AMERICAN HYDROIDÆ.

PART I.

THE PLUMULARIDÆ,

WITH THIRTY-FOUR PLATES.

BY

CHARLES CLEVELAND NUTTING,

PROFESSOR OF ZOOLOGY, UNIVERSITY OF IOWA

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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, Leouhard 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 Plumularidae 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, *Agluophenia franciscana* and *Plumularia arborea*, probably belong to the genus *Hydroidmania*, and would therefore not be included in the Plumularidae.

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 Pourtales in the Gulf Stream. 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 Plumularidae 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, 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 Plumularidae from the material secured.

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 Plumularidae.

At the time of the inception of the present work it is doubtful if more than fifty species of Plumularidae 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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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 Plumularidae 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 medusae, 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 Acalepha, including the accession of knowledge which has been accumulating since the appearance of his "North American Acalepha" in 1865. In this case it would be unnecessary to investigate the hydroid medusae 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 Plumularidae 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. J. 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 Plumularidae 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 1.—THE PLUMULARIDÆ.

MORPHOLOGY OF THE PLUMULARIDÆ.

Only the more distinctive features of the Plumularidae will be discussed here, the intention of the author being to reserve the presentation of the morphology of the Hydroidea 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 Plumularidae have been studied with special care. The most important of these are the nematophores, sarcostyles, and the assemblage of structures known as gonangiæ, phylactocarps, and corbulæ. The morphology, use, and homologies of these organs will be discussed at considerable length. The Plumularidae have been regarded as of special interest by nearly all writers on the Hydroidea, and their characteristic features have been carefully studied and described by a number of our ablest naturalists, of whom Hinecks, 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, Ilamann, Jickell, 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 Plumularidae there is a greater number of simple nonbranching forms than in the other families of the Hydroidea. The name Plumularidae itself suggests the most common outline of the colony, which ordinarily consists of the single upright stem with laterally disposed ultimate branchlets, or "pinnae," 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 algae, 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 *Aглаophenia* and *Cladocarpus*. Others often give off a branch or two quite high up on the main stem, as is the case in *Aглаophenia rigida*. Some are very straggling in habit, resembling vines more than trees; for example, the northern variety of *Monostichus dichotoma*. Of tabellate forms there are many, especially in the statopalean section of the family, as in the genera *Lytocarpus* and *Aглаophenia*.

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*, *Theccocarpus benedicti*, *Cladocarpus granulis*, and *Cladocarpus paradisea*, while a specimen of *Theccocarpus* 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 *Plumularia*, 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 filicinis*, *Menopoea margaretta*, *Galtys humilis*, and *Aглаophenia 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 *Aглаophenia* 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 flexulis* Verrill, which attains a height of 9 or 10 inches, and *Halicorna* *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 ecosarcal tubes, each surrounded by ectoderm and endoderm. These ecosarcal 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 ecosarcal 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 cirrlet or whorl of hydrocladia. The canalicated ecoscar 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 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, *Aglaochenopis 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 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: "The central one gives origin to all of the branches, passing out into the pinnae 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 denudativa* 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 (*Aglaochenopis longicorinis*) to scores or even hundreds (*Plumularia denudativa*). 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 sprang. 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 denudativa*. In some species each of the superficial tubes bears a double row of caudine nematophores (*Cladocarpus paradisea*), while in others these nematophores are very minute (*Lytocarpus clarkei*), consisting of sarcostyles without sarcocoeve (*Plumularia procumbens*), or are absent (*Aglaochenopis hirsuta*).

As to the homology of the accessory tubes, authorities seem to agree that they are modified hydrothelial elements. Bale says on this point: "As regards the origin of the combined stem, it is obvious that the plumularia tubes are hydrothelial elements. Monosiphonic species sometimes occur with a few irregular tubes, which, springing from the hydrothelia, have attached themselves to the basal part of the stem instead of to a foreign body." Mr. Spencer comes to the same conclusion. 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 denudativa*.

The best demonstration of the hydrocladiate 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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1The Genera of the Plumulariidae, with observations on various Australian Hydroids, Melbourne, 1886, p. 5.
2A New Family of Hydroids, together with a Description of the Structure of a New Species of Plumularia, Transactions of the Royal Society of Victoria, 1890, p. 133.
3The Genera of the Plumulariidae, p. 5.
4A New Family of Hydroids, 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 hydrorhiza, 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 Plumatia 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. paradisaea); 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 Hydrozoa 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 ctenosarc, composed, as usual, of ectoderm and endoderm with the intervening stutizalamee, 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 Plumatia procumbens similar connections between the hydrocladia 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 Hincks2 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 hydrocladia tubes of the stem give origin to the hydrocladia 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 hydrocladia 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 hydrocladia 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-

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1 See Notes on the Reproduction of Plumatia Hydroids, American Naturalist, November, 1885; and Journal of the Marine Biological Association of the United Kingdom, IV. 1:96, p. 152, where a detailed account of my observations on stoloniferous reproduction will be found.

tures; and perhaps the growth-period idea, an old one by the way, 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 filiculmis*. This unilateral arrangement is found again in the erect stem of *Streptoeaulus 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 *Monostoceras* 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 eonosare forms a number of anastomosing tubes and is described as a canaliculated eonosare. 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 Plumularidae 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 recognizable. Throughout the Statoplea each node is hydrothecate, but there are many eleutherolean forms in which there are one or more intermediate internodes. In the latter case the hydrocladial 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 Eleutherolea 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 thickening 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 *Agaophenopsis*, than in the Eleutherolea, 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 hydrotheca, nematophores, and nodes; grows rapidly, and is transformed into a stolon or rootstock, from which a new colony...\(^1\)

arises. 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.

_Hydranth._—Those of the Plumulariidae 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, 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 Sertulariidae and Campanulariidae, 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

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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 *Lytocaropus* are remarkable for having the ecomesate 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 algae 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 Sertularidae.

**Hydrotheca.**—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 hydrothecae are almost entirely free and the distal hydrothecae largely adnate. In *Schizotricha tenera*, also, the hydrothecae 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 dendorita* (Plate VIII, fig. 4), *Monostachus quadridentes*, *Diplopteron grande*, and *D. longipinnus*, eleutheroplean forms, have the hydrothecae as closely approximated as in the statoplean *Cladocaropus flexuosus*, *C. bisphousus*, and *Aglaophenopsis distans*. In form and comparative size the hydrothece of the Plumularidae differ very widely. Among the Eleutheroplea many species are much wider than deep as in *Plumularia layeifera* (fig. 8), *Antennopsis longieornis*, *A. nigra* (fig. 10), while they are more than twice as deep as wide in *Diplopteron grande* (fig. 9) and *Calliracaps gracilis*. Among the Statoplea almost as great divergence is found between *Halicornopsis aricularis* Kirchenpauer, on the one hand, and *Cladocaropus 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 *Cladocaropus gracilis* (fig. 28) or *C. paradisca* among the Statoplea.

The aperture of the hydrotheca is often horizontal or at right angles with the hydrocladiatal axis. Sometimes, however, it is vertical, as in *Cladocaropus carinatus* (fig. 30) and *Aglaophenia sarigowata*; but ordinarily the opening is inclined between these extremes. In *Diplocheilinus 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. In a few species there is an anterior keel to the hydrotheca, as in *Halopteris carinata* (late XVII, fig. 8) and *Cladocaropus carinatus* (fig. 30). This structure is produced into a very conspicuous process reaching far beyond the hydrotheca in *Agliphophenia cornuta* (fig. 33).

The margin is almost always plain or destitute of teeth in the Eleutheroplea, the only exception known to me being *Gatlya humilis* Allman (Plate XVII, fig. 10). This genus, however, is almost exactly intermediate in structure between the two great groups of the Plumularidae, although agreeing more nearly with the Eleutheroplea. The margin of the hydrotheca of this latter group, although always toothless, with the exception noted above, is often characterized by more or less pronounced sinuitions, as in *Plumularia filiculmis* (fig. 18). The condition of affairs is exactly the reverse among the Statoplea, where a plain margin, as found in *Cladocaropus porpulesci* (fig. 31), *Nuditheca dalli* (fig. 35), and a very few other species, is the exception. There are almost always either teeth or sinuitions, the latter being especially characteristic of several species of *Halicornopsis*. 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. *Lytocaropus fuseus* (fig. 36) is

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

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

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"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-

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1 The Genera of the Plumiliaridae, with observations on various Australian Hydroids, Melbourne, 1886, p. 4.
Fig. 20. — Aplanophora elegans.
Fig. 21. — A. latirostris.
Fig. 22. — A. gracilisima.
Fig. 23. — A. costefera.
Fig. 24. — A. bicorneata.
Fig. 25. — Chalcoscarpus flexuosus.
Fig. 26. — Theocarpyus normani.
Fig. 27. — Chalcoscarpus superbus.
Fig. 28. — Cy. grandis.

Fig. 29. — C. septatus.
Fig. 30. — C. carinatus.
Fig. 31. — C. parvulus.
Fig. 32. — Aplanophora bicorneata.
Fig. 33. — A. eschata.
Fig. 34. — Halicarpyus superbus.
Fig. 35. — Nuditheca dalli.
Fig. 36. — Lytocarpyus 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 hydrocladal 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. fiteculis* 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 *Aghlophenia crenata*, *Cladocarpus flexuosus*, *C. dolichotheca*, *Thecocarpus bispinosus*, and *Thecocarpus distans*.

The ridge is posterior in all American species of *Aghlophenia*, 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 *Aglaothecopsis*, 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 *Halicormaria* (Plate XXXII, 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 Plumularidae, 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 *Aglaothecopsis micans* (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 *Halicormaria* (fig. 31) 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 sarcodial processes from the sarcostyles penetrate into the hydrothecae. This is particularly apt to be the case where the mesial nematophore has two openings.

**Nematophores.**—The name nematophore was first applied by Busk² to the entire structure which Hineks differentiated into two parts, sarcotheca and sarcostyle, the former designation being applied to the so-called sarcodial 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 Hineks. 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,” “machopoly,” “protoplasmic process,” “sarcodial 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 entrenched 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 hydrotheca are *supraregaline nematophores*; those found on the front of the hydrocladia, *mesial nematophores*; those on the main stem or branches are *caline nematophores*; and finally, those attached to the gonangia or special protective branches of the gososome are *gonosomal nematophores*. They

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¹ Report on the Hydroidea dredged by H. M. S. *Challenger* during the years 1873-76, Pt. 1, Plumularidae, 1883, p. 5.
² Hunterian Lectures, manuscript. London, 1854.
³ Journal of the Marine Biological Association of the United Kingdom, New Ser., IV, No. 2, 1886, 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 regarded as eleutheroplean species, have monothalamic nematophores, while *Xuditheca dallii* (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 Jickel’s genus *Kirchenpaueria*, as modified by Bale, characterized by an absence of the supra- and infracalyceine 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

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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 *Kirchenerpaueria*. Although this group is statoplane, so far as its nematophores are concerned, it is allied by every other character both of trophosome and gonosome to the most typical eleutheroplane genus.

In many Eleutheroplea the mesial nematophore is fixed and not free; for example, *Plumularia clarki* (fig. 38), *P. dendritica*, *Monostaches quadridens* (fig. 41), and *Halopteris carinata* (fig. 50). According to *Bale* 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 statoplane, although its relationship with the eleutheroplane forms is evident. In the remarkable genus *Gatlyga* 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 Plumularidae 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 statoplane. 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 hydrotheca in the Statoplane 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 hydrocanal, 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 clarki* (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 hydrotheca 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 *Monostaches 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 clarki* present a similar series of differences. In most cases the gonosomal nematophores resemble the cauline. The gonosome of *Sciurella ladiensis* 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 *Azgypolon*, and in those species of *Plumularia* which I have suggested should go into the genus *Kirchenpaueria*. Gonosomal nematophores are present in all Plumularidae except certain species of *Halicornaria*.

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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 eleutheroplean nematophores. The typical arrangement among the Statoplea is represented in A. lophocarpa (fig. 53), in which the supracalyxine 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 supracalyxine 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 philippinensis 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), all of these are bithalamic.

The mesial nematophores are always present in the Statopolea, 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, Halicorna 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 Halicorna 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 Aглаophenopsis hirsuta where the nematophore is so broadly forked as to appear in front view to be double (fig. 61). Another unique form is represented in the "double-barreled" mesial nematophore of Aглаophenicia bicornuta (fig. 55). There is much diversity also in the apertures of the mesial nematophores. Where they are short, or are 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 normanii. In Aглаophenopsis this is the case with each part of the forked nematophore, but here the margin is finely dentate. 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 Aглаophenicia 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. lophocarpus (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 Aглаophenicia minuta (fig. 51).

In a number of species of Halicorna (for example, H. longicinauda) 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 Halicorna longirostris that occasionally in parts of the polyplodium the terminal aperture is wanting, the nematophore being closed at the end, but I imagine that this is temporary or abnormal."

The caudine 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 ecosarc 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 (Aglaophenicia) myriophyllum and Thecocarpus benedicti.

The principal variations in size and shape of caudine nematophores among the American species of Statopolea 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

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1 The Australian Hydromedusae, Pt. 1, 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 caudine nematophores are found in the portion of the genus Lytocarpus embraced in the genus Nematophorus of Clarke. In some cases these are almost half as high as the hydrotheca. Aglaophenopsis cornuta Verrill also has remarkably large caudine nematophores which are very beautifully crenulated around the margin.

In many species of both groups of Plumulariidae 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. Alman, 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

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

The eonosarc of the most proximal hydrotheca on each pinna finds its way to the eonosarc 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 eonosarc, 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 eonosarc, 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 eonosarc, and therefore the above distinction between the hydrea 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 hydrothecae. It appears to me that the processes themselves contain no eonosarc, but that the eonosarc 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 canile 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 pinnales 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 hydrotheca 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 polypides 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. plana*. 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. plana*). 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 supracalyceal and mesial nematophores of hydrotheca 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 ramossus* ( Fewkes), and they are further remarkable for having both a terminal and lateral aperture. *Aglaophenopsis*

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

In A. dalli (Plate XXXIV, fig. 6) there is no protective branchlet, and in this case there are two rhizomyic nematophores attached directly to the gonangi, as so commonly found in the Hydroida. This arrangement is, I believe, unique among the Statoplia. In those species of Halicuraria the gonosome of which I have examined there are no gonosomal nematophores.

Sarcostyles.—As before intimated, the writer prefers to designate the sarcoidal contents of the nematophores as sarcostyles, a name originally proposed by Hincks and synonymous with the “extensible process” of Hincks’s earlier work; “protoplasmic process,” “sarcoidal process” of Allman; “wehrpolypen,” “machoplyps,” “wehrthier” of von Lendenfeld, Kirchenpanzer, 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 Hydroidea has given rise to more discussion and invited to more careful investigation than this. From the time when Allman, in 1861, published his communication On the Occurrence of Amboinferm Protoplasm and the Emission of Pseudopodia among the Hydroidea 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 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 sarcoyle 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 (Kirchenpanzer).

In 1864 Allman published the above-mentioned paper, in which he described the sarcoylae 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 Amoeba, and acting in many respects exactly as do certain Rhizopods. The author considers that the sarcostyles are composed of undifferentiated protoplasm in which nematoxeysts are sometimes immersed.

In 1868 Hincks quotes from the above-mentioned paper of Allman and adds: “I have made similar observations on Plumaria setacea and P. fruticoseus. 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 nematoxeysts 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 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 nematoxeysts are stationary, never being carried out by the sarcode or its processes.

1 Zeitschrift für wissenschaftliche Zoologie, XIII, pl. xxviii, fig. 4a.
The Plumularide.

No further investigations of importance seem to have been carried on until eleven years later. In 1882 Hamann 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 fibrilla. The amoeboid 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 amoeboid 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 Hydroïdes. 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 amoeboid 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 hydranth, 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 hydranth, 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. 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-


2 Archives de Zoologie Experimentale 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 SARCOYSTES.

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

Fig. 75.—Sarcoystle of Plunularia sp. in longitudinal section. *eot, endoderm; m, mesoderm.
Fig. 76.—The same greatly expanded. d, endoderm; eot, ectoderm; p, perisarc.
Fig. 77.—Portion of same, showing ectodermal cells embedded in free protoplasm.
Fig. 78.—Young hydranth of Aplysoginia in longitudinal section. f, space formed by a fissure in the ectoderm.
Fig. 79.—The same in a later stage of development. f, space formed by fusion of ectoderm. a, budding nematophore.
Fig. 80.—The same with nematophores fully developed. a, bridge of ectoderm uniting the hydranth and sarcostyle; b, supracalycine nematophore; c, mesal nematophore; d, ectoderm entering base of nematophore; f, the fissure which commenced as represented in figure 78; e, opening of mesial nematophore.
Fig. 81.—Hydrotheca containing the hydranth which is degenerating into a sarcostyle. d, endoderm; c and k, prophyseal processes; p, perisarc.
Fig. 82.—Nematophore and sarcostyle of Plunularia sp. *eot, endoderm; 5, ganglion cells; m and m', muscle striae; n, nematocytes.
Fig. 83.—Sarcoystles of Aplysoginia sp. capturing a Zoan. a, nematocyst-bearing process, and c, adhesive process, of sarcostyle.
Fig. 84.—Portion of end of “adhesive polyp,” highly magnified. a, adhesive globules; s, sense organ.
Fig. 85.—“Adhesive polyp;” eot, endoderm; k, knob at end containing adhesive globules.
salt 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 Plumularidae. 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 solit 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 endodermium, 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 Protocapillaria and a sarcostyle consists of a gradual pressing back (zurückdrängen) 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 *Aglaphenia*, 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. 83). Surface cells, subepithelial muscle cells, ganglia, and an endodermal axis are present. The distal portion consists of crowded pyramidal cells (fig. 81) 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.

¹ Weismann includes Hickel'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.

Third. Sarcostyles with nematocysts and adhesive cells are exclusively found in the paired nematophores of Aglaophenia. 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 statocyst 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, 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 capitae 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:  

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

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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.

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 Plumnlariae; 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 historical 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 stnttzlamelle. The arrangement of cells in Plumnaria pinnata corresponds with that of Plumnaria halecioides as illustrated by Merejkowsky, the ectodermal cells on one side of the axis being very much larger than those on the other. Muscular fibrillar were found in Plumnaria pinnata and Antennularia janice. There are few nematocysts in the sarcostyles of the Euletheroplea so far as examined, but adhesive cells seem to play an important part. In several species of Aylaophenia nematocysts were found forming formidable batteries just inside of the distal end of the nematophores (fig. 86).

In the Euletheroplea the nematophores seem always to be of the simplier type, not being divided into nematocyst-bearing and adhesive parts. In the Statopla 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 Aylaophenia 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 ameboid 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 hydrauthus and mutilated gonangia (fig. 88). They advanced with a creeping motion over the sides of the hydrotheca 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 Aylaophenia 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, crowing the nematocyst battery to one side.

In studying the young gonosomal sarcostyles of Aylaophenia 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 *Agyrophexis* sp., showing battery of nematocysts with threads extruded.

Fig. 87.—Sarcoestyle of *Plumatella pinnata* entering the hydrotheca containing disintegrating hydroid.

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

Fig. 89.—Mesial nematophore of *Agyrophexis helleri*.  *ax*, axial cavity of sarcoestyle; *ext*, the terminal extensible process; *ext1*, the extensible process which projects into the hydrotheca; *n*, battery of nematocysts.

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

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

Fig. 92.—Mesial nematophore of *Antennaria janini* in optical section.  *ax*, axial cavity of sarcoestyle; *ext*, 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 trabecula of eumosare, 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 eumolic 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 hydranths.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 statutlamelle. 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 amoeboid cell quickly pass along the exact axis of the nematophore. This cell had very much the appearance of an amoeba, 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 amoeba (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 amoeboid 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 algae, as was that of Aglaophenia pinnata. In some cases these algae appeared to be in an axial cavity, while the thin walls of the tube could be seen parting immediately above and below them, as in the case of the amoeboid 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

2 This discovery was announced in a paper entitled The Sarcostyles of the Plumularide, 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, 1896, p. 969.
AMERICAN HYDROIDS.

The specimen between and end former among ide met would (Protohydrid), from structed well except of are, seen are are are, colony. 28 cells. ii

Finally, This An interesting new family of hydroids was described by Prof. W. Baldwin Spencer, 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 Plumularide. The whole structure appears to be almost identical with the sarcocystes of Lafoëina tennis Sars.

This family (Hydroceratinide) shows distinct relationship to the Hydrocoralline in the arrangement of the cernosacral tubes and their connection with the hydranths.

Finally, there are many points of resemblance between the sarcocystes of the Plumularide and the dactylozooids of the Milleporide. A fairly satisfactory line of intergradation between the former and the latter may be traced through Lafoëina parasitica, Halecium gorgonide, Hydractinia echinata, and Clathrozoan wilsoni, the only known species of Hydroceratinide.

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 sarcocystes of the Plumularide, 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 sarcocystes of the plumularians and the defensive zooids of other groups may yet be demonstrated.

