....	.....	.....	.....	.....	273	.....	.....	440	.....	.....	W. I.
Aglaophenopsis hirsuta	.....	.....	.....	.....	229	273	.....	352	440	.....	.....	W. I.
distans	.....	.....	.....	.....	.....	.....	.....	352	.....	.....	.....	W. I.
verrilli	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,497	N. Atl.
cornuta	.....	.....	.....	.....	200	.....	.....	.....	.....	.....	.....	N. Atl.
Lytocarpus racemiferus	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	S. Atl.
philippinus	?	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	S. Atl., Eu., W. I., S. P.
ramosus	.....	95	.....	.....	.....	.....	.....	.....	.....	.....	.....	W. I.
grandis	.....	.....	.....	.....	.....	.....	339	.....	.....	.....	.....	W. I.
clarkei	13	67	121	199	201	.....	.....	.....	.....	.....	.....	W. I.
curtus	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	W. I.
furcatus	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	W. I.
Halicornaria speciosa	5	56	.....	.....	.....	.....	.....	.....	.....	.....	.....	W. I.
longicauda	34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	W. I.
variabilis	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	W. I.
Nuditheca dalli	?	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	N. P.
Streptocaulus pulcherrimus	.....	100	.....	.....	.....	.....	.....	.....	.....	.....	?	W. I., Eu.
Number of species	35	15	15	9	8	7	5	5	7	0	5	
Percentages	50	23	23	13	12	10	7	7	10	0	7	
Average percentages of Eleutheroplea and Statoplea	50	18	22	12	11	17	5	10	8	3	4	

The preceding table, while useful in showing what might be called qualitative distribution in depth and in indicating the distribution of individual species, can not be depended upon to show the quantitative distribution of species. It would, on the face of it, seem to indicate that the number of species decreased regularly with the depth. This is in accord with the generally received ideas concerning bathymetric distribution. A little consideration, however, will show that there is an element of error involved which utterly invalidates the showing of this and, so far as I know, all other published tables on bathymetrical distribution, inasmuch as *these zones have been very unequally explored*. If one hundred hauls of the dredge have been made in one zone and only ten in another, the number of species actually found in the first may be several times that found in the second, and yet the second may be in reality a much richer zone. It will thus be seen that the preceding table is, as it stands, of no value whatever as an index of the relative richness of the several zones. In order to obviate this defect I have, with the help of my father, reduced to tabulated form 2,660 dredging stations recorded in American waters down to 500 fathoms,[1] so that the number of hauls made in each vertical zone of 50 fathoms is indicated. Knowing, then, the actual number of stations in each zone and the actual number of species secured, it is easy to construct the following table:

Zone.	Number of stations.	Per cent of stations.	Number of species.	Per cent of species.
1 to 50 fathoms	1,419	53	61	50
50 to 100 fathoms	431	6	23	20
100 to 150 fathoms	293	11	27	22
150 to 200 fathoms	156	6	15	12
200 to 250 fathoms	110	4	15	12
250 to 300 fathoms	68	2	20	17
300 to 350 fathoms	62	2	6	5
350 to 400 fathoms	48	2	12	10
400 to 450 fathoms	37	1	11	10
450 to 500 fathoms	36	1	3	2

[1] This was made possible by the use of the excellent Lists of Dredging Stations in North American Waters, etc., compiled by Sanderson Smith, 1888.

It will readily be seen that this table flatly contradicts the preceding one as well as the prevailing opinion concerning quantitative bathymetrical distribution, in that it indicates a steady and rapid increase of species from the top to the bottom zone. In the top zone 53 per cent of the stations yielded 50 per cent of the species, while in the bottom zone 1 per cent of the stations yielded 2 per cent of the species. Were the distribution of species equal throughout, the second and fourth columns would obviously agree. It will be seen, however, that in all zones below the first the percentages in the fourth column are materially greater than in the second, and that this disparity increases, in a general way, as we descend to the last zone, where the relative proportion of species is more than twice as great as in the first zone. Several notable variations occur, especially in the eighth and ninth zones, where there is a great increase in species, which may be due to a few especially fortunate dredge hauls. This variation does not necessarily invalidate the indication that there is an increase of life as we go downward.

There is still, however, a serious source of error in our computation, and this lies in the fact that there is not a direct ratio between the number of stations in a given zone and the number of species. An illustration will make this clear. Suppose an entomologist were to go out collecting in a new locality for ten successive days. The first day he secures 10 species and the second day he also secures 10 species, but some of them would probably be identical with those secured the first day. Each day, although he may be equally successful in the number of species secured, he will find a less number of novelties. In ten days he will not collect 100 species, and the longer he works the slower will be the increase in his list until the insect fauna is completely explored, when there will be no further additions at all. In this way it can be seen that the fewer the number of dredging stations in the given zone the greater will be the proportion of species secured.

This consideration is fatal to our confidence in accepting the actual percentages as shown in the table, but I do not regard it as sufficient to invalidate the general induction derived from the table regarding an increase in the number of species along with an increase of the depth. My reasons for this position are:

First. None of these zones can be regarded as having been explored with any thoroughness, excepting, perhaps, the first. In other words, the percentage of error is not likely to be very great, because there is in no case any approach to a complete list of the species contained in a given zone.

Second. The territory covered by these zones is often very great, reaching from near the South American coast to Newfoundland, and through many degrees of longitude. This diminishes greatly the likelihood of repeatedly securing the same species.

Third. As a matter of fact, there are few species that are recorded from many different stations. While examining the *Albatross* material at the Smithsonian Institution I found only four species recorded from more than ten stations, and from other sources I have secured a similar record for only three more. At the most, not more than 10 species of the 121 can be regarded as having been secured with sufficient frequency to figure materially in the result of our computation.

Fourth. The difficulty in dredging at considerable depths and the chances of specimens being lost on their way to the surface would offset to an appreciable extent the repeated finding of species in the shallower zones.

It seems practical, therefore, to claim for this investigation that it indicates very clearly, if it does not prove, that plumularian life increases in species down to a depth of 500 fathoms. Below that depth the data are insufficient to warrant any deductions. It can not, however, be too strongly impressed upon the reader that this result is *merely* an indication to be confirmed or denied in the light of prolonged and careful investigations, which will doubtless be undertaken in the future.

It is interesting to note in this connection that Professor W. K. Brooks gives good reason for supposing that the original bottom life of the ocean establishes itself neither near the shore line nor in the abyssal regions, but between the two.[1]

[1] The Journal of Geology, II, No. 5, p. 470. The article on The Origin of the Oldest Fossils, and the Discovery of the Bottom of the Sea, is of very great interest in its relation to the problem of the bathymetrical distribution of life.

Distribution of American genera of Eleutheroplean Plumularidæ.

[The figures in the columns denote the number of species.]

Genus.	Geographical.							Total number of species.	Bathymetrical.					
	Atlantic.				Pacific.									
	Charleston and northward.	S. of Charleston and W. Indies.	South Atlantic.	Coasts of Europe.	North Pacific.	South Pacific.	Australia.		1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.	Over 500 fathoms.
Plumularia	2	15	1	3	6	3	1	26	14	3	3	4	9	1
Monotheca	.....	1	.....	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....
Antennularia	5	2	.....	1	.....	.....	.....	6	1	2	2	2	3	.....
Antennopsis	.....	5	.....	.....	.....	.....	.....	5	.....	.....	.....	4	3	.....
Antennella	.....	1	.....	.....	.....	.....	.....	1	1	.....	1	1	.....	.....
Monostæchas	1	1	.....	.....	.....	.....	.....	1	1	1	1	1	1	.....
Calvinia	.....	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....
Schizotricha	1	2	.....	1	.....	.....	.....	4	2	1	1	.....	3	.....
Diplopteron	.....	3	.....	.....	.....	.....	.....	3	.....	.....	.....	1	2	.....
Polyplumularia	.....	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....
Hippurella	.....	1	.....	.....	.....	.....	.....	1	.....	.....	.....	1	.....	.....
Callicarpa	.....	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....
Halopteris	.....	1	.....	.....	.....	.....	.....	1	1	1	.....	.....	.....	.....
Total	9	35	1	5	6	3	1	52	21	8	8	14	23	1

The above table shows clearly the great preponderance of the West Indian region over all others in its Eleutheroplean fauna. The paucity of forms from the South Atlantic and Pacific, though partly due to lack of research in those regions, is nevertheless remarkable. In the Australian region, however, there is a wealth of Plumularidæ comparable with that found in the West Indies; but there is only one American species among them.

KEY TO THE GENERA OF ELEUTHEROPLEAN PLUMULARIANS.[1]

- Both lateral and mesial nematophores, free and present.
  - Gonangia not protected by special ramuli or modifications of hydrocladia.
    - Hydrocladia pinnately disposed, each bearing more than one hydrotheca ..... *Plumularia.*
    - Each bearing a single hydrotheca ... *Monotheca.*
    - Hydrocladia arranged in verticils, or scattered on all sides of stem; cœnosare canaliculated ..... *Antennularia.*
    - Cœnosare not canaliculated ..... *Antennopsis.*
    - Hydrocladia apparently springing from root stalks, divided into internodes ..... *Antennella.*
    - Not divided into internodes ..... [*Acladia.*]
    - Hydrocladia all springing from upper side of branches ..... *Monostæchas.*
    - Hydrocladia replaced by thorny processes on distal ends of branches ..... [*Acanthella.*]
    - Hydrocladia bearing a jointed nematophorous branchlet at base of each hydrotheca ... *Calvinia.*
  - Gonangia protected by special ramuli or modifications of hydrocladia.
    - Hydrocladia branched, some of the branchlets assuming the function of phylactogonia; gonangia borne on hydrocladia ..... *Schizotricha.*
    - Hydrocladia branched, lateral nematophores in more than one pair ..... *Diplopteron.*
    - Hydrocladia with accessory ramuli; gonangia borne on stem or main branches ..... *Polyplumularia.*
    - Hydrocladia scattered over stem; gonangia protected by symmetrically disposed horny processes ..... [*Sciurella.*]
    - Hydrocladia on distal portion of branches modified into verticillate, nematophorous branchlets inclosing gonangia ..... *Hippurella.*
    - Gonangia borne on special branches and inclosed in verticils of nematophorous branchlets. *Callicarpa.*
- Some of the nematophores either fixed or wanting.[2]
  - Mesial nematophores fixed—Hydrothecal margin toothed ..... *Gattya.*
  - Mesial nematophores fixed—Hydrothecal margin entire ..... [*Heteroplon.*]
  - Lateral nematophores fixed, borne on long processes ..... *Halopteris.*
  - Lateral nematophores wanting ..... [*Azygoplon.*]
  - Lateral nematophores wanting and replaced by naked sarcostyles, mesial nematophores monothalamic ..... [*Kirchenpaueria.*]

[1] The genera whose names are inclosed in brackets are not represented in American waters.

[2] Under certain conditions specimens will be found from which the nematophores, or the greater part of them, have been removed by accident, or perhaps on account of the approaching dissolution of the colony. The key is, of course, based on the characters of normal specimens.

PLUMULARIA Lamarck (in part).

Plumularia LAMARCK, Hist. Nat. des Anim. sans Vert., 1815, 1st ed., p. 123.

Trophosome.—Cœnosarc of stem not canaliculated, hydrocladia unbranched, pinnately disposed, either alternate or opposite, without accessory branches of any kind, and each bearing more than one hydrotheca. Hydrothecæ with smooth margins; all of the nematophores movable.

Gonosome.—Gonangia borne on the hydrocaulus or hydrocladia, simple sac-shaped or bottle-shaped, and without phylactogonia or corbulæ.

Lamarck, in his first edition, includes all of the forms which would now be embraced in the family Plumularidæ in two genera: *Antennularia*, with the hydrocladia arranged in verticils, and *Plumularia*, containing all of the remaining forms. In 1857 McCrady[1] established the genus *Aglaophenia* to accommodate most of the Statoplea known at that time, in which he was followed by Louis Agassiz[2] in 1862, and by Hincks[3] in 1868. The genus *Plumularia* was thus restricted to very nearly its present signification, the other genera now included in the Eleutheroplea being formed almost without exception to accommodate the great number of new and often highly specialized forms which have been brought to light by the various deep-sea expeditions of the last thirty years.

The year 1816 witnessed the appearance of a work entitled Histoire des Polypiers Flexibles, by Lamouroux, who divided the Plumularidæ into two genera: *Aglaophenia*, equal to *Plumularia* of Lamarck, and *Nemertesia*, equal to *Antennularia* of Lamarck. This nearly simultaneous appearance of two classic works with equivalent groups, but with distinct names, caused an immense amount of confusion in the group and a needless addition to the synonymy, which extended down to the appearance of Kirchenpauer's great work, the second part of which appeared in 1876, in which the name *Nemertesia* is used. Subsequent works, however, have very generally adopted Lamarck's nomenclature so far as these two genera *Plumularia* and *Antennularia* are concerned.

Arrangement of genera adopted by various writers from 1815 to 1877.

Lamarck	Lamouroux	Johnston	McCrady	Agassiz	Hincks	Kirchenpauer	Allman
(1815).	(1816).	(1847).	(1857).	(1865).	(1868).	(1876).	(1877).
Plumularia	= *Aglaophenia*	*Plumularia*	*Plumularia* = + *Aglaophenia* = Statoplea of later writers.	*Plumularia* =	*Plumularia*	= *Plumularia*	— *Plumularia* + several other genera.
Antennularia = *Nemertesia*		= *Antennularia*		*Nemertesia* =	*Antennularia* = *Nemertesia*		*Antennularia.* *Antennopsis.*

It is interesting to note the regular alternation between *Antennularia* and *Nemertesia*, each writer differing from his immediate predecessor. The name *Nemertesia* does not appear in any prominent work on this group subsequent to 1876, and it is to be hoped that this persistent ghost of Lamouroux will not reappear to disturb the much harassed synonymy of the Eleutheroplea.

As is usually the case with old genera which have been frequently subdivided, the genus *Plumularia* can best be defined by a process of exclusion resulting in a preponderance of purely negative characters. The group, as above defined, seems a natural division of the Eleutheroplea, including about half of the American species of that division of the Plumularidæ.

The following key to the known American species of the genus *Plumularia* will, it is hoped, enable the student to identify the forms mentioned in this work. It must be remembered, however, that the arrangement is arbitrary at best, and it should also be borne in mind that the arrangement of the internodes is exceedingly inconstant in some species, that given in the key being simply the predominant one in the species under consideration.

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[1] Gymnophthalmata of Charleston Harbor, Proceedings of the Elliott Society, 1857, p. 199.
[2] Contributions to the Natural History of the United States, IV, 1862, p. 358.
[3] History of British Hydroid Zoophytes, 1868, p. 284.

KEY TO SPECIES OF PLUMULARIA.

Hydrocladia composed of alternating hydrothecate and intermediate internodes, divided by straight nodes. *Setacea* Group.	Intermediate internodes short, each bearing a single nematophore; hydrothecæ not distant; gonangia very long, with a tubular "neck" ..... *P. setacea.*
	Intermediate internodes longer, each with two nematophores; hydrothecæ distant, borne near center of internodes; hydranths very large ..... *P. megalocephala.*
	Hydrothecæ near distal ends of internodes; no supracalycine nematophores; hydrocladia short ..... *P. oligopyxis.*
	Hydrothecæ near distal ends of internodes; no nematophores on intermediate internodes; supracalycine nematophores absent ... *P. helleri.*
	Like *P. helleri*, but with much longer internodes ..... *P. altitheca.*
	Internodes and hydrothecæ much as in *P. megalocephala;* hydranths smaller; colony with lateral branches ..... *P. filicula.*
	Hydrocladia annulated at the internodes; hydrothecæ as in *catharina* group ..... *P. floridana.*
	Internodes of stem conical in front view; hydrotheca with posterior corrugation ..... *P. filicaulis.*
Hydrocladia composed of hydrothecate and intermediate internodes, divided by nodes which are alternately straight and oblique; cauline hydrothecæ present. *Catharina* Group.	Hydrocladia opposite, not directed forward; nodes pronounced and alternately straight and oblique ..... *P. catharina.*
	Hydrocladia opposite, often directed forward; colony branching dichotomously; nodes distinct ..... *P. geminata.*
	Hydrocladia opposite, directed either forward or laterally; nodes often indistinct ..... *P. clarkei.*
	Hydrocladia alternate; stem made up of two kinds of internodes. *P. alternata.*
Hydrocladia composed of hydrothecate internodes only. *Attenuata* Group.	Hydrothecæ near distal ends of internodes; nodes on a level with the tops of hydrothecæ ..... *P. plumularioides.*
	Hydrothecæ near distal ends of internodes; nodes above level of top of hydrothecæ; stem slightly geniculate ..... *P. inermis.*
	A peculiar nematophore on the process of stem from which the hydrocladia arise ..... *P. caulitheca.*
	Hydrothecæ on enlarged proximal ends of internodes ..... *P. attenuata.*
	Two hydrocladia to each internode of the stem; nematophores monothalamic ..... *P. goodei.*
Hydrocladial internodes with strong septal ridges; or hydrocladia with more than one intermediate internode. *Lagenifera* Group.	Internodes with septal ridges; hydrothecæ not wider than deep; colony dendritic, strongly branched ..... *P. corrugata.*
	Hydrothecæ not wider than deep; colony not branched ..... *P. palmeri.*
	Hydrothecæ wider than deep ..... *P. lagenifera.*
	No intermediate internodes ..... *P. virginiæ.*
Hydrothecæ more than 1½ times as deep as wide. *Macrotheca* Group.	Intermediate internodes present and bearing nematophores. *P. macrotheca.*
	Two or three deep annulations between hydrothecæ; hydrothecæ separated by about their own depth ..... *P. dendritica.*
	No intermediate internodes; each internode with one hydrotheca; no deep annulations ..... *P. profunda.*
	More than one hydrotheca to each internode ..... *P. paucinoda.*

Distribution of Plumularia.

Species.	Geographical.							Bathymetrical.					
	Atlantic.				Pacific.								
	Charleston and northward.	South of Charleston and West Indies.	South Atlantic.	Coasts of Europe.	North Pacific.	South Pacific.	Australia.	1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.	Over 500 fathoms.
P. setacea	+	+		+	+			+					
P. megalocephala		+						++				+	
P. oligopyxis						+		+					
P. altitheca		+										+	
P. filicula		+								+	+	+	
P. helleri				+		+		+				+	
P. floridana		+						+					
P. filicaulis						+	+	+					
P. catharina		+		+				+	+	+		+	
P. geminata		+								+	+	+	
P. clarkei		+									+		
P. alternata		+						+					
P. plumularioides					+			+					
P. inermis		+						++					
P. caulitheca		+						+				+	
P. attenuata		+									+		+
P. goodei					+				+(?)				
P. corrugata			+						+				
P. palmeri					+			+					
P. lagenifera					+			+					
P. virginiæ					+			+					
P. macrotheca		+										+	
P. profunda		+										+	
P. dendritica		+						+					
P. paucinoda											+		

The above table clearly shows that the West Indian region is the American center of distribution for this genus. The bathymetrical table shows that the great bulk of the species is found in shallow water, that the region from 20 to 100 fathoms seems poor in species, while that from 100 to 500 is represented by a good percentage of species. It must be remembered, however, that in order to make a fair comparison of the life at various depths the same number of hauls should be made at each depth.

PLUMULARIA SETACEA (Ellis).

(Plate I, figs. 1, 4.)

Corallina setacea ELLIS, Nat. Hist. Corallines, 1755, p. 19.
Sertularia setacea PALLAS, Elenchus Zoophytorum, 1766, p. 148.
Sertularia setacea ELLIS, Nat. Hist. Zoophytes, 1786, p. 47.
Sertularia setacea TURTON, Brit. Fauna, 1801, p. 216.
Plumularia setacea LAMARCK, Anim. sans Vert., 1st ed., 1815, p. 129.
Aglaophenia setacea LAMOUROUX, Hist. Polyp. Flex., 1816, p. 172.
Plumularia setacea LAMARCK, Anim. sans Vert., 2d ed., II, 1836, p. 165.
Plumularia setacea DE BLAINVILLE, Manuel d'Actinol., 1836, p. 477.
Plumularia setacea JOHNSTON, Brit. Zooph., 2d ed., I, 1847, p. 97.
Aglaophenia setacea GRAY, Brit. Radiata, 1848, p. 80.
Plumularia setacea LOUIS AGASSIZ, Cont. Nat. Hist. U. S., IV, 1862, p. 358.
Plumularia setacea HINCKS, Brit. Hydroid Zooph., 1868, p. 296.
And all subsequent writers consulted.

Trophosome.—Colony attaining a height of 2 inches, usually unbranched; stem nonfascicled and divided into internodes, each of which bears a hydrocladium on a process from its distal end; hydrocladia alternate, proximal internode short, without hydrotheca or nematophore, next internode hydrothecate and the remainder of the hydrocladium composed of alternate hydrothecate and intermediate internodes; nodal joints often accompanied by one or two internal annulations. Hydrothecæ rather shallow, cup-shaped, and more closely approximated than usual; nematophores small, the supracalycine pair overtopping the hydrothecæ; a mesial nematophore at the base of

each hydrotheca, one on each intermediate internode, one in the axil of each hydrocladium, and one on each internode of the main stem.

Gonosome.—Gonangia (female) greatly elongated, produced above into a long, narrow neck, inserted near the axils of the hydrocladia and about twice as long as the internodes of the stem. Gonangia (male) "linear oblong, slender, smaller than the female, less produced above, and tapering to a fine point with a very minute terminal aperture."[1]

Distribution.—Coasts of Europe and Great Britain;[1] Key West, Florida;[2] Santa Barbara, California, collected by Mrs. Virginia Barrett Gibbs.

A very distinct variety of this species was secured by the *Albatross* from floating gulf weed, which differs from typical specimens in being very minute, rarely attaining more than $\frac{1}{8}$ inch in height, is quite rigid, irregularly branching, and has very slender hydrocladial internodes. Unfortunately, none of the specimens had the gonosome and hence we are obliged to regard this very minute and delicate hydroid as a somewhat aberrant form of *P. setacea*, although I strongly suspect that the gonosome would demonstrate its validity as a distinct species.

The specimens collected at Santa Barbara by Mrs. Gibbs are quite typical, being perhaps a little stouter and larger than specimens from Guernsey.

PLUMULARIA MEGALOCEPHALA Allman.

(Plate I, fig. 5.)

Plumularia megalocephala ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 31, pl. XIX.

Trophosome.—Colony attaining a height of about 3 inches, branching in an irregular manner, the branches being rather stout and rigid; stem and branches not fascicled, divided into internodes each of which bears a hydrocladium on a long process from its distal end, the process having an elevation on its upper side; hydrocladia alternate, slender, the first internode bearing no hydrotheca and the remainder of the hydrocladium consisting of alternate hydrothecate and intermediate internodes, the former being the longer. This is the general arrangement only, and is frequently departed from, both by the intercalation of extra intermediate internodes and the obliteration of the regular ones. Hydrocladia alternate as a rule, but not regularly so in some specimens, where they are occasionally opposite toward the distal end of the stem. Hydrothecæ distant, small, cup-shaped; supracalycine nematophores rather large; one mesial nematophore at the base of each hydrotheca, two on each intermediate internode of the hydrocladium, one or two in the axil of each hydrocladium, and two on each internode of the stem; hydranths very large and unable to retract fully within the hydrothecæ.

Distribution.—Off Alligator Reef, 14 fathoms.—*Albatross* Station 2669, lat. N. 31° 09′, long. W. 79° 33′, 352 fathoms.

The type specimen at Cambridge shows a great irregularity in the arrangement of the internodes. The species is evidently very near *P. filicula*, from which it differs chiefly in its manner of growth, irregularity of branching, and the size of the hydranths.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

PLUMULARIA OLIGOPYXIS Kirchenpauer.

(Plate I, figs. 6, 7.)

Plumularia oligopyxis KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, 1876, Pt. 2, p. 48, pl. VI, fig. 9.
Plumularia oligopyxis MARKTANNER-TURNERETSCHER, Die Hydroiden des k. k. naturhist. Hofmuseums, p. 254.

Trophosome.—Colony attaining a height of about 1 inch, unbranched; stem divided into regular internodes, each of which bears a hydrocladium on a process from its distal end; hydrocladia alternate, short, those on the proximal portion of the stem consisting of a single hydrothecate internode, and those on the distal portion consisting of a short proximal internode, then a hydrothecate internode, then a longer intermediate internode followed by a second hydrothecate

[1] Hincks, History of British Hydroid Zoophytes, 1868, p. 297.

[2] A specimen of this species from Key West is in the Museum of Comparative Zoology at Cambridge and is labeled "Key West, Fla., Agassiz."

internode, making four, or at most six, internodes to each hydrocladium. Hydrothecæ shallow, cup-shaped; supracalycine nematophores sometimes wanting; a mesial nematophore below the base of each hydrotheca and one on the longer intermediate internodes.[1]

Gonosome.—Gonangia large, cyathiform.

Distribution.—Pacific Ocean, west coast of South America.

The first specimens of this species examined by Kirchenpauer had but a single hydrotheca to each hydrocladium. He afterwards found others with two and three hydrothecæ and intermediate internodes, and made three subspecies of them based on the possession of one, two, or three hydrothecæ to each hydrocladium. It seems altogether possible that these are simply individual peculiarities which indicate different stages in the growth of the colony. This species must not be confounded with that belonging to the genus *Monotheca*, which has but one hydrotheca to each hydrocladium, but has also the thickened or forked internode supporting the very conspicuous supracalycine nematophores.

PLUMULARIA ALTITHECA, new species

(Plate II, fig. 1.)

Trophosome.—Colony attaining a height of 2 inches, consisting of a tuft of simple pinnate stems; stem not fascicled, divided into regular internodes, each bearing a hydrocladium on a process from its distal end; hydrocladia alternate, two or three short proximal internodes without hydrothecæ, then a long hydrothecate internode, the remainder of the hydrocladium being made up of alternating intermediate and hydrothecate internodes, the latter being somewhat the longer. Hydrothecæ distant, shallow, cup-shaped, much wider than deep, borne near the distal ends of the internodes; nematophores almost entirely wanting in the specimen examined, although the points of attachment for them are occasionally indicated.

Gonosome.—Gonangia ovate, pediculate, borne on the hydrocladia at the bases of the hydrothecæ.

Distribution.—*Albatross* Station 2671, lat. N. 31° 20′, long. W. 79° 22′, 280 fathoms; *Albatross* Station 2666, lat. N. 30° 47′ 30″, long. W. 79° 49′, 270 fathoms.

This species resembles *P. attenuata*, with the distal part of each hydrocladial internode separated from the basal portion by a distinct node. The processes from the stem are not so large as usual in this group and there is no prominence on the upper part of the process.

Type slides.[2]—Cat. Nos. 18594, 18595, 18596, U.S.N.M.; Cat. Nos. 11733, 11734, 11735, Mus. State Univ. Iowa. Also in collection of the author.

PLUMULARIA FILICULA Allman.

(Plate II, fig. 2.)

Plumularia filicula ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 29, pl. XVIII.

Trophosome.—Colony attaining a height of about 2 inches, usually unbranched; stem not fascicled and divided into internodes, each bearing a hydrocladium on a process from its distal end; hydrocladia alternate, proximal internode short, without hydrotheca, next internode hydrothecate, the remainder of the hydrocladium being composed of alternate intermediate and hydrothecate internodes, the former being slightly shorter. Hydrothecæ rather distant, small, cup-shaped, and placed near the middle of the internodes; supracalycine nematophores rather long; a mesial nematophore at the base of each hydrotheca, two on each intermediate internode, one on the proximal internode of the hydrocladium, one or two in the axil of each hydrocladium, and two cauline nematophores on each internode of the stem.

Gonosome.—Gonangia elongate, oval, smooth, narrowed below into a short peduncle by

[1] Condensed translation of the original description rearranged to suit the plan adopted in this work.

[2] For the purpose of preserving and registering the types of new species the author has adopted the plan of mounting three series of slides from the same type specimen, each slide showing, so far as possible, the specific character of the new species. These series were then distributed to the United States National Museum, the Museum of the State University of Iowa, and the private collection of the author.

which they spring from the axils of the pinnæ, opening on the summit by a wide, oblique aperture.[1]

Distribution.—Alligator Reef, from a depth of 88 fathoms; *Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′, 440 fathoms; *Albatross* Station 2601, lat. N. 34° 39′, long. W. 75° 33′, 197 fathoms; *Albatross* Station 2667, lat. N. 30° 53′, long. W. 79° 43′, 273 fathoms; *Albatross* Station 2669, lat. N. 39° 09′, long. W. 79° 33′, 352 fathoms.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

PLUMULARIA HELLERI Hincks.

(Plate II, fig. 3.)

Anisicalyx setaceus HELLER, Zoophyten und Echinodermen des Adriatischen Meeres, 1868, p. 41.
Plumularia helleri HINCKS, Ann. and Mag. Nat. Hist., 1872, IX, p. 120.
Plumularia helleri KIRCHENPAUER, Ueber die Hydroidenfamilie Plumnlaridæ, 1876, Pt. 2, p. 28.
Plumularia helleri MARKTANNER-TURNERETSCHER, Annalen des k. k. naturhistorischen Hofmuseums, 1890, p. 251, pl. VI, fig. 3.
Plumularia helleri CLARKE, Bull. Mus. Comp. Zool., 1894, XXV, No. 6, p. 76.

Trophosome.—Colony attaining a height of 1.5 to 2 centimeters; stem divided into internodes, each of which bears a hydrocladium on a process from its distal end; hydrocladia composed of alternating hydrothecate and intermediate internodes, the former being the longer. Hydrothecæ bell-shaped, rather distant, and placed on the distal ends of the internodes, their posterior margins being on a level with the nodal joints; a single mesial nematophore below the base of each hydrotheca, none on the intermediate internodes, and only a few scattered over the stem.[2]

Gonosome.—Unknown.

Distribution.—Rovigno (Baron Lichtenstein); Adriatic Sea (Kirchenpauer); *Albatross* Station 3384, Pacific, south of Panama, 458 fathoms.

The original describer suspects that this species is identical with *Plumularia similis* of Hincks. Not having either species before me, I am unwilling to venture an opinion, and therefore leave it as a separate species, although a comparison of Marktanner-Turneretscher's figure of *P. helleri* and Hincks's figure of *P. similis* shows no appreciable difference between the two.

PLUMULARIA FLORIDANA, new species.

(Plate II, figs. 4, 5.)

Trophosome.—Colony attaining a height of one-half inch, a delicate plumose stem; stem not fascicled, divided into very distinct internodes, each bearing a hydrocladium on a process from its distal end, there being two or three annulations at each node; hydrocladia divided into alternate hydrothecate and intermediate internodes, the former being at least twice as long as the latter; there are often two very short intermediate internodes or annulations which look like nodes. Hydrothecæ very large, in the form of short cylinders resembling those of *P. catharina*, the distance between adjacent hydrothecæ being only about twice their diameter; a considerable portion of the posterior face is free from the internode; supracalycine nematophores minute, not reaching the top of the hydrothecæ; one nematophore below the base of each hydrotheca, one on each intermediate internode, one in the axil of each hydrocladium, and a cauline nematophore on each internode of the stem.

Gonosome.—Not known.

Distribution.—Two miles west of Cape Romano, Florida (Lieut. J. F. Moser).

This is a very distinct species, combining the characters of the *setacea* and *catharina* types, having the stem and hydrocladia of the former with the hydrothecæ of the latter.

Type.—In the collection of the U. S. National Museum.

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[1] Original description.

[2] Description condensed from the German and rearranged in accordance with the plan adopted in this work.

PLUMULARIA FILICAULIS Kirchenpauer.

(Plate II, fig. 6.)

Plumularia filicaulis KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, 1876, Pt. 2, p. 47, pl. v, fig. 6.
Plumularia filicaulis BALE, Australian Hydroid Zoophytes, 1884, p. 134, pl. xi.

Trophosome.—Colony attaining a height of about one-fourth inch, sparsely branching, not fascicled; stem divided into internodes which are conical in front view and give off hydrocladia from their proximal portions; hydrocladia with short internodes, every alternate one bearing a hydrotheca near its proximal end; intermediate internodes somewhat shorter than the hydrothecate. Hydrothecæ closely approximated for this genus, campanulate in form and attached to the hydrocladia by the basal half only; there is a corrugation on the posterior surface of the hydrotheca extending about two-thirds around to the anterior face; a mesial nematophore on the proximal end of each intermediate internode, and one in the form of a pediculate projection from the distal part of the internode, which curves upward and supports the hydrotheca in front; supracalycine nematophores wanting in some specimens, but present in others. Color of dried specimens reddish brown.

Gonosome.—Not known.

Distribution.—Found growing on algæ from the Bay of Talcahuano, Chile; Portland, Australia (Bale).

This species was originally named by Poeppig, who did not figure or describe it. Many years afterwards Kirchenpauer found the dried specimens and described the species as named by Poeppig in manuscript. A mere naming of a species without description or figure does not, in the opinion of the writer, meet the requirements of scientific description, and hence the species is here ascribed to Kirchenpauer.

I am indebted to Professor W. M. Bale for an Australian specimen of this rare species. In this specimen both the branched and unbranched forms are found growing from the same hydrorhiza, and both have supracalycine nematophores.

PLUMULARIA CATHARINA Johnston.

(Plate III, figs. 1, 2.)

Plumularia catharina JOHNSTON, Mag. Nat. Hist., 1833, VI, p. 498.
Plumularia catharina JOHNSTON, Brit. Zooph., 1847, p. 97.
Aglaophenia catharina GRAY, Cat. Brit. Mus. Radiata, 1847, p. 81.
Plumularia catharina HINCKS, Brit. Hydroid Zooph., 1868, p. 299, pl. LXVI.
Plumularia catharina KIRCHENPAUER, Hydroidenfamilie Plumularidæ, 1876, p. 27.
Plumularia catharina MARKTANNER-TURNERETSCHER, Annalen des k. k. naturhist. Hofmuseums, 1890, p. 253.

Trophosome.—Colony growing in tufts of plumose stems, attaining a height of 4 inches;[1] stem not fascicled, proximal portion divided into irregular internodes, that portion bearing hydrocladia divided into alternating longer and shorter internodes, the shorter bearing the hydrocladia and a single hydrotheca each, the longer bearing nematophores only; hydrocladia opposite, borne on opposite sides of the stem, lying in the same plane and divided into alternating hydrothecate and intermediate internodes, the latter being slightly the longer with a square node at its proximal and an oblique node at its distal end. Hydrothecæ rather closely approximated, cup-shaped, about as deep as wide, margins slightly everted; lateral nematophores borne on lengthened processes from the internode and reaching the margin of the hydrotheca; usually two mesial nematophores on each internode of hydrocladia, but often only one on the hydrothecate internode; cauline nematophores numerous, scattered somewhat irregularly over the front of the stem.

Gonosome.—Gonangia (female) large, ovate, operculate, pediculate, with a pair of nematophores at their bases; or (male) smaller, much more slender and without nematophores, according to Hincks's figure. Both kinds of gonophores are found on the same stem and even on the same hydrocladium, where they spring from the hydrothecate internode just below the base of the hydrotheca.

Distribution.—Coasts of Great Britain down to 60 fathoms (Hincks); *Albatross* Station 2666, lat. N. 30° 47′ 30″, long. W. 79° 49′, 270 fathoms.

[1] History of British Hydroid Zoophytes, 1868, p. 301. American specimens are usually much smaller, scarcely attaining a height of two inches.

The specimens secured by the *Albatross* agree with the descriptions and figures given by Johnston and Hincks in every particular except the size of the colony, which is less than half that of the British specimens as recorded by the authorities just named.

PLUMULARIA GEMINATA Allman.

(Plate III, figs. 3, 4.)

Plumularia geminata ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 32, pl. xx.
Plumularia geminata CLARK, Bull. Mus. Comp. Zool., 1879, V, No. 10, p. 247.
Plumularia geminata FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 128.

Trophosome.—Colony attaining a height of about 1 inch, dichotomously branched; stem not fascicled, the hydrocladia-bearing portion being divided into alternating longer and shorter internodes, the shorter bearing each a pair of hydrocladia and a hydrotheca on its anterior face; hydrocladia opposite, placed on the anterior face of the stem and directed forward, thus lying in two planes. Internodes and hydrothecæ as in *P. catharina;* nematophores also as in *P. catharina*, but Allman's figure does not show any mesial nematophore at the base of each hydrotheca.

Gonosome.—Gonangia pyriform. The two sexes have not been described.

Distribution.—Off Sand Key, Florida, 120 fathoms (Allman); Barbados, 76 fathoms, *Blake;* off American Shoal Light, Florida, 70 to 80 fathoms, State University of Iowa Expedition; *Albatross* Station 2416, lat. N. 31° 26′, long. W. 79° 07′, 276 fathoms; *Albatross* Station 2669, lat. N. 31° 09′, long. W. 79° 33′, 352 fathoms.

This is a species of somewhat doubtful validity. The position of the hydrocladia and their being anteriorly directed is a character of little or no value, as, in another species, *P. clarkei*, it seems to be due to the stage of development of the individual colony. The dichotomous mode of branching, however, may be a specific character, and it is on this ground mainly that the species is here retained.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

PLUMULARIA CLARKEI Nutting.

(Plate III, fig. 5.)

Plumularia gracilis CLARKE,[1] Bull. Mus. Comp. Zool., 1877, V, No. 10, p. 246, pl. v.

Trophosome.—Colony attaining a height of 1½ inches, growing in tufts of plumose branches; stem not fascicled, divided into often obscure internodes of equal length separated by oblique nodes, and each bearing a pair of hydrocladia and a hydrotheca on the proximal end; hydrocladia opposite, borne either on the sides of stem and lying in the same plane, or on the front of the stem and lying in different planes; hydrocladia divided into indistinct and irregular internodes, or the nodes may apparently be wanting. Hydrothecæ as in *Plumularia catharina;* lateral nematophores borne on processes of the hydrocladia and attaining the level of the top of the hydrothecæ; mesial nematophores, usually three between adjacent hydrothecæ; an irregular row of cauline nematophores along the front of the stem.

Gonosome.—Gonophores as in *Plumularia catharina.*

Distribution.—Off Habana, 175 fathoms, *Blake; Albatross* Station 2327, lat. N. 23° 11′ 45″, long. W. 82° 17′ 54″, 182 fathoms; off Habana, State University of Iowa Expedition.

The distinguishing feature of this species is the tendency to obliteration of the nodes, both of the main stem and of the hydrocladia, a very constant character of all specimens that I have examined from the north coast of Cuba.

The three species, *P. catharina*, *P. geminata*, and *P. clarkei*, form a most perplexing group which may eventually be combined in a single species For the present, however, I do not deem it advisable, in view of the absence of intergrading forms between the dichotomous branching of *geminata* and the tufted colonies of the other two on the one hand, and the very marked nodes of *catharina* and *geminata* and the obliteration of most of the nodes of *clarkei.*

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts (labeled *Plumularia gracilis* Clarke).

[1] The name *Plumularia gracilis* was preoccupied by De Blainville in 1834, Manuel d'Actinologie, p. 479. See also Lamarck, Histoire Naturelle des Animaux sans Vertèbres, 2d ed., II, p. 167.

PLUMULARIA ALTERNATA, new species.

(Plate IV, figs. 1, 2.)

Trophosome.—Colony attaining a height of about one-third inch in the single specimen examined, unbranched; stem not fascicled, divided into regular internodes every alternate one of which bears a hydrotheca on the front of its distal end, and also a lateral process bearing a hydrocladium; a slight bend in the stem behind each of the cauline hydrothecæ imparts a wavy or geniculate aspect to the colony; hydrocladia distant, divided into alternating hydrothecate and intermediate internodes of nearly equal length, each intermediate internode having a distal oblique and proximal transverse node. Hydrothecæ large, rather closely approximated, conical in front view and deeply cup-shaped in lateral view, free for about their distal one-third, margin slightly everted; lateral nematophores borne on strong processes of the internodes, and reaching to the margin of the hydrotheca; a mesial nematophore below the base of each hydrotheca and one on each intermediate internode; the arrangement of the cauline hydrothecæ is as described above.

Gonosome.—Not known.

Distribution.—Barracuda Rocks. Collected by Alexander Agassiz, during the cruise of the *Wild Duck* in the West Indies, in 1893.

This very distinct species is sharply characterized by alternate hydrocladia in connection with cauline hydrothecæ, and by having a single mesial nematophore to each internode both of stem and hydrocladia.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

PLUMULARIA PLUMULARIOIDES (Clark).

(Plate IV, fig. 3.)

Halecium plumularioides CLARK, Proc. Acad. Nat. Sci. Phila., 1876, Pt. 3, p. 217, pl. x, figs. 16, 17.

Trophosome.—Hydrocaulus erect, simple, straight, divided by transverse joints into internodes of considerable length, regularly branched, and with a few annulations at the base; branches arranged alternately on opposite sides of the stem, one to each internode, having their origin in a small shoulder-like process just below each joint, divided usually into regular internodes, though, in some cases, short intermediate internodes occur between the longer ones. Hydrothecæ arranged uniserially, usually one to each internode, partly adherent to the stem, or entirely free, shallow, tapering slightly to the base, with an entire rim.

Gonosome.—Gonangia unknown.

Distribution.—Cape Etolin, Nunivak Island, 8 to 10 fathoms. Height of largest specimen, 20 millimeters.[1]

Dr. Clark refers this species to *Halecium* on account of the absence of nematophores. This, as we now know, is a feature that may be only accidental or temporary, and hence is of little systematic importance.

Clark's figure shows that this species is without intermediate internodes, and that the hydrothecæ are near the distal ends of the internodes with their posterior margins on a level with the nodal joints.

PLUMULARIA INERMIS, new species.

(Plate V, figs. 1, 2, 2*a*.)

Trophosome.—Colony unbranched, attaining a height of about one-half inch; stem not fascicled, strongly sinuous, almost geniculate, divided into internodes each of which bears a hydrocladium on a projection from its distal end; hydrocladia rather distant and slender, projecting at almost a right angle from the stem, basal internode bearing a hydrotheca near its distal end, the remaining internodes long, slender, each with a hydrotheca near its distal end; an occasional intermediate internode appears. Hydrothecæ distant, small, subconical; nematophores minute, supracalycine pair usually absent; a single nematophore below the base of each hydrotheca, and sometimes one above each hydrotheca, and one just above the axil of each hydrocladium;

[1] Original description.

hydranths very large, not capable of retracting into the hydrothecæ; tentacles 16 to 18; proboscis greatly expanded in the shape of a broadly flaring trumpet.

Gonosome.—Not known.

Distribution.—Barracuda Rocks. Collected by Alexander Agassiz during the cruise of the *Wild Duck* in the West Indies in 1893.

A very distinct and delicate species, characterized by a proximal hydrothecal internode, and the apparent absence of the supracalycine nematophores, a feature occurring also in *Plumularia pinnata* of Lamarck.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

PLUMULARIA CAULITHECA Fewkes.

(Plate V, figs. 3–5.)

Plumularia caulitheca FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 130.

Trophosome.[1]—Colony unbranched, attaining a height of about 2 inches; stem fascicled, the anterior tube bearing the hydrocladia not divided into distinct internodes, but giving off long and strong processes which bear the hydrocladia; hydrocladia not closely approximated, divided into regular long internodes, each of which is hydrothecate and has its cavity partly divided by numerous strong septal ridges which are irregular in distribution, being in general more pronounced in the proximal than in the distal internodes. Hydrothecæ distant, deep, entirely adnate to the hydrocladia, aperture horizontal, margin slightly flaring, anterior outline slightly sinuous; nematophores very minute and many of them absent in the type; supracalycine pair arising from minute processes on a level with the top of the hydrotheca, a mesial nematophore on a prominence on the front of each end of each internode; cauline nematophores scattered over the anterior tube of the stem, and a spur-like one near the axil of each hydrocladium. There is an aperture in front of the base of each process of the stem which bears a hydrocladium.

Gonosome.—Not known.

Distribution.—*Blake* Station 264, off Grenada, 416 fathoms; *Albatross* Station 2667, lat. N. 30° 53′, long. W. 79° 43′, 273 fathoms.

P. caulitheca stands almost on the line of demarcation between the *attenuata* and *macrotheca* groups, the hydrocladial internodes all being hydrothecate, and the hydrotheca being almost, sometimes fully, one and a half times as deep as wide. The spur-like nematophore in the axil of each hydrocladia is a common occurrence among the Eleutheroplea, especially those from the West Indian region.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

PLUMULARIA ATTENUATA Allman.

(Plate V, fig. 6.)

Plumularia attenuata ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 30, pl. XVIII.
Plumularia attenuata FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 128.

Trophosome.—Colony attaining a height of about 2 inches, growing in tufts of plumose branches which are sometimes fascicled below; branches divided into distinct internodes below and indistinct internodes above, where the joints are sometimes not discernible. Each internode bears a hydrocladium on a projection from its distal end; hydrocladia with a short proximal internode without a hydrotheca, followed by a long internode with a hydrotheca near its enlarged proximal end and having the distal end long and attenuate. This attenuate portion may be broken up into one or more intermediate internodes, but normally each internode bears a hydrotheca. Hydrothecæ rather small, cup-shaped; supracalycine nematophores large; one mesial nematophore on the proximal end and one on the distal end of each internode, one on the proximal node, a pair at the axil of each hydrocladium, and two to each joint of the stem.

Gonosome.—Not known.

Distribution.—Off Boca Grande, 105 fathoms; Grenada, 576 fathoms (*Blake*).

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

[1] Description of Doctor Fewkes's type specimen in the Museum of Comparative Zoology.

PLUMULARIA GOODEI,[1] new species.

(Plate VII, figs. 1–4.)

Trophosome.—Colony minute, consisting of undivided plumose stems growing from a creeping root stalk, attaining a height of about one-half inch. Stem not fascicled, straight, divided into regular internodes, each of which bears two hydrocladia on projections from its opposite sides, one projection being near the proximal and another near the distal end of the internode. Hydrocladia not very closely approximated, stout, strongly recurved, each with a short proximal internode and three or four other internodes, all of which are hydrothecate and without septal ridges. Hydranths large, incapable of retracting within the hydrothecæ, with broadly expanded, disk-shaped proboscis and about twenty-four tentacles. Hydrothecæ cup-shaped, with slightly recurved marigns, borne near the distal ends of the internodes; *nematophores monothalamic*, a supracalycine pair barely reaching the level of the top of the hydrotheca and a mesial nematophore some distance below each hydrotheca. There is a pair of naked sarcostyles without hydrothecæ in the axil of each hydrocladium.

Gonosome.—Not known.

Distribution.—The type was dredged off Santa Barbara, California, outside of the kelp, by Mrs. Virginia Barrett Gibbs.

This species is closely allied to *P. pinnata*, from which it differs in having supracalycine nematophores and in having constantly two instead of several hydrocladia to each internode of the stem. *P. goodei* is the only American species that I have encountered with monothalamic nematophores, in which it agrees with *P. pinnata*, *P. similis*, and *P. echinulata*—all British species.

Type slides.—Cat. No. 15329, Mus. State Univ. Iowa; Cat. No. 18623, U.S.N.M.

PLUMULARIA CORRUGATA, new species.

(Plate VI, figs. 1–3.)

Trophosome.—Colony a simple plumose stem attaining a height of 1½ inches; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium on a process from its distal end; hydrocladia alternate and lying in the same plane; proximal internode short, with a single internal ridge, next internode hydrothecate and with three or four internal ridges, the next internode intermediate with two internal ridges. The remainder of the hydrocladium is made up of alternate hydrothecate and intermediate internodes with ridges as described above, those bearing hydrothecæ being considerably longer than the intermediate ones, which are at least twice as long as broad. Hydrothecæ distant, about as deep as broad and placed near the middle of the internode; supracalycine nematophores present; a mesial nematophore below the base of each hydrotheca, one on each intermediate internode, one at the axil of each hydrocladium, and one on each stem joint on the side opposite the process which bears the hydrocladium.

Gonosome.—Gonangia of two kinds, much as in *P. lagenifera*, but I have not found both kinds on the same stem. The kind resembling those of *P. setacea* is very greatly elongated, being about fifteen times the length of the hydrothecæ, while in our specimens of *P. setacea* the gonangia are only about seven times the length of the hydrothecæ. It occurs to me that the triangular gonangia spoken of by Marktanner-Turneretscher may be the shriveled gonangia of the first type, which have extruded their contents. A specimen before me would suggest this idea.

Distribution.—Long. W. 40°, lat. S. 22° to 23° (Richard Rathbun); 10 miles east of Petros Island.

This species is closely allied to *P. lagenifera*, from which it differs in the greater length of hydrocladial internodes, number of internal ridges, and in having the hydrocladia in the same plane.

Type slides.—Cat. Nos. 18609, 18610, U.S.N.M.; Cat. Nos. 11721, 11722, Mus. State Univ. Iowa; also in the collection of the author.

[1] Named in honor of the late Doctor G. Brown Goode, a man whose services to marine zoology were no less pronounced than the genial kindliness with which he assisted all workers with whom he came in contact.

PLUMULARIA PALMERI, new species.

(Plate VI, figs. 4, 5.)

Trophosome.—Colony unbranched, growing in dense filamentous tufts of very slender stems, attaining a height of about 4 inches; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium on a process near its distal end, and shows a strong septal ridge near its proximal end and an obscure septal ridge near its distal end; hydrocladia longer than in *P. lagenifera*, divided into alternating hydrothecate and intervening internodes, each of which has a septal ridge near each end; hydrothecate internodes more than twice as long as the others, with a faint septal ridge near the bottom of the hydrotheca, besides the two strong ones at the ends. Hydrothecæ cup-shaped, about as deep as wide, considerably wider at the top than at the bottom, and with a straight anterior profile; supracalycine nematophores with their insertion on a level with the tops of the hydrothecæ; a mesial nematophore on a swelling below the hydrotheca and another on the front of the intermediate internode; two cauline nematophores in the axil of each hydrocladium, and one on the opposite side and proximal end of each cauline internode.

Gonosome.—Not known.

Distribution.—San Diego, California. Collected by Mr. Edward Palmer, after whom I have named the species.

P. palmeri resembles *P. lagenifera* in its mode of growth, but differs from it in the size of the colony, and more particularly in the shape of the hydrothecæ. The septal ridge at the bottom of the hydrotheca is not so strong. The color of the stem is usually horn color. The species differs from *P. corrugata* in mode of growth, the latter being a dendritic rigid species with stiff, long branches, more distant hydrothecæ, longer intermediate internodes, and more numerous septal ridges.

Type slides.—Cat. Nos. 18624, 18625, U.S.N.M.; Cat. No. 15327. Mus. State Univ. Iowa; also in the collection of the author.

PLUMULARIA LAGENIFERA Allman.

(Plate VI, figs. 6–10.)

Plumularia lagenifera ALLMAN, Jour. Linn. Soc. Lond., Zool., 1885, XIX, p. 157, pl. XXVI.

Plumularia californica MARKTANNER-TURNERETSCHER, Annalen des k. k. naturhist. Hofmuseums, 1890, V, No. 2, p. 255, pl. VI.

Trophosome.[1]—Colony sparsely branching, growing in dense filamentous tufts, and attaining a height of about 3 inches; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium on a stout process from its distal end, and a septal ridge near each end; hydrocladia short, with their distal ends recurved toward the stem, divided into alternate hydrothecate and intermediate internodes, the former being the longer and having a thickened transverse septal ridge near each end, and another opposite the bottom of the hydrotheca; intermediate internodes not more than half as long as the hydrothecate, and with a transverse septal ridge at each end. Hydrothecæ stout, somewhat ventricose, wider than deep, borne on a prominent swelling on the middle of the anterior face of the internode; supracalycine nematophores originating above the hydrothecæ; a mesial nematophore borne on a protuberance below the hydrotheca and another on the intermediate internode; one or two cauline nematophores in the axil of each hydrocladium and one on the opposite side and proximal end of each cauline internode.

Gonosome.—Gonangia oviform, with long slender necks and round, terminal openings. They are flattened so as to appear quite slender, like those of *P. setacea* when viewed from the side.

Distribution.—Puget Sound, Dr. Steindachner; coast of California, Clark; Vancouver Island, Allman.

Specimens of this species from the British Museum agree perfectly with Marktanner-Turneretscher's description and figures of *P. californica*, which I regard as a synonym for *P. lagenifera* Allman.

Specimens from Yale University Museum, labeled "Coast of California," marked *P. setacea*, belong undoubtedly to *P. lagenifera*. The resemblance to *P. setacea* being merely superficial as a direct comparison with specimens of the latter species in the South Kensington Museum shows.

[1] Described from specimens from the Museum of Yale University, kindly sent me by Professor A. E. Verrill.

PLUMULARIA VIRGINIÆ, new species.

(Plate VII, figs. 5-10.)

Trophosome.—Colony growing in tufts of simple plumose stems attaining a height of about one-half inch; stem not fascicled, divided into regular internodes each of which bears a hydrocladium on a stout process from near its distal end and shows a thickened internal ridge near each end; hydrocladia alternate, not very closely approximate. Proximal internode short, with a single internal ridge; all of the remaining internodes are hydrothecate, each with a very strong internal thickening on its anterior side just below the mesial nematophore and another below the supracalycine pair. Hydrothecæ borne just above the middle of the internodes on very strong shoulders or protuberances, very shallow, basin shaped, with broadly flaring sides; hydranths very large, robust, with about 24 tentacles and a broadly expanded hypostome, reminding one of *P. halecioides*. Nematophores long, conical, with a very shallow distal chamber, and containing sarcostyles with remarkably symmetrical batteries of small nematocysts and the usual sarcodal process, supracalycine nematophores borne on prominent swellings of the internode and directed upward and outward, a mesial nematophore near the proximal end of each internode and a cauline nematophore in the axil of each hydrocladium.

Gonosome.—Gonangia borne in a row on the front of the stem, long, with the distal end produced into a neck, as in *P. setacea*. The younger gonangia are long conical bodies with truncated distal ends.

Distribution.—Dredged off Santa Barbara, California, outside of the kelp, by Mrs. Virginia Barrett Gibbs, in whose honor it is named. This very distinct species has the shallowest hydrothecæ, together with the largest hydranths, of any American form that I have seen.

Type slides.—Cat. No. 15324, Mus. State Univ. Iowa; Cat. No. 18628, U.S.N.M.

PLUMULARIA MACROTHECA Allman.

(Plate VIII, fig. 1.)

Plumularia macrotheca ALLMAN, Mem. Mus. Comp. Zool., V, No. 2, p. 30, pl. XVIII.

Trophosome.—Hydrocaulus attaining a height of about 2 inches, simple, fascicled, springing from an entangled mass of fine tubular filaments; pinnæ very slender, alternate, composed each of a succession of long internodes alternating with short ones, each of the long internodes bearing a hydrotheca. Hydrothecæ deep, tubular, with very slightly everted margins. Supracalycine nematophores springing each from a short process which projects from the long internode, just below the margin of the hydrotheca, one mesial nematophore carried by the same internode at the proximal side of the hydrotheca, and another on each of the short internodes.

Gonosome.—Not known.

Distribution.—Off Cojima, Cuba, from a depth of 450 fathoms.[1]

This is a very distinct species characterized by its unusually deep hydrothecæ in connection with hydrothecate and intermediate internodes. It has not been found by any expedition subsequent to Pourtalès's explorations of the Gulf Stream. The species has not been seen by the present writer.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

PLUMULARIA PROFUNDA, new species.

(Plate VIII, figs. 2, 3.)

Trophosome.—Colony attaining a height of 6 inches, pinnately branching, forming a flabellate structure; stem consisting of a central tube from which the hydrocladia arise, surrounded by a number of supplementary supporting tubes, fascicled except at distal portions of the branches, the nonfascicled part being divided irregularly into internodes the shorter of which bear one and the longer two hydrocladia upon strong processes from the stem; where one hydrocladium only

[1] Original description.

springs from an internode it is borne on a process from the proximal part of that internode, and where there are two hydrocladia to a single internode they spring from the proximal and distal ends of that internode; there is a hydrotheca borne on each process at its junction with the stem; hydrocladia alternate, borne on the main stem and its branches and divided irregularly into internodes which bear one or two hydrothecæ each; where there is a single hydrotheca to an internode it is borne near the middle of that internode, but where there are two hydrothecæ to an internode they are borne on the ends of that internode. Hydrothecæ deep, cylindrical, almost twice as deep as wide, margin circular and even, very slightly everted; the hydrothecæ borne on the hydrocladial processes at their junction with the stem are shorter than the others; lateral nematophores borne on very slight processes of the internode, just below the top of the hydrothecæ; a mesial nematophore between adjacent hydrothecæ, often two on the proximal internode of the hydrocladium and an apparently irregular number on the main stem and its branches.

Gonosome.—Gonangia ovate, with a circular aperture and containing a number of developing ova. They are borne on the hydrocladia at the bases of the hydrothecæ and are each provided with a pair of nematophores.

Distribution.—*Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′, 440 fathoms; *Albatross* Station 2667, lat. N. 30° 53′, long. W. 79° 42′ 30″, 273 fathoms.

This interesting form is so different from the other species of *Plumularia* that it may eventually be found worthy of a new genus. The structure of the stem appears to be very similar to that found in the family Perisiphonidæ of Allman; the hydrothecæ on the stem at the axils of the hydrocladia show its affinity with the *catharina* group of *Plumularia*, while the shape of the hydrothecæ reminds one forcibly of *P. cylindrica* Kirchenpauer.

Type slides.—Cat. Nos. 18611, 18612, U.S.N.M.; Cat. Nos. 11719, 11720, Mus. State Univ. Iowa; also in collection of the author.

PLUMULARIA DENDRITICA, new species.

(Plate VIII, figs. 4–6.)

Trophosome.—Colony attaining a height of 18 inches, profusely branching in an arborescent manner, there being branches of at least six different ranks. The main stem branches in an irregular manner and these branches divide several times irregularly until the hydrocladia-bearing branches are reached, when the branches assume a pinnate form; stem fascicled, the central tube being divided into irregular but usually very long internodes, each of which normally bears several hydrocladia on processes from the sides of the tube; these processes also bear a small projection such as Dr. Fewkes calls a nematophore in *P. caulitheca;* the nodal joints become less frequent toward the distal ends of the branches; there are no hydrothecæ on the stem or any of the branches except the hydrocladia; hydrocladia alternate, divided into rather long regular hydrothecate internodes, with an occasional very short intermediate internode, the nodes being frequently associated with one or two internal thickened ridges which simulate nodal joints and give the appearance of several very short internodes. Hydrothecæ closely approximated, very small, deep, about twice as deep as wide, margin sinuous in front and obliquely cut away at the postero-lateral corners, aperture slightly less than the greatest diameter of the hydrotheca; supracalycine nematophores borne on very small projections just above and inside of the top of the hydrothecæ, and usually pendant within the cavity of the latter; a single mesial nematophore is borne on a stout process below the base of each hydrotheca, a cauline nematophore is found at the axil of each hydrocladium, and several on each internode of the stem.

