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I.—THE MARINE ALGÆ OF NEW ENGLAND.

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INTRODUCTION.

This report is intended, with the exception of the Diatomes, to include all the marine species at present known to occur on the coast of the United States from New Jersey to Eastport, Me., and a few species are mentioned which, although they have not yet been found within our limits, are nevertheless to be expected from the fact that they occur on the neighboring coast of the British provinces. In preparing the report I have attempted to present, in a compact and more or less popular form, a description of the different orders and species of sea-weeds, so that persons who frequent the coast of New England, and especially those in the service of the Fish Commission, may have at hand the means of determining the forms found in our waters. The descriptive portion of the report is preceded by a short account of the general structure and classification of sea-weeds, which is necessary in the present case, because there is no generally accessible book in the English language which gives a good account of the modern views of the classification and structure of algæ.

The list of papers relating directly to New England algæ is very meager. In January, 1847, Prof. J. W. Bailey published in the American Journal of Arts and Sciences a paper entitled *Notes on the Algæ of the United States*. He enumerates 50 species found in New England, but some of the number are apparently erroneously credited to our coast. Two continuations of the article appeared in May, 1847, and July, 1848, in the former of which 19, and in the latter 17, species new to New England are enumerated. In 1847 Mr. S. T. Olney, in the Proceedings of the Providence Franklin Society, published a paper on *Rhode Island Plants*, in which he mentions 45 species of algæ. Most of the species in the papers above mentioned had been submitted to Prof. W. H. Harvey, of Dublin. The classic work of Harvey, the *Nereis Boreali-Americana*, of which the first two parts were published in the Smithsonian Contributions to Knowledge in 1852, and the third part in 1857, is the only elaborate account ever published with regard to the sea-weeds of the United States, and it has always been the standard authority on the subject. Since the appearance of Harvey's great work comparatively little has been added to our knowledge of the sea-weeds of New England. In the Report of the United States Fish

Commission for 1870–'72 is a *List of the Marine Algæ of the South Coast of New England*, in which 103 species are enumerated; and in the report for 1875 is a *List of the Marine Algæ of the United States*, intended as a catalogue of the sea-weeds exhibited by the Commission at the Centennial Exposition, in which additions were made to the New England flora. Besides the papers referred to, I would mention *Algæ Rhodiaceæ*, by S. T. Olney, published in 1871; *List of Marine Algæ Collected near Eastport, Me.*, by Prof. D. C. Eaton*; two papers by the writer in the Proceedings of the American Academy of Boston†; and *List of the Marine Algæ growing in Long Island Sound within 20 miles of New Haven*, by F. W. Hall‡. A series of dried specimens has been published conjointly by Dr. C. L. Anderson, Prof. D. C. Eaton, and myself, under the title of *Algæ Am.-Borealis*. The 130 species already published, in three fasciculi of 30 sets each, contain a number of the more interesting New England forms. A set has been presented to the Fish Commission, and that, together with the large set prepared for the Centennial Exhibition, to be deposited hereafter in the National Museum, will place in the hands of the members of the Commission sufficient material to render the task of determining our species comparatively easy.

It will be seen that we rely almost wholly on Harvey's *Nereis* for our knowledge of New England algæ, and it is surprising that so few species have been added to the flora in recent years. Of the species recently added, by far the larger number are insignificant in size, the rare *Nemastoma Bairdii* being almost the only species which would attract the eye by its beauty. Professor Harvey himself spent but a few weeks on the New England coast, and we must either suppose that the collectors of Harvey's time were more acute than those of the last few years, or else that the New England flora is very poor. That the flora is not very rich in species, even for a temperate region, is probably true, but it is too soon to assume that it is exceptionally poor.

The number of species which are so large and striking as to attract the amateur collector is nowhere large in temperate regions, and the so-called richness of a flora is generally dependent upon the number of small and insignificant species, which are recognized only by those who make a careful microscopic study. One reason for the apparent poverty of our marine flora is that our collectors have generally been amateurs, who pass a few weeks upon the shore and gather only the more beautiful and striking species. The number of persons who make microscopic examinations of our algæ is, however, increasing, and, as a result, numbers of small, but interesting, species have within a short space of time been brought to light, and it now seems likely that the New England flora is by no means so poor as was formerly supposed. The sever-

* Trans. Conn. Acad., vol. ii, part 2, 1873.

† List of the Marine Algæ of the United States, Proc. Am. Acad. Art. and Sci., vol. x (n. s. ii), p. 351. On some Algæ new to the United States, l. c., vol. xii (n. s. iv), p. 235.