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 sarcocystes 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 Plumularide 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 Plumularide, 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 Plumularide. They would then be morphologically plumularidians in which the development of hydrotheca had been suppressed by the great development of the nematophores, probably the mesial ones; while, on the other hand, the existing plumularidian, with well-developed hydrotheca, 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 hydrotheca 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 hydrotheca, 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, corbula, 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 Plumularide 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 ecmosare of the hydrocanthus, 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 Plumularide, 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 gymnoblastic forms (for example, Eudendrium) in which the hydranth loses its character as a hydranth, the tentacles become

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

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 statalamel 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 ec't, ekt', c'tl, 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 c'tl 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 *Agluophenia*, 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 cletheroplenic forms, and I have seen no statoplenic 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

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\(^1\) *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 hydrotheca. More rarely they spring from the hydrotroph (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 pinna). In the Statoplea the gonangia are borne rather exceptionally on the stem, as in Cladocarpus septatus and several species of Halicormaria, 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 *Halicormaria saccata*. In some cases they are borne on nematophorite appendages to the hydrocladia, as in *Cladocarpus paradicea*. Many cases they appear to replace hydrotheca, 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 *Schizotrepha truncata* (Plate IV, fig. 4) in the shape of a robust horn or cornucopia, the tip of the horn being attached to the hydrocalus and the large end containing the aperture; the oblong ovate form found in Plumularia elegans, 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 *Schizotrepha dichotoma* (Plate XV, fig. 4); the obovate structure with a pronounced operculum of Plumularia stylifera Allman; the annulated gonangia of Plumularia halicoides; and the obconical gonangia with the very wide shelflike rim around the top and branched nematophorite processes shown in the remarkable species *Scieveula indirisa*. 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 *Aglaophenopsis* 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 *Halicormaria* (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 Plumularidae. 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 Hydroids dredged by H. M. S. Challenger during the years 1873-1876, p. 10, Pt. 1, Plumularidae, 1883, p. 10.
Among the Eleutheroplea the genera *Schizotricha*, *Diplopteron*, *Polyplumularia*, *Hippurella*, and *Cullicarpa* are here regarded as phylactocarpal, the remaining genera—*Plumularia*, *Monotheca*, *Antennaria*, *Antennopsis*, *Calvinia*, *Antwella*, and *Monostaches*—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 hydrothece 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 hydrothece are replaced by nematophores, while on the bifurcated part there are no gonangia and one fork has all but the terminal hydrothece 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 hydrothece 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 in branched 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 hydrothece. This form of phylactocarp shows the intergradation between that structure in *Cladocarpus* and *Schizotricha*. In *Cladocarpus* there are no hydrothece on the phylactogonia, in *Diplopteron* there are a few, in *Schizotricha dichotoma* there are a still greater number, while in *S. parenta* 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 hydromasts and sarcostyles are homologous structures and often seem to be interchangeable in the economy of the colony, so that the replacing of hydrothece 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 hydrothece 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 *Calliecarpa* (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 *Halicormaria*, 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 *Agloophenia* and *Thecoecorpus*. The corbula is strictly a highly modified hydrocladium, the proximal part bearing one or more hydrotheca 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 *Agloophenia* (Plate XX, fig. 4), but where there are several hydrotheca between the corbula and the stem, they are apt to be more or less modified, as in *Thecoecorpus*. 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 hydrocalyx 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 corbulae 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 imbriication of the leaves, and thus it comes about that corbulae 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 hydrotheca, complicated by the development on them of secondary nematophores, and thrown alternately to the right and left in accordance with their new protective function." 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.

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1 Report on the Hydroidea dredged by H. M. S. Challenger during the years 1873-76, Pt. I., Plumulariidae, 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 corbulae 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 planulae 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 halecium; and hydranths may apparently be replaced by blastostyles, as in the genus Synethecium of Allman. Nor does this remarkable power of interchange 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 nematóphorous 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, 1885, 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, Agyloophenia*, 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 paradisaea* (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. pourtalesii* there are no branchlets, the phylactogonia consisting of straight stems divided into internodes bearing nematophores and gonangia (Plate XXIX, fig. 2).

In *Agyloophenia* the phylactogonium is supposed to be a greatly produced mesial nematophere 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 hydrothecae 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. kiruta*, 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 Quele 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 pourtalesii*, 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: \(^3\)

*Schizolichia* 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 gonophores 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 gonophores 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.

\(^1\) Report on the Hydrozoa dredged by H. M. S. *Challenger* during the years 1873-76, Pt. 1, Plumaridae, 1883, pl. XXVI, fig. 4.


\(^3\) Ibid., p. 13.
DEVELOPMENT OF THE PLUMULARID.E.

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 bei 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 statzlamelle (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 perisare. 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 statzlamelle. This ectoderm is an important structure, designed to penetrate the thick perisare 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 perisare 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 perisare 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 perisare 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 statzlamelle 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 perisare of the stem, expands rapidly, the result being a hernia-like protrusion formed of ectoderm, statzlamelle, and endoderm, covered with a chitinous investment, a structure immu-
ORIGIN OF THE MALE SEX CELLS IN THE PLUMULARIDAE.

Fig. 96.—Optical section of part of a male colony of *Plumularia ebinulata*. After Weismann. blt, blastostyle; dlp, plug closing end of gonangiun; ect, ectoderm; ch, cap of ectoderm over primary testes; ent, endoderm; gph, gonangium; nph, gonosphere; ped, peduncle of gonosphere; h, testes; kg, hydrantr; et, ectoderm processes; lb, cavity of blastostyle; nph, nemaphore; p, origin of hydrochadum; psl, perisarc; st, stem.

Fig. 97.—A very young male gonangium of *Aphypleura* sp., viewed with transmitted light. blt, blastostyle; ect, ectoderm; p, perisarc of gonangium; sp, mass of sperm cells; spn, spadix; sps, spermatocytes.

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

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

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

Fig. 101.—Gonangium of *Plumularia pinnaata*, showing a gonosphere passing out of the top.

Fig. 102.—Gonangium of *P. planata* with six gonospheres.

Fig. 103.—Cross section of blastostyle of *Plumularia ebinulata*, 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 perisarca 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 perisarca 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 coenosare of the stem, although in the former case there is no ectoderm cap formed, as there is no perisarca 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 ectodermal 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 spermatoza reach maturity; and when the spermaries break, the plug is in some way penetrated by the spermatoza 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 spermatoza 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 perisarca, 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 ameboid 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 lessnumerous 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' (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 Plumularidae have been investigated with the view to determining the origin of the sex cells, and in all these 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 Agleophaenia 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, Agleophaenia pluma, and Agleophaenia 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

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

endoderm of the stem and finally become aggregated under the points of insertion of little buds or stumps, which are the beginnings of the corbulae. 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 corbula of Aglaophenia plumos. 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:

![Diagram of Development of the Corbula of Aglaophenia plumos](image)

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 nematoophores 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. In the ten-leaved corbula (fig. 114) the gonangia have so increased in size that they can readily be distinguished from the nematoophores. Up to the time when about twelve corbula leaves have been acquired (fig. 113) the individual leaves are thick, fleshy lobes filled with eonosarc, 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 eonosarc 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 nematoecysts have appeared, the nematoophores 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, 8). 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.

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 sarcostyles, 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 eolomotic 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 Plumularidae 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 planulae, including, of course, the Plumularidae, Allman says:

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 (blastosphere), 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 gonangia, 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 chitosinous pellicle, the formation of the perisarc, is excreted over a greater or less extent of its surface; the free or oral pole becomes perforated by a month 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.

Hainmann 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 Aglaophenia

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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.
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.
Fig. 116.—Plumula of Aglaophenia helleri.

Fig. 117.—Enlarged process at end of hydrochalam 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 hydrochela of last hydrochalam 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 cenosarc ruptures the chitinous investment at the tip and protrudes naked into the water. A constriction takes place by which this naked cenosarc is divided off and finally separated from the parent stem. 4The detached segment is now the 12 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 hydroclads; 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 hydrocladal processes described above, were seen springing from the interior of the gonangia themselves.

THE POSSIBILITY OF CONJUGATION AMONG THE PLUMULARIID.E.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. plumula Linnaeus, 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 hydrothecae to each internode.

In June it was noticed that a large proportion of the colonies had the end of the main stem...
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 hydroids. 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 Algae (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 amoeboid 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 cymbula 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, 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 Plumatellidae 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

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1The 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 clapsed 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, 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 *Aglaochenia* 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 amoeboid movements, and such movements would, of course, greatly facilitate conjugation. The amoeboid cells observed by me in the clamping 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 *Plumaria pinuata* 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 hydrothecae and hydroidia 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 hydrothecae 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 amoeboid 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.

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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 vertical of filiform tentacles. Hydrothecae, 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 hydrocanthus.

_Gonosome._—Gonophores always inclosed in gonangia, which may be either unprotected, protected by special nematophorous branchlets, or inclosed in corbulae which are highly modified hydrocladia. Free medusae are never formed, the ova developing into ciliated planulae within the gonangia. Colonies almost always unisexual.

Previous to the great work of the elder Agassiz, three genera—_Plumularia, Antennularia_, and _Agaophenia_—all of the plumularians then known, were included with other calypteroeblastic forms in the family Sertulariidae. 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, Hincks² and Bale³, have written the word _“Plumularidae,”_ but the original spelling of Agassiz is here retained, in which the present writer agrees with Kirchenpauer⁴, Allman⁵, and von Lendenfeld.⁶ Allman⁷ constituted a _“legion”_ Plumulariae, 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 _Plumularidae_ constitute a perfectly well defined group of the Calypteroeblastea, related on the one hand to the Sertularidae, and on the other to the Hydroceratinidae, a family recently instituted by Prof. W. Baldwin Spencer to accommodate a remarkable Australian hydroid, _Clathrozoan wilsoni_, which, although widely different from the Plumularidae 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 Zygophyllidae instituted by Mr. John J. Quelech⁹ to accommodate a new form found on the Atlantic cable off the Cape Verde Islands, characterized by a trophosome greatly resembling Allman’s family Perisiphonidae, 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 Plumularidae. 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

¹Contributions to the Natural History of the United States, IV, p. 338.
²British Hydroid Zoophytes, p. 279.
³Australian Hydroid Zoophytes, p. 126.
⁴Ueber die Hydroidenfamilie Plumularidae (title).
⁶The Australian Hydromedusae, Pt. 1, p. 472.
⁸Die Hydroiden des k. k. naturhistorischer Hofmuseums, p. 219.
⁹Annals and Magazine of Natural History, July, 1885, p. 4.
¹⁰I have myself found structures greatly resembling nematophores in another species of this family, _Lafoea 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, 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 Plumularidae.

Taking the average of the proportions of plumularians to other hydroids as shown by a study of the Challenger report, Hineck'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 Plumularidae 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 Plumularidae, indicating in all probability the richest plumularian fauna yet discovered in any part of the globe.

As mentioned above, over 300 species of Plumularidae 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 Plumularidae, each having its most notable centers in the East and West Indies.

As a whole, it may be said that the Plumularidae 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. 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. In an account of the hydroida of Spitzbergen, 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-
rient 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 Plumulariidae. 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, 910 fathoms, Albatross; *Aglaoophenia lophoarpa* Allman, 1,181 fathoms, Albatross; *Aglaoophenia crenata* Fewkes, 1,242 fathoms, Blake; *Aglaoophenopsis verrilli* Nutting, 1,497 fathoms, Albatross; *Aglaoophenopsis verrilli* Nutting, 1,742 fathoms, Albatross.

In the bathymetrical tables given by Sars 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 deducing 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 accidents 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 Plumulariidae.

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### American Hydroids

#### Bathymetrical distribution of American Plumularidae—Continued.

**ELEUTHEROPLEA—Continued.**

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</table>

| Total number of species      | 28                        | 8                         | 12                       | 5                        | 7                        | 13                       | 1                        | 7                        |
| Per centages                 | 50%                       | 15%                       | 25%                      | 10%                      | 13%                      | 25%                      | 2%                       | 19%                      |

1The percentages indicate the per cent of the total number of species of Plumatella 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.

#### STADIPLEA.

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</tr>
</tbody>
</table>

| Total number of species      | 28                        | 8                         | 12                       | 5                        | 7                        | 13                       | 1                        | 7                        |
| Per centages                 | 50%                       | 15%                       | 25%                      | 10%                      | 13%                      | 25%                      | 2%                       | 19%                      |
THE PLUMULARIDE.

Bathymetrical distribution of American Plumularide—Continued.

| Species | Zone 1 to 50 fathoms | Zone 50 to 100 fathoms | Zone 100 to 150 fathoms | Zone 150 to 200 fathoms | Zone 200 to 250 fathoms | Zone 250 to 300 fathoms | Zone 300 to 350 fathoms | Zone 350 to 400 fathoms | Zone 400 to 450 fathoms | Zone 450 to 500 fathoms | Total
<table>
<thead>
<tr>
<th></th>
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<tr>
<td>Cladocarpus sigma</td>
<td>22</td>
<td>114</td>
<td>114</td>
<td>226</td>
<td>352</td>
<td>N. Atl.</td>
<td>940</td>
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<tr>
<td>compressus</td>
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<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>W. I.</td>
<td>100</td>
<td></td>
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<tr>
<td>peneriens</td>
<td>65</td>
<td>100</td>
<td>100</td>
<td>260</td>
<td>430</td>
<td>W. I.</td>
<td>100</td>
<td></td>
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<tr>
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<td>100</td>
<td>100</td>
<td>260</td>
<td>430</td>
<td>W. I.</td>
<td>100</td>
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<tr>
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<td>260</td>
<td>430</td>
<td>W. I.</td>
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<tr>
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<td>100</td>
<td>260</td>
<td>430</td>
<td>W. I.</td>
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<tr>
<td>dolicholobos</td>
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<td>100</td>
<td>100</td>
<td>260</td>
<td>430</td>
<td>W. I.</td>
<td>100</td>
<td></td>
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<tr>
<td>ficusoma</td>
<td>20</td>
<td>100</td>
<td>100</td>
<td>260</td>
<td>430</td>
<td>W. I.</td>
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<td></td>
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<tr>
<td>trunc</td>
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<td>100</td>
<td>100</td>
<td>260</td>
<td>430</td>
<td>W. I.</td>
<td>100</td>
<td></td>
<td></td>
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<tr>
<td>grandis</td>
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<td>100</td>
<td>260</td>
<td>430</td>
<td>W. I.</td>
<td>100</td>
<td></td>
<td></td>
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<tr>
<td>parcadio</td>
<td>20</td>
<td>100</td>
<td>100</td>
<td>260</td>
<td>430</td>
<td>W. I.</td>
<td>100</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>speciosa</td>
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<td>100</td>
<td>100</td>
<td>260</td>
<td>430</td>
<td>W. I.</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Aelaphophyma hercula | 22 | 22 | 22 | 22 | 22 | S. Atl. | 22 |
| distans | 22 | 22 | 22 | 22 | 22 | S. Atl. | 22 |
| verrilli | 22 | 22 | 22 | 22 | 22 | S. Atl. | 22 |
| cornuta | 22 | 22 | 22 | 22 | 22 | S. Atl. | 22 |

| Latocarpus racemiferus | 10 | 10 | 10 | 10 | 10 | S. Atl. | 10 |
| philippinus | 10 | 10 | 10 | 10 | 10 | S. Atl. | 10 |

| caesius | 20 | 20 | 20 | 20 | 20 | S. Atl. | 20 |
| grandis | 20 | 20 | 20 | 20 | 20 | S. Atl. | 20 |
| clarkii | 20 | 20 | 20 | 20 | 20 | S. Atl. | 20 |
| frontalis | 15 | 15 | 15 | 15 | 15 | S. Atl. | 15 |
| Halictocarpus speciosus | 5 | 5 | 5 | 5 | 5 | S. Atl. | 5 |
| loricaria | 34 | 34 | 34 | 34 | 34 | S. Atl. | 34 |

| Nudithon dactylus | 15 | 15 | 15 | 15 | 15 | S. Atl. | 15 |
| Strepocarpus pulcherrimus | 15 | 15 | 15 | 15 | 15 | S. Atl. | 15 |

| Number of species | 35 | 35 | 35 | 35 | 35 | S. Atl. | 35 |
| Percentages | 50 | 50 | 50 | 50 | 50 | S. Atl. | 50 |

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 bathymetrical 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, 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:

<table>
<thead>
<tr>
<th>Zone</th>
<th>Number of stations</th>
<th>Number of species</th>
<th>Per cent of stations</th>
<th>Per cent of species</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 50 fathoms</td>
<td>1,419</td>
<td>53</td>
<td>61</td>
<td>50</td>
</tr>
<tr>
<td>50 to 100 fathoms</td>
<td>431</td>
<td>6</td>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td>100 to 150 fathoms</td>
<td>250</td>
<td>11</td>
<td>27</td>
<td>23</td>
</tr>
<tr>
<td>150 to 200 fathoms</td>
<td>156</td>
<td>6</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>200 to 250 fathoms</td>
<td>110</td>
<td>4</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td>250 to 300 fathoms</td>
<td>68</td>
<td>2</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>300 to 350 fathoms</td>
<td>62</td>
<td>2</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>350 to 400 fathoms</td>
<td>48</td>
<td>2</td>
<td>20</td>
<td>17</td>
</tr>
<tr>
<td>400 to 450 fathoms</td>
<td>37</td>
<td>1</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>450 to 500 fathoms</td>
<td>36</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

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 1 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 plumarian life increases in species down to a depth of 500 fathoms. Below that depth the data are insufficient to warrant any conclusions. 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

1The Journal of Geology, H. No. 5, p. 470. The article on The Origin of the Oldest Fossil, 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 Plumularide.

(The figures in the columns denote the number of species.)

<table>
<thead>
<tr>
<th>Genus</th>
<th>Atlantic</th>
<th>Pacific</th>
<th>Total number of species</th>
<th>Bathymetrical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Charlestown &amp; South Atlantic</td>
<td>South Atlantic &amp; North Pacific</td>
<td>South Pacific</td>
<td>Australian</td>
</tr>
<tr>
<td>Plumularia</td>
<td>2</td>
<td>15</td>
<td>26</td>
<td>14</td>
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<tr>
<td>Monticola</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Antennarida</td>
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<td>2</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Monticola</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Calmaria</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Schizandrae</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Diplopis</td>
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<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
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</tr>
<tr>
<td>Calmaria</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>25</td>
<td>1</td>
<td>5</td>
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</tbody>
</table>

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 Plumularide comparable with that found in the West Indies; but there is only one American species among them.

### Key to the Genera of Eleutheroplean Plumularids

1. Hydroplumularia pinnaately disposed, each bearing more than one hydrotheca. *Plumularia*
   - Each bearing a single hydrotheca... *Monticola*
   - Hydroplumularia arranged in verticils, or scattered on all sides of stem; cenoma caudal.
   - Cenoma not caudal... *Antennaria*
   - Hydroplumularia apparently springing from root stalks, divided into internodes... *Hydroplumularia*
   - Not divided into internodes... *Hydroplumularia*
   - Hydroplumularia all springing from upper side of branches... *Monticola*
   - Hydroplumularia replaced by thorny processes on distal ends of branches... *Acantophora*
   - Hydroplumularia bearing a jointed nematophore branchlet at base of each hydrotheca... *Calmaria*.

2. Hydroplumularia branched, some of the branchlets assuming a function of phylactogonia; gonangia borne on hydroplumularia... *Schizandrae*
   - Hydroplumularia branched, lateral nematophores in more than one pair... *Diplopis*
   - Hydroplumularia with accessory ramuli; gonangia borne on stem or main branches... *Polyplumularia*
   - Hydroplumularia scattered over stem; gonangia protected by symmetrically disposed herm processes... *[Sciaena]*
   - Hydroplumularia on distal portion of branches modified into verticillate, nematophorid branchlets inclosing gonangia... *Hippoplena*
   - Gonangia borne on special branches and inclosed in verticils of nematophorid branchlets... *Calmaria*.

3. Some of the nematophores either fixed or wanting?
   - Mesial nematophores fixed—Hydrothecal margin toothed... *Gattya*
   - Mesial nematophores fixed—Hydrothecal margin entire... *Heteropla*
   - Lateral nematophores fixed, borne on long processes... *Heteropla*
   - Lateral nematophores wanting... *Azyplopia*
   - Lateral nematophores wanting and replaced by naked sarcoledy, mesial nematophores monothalamic... *Kirchenpaneria*.

*The genera whose names are inclosed in brackets are not represented in American waters.*

*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.*
AMERICAN HYDROIDS.

PLUMULARIA Lamarck (in part).


Trochosome.—Ctenosarc 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. Hydrotheca with smooth margins; all of the nematophores movable.

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

Lamarck, in his first edition, includes all of the forms which would now be embraced in the family Plumularidae in two genera: Antennularia, with the hydrocladia arranged in verticils, and Plumularia, containing all of the remaining forms. In 1857 McCrady established the genus Aglaopneuma to accommodate most of the Stateplea known at that time, in which he was followed by Louis Agassiz in 1862, and by Hincks 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 Plumularidae into two genera: Aglaopneuma, 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 Kirchenpanzer’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.

<table>
<thead>
<tr>
<th>Lamarck (1815)</th>
<th>Lamouroux (1816)</th>
<th>Johnston (1847)</th>
<th>McCrady (1857)</th>
<th>Agassiz (1855)</th>
<th>Hincks (1868)</th>
<th>Kirchenpanzer (1876)</th>
<th>Allman (1877)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plumularia</td>
<td>Plumularia</td>
<td></td>
<td>Plumularia</td>
<td>Aglaopneuma</td>
<td>Statoplea</td>
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Antennularia = Nemertesia = Antennularia = Nemertesia = Antennularia = Nemertesia = (Antennularia. Antennopside)

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 the 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 Plumularidae.

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.

2 Contributions to the Natural History of the United States, IV, 1862, p. 338.
3 History of British Hydrozoa, 1868, p. 284.
Hydrocladia composed of alternating hydrothecate and intermediate internodes, divided by straight nodes. Setacea Group.

Hydrocladia composed of hydrothecate and intermediate internodes, divided by nodes which are alternately straight and oblique; cauline hydrothecae present. Catharina Group.

Hydrocladia composed of hydrothecate internodes only. Atteanata Group.

Hydrocladia internodes with strong septal ridges; or hydrocladia with more than one intermediate internode. Lagenafera Group.

Hydrothecae more than 1½ times as deep as wide. Macrotheca Group.

Intermediate internodes short, each bearing a single nematophore; hydrothecae not distant; gonangia very long, with a tubular “neck” ............................................. P. setacea.

Intermediate internodes longer, each with two nematophores; hydrothecae distant, borne near center of internodes; gonangia very large .............................................. P. megalocephala.

Hydrothecae near distal ends of internodes; no supraclaycinic nematophores; hydrocladia short ............................................. P. obly papryra.

Hydrothecae near distal ends of internodes; no nematophores on intermediate internodes; supraclaycinic nematophores absent ....... P. helleri.

Like P. helleri, but with much longer internodes .......... P. alittheca.

Internodes and hydrothecae much as in P. megalocephala; hydranths smaller; colony with lateral branches ................. P. filicina.

Hydrocladia annulated at the internodes; hydrothecae as in catharina group ............................................. P. floridana.

Internodes of stem conical in front view; hydrotheca with posterior corrugation ............................................. P. filicina.

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. gominate.

Hydrocladia opposite, directed either forward or laterally; nodes often indistinct ............... P. clarkei.

Hydrocladia alternate; stem made up of two kinds of internodes. P. alternata.

Hydrothecae near distal ends of internodes; nodes on a level with the tops of hydrothecae ............................................. P. plumularioides.

Hydrothecae near distal ends of internodes; nodes above level of top of hydrothecae; stem slightly geniculate .......... P. inermis.