Gonosome.—Not known.

Distribution.—Near Little Cat Island, Bahamas, shallow water, State University of Iowa Expedition.

Type slides.—Cat. Nos. 11717, 11718, Mus. State Univ. Iowa; Cat. Nos. 18613, 18614, U.S.N.M.; also in the collection of the author.

This is probably the bulkiest species of Plumularian hydroid yet discovered in American waters. The stem in one of our specimens is over half an inch in diameter and greatly resembles a gorgonian stem.

PLUMULARIA PAUCINODA, new species.

(Plate VIII, figs. 7–9.)

Trophosome.—Colony (incomplete) attaining a height of 1½ inches, unbranched; stem fascicled, irregularly divided into internodes; hydrocladia borne on a tube running along the face of the stem and branches, supported on stout projections from the stem, divided into long, irregular internodes, each bearing several (about four) hydrothecæ. Hydrothecæ rather distant, deep, anterior margin slightly deflected, aperture circular and entire; supracalycine nematophores borne on projections from the hydrocladium near the level of the top of the hydrotheca; a mesial nematophore on a projection just at the base of each hydrotheca, and two others between this and the next hydrotheca below; cauline nematophores distributed along the anterior cauline tube from which the hydrocladia spring.

Gonosome.—Unknown.

Distribution.—*Albatross* Station 2330, lat. N. 23° 10′ 48″, long. W. 82° 19′ 15″, 121 fathoms.

This species differs from all the other representatives of the genus in having several hydrothecæ borne on a single internode, a feature found in the genus *Diplopteron*. In the absence of the gonosome, the place here given the species is of course provisional.

Type.—Alcoholic specimen in United States National Museum.

ANTENNULARIA Lamarck (modified).[1]

Nemertesia LAMOUROUX (modified), Hist. des Pol. coral. flex., 1816, p. 161.
Antennularia LAMARCK, Hist. Nat. des Anim. sans Vert., 1836, II, p. 155.

Trophosome.—Cœnosarc of stem canaliculated; hydrocladia usually arranged in verticils, but sometimes scattered irregularly over the stem. Nematophores large, trumpet-shaped.

Gonosome.—Gonangia borne on processes from the stem, usually oblong-ovate, or sac-shaped, and without protective appendages.

In his Report of the Hydroida of the Gulf Stream (1877), Allman separated from the genus *Antennularia* a species characterized by having the hydrocladia scattered over the stem instead of being arranged in verticils. For this species he constituted the genus *Antennopsis*. In his Report on the Plumularidæ secured by the *Challenger*, Professor Allman abandons the genus *Antennopsis* as untenable. In the former work, however, he points out a much better generic character, but evidently did not at that time feel justified in adopting it. He says:

> In all the species of *Antennularia* which I have examined the cœnosarc is canaliculated, the hydrosomal cavity being there represented by a network of intercommunicating canals. In *Antennopsis hippuris* the hydrosomal cavity is of the ordinary simple type, but we do not yet know enough of the species which may compose the genus *Antennopsis* to enable us to regard this as a true generic character.[2]

A number of species brought to light since the above was written indicate that the canaliculated cœnosarc is a good generic character. Its adoption will exclude, however, *Antennularia fascicularis*, described by Allman among the *Challenger* Plumularidæ.

Distribution of American species of Antennularia.

Species.	Geographical. Atlantic.			Bathymetrical.				
	Charleston and Northward.	South of Charleston and West Indies.	Coasts of Europe.	1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.
A. antennina	+	.....	+	+	.....	+	.....	.....
A. americana	+	.....	.....	.....	.....	+	+	+
A. simplex	+	+	.....	.....	+	+	+	+
A. rugosa	+	.....	.....	.....	+	.....	.....	.....
A. geniculata	.....	+	.....	.....	.....	.....	.....	+
A. pinnata	+	.....	.....	.....	.....	+	.....	.....

[1] See discussion of genus *Plumularia*, especially the confusion regarding the generic names introduced by Lamarck and Lamouroux.

[2] Memoirs of the Museum of Comparative Zoology, V, No. 2, p. 34.

KEY TO AMERICAN SPECIES OF ANTENNULARIA.

Hydrocladia strictly verticillate	Intermediate internodes present, internodes without internal thickenings, proximate hydrothecæ divided from stem by two nodes ..... *antennina.*
	Proximate hydrothecæ not divided from stem by nodes ..... *americana.*
	Less than six hydrocladia to each verticil. Intermediate internodes normally absent ..... *simplex.*
	Hydrocladial internodes with distinct internal thickenings .... *rugosa.*
Hydrocladia not strictly verticillate	Hydrocladia borne on very long stout processes from stem. Color of colony, brown ..... *geniculata.*
	Hydrocladia borne on processes of moderate size. Color of colony, yellow ..... *pinnata.*

The arrangement of internodes in the American specimens is utterly unreliable, as the characteristic features of both *A. antennina* and *A. ramosa* is often, indeed usually, found on the same hydrocladium, the proximal portion being made up of alternate hydrothecate and intermediate internodes.

ANTENNULARIA ANTENNINA (Linnæus).

(Plate IX, figs. 1, 2.)

Sertularia antennina LINNÆUS, Systema Naturæ, 1788, p. 1310.
Sertularia antennina PALLAS, Elenchus Zoophytorum, 1766, p. 146.
Nemertesia antennina LAMOUROUX, Hist. des Polyp. coral. flex., 1816, p. 163.
Antennularia indivisa LAMARCK, Anim. sans Vert., 1836, 2d ed., II, p. 156.
Antennularia antennina JOHNSTON, Brit. Zooph., 1847, 2d ed., p. 86.
Antennularia antennina HINCKS, Brit. Hydroid Zooph., 1868, p. 280.
Nemertesia antennina KIRCHENPAUER, Ueber die Hydroidenfam. Plumularidæ, 1876, Pt. 2, p. 51.
Antennularia antennina MARKTANNER-TURNERETSCHER, Die Hydroiden des k. k. naturhis., Hofmus., 1890, p. 260.

Trophosome.—Colony growing in dense clusters of upright stems, attaining a height of 8 to 10 inches, unbranched or very sparsely branched; stem with the cœnosarc canaliculated, divided into obscure internodes, each of which bears a verticil of hydrocladia on processes from its distal end, there being usually more than six hydrocladia to each verticil; hydrocladia divided into alternating hydrothecate and intermediate internodes, the former being the longer. Hydrothecæ small, cup-shaped, with slightly everted margins; supracalycine nematophores present; a mesial nematophore at the base of each hydrotheca, one and sometimes two to each intermediate internode, and two in the axil of each hydrocladium.

Gonosome.—Gonangia ovate, with a subterminal aperture, borne singly in the axils of the hydrocladia.

Distribution.—Shores of Europe and Great Britain (Hincks); Newport, Rhode Island (Verrill); *Albatross* Station 2066, lat. N. 42° 20′, long. W. 65° 50′; depth, 65 fathoms; *Albatross* Station 2302, lat. N. 35° 14′, long. W. 75° 03′; depth, 71 fathoms.

ANTENNULARIA AMERICANA, new species.

(Plate IX, figs. 3, 4.)

Trophosome.—Colony unbranched or sparsely branched, attaining a height of 9 inches. Cœnosarc extensively canaliculated; hydrocladia arranged in distinct verticils of usually more than six, each borne on a very long process from the stem, *which is not separated from the proximal hydrotheca by more than one node;* proximal portion of each hydrocladium made up of hydrothecate internodes only, distal portion usually showing intermediate internodes; all hydrocladial internodes more slender than in *A. antennina.* Hydrothecæ small, cup-shaped, with margins sometimes slightly everted, borne below the middle of the internodes; a pair of large supracalycine nematophores borne on small processes below the postero-lateral margin of each hydrotheca; a mesial nematophore below each hydrotheca, and one or two on each intermediate internode or above each hydrotheca where the intermediate internodes are absent; two or three cauline nematophores in the axil of each hydrocladium, and the others scattered somewhat irregularly over the stem.

Gonosome.—Gonangia ovate, borne singly in the axils of the hydrocladia.

Distribution.—*Albatross* Station 2014, lat. N. 36° 41′, long. W. 74° 39′; depth, 373 fathoms; *Albatross* Station 2265, lat. N. 37° 08′, long. W. 74° 36′, 58 fathoms; *Albatross* Station 2268, lat. N. 35° 11′, long. W. 75° 06′, 68 fathoms; *Albatross* Station 2592, lat. N. 35° 03′, long. W. 75° 12′, 120 fathoms.

This species is evidently very closely allied to *A. antennina*, but the character italicised above appears constant, and this, together with the fact of its being from deeper water, seems to warrant its separation. The arrangement of the hydrocladial internodes is also different, but this is an exceedingly variable character, as already intimated.

Type slides.—Cat. Nos. 18553, 18554, U.S.N.M.; Cat. Nos. 11696, 11697, Mus. State Univ. Iowa; also in the collection of the author.

ANTENNULARIA SIMPLEX Allman.

(Plate IX, fig. 5.)

Antennularia simplex ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 34, pl. XXI.

Trophosome.—Colony attaining a height of about 5 inches, simple, or very sparsely branched; stem, with canaliculated cœnosarc, bearing verticils of hydrocladia on strong processes; hydrocladia arranged in verticils of three to five each, and divided into internodes, each of which bears a hydrotheca near its proximal end, an occasional intermediate internode being found on the distal portions of the hydrocladia. Hydrothecæ rather small, cup-shaped, with slightly everted margins, placed on the lower ends of the internodes; supracalycine nematophores large, as long as the hydrothecæ, borne on processes from the internode; mesial nematophores large, two to each internode, one being above and the other below the hydrotheca; cauline nematophores scattered over the stem.

Gonosome.—Gonangia rather small, ovate, with an oblique aperture, borne in the axils of the hydrocladia.

Distribution.—Off Alligator Reef; depth, 86 fathoms (Pourtalès); *Albatross* Station 2265, lat. N. 37° 08′, long. W. 74° 36′, 70 fathoms; *Albatross* Station 2014, lat. N. 36° 41′, long. W. 74° 39′, 373 fathoms; *Albatross* Station 2269, lat. N. 35° 13′, long. W. 75° 05′, 48 fathoms; *Albatross* Station 2342, lat N. 23° 11′, long. W. 82° 20′, 201 fathoms; *Albatross* Station 2592, lat. N. 35° 02′, long. W. 75° 12′, 120 fathoms; State University of Iowa expedition, Pourtalès Plateau, 70 to 80 fathoms.

This species is closely allied to *A. ramosa*, but differs in being generally simple, not branched, and in having a much less number of hydrocladia to each verticil. Some specimens appear at first sight to have the hydrocladia pinnate and opposite, but as a rule there are three to five hydrocladia arranged in verticils as described above.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

ANTENNULARIA RUGOSA, new species.

(Plate X, figs. 1, 2.)

Trophosome.—Colony attaining a height of 6 inches, unbranched; stem with canaliculated cœnosarc and bearing hydrocladia in closely set verticils of six or eight; hydrocladia borne on stout processes of the stem, swollen at the proximal end and having their lower sides reenforced by a remarkable thickening of the perisarc; internodes very long and irregular, sometimes bearing more than one hydrotheca, divided by sharply marked internodes, with their cavities partially divided by numerous and irregularly disposed chitinous septal ridges or thickenings, which often resemble nodal joints, thus imparting an appearance of many internodes, where in reality there is only one. Hydrothecæ rather small, short, cylindrical, with the postero-lateral margins often cut away, and supported below by a noticeable thickening of the internode; supracalycine nematophores present; two or three mesial nematophores between adjacent hydrothecæ; cauline nematophores scattered rather sparsely over the stem.

Gonosome.—Not known.

Distribution.—*Albatross* Station 2260, off Marthas Vineyard, 46 fathoms.

This very distinct species recalls the *lagenifera* group of the genus *Plumularia* in the numerous thickened internal ridges in the hydrocladia, but is almost unique in the possession of a peculiar support of the hydrocladia effected by a notable thickening of the perisarc on the under or external surface of each hydrocladium. The processes of the stem which support the hydrocladia are unusually short, and each bears a swollen protuberance upon its upper surface.

Type slides.—Cat. No. 18559, U.S.N.M.; Cat. No. 11692, Mus. State Univ. Iowa; also in the collection of the author.

ANTENNULARIA GENICULATA, new species.

(Plate X, figs. 3, 4.)

Trophosome.—Colony attaining a height of 5 inches, unbranched; stem with canaliculated cœnosarc, divided into internodes, and bearing scattered hydrocladia on processes which have a distinct tooth-like projection on the upper surface; distal portion of stem geniculated; hydrocladia borne on long, stout processes scattered over the surface of the stem, but often showing a tendency to a verticillate arrangement; first internode very short, without hydrotheca; second long, hydrothecate, the remainder of the hydrocladium being composed of alternating hydrothecate and intermediate internodes, the latter being the shorter. Hydrothecæ subconical, about as deep as wide, and borne just below the middle of the internode; nematophores rather large, supracalycine pair present; a mesial nematophore at base of each hydrotheca, one or two on each intermediate internode, and a few cauline nematophores scattered rather sparsely on the stem, there being one or two in the axil of each hydrocladium.

Gonosome.—Gonangia borne in pairs in the axils of the hydrocladia, large, ovate, with the distal end turned to one side and the aperture directed laterally.

Distribution.—*Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′, 440 fathoms; *Albatross* Station 2667, lat. N. 30° 53′, long. W. 79° 43′, 273 fathoms; *Albatross* Station 2668, lat. N. 30° 59′, long. W. 79° 39′, 294 fathoms; *Albatross* Station 2669, lat. N. 31° 09′, long. W. 79° 34′, 352 fathoms.

This species illustrates the complete intergradation, so far as distribution of hydrocladia is concerned, between the genera *Antennularia* and *Antennopsis*. Indeed, if only the distal portion of a colony were examined one would be inclined to call it a *Plumularia*, for the hydrocladia are often pinnately arranged toward the end of the stem.

Type slides.—Cat. Nos. 18561, 18562, U.S.N.M.; Cat. Nos. 11689 11690, Mus. State Univ. Iowa; also in the collection of the author.

ANTENNULARIA PINNATA, new species.

(Plate X, figs. 5, 6.)

Trophosome.—Hydrocaulus unbranched or sparsely branched, attaining a height of about 3 inches; stem with few cœnosarcal canaliculi; in some specimens these seem to be largely obliterated, as if the cœnosarc had been broken down by maceration, in others they are as prominent as usual in this group; hydrocladia borne on moderately long processes from the stem, pinnate, alternate, or scattered (according to age of specimen or the part of the colony examined), composed of regularly alternating hydrothecate and intermediate internodes, divided by well-marked nodes, often accompanied by internal thickenings at the ends of the internodes; two nodes between proximal hydrotheca and the stem. Hydrothecæ distant, cup-shaped, about as deep as wide, situated near the middle of the internodes; nematophores large, a supracalycine pair, a mesial one below each hydrotheca, and another on each intermediate internode; a pair of cauline nematophores in the axil of each hydrocladium, and others scattered over the stem.

Gonosome.—Not known.

Distribution.—U. S. Fish Commission Station 872, lat. N. 40° 06′, long. W. 70° 24′; depth, 86 fathoms; Station 949, lat. N. 40° 03′, long. W. 70° 31′; depth, 100 fathoms.

This species is darker colored than most of the genus, being dark brown, lightening to horn color in the distal parts. The hydrocladia are more rigid than usual, and are often arranged

pinnately along a considerable portion of the stem, but they are always irregularly distributed in the distal part of the colony. A verticillate arrangement is not apparent in any of the specimens at hand, which might easily be mistaken for a species of *Plumularia*, so pronounced is the pinnate arrangement of the hydrocladia.

Type slides.—Cat. Nos. 18633, 18634, U.S.N.M.; Cat. Nos. 15320, 15321, Mus. State Univ. Iowa; also in the collection of the author.

MONOTHECA, new genus.

Monopyxis KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, 1876, Pt. 2, pp. 17, 21.

Trophosome.—Stem simple or sparsely branching, divided into internodes; hydrocladia bearing each a single hydrotheca and consisting of two internodes, of which the distal one bears the hydrotheca and supports two supracalycine nematophores on an enlargement or a bifurcation of its distal end.

Gonosome.—Gonangia borne on the stem, usually on the proximal portion, ovate or sac shaped, and without protective appendages.

Kirchenpauer, in his work on the Plumularidæ referred to above, divided the old genus *Plumularia* into three subgenera, which he called "*Isicola*," "*Anisocola*," and "*Monopyxis*." The first and second of these were based upon characters which are of little systematic importance, that is, the possession or absence of intermediate internodes on the hydrocladia. The third subgenus, *Monopyxis*, as Bale justly remarks, "is founded on a more valid distinction,"[1] the possession of a single hydrotheca to each hydrocladium. It therefore seems convenient and proper to raise the subgenus to generic rank. The name *Monopyxis*, however, was preoccupied by Ehrenberg in 1834. I therefore propose the name *Monotheca* as the generic appellation of the group.

MONOTHECA MARGARETTA, new species.

(Plate XI, figs. 1-3.)

Trophosome.—Colony attaining a height of about one-fourth of an inch, usually unbranched, but occasionally sending off a single lateral branch, stem not fascicled, divided regularly into internodes, each of which bears a hydrocladium on a process from its distal end, and plainly geniculate, there being a bend opposite the origin of each hydrocladium; hydrocladia consisting of a proximal short internode bearing neither hydrotheca nor nematophore, and a distal longer internode bearing a hydrotheca and bifurcating at its distal end, thus furnishing supports for the two supracalycine nematophores. Hydrothecæ conical, rather deep, margin circular and entire; supracalycine nematophores overtopping the hydrotheca and borne on the forked ends of the hydrocladia; a mesial nematophore at the base of each hydrotheca, two to four nematophores in the axil of each hydrocladium, and one cauline nematophore to each internode of the stem.

Gonosome.—Not known.

Distribution.—Shallow water, near Little Cat Island, Bahamas. State University of Iowa expedition. Found attached to algæ.

This is an exceedingly delicate and graceful species, which is affectionately dedicated to the author's mother. It may be readily distinguished from its nearest allies by the distinctly forked condition of the distal ends of the hydrocladia.

Type slides.—Cat. Nos. 11715, 11716, Mus. State Univ. Iowa; Cat. Nos. 18615, 18616, U.S.N.M.; also in the collection of the author.

ANTENNOPSIS Allman (modified).

Antennopsis ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 34.

Trophosome.—Stem jointed; cœnosarc not canaliculated; hydrocladia scattered irregularly over the stem, sometimes approaching a verticillate arrangement.

Gonosome.—Gonangia borne in the axils of the hydrocladia, without protective appendages.

[1] Australian Hydroid Zoophytes, 1884, p. 123

In working over the material collected by Count Pourtalès in the Gulf Stream, Professor Allman found a species allied to *Antennularia*, but with hydrocladia scattered over the stem instead of being arranged in verticils, for which he formed the genus *Antennopsis*. As already noted, the examination of the *Challenger* Plumularidæ convinced Allman that his genus *Antennopsis* was untenable on account of its complete intergradation with *Antennularia*. By using the canaliculated cœnosarc as a definite character of *Antennularia*, the remaining forms with scattered hydrocladia can be conveniently grouped under a separate genus, and I therefore reestablish *Antennopsis* for the reception of those forms which would be included under the original definition, minus those having scattered hydrocladia in connection with a canaliculated cœnosarc. So far as I have been able to ascertain, the genus thus circumscribed is represented in American waters only.

Distribution of American species of the genus Antennopsis.

[All the species are found in the Floridian and West Indian region.]

Species.	Bathymetrical.				
	1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.
A. hippuris				+	+
A. longicorna					+
A. nigra				+	
A. distans				+	
A. annulata					+

The above table indicates that this genus is well circumscribed both in geographical and bathymetrical distribution.

KEY TO AMERICAN SPECIES OF ANTENNOPSIS.

Stem not fascicled		*A. hippuris*
Stem fascicled	Hydrocladia borne on very long processes from the stem; first internode hydrothecate.	*A. longicorna*
	Main stem strongly geniculate	*A. nigra*
	First internode of hydrocladia not hydrothecate	*A. distans*
	Hydrothecæ twice as deep as wide	*A. annulata*

ANTENNOPSIS HIPPURIS Allman.

(Plate XI, figs. 4-6.)

Antennopsis hippuris ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 35, pl. XXI.
Antennopsis hippuris FEWKES, Bull. Mus. Comp. Zool., 1880, VIII, No. 7, p. 128.

Trophosome.—Colony attaining a height of about 2 inches, not branched; stem straight, not fascicled nor canaliculated, divided into irregular internodes, each of which supports a hydrocladium on a stout process from its distal end; hydrocladia scattered on all sides of the stem, slender, divided into alternating hydrothecate and intermediate internodes. Hydrothecæ borne on proximal parts of internodes, rather deep, cup shaped, margins not everted; supracalycine nematophores present; a mesial nematophore at the base of each hydrotheca, another on the same internode above it, two on each intermediate internode, and one on the lower side of each hydrocladial process of the stem.

Gonosome.—Gonangia borne singly in the axils of the hydrocladia; male long and slender, with an oblique terminal orifice; female shorter, stouter, slipper-shaped, with the orifice lateral.

Distribution.—Off Double-headed Shot Key, 195 fathoms (Pourtalès); *Blake*, lat. N. 32° 07′, long. W. 78° 37′, 229 fathoms; *Albatross* Station 2665, lat. N. 29° 47′, long. W. 80° 06′, 263 fathoms.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

ANTENNOPSIS DISTANS, new species.

(Plate XII, figs. 1, 2.)

Trophosome.—Colony attaining a height of 6 inches, branching in an irregularly alternate manner; stem fascicled, branches fascicled proximally and nonfascicled on their distal portion, and supporting hydrocladia upon long processes; hydrocladia often arranged in a pinnately

alternate manner, especially on the distal part of each branch, but usually scattered more or less over the branches; two or three proximal hydrocladial internodes without hydrothecæ, the remainder being long and hydrothecate, with only an occasional short intermediate internode. Hydrothecæ distant, small, shallow, cup-shaped, and usually borne on the distal portion of a long internode, but the proximal hydrotheca may be below the middle of its internode; supracalycine nematophores present, two mesial nematophores below the hydrotheca on each long internode; a cauline nematophore in the axil of each hydrocladium.

Gonosome.—Gonangia ovate, borne singly near the axils of the hydrocladia.

Distribution.—*Albatross* Station 2322, lat. N. 23° 11′, long. W. 82° 18′; depth, 115 fathoms.

This species is peculiar in having the distant hydrothecæ borne on the distal ends of the long slender internodes.

Type slides.—Cat. Nos. 18569, 18570, U.S.N.M.; Cat. Nos. 11684, 11686, Mus. State Univ. Iowa; also in the collection of the author.

ANTENNOPSIS LONGICORNA, new species.

(Plate XII, figs. 3, 4.)

Trophosome.—Colony of incomplete specimen attaining a height of about 2 inches, branching in a dendritic manner, color of main stem and branches black; stem and main branches fascicled; hydrocladia-bearing branches not fascicled, except proximally, divided into irregular internodes and bearing hydrocladia on very long processes, usually from their distal ends; hydrocladia scattered, with a tendency toward a pinnate arrangement, slender; proximal internode long and slender, bearing a hydrotheca on its proximal portion, the remainder of the hydrocladia being made up of alternate long hydrothecate and short intermediate internodes with very distinct nodes. Hydrothecæ distant, shallow, cup-shaped, situated on the proximal portions of the long internodes; supracalycine nematophores present, one mesial nematophore to each internode; a pair of cauline nematophores in the axil of each hydrocladium, and occasionally one on the distal part of the long projection which bears the hydrocladium.

Gonosome.—Not known.

Distribution.—*Albatross* Station 2335, lat. N. 23° 11′, long. W. 82° 20′; depth, 204 fathoms.

This species is very near *A. nigra* and may be identical with it, but the very long processes from the stem seem to constitute a perfectly constant character, as does the position of the hydrothecæ on the proximal portions of the long internodes. There seems to be a tendency on the part of the hydrocladia to break off at the end of the long process from the stem. On one branch of a specimen before me the hydrocladia are all broken off in this way, leaving the stem with the processes well displayed, resembling somewhat the gonosome of *Hippurella longicarpa.*

Type slides.—Cat. Nos. 18363, 18364, 18365, 18366, U.S.N.M.; Cat. Nos. 11687, 11688, Mus. State Univ. Iowa; also in the collection of the author.

ANTENNOPSIS NIGRA, new species.

(Plate XII, figs. 5, 6.)

Trophosome.—Colony attaining a height of 5½ inches, branching in a dendritic manner; stem and main branches very dark brown or black, the latter strongly geniculate, giving off hydrocladia bearing branchlets at the geniculations; main stem and branches strongly fascicled; hydrocladia scattered, very slender, supported on long processes of the branches; proximal internode sometimes with a hydrotheca near its middle, but usually short and nonhydrothecate, the remainder of the hydrocladium being composed of alternating hydrothecate and intermediate internodes, the former being the longer. Hydrothecæ distant, borne near the middle of the internodes, quite shallow, cup shaped, much wider than deep; supracalycine nematophores present, a mesial nematophore below the base of each hydrotheca, and one on each intermediate internode; two cauline nematophores in the axil of each hydrocladium, where there is also a small conical process, which may be a modified nematophore.

Gonosome.—Not known.

Distribution.—*Albatross* Station 2330, lat. N. 23° 11′, long. W. 82° 19′; depth, 121 fathoms.

The very dark color of the fascicled main stem and branches, together with the regular and emphatic geniculations of the latter, make this a very well-marked form.

Type slides.—Cat. Nos. 18567, 18568, U.S.N.M.; Cat. No. 11685, Mus. State Univ. Iowa; also in the collection of the author.

ANTENNOPSIS ANNULATA (Allman).

(Plate XII, figs. 7–9.)

Hippurella annulata ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 36, pl. XXI.
Antennopsis ramosa FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 133, pl. III.

Trophosome.—Colony attaining a height of 6 inches, pinnately branched basally and irregularly branched distally; stem fascicled, branches not fascicled, divided into internodes, each of which bears a hydrocladium on a long process from its distal end; hydrocladia alternate on proximal portion of branch, scattered or verticillate on distal portion, and divided into alternating long hydrothecate and short intermediate internodes, there being usually three closely approximated annulations at the nodes. Hydrothecæ deep, cylindrical, with entire slightly everted margins; supracalycine nematophores borne on processes from the internode; one mesial nematophore at the base of each hydrotheca and another on the proximal end of the intermediate internode; a cauline nematophore on each hydrocladial process of the branch and one on the proximal part of each internode.

Gonosome.[1]—Gonangia long, with a somewhat bottle-shaped neck, approaching those of *Plumularia setacea* in shape, and found singly in the axils of the hydrocladia.

Distribution.—Off Pacific Reef, 283 fathoms (Pourtalès); *Blake*, off Savannah, 229 fathoms; *Albatross* Station 2601, lat. N. 34° 39′, long. W. 75° 33′, 107 fathoms.

A specimen distinctly referable to this species is among the *Albatross* material from the West Indies. The gonosome was fortunately present and proved to be quite characteristic of the genus *Antennopsis*. The genus *Hippurella*, as established by Allman on the arrangement of the hydrocladia, I do not regard as tenable on account of the complete intergradation between *Hippurella* and *Antennopsis*.

The type of *Antennopsis ramosa* which Doctor Faxon sent me from the Museum of Comparative Zoology, bearing the locality label quoted in the description, I am unable to separate from *Hippurella annulata* of Allman. The trophosome agrees in every detail with Allman's description and figures of the latter species and with *Albatross* specimens that must be referred to this species.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

MONOSTÆCHAS Allman.

Monostæchas ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 36.

Trophosome.—Colony branched, usually in a dichotomous manner; stem not fascicled; hydrocladia always springing from the upper sides of the branches; otherwise closely resembling those of *Plumularia*, especially the *catharina* group, from which it differs in the entire absence of cauline hydrothecæ.

Gonosome.—Gonangia without protective branches of any kind, ovate, with terminal or subterminal apertures.

MONOSTÆCHAS QUADRIDENS (McCrady).

(Plate XIII, figs. 1–4.)

Plumularia quadridens MCCRADY, Proc. Elliott Soc., April, 1857, p. 97.
Plumularia quadridens LOUIS AGASSIZ, Cont. Nat. Hist. U. S., 1862, IV, p. 358.
Plumularia quadridens ALEXANDER AGASSIZ, North Amer. Acalephæ, 1865, p. 140.
Monostæchas dichotoma ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 37.
Monostæchas dichotoma FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 128.

Trophosome.—Colony attaining a height of 6 inches, flabellate in general form, branching dichotomously; stem not fascicled, with indistinct internodes and branching at irregular intervals,

[1] Hitherto undescribed.

the branches which bear the hydrocladia being divided into long internodes, each of which bears a hydrocladium on its upper side and distal end; a hydrocladium springs from the stem at each forking; hydrocladia divided into alternating hydrothecate and intermediate internodes, which are short and join each other under the hydrothecæ by oblique nodes and above the hydrothecæ by straight nodes. Hydrothecæ large, campanulate, separated by at least twice their height; supracalycine nematophores present, reaching above the level of the hydrothecæ and borne on distinct processes from the hydrocladial internodes; a mesial nematophore at the base of each hydrotheca, and two to each intermediate internode; cauline nematophores numerous in linear series along the upper side of each branch.

Gonosome.—Gonangia sac-shaped; borne on short processes below the bases of the hydrothecæ, each being protected by a pair of basal nematophores.

Distribution.—Off Pacific Reef (Pourtalès); *Blake*, off Barbados, 76 fathoms; *Albatross*, 26 stations in the North Atlantic, from Marthas Vineyard southward, 12 to 296 fathoms; Charleston, South Carolina (McCrady).

In the northern part of its range this beautiful species grows to a much greater height than the specimens described by Professor Allman under the name *Monostæchas dichotoma*, and often assumes a straggling habit of growth very different from the compact, flabellate form of the type The mode of branching seems to be constant, and I have seen no deviation from it in the immense number of specimens from the *Albatross* collections which I have handled. Although I have been unable to find specimens intergrading entirely between Allman's type and the straggling form just mentioned, it hardly seems justifiable, in the absence of any good structural point of difference to separate the two and regard them as distinct.

Specimens of *Plumularia quadridens* from Charleston, which Doctor Agassiz kindly sent me from the Museum of Comparative Zoology, agree very well with specimens of *Monostæchas dichotoma* Allman, except in size, the Charleston specimens being much smaller than those secured by the *Blake* and the *Albatross*. Otherwise the two forms agree so exactly in detail that I am unable to separate them, and am therefore compelled to regard *M. dichotoma* as a synonym of *P. quadridens*. The genus *Monostæchas*, however, seems tenable, and necessitates the removal of the species to that genus.

ANTENNELLA Allman.

Antennella ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 38.

Trophosome.—Colony consisting of hydrocladia springing directly from the hydrorhiza without the intervention of stems or branches; hydrocladial internodes and hydrothecæ as in the *catharina* group of the genus *Plumularia*.

Gonosome.—Not known.

Hincks regarded a species of this genus as a variety of *Plumularia catharina* which had adopted a different habit of growth. In one species, *Plumularia filicaulis* Poeppig, the mode of growth of both *Plumularia* and *Antennella* is seen in a single colony, but this may possibly represent stages of growth rather than an essentially different habit. The entire absence of the stem seems to be a constant character of the present species, however, and until intergrading forms are found it is probably wisest to leave Allman's arrangement undisturbed. The writer is inclined to think, however, that the group of genera first described by Allman and arranged almost, if not quite, exclusively on the branching habit of the various species is not entirely satisfactory, throwing together as it does species quite dissimilar in details of structure and separating into distinct genera forms which agree exactly in details, such as the arrangement of internodes and nematophores and shape of the hydrothecæ. It seems unbelievable that this identity of detail should be the result of approximation from different types rather than an evidence of close relationship. It may ultimately prove best to gather into a separate genus all of the species now in the genera *Plumularia*, *Monostæchas*, and *Antennella*, which have the arrangement of internodes, hydrothecæ, and nematophores, which is found in *Plumularia catharina*, and consider the manner of branching as of secondary importance, useful merely for specific characters.

ANTENNELLA GRACILIS Allman.

(Plate XIII, fig. 5.)

Antennella gracilis ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 38, pl. XXII.

Trophosome.—Colony attaining a height of about 1 inch; stem absent; hydrocladia springing directly from the root stalk, divided into alternating hydrothecate and intermediate internodes, the former being slightly the longer and separated from the internodes below by a distinct oblique node, and from the internodes above by an indistinct straight node. Hydrothecæ deep, cylindrical, with margins not everted; supracalycine nematophores borne on long processes from the internode, which reach to the middle of the side of the hydrotheca; the nematophores themselves scarcely reach the top of the hydrotheca; mesial nematophores, one above and one below each hydrotheca and two on each intervening internode.

Gonosome.—Not known.

Distribution.—Off Carysfort Reef (Pourtalès); depth, 60 fathoms; *Albatross* Station 2607, lat. N. 34° 38′, long. W. 76° 12′; depth, 18 fathoms; State University of Iowa, Bahama expedition, near Habana; depth, 150 to 250 fathoms.

CALVINIA, new genus.[1]

Trophosome.—Colony pinnately branching; stem fascicled; hydrocladia divided into regular internodes, each bearing a hydrotheca; a small, apparently aborted cauline hydrotheca in the axil of each hydrocladium, all of the remaining hydrothecæ protected by jointed nematophorous branches springing from their bases.

Gonosome.—Gonangia ovate, sac-shaped, springing from the side of the proximal nematophorous branch on each hydrocladium.

This very striking generic form is entirely distinct from any other Eleutheroplean plumularians. A number of other genera have nematophorous branches for the protection of the gonangia, but this is the only form that has produced a nematophorous branch for the protection of each hydrotheca. The homology of these strange structures is hard to explain. They do not seem to be highly specialized mesial nematophores, for there is still remaining an ordinary mesial nematophore below the base of each hydrotheca. Among the Statoplea, *Halicornaria ramulifera* Allman, a species dredged by the *Porcupine*, has practically the same arrangement, while the genus *Aglaophenopsis* Fewkes has a single-jointed and usually unbranched nematophorous ramulus at the base of the proximal hydrotheca of each hydrocladium.

CALVINIA MIRABILIS, new species.

(Plate XIV, figs. 1-3.)

Trophosome.—Colony attaining a height of 12 to 14 inches, flabellate in form, branches pinnate and nearly opposite; stem and branches fascicled, with a tube running along the anterior surface; hydrocladia springing from stout processes from this tube, and each process bearing a short, seemingly stunted hydrotheca in its axil; hydrocladia alternate, divided regularly into hydrothecate internodes. Hydrothecæ deep, cup-shaped, with entire and slightly everted margins, borne on the distal portions of the internodes, the posterior side of each hydrotheca being free from the internode for about two-thirds the height of the former. On the anterior side of each hydrotheca there springs from the internode a curved nematophorous branch, composed of three or more joints, besides the long, strong process of the internode with which they are continuous, the whole branch curving slightly over the hydrotheca, being four or five times as long as the latter and having a nematophore on each of the joints; supracalycine nematophores springing from near the bottom of the hydrotheca; a pair of nematophores on the process supporting the nematophorous branch, another pair on the distal portion of each internode; a mesial nematophore at the base of each nematophorous process, and numerous cauline nematophores scattered over the stem and branches.

[1] Named in honor of my revered friend and teacher, Doctor Samuel Calvin, of the State University of Iowa.

Gonosome.—Gonangia ovate, with large terminal apertures, borne on the sides of the proximal nematophorous branches, and each bearing two nematophores near its base.

Distribution.—*Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′; depth, 440 fathoms; Station 2666, lat. N. 30° 48′, long. W. 79° 49′; depth, 270 fathoms; Station 2667, lat. N. 30° 53′, long. W. 79° 43′; depth, 273 fathoms; Station 2668, lat. N. 30° 59′, long. W. 79° 39′; depth, 294 fathoms; Station 2669, lat. N. 31° 09′, long. W. 79° 34′; depth, 352 fathoms.

Type slides.—Cat. Nos. 18576, 18577, 18578, U.S.N.M.; Cat. No. 11713, Mus. State Univ. Iowa; also in the collection of the author.

SCHIZOTRICHA Allman (modified).

Schizotricha ALLMAN, *Challenger* Report, 1883, VII, Pt. 20, p. 28.

Trophosome.—Hydrocladia pinnately disposed, branching once, twice, or oftener; bifurcating beyond the first internode, at least in the mature colony.

Gonosome.—Gonangia springing from the stem or hydrocladia. It is not easy at first sight to distinguish the trophosome of this genus from that of the genus *Polyplumularia* of Sars, in which each hydrocladium bears an accessory hydrothecate ramulus, which might be mistaken for a fork or a branch of the hydrocladium itself were it not that the accessory branch is much smaller than the hydrocladium from which it springs.

The gonosome of *Polyplumularia* springs from the main branches and not from the hydrocladia, as in the case in *Schizotricha*.

A study of the new species herein described seems to indicate that the forking of the hydrocladia is simply one of the many strange modifications found in this group for the protection of the gonangia, as it is often absent in those parts of specimens which are not furnished with the reproductive persons. If this is true, it is evident that the forking can not in strict propriety be regarded as a character of the trophosome, but an accessory part of the gonosomal system.

Distribution of American species of the genus Schizotricha.

Species.	Geographical. Atlantic.			Bathymetrical.			
	Charleston and northward.	West Indian.	Norway.	1 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.
S. dichotoma		+				+	
S. parvula		+					+
S. tenella	+			+			
S. gracillima	+		+	+	+	+	

KEY TO AMERICAN SPECIES OF SCHIZOTRICHA.

Hydrothecæ about twice as deep as wide ..... *S. dichotoma.*
Hydrothecæ not deeper than wide:
  Stem not fascicled; one intermediate internode between adjacent hydrothecæ ..... *S. parvula.*
  Stem not fascicled; two intermediate internodes between adjacent hydrothecæ ..... *S. tenella.*
  Stem fascicled; intermediate internodes normally absent ..... *S. gracillima.*

SCHIZOTRICHA DICHOTOMA, new species.

(Plate XV, figs. 1–4.)

Trophosome.—Colony a single pinnate stem, attaining a height, in incomplete specimens, of about 5 inches; stem fascicled; hydrocladia alternate, not fascicled, directed forward as in *Plumularia geminata* Allman, each giving rise at its second internode to a bifurcation, one of the resultant branches again forking, thus making four ultimate branches to each hydrocladium, three being from one of the primary branches, the other being undivided with distant and irregularly disposed nodes, each internode bearing several hydrothecæ; the branched division of the hydrocladium has irregularly disposed hydrothecæ and will be more minutely described under the gonosome. Hydrothecæ on unbranched division of hydrocladium large, closely approximated, very deep, adherent throughout their length to the hydrocladium; margin almost straight in

front, but cut away at the postero-lateral corners, making the front considerably higher than the back; distance between hydrothecæ nearly equal to their length; supracalycine nematophores borne on processes of the hydrocaulus and apparently capable of hanging down into the hydrothecal cavity; a single mesial nematophore below each hydrotheca; cauline nematophores numerous and irregularly distributed.

Gonosome.—Gonangia borne on one of the forkings of the hydrocladium, almost globular, opening terminal and round, peduncle short, armed with four nematophores. As before indicated, I regard the branched division of the hydrocladium as morphologically a phylactogonium composed of three branches, one of which bears the gonangium and a few scattered hydrothecæ, one being just above the origin of the gonangium; one of the other branches bears a few hydrothecæ on its distal portion and the other bears a single hydrotheca on its distal end, but a great number of nematophores on the side facing the gonangium: there is a hydrotheca at each forking of the hydrocladium.

Distribution.—State University of Iowa, Bahama Expedition, Station 56; Pourtalès Plateau, 200 fathoms.

The remarkable structure which I here consider a phylactogonium may throw light on the origin of phylactogonia in other groups. It here seems to be the homologue of a branch of the hydrocladium out of which a protective structure is produced by the suppression of most of the hydrothecæ and the multiplication of the nematophores. The whole hydrocladium with its modified branches is directed forward, so as to almost meet its fellow from the opposite side of the stem, the two thus clasping the gonangia, as it were, and further securing their safety by bringing into available proximity the six protective branchlets borne by the two hydrocladia. It is interesting to note that in another specimen with less mature gonangia the pinnæ are not directed forward and apposed, but directed laterally, as usual among plumularians. The apposition may therefore be merely a temporary position assumed to protect the matured gonangia.

Still another specimen, associated with the last and apparently of the same species, has unbranched hydrocladia, which are alternate and directed laterally. It may be regarded as a specimen which has not yet attained the phylactogonia and indicates the correctness of the theory advanced above.[1]

Type slides.—Cat. Nos. 11710, 11711, 11712, 11714, Mus. State Univ. Iowa; Cat. Nos. 18579, 18580, U.S.N.M.; also in the collection of the author.

SCHIZOTRICHA PARVULA, new species.

(Plate XV, fig. 5.)

Trophosome.—Colony attaining a height of about 1 inch, springing in a tuft of stems from a common root stalk; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium on a process from its distal end; hydrocladia alternate, directed antero-laterally and dividing into two branchlets at the second internode; first internode bearing a hydrotheca near its middle; second internode bifurcating to support the two branchlets into which the hydrocladium is divided; branchlets composed of alternating hydrothecate and intermediate internodes, the former being about twice as long as the latter. Hydrothecæ distant, shallow, cup-shaped, borne at or just below the middle of the internodes; supracalycine nematophores present; a mesial nematophore below each hydrotheca, one on each intermediate internode and one at the bifurcation of each hydrocladium; there is a cauline nematophore in the axil of each hydrocladium and one on the opposite side of each internode of the stem.

Gonosome.—Gonangia elongated, oval sacs, borne in the bifurcations of the hydrocladia.

Distribution.—*Albatross* Station 2669, lat. N. 31° 09′, long. W. 79° 34′, 352 fathoms.

Type slides.—Cat. No. 18581, U.S.N.M.; Cat. No. 11709, Mus. State Univ. Iowa.

[1] In this connection see Fewkes's discussion of the genus *Pleurocarpa* in Bull. Mus. Comp. Zool., VIII, No. 7, p. 136.

SCHIZOTRICHA TENELLA (Verrill).

(Plate IV, figs. 4, 5.)

Plumularia tenella VERRILL, Invertebrate Animals of Vineyard Sound, 1874, p. 731.
Plumularia tenella CLARK, Trans. Conn. Acad. Sci., 1875, III, p. 65.

Trophosome.[1]—Colony branched dichotomously, attaining a height of 2 inches and growing in clusters; stem divided into alternate longer and shorter internodes, the latter bearing each a hydrotheca and a hydrocladium; hydrocladia often branched alternate, very slender, not very long, proximal internode short and without hydrotheca, the rest of the hydrocladium being composed of three kinds of internodes, every third one being stouter and hydrothecate; next there is a very short internode followed by a long, slender internode five or six times as long as broad, articulated by an oblique node at its distal end with a hydrothecate internode, making two, a short and a long, intermediate internodes between adjacent hydrothecæ. Hydrothecæ subcylindrical, a little longer than broad, having the distal half free; lateral nematophores present; a mesial nematophore at the base of each hydrotheca, one or two on the long intermediate internode; cauline nematophores—one or two to each intermediate internode.

Gonosome.—Gonangia in the shape of curved cornucopiæ, slender at the base and gradually enlarged to the end, and with three or four nematophores at its base.

Distribution.—Off Gay Head, 8 to 10 fathoms; Vineyard Sound, 8 fathoms; New Haven, Connecticut; Greenport, Long Island.[2] Abundant on the piles of the U. S. Fish Commission dock at Woods Hole, and also on the piles of the dock at Vineyard Haven.[3]

The branched hydrocladia may be, as elsewhere suggested, a character which is gonosomal in its nature, but it throws the species into the genus *Schizotricha.*

Type.—In Museum of Yale University.

SCHIZOTRICHA GRACILLIMA (G. O. Sars).

(Plate XIV, figs. 4–6.)

Plumularia gracillima G. O. SARS, Bidrag til Kundskaben om Dyrelivet paa vore Havbanker Chr. a Vid. Selsk. Forh. for 1872.
Plumularia verrillii CLARK, Trans. Conn. Acad., 1875, III, p. 64, pl. x.
Plumularia verrillii VERRILL, Prelim. Check-list Marine Invert. of Atlantic Coast, etc., 1879, p. 18.
Plumularia verrillii FEWKES, Bull. Essex Inst., 1891, XXIII, Nos. 1–3, p. 39.

Trophosome.—Hydrocaulus sparingly branched, and attaining a height of 2½ inches; main stem and branches fascicled, the latter, however, soon becoming simple, divided into regular internodes, each of which supports a hydrocladium on a stout process from near its distal end; hydrocladia alternate, usually branched dichotomously one, two, or three times, beyond its proximal internode, and divided into regular, long, slender internodes, each of which bears a hydrotheca on its distal half; there is an occasional short intermediate internode. Hydrothecæ small, cup-shaped, about as wide as deep; nematophores large, bithalamic; a supracalycine pair, and three or four single mesial ones to each regular internode, or between adjacent hydrothecæ; a cauline nematophore in the axil of each hydrocladium, and others scattered irregularly over the stem.

Gonosome.—Gonangia borne in pairs on the stem near the axils of the hydrocladia, and also at the forkings of the latter. They are cylindrical in shape, tapering at the proximal end and almost sessile, the pedicel being much reduced. Length about two and one-half times the greatest diameter. The younger gonangia are much shorter and inclined to be triangular in outline when viewed from the flattened side.

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[1] Description of specimens from the Museum of Yale University kindly loaned by Professor A. E. Verrill.

[2] Clark, Transactions of the Connecticut Academy of Sciences, III, p. 65.

[3] Since writing the above I have seen Hincks's description and figures of *Plumularia cornucopiæ* in Annals and Magazine of Natural History, November, 1872, and suspect that it may be the same as *Schizotricha tenella.* In the absence of specimens for comparison, however, it seems best to regard them as separate.

Distribution.—Aalesund and Lofot, Norway, 50 to 200 fathoms; New England coast, Verrill and Fewkes; shallow water.

This elegant little species was the second of the Eleutheroplea found on the New England coast. Specimens kindly sent me by Professor Verrill are not separable, either in trophosome or gonosome, from *P. gracillima* Sars, and it therefore becomes necessary to deprive the species of the honored name which it bore, and adopt the very appropriate name proposed by its original describer. The species is clearly a *Schizotricha* if we adopt that genus as described by Allman and further defined in this work.

Typical specimens in the museum of Yale University.

DIPLOPTERON Allman (in part).

Diplopteron ALLMAN, Report on Hydroida of *Porcupine*, 1874, p. 479.

Trophosome.—Two or more pairs of lateral nematophores flanking the hydrothecæ.

Gonosome.—Gonangia protected by accessory ramuli borne on the hydrocladia, and bearing a few scattered hydrothecæ.

The first species described as having two pairs of lateral nematophores was *Diplopteron insigne*, the type species of this genus, and I here adopt the suggestion made by W. M. Bale:[1] "If this genus (*Diplopteron*) be retained, I would suggest that it be modified so as to comprise all species with more than one pair of lateral nematophores."[2] The present writer would not, however, follow the further suggestion that *P. aglaophenoides* be admitted to this genus. The fixed mesial nematophore of that species is a character which, in the opinion of the author, is of considerable systematic importance, at least of generic rank.

The genus *Polyplumularia* Sars, in favor of which Allman in the *Challenger* report abandons his genus *Diplopteron*, was founded on the bipinnate arrangement of the hydrocladia. *Diplopteron*, on the contrary, was established upon an entirely different basis, namely, the two pairs of lateral nematophores. It thus becomes proper to retain the genus, regarding it as distinct from *Polyplumularia*.

As here defined the genus *Diplopteron* would include *D. insigne* and the three new species described below, which differ from *D. insigne* in the almost entire absence of hydrocladial internodes, in which they agree with *Schizotricha dichotoma*. The three genera, *Schizotricha*, *Polyplumularia*, and *Diplopteron*, are very closely allied, and may ultimately be united by the discovery of completely intergrading forms. The author believes that generic distinctions, like specific characters, are based rather upon our ignorance than our knowledge, and that with a complete series of almost any genus or species these distinctions would fail, making it necessary to resort to arbitrary definitions for the sake of convenience in handling groups. It is almost certain that naturalists will in time realize that genera and species are not entities or facts, but convenient fictions useful in discussion, indeed necessary in systematic work, but not really tangible.

Distribution of the American species of the genus Diplopteron.

Species.	Geographical.	Bathymetrical.	
	Floridian and West Indian.	100 to 200 fathoms.	200 to 500 fathoms.
D. quadricorne		+	
D. grande			+
D. longipinna			+

KEY TO AMERICAN SPECIES OF DIPLOPTERON.

One pair of lateral nematophores greatly elongated ..... *D. quadricorne.*
Both pairs of lateral nematophores normal:
  Hydrotheca very large, anterior profile doubly curved ..... *D. grande.*
  Hydrotheca much smaller, anterior profile with a single curve ..... *D. longipinna.*

[1] Catalogue of Australian Hydroid Zoophytes, p. 124.

[2] This author subsequently abandons the genus *Diplopteron* (see The Genera of Plumulariidæ, 1886), but I consider the genus tenable on the grounds suggested above.

DIPLOPTERON QUADRICORNE, new species.

(Plate XV, figs. 6, 7.)

Trophosome.—Colony of fragmentary specimen an unbranched stem, attaining a height of about one-half inch; stem not fascicled, with distant and very oblique nodal joints; hydrocladia alternate, springing from the front of the stem, directed forward and not divided into regular internodes, there being, however, a few very distant and ill-defined constrictions, and one well-defined proximal internode without a hydrotheca and separated from the rest of the hydrocladium by a very oblique node. Hydrothecæ separated by a little more than their own height, one and one-half times as high as wide, conical, adherent to the hydrocladia throughout; margin circular and entire; there is a hydrotheca on the stem at the base of each hydrocladium; a pair of very long lateral nematophores borne on a long process from the stem a little below the top of the hydrotheca; another pair of supracalycine nematophores just above the first, but not borne on distinct processes; two or three mesial nematophores between adjacent hydrothecæ; cauline nematophores of unusual length scattered irregularly over the front of the stem.

Gonosome.—Not known.

Distribution.—Dredged near Habana, Cuba; depth, 150 to 200 fathoms; State University of Iowa, Bahama expedition.

Nearly all of the greatly elongated lower pairs of lateral nematophores were broken off in the specimen secured, but a few were fortunately still attached and proved to be considerably longer than the hydrothecæ and exceedingly slender, with a small, trumpet-shaped enlargement at the distal end.

Type slides.—Cat. No. 11703, Mus. State Univ. Iowa; Cat. No. 18586, U.S.N.M.

DIPLOPTERON GRANDE, new species.

(Plate XVI, figs. 1, 2.)

Trophosome.—Colony attaining a height of 14 inches, unbranched; stem fascicled; hydrocladia alternate, borne on the front of the stem and attaining a length of 2 inches, divided into irregular internodes, the nodes being distinct on the proximal part and becoming obliterated toward the distal end. Hydrothecæ very large, deep, closely approximated; anterior outline doubly curved like the front of a pitcher, margin entire, not cut away posteriorly; a hydrotheca at the base of each hydrocladium; a pair of nematophores borne on processes opposite the middle of each hydrotheca; another pair on very slight processes on a level with the top of the hydrotheca, and a third pair between the second and the base of the next hydrotheca above; cauline nematophores scattered along the front of the stem.

Gonosome.—Gonangia borne on accessory ramuli springing from the hydrocladia and composed of three branches, each armed with numerous nematophores and bearing an occasional hydrotheca. The gonangia are ovate, with the terminal aperture surrounded by a slight rim or collar, and are borne in clusters of three to six on each hydrocladium.

Distribution.—*Albatross* Station 2667, lat. N. 30° 53′, long. W. 79° 42′ 30″, 273 fathoms; Station 2668, lat. N. 30° 59′, long. W. 79° 39′, 294 fathoms; Station 2671, lat. N. 31° 20′, long. W. 79° 22′, 280 fathoms.

This species is closely allied to *D. longipinna*, but can at once be distinguished by its immense hydrothecæ, which are among the largest of the Eleutheroplea and have a very characteristic outline when viewed from the side. The accessory ramulus, which I regard as essentially a phylactogonium, is more highly modified than in other species in which it occurs, the hydrothecæ being sometimes absent except at the bifurcations of the ramulus, where a single one is constantly found.

Type slides.—Cat. Nos. 18582, 18583, U.S.N.M.; Cat. Nos. 11706, 11708, Mus. State Univ. Iowa; also in the collection of the author.

DIPLOPTERON LONGIPINNA, new species.

(Plate XVI, figs. 3, 4.)

Trophosome.—Colony of fragmentary specimen about 4 inches high, but judging from the thickness of the stem and length of hydrocladia it probably attains a height of 1 foot or more; stem fascicled; hydrocladia alternate, closely set, borne on opposite sides of the stem and directed laterally, with usually two distinct internodes on the proximal portion, followed by a few poorly marked and distant nodes, which disappear altogether in the distal portion of the hydrocladium. Hydrothecæ deep, subconical, less than their own length apart, margins entire, but cut away laterally and posteriorly so that the front of the hydrotheca is considerably higher than the back. There is a cauline hydrotheca at the base of each hydrocladium; a pair of lateral nematophores of ordinary size borne on processes from the hydrocladium just above the middle of the hydrotheca; a second pair of nematophores immediately above the margin of the hydrotheca and pendent within its cavity; a third pair of nematophores is found about midway between the second and the base of the next hydrotheca above.

Gonosome.—Not known.

Distribution.—Lat. N. 24° 16′, long. W. 81° 22′, 200 fathoms. State University of Iowa, Bahama Expedition.

The portion of the type specimen obtained shows that this is a robust and large species. One of the hydrocladia has an accessory hydrothecate ramulus. None of the others show this feature, which is doubtless as inconstant as in *Schizotricha*, and probably is to be regarded as an accessory portion of the gonosome.

Type slides.—Cat. Nos. 11704, 11705, Mus. State Univ. Iowa; Cat. Nos. 18584, 18585, U.S.N.M.; also in the collection of the author.

POLYPLUMULARIA G. O. Sars (modified).

Polyplumularia G. O. Sars, Forhandl. Vidensk. Selsk., I, Christiania, 1873, p. 13.

Trophosome.—Colony pinnately branching, fascicled; some of the hydrocladia furnished with a hydrothecate ramulus which springs from the first internode and is more slender than the hydrocladium from which it grows. A single pair of supracalycine nematophores.

Gonosome.—Gonangia sac-shaped, borne either on the fascicled branches or on the hydrocladia near the origin of the accessory ramulus.

Professor Allman, in his report on the *Porcupine* Hydroids, 1873, described a new species for which he instituted the genus *Diplopteron*, characterized by the doubly pinnate hydrocaulus and two pairs of lateral nematophores. In the description of the type species, *D. insigne*, Professor Allman mentions the accessory ramulus of the hydrocladia, but does not seem to regard it as a feature of much importance. A few months before the publication of Professor Allman's report an article appeared by G. O. Sars[1], in which he described the genus *Polyplumularia*, based on the presence of the accessory ramulus, which does not appear from his description to be constant. In 1883 Allman[2] considers the two names *Polyplumularia* and *Diplopteron* as practically synonymous, the former having the priority. The present writer considers it best to retain both genera in modified form, including in *Polyplumularia* those species having the accessory ramulus, a pinnately branching stem, and one pair of lateral nematophores. The distinction between this genus thus modified and *Schizotricha*, as defined in this work, is that in the former an accessory ramulus is borne on the *proximal internode* of the hydrocladium, while in the latter there is a bifurcation of the hydrocladium *beyond* the first internode.

POLYPLUMULARIA ARMATA, new species.

(Plate XVI, figs. 5, 6.)

Trophosome.—Colony attaining a height of 4 inches in an incomplete specimen, pinnately branching, the alternate branches giving forth alternate branchlets from which the hydrocladia

[1] Bidrag til Kundskaben om Norges Hydroida, Videnskabernes Selskabs Forhandlinger for 1873, p. 13, Christiania.

[2] *Challenger* Report, Hydroida, Pt. 1, p. 30.

arise; stem, branches, and branchlets polysyphonic, the latter bearing on the anterior surface of each a tube from which the hydrocladia arise; proximal hydrocladia unbranched, the distal hydrocladia biramous; the unbranched hydrocladia and the posterior ramus of the others divided into regular internodes, each of which bears a hydrotheca; the anterior ramus of the forked hydrocladia bears a hydrotheca at its base and a few toward the distal end, where they become about as closely approximated as in the other branches. Hydrothecæ distant, rather shallow, cup-shaped; nematophores large in size and excessively developed in numbers, especially on the distal portions of the hydrocladia, there being in addition to the usual supracalycine pair sometimes as many as five mesial nematophores to a single internode; cauline nematophores very numerous, there being a row on both sides of the hydrocladia-bearing tube and a number scattered over the rest of the stem.

Gonosome.—Gonangia ovate, sac-shaped, found usually on the stem and branches, but sometimes at the bifurcation of the hydrocladia.

Distribution.—*Albatross* Station 2666, lat. N. 30° 48′, long. W. 79° 49′; depth, 270 fathoms.

This species is especially notable from the size and number of the nematophores. It also goes far to demonstrate the theory advanced by the author that the forking of the hydrocladia is merely a temporary contrivance connected with the maturing of the gonosome. If only the lower portion of the hydrocladia bearing branches were examined, any naturalist would, without hesitation, suppose that he had a species of *Plumularia* to deal with.

Type slides.—Cat. Nos. 18587, 18588, U.S.N.M; Cat. Nos. 11701, 11702, Mus. State Univ. Iowa; also in the collection of the author.

HIPPURELLA Allman (modified by Fewkes).

Hippurella ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 35; Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 134.

Trophosome.—Colony branched; hydrocladia pinnate on the proximal portion of the stem, but scattered on distal portion.