‡ Bulletin of the Torrey Botanical Club, vol. vi, No. 21, Sept., 1876.

ity of the climate, too, renders it difficult to collect during the winter and early spring months, when the species to be found are to a great extent different from those which flourish in summer. A rich harvest might be expected by an algologist who should pass the winter and spring at some exposed point upon the coast. The summer species may be said to be tolerably well known, but our knowledge of the winter forms is very deficient.

For the purpose of examining the algæ of the coast, I have visited Eastport, Portland, Cape Ann, Wood's Holl, Mass., where I passed two summers with the Commission, Newport, Noank, Conn., and Greenport, L. I. Unfortunately, I have not been able to make any excursions during the winter months, except to the coast near Boston, at Nahant and Marblehead, and my knowledge of the winter species is derived from specimens sent by correspondents.

In this connection I would express my sincere thanks to correspondents who have aided me by specimens and information, and I would acknowledge especially my obligations to Prof. D. C. Eaton, of New Haven; Mr. Horace Averill and Mr. A. R. Young, of Brooklyn; Mr. C. B. Fuller, of Portland; Mrs. A. L. Davis and Mrs. M. H. Bray, of Gloucester; Miss M. A. Booth, Mrs. Corcoran, Mrs. J. T. Lusk, Mrs. Beebe, Mr. F. S. Collins, and others, whose names are appended to the different species described. I am particularly indebted to the Fish Commission for their valuable aid in enabling me to dredge and collect in various interesting localities in Southern Massachusetts, at Noank, and at Gloucester, and to Mr. Alexander Agassiz for facilities for examining the coast at Newport. With the materials at hand I have attempted to review critically the species of our coast, and for this purpose it was necessary to compare them with the algæ not only of Great Britain, but of the other shores of Europe. I am, above all, indebted to Dr. Edouard Bornet, of Paris, who has constantly furnished information, both with regard to structure and nomenclature, without which it would have been impossible for me to form an accurate judgment concerning American species. I would also return my thanks to Prof. J. G. Agardh, of Lund; to Prof. J. E. Areschoug, Dr. W. B. Wittrock, and Dr. F. J. Kjellman, of Upsala, through whose kindness I have been able to examine very complete sets of Scandinavian and Arctic algæ, which have a special bearing on the New England flora; to Prof. E. Perceval Wright, of Dublin, who has obligingly allowed me to examine specimens in the Harveyan Herbarium at Trinity College; to M. A. Le Jolis, of Cherbourg, and Prof. J. T. Rostafinski, of Cracow, for valuable notes on *Laminariæ;* and to Mr. F. Hauck, of Trieste, for sets of Adriatic algæ.

If we regard the marine vegetation of the northeastern coast of the United States as a whole, we see that, beginning at Eastport, we have a strongly marked arctic flora, which is a direct continuation of that of Greenland and Newfoundland. As we proceed southward towards Boston, although the luxuriance of growth is less, the general appear-

ance of the flora is still unmistakably arctic, if we except a few sheltered localities. The northern shore of Cape Cod, from its sandy character, is practically destitute of all species of algæ, except a few forms which are here and there found growing on the eel-grass. As soon as we pass to the south of Cape Cod, however, the flora assumes an entirely different aspect. The arctic and Northern European forms have disappeared, except at a few exposed points like Gay Head and Montauk, and, in their place, we find a number of species, as *Dasya elegans*, *Rhabdonia tenera*, *Chondria tenuissima*, *Sargassum vulgare*, characteristic of warmer seas.

The Long Island flora, which may be said to extend from Cape Cod to New Jersey, has a good deal in common with the northern part of the Adriatic. Among the more abundant species are *Dasya elegans*, *Polysiphonia variegata*, and, if we accept Zanardini's view, our common *Chondria Baileyana* and *Lomentaria Baileyana* are identical with *C. striolata* and *L. uncinata*, all species common near Venice. From New Jersey to Charleston, if we except Norfolk and one or two points on the North Carolina coast, almost no sea-weeds are known, presumably on account of the unfavorable nature of the shore, although, it must be confessed, the coast has never been carefully explored. Even with regard to the coast of New Jersey we have but little information. A number of *Florideæ*, usually growing attached to eel-grass, has been reported from Beesley's Point by Samuel Ashmead,* but it is almost certain that southward from that point, very little is to be expected.