A peculiar nematophore on the process of stem from which the hydrocladia arise ............................................. P. caudtheica.

Hydrothecae on enlarged proximal ends of internodes .......... P. attenuata.

Two hydrocladia to each internode of the stem; nematophores monocladial ............................................. P. gooliei.

Internodes with septal ridges; hydrothecae not wider than deep; colony dendritie, strongly branched ......................... P. corrogata.

Hydrothecae not wider than deep; colony not branched .... P. palmieri.

Hydrothecae wider than deep ............................................. P. lagenafera.

No intermediate internodes ............................................. P. virginia.

Intermediate internodes present and bearing nematophores. P. macrotheca.

Two or three deep annulations between hydrothecae; hydrothecae separated by about their own depth .......... P. dendritie.

No intermediate internodes; each internode with one hydrothecae; no deep annulations ............................................. P. profundata.

More than one hydrothecae to each internode ................. P. paucinoda.
### Distribution of Plumularia

<table>
<thead>
<tr>
<th>Species</th>
<th>Atlantic</th>
<th>Pacific</th>
<th>Bathymetrical</th>
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<tr>
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<td>Geographical</td>
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<td>Charleston and northward</td>
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<td>P. setacea</td>
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<td>P. megalophora</td>
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<td>P. oktopomata</td>
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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 1, figs. 1, 4.)

*Sertularia setacea* Pallas, Elenchus Zoophytorum, 1766, p. 148.
*Sertularia setacea* Ellis, Nat. Hist. Zoophytes, 1786, p. 47.
*Plumularia setacea* De Blainville, Mammel d'Action., 1836, p. 477.
And all subsequent writers consulted.

**Trochosome.**—Colony attaining a height of 2 inches, usually unbranched; stem nufascicled 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 hydrothecates and intermediate internodes; nodal joints often accompanied by one or two internal annulations. Hydrothecae rather shallow, cup shaped, and more closely approximated than usual; nematophores small, the supracalycine pair overtopping the hydrothecae; 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.

*Genosome.*— Gonangia (female) greatly elongated, produced above into a long, narrow neck, inserted near the axis 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."

*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 ½ inch in height, is quite rigid, irregularly branching, and has very slender hydrocladiad internodes. Unfortunately, none of the specimens had the genosome and hence we are obliged to regard this very minute and delicate hydroid as a somewhat aberrant form of *P. setacea*, although ¹ strongly suspect that the genosome 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.)


*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. Hydrothecae 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; hydrauths very large and unable to retract fully within the hydrotheca.

*Distribution.*— Off Alligator Reef, 14 fathoms.— *Albatross* Station 2669, lat. N. 31° 09', long. W. 79° 33', 332 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 hydrauths.

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

**PLUMULARIA OLIGOPYXIS** Kirchenpauer.

(Plate I, figs. 6, 7.)

*Plumularia oligopyxis* Kirchenpauer, Ueber die Hydroidenfamilie Pluminariae, 1876, Pt. 2, p. 48, pl. vi, fig. 9.


*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 Hinde, 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. Hydrotheca shallow, cup-shaped; supracalyxine 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 hydrothecae and intermediate internodes, and made three subspecies of them based on the possession of one, two, or three hydrothecae 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 _Monotheea_, which has but one hydrotheca to each hydrocladium, but has also the thickened or forked internode supporting the very conspicuous supracalyxine 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 hydrotheca, 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. Hydrotheca 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 hydrothecae.


This species resembles _P. attenuata_, with the distal part of each hydrocladal 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._—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.)


_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. Hydrothecae rather distant, small, cup-shaped, and placed near the middle of the internodes; supracalyxine 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 canine nematophores on each internode of the stem.

_Gonosome._ Gonangia elongate, oval, smooth, narrowed below into a short peduncle by

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

²For 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 pinæ, 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\(^\circ\) 44', long. W. 79\(^\circ\) 26', 410 fathoms; *Albatross* Station 2601, lat. N. 33\(^\circ\) 39', long. W. 75\(^\circ\) 33', 197 fathoms; *Albatross* Station 2667, lat. N. 30\(^\circ\) 53', long. W. 79\(^\circ\) 43', 273 fathoms; *Albatross* Station 2669, lat. N. 39\(^\circ\) 09', long. W. 79\(^\circ\) 33', 352 fathoms.

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

**PLUMULARIA HELLERI** Hincks.

(Plate II, fig. 3.)

*Anisocalyx setacea* 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 Plumulariæ, 1876, Pt. 2, p. 28.

*Plumularia helleri* Marktanner-Turneretscher, Annalen des k. naturhistorischen Hofmuseums, 1890, p. 254, pl. vi, fig. 3.


**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 Hinck'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. Hydrotheca 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 hydrotheca; one nematophore below the base of each hydrotheca, one on each intermediate internode, one in the axil of each hydrocladium, and a caulinæ 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.

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 Plumularide, 1876, Pt. 2, p. 47, pl. v, fig. 6.
Plumularia filicaulis BAuL, 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 hydrotheca. Hydrothecae 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; supra-calycine nematophores wanting in some specimens, but present in others. Color of dried specimens reddish brown.

Gonosome.—Not known.

Distribution.—Found growing on algae 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 supra-calycine nematophores.

PLUMULARIA CATHARINA Johnston.

(Plate III, figs. 1, 2.)

Plumularia catharina HINCKS, Brit. Hydroid Zooph., 1868, p. 289, pl. LVII.
Plumularia catharina KIRCHENPAUER, Hydrozoenfamilie Plumularide, 1876, p. 27.

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 longer with a square node at its proximal and an oblique node at its distal end. Hydrothecae 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''W, long. W. 79° 59' 39', 270 fathoms.

¹History of British Hydroid Zoophytes, 1868, p. 391. 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.)


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 hydrothecae 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 San Diego 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° 36', 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.)


Trophosome.—Colony attaining a height of 13 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. Hydrothecae as in *Plumularia catharina*; lateral nematophores borne on processes of the hydrocladia and attaining the level of the top of the hydrotheca; mesial nematophores, usually three between adjacent hydrothecae; an irregular row of caudine 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).

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1 The name *Plumularia gracilis* was preoccupied by De Blainville in 1834, Manuel d’Actinologie, p. 473. See also Lamarck, Histoire Naturelle des Animaux sans Vertébres, 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 caudine hydrothecae 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. Hydrotheca 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 caudine hydrotheca is as described above.

Gonosome.—Not known.

Distribution.—Barraenda 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 caudine hydrotheca, 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, figs. 1, 2.)


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. Hydrotheca 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, Nivivak 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 hydrothecae 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, 2a.)

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. Hydrothecae distant, small, subconical; nematophores minute, supracalyceine 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.
PLUMULARIA

PLUMULARIA PANNATA pinnata Each on to numerous anterior broken branches. PLUMULARIA ATTENUATA Allman. (Plate V, fig. 6.)

PLUMULARIA CAULITHECA Fewkes.

(Plate V, figs. 3-5.)

PLUMULARIA ATTENUATA Allman.

Description of Doctor Fewkes's type specimen in the Museum of Comparative Zoology, Cambridge, Massachusetts.
AMERICAN HYDROIDS.

PLUMULARIA GOODEI, 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 hydrotheca; with broadly expanded, disk-shaped proboscis and about twenty-four tentacles. Hydrotheca cup-shaped, with slightly recurved marigns, borne near the distal ends of the internodes; nematophores monothalamic, a supracalyxine 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 hydrothecae 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 supracalyxine 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 hydrothecae being considerably longer than the intermediate ones, which are at least twice as long as broad. Hydrothecae distant, about as deep as broad and placed near the middle of the internode; supracalyxine 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 hydrothecae, while in our specimens of _P. setacea_ the gonangia are only about seven times the length of the hydrothecae. It occurs to me that the triangular gonangia spoken of by Marktaumer-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. 10°, 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 hydrocladiad 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. Hydrothecae 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 hydrotheca; 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 hydrotheca. 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 hydrotheca, 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.


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 hydrotheca, and with a transverse septal ridge at each end. Hydrothecae 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 hydrotheca; 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.—Gonosome 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 VIRGINIAE, 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 hydrocladia at 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 supracalyceine pair. Hydrothecae borne just above the middle of the internodes on very strong should- ers 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 nematoceysts and the usual sarcodal process, supracalyceine 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 caudine 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. scheelei. 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 hydrotheca, 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.)


Trophosome.—Hydrocladius attaining a height of about 2 inches, simple, fascicled, springing from an entangled mass of fine tubular filaments; pinnae very slender, alternate, composed each of a succession of long internodes alternating with short ones, each of the long internodes bearing a hydrotheca. Hydrothecae deep, tubular, with very slightly everted margins. Supracalyceine 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 hydrotheca in connection with hydrothecate and intermediate internodes. It has not been found by any expedition subsequent to Pourtales’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 inter-
nodes which bear one or two hydrotheca each; where there is a single hydrotheca to an internode it
is borne near the middle of that internode, but where there are two hydrotheca to an internode they
are borne on the ends of that internode. Hydrotheca deep, cylindrical, almost twice as deep as
wide, margin circular and even, very slightly everted; the hydrotheca 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 hydrotheca; a mesial nemato-
phore between adjacent hydrotheca, 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 hydrotheca and are each provided
with a pair of nematophores.

_Distribution._—Albatross Station 2415, lat. N. 30° 41′, 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 Perisiphonidae of Allman; the hydrotheca on the stem at the axils of the
hydrocladia show its affinity with the _catharina_ group of _Plumularia_, while the shape of the
hydrotheca reminds one forcibly of _P. cylindrifica_ 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. cauditheca_; the nodal joints become less frequent
toward the distal ends of the branches; there are no hydrotheca on the stem or any of the
branches except the hydrocladia; hydrocladia alternate, divided into rather long regular hydro-
theccate 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. Hydrotheca closely approximated, very small, deep,
about twice as deep as wide, margin sinus 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 hydrotheca,
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.
AMERICAN HYDROIDS.

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 by stout projections from the stem, divided into long, irregular internodes, each bearing several (about four) hydrothecae. Hydrothecae 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 hydrothecae; a mesial nematophore on a projection just at the base of each hydrotheca, and two others between this and the next hydrotheca below; caulinine nematophores distributed along the anterior caulinine tube from which the hydrocladium spring.

Gonosome.—Unknown.

Distribution.—Allatross 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 hydrothecae 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 Lamarek (modified).¹


Trophosome.—Cenosarc of stem canalculated; 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 Hydroidea 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 Plumularidae 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 cenosarc is canalculated, the hydrosomal cavity being there represented by a network of intercommunicating canals. In Antennopsis hipparis 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 canalculated cenosarc is a good generic character. Its adoption will exclude, however, Antennularia fascicularis, described by Allman among the Challenger Plumularidae.

Distribution of American species of Antennularia.

<table>
<thead>
<tr>
<th>Species</th>
<th>Geographical, Atlantic</th>
<th>Bathymetrical</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. antennae</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>A. americana</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>A. simplex</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>A. rugosa</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>A. praeputia</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>A. plumata</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

¹ See discussion of genus Plumularia, especially the confusion regarding the generic names introduced by Lamarek and Lamouroux.
² Memoirs of the Museum of Comparative Zoology, V, No. 2, p. 34.
KEY TO AMERICAN SPECIES OF ANTENNULARIA.

<table>
<thead>
<tr>
<th>Hydrocladia strictly verticillate</th>
<th>Intermediate internodes present, internodes without internal thickenings, proximate hydrothecae divided from stem by two nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrocladia not strictly verticillate</td>
<td>Proximate hydrothecae not divided from stem by nodes... americana. Less than six hydrocladia to each verticil. Intermediate internodes normally absent. Hydrocladial internodes with distinct internal thickenings... rugosa.</td>
</tr>
</tbody>
</table>

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 (Linnaeus).

(Plate IX, figs. 1, 2.)

Sertularia antennina LINNAEUS, Systema Naturae, 1788, p. 1310.
Neumertea antennina LAMOTHEUX, Hist. des Polyp. coral. hét., 1816, p. 163.
Antennularia antennina MARKTANNER-TUNEBERTSCHER, Die Hydroiden des k. k. naturh., Hofmann, 1890, p. 290.

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 cornosarc canalulated, 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. Hydrothecae 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 2068, lat. N. 42° 29'; long. W. 63° 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. Cornosarc extensively canalulated; 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. Hydrothecae 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 posterolateral 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 caudine nematophores in the axil of each hydrocladium, and the others scattered somewhat irregularly over the stem.
AMERICAN HYDROIDS.

Gonosome.—Gonangia ovate, borne singly in the axis 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', 70 fathoms; Albatross Station 2268, lat. N. 35° 11', long. W. 75° 06', 68 fathoms; Albatross Station 2392, 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.)


Trophosome.—Colony attaining a height of about 5 inches, simple, or very sparsely branched; stem, with canaliculated ecosarc, 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. Hydrothecae rather small, cup-shaped, with slightly everted margins, placed on the lower ends of the internodes; supraclayne nematophores large, as long as the hydrothecae, borne on processes from the internode; mesial nematophores large, two to each internode, one being above and the other below the hydrotheca; eauline nematophores scattered over the stem.

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

Distribution.—Off Alligator Reef; depth, 86 fathoms (Pourtales); 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 2268, 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 2392, lat. N. 35° 02', long. W. 75° 12', 120 fathoms; State University of Iowa expedition, Pourtales 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 ecosarc 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 reinforced 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. Hydrothecae rather small, short, cylindrical, with the postero-lateral margins often cut away, and supported below by a noticeable thickening of the internode; supraclayne nematophores present; two or three mesial nematophores between adjacent hydrothecae; eauline 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, Mrs. 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 cerosarc, 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. Hydrothecae 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.*—Gonangi borne in pairs in the axils of the hydrocladia, large, ovate, with the distal end turned to one side and the aperture directed laterally.


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. 11680, 11690, Mrs. State Univ. Iowa; also in the collection of the author.

**ANTENNULARIA PINNATA,** new species.

(Plate X, figs. 5, 6.)

*Trophosome.*—Hydrocanthus unbranched or sparsely branched, attaining a height of about 3 inches; stem with few cerosarcal canaliculi; in some specimens these seem to be largely obliterated, as if the cerosarc 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. Hydrotheca 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. 10° 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 Plumatella, 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 Plumatellidae, 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 supraclavine 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 Plumatellidae referred to above, divided the old genus Plumatella into three subgenera, which he called "Isicola," "Anisocella," 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;" 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 supraclavine nematophores. Hydrotheca conical, rather deep, margin circular and entire; supraclavine 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 caudine 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 algae.

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).


Trophosome.—Stem jointed; crenosarc 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, 1881, p. 123
In working over the material collected by Count Pourtales 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* Plumularidae convinced Allman that his genus *Antennopsis* was untenable on account of its complete intergradation with *Antennularia*. By using the canalicated ecosarc 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 canalicated ecosarc. 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.]

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<tr>
<th>Species</th>
<th>Bathymetrical</th>
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<tr>
<td><em>A. hippociris</em></td>
<td>+</td>
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<tr>
<td><em>A. longicornus</em></td>
<td>+</td>
</tr>
<tr>
<td><em>A. nigra</em></td>
<td>+</td>
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<tr>
<td><em>A. distans</em></td>
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<tr>
<td><em>A. annulata</em></td>
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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

Hydrocladia borne on very long processes from the stem; first internode hydrothecate. *A. hippociris*

Stem fascicled

Main stem strongly geniculate. *A. longicornus*

First internode of hydrocladia not hydrothecate. *A. nigra*

Hydrothecae twice as deep as wide. *A. distans*

Hydrothecae of *Antennopsis* are represented in American waters only.

**ANTENNOPSIS HIPPURIS** Allman.

(Plate XI, figs. 4-6.)


_Trophosome._—Colony attaining a height of about 2 inches, not branched; stem straight, not fascicled nor canalicated, 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. Hydrothecae borne on proximal parts of internodes, rather deep, cup-shaped, margins not everted; supracalceine 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 hydrocladal 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, stoutier, slipper-shaped, with the orifice lateral.

_Distribution._—Off Double-headed Shot Key, 195 fathoms (Pourtales); *Blake*, lat. N. 32° 01', long. W. 78° 37', 229 fathoms; *Albatross* Station 263, 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 non-fascicled 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 hydrothecae, the remainder being long and hydrothecate, with only an occasional short intermediate internode. Hydrotheca distant, small, shallow, cup-shaped, and usually borne on the distal portion of a long internode, but the proximal hydrothecae may be below the middle of its internode; supracalyxine 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 distal hydrotheca 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 fasicled; hydrocladia-bearing branches not fasicled, 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. Hydrotheca distant, shallow, cup-shaped, situated on the proximal portions of the long internodes; supracalyxine 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 hydrotheca 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 fasicled; 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. Hydrotheca distant, borne near the middle of the internodes, quite shallow, cup-shaped, much wider than deep; supracalyxine 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.)


_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 hydrothecae and short intermediate internodes, there being usually three closely approximated annulations at the nodes. Hydrotheca deep, cylindrical, with entire slightly everted margins; supracalyxine 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 hydrocladiad process of the branch and one on the proximal part of each internode.

_Gonosome._—Gonangia long, with a somewhat bottle-shaped neck, approaching those of _Plumularia setacea_ in shape, and found singly in the axes of the hydrocladia.

_Distribution._—Off Pacific Reef, 283 fathoms (Pourtales); 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_ is studied 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.


_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 _catarina_ group, from which it differs in the entire absence of cauline hydrotheca.

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

**MONOSTÆCHAS QUADRIDENS** (McCready).

(Plate XIII, figs. 1-4.)


_Trophosome._—Colony attaining a height of 6 inches, filabellate 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 hydrotheca by oblique nodes and above the hydrotheca by straight nodes. Hydrothecae large, campanulate, separated by at least twice their height; supracalycine nematophores present, reaching above the level of the hydrotheca and borne on distinct processes from the hydrocladal 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 hydrotheca, each being protected by a pair of basal nematophores.

_Distribution._—Off Pacific Reef (Pourtalés); _Blake_, off Barbados, 75 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 _Monostachus 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 _Monostachus 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 _Monostachus_, however, seems tenable, and necessitates the removal of the species to that genus.

_ANTENNELLA_ Allman.


_Trophosome._—Colony consisting of hydrocladia springing directly from the hydrorhiza without the intervention of stems or branches; hydrocladiad internodes and hydrotheca 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 filiculitis_ Poepig, 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 hydrotheca. 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, Monostachus_, and _Antennella_, which have the arrangement of internodes, hydrotheca, 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.)


**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. Hydrothecae deep, cylindrical, with margins not everted; supraclaycine 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.*

**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 hydrothecae 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 Eleutherothecan plumatarians. 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 vanuifera* Allman, a species dredged by the *Porcupine*, has practically the same arrangement, while the genus *Aguadophenopsis* Fewkes has a single-jointed and usually unbranched nematophorous ramius 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. Hydrothecae 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; supraclaycine 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 olate, 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 2665, lat. N. 30° 48', long. W. 79° 19'; depth, 270 fathoms; Station 2667, lat. N. 30° 53', long. W. 79° 43'; depth, 273 fathoms; Station 2668, lat. N. 30° 50', long. W. 79° 39'; depth, 294 fathoms; Station 2669, lat. N. 31° 09', long. W. 79° 34'; depth, 352 fathoms.

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

SCHIZOTRICHIA Allman (modified).

*S. dichotoma* Allman, Challeiiter 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 hydrothecale 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 *Schizotrichia*.

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 Schizotrichia.**

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<td><em>S. gracilina</em></td>
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KEY TO AMERICAN SPECIES OF SCHIZOTRICHIA.

Hydrothecae about twice as deep as wide ........................................ S. dichotoma.
Hydrothecae not deeper than wide:
- Stem not fascièled; one intermediate internode between adjacent hydrothecae ....... *S. perrula*.
- Stem not fascièled; two intermediate internodes between adjacent hydrothecae ....... *S. tenella*.
- Stem fascièled; intermediate internodes normally absent .......................... *S. gracilina*.

**SCHIZOTRICHIA 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 fascièled; hydrocladia alternate, not fascièled, 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 hydrothecae; 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 hydrotheca nearly equal to their length; supracalyceine nematophores borne on processes of the hydrocalus 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 rounded, 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 hydrotheca, one being just above the origin of the gonangium; one of the other branches bears a few hydrotheca 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; Pourtales 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 hydrotheca 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 pinna 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. Hydrothecae distant, shallow, cup-shaped, borne at or just below the middle of the internodes; supracalyceine 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 hydrocladium.

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.

AMERICAN HYDROIDS.

SCHIZOTRICHIA TENELLA (Verrill).

(Plate IV, figs. 4, 5.)

Plumatia tenella Verrill, Invertebrate Animals of Vineyard Sound, 1874, p. 731.

Trophosome.—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 hydrothecae. Hydrothecae 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; caudine nematophores—one or two to each intermediate internode.

Gonosome.—Gonangia in the shape of curved cornucopias, 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. 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.

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

Type.—In Museum of Yale University.

SCHIZOTRICHIA GRACILLIMA (G. O. Sars).

(Plate XIV, figs. 4-6.)

Plumatia gracillima G. O. Sars, Bidrag til Kunde enet om Dyrelivet paa vore Havbanker Chr. a Vid. Selak. Fork. for 1872.
Plumatia verrillii Clark, Trans. Conn. Acad., 1875, III, p. 61, pl. x.
Plumatia verrillii Verrill, Prelim. Check-list Marine Invert. of Atlantic Coast, etc., 1879, p. 18.

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. Hydrothecae small, cup-shaped, about as wide as deep; nematophores large, bithalamic; a supraacalyceina pair, and three or four single mesial ones to each regular internode, or between adjacent hydrothecae; a caudine nematophore in the axil of each hydrocladium, and others scattered irregularly over the stem.

Gonosome.—Gonangia borne in pairs on the stem near the axes 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.

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 Plumatia cornucopio in Annals and Magazine of Natural History, November, 1872, and suspect that it may be the same as Schizotrichia tenella. In the absence of specimens for comparison, however, it seems best to regard them as separate.
**Distribution.**—Aalesund and Loist, 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 *Schizotrichia* 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).