Gonosome.—Gonangia borne on distal portions of the branches, where the hydrocladia become modified into protective nematophorous branches, assume a verticillate arrangement, and inclose the gonangia in a sort of pseudo-corbula; the protective branchlets bear each a row of nematophores, but no hydrothecæ.

Doctor Fewkes thinks that Professor Allman is mistaken in his original description in speaking of the distal branchlets as if they were hydrocladia. Specimens before me, however, have this structure, and for reasons mentioned presently I am of the opinion that Doctor Fewkes was mistaken in his identification of the supposed *Hippurella annulata* collected by the *Blake*, and had before him in reality an altogether different species, which I will call *Hippurella longicarpa*. The genus, therefore, has the trophosome described by Allman, together with the gonosome described by Fewkes.

HIPPURELLA LONGICARPA Nutting.

(Plate XVII, figs. 1-3.)

Hippurella annulata FEWKES (not ALLMAN), Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 134.

Trophosome.[1]—Colony attaining a height of nine inches, unbranched throughout the proximal two-thirds, bearing alternate and subopposite branches on the distal third; stem fascicled, the hydrocladia-bearing tube being surrounded by the accessory tubes; hydrocladia alternate, springing from opposite sides of the branches, divided into long internodes, each of which bears a hydrotheca, although an intermediate internode is occasionally seen; internodes with several, seven or eight, strong septal ridges, two or three of which are behind the hydrotheca. Hydrothecæ separated by one and one-half times their height, deep, gradually widening toward the top; aperture horizontal, anterior profile straight; supracalycine nematophores inserted near the top of the hydrothecæ; a mesial nematophore borne on a protuberance below the hydrotheca and another midway between adjacent hydrothecæ; cauline nematophores numerous, arranged in regular vertical rows upon the stem and branches.

[1] Described from the specimen referred to *Hippurella annulata* Allman by Fewkes in his report on the *Blake* Hydroids.

Gonosome.—Gonangia borne on the distal portions of the main stem and branches, where they are protected by a series of whorls of nematophorous branchlets, there being six branchlets to each whorl, and seventeen whorls in the specimen figured. The gonophores are quite small, orbicular, and spring from the axils of the protective branchlets.

Distribution.—*Blake* Station 269; off St. Vincent; depth, 124 fathoms.

There is no doubt in my mind that Doctor Fewkes was in error when he identified this specimen as *Hippurella annulata* Allman. Through the kindness of Doctor Walter Faxon I have been permitted to examine and sketch the specimen, which differs greatly from *H. annulata* in size of colony and of hydrothecæ, shape and approximation of hydrothecæ, arrangement and septal ridges of the hydrocladial internodes, and particularly in the gonosome.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

CALLICARPA Fewkes.

Callicarpa FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 134.

Trophosome.—Stem not fascicled, bearing alternate hydrocladia arranged in a pinnate manner.

Gonosome.—Gonangia borne on special branches springing from the front of the main stem, and protected by nematophorous branchlets arranged in verticils, the whole having a resemblance to a spike of wheat.

This very remarkable form of gonosome differs greatly from any other yet found among the Eleutheroplea, being one of the most elaborate structures for the protection of the reproductive bodies found in that section of the Plumularidæ. While it bears some superficial resemblance to the corbulæ of *Aglaophenia*, the fundamental structure is widely different. It is as Doctor Fewkes says: "Morphologically speaking, as if the proximal part of the branch which bears pinnæ in *Hippurella* was reduced to a peduncle, and the distal end with its verticillate ribs became the gonosome."

The trophosome of the only known species of this interesting genus resembles greatly that of the well-known *Plumularia*.

CALLICARPA GRACILIS Fewkes.

(Plate XVII, figs. 4–6.)

Callicarpa gracilis FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 134.

Trophosome.[1]—Colony unbranched, but with what appears to be a stump of a single branch, attaining a height of about 6 inches; stem fascicled, with a central hydrocladia-bearing tube surrounded by numerous accessory tubes; distal portion not fascicled and not divided into regular internodes; hydrocladia alternate, not very closely approximated, divided into internodes by inconspicuous nodes, and with a slight constriction or partial annulation on the anterior face near each node; there are no intermediate internodes. Hydrothecæ deep, cylindrical, with the anterior profile nearly straight, aperture horizontal; supracalycine nematophores large, trumpet-shaped, growing from small processes on a level with the top of the hydrotheca; mesial nematophore borne on a small protuberance at the proximal end of the internode.

Gonosome.—Gonangia borne on a specialized branch which bears no hydrocladia, but consists of a central stem or axis bearing a series of verticillate branchlets, each of which terminates in four slender processes, each bearing a row of free nematophores on its inner side. There are three of these branchlets to each verticil. The gonangia grow in the axils of the branchlets.

Distribution.—Unknown. Label lost. It was found among the material brought home by the *Blake* and belongs doubtless to the West Indian fauna.

The gonosome of this remarkable species is the most elaborate and highly specialized found among the Eleutheroplea. It seems that the whole affair is a modified branch, and it is probable that each branchlet, or phylactocarp, is a modified hydrocladium, although such homologies are necessarily obscure and far from satisfactory.

[1] The description is from Doctor Fewkes's type specimen.

The stem of this species differs from that of nearly, if not all, other American Plumularidæ in having the hydrocladia borne on a tube which is central and not anterior to the accessory tubes of the fascicled structure. The accessory tubes are smaller than in most species, which may account for Doctor Fewkes's error in describing the stem as not fascicled.

Types.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

HALOPTERIS Allman.

Halopteris ALLMAN, Mem. Mus. Comp. Zool., V, No. 2, p. 32.

Trophosome.—Stem and hydrocladia divided into internodes, the hydrocladia pinnately arranged. Hydrothecæ cup-shaped and furnished with a pair of lateral nematophores which are fixed instead of free, as in the other Eleutheroplea; mesial nematophores free.

Gonosome.[1]—Gonangia oval, sac-shaped, borne at the bases of the hydrothecæ and unprotected by any form of phylactogonia.

This genus is of peculiar interest from the fact that it combines the characters of the two great groups of Plumularidæ having the fixed nematophores of the Statoplea represented by the lateral pair, and the free mesial nematophores of the Eleutheroplea represented by the mesial and cauline nematophores, all of which are bithalamic. In most respects, however, it shows very decided affinities with the latter group. Not infrequently the upper part of the hydrocladial internode is separated from the rest by a distinct node, thus forming an intermediate internode which is distinctly a character of the Eleutheroplea. The shape of the hydrothecæ, together with the arrangement of the internodes, especially when the intermediate internode is present, the alternating oblique and straight nodes, and the shape and location of the gonangia, show that this genus has decided affinities with the *catharina* group of the genus *Plumularia*.

HALOPTERIS CARINATA Allman.

(Plate XVII, figs. 7-9.)

Halopteris carinata ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 33.

Trophosome.—Colony attaining a height of about 2 inches, sparsely branched; stem not fascicled, divided regularly into internodes, each of which bears a hydrocladium on a process from near its proximal end; hydrocladia alternate, first internode short, the others long, each bearing a hydrotheca; nodes oblique. Hydrothecæ rather deep, cup-shaped, each with an anterior keel ending in a blunt marginal tooth, the margin being otherwise entire; upper third of hydrotheca free from the internode; supracalycine nematophores borne on long curved lateral processes from the internode, cup-shaped and immovable; two mesial nematophores to each internode, one above and one below the hydrotheca; cauline nematophores fixed.

Gonosome.—Gonangia oval, sac-shaped, borne at the bases of the hydrothecæ, and not protected by phylactogonia of any kind.

Distribution.—Off Carysfort Reef, 35 fathoms (Pourtalès). Between Eleuthera and Little Cat Island, Bahamas, 3 to 13 fathoms, State University of Iowa, Bahama Expedition.

As before remarked, there is an occasional intermediate hydrocladial internode. Bale says concerning this species: In Professor Allman's figures, however, the cup of the sarcotheca is shown raised above the margin of the hydrotheca, and the long tubular adnate portion seems rather to resemble the peduncles, which in several species of *Plumularia* support the sarcothecæ, than an intimate part of the latter organs.[2] An examination of the specimens at hand fully bears out Bale's supposition.

These supports are doubtless homologous with the processes bearing the supracalycine nematophores in *Plumularia catharina*, for instance, and renders still more marked the resemblance previously alluded to between *Halopteris* and the *catharina* type of *Plumularia*, the main difference being in the fact that in *Halopteris* these nematophores are entirely immovable.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

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[1] Hitherto undescribed.

[2] The Genera of the Plumulariidæ, pp. 7, 8.

? GATTYA Allman.[1]

Gattya ALLMAN, Journ. Linn. Soc., Zool., 1885, XIX, p. 155.

Trophosome.—Hydrocaulus consisting of hydrocladia which spring from a creeping stolon or from one another through the intervention of a jointed peduncle, and are divided into distinct internodes, each internode carrying a hydrotheca. Hydrothecæ with dentate margin; mesial nematophores fixed, not adnate to the hydrotheca; lateral nematophores movable.

Gonosome—Gonangia destitute of special protective apparatus.

Professor Allman regards this genus as belonging to the Eleutheroplea, although it has marked relations with the Statoplea in having a fixed mesial nematophore and hydrothecal teeth. The pedunculated hydrocladia constitute a feature which I believe to be unique among the Plumularidæ, the peduncle consisting of several short internodes devoid of hydrocladia.

GATTYA HUMILIS Allman.

(Plate XVII, figs. 10, 11.)

Gattya humilis ALLMAN, Journ. Linn. Soc., 1885, XIX, p. 156, pl. XXIV.

Trophosome.[2]—Hydrocladia borne along the length of a creeping tubular stolon, from which each springs by a cylindrical jointed peduncle, occasionally sending off a branch which springs in a similar way from the hydrocladium which carries it; internodes of hydrocladia separated from one another by very distinct joints. Hydrothecæ boat-shaped, adnate to the internode by the whole epicauline wall; aperture with a strong tooth on either side and another in front; no intrathecal ridge; mesial nematophore short, with a wide cup shaped termination, separated by a short interval from the hydrotheca; lateral nematophores trumpet-shaped, supported on short styloid processes which are given off on a level with the hydrothecal margin.

Gonosome.—Gonangia pyriform with a broad truncated summit, springing each by a narrow jointed peduncle from the side of an internode close to the posterior wall of the hydrotheca.

Locality.—Unknown.

I include this remarkable form here, although it is not known to be an American species. It was found by Professor Allman among the species collected by Miss Gatty, many of which came from America. The figure given with the original description represents *G. humilis* as growing on an alga, apparently.

The species is of such unusual interest from a morphological standpoint that it is desirable to include it here for the purpose of calling the attention of American students so that they may be on the lookout for it.

Distribution of the American genera of Statoplean Plumularidæ.

Genera.	Geographical.							Total number of species.	Bathymetrical.					
	Atlantic.				Pacific.									
	Charleston and northward.	South of Charleston and West Indies.	South Atlantic.	Coasts of Europe.	North Pacific.	South Pacific.	Australia.		1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.	Over 500 fathoms.
Aglaophenia	6	25	4	2	2	.....	1	34	19	4	8	9	3	2
Thecocarpus	1	4	.....	1	.....	.....	.....	5	.....	1	.....	1	3	.....
Cladocarpus	6	11	.....	.....	.....	.....	.....	14	.....	2	4	10	7	1
Aglaophenopsis	2	2	.....	.....	.....	.....	.....	4	.....	.....	.....	1	2	1
Lytocarpus	.....	6	2	1	.....	1	1	7	5	1	2	1	2	.....
Halicornaria	.....	3	.....	.....	.....	.....	.....	3	2	1	1	.....	.....	.....
Nuditheca	.....	.....	.....	.....	1	.....	.....	1	1	.....	.....	.....	.....	.....
Streptocaulus	.....	1	.....	1	.....	.....	.....	1	.....	.....	1	.....	.....	.....
Total	15	52	6	5	3	1	2	69	27	9	16	22	17	4

[1] The interrogation mark preceding the name of this genus is placed there to call attention to the fact that it is not known to be American.

[2] Original description quoted entire.

In comparing the above with the table showing the geographical and bathymetrical distribution of the Eleutheroplea we find that the proportion which the West Indian forms bear to the whole number of species is identical in the two groups. In both of them 75 per cent of all the species are found in the West Indian region. The Statoplea are more abundantly represented on our North Atlantic seaboard than the Eleutheroplea, there being 15 species (26 per cent) of the former to 9 species (17 per cent) of the latter. Only 5 (7 per cent) of our American species of Statoplea are represented in Europe, while 5 (10 per cent) of the Eleutheroplea are found on the European coasts. But in each case several genera are represented. In both groups a single species is common to both the American (Pacific) and Australian faunæ.

In the bathymetrical distribution a similar comparison shows that of the Statoplea 52 species (75 per cent) are found inside of the 100-fathom line, while in the Eleutheroplea there are 34 species (65 per cent) found in the same limits. In the Statoplea a single genus is confined to a depth greater than 100 fathoms, while there are 2 of these deep-water genera among the Eleutheroplea.

In the Statoplea 5 species have been dredged from a depth greater than 500 fathoms, the deepest being 1,742[1] fathoms, while in the Eleutheroplea only one such species is recorded found at a depth of 576[2] fathoms.

KEY TO THE GENERA OF STATOPLEAN PLUMULARIDÆ.

Gonosome.	Corbulæ, each of which is a modified hydrocladium.	Lateral marginal teeth not inconspicuous; no hydrotheca at base of each gonangial leaf.....*Aglaophenia.*
		Lateral teeth inconspicuous; a hydrotheca at base of each gonangial leaf.....*Thecocarpus.*
		Two pairs of lateral nematophores to each hydrotheca. (*Pentandra.*)
		Distal hydrocladia replaced by spine-like processes; an anterior intrathecal ridge.....(*Acanthocladium.*)
	Protective branchlets, each of which is an appendage to a hydrocladium.	Cauline nematophores not very large, or, if large, not distinctly crenulated; phylactogonium not jointed. *Cladocarpus.*
		Cauline nematophores large and crenulated; phylactogonium jointed, often with hydrothecæ .....*Aglaophenopsis.*
	Protective branchlets, each of which is a modified hydrocladium.	Stem fascicled; a prominent perforated process at the base of each hydrocladium .....*Lytocarpus.*
	Gonangia without protective contrivance of any kind.	Supracalycine sarcothecæ wanting.....(*Kirchenpaueria.*)
		An anterior intrathecal ridge; no septal ridges in hydrocladial internodes.....*Halicornaria.*
		No marginal teeth; hydrocladia branched.....*Nuditheca.*
		Hydrocladia arranged in a spiral around the stem. *Streptocaulus.*

Hydrothecal wall reduplicated. No supracalycine nematophores.....(*Diplocheilus.*)

AGLAOPHENIA Lamouroux (modified).

CALATHOPHORA (subgenus) Kirchenpauer.

Trophosome.—Stem not fascicled in American species; hydrothecal margin dentate; a posterior intrathecal ridge present and usually well marked; two supracalycine and one mesial nematophore attached to each hydrotheca.

Gonosome.—Gonangia inclosed in a true corbula formed of a modified pinna, its leaves without hydrothecæ at their bases. The corbula may be either open or closed.

This genus as originally described by Lamouroux[3] included all known Plumularidæ except the genus *Nemertesia*=*Antennularia*. In 1857 McCrady[4] restricted the genus to the forms now embraced in the Statoplea, in which he was followed by Agassiz[5] in 1862, and Hincks[6] in 1868. Kirchenpauer[7] in 1872 divided the genus into four subgenera, *Calathophora*, *Pachyrhynchia*,

[1] *Aglaophenopsis verrilli.*
[2] *Plumularia alternata.*
[3] Bulletin Société Philomatique, 1812.
[4] Gymnophthalmata of Charleston Harbor, p. 200.
[5] Contributions to the Natural History of the United States, IV, p. 358.
[6] British Hydroid Zoophytes, p. 284.
[7] Ueber die Hydroidenfamilie Plumularidæ, Pt. 1, *Aglaophenia*, p. 25.

Lytocarpia, and *Macrorhynchia*. His first section, *Calathophora*, included the genus *Aglaophenia* as used here. In his third section, *Lytocarpia*, he includes forms such as *Aglaophenia myriophyllum*, which Allman [1] places in the genus *Lytocarpus*, Bale [2] regards as a part of the genus *Aglaophenia*, and the present writer would place in a new genus, *Thecocarpus*.

It will be seen that I here agree with Bale in the opinion that the corbula of *Thecocarpus* is a true corbula, differing from that of *Aglaophenia* mainly in bearing hydrothecæ at the bases of its leaflets.

Distribution of the American species of Aglaophenia.

Species.	Geographical.							Bathymetrical.					
	Atlantic.				Pacific.								
	Charleston and northward.	South of Charleston and West Indies.	South Atlantic.	Coasts of Europe.	North Pacific coast.	South Pacific coast.	Australia.	1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.	Over 500 fathoms.
A. rhynchocarpa		+						+			+	+	
A. calamus			+					+					
A. rigida	+	+						+	+	+	+	+	
A. dubia									+	+	+		
A. lophocarpa									+		+		+
A. elegans										+			
A. apocarpa										+	+		
A. flowersi		+									+		
A. insignis		+										+	
A. aperta		+									+		
A. cristifrons		+											
A. contorta		+						+					
A. minuta	+	+											
A. perpusilla		+							+				
A. mammillata	+							+					
A. minima		+						+					
A. perforata		+						+					
A. simplex		+						+					
A. allmani		+											
A. robusta		+								+			
A. rathbuni			+					+?					
A. latirostris			+					+?					
A. struthionides					+			+					
A. ramulosa		+				+				+			
A. octocarpa					+			+					
A. gracillima		+								+			
A. patagonica			+					+?					
A. crenata													+
A. trifida	+							+					
A. tricuspis	+							+					
A. constricta		+						+					
A. savignyana		+		+				+?					
A. bicornuta		+									+		
A. pelagica	+	+		+				+					

KEY TO THE AMERICAN SPECIES OF AGLAOPHENIA.

Mesial nematophore short, without constriction or septal ridge, forming an acute angle with hydrotheca. Marginal teeth even and regular. *Rigida* group.

- Axis of hydrotheca forming an acute angle with hydrocladium. Hydrocladial internodes with more than two distinct septal ridges. *rhynchocarpa.*
- Supracalycine nematophores slightly overtopping the hydrotheca. *calamus.*
- Marginal teeth on a level with base of next hydrotheca above. . . *rigida.*
- Marginal teeth distinctly below the base of the next hydrotheca above. . . . . *dubia.*

Axis of hydrotheca nearly or quite parallel with that of hydrocladium.

- Hydrocladia springing from distal ends of stem joints. . . *lophocarpa.*
- Hydrocladia springing from near middle of stem joints. . . . *apocarpa.*
- Colony branched, over 4 inches high. Hydrothecæ approximated. *flowersi.*
- Colony unbranched. Hydrothecæ rather close set. Corbula arcuate . . . . . *elegans.*

[1] *Challenger* Report, Plumularidæ, pp. 12, 40.

[2] See The Genera of the Plumulariidæ, p. 12, etc., for an excellent discussion of this and other points of interest to the systematist.

Mesial nematophore forming nearly a right angle with hydrotheca, without constriction. Marginal teeth even and regular. *Insignis* group.

- Free portion of mesial nematophore longer than width of hydrotheca. *insignis.*
- Free portion of mesial nematophore shorter than width of hydrotheca.
  - Aperture nearly horizontal. Corbula open ..... *aperta.*
  - Aperture nearly horizontal. Corbula closed ..... *cristifrons.*
  - Aperture at an angle of nearly 45° with axis of hydrocladium. *contorta.*

Colony small, unbranched. Mesial nematophore with a constriction or internal horizontal septal ridge. Two strong processes below the base of each hydrocladium, on front of stem. *Minuta* group.

- Hydrothecal keel present:
  - Keel broad. Rootstock distinctly and regularly annulated .. *minuta.*
  - Keel narrow. Rootstock not regularly annulated. Colony less than one-half inch high ..... *perpusilla.*
  - Colony more than 1 inch high ..... *mammillata.*
- No hydrothecal keel:
  - Hydrotheca almost cylindrical ..... *minima.*
  - Hydrotheca obconical ..... *perforata.*
  - Upper portion of hydrotheca free ..... *simplex.*

Mesial nematophore long, adnate, reaching nearly to top of hydrotheca, without internal septal ridge. Marginal teeth even and regular. *Allmani* group.

- Marginal teeth moderately long ..... *allmani.*
- Marginal teeth very long ..... *robusta.*

Marginal teeth uneven; anterior ones often the longest. *Arborea* group.

- Mesial nematophore not reaching near top of hydrotheca ..... *rathbuni.*
- Mesial nematophore expanded and reaching decidedly above top of hydrotheca ..... *latirostris.*
- Mesial nematophore tubular, and reaching decidedly above top of hydrotheca ..... *ramulosa.*
- Colony 4 or more inches high. Three hydrothecæ between corbula and stem ..... *struthionides.*
- Colony not more than 3 inches high. One hydrotheca between corbula and stem ..... *octocarpa.*
- Mesial nematophore very short. Anterior tooth very long ... *gracillima.*
- Two long anterior teeth ..... *patagonica.*

Incertæ sedis .....

- Margins of hydrothecæ almost smooth and crenate ..... *crenata.*
- Margin with 8 to 10 teeth; mesial nematophores near center of hydrotheca ..... *trifida.*
- Margin smooth; mesial nematophore adnate to front of hydrotheca. *tricuspis.*
- Three hydrocladia borne on each internode of stem ..... *constricta.*
- Hydrothecal aperture almost vertical; mesial nematophores very long and tubular ..... *sarignyana.*
- Mesial nematophore double ..... *bicornuta.*
- Colony small, pelagic on gulf-weed, characters not determinable. *pelagica.*

AGLAOPHENIA RHYNCHOCARPA Allman.

(Plate XVIII, figs. 1, 2.)

Aglaophenia rhynchocarpa ALLMAN, Mem. Mus. Comp. Zool., 1877. V, No. 2, p. 40, pl. XXIII.

Trophosome.—Colony usually unbranched, attaining a height of about 2½ inches; stem not fascicled, divided into regular internodes which are more apparent in the distal than in the proximal portion, each of which bears a hydrocladium near its distal end; hydrocladia alternate, rather close together, divided into regular internodes, each of which is itself divided by internal septa or ridges into about five communicating chambers. Hydrothecæ closely approximated, robust, with the anterior profile strongly concave above the mesial nematophore; aperture oblique, margin with about eleven regular teeth. There is a shallow keel in front which projects above the marginal teeth, and a strong oblique intrathecal ridge parallel to the mesial nematophore. Supracalycine nematophores stout, reaching to the level of the top of the hydrotheca; mesial nematophore short, adnate to the hydrotheca for the greater part of its length, with the distal end forming a short spur-like projection.

Gonosome.—A closed corbula with its distal end narrowed and projecting forward like a beak. There are about ten pairs of leaves, each with a row of nematophores on its distal edge and a long spur-like projection at its base. There is a single hydrotheca between the corbula and the stem.

Distribution.—Key West, Florida, 3 to 4 fathoms; *Albatross* Station 2333, lat. N. 23° 11′, long. W. 82° 19′, 169 fathoms; off Habana, Cuba, 150 to 250 fathoms, State University of Iowa Expedition.

The corbula does not always present so striking a "beak" as is seen in the illustration in Allman's work. The species is a well-marked one, however, especially on account of the numerous septa in the hydrocladial internodes.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENIA CALAMUS Allman.

(Plate XXIV, figs. 9–11.)

Aglaophenia calamus ALLMAN, *Challenger* Report, VII, Pt. 20, p. 39, pl. XII.

Trophosome.[1]—Colony attaining a height of about 5 inches; stem monosyphonic, simple, or with a few branches springing from its anterior aspect; hydrocladia rather close, about two-tenths of an inch in length. Hydrothecæ with the margin deeply serrated; intrathecal ridge short, near the floor of the hydrotheca; mesial nematophore adnate to the walls of the hydrotheca for about half their height, and then continued as a short spur-like process, which does not reach the level of the hydrothecal margin; lateral nematophores somewhat flask-shaped, slightly overtopping the margin.

Gonosome.—Corbula rather long, cylindrical, with about seven pairs of adnate costæ, each costa carrying four or five tubular denticles, and with a spur-like denticle at its base.

Dredged off Bahia, from a depth of 10 to 20 fathoms.

This species greatly resembles *A. rigida* Allman, from which it differs, judging from the figures, in having stouter hydrothecæ, longer supracalycine nematophores, and a much less number of corbula ribs with larger and less numerous nematophores.

Type.—In the South Kensington Museum, London.

AGLAOPHENIA RIGIDA Allman.

(Plate XVIII, figs. 3, 4.)

Aglaophenia rigida ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 43, pl. XXV.
Aglaophenia rigida CLARKE, Bull. Mus. Comp. Zool., 1879, V, No. 10, p. 248.

Trophosome.—Colony much branched, slender, attaining a height of 24 inches; stem not fascicled, very slender and wiry, giving off branches usually in pairs from the front of the stem, divided into internodes, each of which supports a hydrocladium on a process near its distal end; hydrocladia short (especially in specimens from the Atlantic coast of the United States), divided into regular internodes, which are shorter than in the preceding species and have two short internal septa, one opposite the intrathecal ridge and another below the supracalycine nematophores. Hydrothecæ closely approximated, stout, with deep concavity in the anterior profile, and having about eight strong, deeply cut, marginal teeth; intrathecal ridge short; supracalycine nematophores about reaching the top of the hydrotheca; mesial nematophore with its distal portion widely separated from the hydrotheca, stout, reaching about to the level of the middle of the hydrotheca.

Gonosome.—Corbula long, cylindrical, with twelve to fourteen pairs of leaves when mature; leaves closed, each with a row of nematophores along its distal edge and a stout short spur at its base.

Distribution.—Off Cape Fear, Florida; depth, 9 fathoms; *Blake*, 10 miles north of Zoblos Island, lat. N. 24° 8′, long. W. 28° 51′; depth, 339 fathoms; *Albatross*, numerous stations from lat. N. 22° to lat. N. 36°, usually in less than 100 fathoms; State University of Iowa Expedition, Station 28, off Sand Key, Florida, 116 fathoms.

Numerous specimens from the coasts of the Carolinas in the region south of Hatteras are very long and slender, with short hydrocladia. This species appears to be the most abundant *Aglaophenia* on our Atlantic seaboard, great quantities having been secured by the U. S. Fish Commission dredging expeditions. The trophosome is difficult to distinguish from that of *A. gracilis* Allman, but the colonies are much larger and the hydrothecæ stouter and more closely set than in that species.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

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[1] Original description quoted entire.

AGLAOPHENIA DUBIA[1] Nutting.

(Plate XVIII, fig. 5.)

Aglaophenia gracilis ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 42, pl. XXV.
Aglaophenia gracilis CLARKE, Bull. Mus. Comp. Zool., 1879, V, No. 10, p. 248.
Aglaophenia gracilis FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 131.

Trophosome.—Colony sparingly branched, attaining a height of 4 inches; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium on a process from near its distal end; hydrocladia divided into regular internodes, each of which bears a hydrotheca and has its cavity partially divided by two incomplete internal septa, one being opposite the intrathecal ridge and the other below the base of the supracalycine nematophores. Hydrothecæ rather stout, slightly separated, with the anterior profile concave and about eight deeply cut teeth around the margin; intrathecal ridge well marked but short; supracalycine nematophores barely overtopping the hydrotheca; mesial nematophore stout, with its distal part widely separated from the hydrotheca and its end reaching to about the middle of the height of the latter; two cauline nematophores on the front of each internode of the stem, and another small one at the base of each hydrocladium.

Gonosome.—Not known.

Distribution.—Off Carysfort Reef; depth, 52 fathoms; *Blake*, West Indies; depth, 37 fathoms (Clarke); *Blake*, Martinique; depth, 96 fathoms (Fewkes); *Albatross* Station 2411, lat. N. 26° 34′, long. W. 83° 16′; depth, 27 fathoms; *Albatross* Station 2413, lat. N. 26°, long. W. 82° 58′, 24 fathoms; State University of Iowa Expedition, Stations 51–52, off Florida Keys, 100 fathoms; State University of Iowa Expedition, Station 12, off Habana, 150 fathoms; State University of Iowa Expedition, Station 72, off Little Cat Island, 6 fathoms.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts, labeled *Aglaophenia gracilis* Allman.

AGLAOPHENIA LOPHOCARPA Allman.

(Plate XVIII, figs. 6–8.)

Aglaophenia lophocarpa ALLMAN, Mem. Mus. Comp. Zool., V, No. 2, p. 41, pl. XXIV.

Trophosome.—Colony usually unbranched, sometimes branching freely, attaining a height of 8 inches; stem not fascicled, divided into rather long internodes, each of which bears a hydrocladium on a projection from near its distal end; hydrocladia somewhat distant for this genus, divided into regular internodes, without internal septal ridges, except slight indications opposite the intrathecal ridge and below the supracalycine nematophore. Hydrothecæ about twice as deep as wide; anterior profile convex, aperture at right angles to the stem, armed with nine large, equal teeth; intrathecal ridge oblique, reaching about halfway around the hydrotheca; supracalycine nematophores reaching a little above the margin of the hydrotheca; mesial nematophore extensively adnate to the hydrotheca, only the terminal portion being free and not reaching the level of the middle of the hydrotheca; two cauline nematophores on each internode of the stem, one near each end on the anterior aspect.

Gonosome.—Corbula composed of about ten pairs of leaves, each of which has its distal edge greatly expanded, projecting forward and upward, and armed with a row of nematophores and a short spur-like projection at its base; a single hydrotheca between the corbula and the stem.

Distribution.—Dry Tortugas; depth, 68 fathoms; *Albatross* Station 2383, lat. N. 28° 32′, long. W. 88° 6′; depth, 1,181 fathoms; *Albatross* Station 2387, lat. N. 29° 24′, long. W. 88° 4′; depth, 32 fathoms; *Albatross* Station 2389, lat. N. 29° 28′, long. W. 87° 56′; depth, 27 fathoms; *Albatross* Station 2410, lat. N. 26° 47′, long. W. 83° 25′; depth, 28 fathoms; *Albatross* Station 2413, lat. N. 26°, long. W. 82° 57′; depth, 24 fathoms; off Habana, Cuba, 200 fathoms, State University of Iowa Expedition.

Specimens from Stations 2387 and 2389 attain a height of 7 or 8 inches, and are straggling and freely branched. The trophosome agrees in other respects with this species, but none of the

[1] Name *Aglaophenia gracilis* preoccupied by Lamouroux, Histoire des Polypiers Coralligènes flexibles, 1816, p. 171.

corbulæ are present. The internodes of the stem are hard to make out in all cases, and it is only occasionally that one can satisfy himself as to the location of the nodes. They are usually distinct in the following species, and thus afford a good character.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENIA APOCARPA Allman.

(Plate XVIII, figs. 9–11.)

Aglaophenia apocarpa ALLMAN, Mem. Mus. Comp. Zool., V, No. 2, p. 41, pl. XXIV.

Trophosome.—Colony unbranched, attaining a height of about 2 inches; stem not fascicled, divided into regular, rather long internodes, each of which bears a hydrocladium on a process from the middle of its antero-lateral aspect; hydrocladia rather distant, with slender internodes slightly bent backward at the ends, forming a sinuosity between the hydrothecæ; no internal thickenings of the internode. Hydrothecæ separated by nearly one-half their height, about two and one-half times as deep as the longest diameter of the aperture, slightly concave in anterior outline, with the aperture tilted forward; margin with nine sharp teeth; intrathecal ridge less oblique than in preceding species; supracalycine nematophores small, short, barely overtopping the hydrotheca; mesial nematophore extensively adnate to the hydrotheca and not quite reaching the middle of the latter; cauline nematophores two to each internode of the stem, one near the middle and another at the proximal end.

Gonosome.—Corbula with about ten pairs of leaves which do not touch each other; leaves narrow, each with a row of nematophores on its distal and another on its proximal edge. There is a single hydrotheca between the corbula and the stem.

Distribution.—Off Sand Key, Florida; depth, 100 fathoms; Milligans Key, 124 fathoms (Fewkes); *Albatross* Station 2157, lat. N. 23° 10′, long. W. 82° 21′; depth, 29 fathoms; Pourtalès plateau (off Florida Keys), 116 fathoms, State University of Iowa Expedition.

The trophosome of this species can with difficulty be distinguished from the last. The best character is in the fact that the cauline internodes bear the hydrocladia on projections from their distal ends in *A. lophocarpa*, and from their middle portions in *A. apocarpa*. The corbulæ are, of course, quite distinct.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENIA FLOWERSI,[1] new species.

(Plate XIX, figs. 1, 2.)

Trophosome.—Colony branched, the branches again dividing into branchlets, attaining a height of about 6 inches in the type specimen; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium on a process springing from near its distal end; hydrocladia growing further down on the main stem than in many of this group, divided into rather slender internodes which are usually without internal thickenings. Hydrothecæ closely approximated for this group, deep, tubular, margin with an anterior slightly recurved tooth, and three rather shallow lateral ones on each side; apertures somewhat oblique; intrathecal ridge very short, scarcely evident; supracalycine nematophore small, attaining the level of the top of the hydrotheca; mesial nematophore short, stout, adnate except at the distal end, not attaining half the height of the hydrotheca; cauline nematophores two on the front of each internode, and a spur-like perforated process at the base of each hydrocladium.

Gonosome.—Corbulæ borne usually in the axils of the branches, very long and slender, composed of about twenty pairs of leaves; the distal portion of each corbula is open at the top from the failure of the leaves to meet above; the leaves on the distal third have few or no nematophores; the proximal portion is composed of leaves, each of which has a row of numerous small nematophores along its distal edge; one or two more or less modified hydrothecæ between the corbula and the stem.

Distribution.—Off Sand Key, Florida, 116 fathoms, State University of Iowa Expedition.

[1] In honor of Captain Charles Flowers, the efficient sailing master of the State University of Iowa Bahama Expedition.

This beautiful species is easily distinguished from its nearest allies, *A. apocarpa* and *A. lophocarpa*, by the closer approximation of the hydrothecæ, the much larger and more branching colonies, and the very distinct and graceful corbulæ, which differ materially from those of any other known species.

Type slides.—Cat. No. 15353, Mus. State Univ. Iowa; Cat. No. 18644, U.S.N.M.; also in the collection of the author.

AGLAOPHENIA ELEGANS, new species.

(Plate XIX, figs. 3, 4.)

Trophosome.—Colony unbranched, growing in loose tufts from a creeping root-stalk and attaining a height of about 4 inches; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium on a process near its distal end; hydrocladia alternate, rather distant, divided into slightly flexuous internodes, each of which is itself divided by an internal septal ridge opposite the intrathecal ridge. Hydrothecæ rather closely approximated, deep, tubular, the anterior profile slightly concave, aperture nearly horizontal, margin armed with about seven moderately sharp teeth; intrathecal ridge short, oblique, supracalycine nematophores small, slightly overtopping the hydrotheca; mesial nematophore short, adnate, except the distal end, which does not attain the level of the middle of the hydrotheca; two cauline nematophores on the front of each internode of the stem, and a perforated process at the base of each hydrocladium.

Gonosome.—Gonangia borne near the distal ends of the stems, strongly arched and composed of about fifteen pairs of broad, strongly imbricating leaves, each of which has a row of nematophores along its distal edge; one or more of the proximal leaves is detached from the others and hangs outward and downward over the rachis. There is a single hydrotheca between the corbula and the stem; pedicel short.

Distribution.—Station 62, off Sand Key, Florida, 70 to 80 fathoms, State University of Iowa Expedition.

This species greatly resembles *A. lophocarpa* and *A. apocarpa*, especially the latter. The hydrocladia are flexuous as in *apocarpa*, but the hydrothecæ are decidedly more closely approximated. The gonosome is quite distinct from that of any of its allies, being arcuate in outline and having the loose, basal leaf as in *A. tubulifera* Hincks.

Type slides.—Cat. No. 15354, Mus. State Univ. Iowa; Cat. No. 18645, U.S.N.M.; also in the collection of the author.

AGLAOPHENIA INSIGNIS Fewkes.

(Plate XIX, figs. 5–7.)

Aglaophenia insignis Fewkes, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 131.

Trophosome.[1]—Colony growing from a woody rootstalk, subpinnately branched and attaining a height of about 3 inches; stem not fascicled divided into regular internodes, each of which bears a hydrocladium on a process from near its middle; hydrocladia moderately approximated, divided into regular internodes, each of which has a very strong horizontal ridge opposite the intrathecal ridge. Hydrothecæ rather closely approximated, deep, with anterior profile concave; aperture oblique, armed with seven prominent teeth; intrathecal ridge low, short, horizontal; supracalycine nematophores small, not attaining the level of the top of the hydrotheca; mesial nematophore large, long, spur-like, directed at right angles from the hydrocladium, distal free portion nearly as long as the hydrotheca is wide; cauline nematophores usually two to each internode of the stem, besides a perforated process at the base of each hydrocladium.

Gonosome.—Corbulæ small, robust, composed of five pairs of broad leaves, the distal edges of which form elevated crests, armed with very large tubular nematophores.

Distribution.—*Blake* Station 249, off Grenada; depth, 262 fathoms.

At first sight the trophosome of this species closely resembles that of *A. aperta*. Upon directly comparing specimens, however, I find that the hydrothecæ of *A. insignis* are very much smaller than those of *A. aperta*. The mesial nematophore of the former is proportionately heavier

[1] Description of Doctor Fewkes's type specimen from the Museum of Comparative Zoology.

than that of the latter, and the lower profile is often concave, while that of *A. aperta* is usually straight. When the gonosome is present there is no danger of confusing the two species, as they are strikingly different in this respect.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENIA APERTA, new species.

(Plate XX, figs. 1, 2.)

Trophosome.—Colony unbranched, attaining a height of about 3 inches; stem not fascicled, without pronounced internodes, the processes bearing hydrocladia with a perforated protuberance on each; hydrocladia alternate, divided into regular internodes, each of which has a single incomplete internal septum opposite the intrathecal ridge. Hydrothecæ rather deep; anterior profile moderately concave; margin with nine well-defined teeth; intrathecal ridge short, but evident; supracalycine nematophores reaching to the level of the top of the hydrotheca; mesial nematophore with its distal portion projected nearly at a right angle with the hydrotheca, and its lower profile straight; two cauline nematophores on the front of each internode of the stem.

Gonosome.—Corbulæ with about eight pairs of free leaves, each with two rows of nematophores on its edges, and a rather strong process at its base; a long, narrow, transparent space is seen in each leaf; the tops of the two leaves composing each "pair" meet in the central line above the corbula and do not alternate so distinctly as in most species.

Distribution.—*Albatross* Station 2326, lat. N. 23° 12′, long. W. 82° 19′; depth, 194 fathoms. State University of Iowa Expedition, off Habana; depth, 200 fathoms.

This species is readily distinguished by its long and prominently projecting mesial nematophore in connection with the deep hydrotheca. It is nearest to *A. apocarpa*, especially in the gonosome, which may be distinguished, however, by the fact that the corbula leaves in *aperta* are more nearly opposite than in *apocarpa*.

Type slides.—Cat. Nos. 18646, 18648, U.S.N.M.; Cat. Nos. 15355, 15356, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENIA CRISTIFRONS, new species.

(Plate XX, figs. 3, 4.)

Trophosome.—Colony unbranched, attaining a height of about 2 inches; stem not fascicled; internodes obscurely indicated; hydrocladia alternate, rather distant, long, projecting at right angles from the stem; internodes without decided internal thickenings. Hydrothecæ not closely approximated, rather deep; anterior profile decidedly concave; margin with nine rather shallow teeth; intrathecal ridge evident, oblique, and extending nearly halfway around the hydrotheca; supracalycine nematophores slightly overtopping the hydrothecæ; mesial nematophore rather long, the distal end forming something less than a right angle with the axis of the hydrotheca; aperture extending along the upper side nearly to the hydrotheca; lower side of nematophore slightly convex; cauline nematophores one at the base of each hydrocladium, and two others on each internode of the stem. Color of stem dark brown.

Gonosome.—Corbulæ closed, robust, composed of five to seven pairs of broad leaves, each of which bears a row of long and prominent nematophores on its distal edge, and a blunt spine at its base. There is a single hydrotheca between the corbula and the stem.

Distribution.—*Albatross* Station 2323, lat. N. 23° 11′, long. W. 82° 19′; 163 fathoms.

The trophosome of this species is different from its allies in the fact that the somewhat distant hydrocladia are given off at exactly a right angle with the stem. The gonosome is quite distinct, being much more robust and broad-leaved than its immediate relatives. The name '*cristifrons*' refers to the prominent crest of nematophores projecting forward from the distal end of the corbula.

Type slides.—Cat. No. 18649, U.S.N.M.; Cat. No. 15357, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENIA CONTORTA, new species.

(Plate XX, figs. 5–7.)

Trophosome.—Colony sparsely branching, attaining a height of about 4 inches in the incomplete specimens examined; stem not fascicled, of very delicate texture, divided into regular internodes, each of which bears a hydrocladium, at least on the distal portion of the stem; hydrocladia alternate, closely approximated, divided into regular internodes by oblique nodes; each internode has a strong internal ridge reaching clear around its cavity nearly opposite the intrathecal ridge, and another running obliquely from just under the supracalycine nematophores, and reaching nearly around the internode. Hydrothecæ small, very closely approximated, exceedingly thin and hyaline in structure, rather deep, with an enlarged proximal portion and an expanded and everted distal portion; margin with its anterior lip greatly produced forward so as to overhang the remainder of the hydrotheca; anterior tooth strong and sharp, two lateral broad and shallow teeth with a long sinuosity between them; intrathecal ridge low, plainly marked and oblique; supracalycine nematophores rather small, curved upward and forward, and overtopping the hydrothecæ; mesial nematophore very large, robust, projecting at nearly a right angle from the hydrotheca, and free for nearly half its length; there are two cauline nematophores on the front of each internode of the stem, one being a rounded projection on the base of the hydrocladium.

Gonosome.—Corbula exceedingly thin and transparent, very large and ornate, with twelve to twenty-five pairs of broad leaves, each of which is greatly expanded, the front edge extending forward and upward over the base of the preceding leaf and armed with a row of nematophores from each of which a fine ridge extends directly toward the inner edge of the leaf. The mature (?) corbula seen in some of the smaller specimens is more or less open, and shows that each leaf has both edges armed with rows of nematophores. There are about four more or less modified hydrothecæ between the corbula and the stem.

Distribution.—Off Key West, Florida; depth, 5½ fathoms, State University of Iowa Expedition. Off Marco, Florida, 2 fathoms (Henry Hemphill).

This is a very distinct and beautiful species in both its trophosome and gonosome. It is of a more delicate texture than any other Plumularian that I have seen. Not only the hydrotheca, but the stem and corbulæ are very difficult to preserve, and especially to mount for microscopical examination. The corbula is the most exquisitely beautiful structure of its kind that I have ever seen, reminding one of the most delicate and intricate designs in spun glass. It is perfectly transparent, and the broad expanded leaves edged with nematophores and ornamented with the fine white lines described above give a delicacy and grace which defies description.

Type slides.—Cat. No. 18650, U.S.N.M.; Cat. No. 15358, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENIA MINUTA Fewkes.

(Plate XXI, figs. 1–3.)

Aglaophenia minuta FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 132.
Aglaophenia late-carinata ALLMAN, Journ. Linn. Soc., Zool., 1885, XIX, p. 151.

Trophosome.—Colony unbranched, springing from a regularly annulated creeping rootstalk, and attaining a height of ¾ inch, but usually not more than ⅛ inch; stem not fascicled, with two or three deep, oblique nodes near its base, the remainder being divided into regular internodes, each of which bears a hydrocladium on a strong process from near its distal end. This process bears two strong nematophores on its outer and lower side; hydrocladia divided into short internodes, each of which has two internal thickened ridges, one opposite the intrathecal ridge and the other below the base of the supracalycine nematophores; nodes very deep. Hydrothecæ deep, obconic at the base, somewhat swollen mesially and with the aperture not expanded; marginal teeth nine, sharp and deeply cut; a broad anterior keel running from above the mesial nematophore to the margin; intrathecal ridge well marked, oblique, extending around the hydrotheca; supracalycine nematophores small, geniculate, not

reaching to the top of the hydrotheca; mesial nematophore rather small, the distal free portion being partly separated from the remainder by a constriction or partial septum.

Gonosome.—Corbula usually borne on a modified hydrocladium at the base of the expanded or pinnate portion of the colony; corbula short, stout, rounded, composed of eight pairs of rather broad leaves, which meet only at the points where the nematophores project, hence leaving a row of perforations between adjacent leaves. Each leaf has a row of large nematophores along its distal edge, and a short spiny process at its base. There is usually but one corbula to a colony, and that is proportionately very large.

Distribution.—Lat. 32° 43′ 25″ N., long. 77° 20′ 30″ W., surface?, Fewkes; Gulf of Mexico, Allman; *Albatross* Station 2038, lat. N. 38° 31′, long. W. 69° 08′, surface; *Albatross* Station 2585, lat. N. 39° 09′, long. W. 72° 17′, surface, floating in the Gulf Stream and in shallow water on the Great Bahama Banks.

This species may be *A. pelagica* Lamouroux, being the most common of the minute species found on floating seaweed, but the original description of that species is not sufficiently definite to permit of any certainty of identification. This is the most abundant *Aglaophenia* in the *minuta* group. Having seen the type specimens at the Museum of Comparative Zoology, I am enabled to give a somewhat more extended description than the original. The gonosome has not hitherto been described. Although the present species does not agree in all respects with the description of Allman's *A. late-carinata*, the general agreement is such that I regard the latter name as a synonym. The diagnostic marks of *A. minuta* are the broad anterior keel to the hydrotheca in connection with the projections at the bases of the hydrocladia and the regularly annulated rootstalk.

Doctor Fewkes says that the specimens secured by the *Blake* were growing *on alga*. If this is true it is unlikely that they came from the bottom at the depth mentioned, as there is no record that I can find of algæ growing at such depths.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENIA PELAGICA Lamouroux.

Aglaophenia pelagica LAMOUROUX, Polyp. Flex., 1816, p. 170.
Plumularia pelagica LAMARCK, An. sans Vert., 1836, 2d ed., II, p. 167.
Dynamena pelasgica (DE BLAINVILLE), Manuel d'Actinologie, 1836, p. 484.
Aglaophenia pelasgica MCCRADY, Gymn. of Charleston Harbor, 1857, p. 98.
Aglaophenia pelasgica AGASSIZ, N. A. Acalephæ, 1865, p. 139.
Aglaophenia pelagica KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, 1872, Pt. 1, p. 29.

The following description is given by McCrady.[1] The words in brackets are my own, and are introduced to make the description more intelligible to those who are used to the present terminology of the science:

> These specimens are attached to the gulf weed [*Sargassum bacciferum*] and were taken in the Atlantic by a homeward bound vessel. * * * It [the species] is characterized by cells [hydrothecæ] quite long in proportion to their breadth. The posterior process [mesial nematophore] is far behind; the anterior lateral processes [supracalycine nematophores] are rather weak and slender. The main stem is recumbent and creeping, giving off at intervals plume-like branches, so much like those of the ordinary true plumularia that it would readily be mistaken at first sight. On my specimens I have found no reproductive capsules [gonangia]. This important portion of the community, however, is represented in Dana's woodcut. * * * It is turned downward, thus depending from the stem. Is this its natural position?
>
> This species is not improbably an occasional visitant of our waters, but I have never encountered it on the Gulf weed thrown on our beaches.
>
> *Distribution.*—Southern coast of England and Ireland, Irish Channel, Sargossa Sea, and Charleston Harbor.

As before intimated, it is by no means improbable that this species is identical with *A. minuta* Fewkes. A good deal of doubt is thrown upon this probability, however, by the fact that no hydrothecal keel is mentioned by McCrady, who was a most careful observer and would hardly miss so conspicuous a character had it been before him.

[1] Gymnophthalmata of Charleston Harbor, p. 201.

AGLAOPHENIA PERPUSILLA Allman.

(Plate XXI, figs. 4, 5.)

Aglaophenia perpusilla ALLMAN, Mem. Mus. Comp. Zool., V, No. 2, p. 48.

Trophosome.—Hydrocaulus attaining the height of about ¼ inch; stem simple, nonfascicled; pinnæ alternate, each springing from the anterior aspect of an internode in the axil of a strong tooth-like process, which carries on its proximal side a fixed nematophore, just below which another strong fixed nematophore also springs from the internode. Hydrothecæ deep, slightly widening upward; margin with about nine strong and deeply cut teeth, the anterior tooth continued into a narrow keel which runs down the front of the hydrotheca; intrathecal ridge distinct, horizontal, situated at the junction of the lower and middle third of the hydrotheca. Supracalycine nematophores strong, overtopping the hydrotheca; mesial nematophore scarcely reaching the intrathecal ridge, adnate as far as its oblique terminal orifice.

Gonosome.—Not known.

Dredged off the quicksands from a depth of 34 fathoms.

I have not seen this species and have copied Professor Allman's description entire. The distinguishing features are the narrow hydrothecal keel, and the supracalycine nematophores which overtop the hydrothecæ. The processes of the hydrocladium are nearly half as long as the height of the hydrotheca to the bases of the marginal teeth.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENIA MAMMILLATA, new species.

(Plate XXI, figs. 6–10.)

Trophosome.—Colony sparsely branching, attaining a height of 1½ inches, growing in clusters from a creeping rootstalk which is not regularly annulated; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium from a process near its distal end; hydrocladia alternate, divided into regular internodes, each of which has an internal ridge reaching around its cavity behind the intrathecal ridge, and another below the supracalycine nematophores; nodes very distinct. Hydrothecæ deep, closely approximated, with a narrow anterior keel reaching to the margin, which is armed with nine sharply cut teeth; intrathecal ridge evident and oblique, reaching clear around the hydrothecæ; supracalycine nematophores rather small, not overtopping the hydrothecæ; mesial nematophore stout, with its free distal portion divided from the rest by a constriction or partial septum. There is an ordinary cauline nematophore at the lower end of each internode of the stem, and a mammillate perforated process at the base of each hydrocladium.

Gonosome.—Not known.

Distribution.—*Albatross* Station 2623, lat. N. 33° 38′, long. W. 77° 36′; depth, 15 fathoms.

The diagnostic marks of this species are its height, which is very much greater than in any others of the *minuta* group, the narrow hydrothecal keel in connection with the absence of distinct annulations on the rootstalk, and the processes at the bases of the hydrocladia being smaller than in the related species.

Type slides.—Cat. Nos. 18653, 18654, U.S.N.M.; Cat. No. 15361, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENIA MINIMA, new species.

(Plate XXI, figs. 11–13.)

Trophosome.—Colony unbranched, exceedingly delicate in texture, attaining a height of one-fourth inch; stem not fascicled, slender and transparent, divided into regular internodes, each with a bifurcated process bearing the hydrocladium, and another long, slender one some distance below it on the proximal end of the internode; nodes distinct; hydrocladia slender, delicate, divided into slender internodes, each of which has a septal ridge opposite the intrathecal ridge. Hydrothecæ very thin and easily collapsed, deep, anterior profile straight and without a keel; aperture oblique, surrounded by eight sharp teeth; intrathecal ridge evident, more nearly horizontal than

in allied species; supracalycine nematophores small, slightly overtopping the hydrotheca; mesial nematophore small, with the distal portion projecting almost at a right angle to the axis of the hydrotheca; cauline nematophores forming spurs on the front of each internode.

Gonosome.—A single, very short, robust corbula attached below the regular hydrocladia, and composed of four very broad pairs of leaves, each of which bears a row of large nematophores along its distal edge; each leaf is scalloped on its posterior edge, making a series of small perforations between the nematophores. There is a considerable portion of the lower proximal part of each leaf cut away. A single hydrotheca is placed between the gonophore and the stem.

Locality.—Near Little Cat Island, Bahamas, shallow water; State University of Iowa Expedition.

This is the smallest and most delicate species of the genus. The entire absence of a hydrothecal keel, together with the very short and stout corbula, will serve as diagnostic characters.

Type slides.—Cat. No. 18655, U.S.N.M.; Cat. No. 15362, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENIA PERFORATA Allman.

(Plate XXI, figs. 14, 15.)

Aglaophenia perforata ALLMAN, Journ. Linn. Soc., Zool., XIX, p. 150, pl. XXI.

Trophosome.[1]—Stem simple, monosyphonic, springing at intervals from a creeping stolon * * * (not exceeding one-fourth of an inch in height). Hydrothecæ wide, margin with about five teeth on either side, and a single mesial tooth in front. Intrathecal ridge strong, transverse, situated at the junction of the middle and posterior third of the hydrotheca; mesial nematophore adnate to about the posterior third of the hydrotheca, and then terminating in a short free process which is separated from the adnate portion by an imperfect septum; lateral nematophores scarcely overtopping the hydrotheca.

Gonosome.—Corbula closed, deep and rather short, with about nine pairs of costæ; sutures of costæ with a wide aperture between every two denticles; peduncles short, carrying a single hydrotheca.

Locality.—St. Vincent Island.

The specimen was found creeping over a piece of gulf weed.

This species is evidently near *A. minima*, from which it differs, according to Professor Allman's figure, in being obconical in shape, the top being much wider than the bottom, and in having more leaves to the corbula, the leaves not having their proximal and basal portions largely cut away. It can be told from any others of the *minima* group by the absence of any hydrothecal keel. Professor Allman does not state whether it has the peculiar nematophores or processes at the bases of the hydrocladia which characterize the rest of the group.

AGLAOPHENIA SIMPLEX (d'Orbigny).

(Plate XXII, fig. 1.)

Plumularia simplex D'ORBIGNY, Voyage dans l'Amérique Méridionale, 1839–46, V, p. 27, pl. XIII, figs. 1, 2.
Aglaophenia simplex KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, 1872, Pt. 1, pl. I, fig. 1.

Never having seen this species, nor an adequate description, I copy the original description verbatim:

P. surculis simplicibus, alternatis pinnatis; cellulis simplicibus; apertura denticulata.

Cette espèce, fixe sur des *Sargassum*, présente seulement de petites branches pennées simples, qui partent de la racine rampante. Chaque branche se forme de petits rameaux alternes courts; ces rameaux sont seulement articulés, de distance en distance, par un étranglement. Chaque segment a sa cellule portée sur une expansion anguleuse, saillante en pointe. La cellule est simple, globuleuse, entourée de six dents anguleuses, dont deux se trouvent de chaque côté.

The figure of this species which I copy does not agree very closely with either the original description nor the figure given by d'Orbigny. Kirchenpauer's figure, however, seems to be based on authentic specimens, and is a much more detailed representation of the species.

[1] Original description quoted from Allman.

AGLAOPHENIA (?) SAVIGNYANA Kirchenpauer.

(Plate XXIV, fig. 4.)

Aglaophenia savignyana KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, 1872, Pt. 1, p. 44.
Aglaophenia savignyana MARKTANNER-TURNERETSCHER, Hydroiden des k. k. naturhist. Hofmus., 1890, p. 267, pl. VI, fig. 13.

Trophosome.—Colony irregularly branched, branches and branchlets sparse, attaining a height of 2 or 3 inches; stem fascicled; internodes indistinct, each bearing a hydrocladium on a process from near its distal end; hydrocladia short, divided into regular internodes, each of which has two delicate septal ridges, one opposite the base of the hydrotheca and another under the supracalycine nematophore, the latter sometimes scarcely discernible. Hydrothecæ cup shaped, with the aperture vertical, margin with a conspicuous lateral tooth on each side; supracalycine nematophores tubular, overtopping the hydrotheca; mesial nematophore long, tubular, attaining the level of the marginal teeth and having two apertures; cauline nematophores one above and one below the base of each hydrocladium on the branches, and arranged nearly in a row on the stem.

Gonosome.—Not known.

Distribution.—Adriatic Sea and Red Sea (Kirchenpauer); Hayti (Marktanner-Turneretscher).

I have not seen this species, and the above description is compiled from those of Kirchenpauer and Marktanner-Turneretscher, together with the figure given by the former. It is almost certain that the species is not an *Aglaophenia* in the sense used in this work, but in the absence of the gonosome it is probably best to leave it where it is.

AGLAOPHENIA ALLMANI Nutting.

(Plate XXII, figs. 2, 3.)

Aglaophenia ramosa ALLMAN,[1] Mem. Mus. Comp. Zool., V, No. 2, 1877, p. 39, pl. XXIII.

Trophosome.—Colony branched, the branches breaking up into ramuli, which may again divide, attaining a height of about 6 inches; stem fascicled; hydrocladia borne on the front of main stem above the origin of the branches, and throughout the length of the latter; each internode bears a hydrotheca and shows a very strong internal ridge or septum extending clear around the cavity of the internode on a level with the intrathecal ridge of the hydrotheca. Hydrothecæ deep for this genus; margin with seven strong even teeth; the aperture inclined a little forward; intrathecal ridge pronounced, extending obliquely forward and upward, dividing the lower one-fourth from the remainder of the hydrotheca; supracalycine nematophores strong, almost cylindrical, reaching considerably above the margin of the hydrotheca; mesial nematophore adnate to the front of the hydrotheca, and reaching the level of the marginal teeth; there is a small perforated prominence at the base of each hydrocladium, and two large triangular cauline nematophores near the base of each hydrocladium.

Gonosome.—Not known.

Distribution.—Florida Reef, 2 to 3 fathoms (Allman); *Albatross* Station 2142, lat. N. 9° 30′, long. W. 76° 20′; 42 fathoms.

The general facies of the trophosome, together with the shape of the cauline nematophores, strongly suggest that this species will ultimately find a place in the genus *Lytocarpus*. It seems to be rare, as only one specimen was obtained in the great number of hauls made by the *Albatross*.

AGLAOPHENIA ROBUSTA Fewkes.

Aglaophenia robusta FEWKES, Bull. Mus. Comp. Zool., VIII, No. 7, 1881, p. 132.

This species has a very large, thick, fascicled hydrosome, which is branching, and gives rise to alternate pinnæ. Hydrothecæ with very large teeth on the margin. Mesial nematophore large, adnate, almost as long as the hydrotheca is deep. Supracalycine nematophores rising slightly above the rim of the hydrotheca. Color of hydrosome bright yellow and brown.

[1] The name *Aglaophenia ramosa* was used by Busk in his account of the Zoophytes of the *Rattlesnake*, and repeated by Kirchenpauer in 1876.