It will be seen that Cape Cod is the dividing line between a marked northern and a southern flora. In fact, the difference between the floræ of Massachusetts Bay and Buzzards Bay, which are only a few miles apart, is greater than the difference between those of Massachusetts Bay and the Bay of Fundy, or between those of Nantucket and Norfolk. This difference in the flora corresponds precisely with what is known of the fauna. That Cape Cod formed a dividing line was known to Harvey, and subsequent observation has only shown, on the one hand, that the flora north of Cape Cod is more decidedly arctic than he supposed, and that, on the other hand, south of the cape it is more decidedly that of warm seas. The general fact of the distinctness of the two floræ is not weakened by the knowledge that we now possess, owing to the investigations of the Fish Commission, of the existence in a few sheltered localities north of Cape Cod of some of the characteristic species of Long Island Sound, and in a few exposed spots south of the cape of northern species. Of the more common species found along the whole coast of New England, by far the greater part are also common in Europe, as *Delesseria sinuosa*, *Corallina officinalis*, *Hildenbrandtia rosea*, *Polysiphonia violacea*, *P. fastigiata*, *P. nigrescens*, *P. urceolata*, *Rhodymenia palmata*, *Chondrus crispus*, *Cystoclonium purpurascens*, *Ahnfeltia plicata*, *Phyllophora Brodiæi*, *P. membranifolia*, *Polyides rotundus*, *Ceramium rubrum*, *Ptilota elegans*, *Leathesia tuberiformis*, *Chordaria fla-*

* *Vid.* Proceed. Acad. Nat. Sci., Philadelphia, vol vi, p. 147, vol. x, p. 8.

gelliformis, *C. divaricata*. *Desmarestia aculeata*, *D. viridis*, *Phyllitis fascia*, *Scytosiphon lomentarius*, the common *Fuci* and *Laminariæ*, not to mention a large number of *Chlorosporeæ* and *Cryptophyceæ*. But a very few exclusively American species are found throughout our limits. Most of the purely American species are either confined to the shore south of Cape Cod or else to the shore from Boston northward. In fact, a good share of our common sea-weeds could be recognized from the figures in the Phycologia Brittanica.

Let us consider next the characteristic species between Boston and Eastport. In studying these we must turn not to works on the algæ of France, or Great Britain, but rather to those on Scandinavian algæ. It is especially instructive to examine the Algæ Scandinavicæ of Professor Areschoug in connection with our own forms. The resemblance is at once striking. At Eastport we have a magnificent growth of *Laminariæ* and *Fuci*, which predominate over all other forms. The larger species are even found high up on the shore, and we find growing in pools *Saccorhiza dermatodea*, *Laminaria longicruris*, *Agarum Turneri*, *Dictyosiphon hippuroides*, *Halosaccion ramentaceum*, and *Monostroma Blytii;* at low-water mark *Lithothamnion fasciculatum* abounds; and *Euthora cristata*, *Delesseria sinuosa*, *D. alata*, and *Callithamnion Pylaisæi* can easily be collected without wading. The rocks are covered with crusts of *Petrocelis cruenta*, and *Ralfsia verrucosa*, and the luxuriant *Fucus evanescens*. With the exception of *Agarum Turneri*, which is not found in Europe, but which occurs in the North Pacific, and *C. Pylaisæi*, which is peculiar to America, all the species named are found in the north of Norway. *Euthora cristata* does not appear south of Scotland, where it is rare, and *Laminaria longicruris* is scarcely known south of the northern part of Scotland. As we proceed southwards from Eastport to Nahant, near Boston, we find that the species named disappear into deeper water, and, with the exception of *Monostroma Blyttii*, are not generally seen except when washed ashore. *Dictyosiphon hippuroides* has not yet been seen south of Eastport, but *Saccorhiza dermatodea*, known to Harvey only from Newfoundland, is now known to occur at Marblehead, near Nahant, and *Halosaccion* is not rare in deep pools at Gloucester, while *Monostroma Blyttii*, in rather a small form, is found on exposed rocks at Little Nahant. *Fucus evanescens*, which is as abundant as *F. vesiculosus* at Eastport, seems to be replaced on the Massachusetts coast by *F. furcatus*. *Calliblepharis ciliata* of Harvey's Nereis, found from Cape Ann northwards is now known to be the same as *Rhodophyllis veprecula*, a common species on northern coasts. As yet none of the Scandinavian species of *Phlœospora* have been found with us, but it is not unlikely that they might be found by a botanist who should collect at Eastport in the spring. It is hardly likely that *Phlœospora tortilis* does not occur with us, for it is not uncommon on the Norwegian coast, and was collected in Greenland by Dr. Kümlien, of the Howgate expedition. *Polysiphonia arctica* may perhaps also be expected, as well as *Chætopteris plumosa*,

a common species of Greenland and Northern Europe. *Odonthalia dentata*, a common species of Northern Europe, has not yet been found within our limits, although it is common at Halifax.