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

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

The first species described as having two pairs of lateral nematophores was *Diplopteron insignae*, 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. aquaphenoides* 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. insignae* and the three new species described below, which differ from *D. insignae* in the almost entire absence of hydrocladial internodes, in which they agree with *Schizotrichia dichotoma*. The three genera, *Schizotrichia*, *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.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Geographical.</th>
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<tr>
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<td>Floridian and West Indian.</td>
<td>100 to 200 fathoms.</td>
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<td><em>D. quadricorne</em></td>
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<td><em>D. grande</em></td>
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<td><em>D. longipinnae</em></td>
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**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. longipinnae*.

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1 Catalogue of Australian Hydroid Zoophytes, p. 124.
2 This author subsequently abandons the genus *Diplopteron* (see *The Genera of Plumulariidae*, 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. Hydrothecae 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 supraacalyxine nematophores just above the first, but not borne on distinct processes; two or three mesial nematophores between adjacent hydrothecae; 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 hydrotheca and exceedingly slender, with a small, trumpet-shaped enlargement at the distal end.

Type slides.—Cat. No. 11703, Mus. State Univ. Iowa; Cat. No. 18580, 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. Hydrothecae 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.


This species is closely allied to D. longipinnus, but can at once be distinguished by its immense hydrotheca, which are among the largest of the Eleutheropleca 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 hydrotheca 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.
DIPOPTERON 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. Hydrothecae 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 caulin 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 hydrothecal 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).


Trophosome.—Colony pinnately branching, fascicled; some of the hydrocladia furnished with a hydrothecal ramulus which springs from the first internode and is more slender than the hydrocladium from which it grows. A single pair of supracalyxine 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 hydrocanthus and two pairs of lateral nematophores. In the description of the type species, D. insignis, 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. Sars¹, 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 Allman² 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 1 inches in an incomplete specimen, pinnately branching, the alternate branches giving forth alternate branchlets from which the hydrocladia

¹ Bidrag til Kundskaben om Norges Hydroidea, Videnskabernes Selskabs Forhandlinger for 1873, p. 13, Christiana.

arise; stem, branches, and branchlets polysynphone, 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 rami of the others divided into regular internodes, each of which bears a hydrotheca; the anterior rami 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. Hydrothecae 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; canline 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. X. 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 *Phialularia* to deal with.

**Type slides.**—Cat. Nos. 15387, 15388, U.S.N.M; Cat. Nos. 11701, 11702, Mus. State Univ. Iowa; also in the collection of the author.

**HIPPURELLA Allman (modified by Fewkes).**


**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 verticiliate arrangement, and inclose the gonangia in a sort of pseudo-corbula; the protective branchlets bear each a row of nematophores, but no hydrothecae.

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.)


**Trophosome.**—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. Hydrothecae 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 hydrotheca; a mesial nematophore borne on a protuberance below the hydrotheca and another midway between adjacent hydrothecae; canline nematophores numerous, arranged in regular vertical rows upon the stem and branches.

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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 hydrotheca, shape and approximation of hydrotheca, arrangement and septal ridges of the hydrocladal internodes, and particularly in the gonosome.

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

**CALLICARPA Fewkes.**


**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 Plumularidae. While it bears some superficial resemblance to the corbule of *Aglaphenia*, the fundamental structure is widely different. It is as Doctor Fewkes says: "Morphologically speaking, as if the proximal part of the branch which bears pinnae 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)


**Trophosome.**—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. Hydrotheca deep, cylindrical, with the anterior profile nearly straight, aperture horizontal; supraalveine 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 axes 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.

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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 Plumulariidae 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.


*Trophosome.*—Stem and hydrocladia divided into internodes, the hydrocladia pinnately arranged. Hydrotheca 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.*—Gonangia oval, sac-shaped, borne at the bases of the hydrothecae 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 Plumulariidae 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 caudine 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 hydrotheca, 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.)


*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. Hydrotheca 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; caudine nematophores fixed.

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

*Distribution.*—Off Carysfort Reef, 35 fathoms (Pourtales). 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 sarotheca 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 sarotheca, than an intimate part of the latter organs.  

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.
THE PLUMULARIDÆ.

? GATTYA Allman. 1


Trochosome.—Hydrocanthus 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. Hydrotheca 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 Pluminularidæ, the peduncle consisting of several short internodes devoid of hydrocladia.

GATTYA HUMILIS Allman.

(Plate XVII, figs. 10, 11.)


Trochosome.—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. Hydrotheca 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.

<table>
<thead>
<tr>
<th>Genera</th>
<th>Atlantic</th>
<th>Geographical</th>
<th>Pacific</th>
<th>Bathymetrical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Charonia and Lohmanniaceæ</td>
<td>South of Charles River to West Indies</td>
<td>South Atlantic</td>
<td>South Pacific</td>
</tr>
<tr>
<td>Aglaophenia</td>
<td>6</td>
<td>25</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Thecacapsa</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Cladiacapsa</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Aglaotheca</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Latrotheca</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Haliornara</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Nuditheca</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Streptolacrus</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>52</td>
<td>6</td>
<td>5</td>
</tr>
</tbody>
</table>

1The 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.

2Original 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 fauna.

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 200 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 1,743 fathoms, while in the Eleutheroplea only one such species is recorded found at a depth of 576 fathoms.

KEY TO THE GENERA OF STATOPEAN PLUMULARIDAE.

| Corbula, each of which is a modified hydrocladium. | Lateral marginal teeth not inconspicuous; no hydrotheca at base of each gonangial leaf. | Aglaophenia. |
| Gonosome. | Lateral teeth inconspicuous; a hydrotheca at base of each gonangial leaf. | (Ilydroidenfamilie.) |
| 
| Protective branchlets, each of which is an appendage to a hydrocladium. | Caulline nematophores not very large, or, if large, distinctly crenulated; phylactogenium not jointed. | Eleutheroplea. |
| 
| Protective branchlets, each of which is a modified hydrocladium. | Caulline nematophores large and crenulated; phylactogenium jointed, often with hydrotheca. | (Ilydroidenfamilie.) |
| 
| Gonangia without protective contrivance of any kind. | Stem fascicled; a prominent perforated process at the base of each hydrocladium. | Aglaophenia. |

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 hydrotheca at their bases. The corbula may be either open or closed.

This genus as originally described by Lamouroux ² included all known Plumulariae 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 ⁸ in 1868, Kirchenpauer in 1872 divided the genus into four subgenera, Calathophora, Pachyhyphonia,

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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 Hydrozoal Zoophytes, p. 281.
⁷ Ueber die Hydrozoenfamilie Plumulariaceae, Pt. I, Aglaophenia, p. 25.
**THE PLUMULARIDE.**

*Lytocarpia,* and *Macrorhynchia.* His first section, *Cniathophora,* 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, *Theocarpus.*

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

**Distribution of the American Species of Aglaophenia.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Geographical</th>
<th>Bathymetrical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Atlantic</td>
<td>Pacific</td>
</tr>
<tr>
<td></td>
<td>South of Cape Lookout and West Indies.</td>
<td>South Atlantic.</td>
</tr>
<tr>
<td><strong>A. rhynochocarpa</strong></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>A. calamus</strong></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>A. rigidissima</strong></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>A. daphnis</strong></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>A. liochocarpus</strong></td>
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<td>+</td>
</tr>
<tr>
<td><strong>A. elegans</strong></td>
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<td>+</td>
</tr>
<tr>
<td><strong>A. apocarpus</strong></td>
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</tr>
<tr>
<td><strong>A. floccus</strong></td>
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<td><strong>A. patentia</strong></td>
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<tr>
<td><strong>A. aperta</strong></td>
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<tr>
<td><strong>A. ceratophora</strong></td>
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<tr>
<td><strong>A. anulata</strong></td>
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<td>+</td>
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<td><strong>A. perennis</strong></td>
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<td>+</td>
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<tr>
<td><strong>A. mammillata</strong></td>
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<td><strong>A. minutissima</strong></td>
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<td>+</td>
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<tr>
<td><strong>A. preforata</strong></td>
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<td><strong>A. simplex</strong></td>
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<td><strong>A. allii</strong></td>
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<tr>
<td><strong>A. robusta</strong></td>
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<tr>
<td><strong>A. rhomboides</strong></td>
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<td><strong>A. latissima</strong></td>
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<td><strong>A. struthioideos</strong></td>
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<td><strong>A. robusta</strong></td>
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<td><strong>A. ostiolaris</strong></td>
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<td><strong>A. gregis</strong></td>
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<td><strong>A. patagonia</strong></td>
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<td><strong>A. crevata</strong></td>
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<td><strong>A. triflora</strong></td>
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<td><strong>A. trifida</strong></td>
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<td><strong>A. thalassina</strong></td>
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<tr>
<td><strong>A. watsonia</strong></td>
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</tr>
<tr>
<td><strong>A. bicorona</strong></td>
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<td>+</td>
</tr>
<tr>
<td><strong>A. pelagonia</strong></td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

**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. *Regula* group.

Axis of hydrothecia forming an acute angle with hydrocladia. *Hydrocladia* internodes with more than two distinct septal ridges.

Supracalycine nematophores slightly overtopping the hydrotheca.

* Rhynochocarpa. Marginal teeth on a level with base of next hydrotheca above. *Calamus.* Marginal teeth distinctly below the base of the next hydrotheca above. *Dahina.*


Colony branched, over 4 inches high. Hydrothecia approximated. *Sicula.*

*Colon.*


---

\(^1\) Challenger Report, Phumularide, pp. 12, 10.

\(^2\) See The Genera of the Plumularide, p. 12, etc., for an excellent discussion of this and other points of interest to the systematist.
AGLAOPHENIA RHYNCHOCARPA Allman.

(Plate XVIII, figs. 1, 2.)


Trochosome.—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; hydrocladium alternate, rather close together, divided into regular internodes, each of which is itself divided by internal septa or ridges into about five communicating chambers. Hydrotheca 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. Supracalyxine 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 hydrocladiad internodes.

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

AGLAOPHENIA CALAMUS Allman.

(Plate XXIV, figs. 9-11.)
Aglaothenia calamus Allman, Challenger Report, VII, Pt. 30, p. 39, pl. xii.

Trophosome.—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. Hydrotheca 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 costae, each costa carrying four or five tubular denticles, and with a spur-like denticle at its base.

Dredged off Baja, 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 hydrothecae, longer supracalectine 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.)

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 supracalectine nematophores. Hydrotheca closely approximated, stout, with deep concavity in the anterior profile, and having about eight strong, deeply cut, marginal teeth; intrathecal ridge short; supracalectine 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. 56°, 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 Aglaopheina 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 hydrotheca stout and more closely set than in that species.

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

1 Original description quoted entire.
AGLAOPHENIA DUBIA \(^1\) Nutting.

(Plate XVIII, fig. 5.)


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 supraclaycine nematophores. Hydrotheca rather stout, slightly separated, with the anterior profile concave and about eight deeply cut teeth around the margin; intrathecal ridge well marked but short; supraclaycine 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 eauline 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.)


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 supraclaycine nematophore. Hydrotheca 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; supraclaycine 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, 64 fathoms; Albatross Station 2383, lat. N. 28° 32', long. W. 88° 6'; depth, 1181 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° 27'; 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 Coralligenes flexibles, 1816, p. 171.
corbulae 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 X VIII, figs. 9-11.)


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 hydrothecae; no internal thickenings of the internode. Hydrothecae 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 (Fowkes); Albatross Station 215, lat. N. 23° 10'; long. W. 82° 21'; depth, 29 fathoms; Pourtales 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 corbulae are, of course, quite distinct.

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

AGLAOPHENIA FLOWERSI, 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. Hydrothecae 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.—Corbula 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 hydrothecae between the corbula and the stem.

Distribution.—Off Sand Key, Florida, 116 fathoms, State University of Iowa Expedition.

1In 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 hydrothecae, the much larger and more branching colonies, and the very distinct and graceful corbulae, which differ materially from those of any other known species.

*Type slides.*—Cat. No. 13353, 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. Hydrothecae 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.**—Gonangi 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 corbulae 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 hydrothecae are decidedly more closely approximated. The gonosome is quite distinct from that of any of its allies, being arculate in outline and having the loose, basal leaf as in *A. tubulifera* Illecks.

*Type slides.*—Cat. No. 13354, 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.)


**Trophosome.**—Colony growing from a woody root-stalk, 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 near its middle; hydrocladia moderately approximated, divided into regular internodes, each of which has a very strong horizontal ridge opposite the intrathecal ridge. Hydrothecae 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.**—Corbulae 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 hydrotheca of _A. insignis_ are 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. Hydrotheca rather deep; anterior profile moderately concave; margin with nine well-defined teeth; intrathecal ridge short, but evident; supracalyceine 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 caudine nematophores on the front of each internode of the stem.

**Gonosome.**—Corbule 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. Hydrothecae 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; supracalyceine nematophores slightly overtopping the hydrotheca; 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; caudine nematophores one at the base of each hydrocladium, and two others on each internode of the stem. Color of stem dark brown.

**Gonosome.**—Corbulae 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 c'ristifrons' 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 fuscicled, 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. Hydrotheca 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 hydrotheca; mesial nematophore very large, robust, projecting at nearly a right angle from the hydrotheca, and free for nearly half its length; there are two canline 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 hydrotheca 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 corbula 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.)


**Trophosome.**—Colony unbranched, springing from a regularly annulated creeping rootstalk, and attaining a height of 3/4 inch, but usually not more than 1/2 inch; stem not fuscicled, 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. Hydrotheca 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 algae. 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 algae growing at such depths.

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

### AGLAOPHENIA PELAGICA Lamouroux.


*Dynamena pelagica* (de Blainville), Manuel d'Anatomologie, 1836, p. 481.

*Aglaophenia pelagica* McCrady, Gymn. of Charleston Harbor, 1857, p. 98.

*Aglaophenia pelagica* Agassiz, N. A. Acad., 1865, p. 139.

*Aglaophenia pelagica* Kichinfaure, Uber die Hydrozoenfamilie Plumulariade, 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 baciferum*] and were taken in the Atlantic by a homeward bound vessel. " " " It [the species] is characterized by cells [hydrotheca] quite long in proportion to their breadth. The posterior process [mesial nematophore] is far behind; the anterior lateral processes [supracalyceine nematophores] are rather weak and slender. The main stem is recumbent and creeping, giving off at intervals plumose-like branches, so much like those of the ordinary true plumulata 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.

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\(^1\) Gymnophthalmata of Charleston Harbor, p. 201.
AGLAOPHENIA PERPUSILLA Allman.

(Plate XXI, figs. 4, 5.)


Trophosome.—Hydrocaulus attaining the height of about $\frac{1}{4}$ inch; stem simple, nonfascicled; pinnae 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. Hydrotheca 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. Supracalyceine nematophores strong, overtopping the hydrotheca; mesial nematophore scarcely reaching the intrathecal ridge, adnate as far as its oblique terminal orifice.

Gonosome.—Not known.

I have not seen this species and have copied Professor Allman’s description entire. The distinguishing features are the narrow hydrothecal keel, and the supracalyceine nematophores which overtop the hydrotheca. 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 $\frac{1}{2}$ 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 supracalyceine nematophores; nodes very distinct. Hydrotheca deep, closely approximated, with a narrow anterior keel reaching to the margin, which is armed with four sharply cut teeth; intrathecal ridge evident and oblique, reaching clear around the hydrotheca; supracalyceine nematophores rather small, not overtopping the hydrotheca; mesial nematophore stony, with its free distal portion divided from the rest by a constriction or partial septum. There is an ordinary canine 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 sepal ridge opposite the intrathecal ridge. Hydrotheca 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; supracalyceine 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; canline 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.)


**Trophosome.**—Stem simple, monosypmonic, springing at intervals from a creeping stolon * * * (not exceeding one-fourth of an inch in height). Hydrotheca 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 costa; sutures of costa 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_ Kirchénpauer, _Über die Hydroidenfamilie Plumularidé_, 1872, Pt. I, pl. i, fig. 1.

Never having seen this species, nor an adequate description, I copy the original description verbatim:

*P. surculus simplicibus, alternatis spinatis; cellulis simplicibus; aperture 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 artéfiés, de distance en distance, par un étranglement. Chaque segment a sa cellule portée sur une expansion anguleuse, satisfaite 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.

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1 Original description quoted from Allman.
AGLAOPHENIA (?) SAVIGNYANA Kirchenpauer.

(Plate XXIV, fig. 4.)

Aglaophenia savigniana Kirchenpauer, Uber die Hydroidenfamilie Planulidae, 1872, Pt. 1, p. 41.

Aglaophenia savigniana Marktanner-Turneretscher, Hydroiden des k. k. naturhist. Hofmuseums, 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. Hydrotheca 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; caudine 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.)


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 infrathecal ridge of the hydrotheca. Hydrotheca deep for this genus; margin with seven strong even teeth; the aperture inclined a little forward; infrathecal 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 caudine 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 caudine 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.


This species has a very large, thick, fascicled hydrosome, which is branching, and gives rise to alternate pinnae. Hydrotheca 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 sepalid 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. Hydrotheca 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 corbulae 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. 15361, 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; hydrocladiad internodes distinct, each with a sepalid ridge behind the intrathecal ridge. Hydrothecae 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. struthionioides.1 There is an aperture between the bases of adjacent leaves, and no prominent spur at the bases. There are two hydrothecae 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.)

Aglaophenia franciscana Alexander Agassiz; N. A. Acadephy, 1885, p. 110.
Aglaophenia arborea Verrill, Report of Commissioner of Fish and Fisheries, 1871-72, p. 730.
Aglaophenia struthionides Marktanner-Turneretscher, Die Hydroïiden des k. k. naturhist. Hofmuseums, 1890, p. 265.

Trochosone.—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. Hydrotheca 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 supracalyxine 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; supracalyxine 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 caulinie nematophore at the base of each hydrocladium that resembles those found in the genus Lytocarpus.

Gonosome.—Corbula on hydrocladia which take the place and position of regular hydrocladia, and bear three hydrotheca 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\(^1\) 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.\(^2\) 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.)

_Aглаопения ramulosa_ Kirchenpauer, Ueber die Hydroideenfamilie Plunmlaridae, 1872, Pl. 1, p. 41, pl. I, fig. 18.
_Aглаопения ramulosa_ Bale, Catalogue Australian Hydrozoa phytes, 1884, p. 171, pl. xxi, 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. Hydrotheca 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; supraclavicular 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, 75 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 fasciuled, 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 supraclavicular nematophores. Hydrotheca 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 retrose, the next long and projected forward, the remainder smaller, varying greatly in shape, being either rounded or sharp pointed; supraclavicular 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._—Corbulae 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. arborca_, from which it differs in the direction of the hydrocladia, size of hydrotheca, 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.)


_Trophosome._—Colony unbranched or sparsely branching, attaining a height of about 3 inches; stem not fasciuled, 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. Hydrotheca closely

1 Description and figures from type specimen kindly sent me by Doctor Walter Faxon from the Museum of Com parative 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 spars-like, free portion tubular, its end not reaching the level of the middle of the hydrotheca; cauline nematophores inconspicuous.

Gonosome.—Corbula: 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 hydrothecae 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 hydrotheca 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.

I have been unable to find any description of this species but the original, which is herewith given.

P. surculus ramosis, flexuosus; ramis alternis pinnatis; celularis complicatis; vesiculis elongatis, compressis, transversim obliquis cristatis.

Habitat.—The shores of Patagonia.

Cette jolie espèce forme des branches longues, terminées par un grand nombre de rameaux arriqués penniformes. Chaque rameau porte des rameules alternes assez étendus. Les rameules sont divisées en segments nombreux, trois par cellules, dont la partie supérieure est terminée en pointe externe. Les cellules sont compoisses 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 dessous quatre sinus et trois pointes. Les vésicules sont allongées, comprimées, dentées obliquement et latéralement.

AGLAOPHENIA (?) CRENATA Fewkes.

(Plate XXIII, figs. 9, 10.)


Vrophosome.—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. Hydrothecae rather deep, cylindrical, anterior profile nearly straight, margin armed with ten or twelve regular, minute teeth or sinuatuons; 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. Hydrothecae rather deep, anterior profile slightly concave, margin not greatly everted, and armed with nine prominent, sharp-pointed teeth; intrathecal ridge very low, evident, oblique; supracalyicine nematophores small, distinctly genculated, 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; caulline nematophores rather large, one on each side of the base of each hydrocladium, and a mamillate 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 (?) CONSTRUCTA Allman.

(Plate XXIV, figs. 1-3.)


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 pinnae (hydrocladia); three pinnae springing from each internode. Hydrothecae with the distal half expanded and separated from the proximal part by a deep constriction; margin with four broad teeth. Supracalyicine 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; caulline 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 trident Alexander Agassiz, N. A. Acropleph., 1865, p. 110.


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.
eladia divided into regular short internodes, each of which is divided back of the intrathecal ridge of the hydrotheca by an internal ridge. Hydrotheca 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 nematophage strong, reaching to about the middle of the hydrotheca, anterior profile regularly convex, the nematophage 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._—Corbulae 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. (McCready.)

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 Harvard 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 plumæa_ of the British coast, but a direct comparison with specimens from Plymouth, England, shows that the American species has hydrothecae with a less concave profile above the mesial nematophage and a much longer and more slender corbula.

**AGLAOPHENIA TRICUSPIS** McCrady.

_Aglaophenia tricuspus_ Alexander Agassiz, N. A. Acad. Phil., 1865, p. 140.
_Aglaophenia tricuspus_ Kirchenpauer, Uber die Hydroidenfam. Plumularide, 1872, Pt. I, p. 27.

This species grows in solitary plumes, much taller than those of _A. pelagica_ 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. Hydrotheca with one or two large anterior teeth, the remainder being small or reduced to minute situations; 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 hydrothecae between the corbula and the stem.