Gonosome.—Unknown.

Montserrat, 88 fathoms.

The above is the original description copied verbatim. No figure is given, and the type was not sent with the rest of Doctor Fewkes's specimens from the Museum of Comparative Zoology.

The description is inadequate, especially in the absence of a figure, and the species is of doubtful validity.

The type is presumably in the Museum of Comparative Zoology.

AGLAOPHENIA RATHBUNI, new species.

(Plate XXII, figs. 4–6.)

Trophosome.—Colony unbranched, attaining a height of three-fourths inch; stem not fascicled, divided into numerous short internodes by oblique nodes; hydrocladia alternate, closely approximated, borne on the front of the stem and projecting nearly at right angles with the stem; divided into short internodes, each of which has a strong septal ridge opposite the intrathecal ridge extending almost around the internode, another shorter one just beneath the supracalycine nematophores, another short but evident one between the two already described, and still another below the intrathecal ridge. Hydrothecæ robust, closely approximated, set at a strong angle with the hydrocladia, as if tilted forward, the distal half being free; anterior profile with a double curve; aperture wide, oblique; margin with an anterior projecting bifid spine, and eight or ten irregular teeth giving a jagged appearance; intrathecal ridge strong, very oblique, reaching entirely around the hydrotheca; supracalycine nematophores not reaching the top of the hydrotheca; mesial nematophore prominent, projecting forward and upward, free for about one-third its length; a mammillate perforated process at the base of each hydrocladium.

Gonosome.—Corbula long, curved, with seven or more pairs of broad leaflets, each of which has a row of nematophores along its distal edge, and a very prominent, heavy spine projecting forward and outward from its base; this spine has a strong spur projecting upward and forward from its upper side. There is a single hydrotheca between the corbula and the stem.

Distribution.—Caravellas, Brazil, 1876; Richard Rathbun.

This is an exceedingly well marked species. The corbulæ are borne on hydrocladia which alternate regularly with the ordinary hydrocladia, and are directed laterally, giving a beautiful example of the homology of the corbula with the hydrocladium.

Type slides.—Cat. Nos. 18657, 18658, U.S.N.M.; Cat. Nos. 15364, 15365, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENIA LATIROSTRIS, new species.

(Plate XXII, figs. 7–9.)

Trophosome.—Colony unbranched, attaining a height of about 2 inches; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium; hydrocladia lying in the same plane, alternate, closely approximated, and projecting at right angles from the stem; hydrocladial internodes distinct, each with a septal ridge behind the intrathecal ridge. Hydrothecæ closely approximated, obconical, margin expanded, and surrounded by eleven very irregular jagged teeth, the anterior one being retrorse, the next directed forward, the remaining four on each side being in two pairs of sharply pointed teeth; intrathecal ridge evident, oblique, reaching nearly around the hydrotheca; lateral nematophores rather small for this group, not reaching the top of hydrotheca; mesial nematophore very large, adnate to the front of the hydrotheca nearly to the top, and then projecting forward into an expanded spout-like distal extremity which often reaches a considerable distance in front of and above the hydrotheca.

Gonosome.—Corbula closed, composed of about eight pairs of moderately narrow leaves, each of which bears a row of nematophores on its distal edge, and another on its inner proximal edge, as in *A. strathionides.*[1] There is an aperture between the bases of adjacent leaves, and no prominent spur at the bases. There are two hydrothecæ between the corbula and the stem.

[1] Only the row on the outer distal edge can be readily seen without dissection.

Distribution.—Brazil, Richard Rathbun. This form may at once be recognized by its very large, spout-like mesial nematophores.

Type slides.—Cat. No. 18659, U.S.N.M.; Cat. No. 15366, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENIA STRUTHIONIDES (Murray).

(Plate XXII, figs. 10-12.)

Plumularia struthionides MURRAY, Ann. and Mag. Nat. Hist., 3d ser., V, 1860, p. 251, pl. XII, fig. 2.
Aglaophenia franciscana ALEXANDER AGASSIZ,[1] N. A. Acalephæ, 1865, p. 140.
Aglaophenia arborea VERRILL, Report of Commissioner of Fish and Fisheries, 1871–72, p. 730.
Aglaophenia franciscana KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, 1876, Pt. 2, p. 24.
Aglaophenia struthionides MARKTANNER-TURNERETSCHER, Die Hydroiden des k. k. naturhist. Hofmuseums, 1890, p. 265.

Trophosome.—Colony unbranched, attaining a height of about 4 inches in an incomplete specimen; stem not fascicled, divided by oblique nodes into short internodes, each of which bears a hydrocladium on its antero-lateral surface; hydrocladia directed forward and upward, closely approximated, divided by oblique nodes into short internodes which are usually less than twice as long as wide. Hydrothecæ closely approximated, obconical in general outline, margin flaring and armed with eleven teeth, the anterior being long, sharp, and directed upward and backward, the next long and directed forward, the next rounded and bent outward, the next rounded and directed upward, and the last, posterior, between the supracalycine nematophores. There is considerable variation in the marginal teeth, but this seems to be the typical arrangement. Intrathecal ridge low, strong, directed forward, and curved slightly upward; upper one-third of the hydrotheca free from the hydrocladium; supracalycine nematophores large, not overtopping the hydrotheca; mesial nematophore large, its distal portion not separated widely from the front of the hydrotheca, and when complete reaching the level of the margin of the latter; there is a large triangular cauline nematophore at the base of each hydrocladium that resembles those found in the genus *Lytocarpus*.

Gonosome.—Corbulæ on hydrocladia which take the place and position of regular hydrocladia, and bear three hydrothecæ on the proximal portion; corbula closed, with eight to thirteen pairs of narrow leaves with a row of nematophores on the distal edge of each, but where the leaves are slightly separated above it is seen that each edge of each leaf is armed with nematophores. There are thus really two rows to each leaf, one of which is ordinarily concealed under the edge of the preceding leaf. There is no pronounced process at the base of each leaf.

Distribution.—Santa Cruz; collected by Anderson. (Yale Museum specimen.) San Diego, California; Edward Palmer. San Francisco, California; Alexander Agassiz. Puget Sound; Doctor Steindachner.

Professor Verrill[2] described a specimen in the Boston Society collection which he considered to be the type specimen of *Plumularia arborea* Desor. This specimen he has kindly permitted me to study, and it proves to be *Aglaophenia* (*Plumularia*) *struthionides* Murray. It seems that further consideration caused Professor Verrill to doubt that the specimen was Desor's type after all. Through the kindness of Miss Slack, the librarian of Museum of Comparative Zoology, at Cambridge, I have received a copy of Desor's original description of *Plumularia arborea*, from which it is seen that the Boston Society specimen can not be Desor's type.[3] Through uncertainty concerning the labels, it is thought by Professor Verrill that the locality given for the specimen in question is incorrect, and the validity of the label is further weakened by the fact that this species has so far been found only on the Pacific coast.

[1] Doctor Agassiz here regards *Plumularia franciscana* Trask as synonymous with *P. struthionides* Murray. A comparison of the original descriptions furnishes good grounds for regarding this as an error.

[2] Invertebrate Animals of Vineyard Sound, 1872, p. 730.

[3] My reason for deciding that the Boston Society specimen can not be Desor's *P. arborea* is found in the following sentence from his original description, Proceedings of the Boston Society of Natural History, III, p. 65: "Cells pyriform *with a plain margin*," etc. The italics are my own. The specimen has the margin of the hydrotheca very strongly dentate, the teeth being unusually jagged and conspicuous.

AGLAOPHENIA RAMULOSA Kirchenpauer.

(Plate XXIII, fig. 1.)

Aglaophenia ramulosa KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, 1872, Pt. 1, p. 41, pl. I, fig. 18.
Aglaophenia ramulosa FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 127.
Aglaophenia ramulosa BALE, Catalogue Australian Hydroid Zoophytes, 1884, p. 171, pl. XVIII, fig. 11.

Trophosome.—Colony attaining a height of 1½ inches, branching in a pinnate manner; branches scattered, short, divergent; hydrocladia divided into rather short internodes, each with a septal ridge opposite the intrathecal ridge. Hydrothecæ approximated, short, margin not flaring, two anterior teeth much longer than the others, of which there are two on each side. There is a thick, strong anterior intrathecal ridge; supracalycine nematophores long, tubular, reaching above the hydrothecal margin; mesial nematophore very long, tubular, curving upward, separated but slightly from the front of the hydrotheca, and extending a considerable distance above its top.

Gonosome.—Not known.

Distribution.—Port Lincoln, Australia (Kirchenpauer); Barbados, 76 and 94 fathoms; Montserrat, 88 fathoms (Fewkes).

The above description is taken partly from Kirchenpauer, partly from Bale, and partly from the figures given by these authors. I have not seen the species, and it is doubtful whether it belongs to this genus or not. In the absence of the gonosome, however, it is here retained in *Aglaophenia*.

AGLAOPHENIA OCTOCARPA, new species.

(Plate XXIII, figs. 2–5.)

Trophosome.—Colony unbranched, attaining a height of 2 inches; stem not fascicled, divided into short internodes, each of which bears a hydrocladium on its antero-lateral surface; hydrocladia closely approximated, directed laterally, divided into short internodes with septal ridges back of the intrathecal ridge and immediately below the supracalycine nematophores. Hydrothecæ small (only a little more than half as large as *A. struthionides*), obconical, margin expanded, terminal one-third of the hydrotheca free from the internode; marginal teeth eleven, uneven, the anterior one long and retrorse, the next long and projected forward, the remainder smaller, varying greatly in shape, being either rounded or sharp pointed; supracalycine nematophores small, reaching to the level of the top of the hydrotheca; mesial nematophore prominent, adnate to front of hydrotheca for about three-fourths the height of the latter, and then pointing forward and upward, the distal end being distant from the hydrotheca, although it hardly reaches the level of its top; distal end not expanded; three cauline nematophores to each internode of the stem.

Gonosome.—Corbulæ rather small and stout, composed of about eight pairs of broad leaves, each of which bears a row of nematophores along its distal edge and a short process at its base. There is a single hydrotheca between the corbula and the stem.

Distribution.—Cape St. Lucas, Gulf of California; John Xantus.

This species looks like a miniature *A. arborea*, from which it differs in the direction of the hydrocladia, size of hydrothecæ, and especially in the gonosome.

Type slides.—Cat. No. 18662, U.S.N.M.; Cat. No. 15369, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENIA GRACILLIMA Fewkes.

(Plate XXIII, figs. 6–8.)

Aglaophenia gracillima FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 131.

Trophosome.[1]—Colony unbranched or sparsely branching, attaining a height of about 3 inches; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium; hydrocladia rather closely approximated, alternate, divided into regular internodes, each of which has its cavity partly divided by about four septal ridges behind the hydrotheca. Hydrothecæ closely

[1] Description and figures from type specimen kindly sent me by Doctor Walter Faxon from the Museum of Comparative Zoology.

approximated, obconic, considerably expanded above, margin with a large horn-like anterior process or tooth, which, when fully developed, is almost as long as the hydrotheca and recurved at its distal portion. Above the base of the process there is a retrorse tooth, and there are four marginal teeth on each side; intrathecal ridge low at its origin, doubly curved, reaching around the hydrotheca to a level with the base of the anterior process; supracalycine nematophores tubular, reaching the level of the top of the hydrotheca; mesial nematophore rather short and spur-like, free portion tubular, its end not reaching the level of the middle of the hydrotheca; cauline nematophores inconspicuous.

Gonosome.—Corbulæ very long and slender, composed of about twenty pairs of leaves, each of which has an expanded truncated process pointing forward and outward, arising from above the base of the leaf; a row of nematophores is situated on the top of the process and distal edge of the leaf. There are three hydrothecæ between the corbula and the stem.

Distribution.—Off Martinique, 96 fathoms, *Blake* collection.

This very striking form reminds one of species found in the Pacific in the shape of the hydrothecæ, and especially in the shape and arrangement of the marginal teeth. The anterior process is exceedingly variable in size. The corbula is very slender, but of firm texture and a dark horn color. It resembles the "*arborea* group" in having more than one hydrotheca on its pedicel.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENIA PATAGONICA (d'Orbigny.)

Plumularia patagonica D'ORBIGNY, Voyage dans l'Amérique Méridionale, 1839–46, V, p. 27, pl. XIII, figs. 3–6.
Aglaophenia patagonica KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, Pt. 1, p. 26.

I have been unable to find any description of this species but the original, which is herewith given.

P. surculis ramosis, flexuosis; ramis alternis pinnatis; cellulis complicatis; vesiculis elongatis, compressis, transversim obliquè cristatis.

Habitat.—The shores of Patagonia.

Cette jolie espèce forme des branches longues, terminées par un grand nombre de rameaux arqués penniformes. Chaque rameau porte des ramules alternes assez étendus. Les ramules sont divisés en segmens nombreux, trois par cellules, dont la partie supérieure est terminée en pointe extérieure. Les cellules sont composées d'un support latéral de chaque côté qui en occupe toute la longueur, d'un autre support inférieur terminé en pointe tronquée. Les bords ont deux expansions latérales, et en dessus quatre sinus et trois pointes. Les vésicules sont allongées, comprimées, dentées obliquement et latéralement.

AGLAOPHENIA (?) CRENATA Fewkes.

(Plate XXIII, figs. 9, 10.)

Aglaophenia crenata FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 132.

Trophosome.[1]—Colony in fragmentary specimen unbranched and attaining a height of about 2 inches; stem fascicled in proximal portion and not fascicled distally, divided into internodes, each of which bears a hydrocladium; hydrocladia not closely approximated, borne on opposite sides of the stem, and divided into regular internodes, each of which has about five septal ridges behind the hydrotheca and three on the anterior side below the hydrotheca. Hydrothecæ rather deep, cylindrical, anterior profile nearly straight, margin armed with ten or twelve regular, minute teeth or sinuations; intrathecal ridge not evident; supracalycine nematophores small, distally contracted, reaching the level of the top of the hydrotheca; mesial nematophore short, tubular, with its distal end free and its margin crenulated; cauline nematophores with distal portion contracted, two to four on the front of each internode of the stem, and one behind the axil of each hydrocladium.

Gonosome.—Not known.

Distribution.—*Blake* Station 308, lat. N. 41° 25′, long. W. 65° 35′; depth, 1,242 fathoms.

This species is almost certainly not an *Aglaophenia*, and in all probability is a *Cladocarpus* or

[1] Description of Doctor Fewkes's type specimen.

Aglaophenopsis. It is apparently very close to *Cladocarpus speciosus* Verrill, from which it differs chiefly in not having the two anterior marginal teeth more conspicuous than the others, and in having a more cylindrical hydrotheca.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENIA BICORNUTA, new species.

(Plate XXIV, figs. 5–8.)

Trophosome.—Colony sparingly branched, attaining a height of about 3 inches; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium on a process from the middle portion of its antero-lateral face; hydrocladia rather distant, alternate, and divided into regular internodes without septal ridges. Hydrothecæ rather deep, anterior profile slightly concave, margin not greatly everted, and armed with nine prominent, sharp-pointed teeth; intrathecal ridge very low, evident, oblique; supracalycine nematophores small, distinctly geniculated, and slightly overtopping the hydrotheca; mesial nematophore double, consisting of two slender tubes placed side by side like the barrels of a shotgun, and pointing forward and a little downward, the free portion being about as long as the hydrotheca is wide; the two tubes are separate and somewhat divergent at their distal ends; cauline nematophores rather large, one on each side of the base of each hydrocladium, and a mammillate one on the base of each hydrocladium.

Gonosome.—Not known.

Distribution.—Off Habana, Cuba, 150 to 250 fathoms, State University of Iowa expedition.

In the absence of the gonosome this species is only provisionally referred to *Aglaophenia.* The "double-barreled" mesial nematophore is a unique feature in this genus, the only approach to it being the double mesial nematophore of *Aglaophenopsis hirsuta*, which, however, is entirely separate from the hydrotheca and very short, with crenate apertures.

Type slides.—Cat. No. 18664, U.S.N.M.; Cat. No. 15370, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENIA (?) CONSTRICTA Allman.

(Plate XXIV, figs. 1–3.)

Aglaophenia constricta ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 47, pl. XXIX.

Trophosome.—Stem attaining a height of about 8 inches, thick, fascicled, springing from an entangled mass of wiry filaments, and sending off numerous, irregularly disposed, simple branches, which carry alternately disposed pinnæ (hydrocladia); three pinnæ springing from each internode. Hydrothecæ with the distal half expanded and separated from the proximal part by a deep constriction; margin with four broad teeth. Supracalycine nematophores slightly overtopping the margin of the hydrotheca; mesial nematophore nearly equaling in length the height of the hydrotheca, to which it is almost entirely adnate; cauline nematophores, two on the axil of each pinna and one immediately below the pinna in front.[1]

Gonosome.—Not known.

Distribution.—Off Conch Reef, from a depth of 30 fathoms.

Although this species almost certainly belongs to another genus, it is here included in the genus *Aglaophenia* on sufferance, as it were, until the gonosome is discovered.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENIA TRIFIDA Agassiz.

Aglaophenia cristata MCCRADY, Gymn. of Charleston Harbor, 1857, p. 100.
Aglaophenia trifida LOUIS AGASSIZ, Cont. Nat. Hist. U. S., 1862, IV, p. 358.
Aglaophenia trifida ALEXANDER AGASSIZ, N. A. Acaleph., 1865, p. 140.
Aglaophenia trifida KIRCHENPAUER, Ueber die Hydroidenfam. Plumularidæ, 1872, Pt. 1, p. 26.

Trophosome.—Colony branched, attaining a height of 5 to 7 inches; stem not fascicled, divided into regular short internodes, each of which bears a hydrocladium on its middle portion; hydro-

[1] Original description quoted exactly.

cladia divided into regular short internodes, each of which is divided back of the intrathecal ridge of the hydrotheca by an internal ridge. Hydrothecæ stout, closely approximated, expanded above, with the anterior profile doubly curved, margin with nine strong subequal teeth, intrathecal ridge strongly developed and projecting straight forward and upward; supracalycine nematophores stout, rather geniculate, slightly overtopping the hydrotheca; mesial nematophore strong, reaching to about the middle of the hydrotheca, anterior profile regularly convex, the nematophore being adnate to the hydrotheca almost to the end of the former, where there is a broad terminal aperture; cauline nematophores, three to each internode of the stem, one being just below the proximal hydrotheca of each hydrocladium and two being on the front of the internode.

Gonosome.—Corbulæ rather long and slender, with 12 to 14 pairs of corbula leaves, each of which bears a row of nematophores along its distal edge and a slightly larger one at its base.

Distribution.—Found thrown up on the beach at Sullivan's Island, Charleston Harbor. (McCrady.)

I was unable to secure either specimens or figures of this species before the plates for this work were printed. Among some material recently sent me for identification by Prof. H. L. Osborn, of Hamline University, I found specimens that appear without a reasonable doubt to belong to this species. The locality from which the specimens were taken was not given, but Professor Osborn thinks they were from Beaufort, North Carolina.

This species is very closely allied to *Aglaophenia pluma* of the British coast, but a direct comparison with specimens from Plymouth, England, shows that the American species has hydrothecæ with a less concave profile above the mesial nematophore and a much longer and more slender corbula.

AGLAOPHENIA TRICUSPIS McCrady.

Aglaophenia tricuspis McCrady, Gymn. Charleston Harbor, 1857, p. 101.
Aglaophenia tricuspis Louis Agassiz, Cont. Nat. Hist. U. S., 1862, IV, p. 358.
Aglaophenia tricuspis Alexander Agassiz, N. A. Acaleph., 1865, p. 140.
Aglaophenia tricuspis Kirchenpauer, Ueber die Hydroidenfam. Plumularidæ, 1872, Pt. 1, p. 27.

This species grows in solitary plumes, much taller than those of *A. pelasgica* and shorter than those of *A. cristata*. The plumes also are of broader expanse than in the latter species and the individual polyp cells are quite different. The three cusps, which are placed as in the species mentioned, are proportionately long and slender, or, which is the same thing, the polyp cell between them is quite shallow, and its rim, instead of appearing distinct from the single cusp behind it, appears to be united with it as with the others. I have also been unable to distinguish any denticulations on the rim, and these are quite conspicuous in the other two species.

The prolific vesicles of this species are as yet unknown. This species was found growing just below dead low-water mark, on the submerged rocks of one of the upper jetties of Sullivan's Island. It was taken in midsummer.[1]

THECOCARPUS, new genus.

Trophosome.—Stem fascicled, usually with the component tubes diverted from their course at intervals to form somewhat flattened protuberances. Hydrothecæ with one or two large anterior teeth, the remainder being small or reduced to minute sinuations; mesial nematophores one or two, less than half the height of the hydrotheca; intrathecal ridge inconspicuous.

Gonosome.—Corbula composed of widely separated leaves, each bearing a hydrotheca near its base and a row of nematophores on its distal portion. There are usually three or more hydrothecæ between the corbula and the stem.

In looking over the very large series of American Aglaopheniæ several were found that differed from all the others and agreed among themselves in the possession of the characters given above. *Aglaophenia myriophyllum* may be taken as a type of this genus, and in it would also be included *Aglaophenia radicellata* Sars.

Allman, in the *Challenger* Report[2] placed these species in the genus *Lytocarpus*, and did not

[1] Original description. I have been unable to find either specimens or later descriptions of this species.
[2] *Challenger* Report, Hydroida, Pt. 1, pp. 12, 40.

regard the gonosome as a true corbula. Bale took exception to this, wisely I think, and included these species in the genus *Aglaophenia*, regarding their gonosomes as true corbulæ. While agreeing fully with the latter author, the present writer considers that the presence of hydrothecæ on the corbula leaves is a good generic distinction, upon which, in connection with the stem character and certain features of the hydrothecæ named above, he has ventured to establish the new genus *Thecocarpus*, which would equal a part of the subgenus *Lytocarpia* Kirchenpauer, part of the genus *Lytocarpus* of Allman, or a part of the genus *Aglaophenia* as defined by Bale.[1]

KEY TO AMERICAN SPECIES OF THE GENUS THECOCARPUS.

2 mesial nematophores	Hydrothecæ separated by more than half their height, narrowed below. *T. bispinosus.*
	Hydrothecæ separated by more than half their height, not appreciably narrowed below. *T. benedicti.*
1 mesial nematophore	Hydrothecæ separated by more than half their height, narrow below. *T. distans.*
	Hydrothecæ closely approximated, no conspicuous internal thickening of internode behind hydrotheca. *T. normani.*
	Hydrothecæ closely approximated, thickenings of internodes evident. *T. myriophyllum.*

Distribution of American species of the genus Thecocarpus.

Species.	Geographical. Atlantic.			Bathymetrical.				
	Charleston and northward.	South of Charleston and West Indies.	European coasts.	1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	Over 200 fathoms.
T. myriophyllum	+		+	+	+			
T. distans		+						+
T. normani		+						+
T. bispinosus		+					+	
T. benedicti		+						+

THECOCARPUS MYRIOPHYLLUM (Linnæus).

(Plate XXIV, figs. 12, 13.)

Sertularia myriophyllum LINNÆUS, Syst. Nat., 1767, p. 1309.
Sertularia myriophyllum PALLAS, Elenchus Zooph., 1766, p. 153.
Aglaophenia myriophyllum LAMOUROUX, Polyp. Cor. flex., 1816, p. 168.
Plumularia myriophyllum LAMARCK, Anim. sans Vert., 1836, 2d ed., II, p. 159.
Plumularia myriophyllum JOHNSTON, Brit. Zooph., 1847, p. 99.
Plumularia myriophyllum LANDSBOROUGH, Pop. Hist. Brit. Zool., 1852, p. 152.
Aglaophenia myriophyllum LOUIS AGASSIZ, Cont. Nat. Hist. U. S., 1862, IV, p. 358.
Aglaophenia myriophyllum HINCKS, Brit. Hydroid Zooph., 1868, p. 290.
Aglaophenia myriophyllum KIRCHENPAUER, Hydroidenfam. Plumulariдæ, 1872, Pt. 1, p. 28.
Lytocarpus myriophyllum ALLMAN, *Challenger* Report, Plumulariдæ, 1883, p. 40.
Lytocarpus myriophyllum PENNINGTON, Brit. Zoophytes, 1885, p. 130.
Lytocarpus myriophyllum MARKTANNER-TURNERETSCHER, Die Hydroiden des k. k. naturhist. Hofmuseums, 1890, p. 277

Trophosome.—Colony unbranched, or sparingly branched, attaining a height of 18 inches; stem fascicled, with flattened protuberances formed by the contortion of the component tubes; hydrocladia alternate, close set, divided into regular internodes, each of which bears a hydrotheca. Hydrothecæ stout, cylindrical, with a median anterior tooth, and lateral sinuations; there are well-marked internal ridges on the side of the internode nearest the hydrotheca, and the intrathecal ridge is more evident than usual in this genus; supracalycine nematophores small, slightly overtopping the hydrotheca; mesial nematophore adnate to the front of the hydrotheca, and attaining the level of the intrathecal ridge; numerous small or rudimentary cauline nematophores on the tubes composing the stem.

[1] Genera of the Plumulariidæ, pp. 12, 14.

Gonosome.—Corbula open, composed of numerous narrow, widely separated leaves, each bearing a hydrotheca near its base and a row of nematophores along its distal end. There are several hydrothecæ between the corbula and the stem.

Distribution.—Coasts of Europe and Great Britain, 12 to 40 fathoms; New England coast (Hincks).

The only mention I can find of the occurrence of this species in American waters is by Hincks,[1] who under "Habitat" says: "Massachusetts Bay (Agassiz), Mingan Islands, Gulf of St. Lawrence (*teste* A. Agassiz)." I have been unable to verify this reference.

Immense specimens referred to this species occur in the Bay of Naples, where they are found branching in a straggling manner, and attaining a height of 3 feet.

THECOCARPUS DISTANS (Allman).

(Plate XXIV, figs. 14–16.)

Aglaophenia distans ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 44, pl. XXVI.

Trophosome.—Hydrocaulus attaining a height of about 4 inches, simple, rooted by an entangled bunch of tubular filaments, fascicled below, becoming nonfascicled above, and here divided into equal internodes, each of which carries a pinna on alternate sides; pinnæ (hydrocladia) distant, attaining the length of nearly an inch. Hydrothecæ deep, nearly cylindrical above, narrowed below; margin crenate, with a single long tooth-like process in front; intrathecal ridge not conspicuous. Supracalycine nematophores not overtopping the hydrotheca; mesial nematophore attaining about a third of the height of the hydrotheca, to which it is adnate for its entire length.

Gonosome.—Corbulæ composed of numerous pairs of ribs, which are quite free from one another, each carrying a small hydrotheca near its origin, and having numerous tooth-like nematophores along its distal edge; peduncle of corbula rather long, carrying three hydrothecæ.

Dredged off Pacific Reef from a depth of 283 fathoms.

The above description is quoted entire from the original. Professor Allman does not state that this species presents the peculiar thickened protuberances on the outer stem found in all the other species that I have placed in this genus. It is interesting to note that the describer distinctly says that the corbulæ "like the corbulæ of other species are metamorphosed pinnæ," although he afterwards, in the *Challenger* Report, places this species in the genus *Lytocarpus*, in which the gonangia are protected by true phylactogonia, which seem to me to be quite distinct from corbulæ.

Types.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

THECOCARPUS NORMANI,[2] new species.

(Plate XXV, figs. 1, 2.)

Trophosome.—Colony sparsely branched, attaining a height of 8 inches, fascicled, with the component tubes diverted from their course at intervals to form flattened protuberances; hydrocladia alternate, about 1½ inches long and divided into regular hydrothecate internodes. Hydrothecæ close set, robust, cylindrical, not appreciably diminishing below; a single somewhat retrorse anterior tooth and a number of minute lateral sinuations around the margin; intrathecal ridge inconspicuous; supracalycine nematophores rather smaller than in other species of the genus, not reaching above the hydrothecal margin; mesial nematophore single, adnate to the hydrotheca, reaching the level of the intrathecal ridge.

Gonosome.—Corbulæ composed of numerous separated pairs of narrow leaves, each bearing a hydrotheca near its base, and a row of nematophores along its distal portion. There are six or seven hydrothecæ between each corbula and the stem, those nearest the corbula being modified by the suppression of their mesial nematophores, the one immediately preceding the corbula being without any nematophore, its distal end free and elevated above the internode.

Distribution.—*Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′, 440 fathoms.

This species bears about the same relation to *T. distans* that *T. benedicti* does to *T. bispinosus*.

[1] British Zoophytes, 1868, p. 292.

[2] In honor of the Reverend Canon A. M. Norman, F. R. Z. S., a veteran worker in the field of marine zoology and to whom the science is greatly indebted.

It differs from *distans* in the more robust and closely approximated hydrothecæ, and in the number and form of the hydrothecæ between the corbula and the stem.

Type slides.—Cat. Nos. 18666, 18667, U.S.N.M.; Cat. No. 15373, Mus. State Univ. Iowa; also in the collection of the author.

THECOCARPUS BENEDICTI, new species.

(Plate XXV, figs. 3–5.)

Trophosome.—Hydrocaulus a sparsely branched fascicled stem, attaining a height of 12 to 15 inches; stem compressed, with knotty protuberances of contorted tubes on the portion which does not bear hydrocladia; hydrocladia arising from the front of the stem, alternate, long and straight (not sinuous as in *A. distans*); divided regularly into internodes, each of which bears a hydrotheca. Hydrothecæ large, stout, closely approximated for this group, with a single anterior spine and several lateral shallow teeth or sinuations on the margin; intrathecal ridge slight, dividing the lower third from the upper two-thirds of the hydrotheca; supracalycine nematophores broad, reaching to the level of the top of the hydrotheca; there are two mesial nematophores, one adnate to the front of the hydrotheca, and attaining the level of the intrathecal ridge, the other considerably shorter, forming a spur at the base of the first.

Gonosome.—Corbulæ very large, borne on pinnæ springing from the front of the stem, directed forward, and bearing about five somewhat modified hydrothecæ between the corbula and the stem; corbula leaves entirely open, narrow, and widely separated, each bearing a modified hydrotheca a little above its base, directed antero-laterally and with small supracalycine nematophores; the distal portion of each leaf curved and bearing a row of nematophores on its distal edge. Gonangia oval, borne at the bases of the leaves. These corbulæ are the largest known to me, being sometimes over half an inch long, composed of 25 or 30 pairs of leaves.

Distribution.—*Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′, 440 fathoms; Station 2666, lat. N. 30° 47′, long. W. 79° 49′, 270 fathoms; Station 2668, lat. N. 30° 58′, long. W. 79° 38′, 294 fathoms; Station 2671, lat. N. 31° 20′, long. W. 79° 22′, 280 fathoms; Station 2672, lat. N. 31° 31′, long. W. 79° 05′, 277 fathoms.

This elegant species is very near *A. bispinosus* Allman, from which it may be distinguished by its more robust and much more closely approximated hydrothecæ, with less pronounced marginal teeth. Named in honor of my friend, Dr. James E. Benedict, of the U. S. National Museum.

Type slides.—Cat. Nos. 18668, 18669, U.S.N.M.; Cat. No. 15374, Mus. State Univ. Iowa; also in the collection of the author.

THECOCARPUS BISPINOSUS Allman.

(Plate XXV, figs. 6–8.)

Aglaophenia bispinosa ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 46, pls. XXVII, XXVIII.

Trophosome.—Stem attaining a height of 8 inches, stout, simple, rising from an entangled mass of branching tubular filaments, fascicled below, and presenting from distance to distance knot-like projections; pinnæ (hydrocladia) alternate, attaining a length of nearly an inch and a half. Hydrothecæ deep, widening upward; margin with a single, strong, tooth like process in front, and with short, blunt teeth in the rest of its extent; intrathecal ridge not conspicuous. Supracalycine nematophores stout, not overtopping the hydrotheca; mesial nematophores two in number, the distal one adnate to the hydrotheca, along which it extends for about one-third of the height of the hydrotheca, the proximal one forming a short, stout, spine-like process just below the distal.

Gonosome.—Corbulæ open, formed by two alternate or subopposite series of free, rib-like processes, each of which carries near its base a small, hydrothecal cup, and along its dista. margin a series of numerous tooth-like nematophores; the rachis of the corbula continued toward the common stem as a long peduncle carrying about five unchanged hydrothecæ.

Distribution.—Off Alligator Reef, Florida, 156 fathoms; off Tennessee Reef, Florida, 200 fathoms.

I have not seen this species and the above description is copied entire from the original.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

CLADOCARPUS Allman (modified).

Cladocarpus ALLMAN, Trans. Zool. Soc. Lond., 1874, VIII, Pt. 8, p. 477; Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 49.

Gonosome.—Stem simple or fascicled; hydrothecæ deep, with margins usually smooth, or with sinuations or crenulations laterally, and one or two distinct anterior teeth; mesial nematophores very short, spur-like, sometimes not adnate to the hydrotheca.

Gonosome.—Gonangia borne on the stem or bases of the hydrocladia, and protected by simple or branched phylactogonia, springing from the proximal internode of the hydrocladium, and bearing nematophores, but no hydrothecæ.

This is one of the many well-defined genera introduced by Professor Allman. The type species was secured by the *Porcupine*. Three more species were added in the Hydroida of the Gulf Stream, several in the *Challenger* Report, and others by Verrill, Clarke, and Fewkes, while five new species are included in the present work. Most, if not all, the species are found in comparatively deep water, which may account for the genus not being discovered earlier than it was.

In the trophosome, *Cladocarpus* resembles *Thecocarpus* more than any other group, especially in the shape and margins of the hydrothecæ, while, on the other hand, its gonosome allies it to *Aglaophenopsis*, from which it differs in having no hydrothecæ on the phylactogonia.

Distribution of American species of the genus Cladocarpus.

Species.	Geographical. Atlantic.				Bathymetrical.					
	Charleston and northward.	South of Charleston and West Indies.	South Atlantic.	Coasts of Europe.	1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.	Over 500 fathoms.
C. sigma	+					+		+	+	
C. compressus		+						+		
C. speciosus	+							+		
C. ventricosus		+					+			
C. flexilis	+	+				+	+	+		
C. obliquus		+						+		
C. septatus	+					+	+	+	+	
C. dolichotheca	+	+						+	+	
C. flexuosus		+								+
C. tenuis		+						+		
C. grandis		+							+	
C. paradisea		+						+	+	
C. pourtalesii	+						+	+	+	
C. carinatus		+							+	

It will be seen that only three of the fourteen species have been found at a depth less than 50 fathoms and none under 20 fathoms, while one, *C. flexuosus*, was dredged from a depth of nearly 1,000 fathoms.

With the exception of *C. formosus* Allman, from the Japan Sea, no species of this genus has been found except in the North Atlantic, so far as I can ascertain, and the center of distribution is evidently the West Indian region.

As would be expected from its bathymetrical distribution, this essentially deep-water genus is more largely represented in northern waters than most of the Plumularian genera.

KEY TO AMERICAN SPECIES OF THE GENUS CLADOCARPUS.

Hydrothecal margin distinctly toothed all around; anterior teeth not decidedly the largest.	Hydrothecæ with conspicuous sigmoid intrathecal ridge	*C. sigma.*
	Hydrotheca without conspicuous intrathecal ridge	*C. compressus.*
A single conspicuous anterior tooth. Lateral teeth replaced by minute sinuations. Hydrocladia not conspicuously slender or sinuous.	Hydrothecæ with deep anterior flexure	*C. ventricosus.*
	Anterior profile nearly straight	*C. flexilis.*
	Anterior profile strongly convex	*C. obliquus.*
	Anterior profile concave above and convex below	*C. septatus.*

Hydrothecæ distant and very slender. Hydrocladia strongly sinuous.	Hydrothecæ almost tubular ..... *C. dolichotheca.*
	Hydrothecæ long, obconic ..... *C. flexuosus.*
	Hydrothecæ with anterior profile strongly concave ..... *C. tenuis.*
Hydrothecæ with two large, shallow anterior teeth.	Upper part of stem flattened, bandlike ..... *C. grandis.*
	Upper part of stem not strongly flattened, no lateral marginal teeth ..... *C. paradisea.*
	Shallow lateral marginal teeth ..... *C. speciosus.*
Hydrothecæ without teeth	Aperture of hydrothecæ directed upward ..... *C. pourtalesii.*
	Aperture of hydrothecæ directed forward ..... *C. carinatus.*

CLADOCARPUS SIGMA (Allman).

(Plate XXVI, figs. 1, 2.)

Aglaophenia sigma ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 45, pl. XXVI.

Trophosome.—Colony profusely and repeatedly branching, attaining a height of nearly 2 feet; stem fascicled except at the extreme tips of the branches; hydrocladia alternate, rather closely set, having their origin from the front of the stem; internodes straight, each having its axial cavity divided by about ten very strong and conspicuous septal ridges, which appear to extend entirely around the internal surface of the internode. Hydrothecæ rather closely approximated for this group, deep, cylindrical, with margins very slightly flaring, and armed with about ten shallow, rounded teeth of nearly the same size; intrathecal ridge conspicuous, with a sigmoid flexure in lateral view, the course being forward, bending gracefully upward, and then forward, downward, and forward again; supracalycine nematophores cylindrical, reaching the margin of the hydrotheca; mesial nematophore small, spurlike, adnate except at the distal end; cauline nematophores as usual in this genus.

Gonosome.[1]—Gonangia borne on phylactogonia, springing from the proximal internode of the hydrocladia, ovate, with a lunate, latero-terminal orifice. Each phylactogonium bears two or three gonangia, and several nematophorous branchlets which loosely embrace the gonangia.

Distribution.—Off Alligator Reef, Florida, 110 fathoms; *Albatross* Station 2416, lat. N. 31° 26′, long. W. 79° 07′, 276 fathoms; *Albatross* Station 2667, lat. N. 30° 53′, long. W. 79° 43′, 273 fathoms; *Albatross* Station 2668, lat. N. 30° 58′, long. W. 79° 39′, 294 fathoms; *Albatross* Station 2669, lat. N. 31° 09′, long. W. 79° 34′, 352 fathoms; *Albatross* Station 2608, lat. N. 34° 26′, long. W. 76° 12′, 22 fathoms; off Sand Key, Florida, 116 fathoms; State University of Iowa expedition.

This species was originally described by Professor Allman from an imperfect specimen without gonosome. Specimens dredged by the Bahama expedition from the State University of Iowa are among the most graceful and largest plumularians known. One in particular reaches a height of nearly two feet, and has a dense cluster of gracefully disposed branches, forming an exceedingly handsome colony.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

CLADOCARPUS COMPRESSUS Fewkes.

(Plate XXVI, figs. 3-5.)

Cladocarpus compressus FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 135.

Trophosome.[2]—Colony unbranched, attaining a height of about 8 inches; stem not fascicled and without distinct nodes; hydrocladia rather closely approximated, divided into regular internodes, each of which has its cavity partly divided by two strong septal ridges back of the hydrotheca, and a very slight one under the supracalycine nematophores. Hydrotheca deep, with its lower portion suddenly constricted by a prolongation inward of the septal ridge, forming a very broad and short intrathecal ridge; margin armed with nine large, conspicuous, rounded teeth; anterior profile nearly straight; supracalycine nematophores small, reaching the top of the hydrotheca; mesial nematophore short and spurlike, the distal end free; a cauline nematophore on each side of the base of each hydrocladium, and another between these; there is a row of denticulate nematophores along the front of the stem below the hydrocladia.

Gonosome.—Gonangia oblong, obovate, with obliquely truncated ends or apertures, borne in great numbers along the front of the stem, and protected by three-pronged phylactogonia.

Locality.—Off St. Vincent; *Blake* Station 224; depth, 114 fathoms.

[1] Hitherto undescribed.

[2] Description of Doctor Fewkes's type specimen from the Museum of Comparative Zoology at Cambridge.

C. compressus has the most conspicuous and even marginal teeth of any species of the genus that I have seen.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

CLADOCARPUS VENTRICOSUS Allman.

(Plate XXVI, figs. 6–8.)

Cladocarpus ventricosus ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 52, pl. XXXI.

Trophosome.—Stem attaining a height of about an inch and a half, not fascicled, simple; pinnæ alternate, each springing from a rather long lateral process of the stem, somewhat waved. Hydrothecæ distant; front wall with a depression just below the margin, then greatly inflated; margin with a long, strong tooth in front, and with shallow crenations in the rest of its extent; intrathecal ridge strong, transverse, springing from a projection of the posterior wall of the hydrotheca near its fundus, and reaching a point about midway between this and the anterior wall. Supracalycine nematophores scarcely overtopping the hydrotheca; mesial nematophore quite detached from the hydrotheca.

Gonosome.—Phylactogonia springing from the proximal internodes of a certain number of the pinnæ, which are situated near the distal end of the stem, twice bifurcating; gonangia springing from the stem in groups, each group close to the axil of a pinna, obovate, with the summit curved over the termino-lateral orifice.

Dredged off Sand Key from a depth of 100 fathoms.

I have not seen this species, and have therefore quoted the original description entire.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

CLADOCARPUS FLEXILIS Verrill.

(Plate XXVI, figs. 9–12.)

Cladocarpus flexilis VERRILL, Report of Commissioner of Fish and Fisheries, 1883, p. 517, pl. IX, fig. 29.

Trophosome.—Colony long, slender, sparsely branching, attaining a height of about 9 inches; stem not fascicled; hydrocladia rather distant, slightly sinuous, divided into rather slender internodes, each of which has a number (seven or eight) septal ridges back of the hydrotheca. Hydrothecæ deep, tubular, anterior profile nearly straight; margin not expanded, with a single strong anterior tooth, and four or five minute lateral sinuations; intrathecal ridge hardly evident; supracalycine nematophores tubular, small, overtopping the hydrotheca; mesial nematophore short, separated from the hydrotheca; two cauline nematophores at the base of each hydrocladium, and one on the front of each internode of the stem.

Gonosome.—Gonangia numerous, borne on the front of the stem and bases of the hydrocladia, oblong-ovate, with a lunate latero-terminal orifice; phylactogonia like stag's horns, with three branches, inserted on the proximal internode of each hydrocladium.

Distribution.—*Fish Hawk* Station 865, Lat. N. 40° 05′, long. W. 70° 23′; depth, 65 fathoms; *Fish Hawk* Station 866, lat. N. 40° 05′, long. W. 70° 22′; depth, 65 fathoms; *Fish Hawk* Station 867, lat. N. 40° 06′, long. W. 70° 22′; depth, 64 fathoms; *Fish Hawk* Station 940, lat. N. 39° 54′, long. W. 69° 52′; depth, 134 fathoms; *Fish Hawk* Station 950, lat. N. 40° 07′, long. W. 70° 32′; depth, 71 fathoms; *Fish Hawk* Station 1027, lat. N. 40° 00′, long. W. 69° 19′; depth, 93 fathoms; *Fish Hawk* Station 1109, lat. N. 40° 03′, long. W. 70° 38′; depth, 89 fathoms; *Albatross* Station 2005, lat. N. 37° 18′, long. W. 74° 28′; depth, 82 fathoms; *Albatross* Station 2012, lat. N. 36° 41′, long. W. 74° 40′; depth, 66½ fathoms; *Albatross* Station 2085, lat. N. 40° 05′, long. W. 70° 35′; depth, 70 fathoms; *Albatross* Station 2264, lat. N. 37° 08′, long. W. 74° 34′; depth, 167 fathoms; *Albatross* Station 2265, lat. N. 37° 08′, long. W. 74° 36′; depth, 70 fathoms; *Albatross* Station 2387, lat. N. 29° 24′, long. W. 88° 04′; depth, 32 fathoms; *Albatross* Station 2388, lat. N. 29° 25′, long. W. 88° 01′; depth, 35 fathoms; *Albatross* Station 2389, lat. N. 29° 28′, long. W. 87° 56′; depth, 27 fathoms.

Professor Verrill informs me that *Cladocarpus flexilis* is the most common species taken by the Fish Commission off Vineyard Sound in the warm zone (80 to 150 fathoms).

The hydrothecæ vary considerably in size in different specimens, but their shape remains constant and will easily distinguish this species.

Type.—In the museum of Yale University.

CLADOCARPUS OBLIQUUS, new species.

(Plate XXVII, figs. 1-3.)

Trophosome.—Colony loosely branching, a plumose stem, attaining a height of about 7 inches; stem not fascicled, bearing hydrocladia only on its distal portion; hydrocladia straight, alternate, divided into regular internodes, each of which has several (about eight) internal septal ridges. Hydrothecæ closely approximated, ovate, with a regularly convex anterior profile, wider at the center than at the top; margin with a single median tooth, and about four minute lateral sinuations on each side; intrathecal ridge short, straight, very oblique; supracalycine nematophores small, tubular, overtopping the hydrotheca; mesial nematophore short, free from the hydrotheca; cauline nematophores at the bases of the hydrocladia and on the front of the stem.

Gonosome.—Gonangia oblong-ovate, with latero-terminal orifice, borne in pairs on the bases of the hydrocladia; phylactogonia like stag's horns, with two or three branches, arching over the front of the stem.

Distribution.—Dredged off Habana, 200 fathoms; State University of Iowa Expedition; U. S. Fish Commission (label lost), from Professor Verrill.

This species is more robust than its allies and differs from all of them in the regularly convex anterior profile of the hydrothecæ.

Type slides.—Cat. No. 15378, Mus. State Univ. Iowa; Cat. No. 18676, U.S.N.M.; also in the collection of the author.

CLADOCARPUS SEPTATUS, new species.

(Plate XXVII, figs. 4-8.)

Trophosome.—Colony branched in a loose manner, attaining a height of about 8 inches; stem not fascicled, divided into obscure internodes; hydrocladia rather closely approximated, divided into slender, flexuous internodes, each of which has about ten imperfect septal ridges back of the hydrothecæ, and also on the portion between adjacent hydrothecæ. Hydrothecæ gibbous, with a ventricose swelling, giving a double curve to the anterior profile; margin with an anterior prominent tooth, and three or four smaller lateral teeth on each side; intrathecal ridge strong, rather short, with its distal end curved abruptly upward; supracalycine nematophores rather large, swollen at the middle, and overtopping the hydrothecæ; mesial nematophore small, slender, free from the hydrotheca, hardly reaching the level of the bottom of the latter; two cauline nematophores at the base of each hydrocladium, and one on the front of each internode of the stem.

Gonosome.—Gonangia oblong ovate, with latero-terminal orifices, borne in pairs at the bases of the hydrocladia. The young gonangia are triangular in outline; phylactogonia like a stag's horn, with three to five branches; those from opposite sides of the stem do not bend over toward each other so far as is usual in this group.

Distribution.—*Albatross* Station 2263, lat. N. 37° 08′, long. W. 74° 33′; depth, 430 fathoms; *Albatross* Station 2265, lat. N. 37° 08′, long. W. 74° 36′; depth, 70 fathoms; *Albatross* Station 2269, lat. N. 35° 13′, long. W. 75° 05′; depth, 48 fathoms; *Albatross* Station 2310, lat. N. 35° 44′, long. W. 74° 51′; depth, 132 fathoms; *Albatross* Station 2422, lat. N. 37° 09′, long. W. 74° 34′; depth, 85 fathoms.

C. septatus is more branched and longer than most of the members of this genus which are nearest to it. The gibbous appearance of the hydrothecæ seems to be a very constant feature.

Type slides.—Cat. No. 18677, U.S.N.M.; Cat. No. 15379, Mus. State Univ. Iowa; also in the collection of the author.

CLADOCARPUS DOLICHOTHECA Allman.

(Plate XXVII, figs. 9, 10.)

Cladocarpus dolichotheca ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 50, pl. xxx.

Trophosome.—Colony unbranched, attaining a height of 2½ inches; stem not fascicled, with several very oblique constrictions just below the proximal hydrocladia; internodes rather long and slender, nodes hardly distinguishable; the hydrothecate portion of stem flexuous or slightly genicu-

late; hydrocladia distant, slender, divided into very long internodes which are bent forward above the top of each hydrotheca, and then reassume the general direction of the hydrocladium; internodes divided by numerous septal ridges, which appear to surround the axial cavity. Hydrothecæ distant, long and deep, cylindrical, with the margin slightly expanded, with a single median anterior tooth, and five or six small lateral teeth on each side; supracalycine nematophores long and tubular, overtopping the hydrotheca; mesial nematophore short, curved, slender, free for nearly its entire length, and with the side toward the hydrotheca open; a cauline nematophore in the axil of each hydrocladium, and another near the middle of each internode of the stem; below the hydrocladiate portion the stem is armed with a row of regularly disposed nematophores along its anterior surface.

Gonosome.—Gonangia borne singly on the stem near the axils of the hydrocladia; oblong-ovate, with a lunate latero-terminal orifice; phylactogonia shaped like stag's horns, with three nematophorous branches arching over the gonangia.

Distribution.—Off Pacific Reef, Florida; depth, 283 fathoms; *Albatross* Station 2601, lat. N. 34° 39′, long. W. 75° 33′; depth, 107 fathoms.

C. dolichotheca is one of the smallest species of the genus, and differs from most of the others in having a nonfascicled stem. In all of the specimens thus far found the bare portion of the stem is very long as compared with the part bearing the hydrocladia.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

CLADOCARPUS FLEXUOSUS, new species.

(Plate XXVII, figs. 11–13.)

Trophosome.—Colony (in incomplete specimen) unbranched, attaining a height of 3 inches; stem not fascicled; hydrocladia alternate, very long and slender, sinuous; internodes very long and slender, sinuous, with a few septal ridges opposite the hydrotheca and at the ends. Hydrothecæ distant, very large, long and slender, shaped like lengthened cones, the anterior profile being almost straight; margin with a strong anterior median tooth, and a number of small lateral sinuations; intrathecal ridge not evident; supracalycine nematophores slender, tubular, overtopping the hydrotheca; mesial nematophore short, slender, free, barely reaching the level of the bottom of the hydrotheca.

Gonosome.—Not known.

Distribution.—*Albatross* Station 2384, lat. N. 28° 45′, long. W. 88° 16′; depth, 940 fathoms.

This very graceful and striking form reminds one most of *C. dolichotheca* Allman, from which it differs in having the hydrothecæ shaped like lengthened cones instead of being nearly tubular. It differs from *C. tenuis* Clarke in having the anterior profile of the hydrotheca straight instead of concave. The single specimen secured by the *Albatross* came up from a depth of 940 fathoms, one of the deepest hauls which have produced Plumularians.

Type slides.—Cat. No. 18679, U.S.N.M.; Cat. No. 15381, Mus. State Univ. Iowa; also in the collection of the author.

CLADOCARPUS TENUIS Clarke.

(Plate XXVIII, figs. 1, 2.)

Cladocarpus tenuis CLARKE, Bull. Mus. Comp. Zool., 1877, V, No. 2, p. 247, pl. v.

Trophosome.—Hydrocaulus attaining a height of an inch and a half, very delicate, pale straw-color, the lower portion bearing a row of nematophores, the upper portion giving rise to branches arranged alternately, and with three or four very oblique internodes just below the branched portion; the branches or pinnæ undivided. Hydrothecæ deep, slender, tubular, smallest in the center and tapering both ways, largest at the distal end, a crenate rim and a large rectangular or obtusely pointed median tooth; each hydrotheca overarched by the portion of the pinna which intervenes between it and the next. Supracalycine nematophores prominent, extending above the edge of the hydrotheca; mesial nematophore of about the same size of the supracalycine, and attached to the enlarged portion of the pinna just below the hydrotheca. The pinnæ are ornamented with a great number of internal chitinous ridges.

Gonosome.—Unknown.

Locality.—Lat. 25° 33′ N., long. 84° 21′ W.; depth, 101 fathoms.

This appears to be a species carrying the slenderness of the hydrothecæ to the extreme limit found among the Plumularidæ. I have not seen this form, and therefore quote the original description entire.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

CLADOCARPUS GRANDIS, new species.

(Plate XXVIII, figs. 3–5.)

Trophosome.—Colony somewhat sparsely branched, attaining a height of 25 inches, each plume having a "spread" of about 4 inches; stem fascicled, greatly compressed laterally, so as to form a band-like structure, especially in the distal portion, the tubes being placed one directly behind the other in antero-posterior rows, so that in a cross section of the stem there will be eight or nine rows of tubes from the front to the back, and only three counting from side to side; the anterior tube bears the hydrocladia; hydrocladia alternate, stout, attaining a length of 2 inches, straight, composed of regular rather stout internodes, which have only one poorly marked septal ridge opposite the equally insignificant intrathecal ridge. Hydrothecæ closely approximated, very large, short and thick, widening toward the top; anterior profile somewhat sinuous; margin smooth with the exception of two blunt teeth, widely separated, forming a lip like that of a pitcher; intrathecal ridge hardly apparent; supracalycine nematophores short, with an expanded upper posterior corner which attains a level somewhat higher than that of the hydrotheca; margin finely crenulated; mesial nematophore short and stout, adnate to the front of the hydrotheca; cauline nematophores in close-set rows along the tubes of the stem, regularly spaced, so that the entire stem is armed with both longitudinal rows and transverse bands of nematophores.

Gonosome.—Gonangia borne on phylactogonia, ovate, with round terminal apertures; phylactogonia borne on the proximal internodes of hydrocladia, straight, divided into regular internodes, each of which bears a straight, short branchlet, with a gonangium in its axil and two or three short, stout nematophores. There are usually three or four, sometimes five or six, of these alternate branchlets.

Distribution.—*Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′; depth, 440 fathoms; *Albatross* Station 266[illegible], lat. N. 29° 16′, long. W. 79° 36′; depth, 438 fathoms; *Albatross* Station 2662, lat. N. 29° 24′, long. W. 79° 43′; depth, 434 fathoms; *Albatross* Station 2666, lat. N. 30° 48′, long. W. 79° 49′; depth, 270 fathoms; *Albatross* Station 2667, lat. N. 30° 53′, long. W. 79° 43′; depth, 273 fathoms; *Albatross* Station 2669, lat. N. 31° 9′, long. W. 79° 34′; depth, 352 fathoms.

This magnificent species is the largest *Cladocarpus* yet discovered. The great length of the pinnæ gives it a particularly striking appearance. The band like structure of the greater part of the stem and branches will at once distinguish the species from *C. paradisea*, its nearest relative.

Type slides.—Cat. Nos. 18680, 18681, U. S. N. M.; Cat. Nos. 15382, 15383, Mus. State Univ. Iowa; also in the collection of the author.

CLADOCARPUS PARADISEA Allman.

(Plate XXVIII, figs. 6, 7.)

Cladocarpus paradisea ALLMAN, Mem. Mus. Comp. Zool., V, No. 2, p. 53, pls. XXXII, XXXIII.

Trophosome.—Colony branched, attaining a height of 16 inches; stem fascicled, except the distal portion, where it is regularly divided into internodes, each of which bears a hydrocladium on a process from near its distal end; hydrocladia rather distant, long, and directed laterally, composed of rather slender internodes, each of which has about five slight septal ridges just behind the hydrotheca. Hydrothecæ not closely approximated, large, deep, cylindrical, with a slight bulging in the middle, and two broad and shallow teeth on the anterior part of the margin, which is otherwise plain; intrathecal ridge indistinct, appearing as a thin wavy horizontal line dividing the hydrotheca near its middle; supracalycine nematophores very broad, scarcely overtopping the hydrotheca and with a constriction on the posterior side; mesial nematophore small,

spur-like, with the orifice directed upward and toward the hydrotheca; about two large cauline nematophores to each stem joint.

Gonosome.—Gonangia borne on special appendages springing from the proximal hydrocladial internode; appendages straight, divided into internodes, each of which bears a nematophorous branchlet in the axil of which grows a gonangium. There may be as many as a dozen gonangia borne on a single phylactogonium.

Distribution.—Tennessee Reef, Florida, 174 fathoms, *Blake*; *Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′, 440 fathoms; *Albatross* Station 2416, lat. N. 31° 26′, long. W. 79° 7′, 276 fathoms; *Albatross* Station 2661, lat. N. 29° 16′, long. W. 79° 36′, 438 fathoms; *Albatross* Station 2662, lat. N. 29° 24′, long. W. 79° 43′, 434 fathoms; *Albatross* Station 2663, lat. N. 29° 39′, long. W. 79° 49′, 421 fathoms; *Albatross* Station 2666, lat. N. 30° 47′, long. W. 79° 49′, 270 fathoms; *Albatross* Station 2667, lat. N. 30° 53′, long. W. 79° 42′, 273 fathoms; *Albatross* Station 2669, lat. N. 31° 09′, long. W. 79° 33′, 352 fathoms; *Albatross* Station 2672, lat. N. 31° 31′, long. W. 79° 05′, 277 fathoms. State University of Iowa Expedition, off Sand Key, 100 to 250 fathoms.

This is the most abundant plumularian in rather deep water off the Florida coast.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

CLADOCARPUS SPECIOSUS Verrill.

(Plate XXVIII, figs. 8–11.)

Cladocarpus speciosus VERRILL, Am. Journ. Sci. and Arts, April, 1879, XVII, p. 311.

Trophosome.—Colony (in fragmentary specimen) unbranched, attaining a height of about three-fourths of an inch; stem fascicled, the distal portion, however, is simple and divided into regular rather long internodes, each of which has a strong internal septal ridge near each end, and bears a hydrocladium on a strong process from near its middle portion; hydrocladia rather distant, divided into regular internodes, each of which has its cavity ornamented by several (about seven) septal ridges, five of which are behind the hydrotheca, and two in the adnate portion of the mesial nematophore. Hydrothecæ stout, regularly widening from base to margin; anterior profile nearly straight, margin with two rounded anterior teeth and four or five shallow teeth or sinuations on each side; intrathecal ridge low, straight, horizontal; supracalycine nematophores with distal portion narrowed; margins crenulated, reaching to the top of the hydrotheca; mesial nematophore spur-like, with the distal end entirely free from the hydrotheca; proximal end adnate and partly divided by two septal ridges; margin crenulated; cauline nematophores, four to each internode, one large one in front at the proximal end of the internode and three somewhat smaller ones at the base of the hydrocladium.

Gonosome.—Gonangia not known; phylactogonia branched, arising from the side of the proximal hydrotheca, and not morphologically a modified mesial nematophore, the latter being present as shown in the plate.

Distribution.—Banquereau, off Sable Island, Nova Scotia; depth, 200 fathoms.

This species was described but not figured by Professor Verrill in 1879. Among the U. S. Fish Commission specimens sent me from Yale by Professor Verrill I find the type of *C. speciosus* from which the above description and the figures were obtained. The species evidently belongs to the *paradisea* group with two prominent anterior teeth. It can be told from *C. paradisea* by its much stouter hydrothecæ and from *C. grandis* by its lateral marginal teeth and distally contracted supracalycine nematophores and the free distal ends of the mesial nematophores.