If north of Boston the principal feature of the marine vegetation is the enormous mass of large *Fuci* and *Phæosporeæ*, the *Floridieæ* forming an insignificant part of the flora, the chief feature of the flora south of Cape Cod is the preponderance of *Floridieæ* and the comparative insignificance of the *Fuci* and *Phæosporeæ*. In the case of the sea-weeds of Long Island Sound we cannot so directly refer them to species of any part of Europe as was possible in the case of the northern flora. Several of the more common and striking species, as I have already said, are identical with or closely related to Adriatic forms. We are not, however to push the comparison too far. The development of *Fuci* and *Laminariæ* in Long Island Sound, although meager compared with what we find north of Boston, is far beyond anything we find in the Adriatic, and, on the other hand, we do not have in Long Island Sound the numerous *Corallineæ* and siphonaceous *Chlorosporeæ*, which are common in the Adriatic, and which unmistakably indicate a subtropical flora. *Grinnellia americana*, *Dasya elegans*, *Rhabdonia tenera*, *Lomentaria Baileyana*, *Sargassum vulgare*, and most of the common species of Long Island Sound, are found as far south as the West Indies.

A consideration of the apparent exceptions to the law of the distribution of sea-weeds on our coast is not without interest. In the cold waters off Gay Head and Block Island, *Euthora cristata*, in a depauperate form, is sometimes found, and at exposed points we find a decided growth of *Laminariæ*, especially the digitate forms. *Ptilota serrata*, a typical northern species, has also been found in a much reduced form at the Thimble Islands, near New Haven.

In the town of Gloucester, near the village of Squam, is a small sheet of water called Goose Cove. The narrow entrance to the cove has been dammed up, and the water from the ocean enters only for a short time at the high tide. In this cove, to my surprise, I found *Rhabdonia tenera*, *Gracilaria multipartita*, *Chondria Baileyana*, and a large mass of *Polysiphonia Harveyi* and *P. Olneyi*. In short, the flora was entirely different from anything I had ever seen before north of Cape Cod, and entirely different from that of the adjacent shore, where the flora is entirely arctic. Furthermore, Squam is on the northern and inner side of Cape Ann, and as there is no connection of Goose Cove with the southern side of Cape Ann, and inasmuch as no vessels ever enter the cove, it is very difficult to account for the presence of the sea-weeds which grow there. The water which is confined by the dam is much warmer than that of the surrounding ocean, which would enable the species of warm waters to live if they were once introduced, but how are we to suppose that the spores were brought into the cove? It is hard to believe that they could have been brought by currents, for, as a matter of fact, the currents move in the wrong direction to produce such

an effect. Certainly, *Rhabdonia tenera* is quite unknown in any other spot north of Cape Cod, the nearest locality being the coast near Nantucket, and it is very difficult to conceive that spores of that delicate species would survive in a very cold current, which not only must carry them outside of Cape Cod and across Massachusetts Bay, but also around to the sheltered cove at the point where Cape Ann joins the mainland at the north. If we compare the exceptional case of Goose Cove in the north with Gay Head and Montauk in the south, it seems to be the rule that wherever the water is cold enough, we meet arctic species, and wherever it is warm enough we have Long Island species, regardless of the remoteness of localities where the species naturally abound, and, as far as we know, of the absence of currents to transport the spores.

Our marine flora is marked by the complete absence of any members of the order *Dictyotaceæ*. *Haliseris polypodioides* has been found on the coast of North Carolina and, at Charleston, *Padina pavonia* begins to become common, but north of Norfolk not a single species of the order is known, the northern species referred by Harvey in the Nereis to the *Dictyotaceæ* being now known to belong to another order. Nor does any species of *Tilopteris* or *Cutleria* occur in New England. The absence of some of the common European genera of *Florideæ* is also worthy of notice. The genus *Nitophyllum* is entirely wanting north of North Carolina, and, although a species is said to have been collected off Cape Fear, and although *N. ocellatum* is occasionally found at Key West, this genus, which forms one of the more striking features of the European flora, may be said to be practically almost unknown anywhere on our Atlantic coast. *Bonnemaisonia asparagoides*, which occurs as far north as Norway, although rare, may perhaps be found with us. No species of *Schizymenia* or the related genera is found with us although the western coast is perhaps too rich in species of this perplexing group. *Plocamium coccineum*, one of the commonest red sea-weeds not only of Europe but of our west coast, is known with us in only one doubtful case. *Gelidium corneum*, which is abundant in almost all parts of the world, is only occasionally found in New England, and then only in the reduced form, separated by some as a distinct species, under the name of *G. crinale*. It may here be remarked that it is often a difficult matter to determine whether some of the more beautiful sea-weeds of Europe really occur with us or not. Our amateur collectors have frequently exchanged with European collectors, and one not unfrequently sees specimens of *Plocamium coccineum*, *Callophyllis laciniata* and other European species prized for their beauty, which are said to have been collected on our own coast. But inasmuch as no careful collector has found the species in question, I have considered it too unsafe to accept the statements of amateurs who, to my knowledge, have received specimens from Europe, and who, in general, are not accurate as to dates and localities. The preceding remark will not, however, apply to the species of *Fucus* and the coarser sea-weeds. *Fucus serratus*, very