In looking over the very large series of American _Aglaophenia_ several were found that differed from all the others and agreed among themselves in the possession of the characters given above. _Aglaophenia myriophylla_ 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

¹Original description. I have been unable to find either specimens or later descriptions of this species.
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 corbulae. While agreeing fully with the latter author, the present writer considers that the presence of hydrothecae on the corbula leaves is a good generic distinction, upon which, in connection with the stem character and certain features of the hydrothecae 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.**

<table>
<thead>
<tr>
<th>2 mesial nematophores</th>
<th>Hydrotheca separated by more than half their height, narrowed below. <em>T. biipinum</em>.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hydrotheca separated by more than half their height, not appreciably narrowed below. <em>T. benedictii</em>.</td>
</tr>
<tr>
<td></td>
<td>Hydrotheca separated by more than half their height, narrow below. <em>T. distans</em>.</td>
</tr>
<tr>
<td>1 mesial nematophore</td>
<td>Hydrotheca closely approximated, no conspicuous internal thickening of internode behind hydrotheca. <em>T. normani</em>.</td>
</tr>
<tr>
<td></td>
<td>Hydrotheca closely approximated, thickenings of internodes evident. <em>T. myriophyllum</em>.</td>
</tr>
</tbody>
</table>

**Distribution of American Species of the Genus Thecocarpus.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Geographical, Atlantic.</th>
<th>Bathymetrical.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Caribbean and Gulf Coast</td>
<td>3 to 20 fathoms</td>
</tr>
<tr>
<td><em>T. myriophyllum</em></td>
<td></td>
<td>20 to 50 fathoms</td>
</tr>
<tr>
<td><em>T. distans</em></td>
<td></td>
<td>50 to 100 fathoms</td>
</tr>
<tr>
<td><em>T. normani</em></td>
<td></td>
<td>Over 200 fathoms</td>
</tr>
<tr>
<td><em>T. bispinosiis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>T. benedictii</em></td>
<td></td>
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</tr>
</tbody>
</table>

**Thecocarpus Myriophyllum** (Linnaeus).

(Plate XXIV, figs. 12, 13.)

*Sertularia myriophyllum* *Pallas*, Elenchus Zooph., 1766, p. 153.
*Aglaophenia myriophyllum* *LaMouroux*, Polypl. Cor. flex., 1816, p. 168.
*Plumularia myriophyllum* *Lamarck*, Anm. sans Vert., 1836, 2d ed., II, p. 159.
*Aglaophenia myriophyllum* *Kirchenpauer*, Hydroidenfam. Plumularidae, 1872, Pt. 1, p. 28.
*Lytocarpus myriophyllum* *Pennington*, Brit. Zoophytes, 1885, p. 130.
*Lytocarpus myriophyllum* *Marktanner-Tuerkenscher*, Die Hydroiden des k. k. Naturhist. Hofmuseums, 1890, p. 277

**Trophosoma.**—Colony unbranched, or sparingly branched, attaining a height of 18 inches; stem fascicled, with flattened protuberances formed by the contortion of the component tubes; hydrocolula alternate, close set, divided into regular internodes, each of which bears a hydrotheca. Hydrothecae stout, cylindrical, with a median anterior tooth, and lateral situations; 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; supracalyceine 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 caudine nematophores on the tubes composing the stem.

¹ Genera of the Plumularidae, pp. 12, 14.
**THE PLUMULARIDE.**

**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 hydrothecae 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, who under "Habitat" says: "Massachusetts Bay (Agassiz), Mingan Islands, Gulf of St. Lawrence (test 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.)


**Trochosome.** — 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; pinnae (hydrocladia) distant, attaining the length of nearly an inch. Hydrotheca 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.** — Corbula 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 hydrothecae.

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 corbula "like the corbula of other species are metamorphosed pinnae," although he afterwards, in the *Challenger* Report, places this species in the genus *Lybacarpus*, in which the gonangia are protected by true phylactogonia, which seem to me to be quite distinct from corbula.

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

**THECOCARPUS NORMANI,** new species.

(Plate XXV, figs. 1, 2.)

**Trochosome.** — 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. Hydrotheca close set, robust, cylindrical, not appreciably diminishing below; a single somewhat retrorse anterior tooth and a number of minute lateral sinuations around the margin; intrathcal 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.** — Corbula 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 hydrothecae 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.


This species bears about the same relation to *T. distans* that *T. benedicti* does to *T. bispinosus.*

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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 hydrotheca, and in the number and form of the hydrotheca 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.**—Hydrocanthus 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 sinus as in *A. distans*); divided regularly into internodes, each of which bears a hydrotheca. Hydrotheca large, stout, closely approximated for this group, with a single anterior spine and several lateral shallow teeth or summations 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.**—Corbula very large, borne on pinnae springing from the front of the stem, directed forward, and bearing about five somewhat modified hydrotheca 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 corbulae 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', 410 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 hydrotheca, 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.)


**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; pinnae (hydrocladia) alternate, attaining a length of nearly an inch and a half. Hydrotheca 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.**—Corbulae open, formed by two alternate or subopposite series of free, rib-like processes, each of which carries near its base a small, hydrothecal cep, 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 hydrotheca.

**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).


**Gonosome.**—Stem simple or fascicled; hydrotheca 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 bronched phylactogonia, springing from the proximal internode of the hydrocladium, and bearing nematophores, but no hydrotheca.

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 Hydroidea 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 hydrotheca, while, on the other hand, its gonosome allies it to *Agaophenopsis*, from which it differs in having no hydrotheca on the phylactogonia.

**Distribution of American species of the genus Cladocarpus.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Geographical Atlantic</th>
<th>Bathymetrical</th>
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<tbody>
<tr>
<td></td>
<td>Charleston and Norfolk</td>
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<td></td>
<td>South of Charles-</td>
<td>Coast of Europe</td>
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<tr>
<td></td>
<td>ton and West</td>
<td>1 to 20 fathoms</td>
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<tr>
<td><em>C. sigma</em></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>C. compressus</em></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>C. ptericus</em></td>
<td>+</td>
<td>+</td>
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<tr>
<td><em>C. flexuosus</em></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>C. obliquus</em></td>
<td>+</td>
<td>+</td>
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<tr>
<td><em>C. septatus</em></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>C. distichotheca</em></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><em>C. fornatus</em></td>
<td>+</td>
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<tr>
<td><em>C. gramineus</em></td>
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<tr>
<td><em>C. paradica</em></td>
<td>+</td>
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<td><em>C. vorticella</em></td>
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<tr>
<td><em>C. carinatus</em></td>
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</tbody>
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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. fornatus* 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 Plumarid genera.

**KEY TO AMERICAN SPECIES OF THE GENUS CLADOCARPUS.**

- Hydrothecal margin distinctly toothed all around; anterior teeth not decidedly the largest.
- Hydrothecal margin with conspicuous sigmoid intrathecal ridge.
- Hydrothecal margin without conspicuous intrathecal ridge.
- Hydrotheca with deep anterior flexure.
- Anterior profile nearly straight.
- Anterior profile strongly convex.
- Anterior profile concave above and convex below.

Hydrotheae distant and very slender
Hydrocladia strongly sinuous.

Hydrotheae with two large, shallow anterior teeth.

Hydrotheae without teeth.

Hydrotheae almost tubular.............................. C. dolichotheca.
Hydrotheae long, oblong................................. C. hexaonos.
Hydrotheae with anterior profile strongly concave........ C. tenuis.
Upper part of stem flattened, handlike.................. C. grandis.
Upper part of stem not strongly flattened, no lateral marginal teeth.... C. paradoxa.
Aperture of hydrothea directed upward................... C. portulataes.
Aperture of hydrothea directed forward.................. C. carinates.

CLADOCARPUS SIGMA (Allman).
(Plate XXVI, figs. 1, 2.)

_Aglapheina 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. Hydrotheae 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; caudine nematophores as usual in this genus.

_Gonosome._—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 nematophorons branches 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° 55', long. W. 79° 43', 273 fathoms; _Albatross_ Station 2668, lat. N. 30° 58', long. W. 79° 39', 291 fathoms; _Albatross_ Station 2669, lat. N. 31° 09', long. W. 79° 34', 352 fathoms; _Albatross_ Station 2658, lat. N. 34° 26', long. W. 70° 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.)


_Trophosome._—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 caudine nematophore on each side of the base of each hydrocladium, and another between these; there is a row of dentilicate 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-proonged 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.

CLADOCARPS VENTRICOSUS Allman.

(Plate XXVI, figs. 6-8.)


Trophosome.—Stem attaining a height of about an inch and a half, not fascicled; pinna alternate, each springing from a rather long lateral process of the stem, somewhat waved. Hydrotheca distinct; 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. Supraretacine nematophores scarcely overtopping the hydrotheca; mesial nematophore quite detached from the hydrotheca.

Gonosome.—Phyllactogonia springing from the proximal internodes of a certain number of the pinnae, 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, obvate, 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.

CLADOCARPS FLEXILIS Verrill.

(Plate XXVI, figs. 9-12.)

Cladocarps 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. Hydrotheca 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; supraretacine nematophores tubular, small, overtopping the hydrotheca; mesial nematophore short, separated from the hydrotheca; two caulin 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; phyllactogonia 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, 61 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, 66 fathoms; Albatross Station 2085, lat. N. 40° 03', 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 2393, lat. N. 29° 28', long. W. 87° 56'; depth, 27 fathoms.

Professor Verrill informs me that Cladocarps flexilis is the most common species taken by the Fish Commission off Vineyard Sound in the warm zone (80 to 150 fathoms).

The hydrotheca 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. Hydrothecae 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 situations on each side; intrathecal ridge short, straight, very oblique; supracalycine nematophores small, tubular, overtopping the hydrotheca; mesial nematophore short, free from the hydrotheca; caune nematophores at the bases of the hydrocladia and on 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 hydrotheca.

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 hydrotheca, and also on the portion between adjacent hydrothecae. Hydrothecae gibbons, 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 hydrotheca; mesial nematophore small, slender, free from the hydrotheca, hardly reaching the level of the bottom of the latter; two caune 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 on the bases of the hydrocladia; phylactogonia like stag's horns, with two or three branches, arching over the front of the stem.

Distribution.—Albatross Station 2263, Lat. N. 37° 06', 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° 31'; depth, 85 fathoms.

C. septatus is more branched and longer than most of the members of this genus which are nearest to it. The gibbons appearance of the hydrothecae 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.)


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 reassert the general direction of the hydrocladium; internodes divided by numerous septal ridges, which appear to surround the axial cavity. Hydrothecae 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; phylactogouia 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. dolichothea* 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. Hydrothecae 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 sinuities; 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. dolichothea* Allman, from which it differs in having the hydrothecae 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.)


**Trophosome.**—Hydrocladium 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 pinna undivided. Hydrothecae 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 pinnae are ornamented with a great number of internal chitinous ridges.
**AMERICAN HYDROIDS.**

**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 hydrothecae to the extreme limit found among the Plumulariidae. 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. Hydrothecae 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 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 hydrothecae; margin finely crenulated; mesial nematophore short and stout, adnate to the front of the hydrotheca; caudine 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, 410 fathoms; Albatross Station 266, 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 pinna 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. paradisiae, 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.)


**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. Hydrothecae 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 caudine 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 nematophoran 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', 433 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° 17', 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 plankumarian 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.)


_Trophaosme._—Colony (in fragmentary specimen) unbranched, attaining a height of about three-fourths of an inch; stem fasciiced, 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 hydrocladial 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. Hydrotheca 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; caudine 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 _paradisca_ group with two prominent anterior teeth. It can be told from _C. paradisca_ by its much stouter hydrotheca 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 POURTALESI_ Verrill.

(Plate XXIX, figs. 1, 2.)


_Trophaosme._—Colony irregularly branched, attaining a height of about 18 inches; stem fasciiced, 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. Hydrothecae 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; suprACLavine 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; caulinie 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. 35° 09', 90 fathoms.

This species resembles *Aglaophenia integra* G. O. Sars,¹ so far as the shape of the hydrotheca is concerned, but the figure given by Sars indicates that his species has a row of hydrothecae 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. Hydrotheca 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; supra-clavine 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; caulinie 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. 30° 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 slide.**—Cat. Nos. 13685, 18686, U.S.N.M.; Cat. Nos. 15388, 15389, Mns. State Univ. Iowa; also in the collection of the author.

¹ Bidrag til Kundskaben om Norges Hydroider (1873), p. 12, pl. ii.
THE PLUMULARIDÆ.

AGLAOPHENOPSIS Fewkes (modified).


Trophosome.—Stem usually fascicled; hydrocladia with numerous internal septal ridges; hydrothecal margin toothed; nematophores with crenulated margins.

Genosome.—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 hydrotheca.

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. Baily, 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 hydrotheca on its distal end. In one species, Aglaophenopsis kirsutae, the appendage is unbranched, usually without a distally placed hydrotheca, but sometimes with one. In Aglaophenopsis cornuta and Aglaophenopsis verrilli the appendage is branched, each branch bearing one or more hydrothecae. In Aglaophenopsis cornuta there is a hydrotheca in the axis of each of these secondary branchlets, while in Aglaophenopsis 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.

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<th>Species</th>
<th>Geographical North Atlantic</th>
<th>Bathymetrical</th>
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<td>Centrales northward</td>
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<td>1-20 fathoms</td>
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<td>200-500 fathoms</td>
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<td>A. kirsutae</td>
<td>+</td>
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<td>A. cornuta</td>
<td>+</td>
<td>+</td>
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<td>A. verrilli</td>
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<td>A. distans</td>
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</table>

KEY TO AMERICAN SPECIES OF THE GENUS AGLAOPHENOPSIS.

Mesial nematophore double. ........................................ A. kirsutae.
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.)


Trophosome.—Colony consisting of one to three main upright branches, which give off alternate hydrocladia-bearing branchlets, which may themselves again divide into hydrocladiate rami; 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 hydrotheca. Hydrothecae 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 Plumulariidae, 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; supraclecine nematophores tubular, with crenulated margins, overtopping the hydrotheca; mesial nematophore divided into two parts which are widely divergent, their crenulated margins being almost on a line with those of the supraclecine pair; the proximal hydrotheca on the hydrocladia-bearing protective appendage has only one mesial nematophore; canine 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 canule nematophores remind one somewhat of those found in some species of *Lytoparopus* (for example, *L. clarkeii*). The variation in the degree to which the hydrotheca are adnate to their internodes is very great. Indeed, one could easily imagine two hydrotheca, 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. Hydrotheca 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; supraclecine 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 canule nematophores near the axil of each hydrocladium, and one below it on the anterior aspect of the internode.

*Gonosome.-(Immature.)* Gonangia subcyindrical, 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 filabellate, consisting of a main stem, giving off lateral branches, and attaining a height of about nine inches; stem fasciected, the anterior tube giving off the hydrolcladia; hydrolcladia borne on main stem and branches, not very closely approximated, divided into regular internodes, each with a number of small sepal ridges behind the hydrotheca, and two at the base of each mesial nematophore. Hydrothecae 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; cauleine nematophores small, one or two on the front of each internode of the stem, and one in the axil of each hydrolcladium.

Gonosome.—Gonangia obovate, borne on protective appendages to the hydrolcladia, which spring from immediately behind the bases of the hydrothcae; 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 hydrothecae, 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. 15860, 15861, 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.)


Trophosome.—Colony branched in a somewhat pinnate manner, the main branches and branchlets again branching pinnately, the whole structure being rigid and filabellate, with all of the branches and branchlets directed at right angles with the branches from which they originate; total height about seven inches; stem fasciected, the hydrolcladia being borne on an anterior tube which is easily separable from the rest; hydrolcladia 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. Hydrothecae obovate, 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; cauleine nematophores very large, one just at the base of each hydrolcladium, another immediately below this, and a third, long and spur-like, opposite the base of each hydrolcladium.

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 hydrolcladium, 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 hydrocladal internode form a feature that I have not seen elsewhere. The anterior keel far surpasses any other that is found among the American Plumulariidae.

Type.—In the Museum of Yale University.

LYTOCARPUS (Kirchenpauer) Allman¹ (modified).

Lytocarpus (Subgenus) Kirchenpauer, Ueber die Hydroidenfamilie Plumulariidae, 1872, p. 27.

Trochosome.—Stem fascicled; hydrotheal margin strongly toothed or serrated; 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 hydrothecae 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 Plumulariidae, Bale clearly shows that that portion of the genus Lytocarpus as defined by Allman, which is typified by Aglaophenia myriophylla 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, however, in not having true hydrothecae on the stem, but having one at the base of each protective branchlet. It is somewhat difficult to determine the true position of these hydrothecae, and I am inclined to think that we have here no exception to the otherwise invariable rule that there are no caudal hydrothecae among the Statoplia.

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 supracalyceine nematophores, the place of the hydrothecae 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 Statoplia, 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.

² Since the above was written I have been permitted to examine Doctor Fewkes's type of this genus, and find no hydrotheca 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*.

Mesial nematophore not reaching top of
hydrotheca; its distal end free. Anterior profile of mesial nematophore simply convex ..... *L. grandis*.

Mesial nematophore rising decidedly above middle of hydrotheca.

Mesial nematophore pointing forward from middle of hydrotheca; free portion very short .......... *L. clarkei*.

Supracalyicine nematophores with their distal ends forked.... *L. racemiferus*.

**Distribution of American species of the genus Lytocarpus.**

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<td>Charleston and northward.</td>
<td>South of Charleston and east.</td>
<td>South Atlantic.</td>
<td>Coasts of Europe.</td>
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<tr>
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<td><em>L. grandis</em></td>
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<td><em>L. clarkei</em></td>
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<td><em>L. racemiferus</em></td>
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**LYTOCARPUS PHILIPPINUS** (Kirchenpauer).

(*Plate XXXI, figs. 4–7.*

*Aglaophenia philippina* Kirchenpauer, Ueber die Hydroidenfamilie Plumularidae, 1872, Pt. 1, p. 45.


*Lytocarpus philippinus* Marklann-Türnervetscher, Die Hydroiden des k. k. naturhist. Hofmuseum, 1890, p. 274, 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. Hydrotheca 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; supracalyicine 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; caudine 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
AMERICAN HYDROIDS.

123

(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.)


Trophosome. — 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. Hydrotheca 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 simons, not strongly convex; supracalyceine nematophores tubular, very long on distal part of hydrocladia, and much shorter, scarcely overtopping the hydrotheca, 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 hydrotheca. 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 hydrothecae. A careful examination shows that these hydrothecae are actually borne on the so-called ribs near their bases, although this is difficult to see without dissection. The species is very near Lycocarpus 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.)


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. Hydrothecae 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; supracalyceine 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, \(^1\) 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 hydrotheca. At the base of each pinna in a direct line with the hydrotheca 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.)

**Trochosome.**—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 supracycline nematophores; hydrotheca 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; supracycline 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, 144 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, 67 fathoms; Albatross Station 2337, lat. N. 23° 11', long. W. 82° 20'; depth, 199 fathoms; Albatross Station 2338, lat. N. 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 ecmosarc 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, 1881, 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. 15100, Msns. 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 supracyclic nematophores. Hydrotheca stout, oval, with margins slightly contracted, and seven rather sharp, incurved teeth; intrathecal ridge strong, horizontal; supracyclic 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 ecosarc, but they are not so numerous as in L. clarkii.

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. Hydrotheca 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; supracyclic 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 supracyclic nematophores of this species are, so far as I know, unique. There is an approach to it in Halicurina ascidoides Bale, 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 phylopteuma.

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, 1881, p. 176, pl. XIII, fig. 2.
LYTOCARPUS RACEMIFERUS Allman.

(Plate XXXI, figs. 1-3.)

Lytocarpus racemiferus Allman, Challenger Report, Hydroidea, 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. Hydrothecae rather deep, margin serrated, teeth blunt; intrathecal ridge well marked, situated near the fundus of the hydrotheca; mesial nematophore adunate 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 hydrothecae, 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 hydrotheca 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; hydrocladal internodes without septal ridges.

_Gonosome._—Gonangia borne on the stem or on the bases of the hydrocladia, not taking the place of hydrothecae, and not protected by corbule or phylactocarps of any description.

As originally defined, this genus included all plumularians which did not have corbules. In 1874 Allman^1^ restricted the genus so as to include only "such Plumulariids as possess the trophosome of _Aglaophenia_, but have their gonangia destitute of corbule or other protection." In 1886 Bale^2^ suggested that Allman's _Halicornaria ramosifera_, 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 hydrocladal 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 hydrotheca, while in _Nuditheca_ they do not. _Halicornaria nitritata_ 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.

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^1^ Report on the Hydroidea collected during the expeditons of H. M. S. Porcupine, Transactions of the Zoological Society, 1874, VIII, p. 476.

^2^ The Genera of the Plumulariids, 1886, p. 18.

AMERICAN HYDROIDS.

KEY TO AMERICAN SPECIES OF THE GENUS HALICORNARIA.

Caulline nematophores not very large .................. H. speciosa
Mesial nematophore not projecting far above margin of hydrotheca. H. longicauda
Caulline 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. Hydrotheca 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 sinuiterations on each side, and a very strong anterior flexure and intrathecal ridge; supraclavicular nematophores stouter, 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; caulline 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 Phunularidie, reminding one of some of the striking forms found in Australia.

Type slides.—Cat. No. 18701, U.S.N.M.; Cat. Nos. 15403, 15401, Mus. State Univ. Iowa; also in the collection of the author.

HALICORNARIA SPECIOSA Allman.

(Plate XXXIII, figs. 1-3.)


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. Hydrotheca 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; supraclavicular nematophores stouter, scarcely overtopping the hydrotheca; mesial nematophore aninate nearly to its distal end, which attains the level of the top of the hydrotheca; caulline 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 2610, lat. N. 25° 05', long. W. 80° 15'; depth, 50 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 Pouteleas 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. Hydrothecae 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 hydrotheca. 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 hydrothecae 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, 15108, 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 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 hydrothecae, is a feature not elsewhere found among the Statoplea. These subdivisions of the hydrocladia must not be confounded with the various accessory rami, 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 Halicornaia 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.

NUDITHECA DALLI (Clark).

(Plate XXXIV, figs. 4-6.)


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. Hydrotheca 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.—Gouangia 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 gouangium.

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.


Trophosome.—Hydrocladia disposed in a continuous spiral round the stem. Hydrotheca with entire margin. Mesial nematophore not adnate to the walls of the hydrotheca.

Gonosome.—Gouangia 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.)


Trophosome!—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. Hydrotheca 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.—Gouangia 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 quekch.
ANOTATED BIBLIOGRAPHY.

The author has included in the bibliography for this section:
First. The works containing original descriptions of the genera of Plumularidae, and also those containing original descriptions of the species of this family found in American waters.
Second. All works containing a discussion of the morphology and embryology of the characteristic features of the Plumularidae.
Third. All works containing an important systematic discussion of this group.

A bibliography of species of Plunularia and Aglaophenia, besides an excellent bibliography of the Aculepha in general.

AGASSIZ, LOUIS.............Contributions to the Natural History of the United States of America, IV, 1862.
Hydroids.
Contains a general discussion of the classification of the hydroids and an extensive bibliography of the whole group. Establishes the family Plumularidae.