Type.—In the museum of Yale University.

CLADOCARPUS POURTALESII Verrill.

(Plate XXIX, figs. 1, 2.)

Cladocarpus pourtalesii VERRILL, Am. Jour. Sci. and Arts, April, 1879, XVII, p. 309.

Trophosome.—Colony irregularly branched, attaining a height of about 18 inches; stem fascicled, very thick and heavy in old specimens, the anterior tube alone bearing hydrocladia; hydrocladia closely approximated, alternate, divided into regular short internodes, each of which has three or four short septal ridges, one behind the intrathecal ridge, one under the supracalycine nematophores, one between these two, and often a small inconspicuous one reaching obliquely backward and

downward from the bottom of the hydrotheca. Hydrothecæ closely approximated, rather short for this genus, tubular, gradually increasing in size from below upward; anterior profile above the mesial nematophore almost straight; margin perfectly smooth and level all the way around; intrathecal ridge short, strong, curved sharply upward; supracalycine nematophores stout, overtopping the hydrotheca; mesial nematophore short, spur-like, with the basal part adnate, and the distal part closely approximated to the hydrotheca; a slight internal ridge crosses the nematophore near its middle; cauline nematophores numerous, there being apparently two rows to each of the component tubes of the stem.

Gonosome.—Gonangia oblong-ovate, with lunate subterminal apertures, borne on an unbranched phylactogonium springing from the side of the base of the proximal hydrotheca of the hydrocladium. There are from one to five, usually two, gonangia on each phylactogonium.

Distribution.—Southwest from Cape Sable, Nova Scotia, 300 fathoms (Verrill); *Albatross* Station 2474, lat. N. 44° 28′, long. W. 57° 11′, 133 fathoms; *Albatross* Station 2479, lat. N. 44° 06′, long. W. 57° 17′, 129 fathoms; *Albatross* Station 2666, lat. N. 30° 48′, long. W. 79° 49′, 270 fathoms; *Albatross* Station 2698, lat. N. 45° 07′, long. W. 55° 09′, 90 fathoms.

This species resembles *Aglaophenia integra* G. O. Sars,[1] so far as the shape of the hydrothecæ is concerned, but the figure given by Sars indicates that his species has a row of hydrothecæ on the anterior tube of the stem, and the gonangia are represented as unprotected by phylactogonia.

Type.—In the Museum of Yale University.

CLADOCARPUS CARINATUS, new species.

(Plate XXIX, figs. 3–7.)

Trophosome.—Colony branching in an irregularly alternate manner, flabellate, the branches and branchlets growing at right angles with the stem and branches from which they originate, attaining a height of 10 to 12 inches; stem fascicled, the anterior tube bearing the hydrocladia; hydrocladia alternate, lying in the same plane, rather closely approximated, sinuous, divided into regular internodes, each of which has a very slight double curve corresponding roughly to the sigmoid curve of the hydrotheca, and strong septal ridges, one near each end, three opposite the hydrotheca, and one between the hydrotheca and the mesial nematophore. Hydrothecæ having the form of short tubes bent into a sigmoid outline, with a strong posterior intrathecal ridge dividing the lower third from the upper two-thirds, and an anterior flexure below the strongly everted margin; a thickened anterior ridge ends in a blunt-pointed keel on the middle of the anterior face; aperture smooth, flexed forward so as to open almost directly in front; supracalycine nematophores rather long, tubular, slightly overtopping the hydrotheca, and having a small, round, terminal opening; mesial nematophore widely separated from the hydrotheca, rather short, slightly recurved, and with a constricted terminal aperture; cauline nematophores irregular in size, large ones on the bases of the hydrocladia, and on the proximal end of the front of the stem joints; smaller ones at the distal ends of the stem joints.

Gonosome.—Gonangia simple, very much lengthened, ovate sacs, borne at the bases of the hydrocladia, and protected by stout phylactogonia, each with three short, flattened, almost straight leaf-like branches, armed with a few nematophores along their distal edges. The phylactogonia are so arranged that the two rows on opposite sides of the stems almost completely inclose the gonangia.

Distribution.—*Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′; depth, 440 fathoms; *Albatross* Station 2663, lat. N. 29° 39′, long. W. 79° 49′; depth, 421 fathoms; *Albatross* Station 2667, lat. N. 30° 53′, long W. 79° 43′; depth, 273 fathoms; *Albatross* Station 2668, lat. N. 30° 59′, long. W. 79° 39′; depth, 294 fathoms.

This is perhaps the most curious and aberrant *Cladocarpus* found by the *Albatross*. Indeed, its characters are so strongly marked that one is inclined to doubt that it can properly be placed in that genus at all. In diagnostic features, however, it comes well within the generic definition adopted in this work.

Type slides.—Cat. Nos. 18685, 18686, U.S.N.M.; Cat. Nos. 15388, 15389, Mus. State Univ. Iowa; also in the collection of the author.

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[1] Bidrag til Kundskaben om Norges Hydroider (1873), p. 12, pl. II.

AGLAOPHENOPSIS Fewkes (modified).

Aglaophenopsis FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 132.

Trophosome.—Stem usually fascicled; hydrocladia with numerous internal septal ridges; hydrothecal margin toothed; nematophores with crenulated margins.

Gonosome.—Gonangia protected by special appendages growing from the proximal joint of the hydrocladia, and apparently of the nature of greatly modified mesial nematophores of the proximal hydrothecæ.

As originally defined, this genus was further characterized by the fact that the gonophores are never borne on the hydrocladia, and that the protective appendages are jointed and unbranched. Further discoveries, however, have made it necessary to modify the generic definition in order to accommodate new forms. Bale[1] as usual seizes upon the truly salient character of the group, which is the fact that the protective structure pertaining to the gonosome is an appendage of the hydrocladium in the shape of a greatly modified mesial nematophore.

It must be confessed that the genus as here defined is a rather heterogeneous group, which will probably require further modification. The protective appendage may be simple or branched, with or without hydrothecæ on its distal end. In one species, *A. hirsuta*, the appendage is unbranched, usually without a distally placed hydrotheca, but sometimes with one. In *cornuta* and *verrilli* the appendage is branched, each branch bearing one or more hydrothecæ. In *cornuta* there is a hydrotheca in the axis of each of these secondary branchlets, while in *verrilli* there is a gonangium in the same position. In all of the species that I have examined the hydrocladia are furnished with numerous septal ridges, and the nematophores have crenulated margins.

Distribution of American species of the genus Aglaophenopsis.

Species.	Geographical. North Atlantic.		Bathymetrical.					
	Charleston and northward.	South of Charleston, and West Indies.	1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.	Over 500 fathoms.
A. hirsuta		+					+	
A. cornuta	+					+		
A. verrilli	+							+
A. distans		+					+	

KEY TO AMERICAN SPECIES OF THE GENUS AGLAOPHENOPSIS.

Mesial nematophore double ..... *A. hirsuta.*
Mesial nematophore small, separate from hydrotheca—
  A prominent anterior tooth on margin of hydrotheca ..... *A. distans.*
  Marginal teeth subequal ..... *A. verrilli.*
Mesial nematophore large, a widely expanded keel to hydrotheca ..... *A. cornuta.*

AGLAOPHENOPSIS HIRSUTA Fewkes.

(Plate XXIX, figs. 8-13.)

Aglaophenopsis hirsuta FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 133.

Trophosome.—Colony consisting of one to three main upright branches, which give off alternate hydrocladia-bearing branchlets, which may themselves again divide into hydrocladiate ramuli; height of colony, 8 to 10 inches; stem fascicled, the anterior tube giving off the hydrocladia; hydrocladia sinuous, divided into internodes which are regularly curved, the profile of the posterior side of the internode being convex opposite the hydrotheca; cavity of each internode divided by numerous septal ridges, which occur not only behind the hydrotheca, but in those portions of the internode between the hydrothecæ. Hydrothecæ rather distant, deep, tubular, those on the proximal part of the hydrocladium with their upper third bent slightly forward and free from the

[1] The Genera of the Plumulariidæ, 1886, p. 16.

internode; those on the distal part of the hydrocladium completely adnate to the internode; margin armed with about nine broad but sharp-pointed teeth, of nearly equal size; intrathecal ridge strong, oblique; supracalycine nematophores tubular, with crenulated margins, overtopping the hydrothecæ; mesial nematophore divided into two parts which are widely divergent, their crenulated margins being almost on a line with those of the supracalycine pair; the proximal hydrotheca on the hydrocladia-bearing protective appendage has only one mesial nematophore; cauline nematophores very large, butterfly-shaped, arranged in a row on the front of the stem; opposite the origin of each hydrocladium is a long tubular nematophore, and there is a perforated process at the base of each hydrocladium.

Gonosome.—Gonangia oblong-oval, attached to the front of the stem near the bases of the hydrocladia, and protected by a jointed unbranched appendage springing from the base of the first hydrotheca on the adjacent hydrocladium, and replacing one of the two mesial nematophores of that hydrotheca. This appendage bears a single row of strong tubular nematophores, and sometimes a terminal hydrotheca. The axial cavity of the appendage is divided by numerous internal septal ridges.

Distribution.—*Blake* Station 316, lat. N. 32° 07′, long. W. 78° 37′; depth, 229 fathoms; *Albatross* Station 2415, lat. N. 30° 44′, long. W. 79° 26′; depth, 440 fathoms; *Albatross* Station 2663, lat. N. 29° 39′, long. W. 79° 49′; depth, 421 fathoms; *Albatross* Station 2667, lat. N. 30° 53′, long. W. 79° 43′; depth, 273 fathoms; *Albatross* Station 2668, lat. N. 30° 59′, long. W. 79° 39′; depth, 294 fathoms; *Albatross* Station 2669, lat. N. 31° 09′, long. W. 79° 34′; depth, 352 fathoms.

This is one of the most striking of the many interesting plumularians obtained by the *Blake* and *Albatross*. The double mesial nematophore is quite unique, and the very large cauline nematophores remind one somewhat of those found in some species of *Lytocarpus* (for example, *L. clarkei*). The variation in the degree to which the hydrothecæ are adnate to their internodes is very great. Indeed, one could easily imagine two hydrothecæ, one from the proximal and another from the distal part of the same hydrocladium, to belong to entirely different species.

A comparison with Dr. Fewkes's type from the Museum of Comparative Zoology shows that the *Blake* and *Albatross* specimens are identical. The double nature of the mesial nematophore is only seen in front view, and thus escaped the original describer.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

AGLAOPHENOPSIS (?) DISTANS, new species.

(Plate XXX, figs. 1, 2.)

This species is described from a fragmentary specimen.

Trophosome.—Colony unbranched, attaining a height of about one inch; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium on a stout process from its middle portion; hydrocladia slender, sinuous, divided into regular internodes, each of which has about eight septal ridges behind the hydrotheca, and four or five below it. Hydrothecæ distant, deep, anterior profile with a very slight double curve; margin with a strong anterior tooth, and four or five very shallow lateral teeth or sinuations on each side; intrathecal ridge not evident; supracalycine nematophores small, not reaching above the top of the hydrotheca; mesial nematophore small, spur-like, separate, its distal end not attaining the level of the bottom of the hydrotheca; margin crenulated; two cauline nematophores near the axil of each hydrocladium, and one below it on the anterior aspect of the internode.

Gonosome.—(Immature.) Gonangia subcylindrical, truncate at the distal end, borne on the front of the stem; a short unbranched protective appendage grows from immediately behind the proximal hydrotheca, and this appendage bears several nematophores, and a structure which appears to be a developing hydrotheca.

Distribution.—*Albatross* Station 2669, lat. N. 31° 09′, long. W. 79° 34′; depth, 352 fathoms.

This species may belong to the genus *Cladocarpus*. The gonosome on the single specimen secured was so imperfectly developed that it is impossible to make out its characters with certainty.

Type slides.—Cat. No. 18689, U.S.N.M.; Cat. No. 15392, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENOPSIS VERRILLI, new species.

(Plate XXX, figs. 3–5.)

Trophosome.—Colony fiabellate, consisting of a main stem, giving off lateral branches, and attaining a height of about nine inches; stem fascicled, the anterior tube giving off the hydrocladia; hydrocladia borne on main stem and branches, not very closely approximated, divided into regular internodes, each with a number of small septal ridges behind the hydrotheca, and two at the base of each mesial nematophore. Hydrothecæ rather distant for this group, deep, almost cylindrical; anterior margin nearly straight; intrathecal ridge very small and short; supracalycine nematophores small, margins finely crenulated, not reaching the top of the hydrotheca; mesial nematophore short, spur-like, only slightly adnate to the hydrotheca; margin crenulated; cauline nematophores small, one or two on the front of each internode of the stem, and one in the axil of each hydrocladium.

Gonosome.—Gonangia obovate, borne on protective appendages to the hydrocladia, which spring from immediately behind the bases of the hydrothecæ; each appendage bifurcates shortly above its origin, one branch bearing the gonangium at its base, several nematophores in a row on its proximal portion, and a terminal hydrotheca; the other branch is long and bears a row of unmodified hydrothecæ, with an extra nematophore behind the proximal one.

Distribution.—*Albatross* Station 2106, lat. N. 37° 41′, long. W. 73° 03′; depth, 1,497 fathoms; *Albatross* Station 2573, lat. N. 40° 34′, long. W. 66° 04′; depth, 1,742 fathoms.

My attention was called to this species by Professor Verrill, who suggested that it was probably new, and I take pleasure in naming it in his honor. *A. verrilli* was dredged from the greatest depth at which any plumularian has been obtained. The deepest haul made by the *Challenger* which yielded a plumularian (*Cladocarpus pectiniferus* Allman) was 900 fathoms.

Type slides.—Cat. Nos. 18690, 18691, U.S.N.M.; Cat. Nos. 15393, 15394, Mus. State Univ. Iowa; also in the collection of the author.

AGLAOPHENOPSIS CORNUTA (Verrill).

(Plate XXX, figs. 6–9.)

Cladocarpus cornutus VERRILL, Amer. Journ. Sci. and Arts, 1879, XVII, p. 310.

Trophosome.—Colony branched in a somewhat pinnate manner, the main branches and branchlets again branching pinnately, the whole structure being rigid and flabellate, with all of the branches and branchlets directed at right angles with the branches from which they originate; total height about seven inches; stem fascicled, the hydrocladia being borne on an anterior tube which is easily separable from the rest; hydrocladia alternate, not very closely approximated, forming a right angle with the branches from which they arise; internodes divided internally by about six strong septal ridges, and with a flattened, external, longitudinal ridge behind. Hydrothecæ obconical, rather deep, with a very large, anterior, wing-like keel or projection, which begins immediately above the mesial nematophore and extends far above and beyond the top of the hydrotheca; margin with five small teeth on each side; intrathecal ridge small and oblique; supracalycine nematophores long, tubular, with crenulated apertures, reaching considerably above the top of the hydrotheca; mesial nematophore nearly straight, spur-like, with crenulated margins, reaching to a point about opposite the middle of the hydrotheca; cauline nematophores very large, one just at the base of each hydrocladium, another immediately below this, and a third, long and spur-like, opposite the base of each hydrocladium.

Gonosome.—Gonangia borne on the terminal branchlets, oblong-oval, with lateral terminal apertures; protective appendages unbranched or bifurcated, borne at the side of the proximal hydrotheca on each hydrocladium, having a hydrotheca at its distal end, and two when it is forked. There is an axial cavity divided by numerous strong septal ridges.

Distribution.—Off Sable Island, Nova Scotia, 200 fathoms. (Verrill.) Greenland, specimen from Copenhagen Museum, given me by the Reverend Canon A. M. Norman.

This is an unusually striking and well-marked species. Professor Verrill kindly furnished me with specimens from which the above description and the drawings were made. The flattened

projections behind each hydrocladial internode form a feature that I have not seen elsewhere. The anterior keel far surpasses any other that is found among the American Plumularidæ.

Type.—In the Museum of Yale University.

LYTOCARPUS (Kirchenpauer) Allman[1] (modified).

Lytocarpia (Subgenus) KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidae, 1872, p. 27.
Lytocarpus BALE, The Genera of the Plumulariidæ, 1886, p. 15.
Nematophorus CLARKE, Bull. Mus. Comp. Zool., 1879, V, No. 101, p. 248.
Pleurocarpa FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 136.

Trophosome.—Stem fascicled; hydrothecal margin strongly toothed or sinuous; mesial nematophore usually (always in the American species) with two openings, a prominent perforated process at the base of each hydrocladium, and broad triangular cauline nematophores.

Gonosome.—Gonangia borne on hydrocladia which are modified so as to form protective branchlets, often aggregated into a pseudocorbula, which differs from a real corbula in the fact that its leaves are formed by modified hydrocladia instead of appendages to hydrocladia, as in the genus *Aglaophenia*. The gonangia take the place of hydrothecæ in the species which I have examined, and there is a hydrotheca on the proximal part of each protective branch.

In his admirable discussion of the genera of the Plumularidæ, Bale clearly shows that that portion of the genus *Lytocarpus* as defined by Allman, which is typified by *Aglaophenia myriophyllum* is out of place in *Lytocarpus*, as its gonosome forms a real corbula in the shape of a highly modified hydrocladium. I have been so fortunate as to discover a species closely related to *Nematophorus grandis* Clarke, the gonosome of which has been hitherto unknown, which agrees well with that of Fewkes's genus *Pleurocarpa*, in which the gonosome is a pseudocorbula formed of the proximal part of a branch, with hydrocladia transformed into protective branchlets bearing gonangia. It differs from Doctor Fewkes's description,[2] however, in not having true hydrothecæ on the stem, but having one at the base of each protective branchlet. It is somewhat difficult to determine the true position of these hydrothecæ, and I am inclined to think that we have here no exception to the otherwise invariable rule that there are no cauline hydrothecæ among the Statoplea.

The nematophores on the protective branchlets in *Lytocarpus grandis* are long, tubular, and do not occur on all sides of the branchlet. The latter is divided into regular internodes, the first of which bears a hydrotheca, the second and several succeeding ones bear the mesial and supracalycine nematophores, the place of the hydrotheca being occupied by a gonangium. The distal portion of the branchlet bears a close resemblance to an unbranched phylactogonium of the genus *Cladocarpus*.

The nematophores in this genus are often very large and bear exceedingly large nematocysts, which are capable of inflicting severe pain when brought in contact with the skin. This is the only plumularian, so far as I know, that is capable of sensibly irritating the human skin.

My reason for doing away with the genus *Pleurocarpa* of Fewkes is twofold. In the first place, it is the same as the genus *Nematophorus* of Clarke, which has the precedence. In the second place, it seems evident that the protective branchlets are really altered hydrocladia, as maintained by Fewkes, and thus the structure is inseparable from that found in the genus *Lytocarpus* as defined by Allman. The fact that there are true hydrocladia beyond the pseudocorbula does not at all invalidate this position, as exactly the same thing is found in *Lytocarpus racemiferus* Allman.

In regard to the abandonment of the genus *Nematophorus* of Clarke, that genus was based on the presence of the peculiar perforated protuberances on the bases of the hydrocladia. These structures, however, are found in less prominent form in very many plumularians, indeed in most genera of the Statoplea, and especially in *Lytocarpus*. The genus *Nematophorus* being in my opinion, untenable, its single species, with other closely allied forms, is here referred to the genus *Lytocarpus* which Allman raised to generic rank from the old subgenus *Lytocarpia* of Kirchenpauer.

[1] *Challenger* Report, Hydroida, Pt. 1, 1883, p. 40.

[2] Since the above was written I have been permitted to examine Doctor Fewkes's type of this genus, and find no hydrothecæ on the stem of the pseudocorbula, and one at the base of each protective branchlet.

KEY TO AMERICAN SPECIES OF THE GENUS LYTOCARPUS.

Hydrotheca with deep anterior constriction ..... *L. philippinus.*

Mesial nematophore adnate to the front of the hydrotheca to the top of the latter.
- Anterior profile of mesial nematophore doubly curved ..... *L. ramosus.*
- Anterior profile of mesial nematophore simply convex ..... *L. grandis.*

Mesial nematophore not reaching top of hydrotheca; its distal end free.
- Mesial nematophore rising decidedly above middle of hydrotheca ..... *L. clarkei.*
- Mesial nematophore pointing forward from middle of hydrotheca; free portion very short ..... *L. curtus.*
- Supracalycine nematophores with their distal ends forked ... *L. furcatus.*

Mesial nematophore reaching top of hydrotheca; its distal end free ..... *L. racemiferus.*

Distribution of American species of the genus Lytocarpus.

Species.	Geographical.							Bathymetrical.				
	Atlantic.				Pacific.							
	Charleston and northward.	South of Charleston and West Indies.	South Atlantic.	Coasts of Europe.	Pacific coast north of Panama.	Panama and southward.	Australia.	1 to 20 fathoms.	20 to 50 fathoms.	50 to 100 fathoms.	100 to 200 fathoms.	200 to 500 fathoms.
L. philippinus		+	+	+		+	+	+				
L. ramosus		+								+		
L. grandis		+										+
L. clarkei		+						+	+	+	+	+
L. curtus		+						+				
L. furcatus		+						+				
L. racemiferus			+					+				

LYTOCARPUS PHILIPPINUS (Kirchenpauer).

(Plate XXXI, figs. 4–7.)

Aglaophenia philippina KIRCHENPAUER, Ueber die Hydroidenfamilie Plumularidæ, 1872, Pt. 1, p. 45.
Lytocarpus phillipinus BALE, Proc. Linn. Soc. of New South Wales, 1888, III, 2d ser., p. 786, pl. XXI.
Lytocarpus philippinus MARKTANNER-TURNERETSCHER, Die Hydroiden des k. k. naturhist. Hofmuseums, 1890, p. 271, pl. VI, fig. 16.

Trophosome.—Colony pinnately branched, the branches again divided pinnately into branchlets which bear the hydrocladia, attaining a height of about 8 inches in an incomplete specimen; stem fascicled, as are the branches and branchlets, nearly to their tips, the component tubes being somewhat loosely attached, so that the anterior tube bearing the hydrocladia can be stripped off from the others; a considerable portion of the proximal part of each branch is devoid of hydrocladia; hydrocladia alternate, directed forward and outward, with a septal ridge behind each intrathecal ridge, and another just under the lateral nematophores. Hydrothecæ closely approximated, each with a deep constriction in front, the upper part being flexed forward so that the aperture is nearly vertical; margin with a sharp anterior tooth and a broad lateral lobe on each side; intrathecal ridge extending downward and forward; supracalycine nematophores long, straight, tubular, reaching far above the top of the hydrotheca, and having two apertures; mesial nematophore tubular, not reaching above the level of the top of the hydrotheca, and having two openings; cauline nematophores, two between adjacent hydrocladia, and a perforated process at the base of each hydrocladium.

Gonosome.—Gonangia flattened ovoid, borne on modified hydrocladia, each with a hydrotheca on its proximal end; the next hydrotheca is replaced by a gonangium, and there is usually a second gonangium above the first; the remaining portion of each phylactocarp is straight and armed with nematophores.

Distribution.—Philippine Islands (Kirchenpauer); Queensland, Australia (Bale); Red Sea

(v. Frauenfeld); Mediterranean (Kattegat); Jamaica (specimens from Yale Museum); Panama (specimens from Yale Museum); Bahia, Brazil (Rathbun).

Specimens from Panama and Bahia are not constant in having all the branches directed forward, as described by Bale. They also differ from Australian specimens in having shorter mesial nematophores.

LYTOCARPUS RAMOSUS (Fewkes).

(Plate XXXI, figs. 8–13.)

Pleurocarpa ramosa FEWKES, Bull. Mus. Comp. Zool., 1881, VIII, No. 7, p. 136.

Trophosome.[1]—Colony branching in a subpinnate manner and attaining a height of about 8 inches; stem fascicled almost to the tips of the branches, the anterior tube bearing the hydrocladia; nodes obscure; hydrocladia alternate, rather closely approximated, divided into regular internodes, each of which has a very strong horizontal septal ridge behind the intrathecal ridge. Hydrothecæ closely approximated, rather deep, obconic, aperture nearly horizontal; margin armed with about eight large, broadly rounded teeth; intrathecal ridge strong, oblique, reaching forward toward the mesial nematophore; mesial nematophore considerably overtopping the hydrotheca near the distal end of the hydrocladium, and scarcely rising above the hydrotheca on the proximal portion of the hydrocladium; the anterior profile of the mesial nematophore is sinuous, not strongly convex; supracalycine nematophores tubular, very long on distal part of hydrocladia, and much shorter, scarcely overtopping the hydrothecæ, on the proximal portion; cauline nematophores small for this group, with their free edges trilobate, one on either side of the base of each hydrocladium. There is a rounded perforated process at the base of the hydrocladium.

Gonosome.—A pseudo-corbula formed on the proximal portion of a branch which bears regular hydrocladia on its distal portion, and also occasionally between the pseudo-corbula and the stem. The ribs of the pseudo-corbula bear each a single hydrotheca near its base, and a number of tubular nematophores in sets of three. The ribs are distinctly jointed, one joint bearing two opposite nematophores and the next bearing a median nematophore in regular alternation. The stem of this modified branch bears nematophores, but no hydrothecæ. The gonangia are not present, but are evidently borne on the ribs, as in *L. clarkei*.

Distribution.—*Blake* Station 231, off St. Vincent, 95 fathoms.

It will be seen that this description differs from that of Doctor Fewkes in several particulars, notably in describing the stem as fascicled, the pseudo-corbula ribs as having nematophores on three sides only, and the corbula stem as not bearing hydrothecæ. A careful examination shows that these hydrothecæ are actually borne on the so-called ribs near their bases, although this is difficult to see without dissection. The species is very near *Lytocarpus clarkei*, but differs decidedly in the anterior profile of the mesial nematophore, and especially in having much smaller cauline nematophores than that species.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

LYTOCARPUS GRANDIS (Clarke).

(Plate XXXII, figs. 1–4.)

Nematophorus grandis CLARKE, Bull. Mus. Comp. Zool., 1879, V, No. 10, p. 248, pl. v.

Trophosome.—Colony branching, branches generally alternate, flabellate, attaining a height of 12 inches; stem and branches fascicled, except on their extreme distal portions, the anterior tube giving off the hydrocladia; hydrocladia alternate, divided into regular internodes, each of which has a very strong horizontal internal septum opposite the intrathecal ridge. Hydrothecæ rather closely approximated, robust, slightly constricted above, being ovate in outline; orifice oblique; margin with about five rounded teeth, which have a tendency to curve inward; intrathecal ridge very evident, horizontal and straight, extending clear round the hydrotheca, dividing the lower one-fourth from the upper three-fourths; supracalycine nematophores large, tubular, extending far above the hydrotheca; mesial nematophore adnate throughout, extending decidedly above

[1] Description of Doctor Fewkes's type specimen from the Museum of Comparative Zoology.

the hydrotheca; orifice terminal, and continuing downward on the side facing the hydrotheca; cauline nematophores very large, "variable in form, two on each internode, more or less triangular, rounded, or with one of the upper corners greatly produced, tapering toward the base; the external orifice is very large, extending entirely across the upper margin and into the lateral processes when the latter exist; the opening from the cavity of the nematophore into the stem is also very large, often being equal in size to the internal orifice of the hydrothecæ. At the base of each pinna in a direct line with the hydrothecæ is an oval swollen process, with a small circular orifice on the upper surface near the proximal end; its cavity is distinctly continuous with that of the hydrotheca in front of it, and also with that of the stem."[1]

Gonosome.—Unknown.

Distribution.—*Blake*, lat. N. 24° 08′, long. W. 82° 51′; depth, 339 fathoms.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

LYTOCARPUS CLARKEI, new species.

(Plate XXXII, figs. 5–7.)

Trophosome.—Colony rather profusely branched in an alternate manner, rigid, very dark colored when fresh, attaining a height of 12 to 14 inches; stem fascicled throughout; the branches, branchlets, and hydrocladia springing from the anterior tube only; hydrocladia alternate, divided into regular internodes, each of which has a very strong horizontal septal ridge opposite the intrathecal ridge, and sometimes another inconspicuous oblique ridge opposite the supracalycine nematophores; hydrothecæ rather closely approximated, ovate in outline, the margin usually flaring very slightly; marginal teeth seven in number, rounded, often incurved; intrathecal ridge conspicuous, horizontal, reaching across the hydrotheca; supracalycine nematophores varying in length, usually slightly overtopping the hydrotheca, and sometimes nearly as long as in *L. grandis;* mesial nematophore not attaining the level of the top of the hydrotheca; distal portion free and distinctly separated from the hydrotheca, which has a round opening just above its junction with the mesial nematophore; cauline nematophores very large, two to each internode of the stem, one triangular in outline, and the other with one corner produced into a long, spurlike projection; there is a perforated process on the base of each hydrocladium.

Gonosome.—Gonangia borne on modified hydrocladia, which are aggregated together to form a pseudo-corbula; the distal portion of the branch giving off ordinary alternate hydrocladia.[2]

Distribution.—*Albatross* Station 2162, lat. N. 23° 11′, long. W. 82° 20′; depth, 122 fathoms; *Albatross* Station 2164, lat. N. 23° 11′, long. W. 82° 20′; depth, 192 fathoms; *Albatross* Station 2167, lat. N. 23° 11′, long. W. 82° 21′; depth, 201 fathoms; *Albatross* Station 2169, lat. N. 23° 10′, long. W. 82° 20′; depth, 78 fathoms; *Albatross* Station 2330, lat. N. 23° 11′, long. W. 82° 19′; depth, 121 fathoms; *Albatross* Station 2331, lat. N. 23° 11′, long. W. 82° 20′; depth, 114 fathoms; *Albatross* Station 2334, lat. N. 23° 11′, long. W. 82° 18′; depth, 67 fathoms; *Albatross* Station 2336, lat. N. 23° 11′, long. W. 82° 19′; depth, 157 fathoms; *Albatross* Station 2337, lat. N. 23° 11′, long. 82° 20′; depth, 199 fathoms; *Albatross* Station 2338, lat. 23° 11′, long. W. 82° 20′; depth, 189 fathoms; *Albatross* Station 2365, lat. N. 22° 18′, long. W. 87° 04′; depth, 24 fathoms. State University of Iowa expedition; off Little Cat Island, Bahamas, 13 fathoms.

This species comes very near to *L. grandis*, but it differs constantly in the fact that the mesial nematophore does not attain the level of the top of the hydrotheca, and has its distal end free. Specimens from shallow water, near Little Cat Island, Bahamas, are more rigid than the others, and have the cœnosarc crowded full of black pigment cells of some sort, while others do not show so many of these granular bodies. The *Albatross* specimens from deeper water are not so rigid, and have a straggling, irregular manner of branching. The specimen from Station 2167 is very symmetrical and typical, and is the one having the gonosome. It was taken on May 1, 1884, while most of the other *Albatross* specimens were taken in June, 1885. The specimens from Little Cat Island were dredged in June, 1893, and the gonosome was not present in any of them.

Type slides.—Cat. No. 15400, Mus. State Univ. Iowa; Cat. No. 18698, U.S.N.M.; also in the collection of the author.

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[1] From Doctor Clarke's original description.

[2] For details of this interesting structure see the description of this genus.

LYTOCARPUS CURTUS, new species.

(Plate XXXII, figs. 8–11.)

Trophosome.—Colony irregularly branched, with a tendency to an alternate arrangement of the branches, attaining a height of about 6 inches; stem fascicled, the anterior tube bearing the branchlets or hydrocladia; hydrocladia alternate, more distant than in the preceding species, divided into regular internodes, each of which has a strong horizontal septal ridge opposite the intrathecal ridge, and a much less conspicuous oblique one at the base of the supracalycine nematophores. Hydrothecæ stout, oval, with margins slightly contracted, and seven rather sharp, incurved teeth; intrathecal ridge strong, horizontal; supracalycine nematophores small, just reaching the level of the top of the hindmost marginal tooth; mesial nematophore short, spur-like, with its distal end projecting slightly forward from the middle of the hydrotheca, which has a small round aperture just above its junction with the mesial nematophore; cauline nematophores considerably smaller than in the preceding species, not so definitely triangular in outline, two to each internode of the stem; there is a perforated process at the base of each hydrocladium.

Gonosome.—Not known.

Distribution.—Shallow water between Little Cat Island and Eleuthera, Bahamas; State University of Iowa Expedition.

This species shows the black granules in the cœnosarc, but they are not so numerous as in *L. clarkei*.

Type slides.—Cat. No. 15401, Mus. State Univ. Iowa; Cat. No. 18699, U.S.N.M; also in the collection of the author.

LYTOCARPUS FURCATUS, new species.

(Plate XXXII, figs. 12–15.)

Trophosome.—Colony divided into several large branches, which give off branchlets in a straggling, irregular, pinnate manner, attaining a height of about 11 inches in the largest specimen secured; stem fascicled, the anterior tube giving off the hydrocladia; hydrocladia rather sparse and short, divided into regular internodes, each of which has a strong horizontal septal ridge opposite the intrathecal ridge. Hydrothecæ deep, somewhat gibbous below, slightly flaring immediately below the aperture, which is armed with about nine very sharp, strongly incurved teeth, so strongly curved that their points are directed downward toward the center of the hydrotheca; intrathecal ridge strong, but not reaching entirely around the hydrotheca; supracalycine nematophores forked, with anterior shorter portion reaching the level of the top of the hydrotheca, and the posterior, much longer portion, reaching far above that level; both parts have apertures at their ends; mesial nematophore short, spur-like, distal end free, pointed forward and upward, and reaching a little above the middle of the hydrotheca; cauline nematophores very large, two to each internode of the stem, triangular in outline, and greatly resembling those of *L. grandis*. There is a perforated process on the base of each hydrocladium.

Gonosome.—Not known.

Distribution.—Shallow water, between Little Cat Island and Eleuthera, Bahamas; State University of Iowa Expedition.

The bifurcated supracalycine nematophores of this species are, so far as I know, unique. There is an approach to it in *Halicornaria ascidioides* Bale,[1] in which these nematophores have two, rarely three or four, tubular apertures. The incurved teeth of *L. furcatus* resemble those of another of Bale's species, *Aglaophenia phyllocarpa*.

Type slides.—Cat. No. 15402, Mus. State Univ. Iowa; Cat. No. 18700, U.S.N.M.; also in the collection of the author.

[1] Catalogue of Australian Hydroid Zoophytes, 1884, p. 176, pl. XIII, fig. 2.

LYTOCARPUS RACEMIFERUS Allman.

(Plate XXXI, figs. 1-3.)

Lytocarpus racemiferus ALLMAN, *Challenger* Report, Hydroida, 1883, Pt. 1, p. 41, pl. XIII.

Trophosome.—Colony attaining a height of about 12 inches; stem fascicled, much and irregularly branched, main branches all directed toward one side of the stem; hydrocladia alternate, scarcely exceeding one-tenth of an inch in length. Hydrothecæ rather deep, margin serrated, teeth blunt; intrathecal ridge well marked, situated near the fundus of the hydrotheca; mesial nematophore adnate to the walls of the hydrotheca for nearly their entire height, and then continued as a short, blunt beak, which scarcely overtops the hydrotheca and has both a terminal and a lateral orifice; lateral nematophores slightly overtopping the hydrotheca.

Gonosome.—Phylactocarps in the form of long racemes, laden with gonangia, springing from certain branches of the trophosome at points near the origin of the branches from the stem, and there taking the places of the proximal four or six hydrocladia, consisting of a series of internodes having every internode provided with one median and two lateral spines, each of the proximal five to eight internodes carrying also an ovate pedunculated gonangium.

Dredged off Bahia; depth, 10 to 20 fathoms.

The above description is quoted entire from Allman. His figure shows that the gonangia take the place of hydrothecæ, and are more numerous than in other American species of *Lytocarpus*. The arrangement of the nematophores on the phylactocarp suggests that the latter is merely a hydrocladium, with the hydrothecæ obliterated on the distal portion and replaced by gonangia on the proximal part. It differs, however, from the other species which I have seen in the fact that there is no hydrotheca at the base of each phylactocarp.

Type.—In the South Kensington Museum, London.

HALICORNARIA Busk (modified).

Halicornaria BUSK, Narrative, Voyage of H. M. S. *Rattlesnake*, 1852, I, Appendix.

Trophosome.—Stem not fascicled, no posterior intrathecal ridge; an anterior intrathecal ridge usually present; hydrocladia not branched; hydrocladial internodes without septal ridges.

Gonosome.—Gonangia borne on the stem or on the bases of the hydrocladia, not taking the place of hydrothecæ, and not protected by corbulæ or phylactocarps of any description.

As originally defined, this genus included all plumularians which did not have corbulæ. In 1874 Allman[1] restricted the genus so as to include only "such Plumularidæ as possess the trophosome of *Aglaophenia*, but have their gonangia destitute of corbulæ or other protection." In 1886 Bale[2] suggested that Allman's *Halicornaria ramulifera*, a species with accessory ramuli, should be placed in a distinct genus. So far as I have been able to ascertain, none of the systematists up to the present time have endeavored to find systematic characters in the trophosome by which this genus can be recognized. The above combination of nonfascicled stem, absence of septal ridges in the hydrocladial internodes, and the absence of a posterior intrathecal ridge, seems to be sufficient to constitute good criteria for the genus. As here defined, *Halicornaria* approaches the genus *Nuditheca* of this work, from which it differs in having unbranched hydrocladia and gonangia borne on the stem or near the bases of the hydrocladia. In the only species of *Halicornaria* which has gonangia out on the hydrocladia, the gonangia evidently take the place of hydrothecæ, while in *Nuditheca* they do not. *Halicornaria mitrata* Allman[3] has a fascicled stem, strong septal ridges in the hydrocladia, and a well-marked posterior intrathecal ridge. The gonosome is unknown, and its author regards its place in the genus *Halicornaria* as provisional. By the present arrangement it would be excluded from the genus.

All three of the American species of the genus *Halicornaria* are from the West Indian region, and all are found in comparatively shallow water.

[1] Report on the Hydroida collected during the expeditions of H. M. S. *Porcupine*, Transactions of the Zoological Society, 1874, VIII, p. 476.

[2] The Genera of the Plumulariidæ, 1886, p. 18.

[3] Journal of the Linnæan Society, London, 1885, XIX, p. 153, pl. XX.

KEY TO AMERICAN SPECIES OF THE GENUS HALICORNARIA.

Cauline nematophores not very large { Mesial nematophore not projecting far above margin of hydrotheca. *H. speciosa*
{ Mesial nematophore projecting far above margin of hydrotheca. *H. longicauda*
Cauline nematophores very large and bilobed ..... *H. variabilis*

HALICORNARIA LONGICAUDA, new species.

(Plate XXXIII, figs. 4, 5.)

Trophosome.—Colony unbranched, attaining a height of about 6 inches; stem not fascicled, divided into regular internodes, each of which bears a hydrocladium; hydrocladia closely approximated, alternate, divided into rather short internodes; no septal ridges. Hydrothecæ moderately deep, closely approximated, with their long axes forming a wide angle with the axis of the hydrocladium, and their distal half free; aperture nearly vertical, with two shallow sinuations on each side, and a very strong anterior flexure and intrathecal ridge; supracalycine nematophores stout, triangular in outline, not reaching the level of the top of the hydrotheca; mesial nematophore very long, reaching far beyond the top of the hydrotheca, distal end curved slightly upward; two apertures, one at the end and the other immediately above the top of the hydrotheca; cauline nematophores of moderate size, one on each side of the base of each hydrocladium.

Gonosome.—Not known.

Distribution.—*Albatross* Station 2147, lat. N. 9° 32′, long. W. 79° 55′; depth, 34 fathoms.

The mesial nematophore of *H. longicauda* is longer than any other found among American Plumularidæ, reminding one of some of the striking forms found in Australia.

Type slides.—Cat. No. 18701, U.S.N.M.; Cat. Nos. 15403, 15404, Mus. State Univ. Iowa; also in the collection of the author.

HALICORNARIA SPECIOSA Allman.

(Plate XXXIII, figs. 1–3.)

Halicornaria speciosa ALLMAN, Mem. Mus. Comp. Zool., 1877, V, No. 2, p. 54, pl. XXXIV.

Trophosome.—Colony unbranched, attaining a height of about 12 inches; stem not fascicled, divided into regular short internodes, each of which bears two hydrocladia; hydrocladia nearly opposite on the basal part of the colony, and subalternate on the distal portion, divided into regular short internodes by rather oblique nodes; septal ridges wanting. Hydrothecæ closely approximated, not deep; aperture wide, its axis forming an angle of 45 degrees with that of the hydrocladium; margin with three broad, shallow sinuations, or lobes, on each side; intrathecal ridge anterior, perpendicular to the axis of the hydrotheca and slightly turned upward at its distal end; supracalycine nematophores stout, scarcely overtopping the hydrotheca; mesial nematophore adnate nearly to its distal end, which attains the level of the top of the hydrotheca; cauline nematophores small, one on either side of the base of each hydrocladium.

Gonosome.—Gonangia obconic, with an abruptly truncated distal end; borne singly at the bases of the hydrocladia. No protective contrivances of any kind. Sometimes the gonangia are almost hemispherical in shape.

Distribution.—Double-headed Shot Key, Florida; depth, 4 to 5 fathoms; *Albatross* Station 2640, lat. N. 25° 05′, long. W. 80° 15′; depth, 56 fathoms.

This species, with some others of the same genus, is remarkable from the fact that each stem joint bears two hydrocladia. The specimens secured by the *Albatross* are much larger than those found by Count Pourtalès and came from considerably deeper water. They differ slightly from the type, having two instead of three well-defined marginal teeth on each side, and not having the anterior profile straight.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

HALICORNARIA VARIABILIS, new species.

(Plate XXXIII, figs. 6–11.)

Trophosome.—Adult colony pinnately branched, attaining a height of about 5 inches; stem not fascicled, divided into rather short internodes, each of which bears a pair of hydrocladia; hydrocladia nearly opposite on the proximal part of the full-grown colony, and alternate

on the remaining portions, divided into regular internodes without septal ridges. Hydrothecæ quite variable in colonies of different ages, usually rather deep, axis of aperture inclined at an angle of 45 degrees with that of the hydrocladium; three lobate teeth on each side of the margin; a strong anterior fold or flexure and an anterior ridge reaching the middle of the hydrotheca, and turned upward at its distal end; supracalycine nematophores small, short, not reaching the top of the hydrotheca; mesial nematophores exceedingly variable, consisting of a mere spur at the base of the hydrotheca in the very young colony, and increasing in size until the distal end considerably overlaps the hydrotheca in fully developed colonies; cauline nematophores bilobate, very large, two at the base of each hydrocladium. These also vary in size with the size of the colony.

Gonosome.—Gonangia almost hemispherical, the distal ends being very broad and perfectly flat, borne singly at the bases of the hydrocladia. No protective appendages of any kind.

Distribution.—Shallow water between Eleuthera and Little Cat Island, Bahamas; State University of Iowa Expedition.

This species begins life as a parasite on *Lytocarpus clarkei*, to which it attaches itself by a creeping root-stalk. The very young colony takes the shape of a single hydrocladium, standing erect from this root-stalk. Later the hydrocladium seems to send off lateral hydrocladia, itself becoming a stem without hydrothecæ. How this transformation takes place is not shown by my specimens, and I am not sure that I have rightly interpreted the process. Both single hydrocladia and stems giving forth regular hydrocladia grow from the same creeping root-stalk.

At certain stages the hydrothecæ of this species greatly resemble those of *H. speciosa*. The bilobate and very large cauline nematophores constitute a good feature by which *H. variabilis* may be identified.

Type slides.—Cat. Nos. 15107, 15408, Mus. State Univ. Iowa; Cat. Nos. 18705, 18706, 18707, U.S.N.M.; also in the collection of the author.

NUDITHECA, new genus.

Trophosome.—Stem fascicled; hydrocladia compound, or branched; supracalycine and mesial nematophores present; hydrothecal margin without teeth.

Gonosome.—Gonangia borne singly on the hydrocladia, and devoid of phylactogonia, but with two or three nematophores on their pedicels.

This genus is based on a remarkable species described by S. F. Clark[1] in 1876. The unusual features of this species seem to have escaped the attention of the leading workers in Hydroids, as no mention of it is made in any of the more comprehensive works since its original description twenty years ago.

The compound hydrocladia, each branch of which bears numerous hydrothecæ, is a feature not elsewhere found among the Statoplea. These subdivisions of the hydrocladia must not be confounded with the various accessory ramuli, phylactogonia, etc., for the protection of the gonangia. They are, on the contrary, genuine, unmodified hydrocladia. The position of the gonangia is similar to that found in *Halicornaria saccaria* Allman, with this difference, however, that in the latter species the gonangium manifestly takes the place of a hydrotheca, while in *Nuditheca* no hydrotheca is wanting, the gonangium being interposed between a mesial nematophore and the hydrotheca behind it. In other words, the gonangium does not seem to be the homologue either of a hydrotheca or a nematophore.

This genus has strong affinities with the Eleutheroplean group. The nematophores are expanded above, and bithalamic, although strictly "fixed." Moreover, branched hydrocladia are found only in that group. The two or three nematophores at the base of the unprotected gonangium also remind one forcibly of numerous similar arrangements among the Eleutheroplea.

[1] Proceedings of the Academy of Natural Sciences of Philadelphia, 1876, p. 230.

NUDITHECA DALLI (Clark).

(Plate XXXIV, figs. 4–6.)

Macrorhynchia dallii CLARK, Proc. Acad. Nat. Sci. Phila., 1876, p. 230, pl. XI.

Trophosome.—Colony branched, attaining a height of 5 inches; stem coarse, strongly fascicled; hydrocladia closely approximated, compound; consisting of a main straight branch, which usually gives off three branchlets from its proximal portion; main branch hydrothecate, except in the region from which the branchlets originate; branchlets regularly hydrothecate, with a hydrotheca in the axil of each; hydrocladia divided into short internodes, each with a strong internal septal ridge opposite the base of the hydrotheca and another opposite the supracalycine nematophores; proximal portion of each internode very broad, forming a shoulder on its front side, upon which the hydrotheca rests. Hydrothecæ broad, cupshaped; margin slightly expanded and smooth; no intrathecal ridge; supracalycine nematophores broad, somewhat expanded above, and with a strong internal ridge near the base; mesial nematophores resting on the broadened base of the internode, short and free, slightly expanded above. There are two or three nematophores on each internode of that portion of the main branch of the hydrocladium which bears branchlets; cauline nematophores numerous.

Gonosome.—Gonangia very large, long, almost cylindrical, borne on the branchlets of the hydrocladia on the distal part of the colony. There are two or three nematophores near the base of each gonangium.

Distribution.—Unalaska, Alaska. Found on the beach. (Dall.) Specimens which I suppose to be the original types of this species are in the museum of Yale University.

STREPTOCAULUS Allman.

Streptocaulus ALLMAN, *Challenger* Report, Hydroida, 1883, Pt. 1, p. 48.

Trophosome.—Hydrocladia disposed in a continuous spiral round the stem. Hydrothecæ with entire margin. Mesial nematophore not adnate to the walls of the hydrotheca.

Gonosome.—Gonangia borne on unbranched, jointed appendages of the hydrocladia, springing from the side of a mesial nematophore.

This, as Professor Allman remarks, is "rendered very striking by the spiral instead of pinnate disposition of the hydrocladia." It is as if the hydrocladia had grown on one side of the stem only, and then the stem had been twisted so as to throw the unilateral hydrocladia into a spiral.

STREPTOCAULUS PULCHERRIMUS Allman.

(Plate XXXIV, figs. 1–3.)

Streptocaulus pulcherrimus ALLMAN, *Challenger* Report, Hydroida, 1883, Pt. 1, p. 48, pl. I.
Streptocaulus pulcherrimus QUELCH, Ann. and Mag. Nat. Hist., 5th ser., XVI, 1885, p. 11.

Trophosome.[1]—Colony attaining a height of about 9 inches; stem simple, fascicled, wavy; hydrocladia nearly an inch in length, occupying about the distal half of the stem. Hydrothecæ deep, thimble-shaped, margin with a single toothlike extension in front; mesial nematophore in the form of a free conical spine, with a terminal and a lateral aperture, springing from a point of the hydrothecal internode immediately below the hydrotheca; lateral nematophores pyriform, overtopping the hydrotheca.

Gonosome.[2]—Gonangia sessile, elongato-pyriform, with a suboval, subterminal orifice, borne on appendages of the hydrocladia, which are unbranched and jointed, each joint being obconical. The appendages spring from immediately below the base of a hydrotheca (apparently not the proximal one) at the side of the mesial nematophore.

Distribution.—Porto Praya, St. Jago, from a depth of 100 fathoms. From the cable, off the Cape Verde Islands; depth, over 500 fathoms.

Type.—In the South Kensington Museum, London.

[1] Description quoted is from Allman, in the *Challenger* Report.
[2] Description condensed from that given by Quelch.

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A magnificent monograph; illustrated by colored plates and giving a complete account of the origin of the sex-cells in several of the Plumularidæ.

EXPLANATION OF PLATES.

All of the figures in the plates were drawn by Miss Lilian Hulsebus. Where figures have been copied from the works of other authors, the source is indicated. Nearly all of the figures copied from Allman, Clarke, and Fewkes are from publications of the Museum of Comparative Zoology, Cambridge, Massachusetts, by permission of Doctor Alexander Agassiz.

In all cases where no other source is indicated, the figures were drawn by Miss Hulsebus from camera lucida sketches from nature by Professor C. C. Nutting.

All of the figures in the text were drawn by Miss Mary Macbride. Unless otherwise indicated, they are after camera lucida sketches by Professor C. C. Nutting.

PLATE I.

FIG. 1. *Plumularia setacea* Ellis. Portion of colony with gonangia (enlarged).
1*a*. *Plumularia setacea*. Young gonangium (enlarged).
2. *Plumularia setacea*. Hydrotheca and hydranth (greatly enlarged).
3. *Plumularia setacea*. Part of a hydrocladium (enlarged).
4. *Plumularia setacea*. Portion of same (greatly enlarged).
5. *Plumularia megalocephala* Allman (enlarged). (After Allman.)
6. *Plumularia oligopyxis* Kirchenpauer (enlarged). (After Kirchenpauer.)
7. *Plumularia oligopyxis*. Hydrotheca (greatly enlarged). (After Kirchenpauer.)

PLATE II.

FIG. 1. *Plumularia altitheca* Nutting (enlarged).
2. *Plumularia filicula* Allman (enlarged). (After Allman.)
3. *Plumularia helleri* Hincks (enlarged). (After Marktanner-Turneretscher.)
4. *Plumularia floridana* Nutting (enlarged).
5. *Plumularia floridana*. Portion of hydrocladium (greatly enlarged).
6. *Plumularia filicaulis* Kirchenpauer. Portion of hydrocladium (enlarged). (After Bale.)

PLATE III.

FIG. 1. *Plumularia catharina* Hincks. Portion of a hydrocladium (enlarged). (After Hincks.)
2. *Plumularia catharina*. Gonangium (enlarged). (After Hincks.)
3. *Plumularia geminata* Allman (enlarged). (After Allman.)
4. *Plumularia geminata*. Portion of a hydrocladium (greatly enlarged). (After Allman.)
5. *Plumularia clarkei* Nutting (enlarged).

PLATE IV.

FIG. 1. *Plumularia alternata* Nutting (enlarged).
2. *Plumularia alternata*. Portion of hydrocladium (greatly enlarged).
3. *Plumularia plumularoides* (Clark) (greatly enlarged). (After Clark.)
4. *Schizotricha tenella* (Verrill) (greatly enlarged).
5. *Schizotricha tenella*. Portion of hydrocladium (greatly enlarged).

PLATE V.

FIG. 1. *Plumularia inermis* Nutting (enlarged).
2. *Plumularia inermis*. Hydrotheca and hydranth (greatly enlarged).
2*a*. *Plumularia inermis*. Hydrotheca (greatly enlarged.
3. *Plumularia caulitheca* Fewkes. Portion of stem (enlarged).
4. *Plumularia caulitheca*. Portion of hydrocladium (enlarged).
5. *Plumularia caulitheca*. Hydrothecal internode (greatly enlarged).
6. *Plumularia attenuata* Allman (enlarged). (After Allman.)

PLATE VI.

FIG. 1. *Plumularia corrugata* Nutting (enlarged).
2. *Plumularia corrugata*. Portion of hydrocladium (greatly enlarged).
3. *Plumularia corrugata*. Part of colony, showing gonangia (enlarged).
4. *Plumularia palmeri* Nutting. Portion of hydrocladium (enlarged).
5. *Plumularia palmeri*. Hydrocladial internode (greatly enlarged).
6. *Plumularia lagenifera* Allman. Hydrocladial internode (enlarged).
. *Plumularia lagenifera*. Portion of stem and a hydrocladium.
8. *Plumularia lagenifera*. Gonangia.
9. *Plumularia lagenifera* Allman. Part of colony with gonangium. (After Allman.)
10. *Plumularia lagenifera*. Part of a hydrocladium. (After Allman.)

PLATE VII.

FIG. 1. *Plumularia goodei* Nutting. Part of stem, showing nodes and origin of hydrocladia (enlarged).
2. *Plumularia goodei*. A single hydrocladium (greatly enlarged).
3. *Plumularia goodei*. A hydrocladial internode (still more enlarged).
4. *Plumularia goodei*. Mesial nematophore (greatly magnified).
5. *Plumularia virginiæ* Nutting. Part of hydrocladium (enlarged).
6. *Plumularia virginiæ*. Single internode (greatly enlarged).
7. *Plumularia virginiæ*. Hydranth (greatly enlarged).
8. *Plumularia virginiæ*. Front of stem, showing internodes and origin of hydrocladia (enlarged).
9. *Plumularia virginiæ*. Nematophore, showing sarcostyle (highly magnified).
10. *Plumularia virginiæ*. Gonangia (enlarged).

PLATE VIII.

FIG. 1. *Plumularia macrotheca* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
2. *Plumularia profunda* Nutting. Part of hydrocladium (greatly enlarged).
3. *Plumularia profunda*. Part of hydrocladium, bearing gonangia (greatly enlarged).
4. *Plumularia dendritica* Nutting. Part of hydrocladium (enlarged).
5. *Plumularia dendritica*. Side view of hydrotheca (greatly enlarged).
6. *Plumularia dendritica*. Front view of hydrotheca (greatly enlarged).
7. *Plumularia paucinoda* Nutting. Part of stem (enlarged).
8. *Plumularia paucinoda*. Part of hydrocladium (enlarged).
9. *Plumularia paucinoda*. Part of hydrocladium (greatly enlarged).

PLATE IX.

FIG. 1. *Antennularia antennina* Linnæus. Part of stem and bases of hydrocladia (enlarged).
2. *Antennularia antennina*. Part of hydrocladium (greatly enlarged).
3. *Antennularia americana* Nutting. Part of stem and hydrocladia (enlarged).
4. *Antennularia americana*. Part of hydrocladium (greatly enlarged).
5. *Antennularia simplex* Allman (enlarged). (After Allman.)

PLATE X.

FIG. 1. *Antennularia rugosa* Nutting. Part of stem with hydrocladia (enlarged).
2. *Antennularia rugosa*. Hydrocladium, showing thickening of perisarc at base (greatly enlarged)
3. *Antennularia geniculata* Nutting. Portion of stem with bases of hydrocladia (enlarged).
4. *Antennularia geniculata*. Part of hydrocladium (greatly enlarged).
5. *Antennularia pinnata* Nutting. Part of stem with hydrocladia (enlarged).
6. *Antennularia pinnata*. Part of hydrocladium (greatly enlarged).

PLATE XI.

FIG. 1. *Monotheca margaretta* Nutting. Entire colony, except the hydrocaulus (enlarged).
2. *Monotheca margaretta*. Side view of hydrotheca (greatly enlarged).
3. *Monotheca margaretta*. Back view of hydrotheca (greatly enlarged).
4. *Antennopsis hippuris* Allman. Part of stem with hydrocladia (enlarged). (After Allman.)
5. *Antennopsis hippuris*. Part of hydrocladium (greatly enlarged). (After Allman.)
6. *Antennopsis hippuris*. Gonangia (enlarged). (After Allman.)

PLATE XII.

FIG. 1. *Antennopsis distans* Nutting. Part of stem with hydrocladia (enlarged).
2. *Antennopsis distans*. Part of hydrocladium (greatly enlarged).
3. *Antennopsis longicorna* Nutting. Part of stem with hydrocladia (enlarged).
4. *Antennopsis longicorna*. Part of hydrocladium (greatly enlarged).
5. *Antennopsis nigra* Nutting. Part of stem with hydrocladia (enlarged).
6. *Antennopsis nigra*. Part of hydrocladium (greatly enlarged).
7. *Antennopsis annulata* (Allman). Part of stem with hydrocladia and gonangia (enlarged).
8. *Antennopsis annulata*. Part of hydrocladium (greatly enlarged).
9. *Antennopsis annulata*. Part of hydrocladium (still more enlarged).

PLATE XIII.

FIG. 1. *Monostæchas quadridens* (McCrady). Part of colony dichotomously branching (enlarged). (After Allman.)
2. *Monostæchas quadridens*. Part of hydrocladium, showing hydrothecæ and gonangia (greatly enlarged). (After Allman.)
3. *Monostæchas quadridens*. Hydrocladium of form having closely approximated hydrothecæ (greatly enlarged).
4. *Monostæchas quadridens*. Single hydrotheca of the same (greatly enlarged).
5. *Antennella gracilis* Allman. Portion of hydrocladium (greatly enlarged). (After Allman.)

PLATE XIV.

FIG. 1. *Calvinia mirabilis* Nutting. Portion of stem showing hydrothecæ and gonangia (enlarged).
2. *Calvinia mirabilis*. Part of hydrocladium, side view (greatly enlarged).
3. *Calvinia mirabilis*. Part of hydrocladium, front view (greatly enlarged).
4. *Schizotricha gracillima* (Sars). Showing branched hydrocladium (enlarged).
5. *Schizotricha gracillima*. Part of hydrocladium (greatly enlarged).
6. *Schizotricha gracillima*. Gonangium (enlarged).

PLATE XV.

FIG. 1. *Schizotricha dichotoma* Nutting. Forked hydrocladium (enlarged).
2. *Schizotricha dichotoma*. Part of hydrocladium (greatly enlarged).
3. *Schizotricha dichotoma*. Nematophorous branchlet of hydrocladium (greatly enlarged).
4. *Schizotricha dichotoma*. Gonangium (greatly enlarged).
5. *Schizotricha parvula* Nutting. Portion of stem and hydrocladia (enlarged).
6. *Diplopteron quadricorne* Nutting. Side view of hydrocladium (greatly enlarged).
7. *Diplopteron quadricorne*. Front view of hydrocladium (greatly enlarged).