common in Europe, is very rare with us, having been found in but one locality in the United States and one in Nova Scotia. *Fucus canaliculatus*, *Himanthalia lorea*, and the common European *Cystoseiræ* are quite wanting. The nearly ubiquitous *Codium tomentosum* is a species which has not yet been found on our northern coast. On the other hand some species, as *Spyridia filamentosa* and *Chordaria divaricata*, are more abundant in New England than in Europe, and the same is probably true of *Euthora cristata* and *Ptilota serrata*, if we except perhaps the arctic zone.

It is evident that a great deal remains to be done before we can say that we have as accurate a knowledge of our marine flora as we have of that of most European countries. Hereafter any advance in the knowledge of our marine algæ must be made by a careful microscopic study on the shore. Probably all the large and striking species are now known, or if any remain to be discovered their discovery will be by mere chance, and not by any systematic search. What is especially needed is information about our winter and spring forms, and this can be best obtained by persons who either live on the shore or spend several months there, so as to be able to take advantage of the comparatively few days for collecting, which occur in our severe winters. The habits and structure of our *Laminariæ* need careful examination, microscopic as well as in the gross. The whole order of the *Phæosporeæ*, in fact, which abound in spring, should be studied, especially the genus *Ectocarpus* and its allies. Our *Cladophoræ* are in great confusion, and in the present paper I have been able to contribute but little towards their proper arrangement. Several years of study are necessary for the purpose, and, in fact, the task cannot well be accomplished until the European species are better known. Our *Ulveæ* are not in much better condition. The *Ulvæ* proper, thanks to the elaborate account of the genus given in Le Jolis's Liste des Algues Marines de Cherbourg, can be tolerably well made out; but the determination of some of the species of *Monostroma* is merely approximate. The *Cryptophyceæ*, which inhabit the shores and brackish localities, are very numerous, and a large number of forms probably remain to be discovered. A study of the last-named order is, moreover, not without a practical bearing, as is shown in another part of the report, by the fact that the cause of the so-called red fish is due to the growth of an alga of this order. It is probable that we have with us nearly all the European species of this order, and an excellent guide for our students, is the admirable paper by Warming on the Bacteria of the Danish Coast.*

Another group requiring study is the *Squamarieæ*, a small order consisting of species, which form crusts on stones and shells, often in deep water. As a rule comparatively little in the way of sea-weeds is found by dredging; but an examination of shelly and gravelly bottoms for *Squamariæ* is to be desired. Dredging is most successful between 10

* Om nogle ved Danmarks Kyster levende Bakterier, in Videns. Med. Natur. Foren., Copenhagen, 1875.

and 30 fathoms, and at a greater depth than 50 fathoms almost nothing is found. The oyster-beds of the coast should be carefully searched for *Cutlerieæ* and other sea-weeds found in similar localities in Europe. Finally, a thorough exploration of the tidal rivers and sheltered coves of the eastern coast of New England is much to be desired, in order that we may know to what extent the southern forms extend northward when they find sufficiently warm water and a suitable place of growth.

From an economical point of view, but little need be said with regard to our sea-weeds as an article of food. *Chondrus crispus*, the Irish moss, as it is called in this country, is the only species of any commercial value. It is collected in considerable quantities at several localities, but especially at Hingham, Mass. It is used for making sea-moss farine, and is also employed to some extent by brewers for clarifying beer. As yet the use of *Porphyra vulgaris*, the laver, one of the common species for making soups, has not been introduced. The Chinese employed in the shoe factories at North Adams, Mass., import the same species from China, not apparently knowing that they could obtain an abundance of it in Massachusetts. The dulse, *Rhodymenia palmata*, is sold to some extent in the seaport towns, especially in Boston, where it is eaten principally by sailors and the Irish population. It is generally imported from the British provinces, but it could be obtained in abundance anywhere north of Boston, or even in some places in Long Island Sound. The great use of our sea-weeds is for the purpose of making fertilizers, and immense quantities are carted from the beaches and spread over the land near the shore. Usage, however, varies at different localities, for at Eastport the larger sea-weeds, which are practically the same species that are highly esteemed in New Hampshire and Massachusetts, are considered of little value in comparison with animal manure. As far as I know, there are no manufactories of iodine or soda salts on our coast, although our species greatly resemble those used in Scotland for the purpose. The stem of the devil's aprons, *Laminariæ*, are used by surgical-instrument makers in the manufacture of sponge-tents.