ALDER, JOSHUA.............A catalogue of the Zoophytes of Northumberland and Durham. (Transactions of the Tyneside Naturalists’ Field Club, 1857.)
Contains a discussion of the distinction between the two British species of the genus Antennularia.

ALLMAN, GEORGE J..........On the occurrence of Ameboflagellate Protoplasm and the emission of Pseudopodia among the Hydroids. (Annals and Magazine of Natural History, March, 1864.)
Contains the earliest description of the activity of the sarcostyles that I have been able to find.

ALLMAN, GEORGE J..........On the Construction and Limitation of Genera among the Hydroids. (Annals and Magazine of Natural History, May, 1864.)
The author insists on the importance of including the characters of both the medusa and hydroid forms in classification. No new plumularian genera described.

ALLMAN, GEORGE J..........A Monograph of the Gymnoflagellate or Tubularian Hydroids. (London, Ray Society, 1871.)
An elaborate discussion of the morphology, classification, development, etc., of the hydroids in general, and also a discussion of the sarcostyles and a presentation of his argument for considering the plumularians as closely allied to the graptolites.

Gives number of species secured and a few general remarks on the Hydroidea of the Gulf Stream.

ALLMAN, GEORGE J..........Report on the Hydroids Collected during the Expeditons of H. M. S. Forcupine. (Transactions of the Zoological Society, VIII, 1874.)
Original description of the genera Diplopteron and Cladocarpus.

ALLMAN, GEORGE J..........Diagnoses of new Genera and Species of Hydroidea. (Journal of the Linnean Society, London, XII, 1876.)
Modifies the genus Haliceteria as first described by Bash.

This is a very important work. Many new species of Plumularidae are described, besides the following new genera: Antennella, Monostechus, Antennopsis, Halopteris, Hippocrella, and Cladocarpus. The work is beautifully illustrated.

A general morphological discussion, including remarks on the sarcostyles. Several new genera described and a few new species from American waters.

ALLMAN, GEORGE J..........Description of Australian, Cape, and other Hydroids, mostly new, from the collection of Miss H. Gatty. (Journal of the Linnean Society, London, IX, 1883.)
Describes the genus Gattyna and several new species of Plunularia and Aglaophenia from American waters.
THE PLUMULARIDE.


BALE, W. M. On the Hydroidea of Southeastern Australia, with descriptions of supposed new species and notes on the genus Aglaocephis. (Journal of the Microscopical Society, Victoria, 1881.) Discussion of the genus Aglaocephis and the orifices of the nematophores of Australian species of that genus.


BALE, W. M. The Genera of Plumularidae, with observations on various Australian Hydroidea. (Proceedings of the Royal Society, Victoria, 1886.) An excellent work, discussing the genera established by Allman, Fewkes, and von Lendenfeld, and establishing the genus Halicarpopsis.


BUSK, G. An Account of the Polyzoa and Sertularian Zoophytes collected on the Voyage of the Rattlesnake, etc. Narrative, Appendix, IV, London, 1852. I have not seen this work, but it is said to contain descriptions of one or two species since found in America.

CLARK, S. F. Descriptions of new and rare Species of Hydroidea from the New England Coast. (Transactions of the Connecticut Academy of Arts and Sciences, XIII, 1876.) Contains description of Plumularia verrillii = Schizotricha gracilis (Sars).


CLARK, S. F. The Hydroidea of the Pacific Coast of the United States, South of Vancouver Island. (Transactions of the Connecticut Academy of Arts and Sciences, 11, 1876.) Contains descriptions of Aglaocephis struthionides and reports Plumularia selacea.


COUGHTREY, M. Notes on New Zealand Hydroidea. (Transactions and Proceedings of the New Zealand Institute, VII, Wellington, 1875.) This is another work that I have not seen and do not know that it has a rightful place in this list.

DRIESCH, HANS. Tektonische Studien an Hydrozoenpolypen. Jena. Discusses the order of succession in which the various persons of the colony appear and also the nature of the saccostyle.

DESEUR, E. [Zoological investigations among the shoals of Nantucket on board the surveying steamer Bibb.] (Proceedings of the Boston Society of Natural History, III, 1848.) Describes Plumaria (original spelling) arborea, a species which can now be identified.

ELLIS, JOHN. An Essay towards a Natural History of the Corallines and other Marine Productions of the Isle of Kind commonly found on the Coast of Great Britain and Ireland. (London, 1755.) This is a classic work, with figures which are remarkably good for that early day.

ELLIS, JOHN, AND SOLANDER. The Natural History of Many Curious and Uncommon Zoophytes, etc. London, 1786. Daniel. Contains good colored plates of some species common to Europe and America.


FEWKES, J. WALTER. Bibliography to accompany Selections from Embryological Monographs, Acalepha. (Bulletin of the Museum of Comparative Zoology, XI, 1884, No. 10.) This bibliography does not give all the systematic works, but mentions those only which contain embryological material.
AMERICAN HYDROIDS.

133


Gives figures illustrating the development of the corbula of Aplysia perna.


Contains descriptions of a few Plumularidae.

Forbes, Edward. On the Morphology of the Reproductive System of the Sertularian Zoophyte, etc. (Annals and Magazine of Natural History, December, 1844.)

A classic paper treating of the anatomy between Hydrozoa and plants, especially in their reproductive features.

Gray, J. E. List of the Specimens of British Animals in the Collection of the British Museum.


Contains a systematic arrangement of the Hydrozoa.


Describes the nematocysts and the origin of the sex cells in Plumularia fragilis, and the formation of the planula.


Breaks up the old genus Plumularia into three genera, Anisocalyx, Heteropyxis, and Plumularia.


A splendid classic work containing general discussion of the Hydrozoa and descriptions of several species of Plumularide which have since been found in American waters.


Criticises Heller for ignoring British writers and objects to his subdivision of the genus Plumularia.


Discusses Sars's paper and establishes the genus Ophionema for Sars's Ophiodes parasiticus.

Jickell, Carl F. Ueber den histologischen Bau von Tubularia, Corallium, Cylindrophyra, Cylindropa, Gymnasterias, etc. (Morphologisches Jahrbuch, V.)

Describes the sarcostyles and the histology of Plumularia keloctioidea; also discusses the relationship between the Plumularidae and graptolites.


Another classic work containing good figures and descriptions of some of the Plumularidae common to Europe and America.


This and the preceding constitute a very important work describing all known Plumularidae and giving a systematic discussion of their gross anatomy, illustrated by excellent plates. Part 2 includes all of the Eleutheropidae then known. Part 1 is devoted to the Stomatopoda.


Contains a few original descriptions of Plumularidae some of which have since been found in American waters.


A work which is necessary for the understanding of the synonymy of several American species but more particularly the genera Plumularia and Jettunplumula.


Contains much the same matter as the preceding with the addition of some new descriptions.


A work written in a pleasing style, with good colored plates of several Plumularidae since found in American waters.


A general discussion of the morphology and classification of the Hydrozoa.
THE PLUMULARIDE.

Lendenfeld, R. von .......................... Über Ctenolenteraten der Süßsee, III. Über Wehrpolypen und Nesselzellen. (Zeitschrift für wissenschaftliche Zoologie, XXXVIII, 1883.)
An excellent study of the nematophores and their contents.

Lendenfeld, R. von .......................... Über Ctenolenteraten der Süßsee, V. Die Hydromedusen des australischen Gebietes. (Zeitschrift für wissenschaftliche Zoologie, XLI, 1884.)
Contains a bibliography and a scheme of classification for the Hydroidea.

Part 4 contains a discussion of the Plumularide and a description of the new genus Pentandria.

Linnæus, C. .............................. Systema Naturae, Vindobonae, 1, Parts 2, 12th ed., 1767.
A few original descriptions of Plumularia which are, however, very inadequate, but form the basis for the names of several species.

Loman, J. C. C. ........................... Über Hydroidopolypen mit zusammengesetzten Coenosapheren, etc. (Tidschrift van de Nederlandsche Dierkundige Vereeniging, 1889.)
Discusses the polysiphonic stem and also the canaliculated ctenose of Antennularia, etc.

McCady, John .............................. Gymnophthalnata of Charleston Harbor. (Proceedings of the Elliott Society, 1, 1856.)
Very rare, but an important work containing the original separation of the genera Plumularia and Aglophenia and the description of several new species.

Marktanner-Turneretscher, G. .......................... Die Hydroiden des k. k. naturhistorischen Hofmuseums. (Annalen des k. k. naturhistorischen Hofmuseums, V, 1880.)
Description of the general collection with a few American species, together with the new genus Actolida. The work is illustrated by excellent outline drawings.

Merejkowsky, C. de. .......................... Structure et Développement des Nematophores chez les Hydroïdes. Archives de Zoologie Expérimentale et Générale, 1882, X.
An important contribution to our knowledge of the sacrostyles. Illustrated by very good plates.

Murray, A. .............................. Description of new Sertulariads from the Californian coast. (Annals and Magazine of Natural History, April, 1869.)
Contains original description of Plumularia struthionides.

Nutting, C. C. ............................ The Bahama Expedition. (Natural History Bulletin from the State University of Iowa, III, Nos. 1, 2, 1885.)
Remarks on the Hydroïd fauna, especially the Plumularide, of the West Indies.

Nutting, C. C. .............................. Notes on the reproduction of Plumularian Hydroids. (American Naturalist, November, 1895.)
Contains the announcement of the discovery of asexual stoloniferous multiplication, and the possibility of conjugation among the Hydroids.

Contains discussion of the sacrostyles and the origin of the sex-cells in Plumularia pinata.

Not necessary for the study of Plumularide, but of interest on account of the quaint views expressed.

A manual or handbook, with a general discussion of the Hydroïdidae. Places Aglophenia myriophyllum in the genus Lytocarpus.

Pieper, F. W. .............................. Zwei neue Arten zum Genus Plumularia gehörrende Hydroidopolypen. (Siebenter Jahresberichte des Westfälischen Provinzialverwes. Munster, 1878.)
I have not seen this work, and it may be out of place in this list.

Poupart, L. F. de. .......................... Contributions to the fauna of the Gulf Stream at great depths. (Bulletin of the Museum Comparative Zoology, 1, 1867–68, Nos. 6, 7.)
A description of Antennularia trisritata, which is not, however, sufficient to diagnose the species.

Quelch, John J. .......................... On some Deep-sea and Shallow-water Hydrozoa. (Annals and Magazine of Natural History, July, 1855.)
Descriptions of gonosome of Streplocaudus, and discussion of the phylactocarp of the Plumularide.
SARS, G. O ..................Bidrag til Kundskaben om Norges Hydroider. (Videnskabernes Selskabs Forhandlinger, 1873.)
Describes Plumularia gracillima=Schizotrioia gracillima and the new genus Polyplumaria. The author’s investigations also increase the known distribution of several Plumularidae.

SPENCER, W. BALDWIN ......A new family of Hydroidea, together with a description of the structure of a new species of Plumularia. (Transactions of the Royal Society, Victoria, 1890.)
Important, as showing the intergradation between the Plumularidae and Hydrocorallidae.

TRASK, JOHN B .............On some New Microscopic Organisms. (Proceedings of the California Academy of Science, March, 1887.)
Contains original description of Plumularia franciscana.

Discusses the origin of sex-cells in Plumularia echinulata. The work is beautifully illustrated.

VERRILL, A. E. and SMITH, S. I. Report upon the invertebrate animals of Vineyard Sound and adjacent waters, etc. (Report of the U. S. Commissioner of Fish and Fisheries, 1871-72.)
Describes several American Plumularidae, Plumularia tenuilla being new. Also discusses Plumularia arborae Desor under the name Aglaophenia arborae Verrill.

VERRILL, A. E ..............Notice of recent Additions to the Marine Fauna of the eastern coast of North America, No. 4. Brief Contributions to Zoology from the Museum of Yale College, No. XLI. (American Journal of Science, April, 1879.)
Contains original descriptions of Cladoearpus pourtalesii, Cladoearpus cornutus, and Cladoearpus speciosus.

VERRILL, A. E ..............Preliminary check list of the Marine Invertebrata of the Atlantic Coast, etc. (Report of the U. S. Commissioner of Fish and Fisheries, 1879.)
Includes all Plumularidae of our eastern coast so far as then known.

VERRILL, A. E ..............Notice of recent Additions to the Marine Invertebrata of the Northeastern Coast of America, etc., Part 5. (Proceedings of the U. S. National Museum, VIII, 1885.)
Contains the original description of Cladoearpus flexilis.

A magnificent monograph; illustrated by colored plates and giving a complete account of the origin of the sex-cells in several of the Plumularidae.
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).
1a. Plumularia setacea. Young gonangium (enlarged).
5. Plumularia megalocephala Allman (enlarged). (After Allman.)
6. Plumularia oligopogon Kirchenpauer (enlarged). (After Kirchenpauer.)
7. Plumularia oligopogon. 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).

PLATE III.

Fig. 1. Plumularia catarina Hincks. Portion of a hydrocladium (enlarged). (After Hincks.)
2. Plumularia catarina. Gonangium (enlarged). (After Hincks.)
3. Plumularia geminata Allman (enlarged). (After Allman.)
4. Plumularia geminata. Portion of a hydrocladium (greatly enlarged). (After Allman.)
5. Plumularia clarki Nutting (enlarged).

PLATE IV.

Fig. 1. Plumularia altenata Nutting (enlarged).
3. Plumularia plumularoides (Clark) (greatly enlarged). (After Clark.)
4. Schizotrichia tenella (Verrill) (greatly enlarged),

PLATE V.

Fig. 1. Plumularia inermis Nutting (enlarged).
5. Plumularia calitheca. Hydrothecal internode (greatly enlarged).
6. Plumularia attenuata Allman (enlarged). (After Allman.)

PLATE VI.

Fig. 1. Plumularia corrugata Nutting (enlarged).
3. Plumularia corrugata. Portion of colony, showing gonangia (enlarged).
5. Plumularia palmeri. Hydrocladal internode (greatly enlarged).
THE PLUMULARIDÆ.

PLATE VII.

Fig. 1. *Plumularia goodi* Nutting. Part of stem, showing nodes and origin of hydrocladia (enlarged).
8. *Plumularia virginia*. Front of stem, showing internodes and origin of hydrocladia (enlarged).

PLATE VIII.

Fig. 1. *Plumularia macrotheca* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)

PLATE IX.

Fig. 1. *Antennularia antennina* Linnæus. Part of stem and bases of hydrocladia (enlarged).
2. *Antennularia antennina*. Part of hydrocladium (greatly enlarged).
5. *Antennularia simplex* Allman (enlarged). (After Allman.)

PLATE X.

Fig. 1. *Antennularia ramosa* Nutting. Part of stem with hydrocladia (enlarged).
2. *Antennularia ramosa*. Hydrocladium, showing thickening of perisarc at base (greatly enlarged).
5. *Antennularia pinnata* Nutting. Part of stem with hydrocladia (enlarged).

PLATE XI.

Fig. 1. *Monotheca margarettæ* Nutting. Entire colony, except the hydrocaulus (enlarged).
4. *Antennopsis hippuris* Allman. Part of stem with hydrocladia (enlarged). (After Allman.)
5. *Antennopsis hippuris*. Part of hydrocladium (greatly 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 longivormæ* Nutting. Part of stem with hydrocladia (enlarged).
5. *Antennopsis nigra* Nutting. Part of stem with hydrocladia (enlarged).

PLATE XIII.

Fig. 1. *Monostecas quadridentes* (McCrady). Part of colony dichotomously branching (enlarged). (After Allman.)
2. *Monostecas quadridentes*. Part of hydrocladium, showing hydrothecæ and gonangia (greatly enlarged). (After Allman.)
5. *Antennella gracilis* Allman. Portion of hydrocladium (greatly enlarged). (After Allman.)
AMERICAN HYDROIDS.

PLATE XIV.

Fig. 1. Calcinea mirabilis Nutting. Portion of stem showing hydrothecae and gonangia (enlarged).

2. Calcinea mirabilis. Part of hydrocladium, side view (greatly enlarged).

3. Calcinea mirabilis. Part of hydrocladium, front view (greatly enlarged).

4. Schizotricha gracillima (Sars). Showing branched hydrocladium (enlarged).

5. Schizotricha gracillima. Part of hydrocladium (greatly enlarged).


PLATE XV.

Fig. 1. Schizotricha dichotoma Nutting. Forked hydrocladium (enlarged).

2. Schizotricha dichotoma. Part of hydrocladium (greatly enlarged).


5. Schizotricha parenta Nutting. Portion of stem and hydrocladia (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 longipinnus Nutting. Side view of part of hydrocladium (greatly enlarged).

4. Diplopteron longipinnus. 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. Hydrocladiad internode (greatly enlarged)

3. Hippurella longicarpa. Phylactocarp and gonangia (enlarged).


7. Halopteris carinata Allman. Part of colony (enlarged). (After Allman.)

8. Halopteris carinata. Part of hydrocladium, side view (greatly enlarged). (After Allman.)


10. Guttia humilis Allman (enlarged). (After Allman.)


PLATE XVIII.

Fig. 1. Aglaophenia rhynchocarpa Allman. Part of hydrocladium (greatly enlarged). (After Allman.)

2. Aglaophenia rhynchocarpa. Corbula (enlarged). (After Allman.)

3. Aglaophenia rigidia Allman. Part of hydrocladium (greatly enlarged). (After Allman.)


5. Aglaophenia dubia (Nutting). Part of hydrocladium (greatly enlarged). (After Allman.)

6. Aglaophenia lapthorcarpa Allman. Part of hydrocladium (greatly enlarged). (After Allman.)

7. Aglaophenia lapthorcarpa. Front view of stem (greatly enlarged). (After Allman.)

8. Aglaophenia lapthorcarpa. Corbula (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).


3. Aglaophenia elegans Nutting. Part of hydrocladium (greatly enlarged).


5. Aglaophenia insignis Fewkes. Part of hydrocladium (enlarged).


THE PLUMULARIDÆ.

PLATE XX.

Fig. 1. *Aglaophenia operta* Nutting. Part of hydrocladium (greatly enlarged).
2. *Aglaophenia operta*. Corbula (enlarged).
5. *Aglaophenia contorta* Nutting. Part of hydrocladium (enlarged).

PLATE XXI.

Fig. 1. *Aglaophenia minuta* Fewkes. Hydrothece (greatly enlarged).
2. *Aglaophenia minuta*. Base of hydrocladium, showing the processes (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.)
10. *Aglaophenia mammillata*. Side view of stem, showing processes (enlarged).
15. *Aglaophenia perforata*. Corbula (enlarged). (After Allman.)

PLATE XXII.

Fig. 1. *Aglaophenia simplex* Kirchenpauer. Hydrothece (greatly enlarged). (After Kirchenpauer.)
2. *Aglaophenia allmani* Nutting. Side view of hydrothece (greatly enlarged). (After Allman.)
3. *Aglaophenia allmani*. Front view of hydrothece (greatly enlarged). (After Allman.)
5. *Aglaophenia rathbuni*. Hydrothece (greatly enlarged).
8. *Aglaophenia latirostris*. Front view of hydrothece (greatly enlarged).

PLATE XXIII.

Fig. 1. *Aglaophenia ramulosa* Kirchenpauer (greatly enlarged). (After Kirchenpauer.)

PLATE XXIV.

Fig. 1. *Aglaophenia constricta* Allman. Side view of hydrothece (greatly enlarged). (After Allman.)
2. *Aglaophenia constricta*. Front view of hydrothece (greatly enlarged). (After Allman.)
3. *Aglaophenia constricta*. Front of stem (enlarged). (After Allman.)
5. *Aglaophenia bicorneata* Nutting. Part of hydrocladium (enlarged).
10. *Aglaophenia calamus*. Front view of hydrothece (enlarged). (After Allman.)
11. *Aglaophenia calamus*. Corbula (enlarged). (After Allman.)
12. *Thecocarpus nyropiphyllum* (Liunaeus). Part of hydrocladium (enlarged),
AMERICAN HYDROIDS.

Fig. 13. *Thecocarpus myriophyllum*. Hydrotheca (greatly enlarged).

15. *Thecocarpus distans*. Corbula (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).

**PLATE XXVI.**

Fig. 1. *Cladocarpus sigmata* (Allman). Hydrocladium bearing phylactocarp and gonangia (enlarged).
7. *Cladocarpus ventricosus*. Part of colony showing phylactogonia and gonangia (after Allman).

**PLATE XXVII.**

Fig. 1. *Cladocarpus obliquus* Nutting. Part of hydrocladium (enlarged).
7. *Cladocarpus septatus*. Front of stem (greatly enlarged).
9. *Cladocarpus dolichotheca* Allman. Part of colony showing phylactogonia and gonangia (enlarged). (After Allman.)

**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.)
5. *Cladocarpus grandis*. Phylactocarp and gonangia (enlarged).
7. *Cladocarpus paradisea*. Phylactocarp and gonangia (enlarged). (After Allman.)
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).
5. *Cladocarpus carinatus*. Front view of hydrotheca (greatly enlarged).
Fig. 10. Aglaophenopsis hirsuta. Front view of hydrotheca (greatly enlarged).

Plate XXX.

Fig. 1. Aglaophenopsis distans Nutt. Part of hydrocladium (greatly enlarged).
5. Aglaophenopsis verrilli. Side view of hydrotheca (greatly enlarged).
8. Aglaophenopsis cornuta. Front of stem, showing proximal hydrotheca and nematophores (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 philippinns (Kirchenpauer). Part of hydrocladium (enlarged).
5. Lytocarpus philippinns. Front of stem (enlarged).
8. Lytocarpus ramosus (Fewkes). Part of hydrocladium (enlarged).
10. Lytocarpus ramosus. Hydrotheca, with longer nematophores (greatly enlarged).
11. Lytocarpus ramosus. Pseudocorbnia (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).
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).
11. Lytocarpus curtus. Base of hydrocladium, showing nematophores (enlarged).
12. Lytocarpus furcatus Nutting. Part of hydrocladium (enlarged).
15. Lytocarpus furcatus. Front of stem, showing cauline nematophores and perforated process (enlarged).

Plate XXXIII.

Fig. 1. Halicormaria speciosa Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
2. Halicormaria speciosa. Front view of hydrocladium (greatly enlarged). (After Allman.)
3. Halicormaria speciosa. Front of stem, showing gonangia (enlarged). (After Allman.)
5. Halicormaria longicanda. Front view of hydrotheca (greatly enlarged).
7. Halicormaria variabilis. Part of young hydrocladium (enlarged).
9. Halicormaria variabilis. Front of stem, showing large nematophores (enlarged).