PLATE XVI.

FIG. 1. *Diplopteron grande* Nutting. Side view of portion of a hydrocladium (greatly enlarged).
2. *Diplopteron grande*. Hydrocladium, phylactocarp, and gonangia (enlarged).
3. *Diplopteron longipinna* Nutting. Side view of part of hydrocladium (greatly enlarged).
4. *Diplopteron longipinna*. Front view of part of hydrocladium (greatly enlarged).
5. *Polyplumularia armata* Nutting. Part of stem and hydrocladia (enlarged).
6. *Polyplumularia armata*. Part of hydrocladium (greatly enlarged).

PLATE XVII.

FIG. 1. *Hippurella longicarpa* Nutting. Part of hydrocladium (enlarged).
2. *Hippurella longicarpa*. Hydrocladial internode (greatly enlarged).
3. *Hippurella longicarpa*. Phylactocarp and gonangia (enlarged).
4. *Callicarpa gracilis* Fewkes. Part of hydrocladium (enlarged).
5. *Callicarpa gracilis*. Hydrocladial internode (greatly enlarged).
6. *Callicarpa gracilis*. Phylactocarp (enlarged).
7. *Halopteris carinata* Allman. Part of colony (enlarged). (After Allman.)
8. *Halopteris carinata*. Part of hydrocladium, side view (greatly enlarged). (After Allman.)
9. *Halopteris carinata*. Front view of hydrotheca (greatly enlarged). (After Allman.)
10. *Gattya humilis* Allman (enlarged). (After Allman.)
11. *Gattya humilis*. Front view of hydrotheca (greatly enlarged).

PLATE XVIII.

FIG. 1. *Aglaophenia rhynchocarpa* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
2. *Aglaophenia rhynchocarpa*. Corbula (enlarged). (After Allman.)
3. *Aglaophenia rigida* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
4. *Aglaophenia rigida*. Corbula (enlarged). (After Allman.)
5. *Aglaophenia dubia* (Nutting). Part of hydrocladium (greatly enlarged). (After Allman.)
6. *Aglaophenia lophocarpa* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
7. *Aglaophenia lophocarpa*. Front view of stem (greatly enlarged). (After Allman.)
8. *Aglaophenia lophocarpa*. Corbula (enlarged). (After Allman.)
9. *Aglaophenia apocarpa* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
10. *Aglaophenia apocarpa*. Front view of stem (greatly enlarged). (After Allman.)
11. *Aglaophenia apocarpa*. Corbula (enlarged). (After Allman.)

PLATE XIX.

FIG. 1. *Aglaophenia flowersi* Nutting. Part of hydrocladium (greatly enlarged).
2. *Aglaophenia flowersi*. Corbula (enlarged).
3. *Aglaophenia elegans* Nutting. Part of hydrocladium (greatly enlarged).
4. *Aglaophenia elegans*. Corbula (enlarged).
5. *Aglaophenia insignis* Fewkes. Part of hydrocladium (enlarged).
6. *Aglaophenia insignis*. Hydrotheca (greatly enlarged).
7. *Aglaophenia insignis*. Corbula (enlarged).

PLATE XX.

FIG. 1. *Aglaophenia aperta* Nutting. Part of hydrocladium (greatly enlarged).
2. *Aglaophenia aperta.* Corbula (enlarged).
3. *Aglaophenia cristifrons* Nutting. Part of hydrocladium (greatly enlarged).
4. *Aglaophenia cristifrons.* Corbula (enlarged).
5. *Aglaophenia contorta* Nutting. Part of hydrocladium (enlarged).
6. *Aglaophenia contorta.* Hydrothecæ (greatly enlarged).
7. *Aglaophenia contorta.* Corbula (enlarged).

PLATE XXI.

FIG. 1. *Aglaophenia minuta* Fewkes. Hydrotheca (greatly enlarged).
2. *Aglaophenia minuta.* Base of hydrocladium, showing the processes (enlarged).
3. *Aglaophenia minuta.* Corbula (enlarged).
4. *Aglaophenia perpusilla* Allman. Part of hydrocladium (enlarged). (After Allman.)
5. *Aglaophenia perpusilla.* Side view of stem, showing processes at bases of hydrocladia (enlarged). (After Allman.)
6. *Aglaophenia mammillata* Nutting. Part of hydrocladium (enlarged).
7. *Aglaophenia mammillata.* Hydrotheca (greatly enlarged).
8. *Aglaophenia mammillata.* Front view of hydrothecæ (enlarged).
9. *Aglaophenia mammillata.* Front view of stem (enlarged).
10. *Aglaophenia mammillata.* Side view of stem, showing processes (enlarged).
11. *Aglaophenia minima* Nutting. Hydrotheca (greatly enlarged).
12. *Aglaophenia minima.* Corbula (enlarged).
13. *Aglaophenia minima.* Side view of stem, showing processes (enlarged).
14. *Aglaophenia perforata* Allman. Part of hydrocladium (enlarged). (After Allman.)
15. *Aglaophenia perforata.* Corbula (enlarged). (After Allman.)

PLATE XXII.

FIG. 1. *Aglaophenia simplex* Kirchenpauer. Hydrotheca (greatly enlarged). (After Kirchenpauer.)
2. *Aglaophenia allmani* Nutting. Side view of hydrothecæ (greatly enlarged). (After Allman.)
3. *Aglaophenia allmani.* Front view of hydrotheca (greatly enlarged). (After Allman.)
4. *Aglaophenia rathbuni* Nutting. Part of hydrocladium (enlarged).
5. *Aglaophenia rathbuni.* Hydrotheca (greatly enlarged).
6. *Aglaophenia rathbuni.* Corbula (enlarged).
7. *Aglaophenia latirostris* Nutting. Part of hydrocladium (greatly enlarged).
8. *Aglaophenia latirostris.* Front view of hydrothecæ (greatly enlarged).
9. *Aglaophenia latirostris.* Corbula (greatly enlarged).
10. *Aglaophenia struthionides* (Murray). Part of hydrocladium (enlarged).
11. *Aglaophenia struthionides.* Hydrotheca (greatly enlarged).
12. *Aglaophenia struthionides.* Corbula (enlarged).

PLATE XXIII.

FIG. 1. *Aglaophenia ramulosa* Kirchenpauer (greatly enlarged). (After Kirchenpauer.)
2. *Aglaophenia octocarpa* Nutting. Part of hydrocladium (enlarged).
3. *Aglaophenia octocarpa.* Hydrotheca (greatly enlarged).
4. *Aglaophenia octocarpa.* Front view of stem (enlarged).
5. *Aglaophenia octocarpa.* Corbula (enlarged).
6. *Aglaophenia gracillima* Fewkes. Part of hydrocladium (enlarged).
7. *Aglaophenia gracillima.* Hydrotheca (greatly enlarged).
8. *Aglaophenia gracillima.* Corbula (enlarged).
9. *Aglaophenia crenata* Fewkes. Part of hydrocladium (enlarged).
10. *Aglaophenia crenata.* Hydrotheca (greatly enlarged).

PLATE XXIV.

FIG. 1. *Aglaophenia constricta* Allman. Side view of hydrothecæ (greatly enlarged). (After Allman.)
2. *Aglaophenia constricta.* Front view of hydrotheca (greatly enlarged). (After Allman.)
3. *Aglaophenia constricta.* Front of stem (enlarged). (After Allman.)
4. *Aglaophenia savignyana* Marktanner-Turneretscher (enlarged). (After Marktanner-Turneretscher.)
5. *Aglaophenia bicornuta* Nutting. Part of hydrocladium (enlarged).
6. *Aglaophenia bicornuta.* Quartering view of hydrothecæ (enlarged).
7. *Aglaophenia bicornuta.* Front view of hydrothecæ (enlarged).
8. *Aglaophenia bicornuta.* Hydrotheca (greatly enlarged).
9. *Aglaophenia calamus* Allman. Part of hydrocladium (enlarged). (After Allman.)
10. *Aglaophenia calamus.* Front view of hydrothecæ (enlarged). (After Allman.)
11. *Aglaophenia calamus* Corbula (enlarged). (After Allman.)
12. *Thecocarpus myriophyllum* (Linnæus). Part of hydrocladium (enlarged).

FIG. 13. *Thecocarpus myriophyllum.* Hydrotheca (greatly enlarged).
14. *Thecocarpus distans* (Allman). Part of hydrocladium (greatly enlarged). (After Allman.)
15. *Thecocarpus distans.* Corbula (enlarged). (After Allman.)
16. *Thecocarpus distans.* Corbula leaf (enlarged). (After Allman.)

PLATE XXV.

FIG. 1. *Thecocarpus normani* Nutting. Part of hydrocladium (greatly enlarged).
2. *Thecocarpus normani.* Basal part of corbula, and corbula stem (enlarged).
3. *Thecocarpus benedicti* Nutting. Part of hydrocladium (greatly enlarged).
4. *Thecocarpus benedicti.* Front view of hydrothecæ (greatly enlarged).
5. *Thecocarpus benedicti.* Part of corbula (enlarged).
6. *Thecocarpus bispinosus* (Allman). Part of hydrocladium (greatly enlarged). (After Allman.)
7. *Thecocarpus bispinosus.* Corbula (enlarged). (After Allman.)
8. *Thecocarpus bispinosus.* Base of corbula leaf (enlarged). (After Allman.)

PLATE XXVI.

FIG. 1. *Cladocarpus sigma* (Allman). Hydrocladium bearing phylactocarp and gonangia (enlarged).
2. *Cladocarpus sigma.* Part of hydrocladium (greatly enlarged).
3. *Cladocarpus compressus* Nutting. Part of hydrocladium (enlarged).
4. *Cladocarpus compressus.* Hydrotheca (greatly enlarged).
5. *Cladocarpus compressus.* Phylactogonium (enlarged).
6. *Cladocarpus ventricosus* Allman. Part of hydrocladium (after Allman).
7. *Cladocarpus ventricosus.* Part of colony showing phylactogonia and gonangia (after Allman).
8. *Cladocarpus ventricosus.* Gonangium (after Allman).
9. *Cladocarpus flexilis* Verrill. Part of hydrocladium.
10. *Cladocarpus flexilis.* Side view of hydrotheca.
11. *Cladocarpus flexilis.* Front view of hydrotheca.
12. *Cladocarpus flexilis.* Phylactogonia and gonangia.

PLATE XXVII.

FIG. 1. *Cladocarpus obliquus* Nutting. Part of hydrocladium (enlarged).
2. *Cladocarpus obliquus.* Side view of hydrotheca (greatly enlarged).
3. *Cladocarpus obliquus.* Phylactogonia and gonangia (enlarged).
4. *Cladocarpus septatus* Nutting. Part of hydrocladium (enlarged).
5. *Cladocarpus septatus.* Side view of hydrotheca (greatly enlarged).
6. *Cladocarpus septatus.* Front view of hydrotheca (greatly enlarged).
7. *Cladocarpus septatus.* Front of stem (greatly enlarged).
8. *Cladocarpus septatus.* Phylactogonia and gonangia (enlarged).
9. *Cladocarpus dolichotheca* Allman. Part of colony showing phylactogonia and gonangia (enlarged). (After Allman.)
10. *Cladocarpus dolichotheca.* Side view of hydrotheca (greatly enlarged). (After Allman.)
11. *Cladocarpus flexuosus* Nutting. Part of hydrocladium (enlarged).
12. *Cladocarpus flexuosus.* Front view of hydrotheca (greatly enlarged).
13. *Cladocarpus flexuosus.* Side view of hydrotheca (greatly enlarged).

PLATE XXVIII.

FIG. 1. *Cladocarpus tenuis* Clarke. Part of hydrocladium (greatly enlarged). (After Clarke.)
2. *Cladocarpus tenuis.* Side view of hydrothecæ (greatly enlarged). (After Clarke.)
3. *Cladocarpus grandis* Nutting. Part of hydrocladium (enlarged).
4. *Cladocarpus grandis.* Hydrotheca (greatly enlarged).
5. *Cladocarpus grandis.* Phylactocarp and gonangia (enlarged).
6. *Cladocarpus paradisea* Allman. Part of hydrocladium (enlarged). (After Allman.)
7. *Cladocarpus paradisea.* Phylactocarp and gonangia (enlarged). (After Allman.)
8. *Cladocarpus speciosus* Verrill. Part of hydrocladium (enlarged).
9. *Cladocarpus speciosus.* Hydrotheca (greatly enlarged).
10. *Cladocarpus speciosus.* Front of stem showing growing phylactogonium (enlarged).
11. *Cladocarpus speciosus.* Proximal hydrotheca, and a budding phylactogonium (greatly enlarged).

PLATE XXIX.

FIG. 1. *Cladocarpus pourtalesii* Verrill. Part of hydrocladium (greatly enlarged).
2. *Cladocarpus pourtalesii.* Phylactogonium and gonangia (enlarged).
3. *Cladocarpus carinatus* Nutting. Part of hydrocladium (enlarged).
4. *Cladocarpus carinatus.* Side view of hydrotheca (greatly enlarged).
5. *Cladocarpus carinatus.* Front view of hydrothecæ (greatly enlarged).
6. *Cladocarpus carinatus.* Front of stem (enlarged).
7. *Cladocarpus carinatus.* Part of hydrocladium bearing phylactogonia and gonangia (enlarged).
8. *Aglaophenopsis hirsuta* Fewkes. Part of hydrocladium (enlarged).
9. *Aglaophenopsis hirsuta.* Side view of hydrotheca (greatly enlarged).

FIG. 10. *Aglaophenopsis hirsuta.* Front view of hydrotheca (greatly enlarged).
11. *Aglaophenopsis hirsuta.* Front view of stem (enlarged).
12. *Aglaophenopsis hirsuta.* Basal hydrotheca and phylactogonium (enlarged).
13. *Aglaophenopsis hirsuta.* Gonangium.

PLATE XXX.

FIG. 1. *Aglaophenopsis distans* Nutting. Part of hydrocladium (greatly enlarged).
2. *Aglaophenopsis distans.* Front of stem (enlarged).
3. *Aglaophenopsis verrilli* Nutting. Branched hydrocladium bearing gonangium (enlarged).
4. *Aglaophenopsis verrilli.* Part of hydrocladium (enlarged).
5. *Aglaophenopsis verrilli.* Side view of hydrotheca (greatly enlarged).
6. *Aglaophenopsis cornuta* (Verrill). Part of hydrocladium (enlarged).
7. *Aglaophenopsis cornuta.* Branched hydrocladium.
8. *Aglaophenopsis cornuta.* Front of stem, showing proximal hydrotheca and nematophores (enlarged).
9. *Aglaophenopsis cornuta.* Gonangium (enlarged).

PLATE XXXI.

FIG. 1. *Lytocarpus racemiferus* Allman. Part of hydrocladium (enlarged). (After Allman.)
2. *Lytocarpus racemiferus.* Gonosome (enlarged). (After Allman).
3. *Lytocarpus racemiferus.* Part of phylactocarp with gonangia (enlarged). (After Allman.)
4. *Lytocarpus philippinus* (Kirchenpauer). Part of hydrocladium (enlarged).
5. *Lytocarpus philippinus.* Front of stem (enlarged).
6. *Lytocarpus philippinus.* Gonangia on phylactocarp (enlarged).
7. *Lytocarpus philippinus.* Hydrotheca (greatly enlarged).
8. *Lytocarpus ramosus* (Fewkes). Part of hydrocladium (enlarged).
9. *Lytocarpus ramosus.* Hydrotheca (greatly enlarged).
10. *Lytocarpus ramosus.* Hydrotheca, with longer nematophores (greatly enlarged).
11. *Lytocarpus ramosus.* Pseudocorbula (enlarged). (After Fewkes.)
12. *Lytocarpus ramosus.* Phylactogonium, showing hydrotheca at base (enlarged).
13. *Lytocarpus ramosus.* Phylactogonium, viewed from the side (enlarged).

PLATE XXXII.

FIG. 1. *Lytocarpus grandis* (Clarke). Part of hydrocladium (enlarged).
2. *Lytocarpus grandis.* Phylactocarp (enlarged).
3. *Lytocarpus grandis.* Basal part of phylactogonium (greatly enlarged).
4. *Lytocarpus grandis.* Entire phylactogonium (greatly enlarged).
5. *Lytocarpus clarkei* Nutting. Part of hydrocladium (enlarged).
6. *Lytocarpus clarkei.* Front of stem, showing nematophores (enlarged).
7. *Lytocarpus clarkei.* Front view of hydrocladium (enlarged).
8. *Lytocarpus curtus* Nutting. Part of hydrocladium (enlarged).
9. *Lytocarpus curtus.* Front view of hydrothecæ (enlarged).
10. *Lytocarpus curtus.* Hydrotheca (greatly enlarged).
11. *Lytocarpus curtus.* Base of hydrocladium, showing nematophores (enlarged).
12. *Lytocarpus furcatus* Nutting. Part of hydrocladium (enlarged).
13. *Lytocarpus furcatus.* Front view of hydrothecæ (enlarged).
14. *Lytocarpus furcatus.* Hydrothecæ (greatly enlarged).
15. *Lytocarpus furcatus.* Front of stem, showing cauline nematophores and perforated process (enlarged).

PLATE XXXIII.

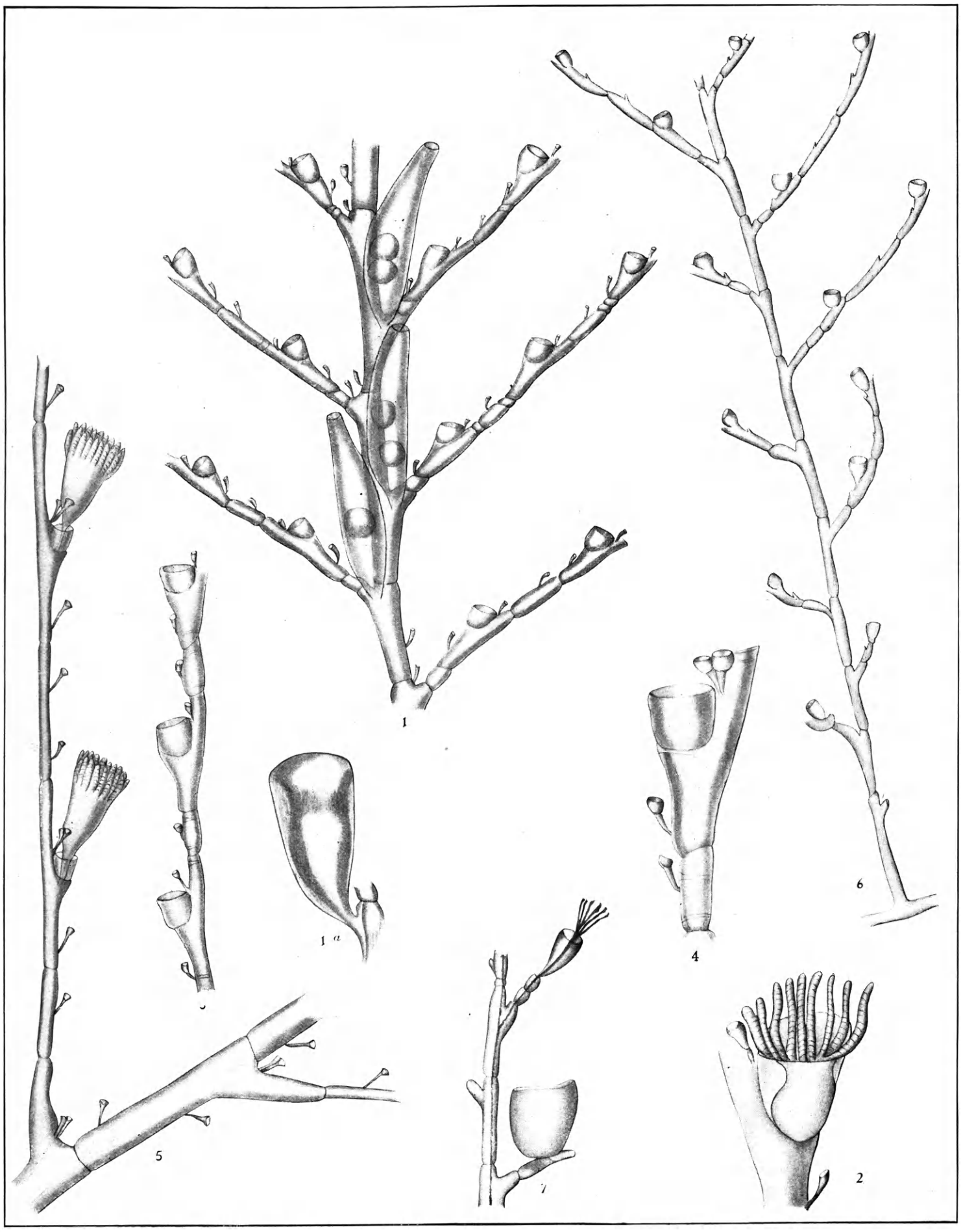
FIG. 1. *Halicornaria speciosa* Allman. Part of hydrocladium (greatly enlarged). (After Allman).
2. *Halicornaria speciosa.* Front view of hydrocladium (greatly enlarged). (After Allman).
3. *Halicornaria speciosa.* Front of stem, showing gonangia (enlarged). (After Allman).
4. *Halicornaria longicauda* Nutting. Part of hydrocladium (greatly enlarged).
5. *Halicornaria longicauda.* Front view of hydrothecæ (greatly enlarged).
6. *Halicornaria variabilis* Nutting. Part of hydrocladium (enlarged).
7. *Halicornaria variabilis.* Part of young hydrocladium (enlarged).
8. *Halicornaria variabilis.* Young hydrotheca with short nematophore (greatly enlarged).
9. *Halicornaria variabilis.* Front of stem, showing large nematophores (enlarged).
10. *Halicornaria variabilis.* Gonangia (enlarged).

PLATE XXXIV.

FIG. 1. *Streptocaulus pulcherrimus* Allman. Entire colony. (After Allman.)
2. *Streptocaulus pulcherrimus.* Part of hydrocladium (enlarged). (After Allman.)
3. *Streptocaulus pulcherrimus.* Front view of hydrothecæ (enlarged). (After Allman.)
4. *Nuditheca dalli* (Clark). Branched hydrocladium (enlarged).
5. *Nuditheca dalli.* Part of hydrocladium (greatly enlarged).
6. *Nuditheca dalli.* Part of hydrocladium with gonangium (enlarged).

EXPLANATION TO PLATE I.

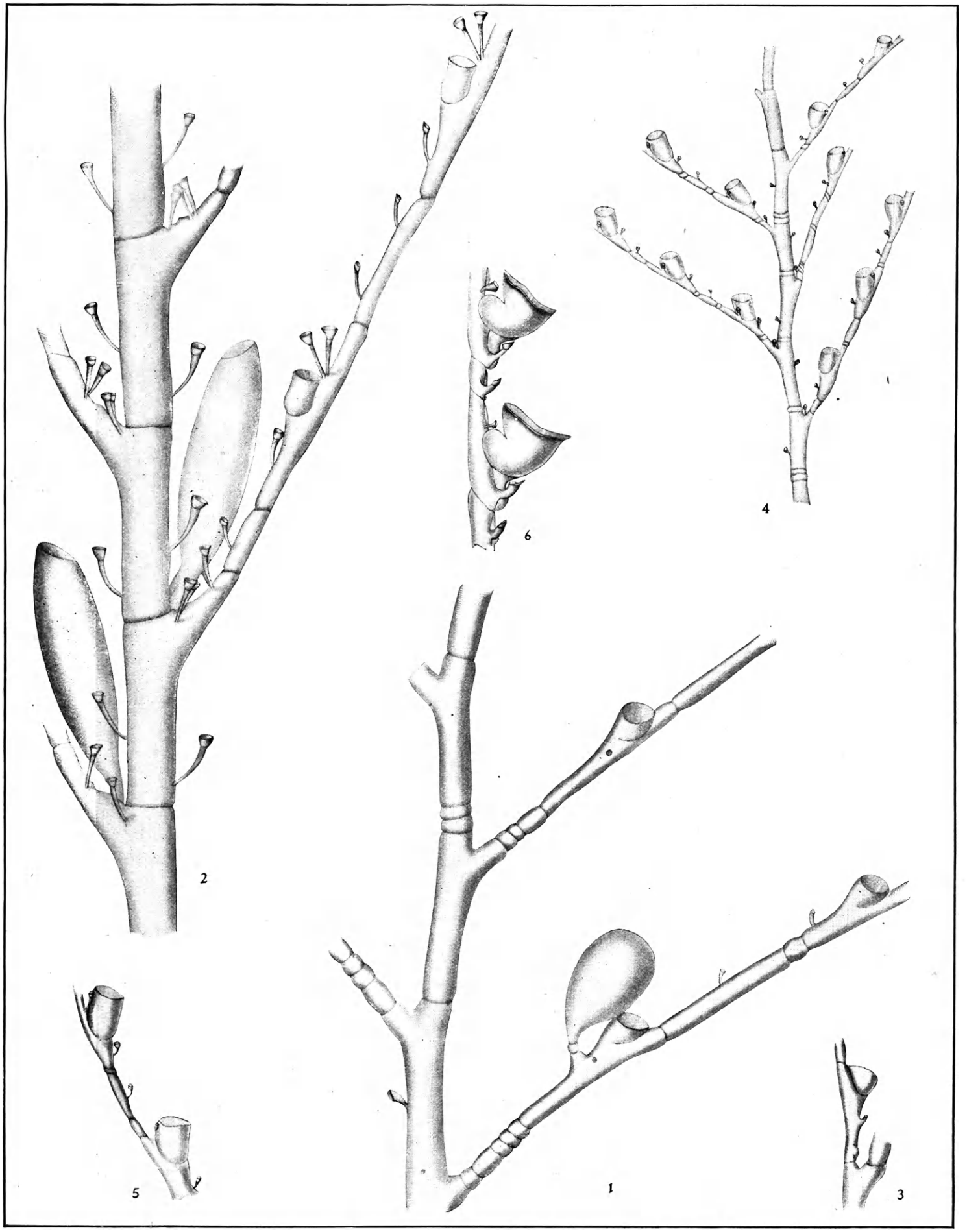
FIG. 1. *Plumularia setacea* Ellis. Portion of colony with gonangia (enlarged).
1a. *Plumularia setacea.* Young gonangium (enlarged).
2. *Plumularia setacea.* Hydrotheca and hydranth (greatly enlarged).
3. *Plumularia setacea.* Part of a hydrocladium (enlarged).
4. *Plumularia setacea.* Portion of same (greatly enlarged).
5. *Plumularia megalocephala* Allman (enlarged). (After Allman.)
6. *Plumularia oligopyxis* Kirchenpauer (enlarged). (After Kirchenpauer.)
7. *Plumularia oligopyxis.* Hydrotheca (greatly enlarged). (After Kirchenpauer.)



PLUMULARIDÆ.

EXPLANATION TO PLATE II.

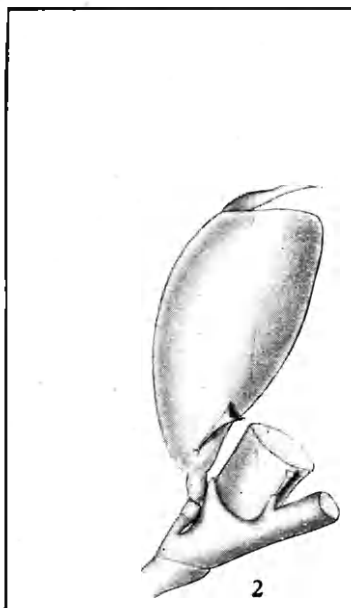
FIG. 1. *Plumularia altitheca* Nutting (enlarged).
2. *Plumularia filicula* Allman (enlarged). (After Allman.)
3. *Plumularia helleri* Hincks (enlarged). (After Marktanner-Turneretscher.)
4. *Plumularia floridana* Nutting (enlarged).
5. *Plumularia floridana*. Portion of hydrocladium (greatly enlarged).
6. *Plumularia filicaulis* Kirchenpauer. Portion of hydrocladium (enlarged). (After Baie.)



PLUMULARIDÆ.

EXPLANATION TO PLATE III.

FIG. 1. *Plumularia catharina* Hincks. Portion of a hydrocladium (enlarged). (After Hincks.)
2. *Plumularia catharina*. Gonangium (enlarged). (After Hincks.)
3. *Plumularia geminata* Allman (enlarged). (After Allman.)
4. *Plumularia geminata*. Portion of a hydrocladium (greatly enlarged). (After Allman.)
5. *Plumularia clarkei* Nutting (enlarged).



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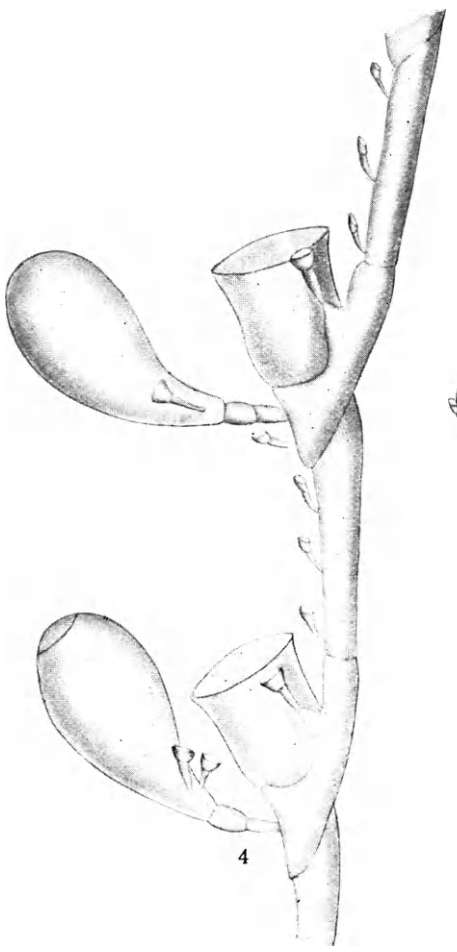

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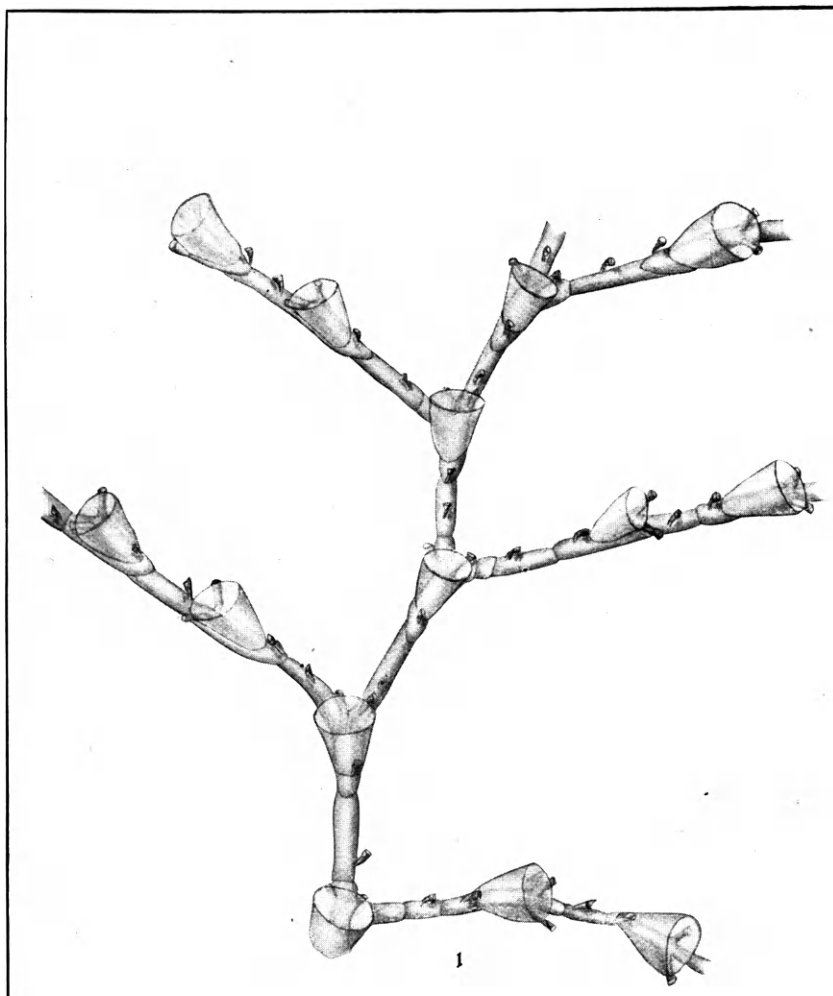
PLUMULARIDÆ.

EXPLANATION TO PLATE IV.

FIG. 1. *Plumularia alternata* Nutting (enlarged).
2. *Plumularia alternata*. Portion of hydrocladium (greatly enlarged).
3. *Plumularia plumularoides* (Clark) (greatly enlarged). (After Clark.)
4. *Schizotricha tenella* (Verrill) (greatly enlarged).
5. *Schizotricha tenella*. Portion of hydrocladium (greatly enlarged).



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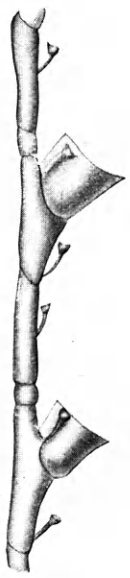

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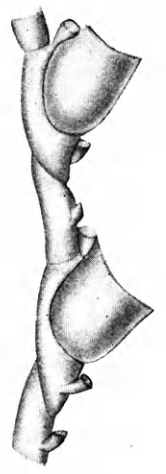

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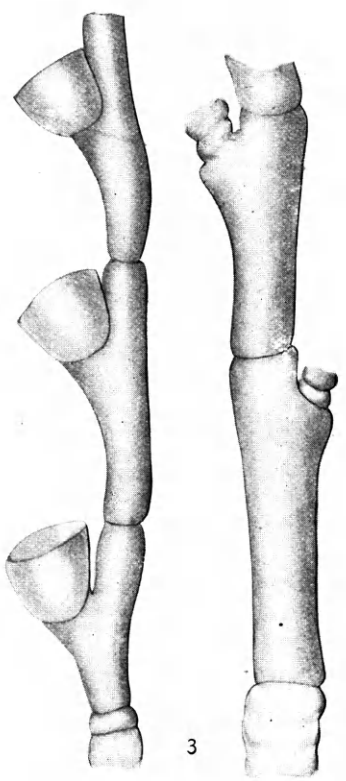

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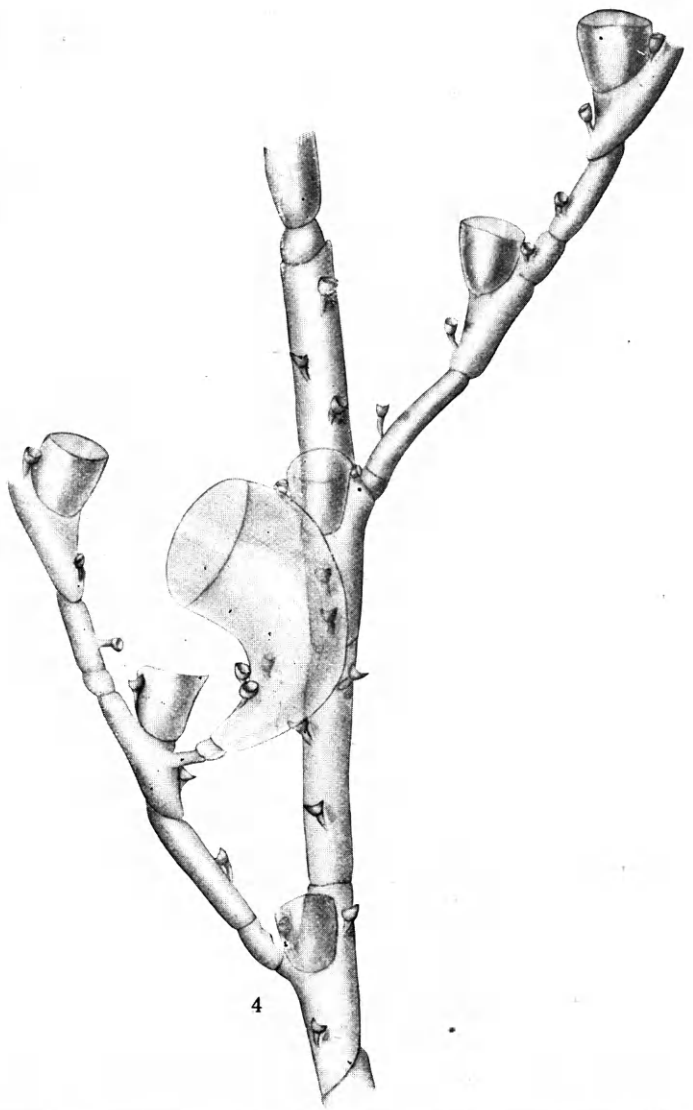

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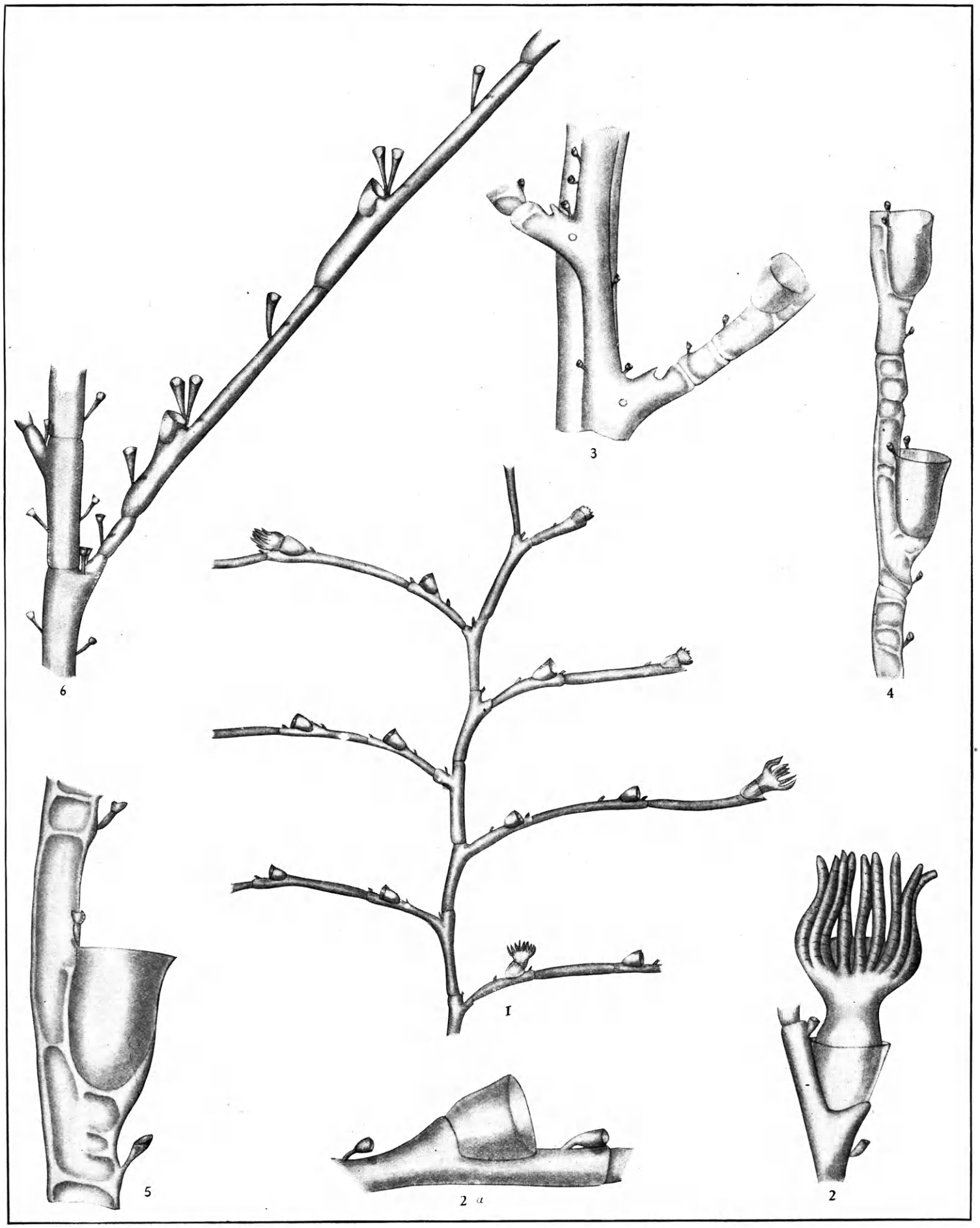
PLUMULARIDÆ.

EXPLANATION TO PLATE V.

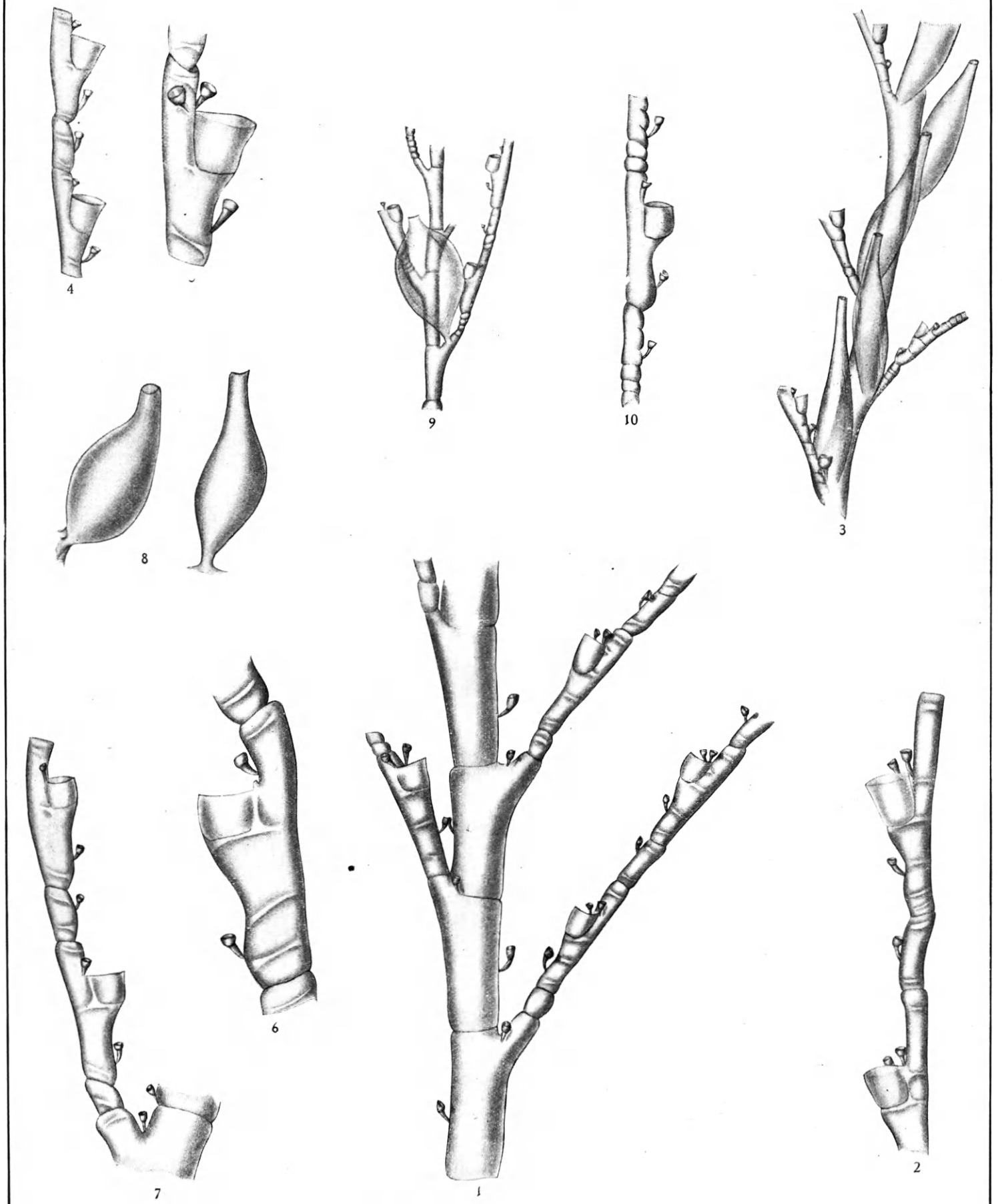
FIG. 1. *Plumularia inermis* Nutting (enlarged).
2. *Plumularia inermis*. Hydrotheca and hydranth (greatly enlarged).
2*a*. *Plumularia inermis*. Hydrotheca (greatly enlarged.
3. *Plumularia caulitheca* Fewkes. Portion of stem (enlarged).
4. *Plumularia caulitheca*. Portion of hydrocladium (enlarged).
5. *Plumularia caulitheca*. Hydrothecal internode (greatly enlarged).
6. *Plumularia attennata* Allman (enlarged). (After Allman.)



PLUMULARIDÆ.

EXPLANATION TO PLATE VI.

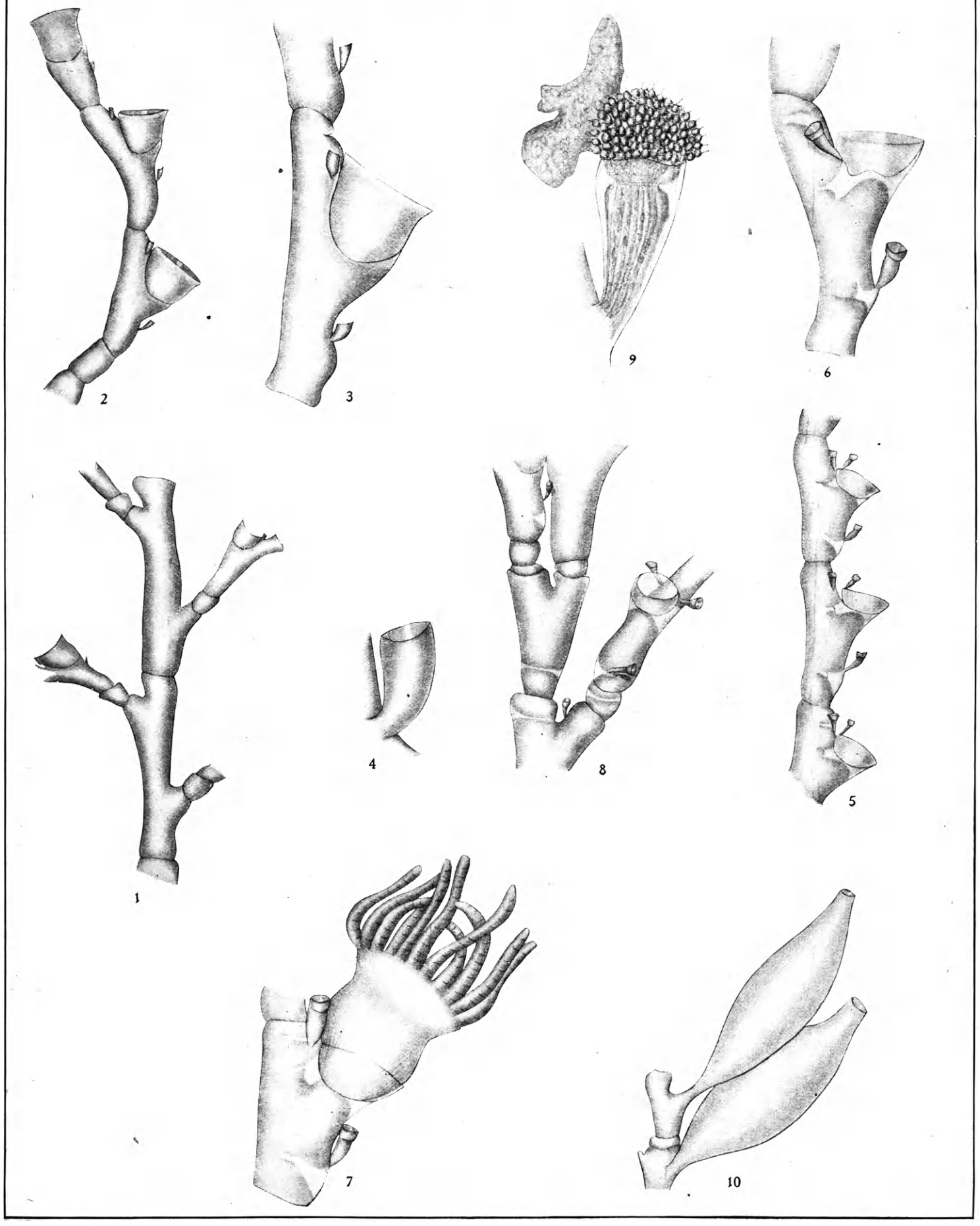
FIG. 1. *Plumularia corrugata* Nutting (enlarged).
2. *Plumularia corrugata.* Portion of hydrocladium (greatly enlarged).
3. *Plumularia corrugata.* Part of colony, showing gonangia (enlarged).
4. *Plumalaria palmeri* Nutting. Portion of hydrocladium (enlarged).
5. *Plumularia palmeri.* Hydrocladial internode (greatly enlarged).
6. *Plumularia lagenifera* Allman. Hydrocladial internode (enlarged).
7. *Plumularia lagenifera.* Portion of stem and a hydrocladium.
8. *Plumularia lagenifera.* Gonangia.
9. *Plumularia lagenifera* Allman. Part of colony with gonangium. (After Allman.)
10. *Plumularia lagenifera.* Part of a hydrocladium. (After Allman.)



PLUMULARIDÆ.

EXPLANATION TO PLATE VII.

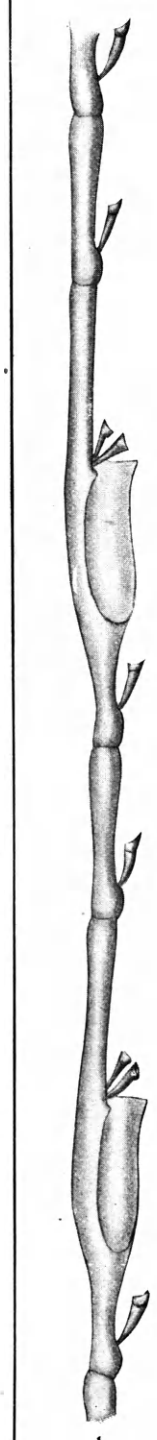
FIG. 1. *Plumularia goodei* Nutting. Part of stem, showing nodes and origin of hydrocladia (enlarged).
2. *Plumularia goodei.* A single hydrocladium (greatly enlarged).
3. *Plumularia goodei.* A hydrocladial internode (still more enlarged).
4. *Plumularia goodei.* Mesial nematophore (greatly magnified).
5. *Plumularia virginiæ* Nutting. Part of hydrocladium (enlarged).
6. *Plumularia virginiæ.* Single internode (greatly enlarged).
7. *Plumularia virginiæ.* Hydranth (greatly enlarged).
8. *Plumularia virginiæ.* Front of stem, showing internodes and origin of hydrocladia (enlarged).
9. *Plumularia virginiæ.* Nematophore, showing sareostyle (highly magnified).
10. *Plumularia virginiæ.* Gonangia (enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE VIII.

FIG. 1. *Plumularia macrotheca* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
2. *Plumularia profunda* Nutting. Part of hydrocladium (greatly enlarged).
3. *Plumularia profunda*. Part of hydrocladium, bearing gonangia (greatly enlarged).
4. *Plumularia dendritica* Nutting. Part of hydrocladium (enlarged).
5. *Plumularia dendritica*. Side view of hydrotheca (greatly enlarged).
6. *Plumularia dendritica*. Front view of hydrotheca (greatly enlarged).
7. *Plumularia paucinoda* Nutting. Part of stem (enlarged).
8. *Plumularia paucinoda*. Part of hydrocladium (enlarged).
9. *Plumularia paucinoda*. Part of hydrocladium (greatly enlarged).



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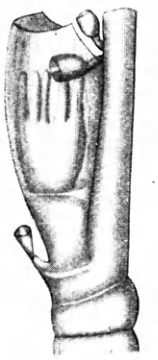

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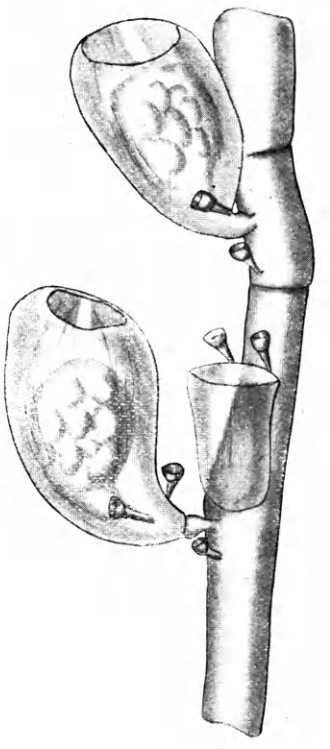

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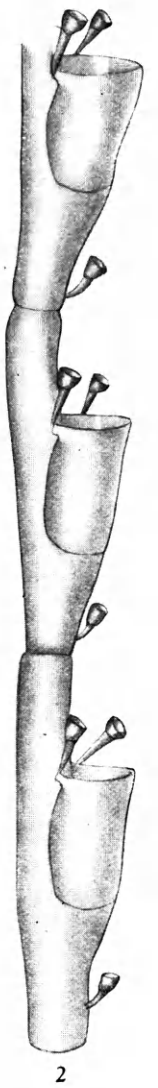

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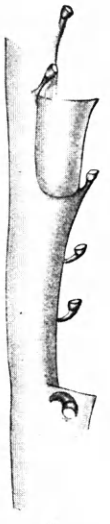

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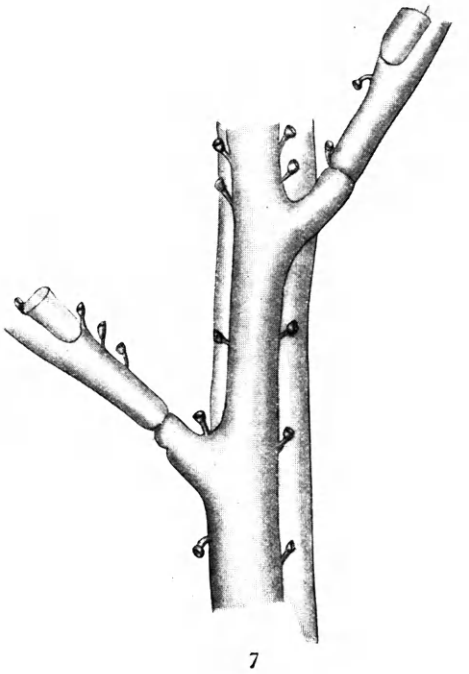

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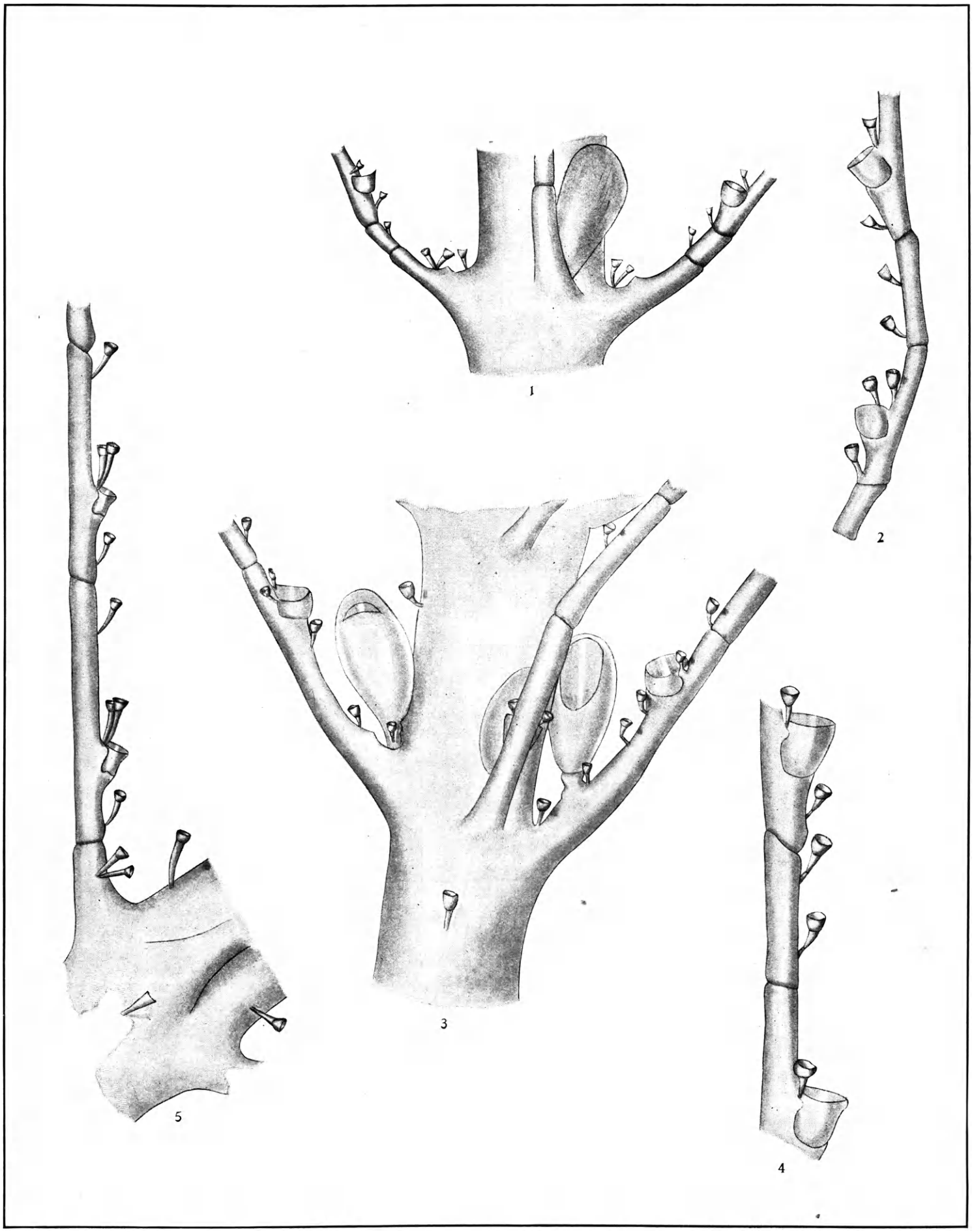
PLUMULARID.E.