Respectfully submitted.

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STRUCTURE AND CLASSIFICATION OF SEA-WEEDS.

With a very few exceptions, all the plants of our coast which may be said really to grow in the water belong to the division of the vegetable kingdom known as the *Cryptogams*, or plants having no true flowers or seeds. Only two species of flowering plants are commonly found submerged in salt water, viz, *Zostera marina*, the salt-water eel-grass, and *Ruppia maritima*. The former is familiar to every one who has ever been to the shore, and is sometimes washed ashore in immense quanti-

ties. The latter is a common species of brackish bays and coves. If we add *Zannichellia palustris*, a species closely related to *Ruppia*, and a few species of *Potamogeton*, which occasionally make their way into brackish-water ditches and streams, we have completed the list of flowering plants which the student of marine vegetation is likely to meet on our coast. Excepting the few flowering plants just named, and a few *Characeæ*, an order whose place is doubtful but which is now generally placed near the mosses, which probably inhabit our brackish waters, our marine flora consists wholly of *Thallophytes*, the lowest division of the *Cryptogams*, the species of which are supposed to be destitute of any true axis and leaves such as are found in the higher plants. The *Thallophytes* have been divided into three classes, *Algæ*, *Fungi*, and *Lichens*. This classification, as we shall see, is based on physiological rather than on morphological grounds, and is very far from being satisfactory; but, although new classifications have been proposed, which, in time, will almost certainly supersede the old, at present it is impossible to ignore the old divisions, which may be said rather to be convenient than to be based on accurate knowledge of structure and development.

Of the three old groups, the *Algæ* may be described as *Thallophytes* which grow submerged in water or in wet places, which contain chlorophyl, or leaf-green, and which are able to transform inorganic into organic material, or, in other words, to support themselves from the inorganic matter about them. The *Fungi* do not grow submerged, do not contain chlorophyl, and are unable to change inorganic into organic matter, and hence must live as parasites upon bodies which contain organized matter. The *Lichens* were supposed by the older writers to be distinct from algæ and fungi, and characterized by having in their interior certain green bodies known as gonidia. It is to the first of the three divisions named, the algæ, that, with very few exceptions, all the strictly marine plants belong. How unscientific the division into algæ, fungi, and lichens is may be seen by the fact that on our coast there is one species of fungus which grows submerged in salt water, an undescribed species of *Sphæria*, which is parasitic on the stems of the large devil's apron, *Laminaria longicruris*. A few species of lichens grow between tide-marks, and several in places exposed to the spray. *Verrucaria mucosa* T. Fr. is abundant on our northern coast, and might be mistaken by a collector for *Isactis plana*. *Verrucaria maura* T. Fr., and one or two other *Verrucariæ*, are rather common near high-tide mark, but are not generally submerged. Practically speaking, then, when we speak of our sea-weeds we refer merely to the algæ, which constitute ninety-nine one-hundredths of the flora.

Harvey, in his Nereis, divided algæ into three classes, *Melanospermeæ*, *Rhodospermeæ*, and *Chlorospermeæ*. These three classes are distinguished by their color, the first being olive-brown, the second red or purple, the third green. This classification, which answered tolerably well for distinguishing the species at sight rests, upon what modern researches

have shown to be erroneous views with regard to the structure and development of the different species, and Harvey's three classes no longer serve as a basis for classification. The *Melanospermeæ* and *Chlorospermeæ* are entirely rearranged, and although the *Rhodospermeæ* are still considered to form a natural group, the older name, *Florideæ*, employed by Agardh, is used to designate them. The basis of classification is the structure of the fruit and the organs of fructification, in the knowledge of which a great advance has been made during the last twenty years.

CRYPTOPHYCEÆ.—The lowest of all the algæ are those which belong to the order *Cryptophyceæ*, in which, as yet, the only reproduction known is by means of non-sexual spores and hormogonia. Most of the species of the order are bluish green, but some are purplish, brown, or even pink. The bluish-green coloring matter is due to the presence of phycochrome, which is a mixture of chlorophyl and phycocyanin. The last is extracted by water when the algæ containing it are bruised, the chlorophyl being soluble in alcohol. The species of *Cryptophyceæ* consist of cells which are usually roundish, or disk-shaped, and which are generally held together by a mass of gelatinous substance which surrounds them. The order is divided into two suborders, according to the arrangement of the cells in relation to the jelly. The first suborder, the *Chroococcaceæ*, includes all the species in which the cells are either isolated or arranged in amorphous or more or less spherical masses. Some of the species of this suborder are very small, and in some of the modern classifications are placed with the *Bacteria*, in the order *Protophytes*. The mode of growth of the *Chroococcaceæ* is by division of the cells, first into two, then into four, and so on. The masses which they form may be called colonies, each cell forming a distinct individual, which is usually capable of living apart from its fellows. Spores, which are known in only one species, are formed by some of the cells enlarging and taking on a thick cell-wall. Nothing like sexual reproduction is seen either in this or the next suborder.