Plate XXXIV.

Fig. 1. Streptochaeta pulcherrimus Allman. Entire colony. (After Allman.)
2. Streptochaeta pulcherrimus. Part of hydrocladium (enlarged). (After Allman.)
3. Streptochaeta pulcherrimus. Front view of hydrotheca (enlarged). (After Allman.)
EXPLANATION TO PLATE I.

Fig. 1. *Plumularia setacea* Ellis. Portion of colony with gonangia (enlarged).


5. *Plumularia megalorephula* Allman (enlarged). (After Allman.)


NUTTING—AMERICAN HYDROIDS.

PLATE 1.

Plumularidæ.
EXPLANATION TO PLATE II.

Fig. 1. Planularia allithrea Nutting (enlarged).
2. Planularia pliicata Allman (enlarged). (After Allman.)
3. Planularia helici Hineks (enlarged). (After Marktanner-Turneretscher.)
4. Planularia floridana Nutting (enlarged).
5. Planularia floridana. Portion of hydrocladium (greatly enlarged).
6. Planularia filicintls Kirchenpauer. Portion of hydrocladium (enlarged). (After Baise.)
EXPLANATION TO PLATE III.

Fig. 1. *Plumularia catarina* Hineks. Portion of a hydroidium (enlarged). (After Hineks.)
2. *Plumularia catarina*. Gonangium (enlarged). (After Hineks.)
3. *Plumularia geminata* Allman (enlarged). (After Allman.)
5. *Plumularia clarkei* Nutting (enlarged).

152
PLUMULARIDÆ.
EXPLANATION TO PLATE IV.

Fig. 1. *Plumularia alternata* Nutting (enlarged).


3. *Plumularia plumularoides* (Clark) (greatly enlarged). (After Clark.)


156
PLUMULARIDÆ.
EXPLANATION TO PLATE V.

1. *Plumularia incermis* Nutting (enlarged).
EXPLANATION TO PLATE VI.

Fig. 1. *Planularia corrugata* Nutting (enlarged).


3. *Planularia corrugata*. Part of colony, showing gonangia (enlarged).


EXPLANATION TO PLATE VII.

1. *Plumularia goodii* Nutting. Part of stem, showing nodes and origin of hydrocladia (enlarged).
8. *Plumularia virginia*. Front of stem, showing internodes and origin of hydrocladia (enlarged).
EXPLANATION TO PLATE VIII.

Fig. 1. *Plumularia macrotheca* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
EXPLANATION TO PLATE IX.

Fig. 1. Antennularia antennina Linnaeus. Part of stem and bases of hydrochidia (enlarged).
2. Antennularia antennina. Part of hydrochadium (greatly enlarged).
3. Antennularia americana Nutting. Part of stem and hydrochidia (enlarged).
5. Antennularia simplex Allmain (enlarged). (After Allmain.)
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).


5. *Antennularia pinnata* Nutting. Part of stem with hydrocladia (enlarged).

Plumularidae.
EXPLANATION TO PLATE XI.

1. _Mastoglena margaretta_ Nutting. Entire colony, except the hydrocanthus (enlarged).
2. _Mastoglena margaretta_. Side view of hydrotheca (greatly enlarged).
3. _Mastoglena margaretta_. Back view of hydrotheca (greatly enlarged).
4. _Intemopsis hippocrepis_ Allman. Part of stem with hydrocladia (enlarged). (After Allman.)
5. _Intemopsis hippocrepis_. Part of hydrocladium (greatly enlarged). (After Allman.)
6. _Intemopsis hippocrepis_. Gonangia (enlarged). (After Allman.)
EXPLANATION TO PLATE XII.

Fig. 1. *Antennopis distans* Nutting, Part of stem with hydrocladia (enlarged).
3. *Antennopis longicornis* Nutting. Part of stem with hydrocladia (enlarged).
5. *Antennopis nigra* Nutting. Part of stem with hydrocladia (enlarged).
Plumularidæ.
Fig. 1. *Monostrochas quadricus* (McCrady). Part of colony dichotomously branching (enlarged). (After Allman.)

2. *Monostrochas quadricus*. Part of hydrochaete, showing hydrothecae and gonangia (greatly enlarged).
   (After Allman.)


EXPLANATION TO PLATE XIV.

Fig. 1. *Calvinia mirabilis* Nutting. Portion of stem showing hydrothecae and gonangia (enlarged).
EXPLANATION TO PLATE XV.

2. Schizotricha dichotoma. Part of hydrocladium (greatly enlarged).
7. Diplopteron quadricorne. Front view of hydrocladium (greatly enlarged).
PLUMULARIDÆ.
EXPLANATION TO PLATE XVI.

Fig. 1. *Diplopteris grande* Nutting. Side view of portion of a hydrocladium (greatly enlarged).


PLUMULARIDAE.
EXPLANATION TO PLATE XVII.

Fig. 1. *Hippocrella longicarpa* Nutting. Part of hydrocladium (enlarged).
7. *Halopteris carinata* Allman. Part of colony (enlarged). (After Allman.)
8. *Halopteris carinata*. Part of hydrocladium, side view (greatly enlarged). (After Allman.)
10. *Gatilga hamilton* Allman (enlarged). (After Allman.)

208
PLUMULARIIDÆ.
EXPLANATION TO PLATE XVIII.

Fig. 1. *Apleuracea rhynchocarpa* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
2. *Apleuracea rhynchocarpa*. Corbula (enlarged). (After Allman.)
3. *Apleuracea rigida* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
4. *Apleuracea rigida*. Corbula (enlarged). (After Allman.)
5. *Apleuracea dubia* (Nutting). Part of hydrocladium (greatly enlarged). (After Allman.)
6. *Apleuracea lophocarpa* Allman. Part of hydrocladium (greatly enlarged). (After Allman.)
7. *Apleuracea lophocarpa*. Front view of stem (greatly enlarged). (After Allman.)
8. *Apleuracea lophocarpa*. Corbula (enlarged). (After Allman.)
10. *Apleuracea apocarpa*. Front view of stem (greatly enlarged). (After Allman.)
11. *Apleuracea apocarpa*. Corbula (enlarged). (After Allman.)
EXPLANATION TO PLATE XIX.

Fig. 1. *Aglaotheca floccosa* Nutting. Part of hydrocladium (greatly enlarged).
5. *Aglaotheca insignis* Fewkes. Part of hydrocladium (enlarged)

216
EXPLANATION TO PLATE XX.

Fig. 1. *Aglaotheca* aperta Nutting. Part of hydrocladium (greatly enlarged).


5. *Aglaotheca costata* Nutting. Part of hydrocladium (enlarged).


NUTTING—AMERICAN HYDROIDS.

PLATE XX.

PLUMULARIDÆ.
EXPLANATION TO PLATE XXI.

Fig. 1. Aglaophenia minuta Fewkes. Hydrotheca (greatly enlarged).
2. Aglaophenia minuta. Base of hydrocladium, showing the processes (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.)
10. Aglaophenia mammillata. Side view of stem, showing processes (enlarged).
13. Aglaophenia minima. Side view of stem, showing processes (enlarged).
15. Aglaophenia perforata. Corbula (enlarged). (After Allman.)
NUTTING—AMERICAN HYDROIDS.

PLATE XXI.

PLUMULARIDÆ.
EXPLANATION TO PLATE XXII.

Fig. 1. Aglaophenia simplex Kirchenpauer. Hydrotheca (greatly enlarged). (After Kirchenpauer.)
2. Aglaophenia allmani Nutting. Side view of hydrotheca (greatly enlarged). (After Allman.)
3. Aglaophenia allmani. Front view of hydrotheca (greatly enlarged). (After Allman.)
5. Aglaophenia rathbuni. Hydrotheca (greatly enlarged).
7. Aglaophenia latirostris Nutting. Part of hydrocladium (greatly enlarged).
8. Aglaophenia latirostris. Front view of hydrotheca (greatly enlarged).
10. Aglaophenia strathionides (Murray). Part of hydrocladium (enlarged).

228
EXPLANATION TO PLATE XXIII.

Fig. 1. *Aglaopecnia rawhbo* Kirchenpauer (greatly enlarged). (After Kirchenpauer.)
4. *Aglaopecnia octocarpa.* Front view of stem (enlarged).
5. *Aglaopecnia octocarpa.* Corbula (enlarged).
PLUMULARIDÆ.
EXPLANATION TO PLATE XXIV.

Fig. 1. *A. constricta* Allman. Side view of hydrotheca (greatly enlarged). (After Allman.)
2. *A. constricta*. Front view of hydrotheca (greatly enlarged). (After Allman.)
3. *A. constricta*. Front of stem (enlarged). (After Allman.)
4. *A. sicca* Markman-Turneretsecher (enlarged). (After Markman-Turneretsecher.)
5. *A. bicornula* Nutting. Part of hydrocladium (enlarged).
10. *A. calamus*. Front view of hydrotheca (enlarged). (After Allman.)
11. *A. calamus* Corbulula (enlarged). (After Allman.)
15. *Thecocarpus distans*. Corbulula (enlarged). (After Allman.)
EXPLANATION TO PLATE XXV.

Fig. 1. Thecocarpus normani Nutting. Part of hydrothecium (greatly enlarged).
2. Thecocarpus normani. Basal part of corbula, and corbula stem (enlarged).
3. Thecocarpus benedicti Nutting. Part of hydrothecium (greatly enlarged).
4. Thecocarpus benedicti. Front view of hydrothecium (greatly enlarged).
5. Thecocarpus benedicti. Part of corbula (enlarged).
6. Thecocarpus bispinosus (Allman). Part of hydrothecium (greatly enlarged). (After Allman.)
7. Thecocarpus bispinosus. Corbula (enlarged). (After Allman.)
8. Thecocarpus bispinosus. Base of corbula leaf (enlarged). (After Allman.)

240
PLUMULARIDÆ.
EXPLANATION TO PLATE XXVI.

Fig. 1. Cladocarpus sigma (Allman). Hydrocladium bearing phylactocarp and gonangia (enlarged).
2. Cladocarpus sigma. Part of hydrocladium (greatly enlarged).
7. Cladocarpus ventricosus. Part of colony showing phylaetogonia and gonangia (after Allman).
PLUMULARID.E.
EXPLANATION TO PLATE XXVII.

Fig. 1. Cladocarpus obliquus Nutting. Part of hydrocladium (enlarged).
2. Cladocarpus obliquus. Side view of hydrotheca (greatly enlarged).
5. Cladocarpus septatus. Side view of hydrotheca (greatly enlarged).
7. Cladocarpus septatus. Front of stem (greatly 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.)
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.)


5. *Cladocarpus grandis*. Phylactocarp and gonangia (enlarged).


7. *Cladocarpus paradisca*. Phylactocarp and gonangia (enlarged). (After Allman.)


10. *Cladocarpus speciosus*. Front of stem showing growing phylactogonium (enlarged).

11. *Cladocarpus speciosus*. Proximal hydrotheca, and a budding phylactogonium (greatly enlarged).

252
Plumularidæ.
EXPLANATION TO PLATE XXIX.

1. Cladocarpus portalesii Verrill. Part of hydrocladium (greatly enlarged).
2. Cladocarpus portalesii Phylactogonium and gonangia (enlarged).
5. Cladocarpus carinatus. Front view of hydrotheca (greatly enlarged).
7. Cladocarpus carinatus. Part of hydrocladium bearing phylactogonium and gonangia (enlarged).
10. Aglaophenopsis hirsuta. Front view of hydrotheca (greatly enlarged).
EXPLANATION TO PLATE XXX.

Fig. 1. *Aglaophenopsis distans* Nutting. Part of hydrocladium (greatly enlarged).
2. *Aglaophenopsis distans*. Front of stem (enlarged).
8. *Aglaophenopsis coronata*. Front of stem, showing proximal hydrotheca and nematophores (enlarged).
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.)


12. *Lytocarpus ramosus*. Phylactogonium, showing hydrotheca at base (enlarged).

PLUMULARIDAE.
EXPLANATION TO PLATE XXXII.

Fig. 1. *Lytocarpus grandis* (Clarke). Part of hydrocladium (enlarged).
11. *Lytocarpus cartus*. Base of hydrocladium, showing nematophores (enlarged).
15. *Lytocarpus furcatus*. Front of stem, showing caudine nematophores and perforated process (enlarged).
EXPLANATION TO PLATE XXXIII.

Fig. 1. Halicosturia speciosa Allman. Part of hydrocladium (greatly enlarged). (After Allman).
3. Halicosturia speciosa Front of stem, showing gonangia (enlarged). (After Allman).
7. Halicosturia variabilis. Part of young hydrocladium (enlarged).
9. Halicosturia variabilis. Front of stem, showing large nematophores (enlarged).

272
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 hydrothece (enlarged). (After Allman.)
5. *Nuditheca dalli*. Part of hydrocladium (greatly enlarged).
INDEX.

[The figures in black-faced type indicate references to the formal descriptions in the systematic part of the work.]

<table>
<thead>
<tr>
<th>Species</th>
<th>Page(s)</th>
<th>Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthella</td>
<td></td>
<td>53</td>
</tr>
<tr>
<td>Acanthocladium</td>
<td></td>
<td>88</td>
</tr>
<tr>
<td>Accessory tubes, homology</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Acladia</td>
<td></td>
<td>53</td>
</tr>
<tr>
<td>Adhesive cells</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>Agassiz, Alexander</td>
<td>1, 2, 73, 131</td>
<td></td>
</tr>
<tr>
<td>Agassiz, Louis</td>
<td>1, 88, 131</td>
<td></td>
</tr>
<tr>
<td>on the family Plumularida</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>Aglaophenia</td>
<td>4, 10, 13, 16, 17, 19, 20, 22, 23, 24, 29, 30, 31, 33, 37, 41, 43, 45, 47, 54, 87, 88, 89, 107</td>
<td></td>
</tr>
<tr>
<td>allmani</td>
<td>89, 90, 100</td>
<td>XXII</td>
</tr>
<tr>
<td>aperta</td>
<td>16, 50, 89, 90, 94, 95</td>
<td>XX</td>
</tr>
<tr>
<td>apocarpa</td>
<td>50, 89, 93, 94, 95</td>
<td>XVIII</td>
</tr>
<tr>
<td>arborea</td>
<td>102, 103</td>
<td>XXIV</td>
</tr>
<tr>
<td>bicornuta</td>
<td>12, 16, 17, 50, 89, 93, 105</td>
<td>XXIV</td>
</tr>
<tr>
<td>bispinosa</td>
<td>109</td>
<td>XXIV</td>
</tr>
<tr>
<td>calamus</td>
<td>50, 89, 91</td>
<td>XXIV</td>
</tr>
<tr>
<td>catharina</td>
<td>60</td>
<td>XXIV</td>
</tr>
<tr>
<td>constricta</td>
<td>50, 89, 90, 105</td>
<td>XXIV</td>
</tr>
<tr>
<td>contorta</td>
<td>12, 50, 89, 96</td>
<td>XX</td>
</tr>
<tr>
<td>crenata</td>
<td>13, 49, 50, 89, 90</td>
<td>XXIII</td>
</tr>
<tr>
<td>cristata</td>
<td>105</td>
<td>XX</td>
</tr>
<tr>
<td>cristifrons</td>
<td>16, 50, 89, 95</td>
<td>XX</td>
</tr>
<tr>
<td>distans</td>
<td>108</td>
<td>XXVIII</td>
</tr>
<tr>
<td>dubia</td>
<td>50, 89, 92</td>
<td>XX</td>
</tr>
<tr>
<td>elegans</td>
<td>12, 50, 89, 94</td>
<td>XIX</td>
</tr>
<tr>
<td>flowersi</td>
<td>89, 93</td>
<td>XIX</td>
</tr>
<tr>
<td>(franciscana)</td>
<td>1, 102</td>
<td>XXI</td>
</tr>
<tr>
<td>(gracilis)</td>
<td>91, 92</td>
<td>XXI</td>
</tr>
<tr>
<td>gracillima</td>
<td>12, 13, 50, 89, 90, 103</td>
<td>XXI</td>
</tr>
<tr>
<td>helleri</td>
<td>25, 43</td>
<td>XX</td>
</tr>
<tr>
<td>insignis</td>
<td>34, 50, 89, 90, 94</td>
<td>XIX</td>
</tr>
<tr>
<td>Integra</td>
<td>117</td>
<td>XX</td>
</tr>
<tr>
<td>(late-carinata)</td>
<td>96, 97</td>
<td>XXI</td>
</tr>
<tr>
<td>latirostris</td>
<td>10, 12, 50, 89, 90, 101</td>
<td>XXII</td>
</tr>
<tr>
<td>longicornis</td>
<td>6</td>
<td>XX</td>
</tr>
<tr>
<td>lophocarpa</td>
<td>16, 17, 19, 49, 50, 89, 92, 94</td>
<td>XVIII</td>
</tr>
<tr>
<td>maunuilata</td>
<td>16, 50, 89, 90, 96</td>
<td>XXI</td>
</tr>
<tr>
<td>minima</td>
<td>50, 89, 90, 96</td>
<td>XXI</td>
</tr>
<tr>
<td>minuta</td>
<td>13, 16, 17, 50, 89, 90, 96</td>
<td>XXI</td>
</tr>
<tr>
<td>myriophyllum</td>
<td>89, 106, 107</td>
<td>XXIII</td>
</tr>
<tr>
<td>octocarpa</td>
<td>50, 89, 90, 103</td>
<td>XXIII</td>
</tr>
<tr>
<td>patagonica</td>
<td>50, 89, 90, 104</td>
<td>XXI</td>
</tr>
<tr>
<td>pelagica</td>
<td>50, 89, 90, 97</td>
<td>XXI</td>
</tr>
<tr>
<td>perforata</td>
<td>89, 90, 99</td>
<td>XXI</td>
</tr>
<tr>
<td>perpenillar</td>
<td>4, 18, 30, 89, 90, 98</td>
<td>XXI</td>
</tr>
<tr>
<td>philippinus</td>
<td>122</td>
<td>XXII</td>
</tr>
<tr>
<td>phyllocarpa</td>
<td>11, 125</td>
<td>XXII</td>
</tr>
<tr>
<td>pluma</td>
<td>19, 25, 39, 40, 41, 106</td>
<td>XXII</td>
</tr>
<tr>
<td>radicellata</td>
<td>106</td>
<td>XXII</td>
</tr>
<tr>
<td>(ramosa)</td>
<td>100</td>
<td>XXII</td>
</tr>
<tr>
<td>ramulosa</td>
<td>50, 89, 90, 103</td>
<td>XXIII</td>
</tr>
<tr>
<td>rathbuni</td>
<td>19, 59, 89, 90, 101</td>
<td>XXIII</td>
</tr>
<tr>
<td></td>
<td>279</td>
<td></td>
</tr>
<tr>
<td>Species</td>
<td>Page(s)</td>
<td>Plate</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td>Aglaophenia rhynchoeocarpa</td>
<td>16, 50, 89, 90</td>
<td>XVIII</td>
</tr>
<tr>
<td>rigida</td>
<td>4, 10, 50, 89, 91</td>
<td>XVIII</td>
</tr>
<tr>
<td>robusta</td>
<td>50, 89, 90, 100</td>
<td></td>
</tr>
<tr>
<td>savignyana</td>
<td>16, 50, 88, 90, 100</td>
<td>XXIV</td>
</tr>
<tr>
<td>setacea</td>
<td>50, 89, 90, 99</td>
<td>XXII</td>
</tr>
<tr>
<td>simplex</td>
<td>50, 89, 90, 102</td>
<td>XXII</td>
</tr>
<tr>
<td>struthiocephala</td>
<td>50, 89, 90, 106</td>
<td></td>
</tr>
<tr>
<td>trienspsis</td>
<td>50, 89, 90, 105</td>
<td></td>
</tr>
<tr>
<td>tridactylata</td>
<td>31, 94</td>
<td></td>
</tr>
<tr>
<td>tubilifera</td>
<td>31, 94</td>
<td></td>
</tr>
<tr>
<td>Aglaophenopsis</td>
<td>4, 8, 13, 15, 19, 31, 35, 87, 88, 118</td>
<td>XXX</td>
</tr>
<tr>
<td>cornuta</td>
<td>10, 12, 18, 118, 120</td>
<td>XXX</td>
</tr>
<tr>
<td>distans</td>
<td>10, 13, 51, 118, 119</td>
<td>XXX</td>
</tr>
<tr>
<td>hirsuta</td>
<td>6, 10, 12, 17, 19, 31, 105, 116, 119</td>
<td>XXXX</td>
</tr>
<tr>
<td>verrilli</td>
<td>35, 49, 51, 118, 120</td>
<td></td>
</tr>
<tr>
<td>Albatross</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>Alder, Joshua</td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Allen, E. I</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Allman, George J</td>
<td>2, 3, 47, 48, 83, 108, 131</td>
<td></td>
</tr>
<tr>
<td>Antennularia</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Chloocarpus</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Diplopteron</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>Antennopsis</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Lytocarpus</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>on pseudopodia from sarcostyles</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>on the development of the corbula</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>on the echinodome</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>on the homology of the corbula leaves</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Antennularia</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Antennula</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>gracilis</td>
<td>8, 59, 77</td>
<td>XIII</td>
</tr>
<tr>
<td>Antennopsis</td>
<td>6, 8, 15, 52, 53, 72</td>
<td></td>
</tr>
<tr>
<td>annullata</td>
<td>8, 11, 51, 50, 73, 75</td>
<td>XI</td>
</tr>
<tr>
<td>distans</td>
<td>15, 50, 73</td>
<td></td>
</tr>
<tr>
<td>hirsuta</td>
<td>50, 73</td>
<td>XI</td>
</tr>
<tr>
<td>longicornis</td>
<td>10, 50, 73, 74</td>
<td></td>
</tr>
<tr>
<td>sigma</td>
<td>10, 50, 73, 74</td>
<td></td>
</tr>
<tr>
<td>ramosa</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Antennularia</td>
<td>4, 8, 10, 15, 21, 30, 32, 39, 47, 53, 54, 68, 69, 88</td>
<td></td>
</tr>
<tr>
<td>americana</td>
<td>31, 50, 68, 69</td>
<td>IX</td>
</tr>
<tr>
<td>antenninna</td>
<td>39, 50, 68, 69</td>
<td>IX</td>
</tr>
<tr>
<td>geniculata</td>
<td>50, 68, 69, 71</td>
<td>X</td>
</tr>
<tr>
<td>janina</td>
<td>25, 36, 39</td>
<td></td>
</tr>
<tr>
<td>pinnata</td>
<td>50, 68, 69, 71</td>
<td>X</td>
</tr>
<tr>
<td>rugosa</td>
<td>50, 68, 69, 70</td>
<td>IX</td>
</tr>
<tr>
<td>simplex</td>
<td>50, 68, 69, 70</td>
<td>IX</td>
</tr>
<tr>
<td>tetrasticha</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>tubilifera</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Axial cavity of the sarcostyle</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Azygoplon</td>
<td>15, 53</td>
<td></td>
</tr>
<tr>
<td>Bale, William M</td>
<td>2, 3, 47, 60, 89, 131</td>
<td></td>
</tr>
<tr>
<td>on Diplopteron</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>on Halopteris</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>on morphology of fascicled stem</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>on nematophores of Halicornea longirostris</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>on processes of hydrocladia</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>on the intratbeal ridge</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Bahamas expedition from the State University of Iowa</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Bathymetrical distribution</td>
<td>19, 50, 52</td>
<td></td>
</tr>
</tbody>
</table>
INDEX.