EXPLANATION TO PLATE IX.

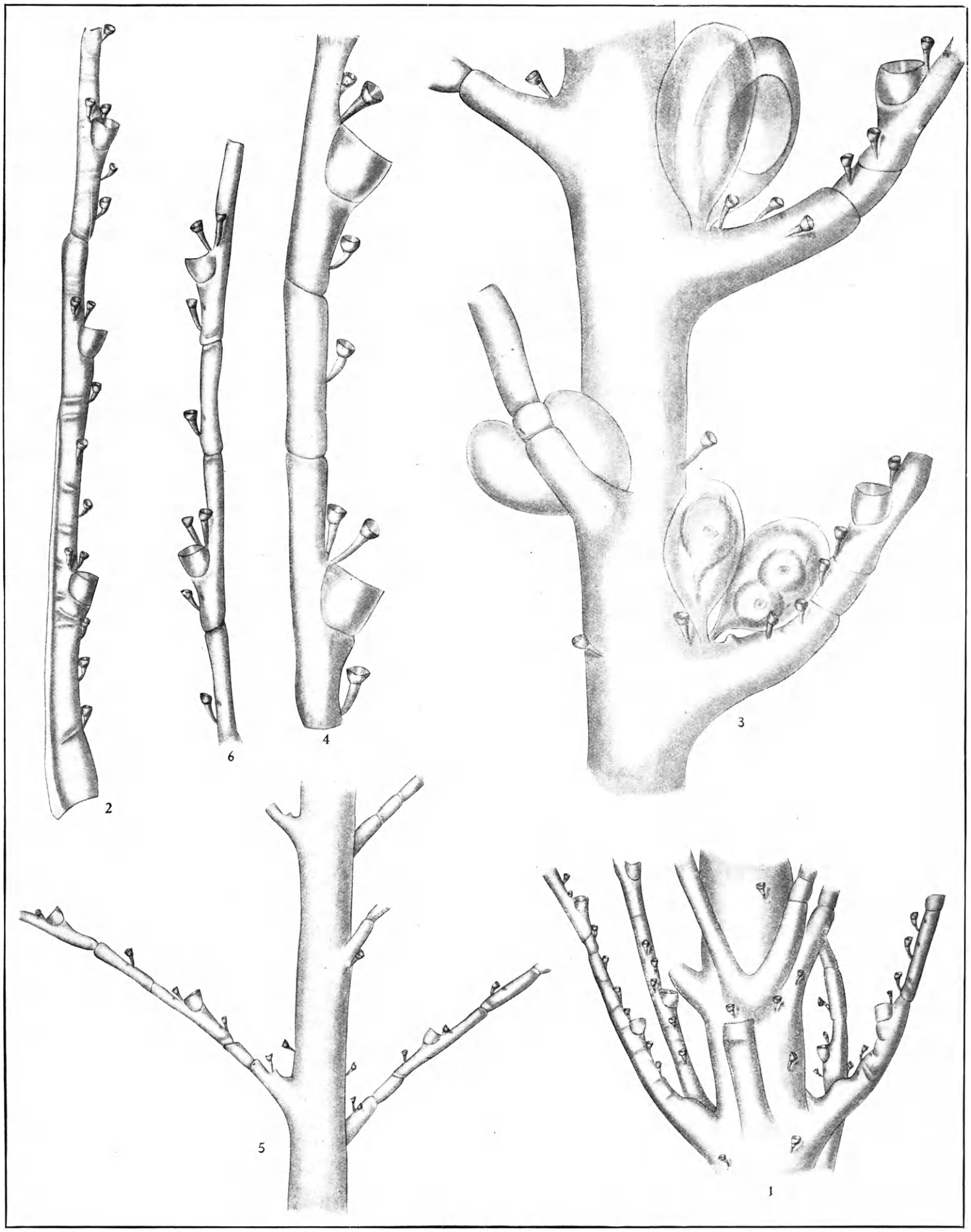
FIG. 1. *Antennularia antennina* Linnæus. Part of stem and bases of hydrocladia (enlarged).
2. *Antennularia antennina*. Part of hydrocladium (greatly enlarged).
3. *Antennularia americana* Nutting. Part of stem and hydrocladia (enlarged).
4. *Antennularia americana*. Part of hydrocladium (greatly enlarged).
5. *Antennularia simplex* Allman (enlarged). (After Allman.)



PLUMULARIDÆ.

EXPLANATION TO PLATE X.

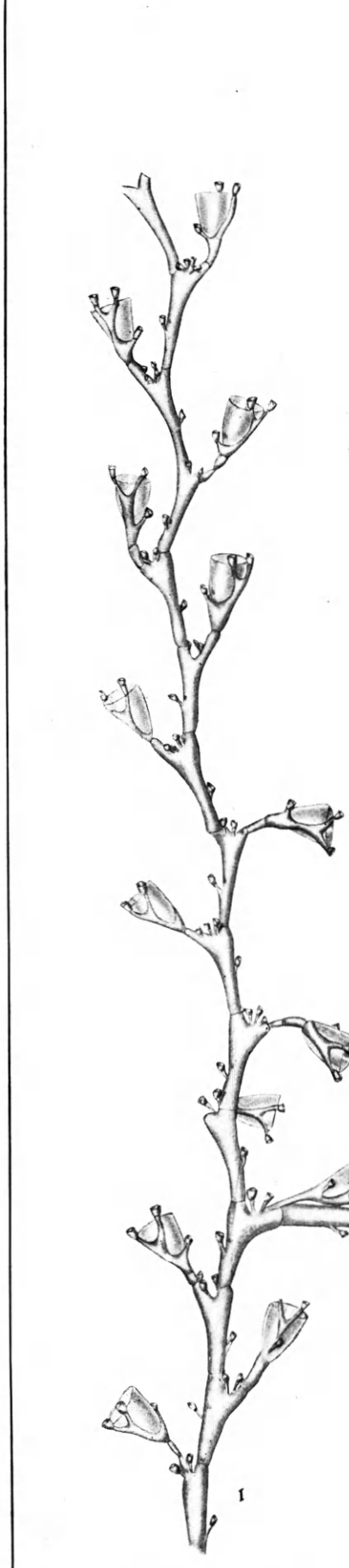
FIG. 1. *Antennularia rugosa* Nutting. Part of stem with hydrocladia (enlarged).
2. *Antennularia rugosa*. Hydrocladium, showing thickening of perisarc at base (greatly enlarged).
3. *Antennularia geniculata* Nutting. Portion of stem with bases of hydrocladia (enlarged).
4. *Antennularia geniculata*. Part of hydrocladium (greatly enlarged).
5. *Antennularia pinnata* Nutting. Part of stem with hydrocladia (enlarged).
6. *Antennularia pinnata*. Part of hydrocladium (greatly enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XI.

FIG. 1. *Monotheca margaretta* Nutting. Entire colony, except the hydrocaulus (enlarged).
2. *Monotheca margaretta*. Side view of hydrotheca (greatly enlarged).
3. *Monotheca margaretta*. Back view of hydrotheca (greatly enlarged).
4. *Antennopsis hippuris* Allman. Part of stem with hydrocladia (enlarged). (After Allman.)
5. *Antennopsis hippuris*. Part of hydrocladium (greatly enlarged). (After Allman.)
6. *Antennopsis hippuris*. Gonangia (enlarged). (After Allman.)



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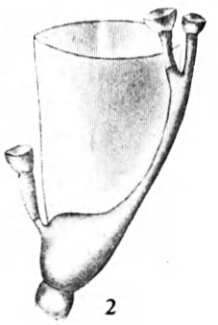

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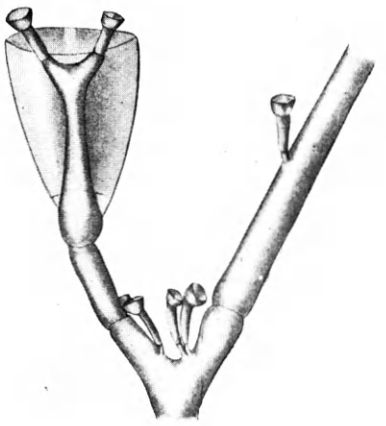

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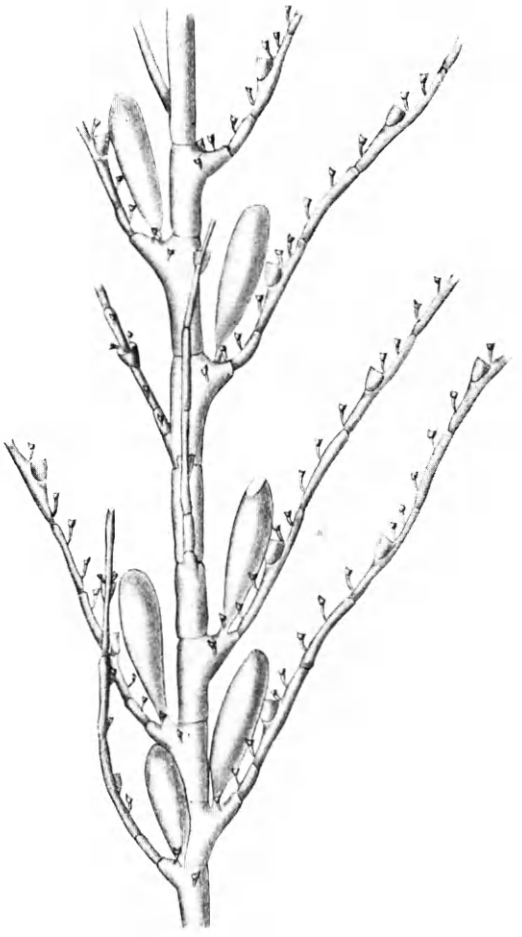

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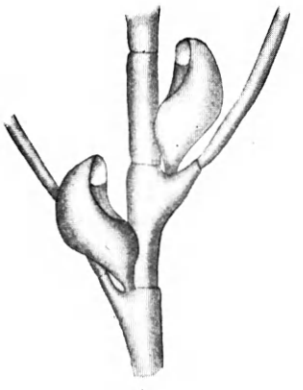

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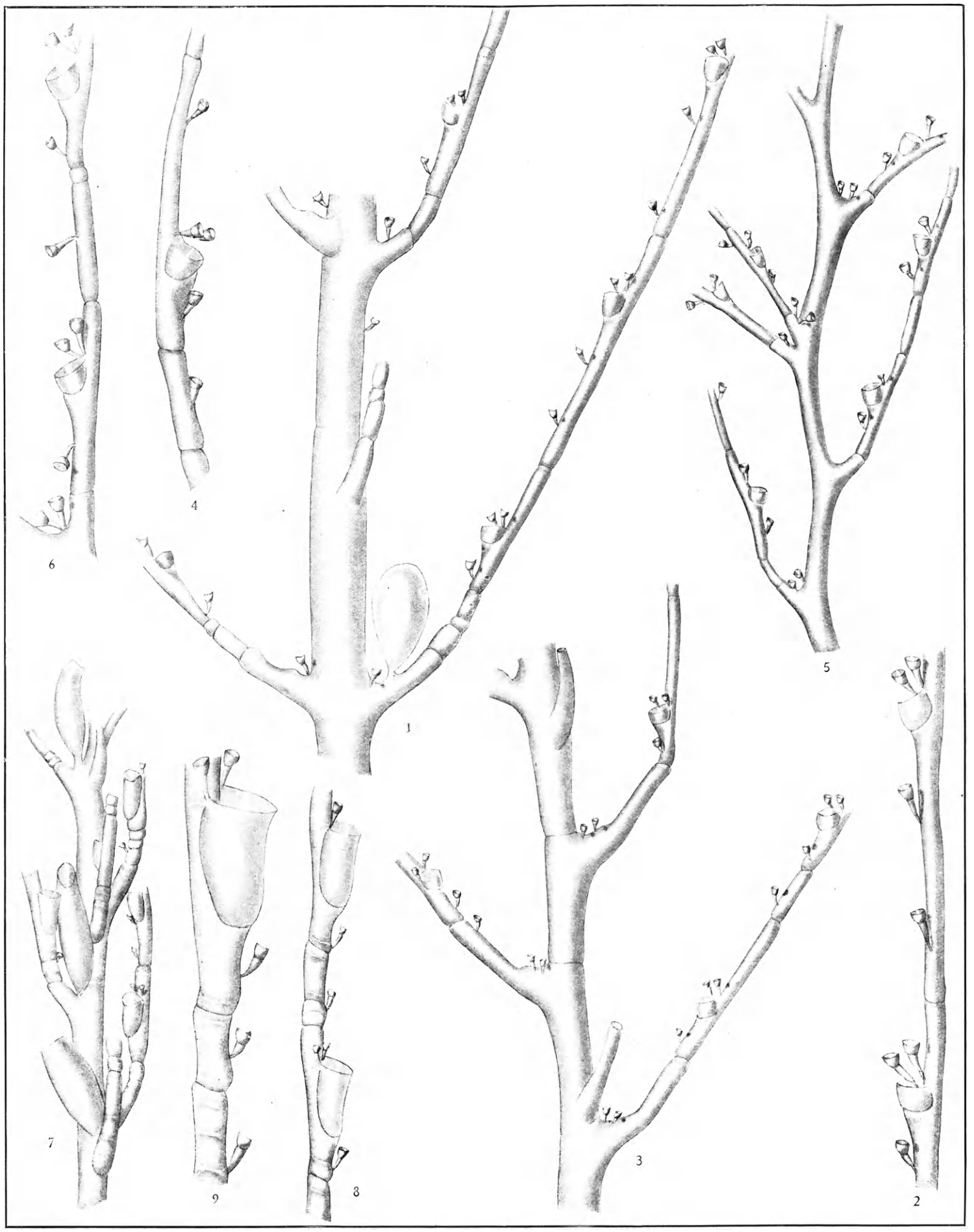
PLUMULARIDÆ.

EXPLANATION TO PLATE XII.

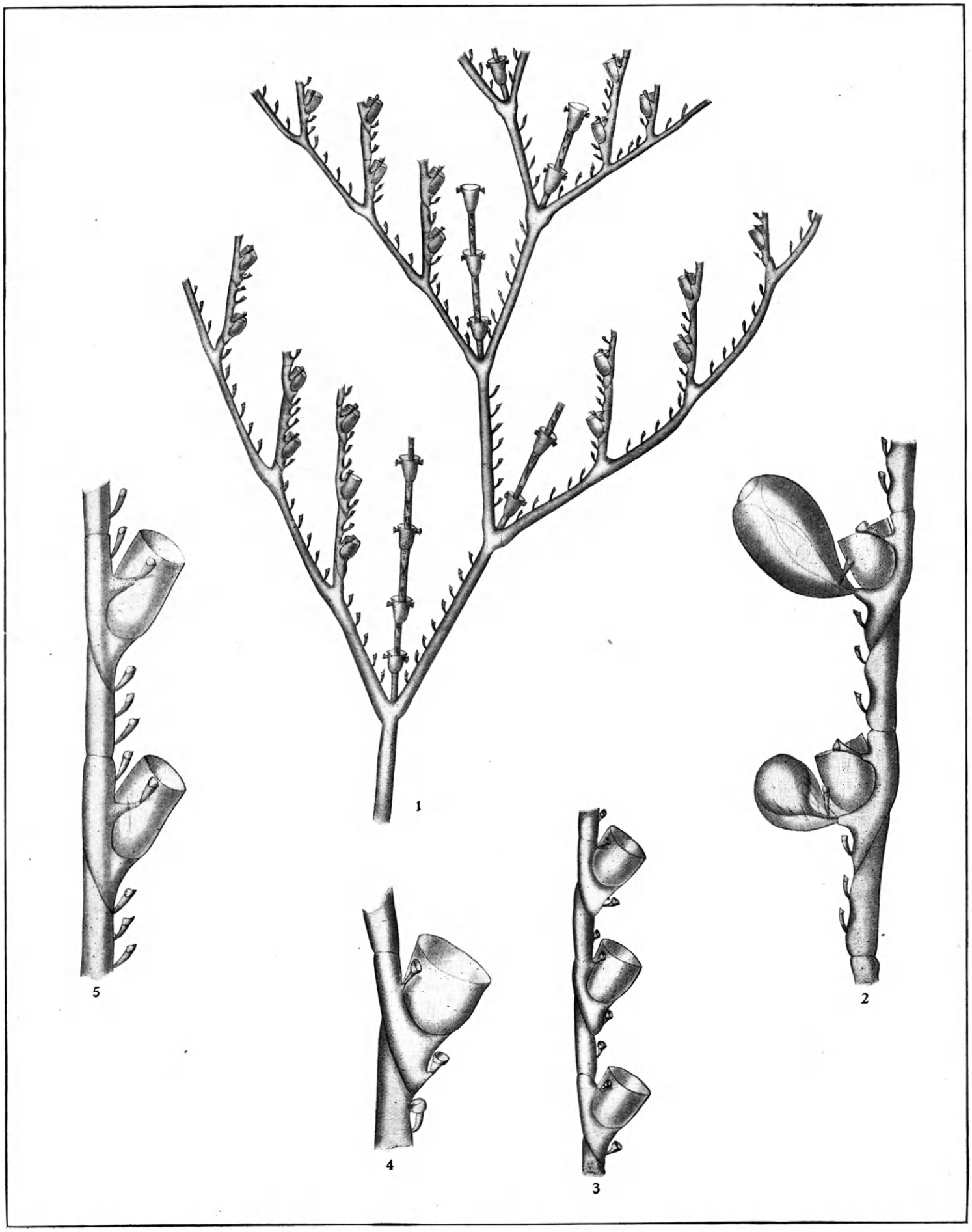
FIG. 1. *Antennopsis distans* Nutting. Part of stem with hydrocladia (enlarged).
2. *Antennopsis distans*. Part of hydrocladium (greatly enlarged).
3. *Antennopsis longicorna* Nutting. Part of stem with hydrocladia (enlarged).
4. *Antennopsis longicorna*. Part of hydrocladium (greatly enlarged).
5. *Antennopsis nigra* Nutting. Part of stem with hydrocladia (enlarged).
6. *Antennopsis nigra*. Part of hydrocladium (greatly enlarged).
7. *Antennopsis annulata* (Allman). Part of stem with hydrocladia and gonangia (enlarged).
8. *Antennopsis annulata*. Part of hydrocladium (greatly enlarged).
9. *Antennopsis annulata*. Part of hydrocladium (still more enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XIII.

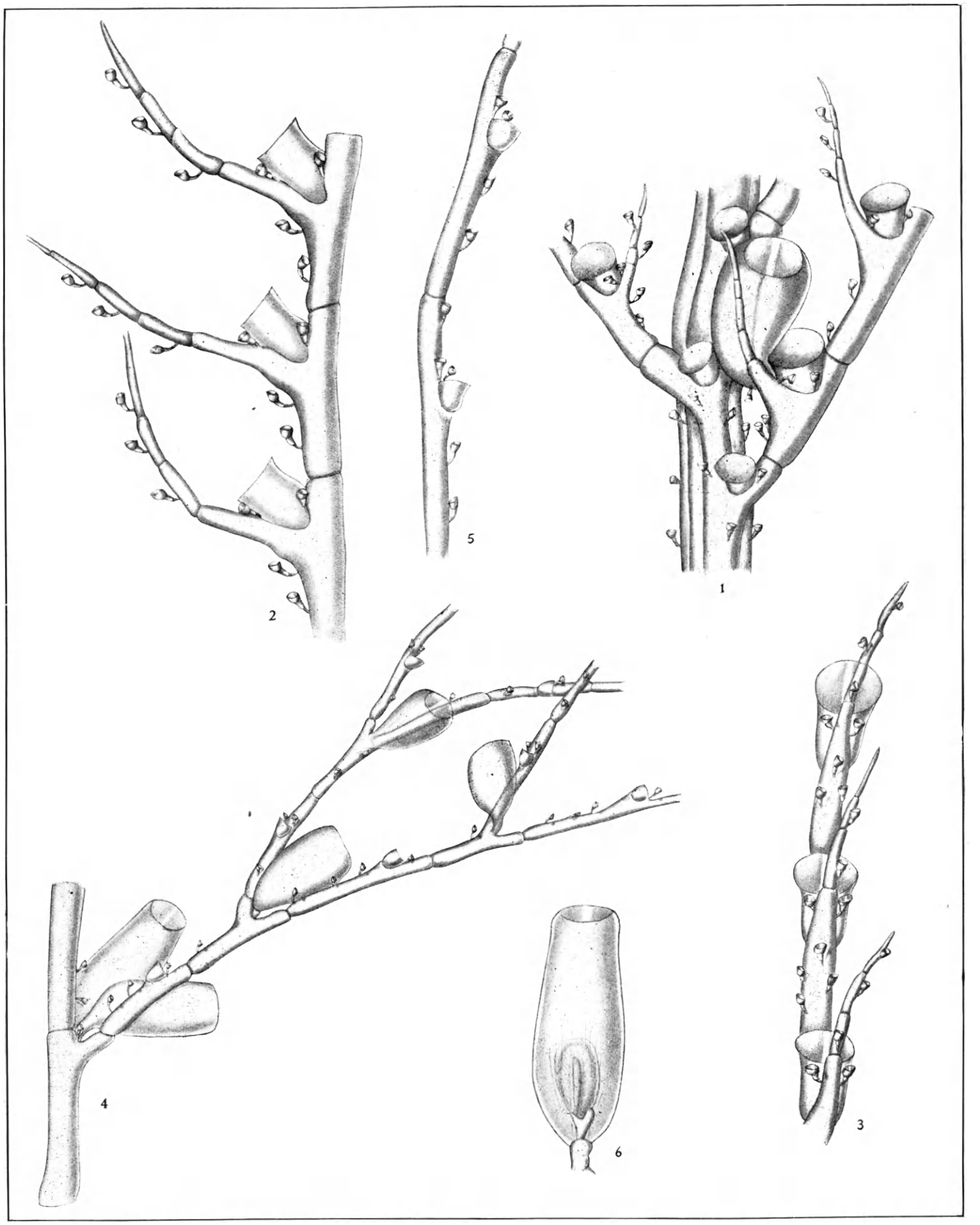
FIG. 1. *Monostachas quadridens* (McCrady). Part of colony dichotomously branching (enlarged). (After Allman.)
2. *Monostachas quadridens*. Part of hydrocladium, showing hydrothecæ and gonangia (greatly enlarged). (After Allman.)
3. *Monostachas quadridens*. Hydrocladium of form having closely approximated hydrothecæ (greatly enlarged).
4. *Monostachas quadridens*. Single hydrotheca of the same (greatly enlarged).
5. *Antennella gracilis* Allman. Portion of hydrocladium (greatly enlarged). (After Allman.)



PLUMULARIDÆ.

EXPLANATION TO PLATE XIV.

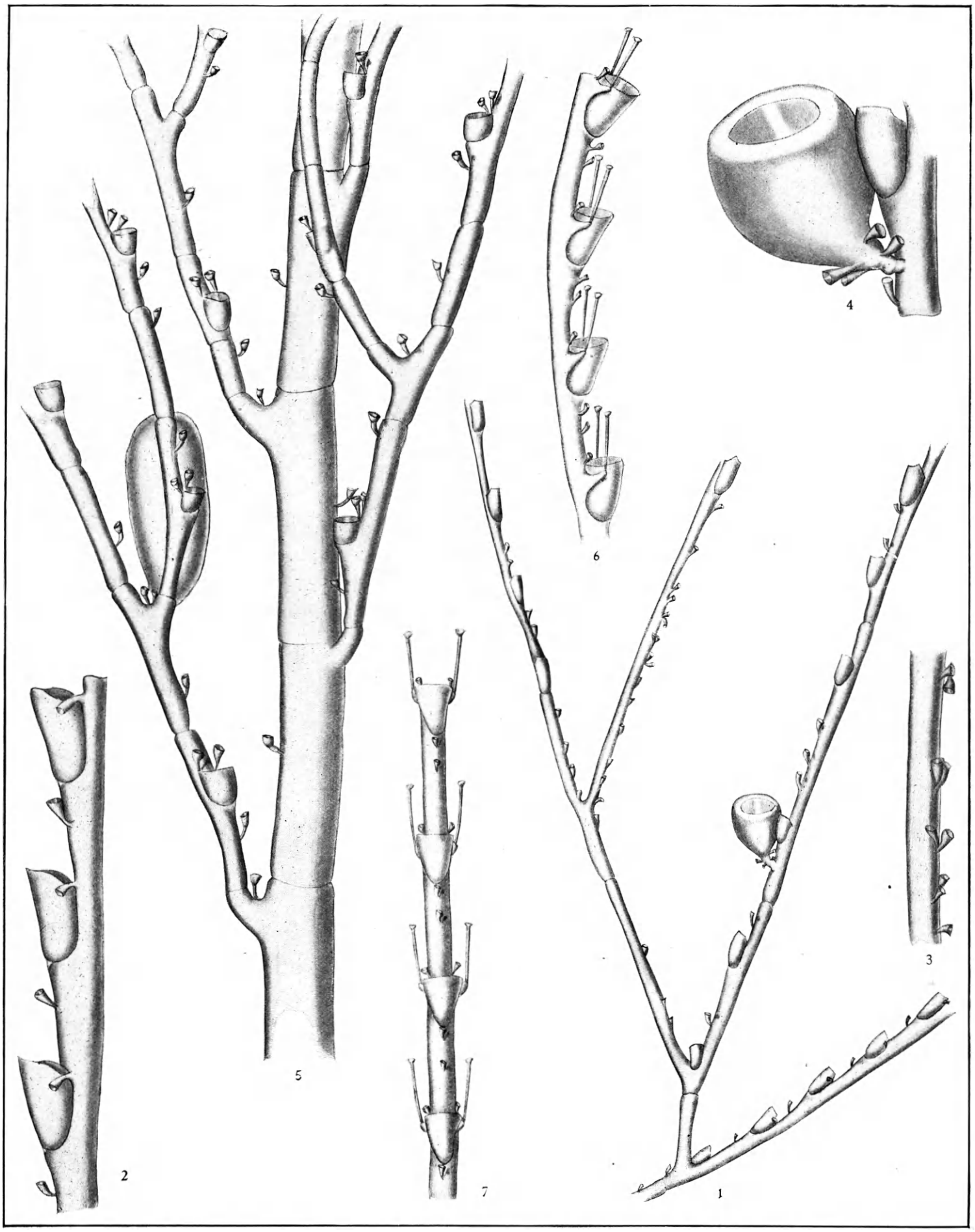
FIG. 1. *Calvinia mirabilis* Nutting. Portion of stem showing hydrothecæ and gonangia (enlarged).
2. *Calvinia mirabilis*. Part of hydrocladium, side view (greatly enlarged).
3. *Calvinia mirabilis*. Part of hydrocladium, front view (greatly enlarged).
4. *Schizotricha gracillima* (Sars). Showing branched hydrocladium (enlarged).
5. *Schizotricha gracillima*. Part of hydrocladium (greatly enlarged).
6. *Schizotricha gracillima*. Gonangium (enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XV.

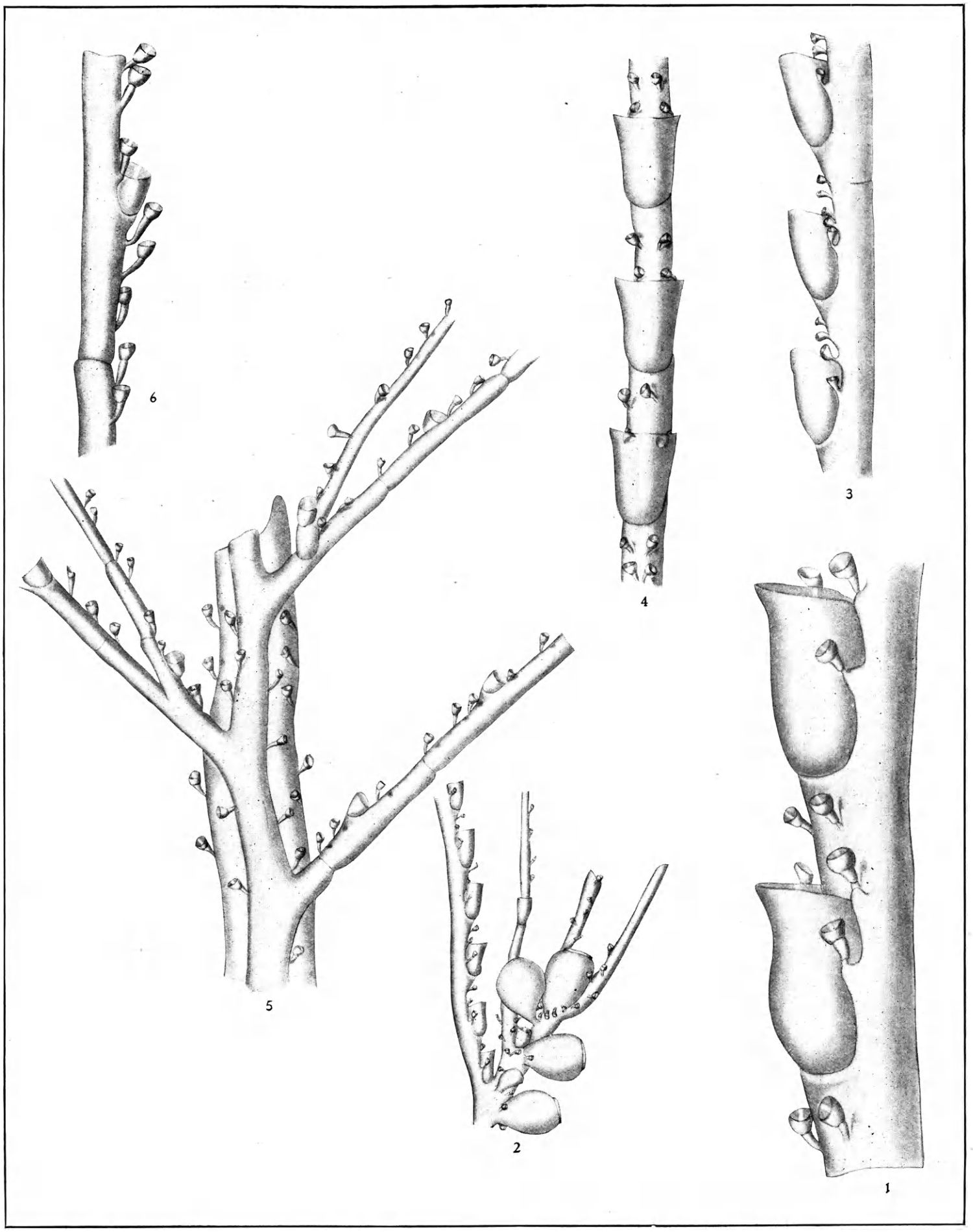
FIG. 1. *Schizotricha dichotoma* Nutting. Forked hydrocladium (enlarged).
2. *Schizotricha dichotoma*. Part of hydrocladium (greatly enlarged).
3. *Schizotricha dichotoma*. Nomatophorous branchlet of hydrocladium (greatly enlarged).
4. *Schizotricha dichotoma*. Gonangium (greatly enlarged).
5. *Schizotricha parvula* Nutting. Portion of stem and hydrocladia (enlarged).
6. *Diplopteron quadricorne* Nutting. Side view of hydrocladium (greatly enlarged).
7. *Diplopteron quadricorne*. Front view of hydrocladium (greatly enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XVI.

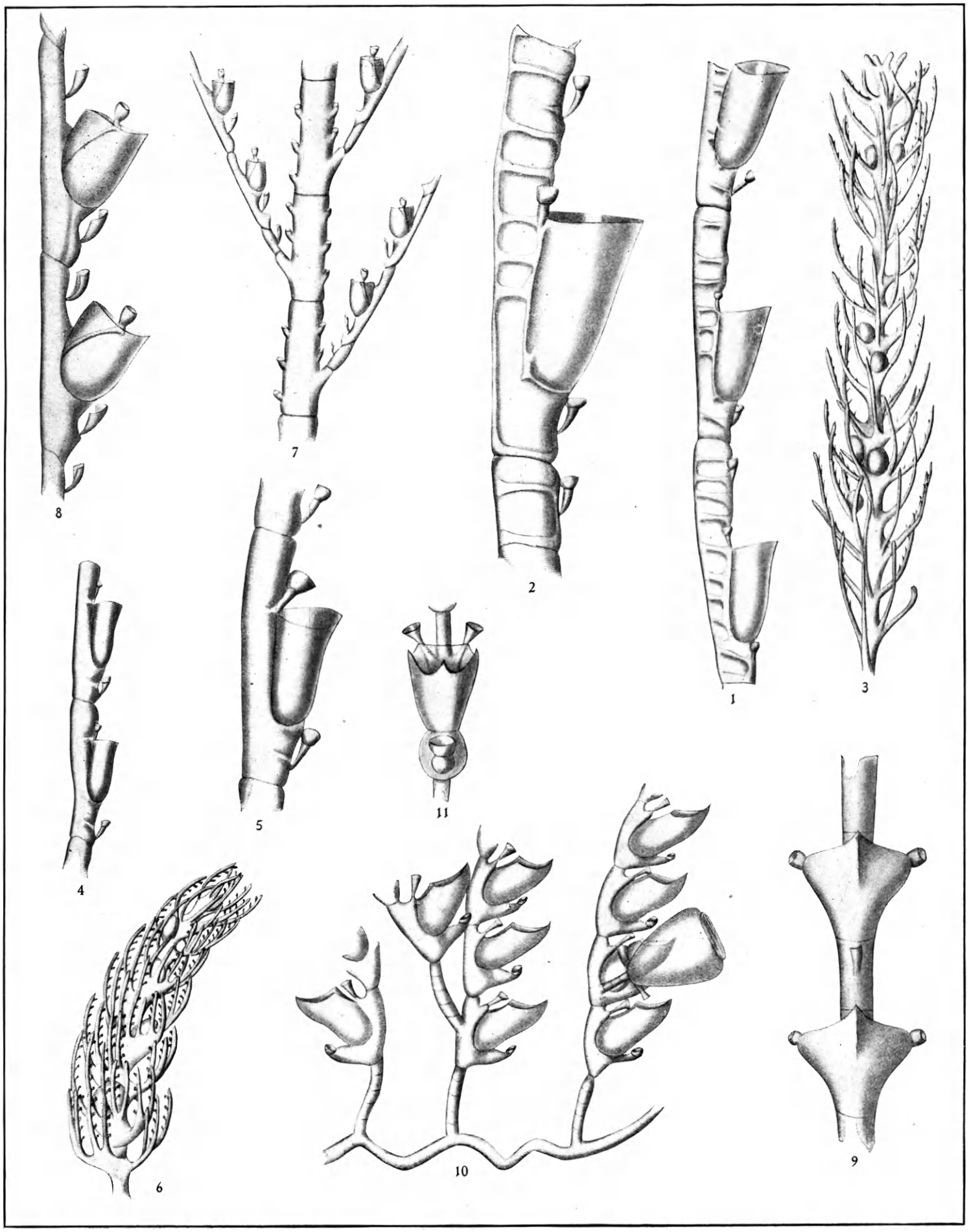
FIG. 1. *Diplopteron grande* Nutting. Side view of portion of a hydrocladium (greatly enlarged).
2. *Diplopteron grande.* Hydrocladium, phylactocarp, and gonangia (enlarged).
3. *Diplopteron longipinna* Nutting. Side view of part of hydrocladium (greatly enlarged).
4. *Diplopteron longipinna.* Front view of part of hydrocladium (greatly enlarged).
5. *Polyplumularia armata* Nutting. Part of stem and hydrocladia (enlarged).
6. *Polyplumularia armata.* Part of hydrocladium (greatly enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XVII.

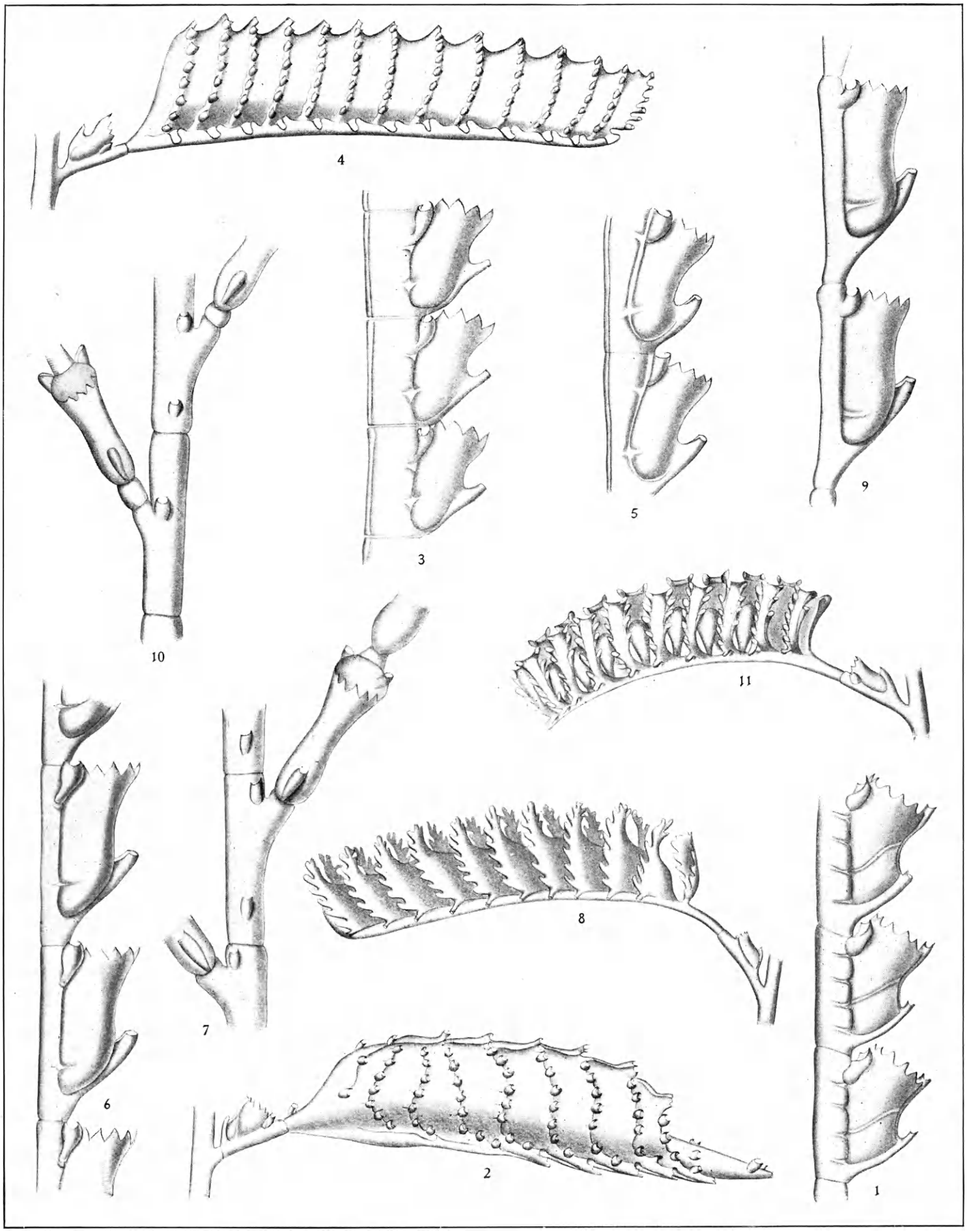
FIG. 1. *Hippurella longicarpa* Nutting. Part of hydrocladium (enlarged).
2. *Hippurella longicarpa.* Hydrocladial internode (greatly enlarged).
3. *Hippurella longicarpa.* Phylactocarp and gonangia (enlarged).
4. *Callicarpa gracilis* Fewkes. Part of hydrocladium (enlarged).
5. *Callicarpa gracilis.* Hydrocladial internode (greatly enlarged).
6. *Callicarpa gracilis* Phylactocarp (enlarged).
7. *Halopteris carinata* Allman. Part of colony (enlarged). (After Allman.)
8. *Halopteris carinata.* Part of hydrocladium, side view (greatly enlarged). (After Allman.)
9. *Halopteris carinata.* Front view of hydrothecæ (greatly enlarged). (After Allman.)
10. *Gattya humilis* Allman (enlarged). (After Allman.)
11. *Gattya humilis.* Front view of hydrotheca (greatly enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XVIII.

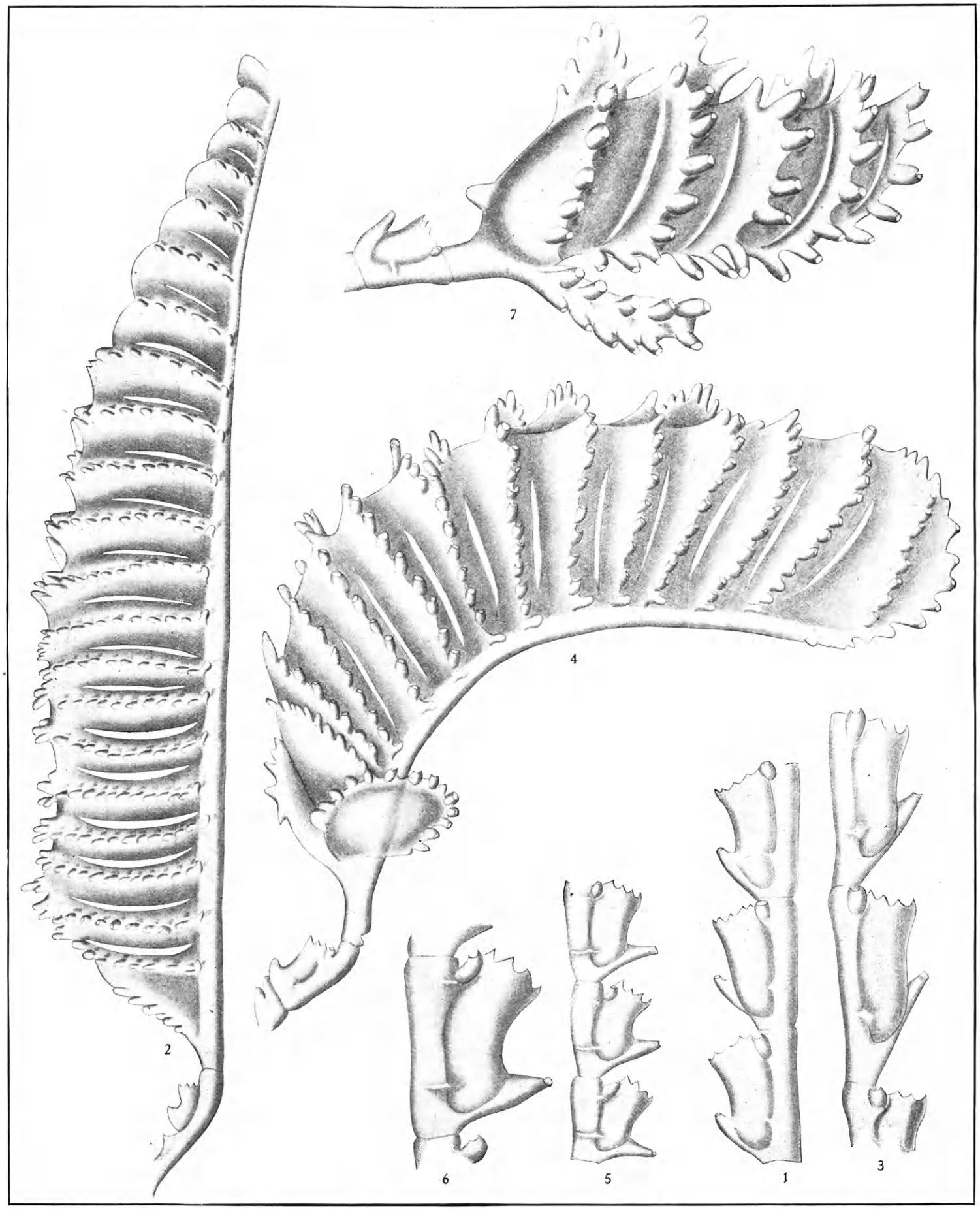
FIG. 1. *Aglaophenia rhynchocarpa* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
2. *Aglaophenia rhynchocarpa.* Corbula (enlarged). (After Allman.)
3. *Aglaophenia rigida* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
4. *Aglaophenia rigida.* Corbula (enlarged). (After Allman.)
5. *Aglaophenia dubia* (Nutting). Part of hydrocladium (greatly enlarged). (After Allman.)
6. *Aglaophenia lophocarpa* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
7. *Aglaophenia lophocarpa.* Front view of stem (greatly enlarged). (After Allman.)
8. *Aglaophenia lophocarpa.* Corbula (enlarged). (After Allman.)
9. *Aglaophenia apocarpa* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
10. *Aglaophenia apocarpa.* Front view of stem (greatly enlarged). (After Allman.)
11. *Aglaophenia apocarpa.* Corbula (enlarged). (After Allman.)



PLUMULARIDÆ.

EXPLANATION TO PLATE XIX.

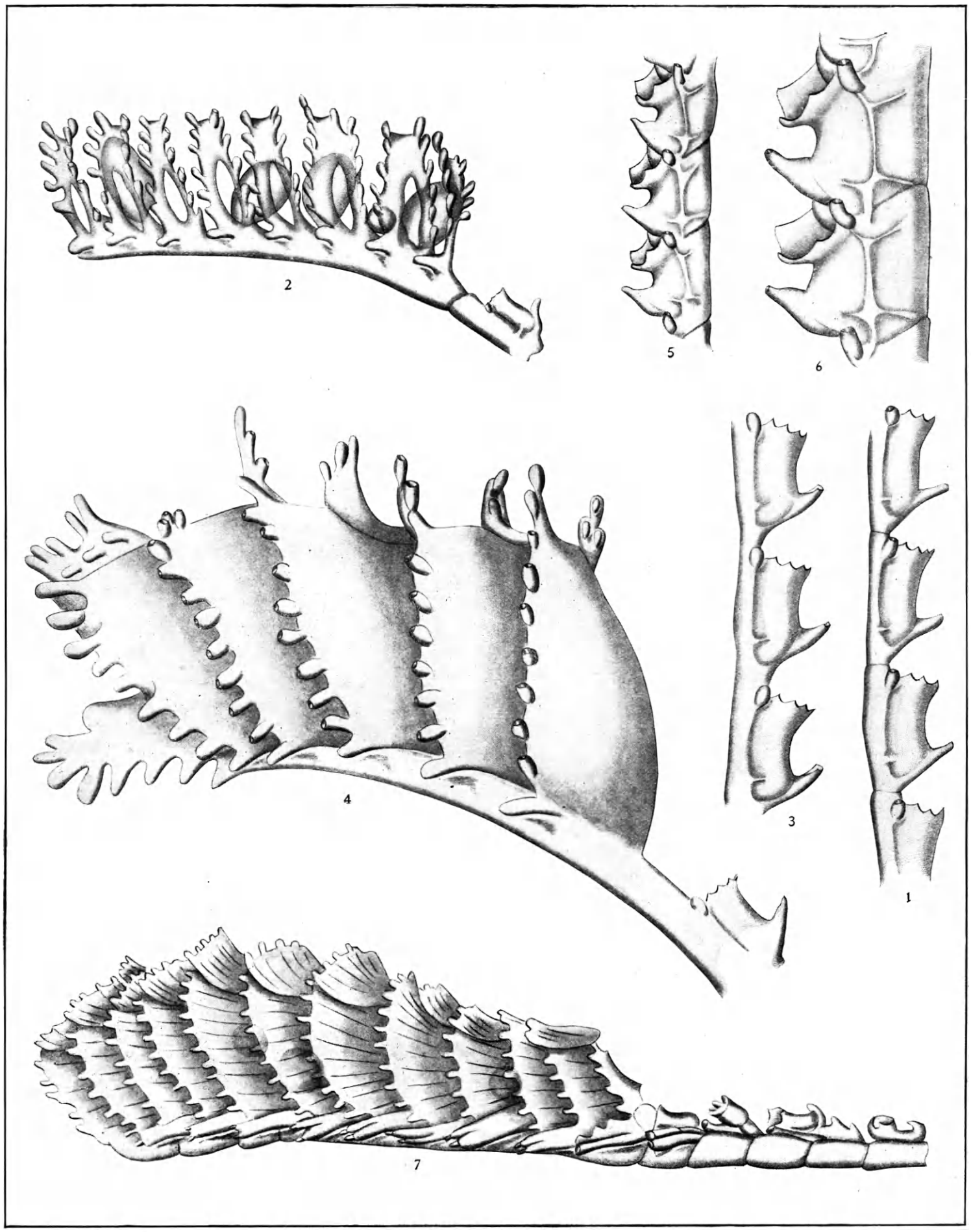
FIG. 1. *Aglaophenia flowersi* Nutting. Part of hydrocladium (greatly enlarged).
2. *Aglaophenia flowersi*. Corbula (enlarged).
3. *Aglaophenia elegans* Nutting. Part of hydrocladium (greatly enlarged).
4. *Aglaophenia elegans*. Corbula (enlarged).
5. *Aglaophenia insignis* Fewkes. Part of hydrocladium (enlarged).
6. *Aglaophenia insignis*. Hydrotheca (greatly enlarged).
7. *Aglaophenia insignis*. Corbula (enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XX.

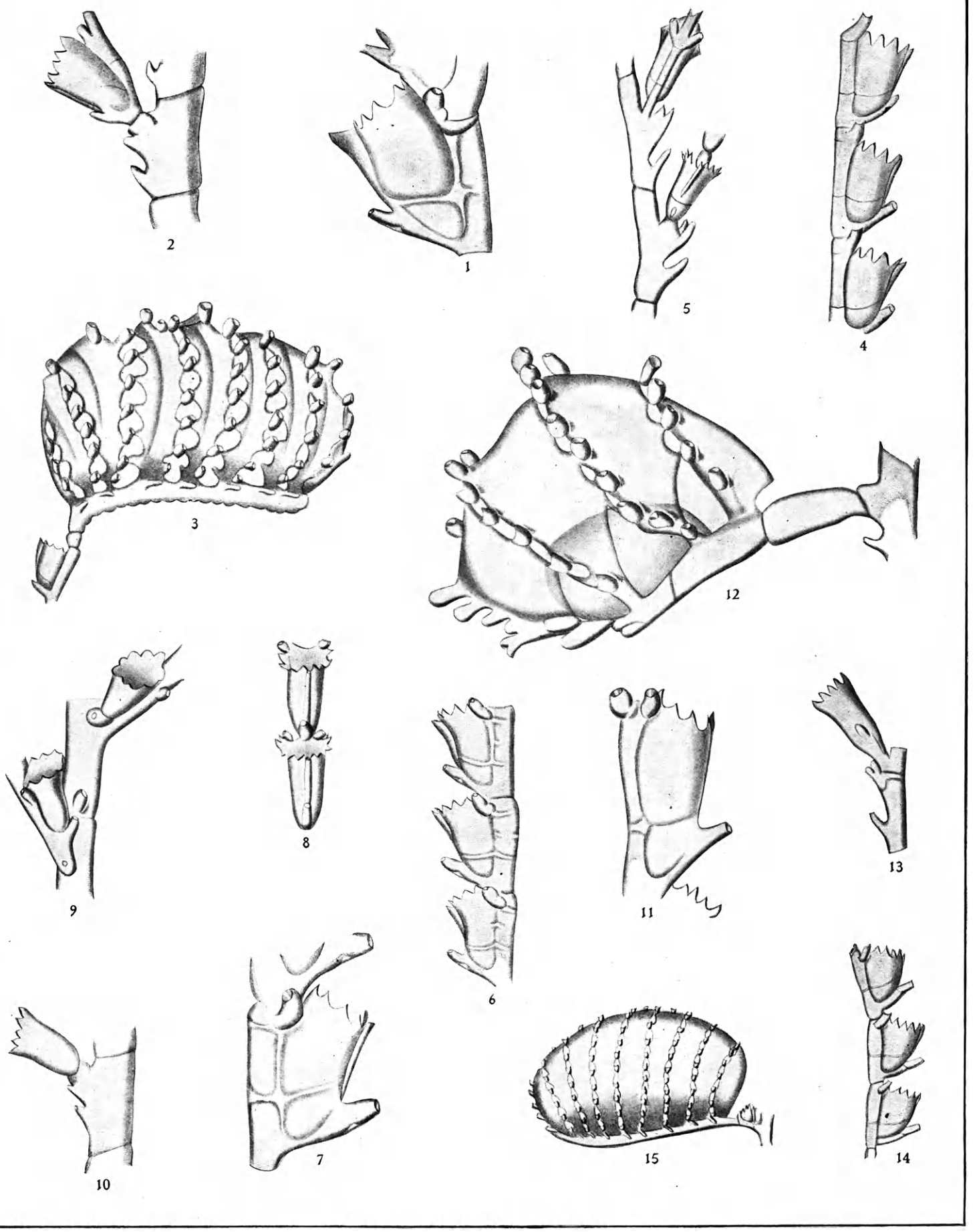
FIG. 1. *Aglaophenia aperta* **Nutting.** Part of hydrocladium (greatly enlarged).
2. *Aglaophenia aperta.* Corbula (enlarged).
3. *Aglaophenia cristifrons* Nutting. Part of hydrocladium (greatly enlarged).
4. *Aglaophenia cristifrons.* Corbula (enlarged).
5. *Aglaophenia contorta* Nutting. Part of hydrocladium (enlarged).
6. *Aglaophenia contorta.* Hydrotheca (greatly enlarged).
7. *Aglaophenia contorta.* Corbula (enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XXI.

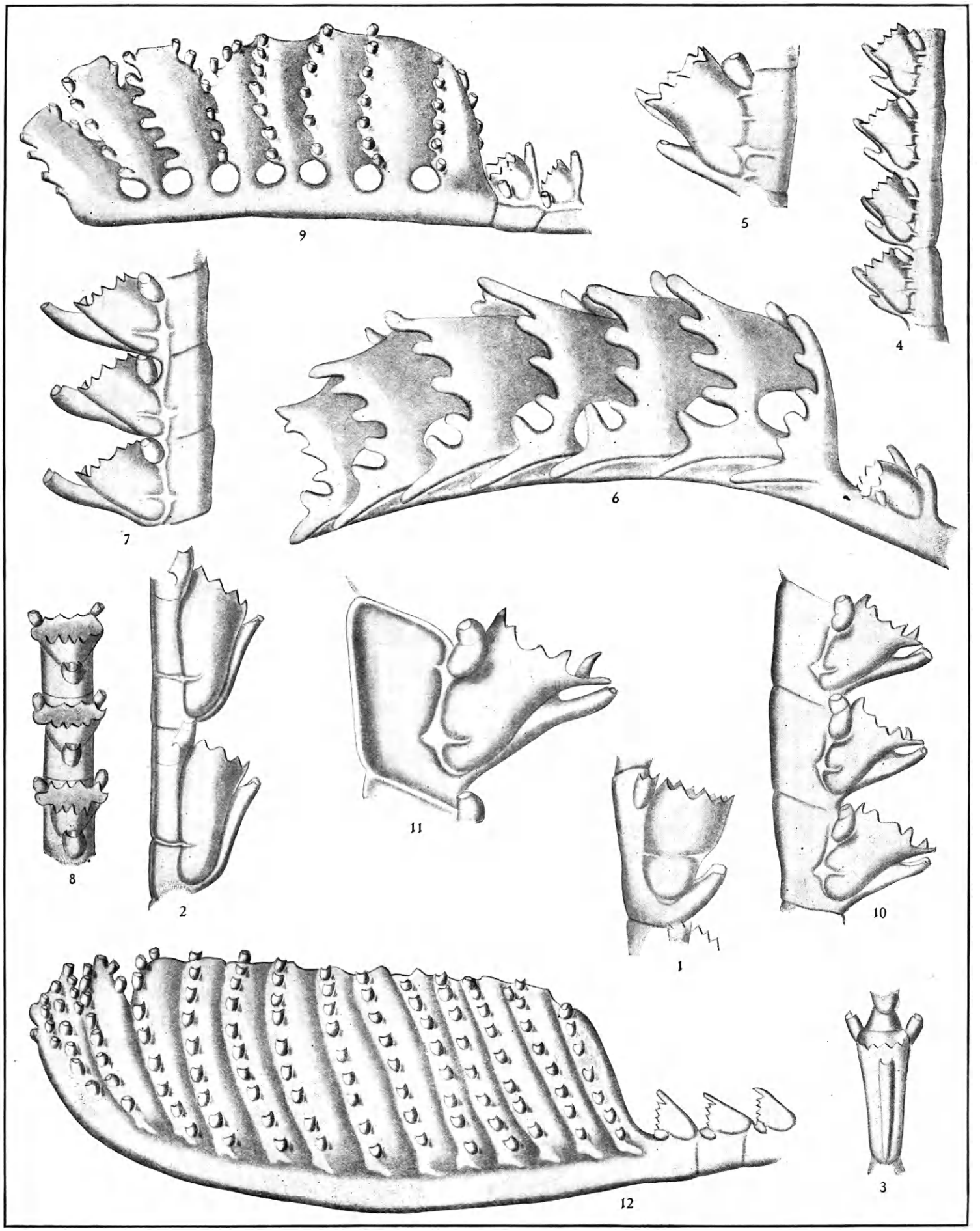
FIG. 1. *Aglaophenia minuta* Fewkes. Hydrotheca (greatly enlarged).
2. *Aglaophenia minuta*. Base of hydrocladium, showing the processes (enlarged).
3. *Aglaophenia minuta*. Corbula (enlarged).
4. *Aglaophenia perpusilla* Allman. Part of hydrocladium (enlarged). (After Allman.)
5. *Aglaophenia perpusilla*. Side view of stem, showing processes at bases of hydrocladia (enlarged). (After Allman.)
6. *Aglaophenia mammillata* Nutting. Part of hydrocladium (enlarged).
7. *Aglaophenia mammillata*. Hydrotheca (greatly enlarged).
8. *Aglaophenia mammillata*. Front view of hydrotheca (enlarged).
9. *Aglaophenia mammillata*. Front view of stem (enlarged).
10. *Aglaophenia mammillata*. Side view of stem, showing processes (enlarged).
11. *Aglaophenia minima* Nutting. Hydrotheca (greatly enlarged).
12. *Aglaophenia minima*. Corbula (enlarged).
13. *Aglaophenia minima*. Side view of stem, showing processes (enlarged).
14. *Aglaophenia perforata* Allman. Part of hydrocladium (enlarged). (After Allman.)
15. *Aglaophenia perforata*. Corbula (enlarged). (After Allman.)



PLUMULARIDÆ.