NOSTOCHINEÆ.—In the second suborder of the *Cryptophyceæ*, the *Nostochineæ*, the cells are always attached to one another in the form of filaments, to which the name of *trichomata* is given. The trichomata may either be free, as in *Oscillaria* (Pl. I, fig. 5), inclosed in a sheath, as in *Lyngbya* (Pl. I, fig. 4), or packed in a dense mass of jelly, as in *Rivularia* (Pl. II, fig. 2). The cells composing the trichomata are usually disk-shaped or cylindrical, but are sometimes nearly spherical.

Besides the ordinary cells, we find in many species a second kind of cell, distinguished from the others by its glassy appearance and its yellowish or brownish rather than bluish-green color. (Pl. I, fig. 3, *a*; fig. 6, *b*; Pl. II, figs. 1 and 2, *a*.) They are called *heterocysts*, and are found sometimes scattered amongst the other cells, and sometimes at the end of the trichomata, their position often serving as a generic character. The reproduction of the *Nostochineæ* takes place in two ways, by *hormo-*

gonia and by spores. Both modes, however, are entirely of a non-sexual character. In the genera with numerous heterocysts, as *Nostoc*, the hormogonia are formed as follows: The cells intermediate between two heterocysts escape in the form of a small chain, called a *hormogonium*, and swim about with a spiral motion through the water. They at length become quiescent and begin to divide both transversely and longitudinally. Of the cells thus formed some become heterocysts, and in process of time a new *Nostoc* is formed. In the species destitute of heterocysts, or in which the heterocysts are few in number, the hormogonia are formed in a different manner. At certain points in the sheath of the trichoma constrictions are formed, and the cells between the constriction adhere to one another to form a hormogonium. We thus have formed a necklace of hormogonia, which are capable of moving upwards and downwards in the sheath until finally it is ruptured and the hormogonia make their escape. When free they are capable of moving about to a slight degree in the water, and eventually come to rest, and new heterocysts and trichomata are then formed by cell division.

The so-called spores of the *Nostochineæ* are formed by the enlargement of some of the ordinary cells to several times their original length until they become ovoid or cylindrical (Pl. I, fig. 3, *b*). They are found in a number of genera but in a number of others they have not yet been observed. They usually occupy a fixed position with regard to the heterocyst, so that they are used as a generic mark. When ripe they have a dense outer covering and become at times quite dark colored. They are more resistant than the ordinary cells and do not usually germinate until after a period of rest. In germination, which has only been observed in a few instances, the outer wall of the spore bursts open and the contents grow out in the form of a filament, in which by transverse division the ordinary cells are formed.

The *Cryptophyceæ* are algæ which flourish only in summer, but which can be found to some extent at all seasons. Most of them form slimy expansions on mud, wharves, stones, and on dead algæ. They are not often found submerged at any depth, but are most abundant near high-water mark. A few filamentous species attain a length of some inches but only one, *Lyngbya majuscula*, is sufficiently striking to have gained a popular name—*mermaid's hair*. The species of *Oscillaria*, *Spirulina*, and *Beggiatoa*, are capable of oscillating rapidly, but in this respect the marine species are not so well marked as the species of fresh water. The *Beggiatoæ* which are found on putrefying algæ give off the disagreeable odor of sulphuretted hydrogen often noticed at the sea-shore in hot weather. The species of *Cryptophyceæ* are very widely diffused, and, with two exceptions, our forms are all common in Europe.

ZOOSPOREÆ.—This order includes not only the greater part of the *Chlorospermeæ* of Harvey's Nereis, with the exception of the *Oscillatoriaceæ*, which belong to the *Cryptophyceæ*, but also the *Laminariaceæ* and all the *Dictyotaceæ* which Harvey attributes to the New England coast. Al-