Bianco, Salvatore L.o. ........................................... 2
Bithalamic nematophores ................................. 14
Brice, J. O., Hon .................................................. 2
Brooks, William K., on the bottom life in the ocean .... 52
Busk, G., on nematophores .................................. 53
Calathophores ................................................... 88
Callicarpa .......................................................... 85
   gracilis ....................................................... 50
Calvinia .......................................................... 85
   mirabilis ..................................................... 6, 11, 14, 50
   XVII
   XIV
Calypetrobasista ............................................... 47
Calvinian nematophores ................................... 13
Challenger expedition, Plunularide collected by ....... 47
   47, 48
Cladocarpus .................................................... 119
   carinatus ...................................................... 10, 12, 13, 16, 17, 51, 110, 111, 117
   compressus .................................................. 51, 110, 111
   cornutus ...................................................... 120
   dolichotheca ................................................ 13, 51, 110, 111, 113, 114
   flexilis ....................................................... 4, 5, 31, 51, 110, 112
   flexuosus ..................................................... 10, 12, 13, 19, 51, 110, 111, 114
   formosus ...................................................... 49
   grandis ....................................................... 1, 10, 12, 17, 51, 110, 111, 115, 116
   obliquus ...................................................... 51, 110, 113
   paradisea ..................................................... 4, 6, 7, 16, 17, 31, 51, 110, 111, 115, 116
   pectiniferus .................................................. 17, 49, 120
   porrecta ....................................................... 10, 12, 31, 51, 110, 111, 116
   septata ......................................................... 2, 13, 31, 51, 110, 113
   sigma ........................................................ 11
   speciosus .................................................... 12, 51, 105, 110, 111, 116
   tennis ......................................................... 51, 110, 111, 114
   ventricosa .................................................. 51, 110, 112
   XXVII
   XXVIII
   XV
   XVII
   XV
   XVII
   XVII
   XXVIII
   XXVIII
   XXIX
   XXVIII
   XXVII
   XVII
   XV
   XVII
   XXVIII
   XXVIII
   XXVII
   XV
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XV
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
   XVII
   XVII
   XXVIII
   XXVIII
   XXVII
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Schizotricha</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Thecocarpus</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td></td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Dohrn, Anton</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Driesch, Hans</td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Eisig, Hugo</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Eleutheroplea</td>
<td>10, 13, 15, 16, 27, 31, 33, 34, 40, 50, 54, 86, 87, 88, 123</td>
<td></td>
</tr>
<tr>
<td>Ellis, John</td>
<td>132</td>
<td></td>
</tr>
<tr>
<td>Endoceratides</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Fascicled stem</td>
<td>4, 5</td>
<td></td>
</tr>
<tr>
<td>Faxon, Walter</td>
<td>2, 85</td>
<td></td>
</tr>
<tr>
<td>Pewkes, J. Walter, on Hippurella.</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>on new genera of Plumularida.</td>
<td>32, 85, 110, 116, 123, 132</td>
<td></td>
</tr>
<tr>
<td>on (Pleurocarpa).</td>
<td>34, 121</td>
<td></td>
</tr>
<tr>
<td>Fish Commission, United States</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>Fleming, J.</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>Flower, Sir William H.</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Gattya</td>
<td>8, 15, 29, 87</td>
<td>XVII</td>
</tr>
<tr>
<td>humilis</td>
<td>4, 10, 50, 87</td>
<td>XVII</td>
</tr>
<tr>
<td>Gibbes, Mrs. Virginia Barrett</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Gonangium</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Gonophores</td>
<td>29, 30</td>
<td></td>
</tr>
<tr>
<td>Gonosomal nematophores</td>
<td></td>
<td></td>
</tr>
<tr>
<td>of the Statopela</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Graptolites</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Gray, J. E</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>Gymnocarpa</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Halicoraia</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>gonomide</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>haleciuim</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Haliocnoria</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>aseidioides</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>ilicistoma</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>longicauda</td>
<td>127</td>
<td>XXXIII</td>
</tr>
<tr>
<td>longirostris</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>mitrata</td>
<td>129</td>
<td></td>
</tr>
<tr>
<td>ramulitera</td>
<td>126</td>
<td></td>
</tr>
<tr>
<td>sacertia</td>
<td>128</td>
<td></td>
</tr>
<tr>
<td>sacata</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>speciosa</td>
<td></td>
<td>XXXIII</td>
</tr>
<tr>
<td>superba</td>
<td>4, 51, 127, 127</td>
<td>XXXIII</td>
</tr>
<tr>
<td>variabilis</td>
<td>34, 127, 128</td>
<td>XXXIII</td>
</tr>
<tr>
<td>Havletera</td>
<td>94, 128</td>
<td>XXXIII</td>
</tr>
<tr>
<td>carinata</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Hamann, Otto</td>
<td>14, 15, 50, 86</td>
<td>XVII</td>
</tr>
<tr>
<td>on the formation of the planula</td>
<td>3, 28, 133</td>
<td></td>
</tr>
<tr>
<td>on the fascicled stem</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>on the structure of sarcostyles</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Heller, Camil</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>Heteroplom</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Hincks, Rev. Thomas</td>
<td>3, 47, 54, 88, 133</td>
<td></td>
</tr>
<tr>
<td>on sarcostyles</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>on the fascicled stem</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Hippurella</td>
<td>32, 53, 75, 84, 85</td>
<td></td>
</tr>
<tr>
<td>annuata</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>longicarpa</td>
<td>50, 74, 84</td>
<td>XVII</td>
</tr>
<tr>
<td>Hydanth</td>
<td>9, 10</td>
<td></td>
</tr>
<tr>
<td>Hydroceratida</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Hydrocladia</td>
<td>7, 8</td>
<td></td>
</tr>
<tr>
<td>Hydrocladate tube</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Hydrotheca</td>
<td>10, 12</td>
<td></td>
</tr>
<tr>
<td>Intrathedral ridge</td>
<td>9, 11, 13</td>
<td></td>
</tr>
<tr>
<td>Introductory note</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Jeffell, Carl F</td>
<td>3, 28, 123</td>
<td></td>
</tr>
<tr>
<td>on sarcostyles</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Johnston, George</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>Key, to genera of eleutheroplean plumularians</td>
<td>Page</td>
<td>Plate</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>to genera of statoplean plumularians</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>to species of Aglaophenia</td>
<td>89</td>
<td></td>
</tr>
</tbody>
</table>

**Aglaophenopsis** ................................................. 118

**Antennopsis** ................................................. 73

**Antennularia** ................................................. 69

**Cladocarpus** ................................................ 110

**Diplopteron** ................................................ 127

**Halicornaria** ................................................ 133

**Lytocarpus** ................................................ 122

**Plumularia** ................................................ 55

**Schizotrichia** ................................................ 78

**Thecocarpus** ................................................ 107

**Kirchenpauer, G. H.** ........................................ 3, 14, 15, 17, 47, 88, 133

**Kirchenpaueria** ............................................... 58, 88

**Lafontina tennis** ............................................ 28

**Lamarch, J. B. P. A. de** ................................. 54, 133

**Lamouroux, J. V. F.** .......................................... 54, 88, 133

**Landsborough, D.** ........................................... 133

**Lankester, E. Ray** ............................................ 133

**Lendenfeld, Robert von** ..................................... 2, 3, 29, 47, 134

**Linnaeus, C.** .................................................... 134

**Lamarck, J. B. P. A. de** ...................................... 54, 133

**Lamaroux, J. A. de** .......................................... 54, 88, 133

**Laudsborough, D.** ........................................... 133

**Lankester, E. Ray** ............................................ 133

**Lendenfeld, Robert von** ..................................... 2, 3, 29, 47, 134

**Linnaeus, C.** .................................................... 134

**Lamarck, J. B. P. A. de** ...................................... 54, 133

**Lamaroux, J. A. de** .......................................... 54, 88, 133

**Laudsborough, D.** ........................................... 133

**Lankester, E. Ray** ............................................ 133

**Lendenfeld, Robert von** ..................................... 2, 3, 29, 47, 134

**Limnias, C.** .................................................... 134

**Luman, J. C. C.** ............................................... 134

**Lytocarpia** ..................................................... 89, 121

**Lytocarpus** ..................................................... 4, 10, 13, 19, 28, 29, 31, 34, 35, 37, 87, 88, 100, 106, 108, 119, 121

**clarkei** .......................................................... 12, 17, 18, 35, 61, 119, 123, 124, 128

**curtus** .......................................................... 12, 17, 18, 35, 61, 119, 123, 124, 128

**furcatus** ....................................................... 12, 17, 18, 35, 61, 119, 123, 124, 128

**grandis** ........................................................ 119, 121, 123, 124, 125

**(myriophyllum)** ................................................ 107

**philippinus** .................................................... 13, 17, 19, 35, 51, 122

**racemiferus** ................................................... 51, 122, 126

**ramosus** ........................................................ 17, 19, 51, 122, 123

**spectabilis** .................................................... 35

**Machrorhynchia** ................................................ 89

**Marktanner-Turueretscher, Gottlieb** .................. 2, 47, 48, 134

**McCrady, John** ................................................ 47, 88, 134

**on Aglaophenia pelagica** ...................................... 97

**on genera of Plumulariae** .................................... 54

**McMurtrie, J. Playfair** ....................................... 46

**Merejkowsky, C. de** .......................................... 3, 23, 134

**on nematophores** .............................................. 21, 34

**Meyer, Paul** .................................................... 2

**Monocaulus imperator** ......................................... 4

**Monostichas** ................................................... 8, 9, 32, 33, 75, 76

**(dichotoma)** .................................................... 75, 76

**quadridens** .................................................... 14, 15, 50, 75

**XIII**

**Monothea** ....................................................... 32, 55, 58, 72

**margarita** ...................................................... 4, 88, 50, 72

**Murray, Andrew** ................................................. 134

**Naples Zoological Station** ................................. 41

**Nematocystis** .................................................. 9, 28

**Nematophores** ................................................... 13, 14, 16, 18, 20

**(Nematophorus)** ................................................ 18, 121

**grandis** ........................................................ 121, 123

**(Nemertesia)** ................................................... 54, 88

**Neman, Rev. Canon A. M.** ...................................... 2, 129

**Nutitheca** ....................................................... 31, 38, 51, 87, 88, 128

**Nuttling, C. C.** ................................................ 134, 137

**Ophiodes** ........................................................ 24

**mirabilis** ....................................................... 28

**parasitica** ...................................................... 28

**Ophlorhiza parvula** ............................................ 28
<table>
<thead>
<tr>
<th>Term</th>
<th>Page(s)</th>
<th>Plate(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbigny, Alcide d', on Aglaophenia patagonica</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>on Aglaophenia simplex</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>Ova, origin of, in Plunmlulariidae</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Pachyrrhynchia</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Pallas, P. S.</td>
<td>134</td>
<td></td>
</tr>
<tr>
<td>Pennington, Arthur</td>
<td>134</td>
<td></td>
</tr>
<tr>
<td>Pentandria</td>
<td>17-88</td>
<td></td>
</tr>
<tr>
<td>Perisiphonia iliculata</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Perisiphonidae</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Phylactocarp.</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Phylactocarpa</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Phylactoegonia</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Pieper, F. W.</td>
<td>134</td>
<td></td>
</tr>
<tr>
<td>Planula</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>(Pleurocarpa) Ramoso</td>
<td>121</td>
<td></td>
</tr>
<tr>
<td>Polyplumularia</td>
<td>32, 53, 81, 83</td>
<td></td>
</tr>
<tr>
<td>armata</td>
<td>11, 14, 15, 50, 63</td>
<td>XVI</td>
</tr>
<tr>
<td>Pourtales, Count L. F. de.</td>
<td>1, 134</td>
<td></td>
</tr>
<tr>
<td>Plunularia</td>
<td>8, 10, 13, 14, 15, 20, 21, 22, 23, 30, 32, 41, 47, 53, 54, 55, 56, 76, 86</td>
<td></td>
</tr>
<tr>
<td>aglaophenoides</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>alternata</td>
<td>49, 50, 55, 56</td>
<td>IV</td>
</tr>
<tr>
<td>altitheca</td>
<td>31, 49, 55, 56</td>
<td>VI</td>
</tr>
<tr>
<td>attenuata</td>
<td>50, 55, 56, 63</td>
<td>V</td>
</tr>
<tr>
<td>(arbores)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(californica)</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>catherina</td>
<td>30, 19, 55, 56, 60, 81, 76</td>
<td>III</td>
</tr>
<tr>
<td>cautitheca</td>
<td>11, 50, 55, 56</td>
<td></td>
</tr>
<tr>
<td>clarkei</td>
<td>11, 15, 49, 55, 66</td>
<td>III</td>
</tr>
<tr>
<td>cornuopis</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>corrugata</td>
<td>50, 55, 56</td>
<td>IV</td>
</tr>
<tr>
<td>dendritica</td>
<td>3, 4, 6, 10, 15, 50, 55, 56</td>
<td>VIII</td>
</tr>
<tr>
<td>echinulata</td>
<td>30, 31, 36, 37, 38, 39, 64</td>
<td></td>
</tr>
<tr>
<td>elegantula</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>fileafilis</td>
<td>4, 7, 8, 10, 11, 13, 49, 55, 56, 60, 76</td>
<td>II</td>
</tr>
<tr>
<td>filicula</td>
<td>49, 55, 56, 57</td>
<td>III</td>
</tr>
<tr>
<td>floriculosa</td>
<td>49, 55, 56, 59</td>
<td>III</td>
</tr>
<tr>
<td>fragilis</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>frutescens</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>geminata</td>
<td>32, 49, 55, 56</td>
<td>III</td>
</tr>
<tr>
<td>goldsteinii</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>goodel</td>
<td>50, 55, 56, 64</td>
<td>VII</td>
</tr>
<tr>
<td>(gracilis)</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>habeciolida</td>
<td>50, 49, 51, 34, 39</td>
<td></td>
</tr>
<tr>
<td>helleri</td>
<td>49, 55, 56</td>
<td>II</td>
</tr>
<tr>
<td>inermis</td>
<td>50, 55, 56</td>
<td>V</td>
</tr>
<tr>
<td>lagenifera</td>
<td>10, 50, 55, 56, 64</td>
<td>VI</td>
</tr>
<tr>
<td>macrotheca</td>
<td>50, 55, 56, 66</td>
<td>VIII</td>
</tr>
<tr>
<td>megaloccephala</td>
<td>14, 49, 55, 56</td>
<td>I</td>
</tr>
<tr>
<td>oligopyla;</td>
<td>49, 55, 56</td>
<td>I</td>
</tr>
<tr>
<td>palmaris</td>
<td>50, 55, 56</td>
<td>VI</td>
</tr>
<tr>
<td>paucinoda</td>
<td>50, 55, 56</td>
<td>VIII</td>
</tr>
<tr>
<td>pinunata</td>
<td>7, 14, 25, 26, 23, 31, 34, 37, 38, 42, 43, 14, 46, 53</td>
<td></td>
</tr>
<tr>
<td>plunularioides</td>
<td>50, 55, 56</td>
<td>IV</td>
</tr>
<tr>
<td>procambens</td>
<td>1, 5, 19</td>
<td></td>
</tr>
<tr>
<td>profunda</td>
<td>6, 50, 55, 56</td>
<td>VIII</td>
</tr>
<tr>
<td>quadridens</td>
<td>7, 70</td>
<td></td>
</tr>
<tr>
<td>setacea</td>
<td>20, 31, 36, 56, 57, 64</td>
<td>I</td>
</tr>
<tr>
<td>similis</td>
<td>14, 39, 59, 64</td>
<td></td>
</tr>
<tr>
<td>simplex</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>struthionides</td>
<td>102</td>
<td></td>
</tr>
<tr>
<td>stylifera</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>tripartita</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>(verrilli)</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>virginis</td>
<td>50, 55, 56, 66</td>
<td>VII</td>
</tr>
</tbody>
</table>

Plumularian fauna
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plumularian stem</td>
<td>48</td>
</tr>
<tr>
<td>Plumulariidae</td>
<td>3, 9, 18, 28, 29, 31, 36, 47, 48</td>
</tr>
<tr>
<td>Proboscis</td>
<td>9</td>
</tr>
<tr>
<td>Protohydra</td>
<td>23</td>
</tr>
<tr>
<td>Quelch, John J</td>
<td>134</td>
</tr>
<tr>
<td>on Streptocaulus</td>
<td>35</td>
</tr>
<tr>
<td>on Zygophylacida</td>
<td>47</td>
</tr>
<tr>
<td>Reproduction, stoloniferous</td>
<td>42, 43</td>
</tr>
<tr>
<td>Sarcostyles</td>
<td>13, 29, 24, 26</td>
</tr>
<tr>
<td>Sars, G. O</td>
<td>135</td>
</tr>
<tr>
<td>on bathymetrical zones</td>
<td>49</td>
</tr>
<tr>
<td>on Polyplumaria</td>
<td>83</td>
</tr>
<tr>
<td>Schizocladium ranosum</td>
<td>44</td>
</tr>
<tr>
<td>Schizotrichia</td>
<td>8, 14, 15, 31, 32, 56, 78, 84, 88, 129</td>
</tr>
<tr>
<td>dichotoma</td>
<td>XV</td>
</tr>
<tr>
<td>gracillima</td>
<td>XIV</td>
</tr>
<tr>
<td>parvula</td>
<td>XV</td>
</tr>
<tr>
<td>tenella</td>
<td>IV</td>
</tr>
<tr>
<td>Sciurella</td>
<td>53</td>
</tr>
<tr>
<td>indivisa</td>
<td>15, 31</td>
</tr>
<tr>
<td>Semper, Carl</td>
<td>20, 27</td>
</tr>
<tr>
<td>Septal ridges</td>
<td>8</td>
</tr>
<tr>
<td>Sertularia myriophyllum</td>
<td>107</td>
</tr>
<tr>
<td>secaea</td>
<td>56</td>
</tr>
<tr>
<td>Sertularida</td>
<td>9, 10, 47</td>
</tr>
<tr>
<td>Sex cells, origin of</td>
<td>36, 37, 38</td>
</tr>
<tr>
<td>Solander, Daniel</td>
<td>132</td>
</tr>
<tr>
<td>Spencer, W. Baldwin</td>
<td>2, 6, 135</td>
</tr>
<tr>
<td>on Hydroceratinida</td>
<td>28</td>
</tr>
<tr>
<td>on Polyplumaria procumbens</td>
<td>48</td>
</tr>
<tr>
<td>State University of Iowa</td>
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</tr>
<tr>
<td>Statopedia</td>
<td>15, 16, 17, 20, 31, 32, 33, 34, 49, 50, 51, 87, 88</td>
</tr>
<tr>
<td>Stem of Plumulariida</td>
<td>3, 4</td>
</tr>
<tr>
<td>Stoloniferous reproduction</td>
<td>42</td>
</tr>
<tr>
<td>Stomatobrachium mirabile</td>
<td>44</td>
</tr>
<tr>
<td>Streptocaulus</td>
<td>35, 37, 88, 129</td>
</tr>
<tr>
<td>pulcherrius</td>
<td>XXXIV</td>
</tr>
<tr>
<td>Synecryne eximata</td>
<td>8, 48, 51, 129</td>
</tr>
<tr>
<td>Synthecium</td>
<td>34</td>
</tr>
<tr>
<td>Tentacles of the Plumulariida</td>
<td>9</td>
</tr>
<tr>
<td>Thecocarpus</td>
<td>6, 7, 8, 13, 33, 34, 87, 88, 89, 106, 107, 110</td>
</tr>
<tr>
<td>benedetti</td>
<td>XXV</td>
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<td>bispinosus</td>
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<td>myriophyllum</td>
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<td>normani</td>
<td>XXV</td>
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<td>135</td>
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<tr>
<td>Trophosome</td>
<td>3</td>
</tr>
<tr>
<td>United States Coast Survey</td>
<td>48</td>
</tr>
<tr>
<td>United States Fish Commission</td>
<td>48</td>
</tr>
<tr>
<td>Varene, A. de</td>
<td>135</td>
</tr>
<tr>
<td>Verrill, A. E.</td>
<td>2, 4, 110, 120, 135</td>
</tr>
<tr>
<td>on Aglaophenia struthionides</td>
<td>102</td>
</tr>
<tr>
<td>on Atlantic coast Plumulariida</td>
<td>1</td>
</tr>
<tr>
<td>on Cladocarpus flexils</td>
<td>112</td>
</tr>
<tr>
<td>on stoloniferous reproduction</td>
<td>46</td>
</tr>
<tr>
<td>Weismann, August</td>
<td>3, 29, 135</td>
</tr>
<tr>
<td>on ameboid movements in sex cells</td>
<td>46</td>
</tr>
<tr>
<td>on development of the corbula</td>
<td>39</td>
</tr>
<tr>
<td>on homology of the gamophore</td>
<td>39</td>
</tr>
<tr>
<td>on sarcostyles</td>
<td>23</td>
</tr>
<tr>
<td>on the origin of the sex cells</td>
<td>36</td>
</tr>
<tr>
<td>West Indian region, plumularian fauna of</td>
<td>1</td>
</tr>
<tr>
<td>Zygophylacida</td>
<td>47</td>
</tr>
</tbody>
</table>