EXPLANATION TO PLATE XXII.

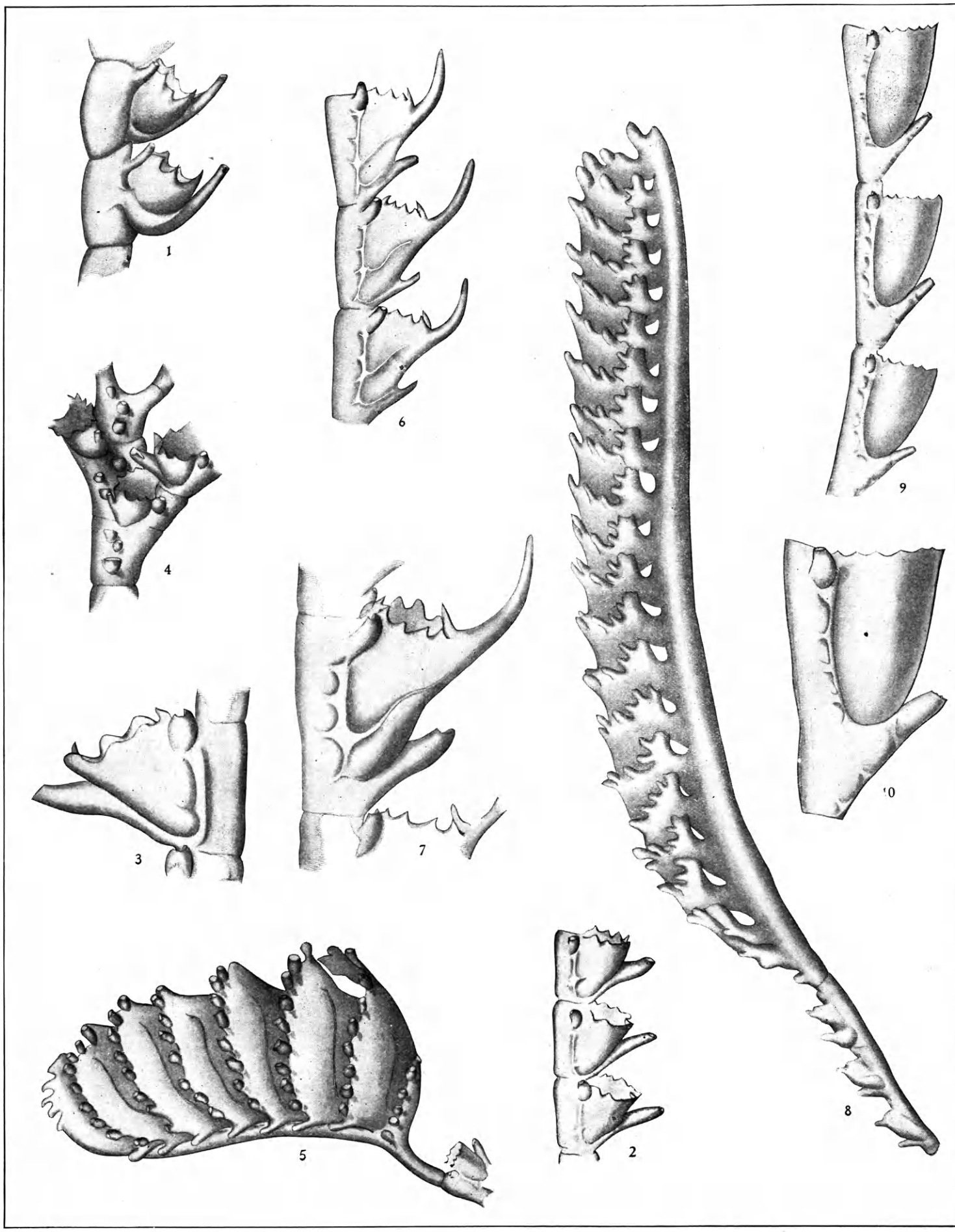
FIG. 1. *Aglaophenia simplex* Kirchenpauer. Hydrotheca (greatly enlarged). (After Kirchenpauer.)
2. *Aglaophenia allmani* Nutting. Side view of hydrothecæ (greatly enlarged). (After Allman.)
3. *Aglaophenia allmani*. Front view of hydrotheca (greatly enlarged). (After Allman.)
4. *Aglaophenia rathbuni* Nutting. Part of hydrocladium (enlarged).
5. *Aglaophenia rathbuni*. Hydrotheca (greatly enlarged).
6. *Aglaophenia rathbuni*. Corbula (enlarged).
7. *Aglaophenia latirostris* Nutting. Part of hydrocladium (greatly enlarged).
8. *Aglaophenia latirostris*. Front view of hydrothecæ (greatly enlarged).
9. *Aglaophenia latirostris*. Corbula (greatly enlarged).
10. *Aglaophenia struthionides* (Murray). Part of hydrocladium (enlarged).
11. *Aglaophenia struthionides*. Hydrotheca (greatly enlarged).
12. *Aglaophenia struthionides*. Corbula (enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XXIII.

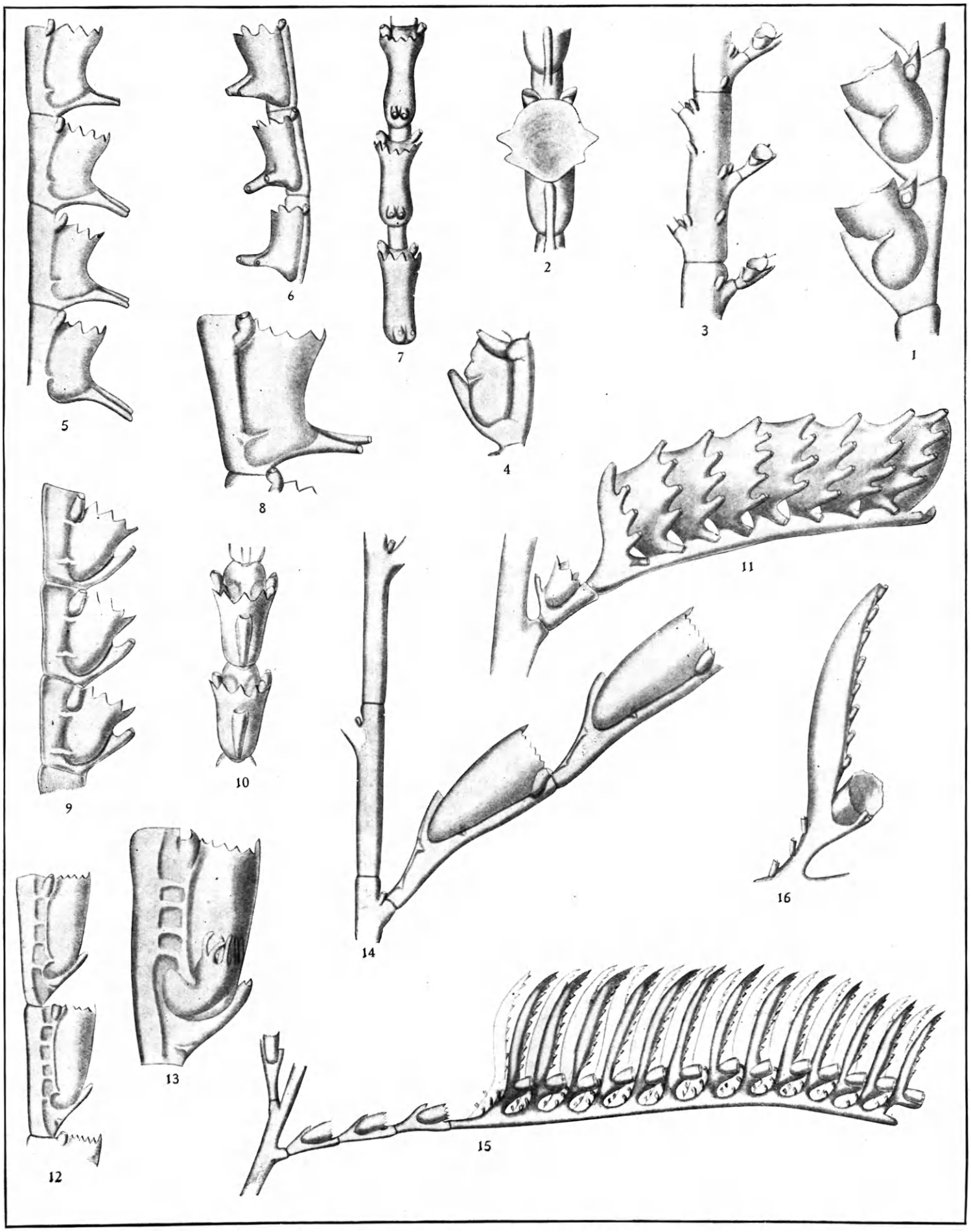
FIG. 1. *Aglaophenia ramulosa* Kirchenpauer (greatly enlarged). (After Kirchenpauer.)
2. *Aglaophenia octocarpa* Nutting. Part of hydrocladium (enlarged).
3. *Aglaophenia octocarpa*. Hydrotheca (greatly enlarged).
4. *Aglaophenia octocarpa*. Front view of stem (enlarged).
5. *Aglaophenia octocarpa*. Corbula (enlarged).
6. *Aglaophenia gracillima* Fewkes. Part of hydrocladium (enlarged).
7. *Aglaophenia gracillima*. Hydrotheca (greatly enlarged).
8. *Aglaophenia gracillima*. Corbula (enlarged).
9. *Aglaophenia crenata* Fewkes. Part of hydrocladium (enlarged).
10. *Aglaophenia crenata*. Hydrotheca (greatly enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XXIV.

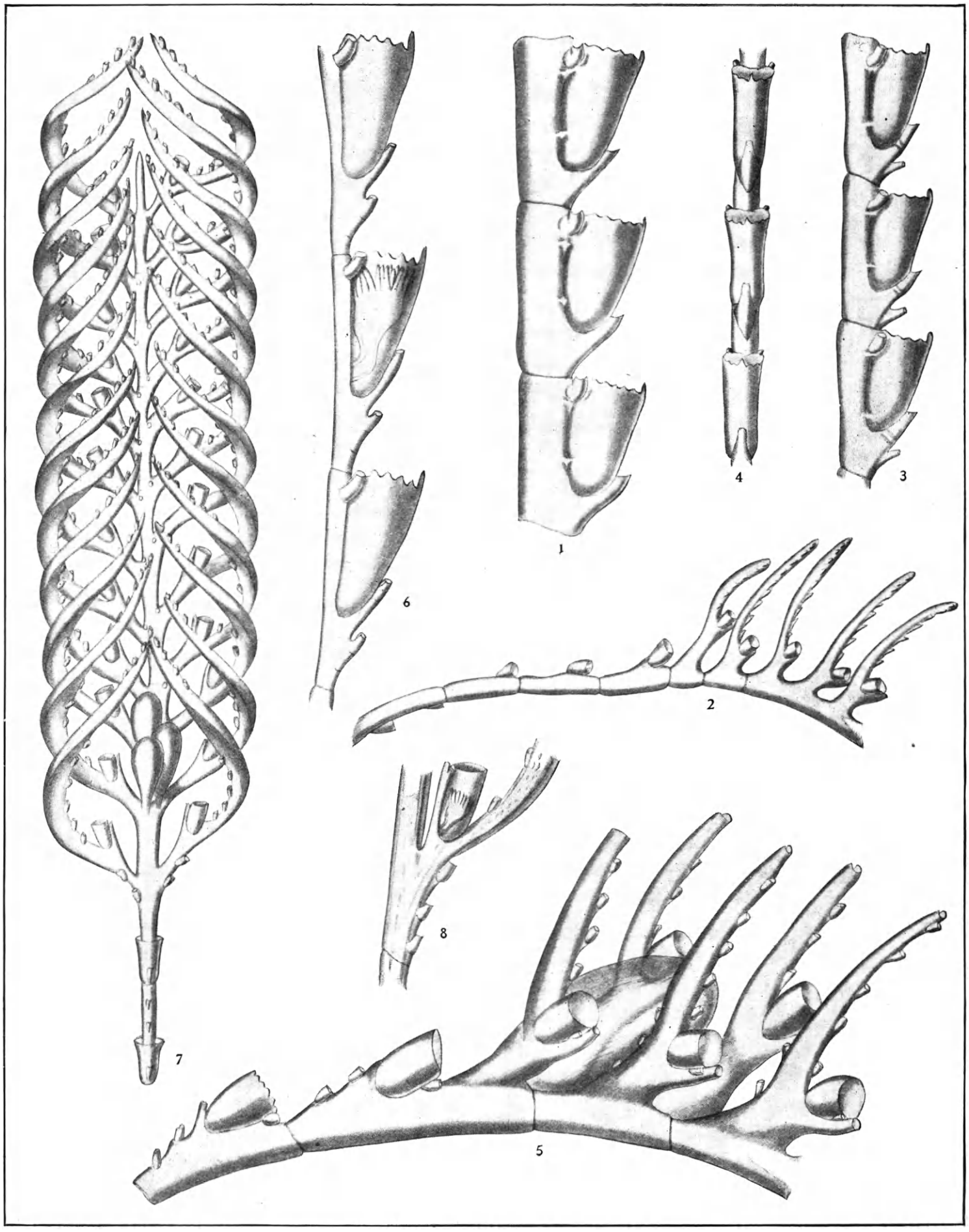
FIG. 1. *Aglaophenia constricta* Allman. Side view of hydrotheca (greatly enlarged). (After Allman.)
2. *Aglaophenia constricta*. Front view of hydrotheca (greatly enlarged). (After Allman.)
3. *Aglaophenia constricta*. Front of stem (enlarged). (After Allman.)
4. *Aglaophenia sarignyana* Marktanner-Turneretscher (enlarged). (After Marktanner-Turneretscher.)
5. *Aglaophenia bicornuta* Nutting. Part of hydrocladium (enlarged).
6. *Aglaophenia bicornuta*. Quartering view of hydrotheca (enlarged).
7. *Aglaophenia bicornuta*. Front view of hydrotheca (enlarged).
8. *Aglaophenia bicornuta*. Hydrotheca (greatly enlarged).
9. *Aglaophenia calamus* Allman. Part of hydrocladium (enlarged). (After Allman.)
10. *Aglaophenia calamus*. Front view of hydrotheca (enlarged). (After Allman.)
11. *Aglaophenia calamus* Corbula (enlarged). (After Allman.)
12. *Thecocarpus myriophyllum* (Linnaeus). Part of hydrocladium (enlarged).
13. *Thecocarpus myriophyllum*. Hydrotheca (greatly enlarged).
14. *Thecocarpus distans* (Allman). Part of hydrocladium (greatly enlarged). (After Allman.)
15. *Thecocarpus distans*. Corbula (enlarged). (After Allman.)
16. *Thecocarpus distans*. Corbula leaf (enlarged). (After Allman.)



PLUMULARIDÆ.

EXPLANATION TO PLATE XXV.

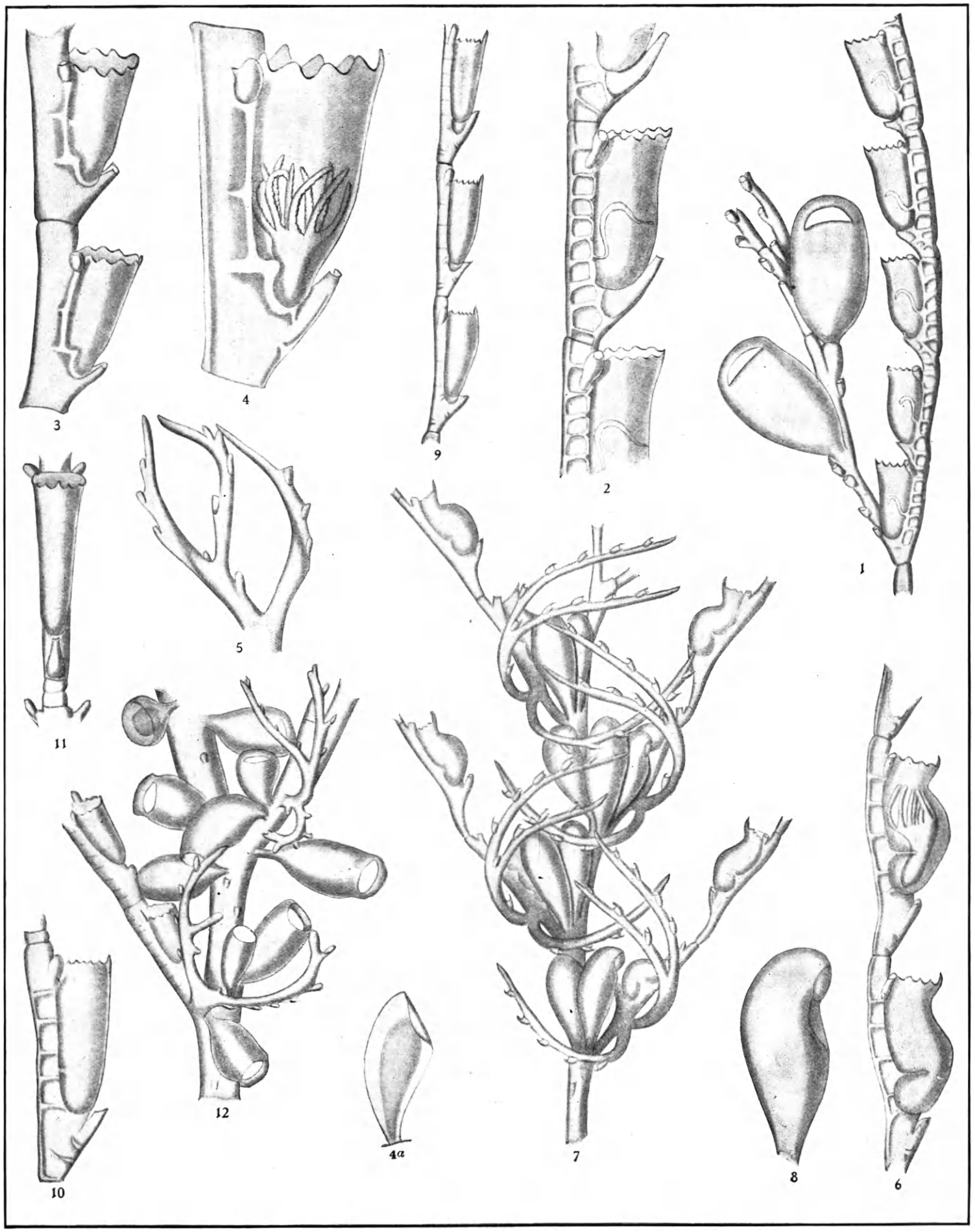
FIG. 1. *Thecocarpus normani* Nutting. Part of hydrocladium (greatly enlarged).
2. *Thecocarpus normani.* Basal part of corbula, and corbula stem (enlarged).
3. *Thecocarpus benedicti* Nutting. Part of hydrocladium (greatly enlarged).
4. *Thecocarpus benedicti.* Front view of hydrothecæ (greatly enlarged).
5. *Thecocarpus benedicti.* Part of corbula (enlarged).
6. *Thecocarpus bispinosus* (Allman). Part of hydrocladium (greatly enlarged). (After Allman.)
7. *Thecocarpus bispinosus.* Corbula (enlarged). (After Allman.)
8. *Thecocarpus bispinosus.* Base of corbula leaf (enlarged). (After Allman.)



PLUMULARIDÆ.

EXPLANATION TO PLATE XXVI.

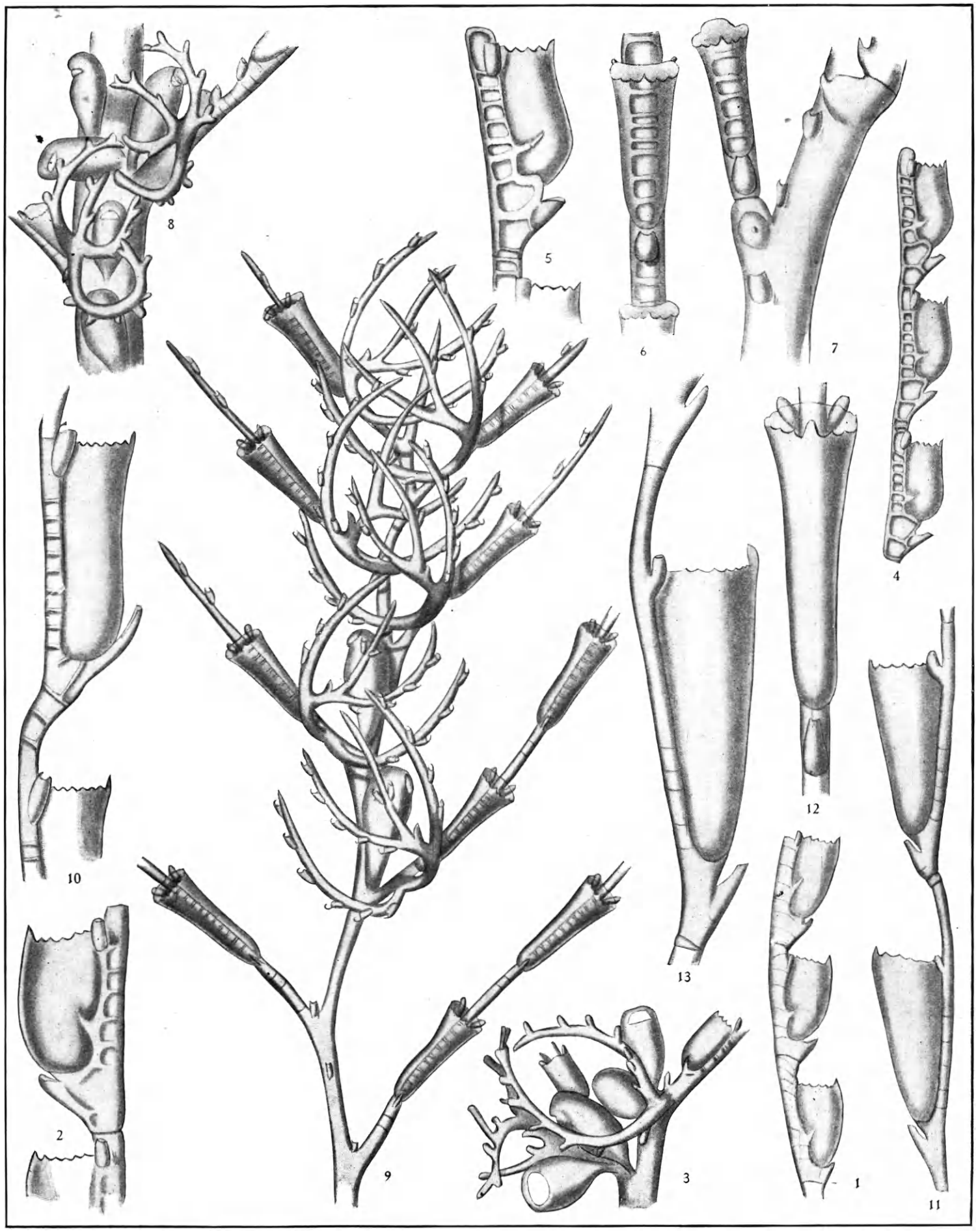
FIG. 1. *Cladocarpus sigma* (Allman). Hydrocladium bearing phylactocarp and gonangia (enlarged).
2. *Cladocarpus sigma*. Part of hydrocladium (greatly enlarged).
3. *Cladocarpus compressus* Nutting. Part of hydrocladium (enlarged).
4. *Cladocarpus compressus*. Hydrotheca (greatly enlarged).
5. *Cladocarpus compressus*. Phylactogonium (enlarged).
6. *Cladocarpus ventricosus* Allman. Part of hydrocladium (after Allman).
7. *Cladocarpus ventricosus*. Part of colony showing phylactogonia and gonangia (after Allman).
8. *Cladocarpus ventricosus*. Gonangium (after Allman).
9. *Cladocarpus flexilis* Verrill. Part of hydrocladium.
10. *Cladocarpus flexilis*. Side view of hydrotheca.
11. *Cladocarpus flexilis*. Front view of hydrotheca.
12. *Cladocarpus flexilis*. Phylactogonia and gonangia.



PLUMULARIDÆ.

EXPLANATION TO PLATE XXVII.

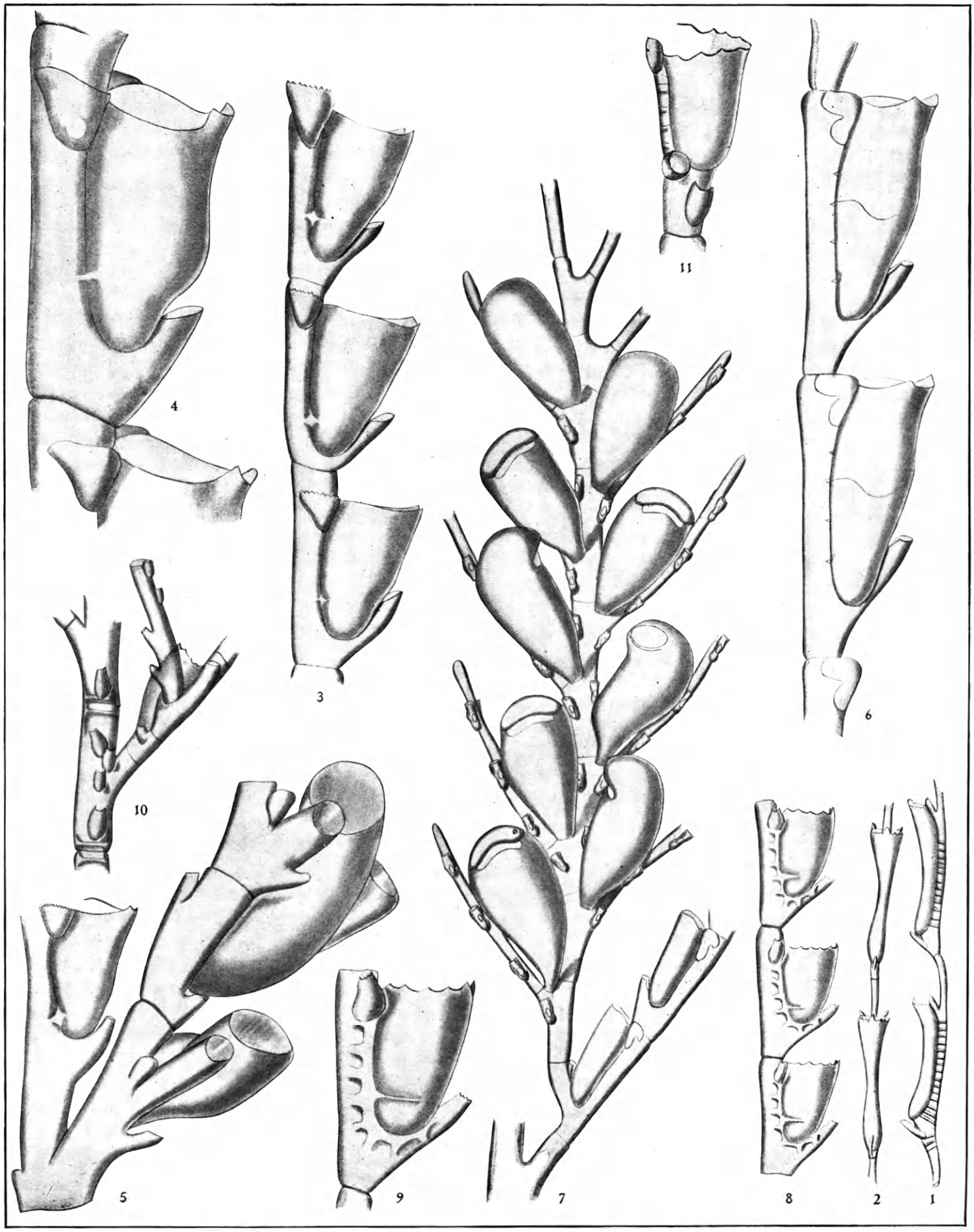
FIG. 1. *Cladocarpus obliquus* Nutting. Part of hydrocladium (enlarged).
2. *Cladocarpus obliquus.* Side view of hydrotheca (greatly enlarged).
3. *Cladocarpus obliquus.* Phylactogonia and gonangia (enlarged).
4. *Cladocarpus septatus* Nutting. Part of hydrocladium (enlarged).
5. *Cladocarpus septatus.* Side view of hydrotheca (greatly enlarged).
6. *Cladocarpus septatus.* Front view of hydrotheca (greatly enlarged).
7. *Cladocarpus septatus.* Front of stem (greatly enlarged).
8. *Cladocarpus septatus.* Phylactogonia and gonangia (enlarged).
9. *Cladocarpus dolichotheca* Allman. Part of colony showing phylactogonia and gonangia (enlarged). (After Allman.)
10. *Cladocarpus dolichotheca.* Side view of hydrotheca (greatly enlarged). (After Allman.)
11. *Cladocarpus flexuosus* Nutting. Part of hydrocladium (enlarged).
12. *Cladocarpus flexuosus.* Front view of hydrotheca (greatly enlarged).
13. *Cladocarpus flexuosus.* Side view of hydrotheca (greatly enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XXVIII.

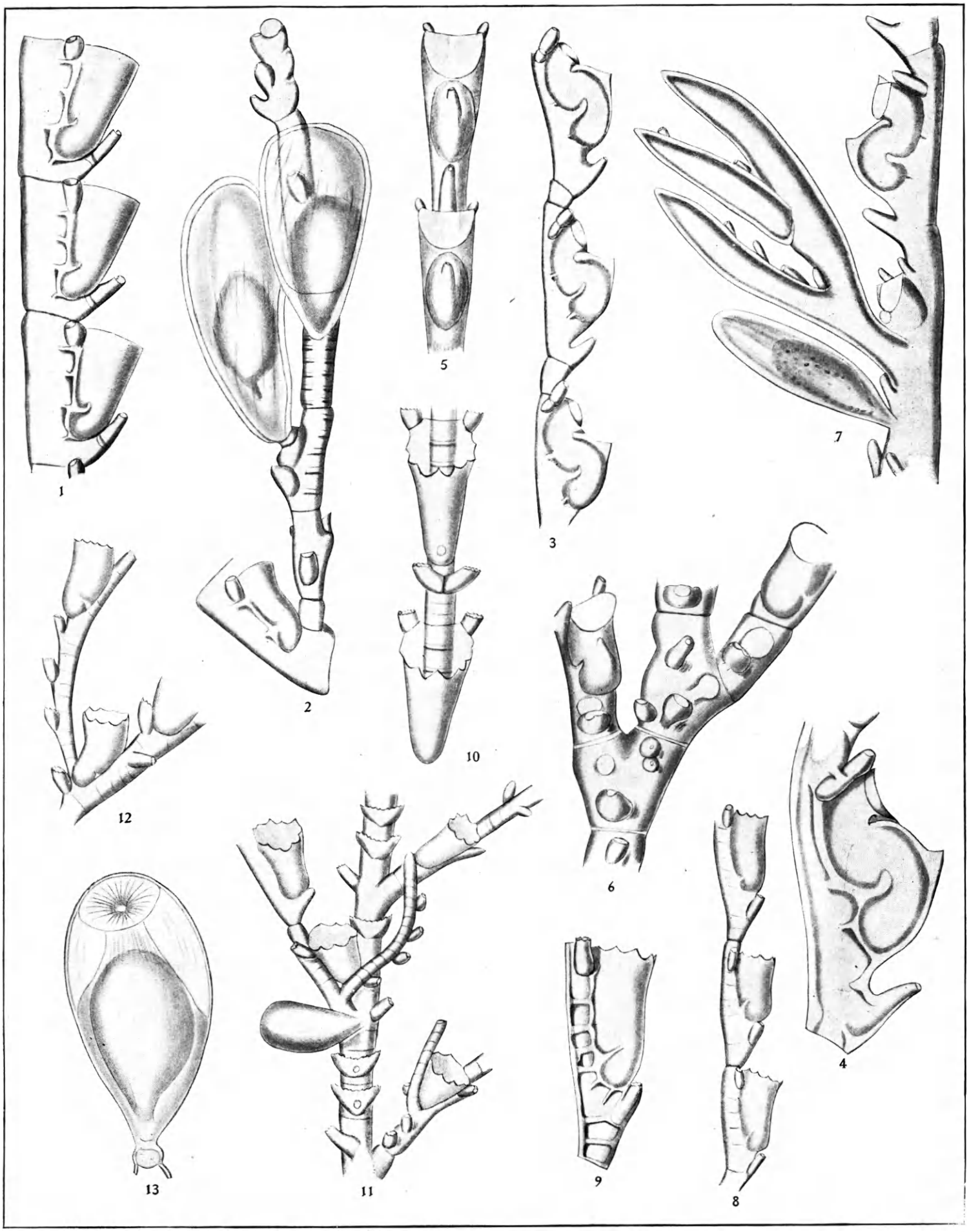
FIG. 1. *Cladocarpus tenuis* Clarke. Part of hydrocladium (greatly enlarged). (After Clarke.)
2. *Cladocarpus tenuis.* Side view of hydrotheca (greatly enlarged). (After Clarke.)
3. *Cladocarpus grandis* Nutting. Part of hydrocladium (enlarged).
4. *Cladocarpus grandis.* Hydrotheca (greatly enlarged).
5. *Cladocarpus grandis.* Phylactocarp and gonangia (enlarged).
6. *Cladocarpus paradisea* Allman. Part of hydrocladium (enlarged). (After Allman.)
7. *Cladocarpus paradisea.* Phylactocarp and gonangia (enlarged). (After Allman.)
8. *Cladocarpus speciosus* Verrill. Part of hydrocladium (enlarged).
9. *Cladocarpus speciosus.* Hydrotheca (greatly enlarged).
10. *Cladocarpus speciosus.* Front of stem showing growing phylactogonium (enlarged).
11. *Cladocarpus speciosus.* Proximal hydrotheca, and a budding phylactogonium (greatly enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XXIX.

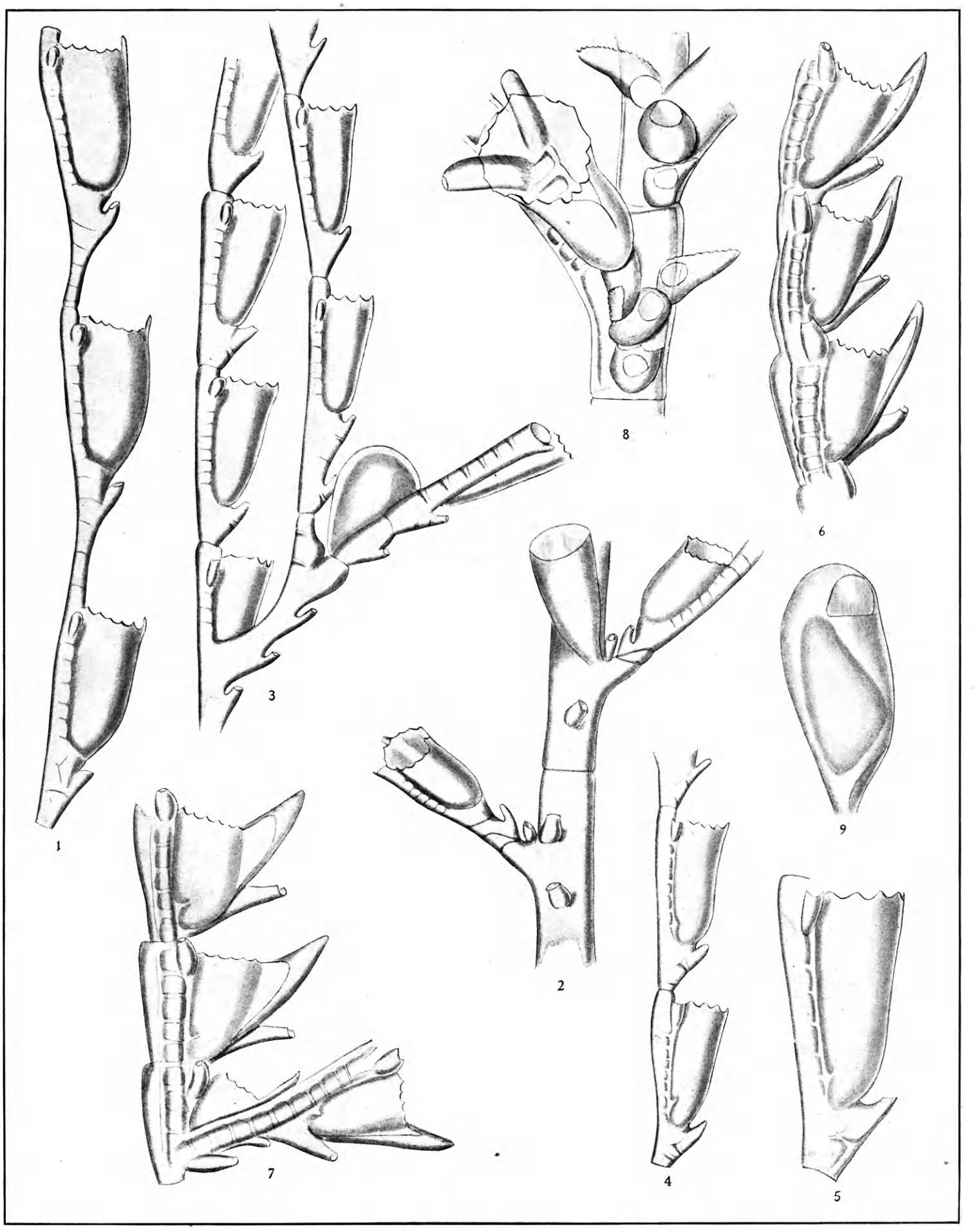
FIG. 1. *Cladocarpus pourtalesii* Verrill. Part of hydrocladium (greatly enlarged).
2. *Cladocarpus pourtalesii*. Phylactogonium and gonangia (enlarged).
3. *Cladocarpus carinatus* Nutting. Part of hydrocladium (enlarged).
4. *Cladocarpus carinatus*. Side view of hydrotheca (greatly enlarged).
5. *Cladocarpus carinatus*. Front view of hydrotheca (greatly enlarged).
6. *Cladocarpus carinatus*. Front of stem (enlarged).
7. *Cladocarpus carinatus*. Part of hydrocladium bearing phylactogonia and gonangia (enlarged).
8. *Aglaophenopsis hirsuta* Fewkes. Part of hydrocladium (enlarged).
9. *Aglaophenopsis hirsuta*. Side view of hydrotheca (greatly enlarged).
10. *Aglaophenopsis hirsuta*. Front view of hydrotheca (greatly enlarged).
11. *Aglaophenopsis hirsuta*. Front view of stem (enlarged).
12. *Aglaophenopsis hirsuta*. Basal hydrotheca and phylactogonium (enlarged).
13. *Aglaophenopsis hirsuta*. Gonangium.



PLUMULARIDÆ.

EXPLANATION TO PLATE XXX.

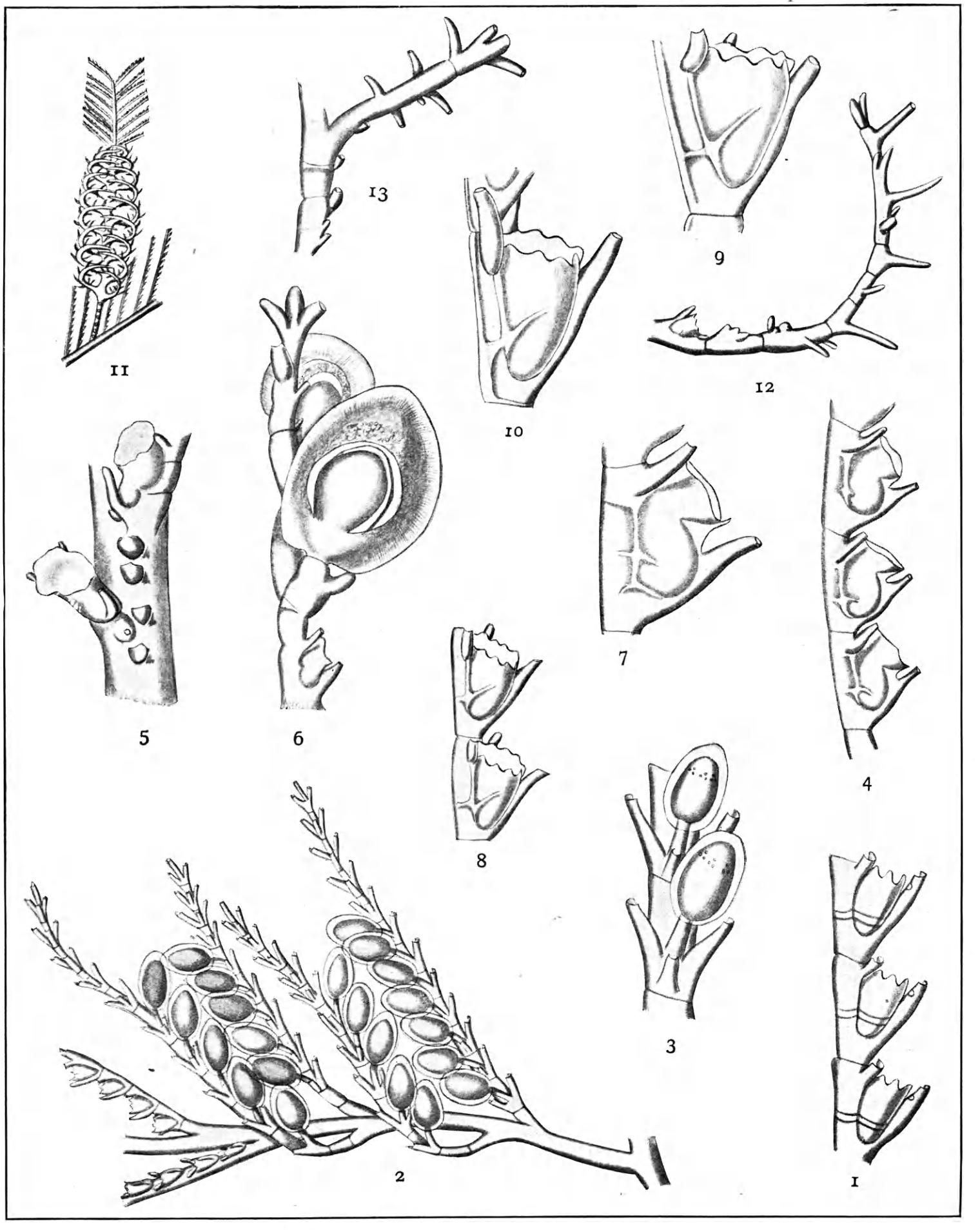
FIG. 1. *Aglaophenopsis distans* Nutting. Part of hydrocladium (greatly enlarged).
2. *Aglaophenopsis distans.* Front of stem (enlarged).
3. *Aglaophenopsis verrilli* Nutting. Branched hydrocladium bearing gonangium (enlarged).
4. *Aglaophenopsis verrilli.* Part of hydrocladium (enlarged).
5. *Aglaophenopsis verrilli.* Side view of hydrotheca (greatly enlarged).
6. *Aglaophenopsis cornuta* (Verrill). Part of hydrocladium (enlarged).
7. *Aglaophenopsis cornuta.* Branched hydrocladium.
8. *Aglaophenopsis cornuta.* Front of stem, showing proximal hydrotheca and nematophores (enlarged).
9. *Aglaophenopsis cornuta.* Gonangium (enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XXXI.

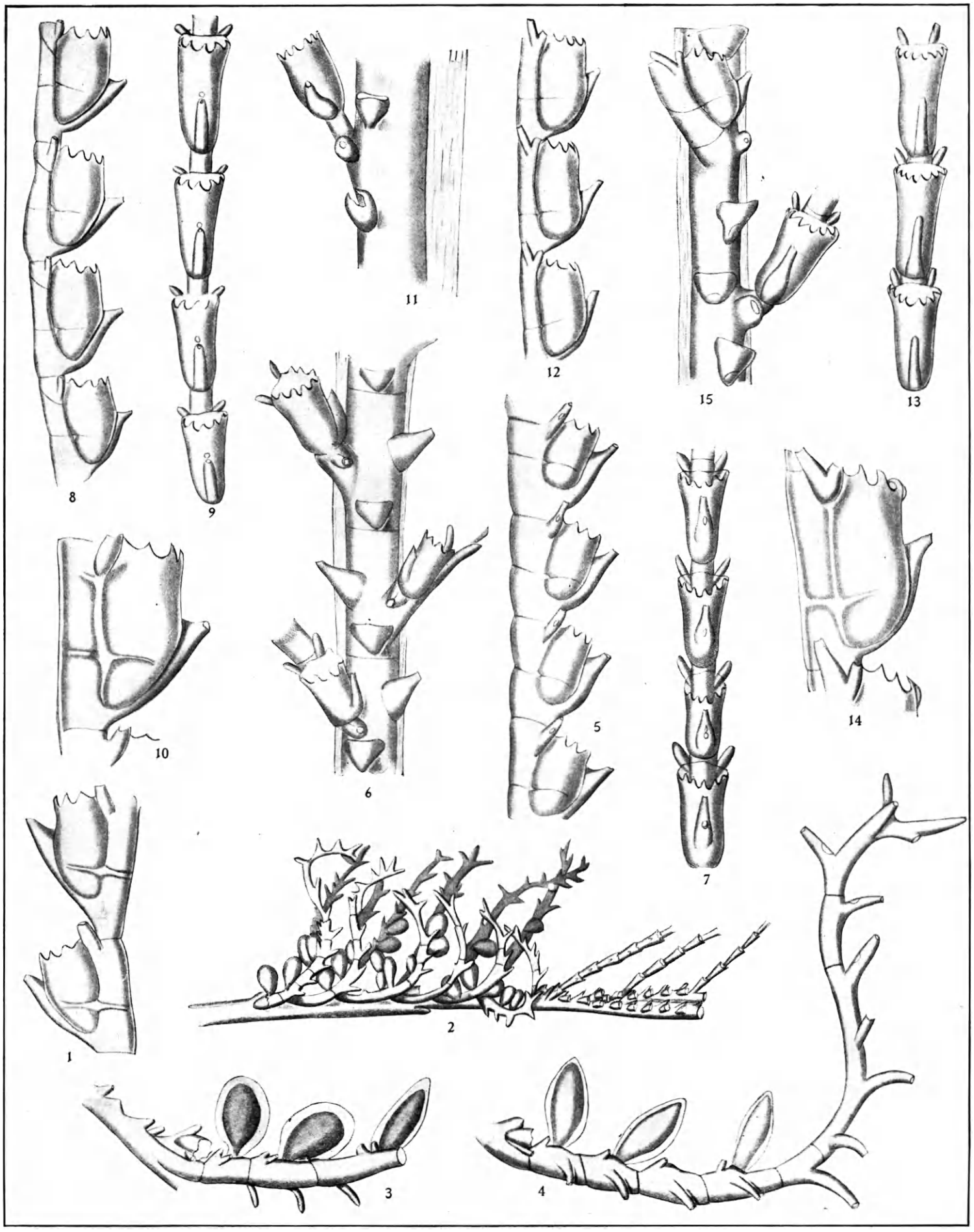
FIG. 1. *Lytocarpus racemiferus* Allman. Part of hydrocladium (enlarged). (After Allman.)
2. *Lytocarpus racemiferus.* Gonosome (enlarged). (After Allman).
3. *Lytocarpus racemiferus.* Part of phylactocarp with gonangia (enlarged). (After Allman.)
4. *Lytocarpus philippinus* (Kirchenpauer). Part of hydrocladium (enlarged).
5. *Lytocarpus philippinus.* Front of stem (enlarged).
6. *Lytocarpus philippinus.* Gonangia on phylactocarp (enlarged).
7. *Lytocarpus philippinus.* Hydrotheca (greatly enlarged).
8. *Lytocarpus ramosus* (Fewkes). Part of hydrocladium (enlarged).
9. *Lytocarpus ramosus.* Hydrotheca (greatly enlarged).
10. *Lytocarpus ramosus.* Hydrotheca, with longer nematophores (greatly enlarged).
11. *Lytocarpus ramosus.* Pseudocorbula (enlarged). (After Fewkes.)
12. *Lytocarpus ramosus.* Phylactogonium, showing hydrotheca at base (enlarged).
13. *Lytocarpus ramosus.* Phylactogonium, viewed from the side (enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XXXII.

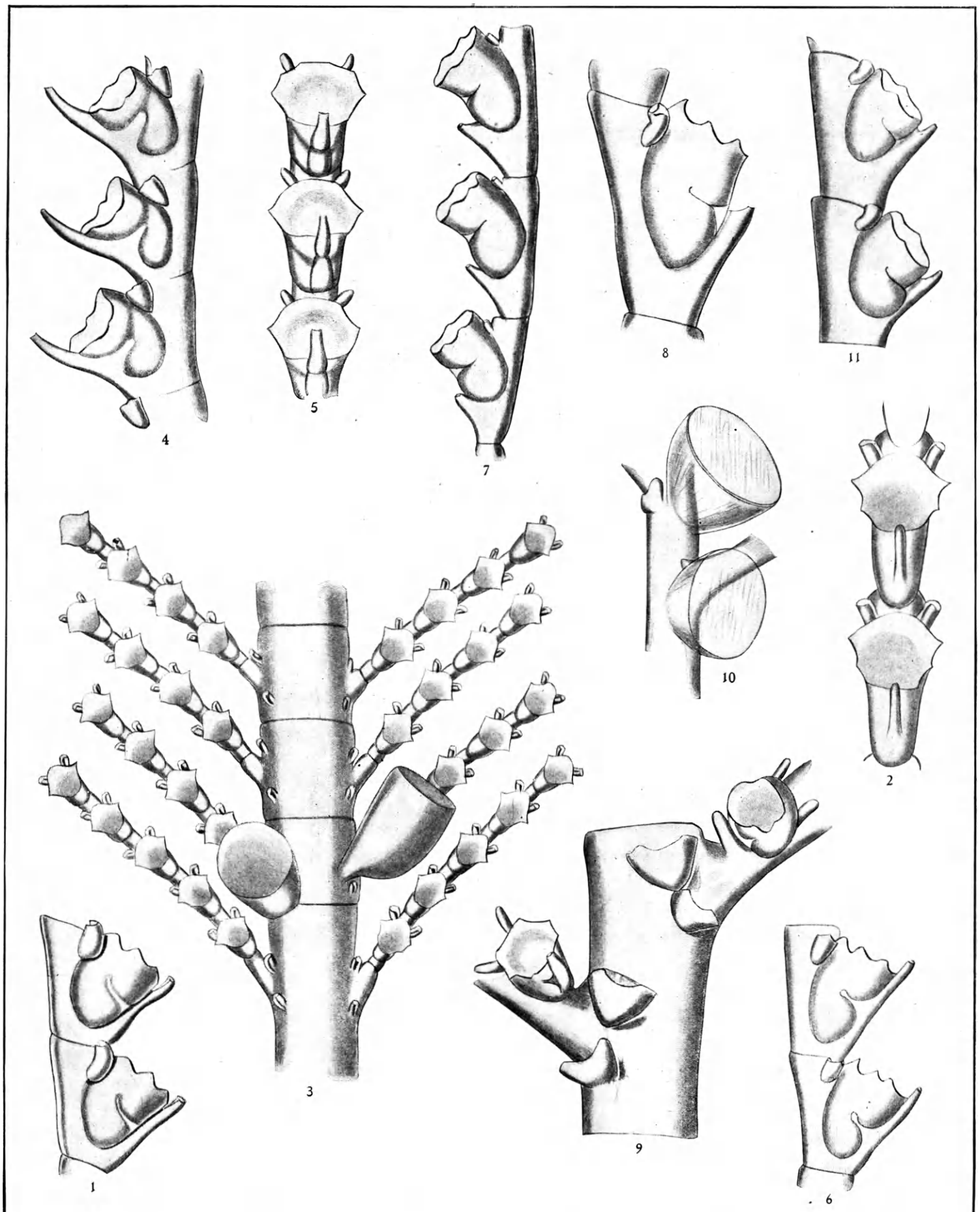
FIG. 1. *Lytocarpus grandis* (Clarke). Part of hydrocladium (enlarged).
2. *Lytocarpus grandis.* Phylactocarp (enlarged).
3. *Lytocarpus grandis.* Basal part of phylactogonium (greatly enlarged).
4. *Lytocarpus grandis.* Entire phylactogonium (greatly enlarged).
5. *Lytocarpus clarkei* Nutting. Part of hydrocladium (enlarged).
6. *Lytocarpus clarkei.* Front of stem, showing nematophores (enlarged).
7. *Lytocarpus clarkei.* Front view of hydrocladium (enlarged).
8. *Lytocarpus curtus* Nutting. Part of hydrocladium (enlarged).
9. *Lytocarpus curtus.* Front view of hydrothecæ (enlarged).
10. *Lytocarpus curtus.* Hydrotheca (greatly enlarged).
11. *Lytocarpus curtus.* Base of hydrocladium, showing nematophores (enlarged).
12. *Lytocarpus furcatus* Nutting. Part of hydrocladium (enlarged).
13. *Lytocarpus furcatus.* Front view of hydrothecæ (enlarged).
14. *Lytocarpus furcatus.* Hydrothecæ (greatly enlarged).
15. *Lytocarpus furcatus.* Front of stem, showing cauline nematophores and perforated process (enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XXXIII.

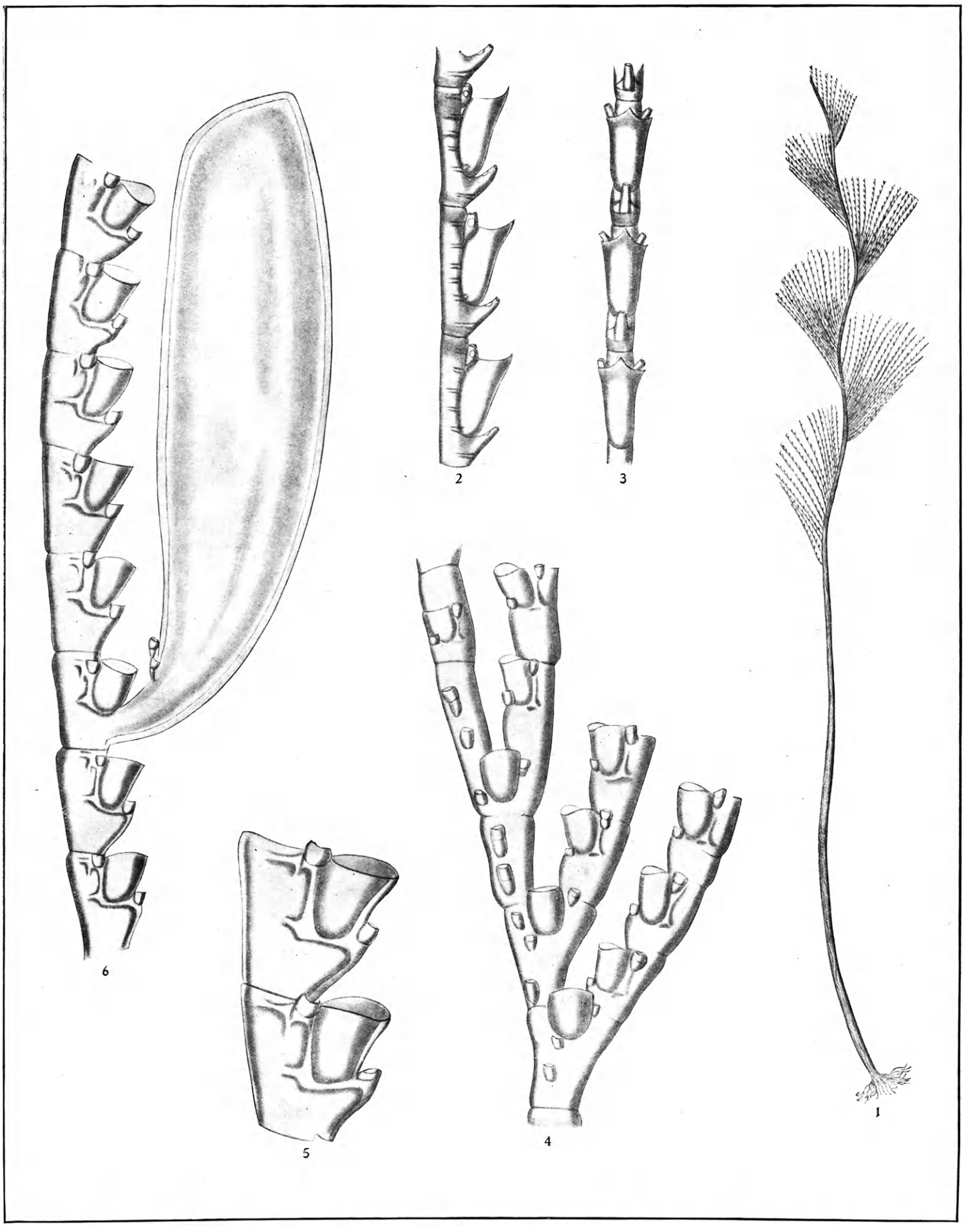
FIG. 1. *Halicornaria speciosa* Allman. Part of hydrocladium (greatly enlarged). (After Allman).
2. *Halicornaria speciosa*. Front view of hydrocladium (greatly enlarged). (After Allman).
3. *Halicornaria speciosa*. Front of stem, showing gonangia (enlarged). (After Allman).
4. *Halicornaria longicauda* Nutting. Part of hydrocladium (greatly enlarged).
5. *Halicornaria longicauda*. Front view of hydrothecæ (greatly enlarged).
6. *Halicornaria variabilis* Nutting. Part of hydrocladium (enlarged).
7. *Halicornaria variabilis*. Part of young hydrocladium (enlarged).
8. *Halicornaria variabilis*. Young hydrotheca with short nematophore (greatly enlarged).
9. *Halicornaria variabilis*. Front of stem, showing large nematophores (enlarged).
10. *Halicornaria variabilis*. Gonangia (enlarged).



PLUMULARIDÆ.

EXPLANATION TO PLATE XXXIV.

FIG. 1. *Streptocaulus pulcherrimus* Allman. Entire colony. (After Allman.)
2. *Streptocaulus pulcherrimus*. Part of hydrocladium (enlarged). (After Allman.)
3. *Streptocaulus pulcherrimus*. Front view of hydrothecæ (enlarged). (After Allman.)
4. *Nuditheca dalli* (Clark). Branched hydrocladium (enlarged).
5. *Nuditheca dalli*. Part of hydrocladium (greatly enlarged).
6. *Nuditheca dalli*. Part of hydrocladium with gonangium (enlarged).



PLUMULARIDÆ.

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