though the species included in this large order differ from one another in size and habit to an extent that would certainly forbid their being placed together, if we considered merely the character of the frond, yet they resemble one another very closely in their mode of reproduction, which is accomplished by means of zoospores. The *Zoosporeæ* are divided into four suborders, the *Chlorosporeæ*, or *Chlorozoosporeæ*, as the name is sometimes written, the *Phæosporeæ*, or *Phæozoosporeæ*, the *Bryopsideæ*, and the *Botrydieæ*. The former are abundant in both fresh and salt water. They especially frequent brackish waters and high tide-pools. The mass of the vegetation in brackish rivers is formed of species of this order. The species are either filamentous or else in the form of green membranes, as in the sea-lettuces, *Ulvæ*, which abound in muddy places between tide-marks. The contents of any of the cells may be transformed into zoospores, which escape from the mother cell usually at daybreak. The zoospores are of two kinds, microzoospores and macrozoospores. The latter are produced few in number in the mother cell, and when they have escaped into the water they are seen to be furnished with four cilia placed at one end, and with a dark red spot on one side. After swimming about for a short time they come to rest, the cilia disappear, a wall of cellulose is formed around the zoospore, which then begins to divide and produce a plant like that from which it came. The microzoospores are borne in considerable numbers in the mother cell, and when they escape they are seen to have only two cilia at one end, and a dark red spot on the side. The microzoospores, after swimming about a short time, approach one another in pairs, occasionally in threes, which in a short time coalesce so as to form a body known as the zygospore, or, to use a term first applied by Rostafinski, the isospore, which has four cilia and two dark red spots. The zygospore swims about for a short time, then comes to rest, takes on a cellulose wall, and begins to divide in the same manner as a macrospore. This process of union is called conjugation, and represents sexuality in its lowest form, it being impossible to say which of the conjugating bodies is male and which is female. It is only the microzoospores which come from different mother-cells which conjugate, but it is not quite certain whether the cells must belong to different individuals. The microzoospores, however, do not always conjugate. More frequently they do not, but, after swimming about separately for a short time, lose their cilia and begin to grow just like the macrozoospores. If one wishes to examine the zoospores, he has only at evening to put a piece of sea-lettuce into a vessel of salt water, and at daybreak the zoospores will have formed a green cloud in the water. If the cloud consists of microzoospores, it will collect in the vessel on the side nearest the light; if composed of macrozoospores, on the side away from the light. Conjugation was first observed in a marine species (*Ulva*) by Areschoug, but had previously been observed by Pringsheim in a fresh-water species (*Pandorina*). Since then conjugation of zoospores has been studied by several observers.

BRYOPSIDEÆ.—In the present paper this suborder includes a single species of our coast, *Bryopsis plumosa*, which consist of a single cell of very large size, which branches in a pinnate fashion. When about to reproduce, some of the branches are shut off from the rest of the frond by a cell-wall, and the contents are then transformed into zoospores. A conjugation has not yet been seen in this species. From its unicellular structure one might suppose that *Bryopsis* should be placed near *Vaucheria*, but no oospores have yet been observed like those in the last-named genus. In the absence of a knowledge of the development of the genus, it is retained as a divsion of the *Zoosporeæ*, differing from the *Chlorosporeæ* in the unicellular character of the frond.

BOTRYDIEÆ.—The development of *Botrydium granulatum*, which was fully studied by Rostafinski and Woronin, differs from that of the *Chlorosporeæ* which we have already described in the fact that there is first produced in the small unicellular frond of which this species is composed a number of round spores, or more properly zoosporangia, which are discharged from the mother cell. There is then formed in each zoosporangium a number of zoospores, which escape and conjugate with one another. De Bary and Strasburger have described a similar process in *Acetabularia mediterranea*, and have applied the name *gameten* to the zoospores which conjugate, and *zygote* to the body formed by conjugation. Secondary modes of reproduction by means of zoospores with a single cilium and so-called root-cells occur in *Botrydium granulatum*. *Botrydium* (*Codiolum*) *gregarium*, our only marine species, resembles *B. granulatum*, but its development has never been fully studied.

PHÆOSPOREÆ.—The *Phæosporeæ* are all marine, with one possible exception, and are, when growing, of an olive-brown color. They possess only one form of zoospore, which is more or less oval and pointed at one end and olive-brown in color, and are furnished with two cilia attached at one side and a red spot. The zoospores are not born indefinitely in any cell, but are produced only in certain cells or sporangia. Each species is supposed to have two kinds of sporangia: one called the unilocular sporangium, which contains a large number of zoospores, and another, called the plurilocular sporangium, which consist of an aggregation of small cells, each of which contains a single zoospore. The name of oosporangia was originally given by Thuret to the unilocular sporangia because they are usually more or less oval in shape, but he afterwards abandoned the name because it is more appropriately applied to the spores of the *Oosporeæ*. The older name of trichosporangia, which was at first applied to the plurilocular sporangia, has also been abandoned. Although, as has been said, each species is supposed to have both kinds of sporangia, in a large number of species only one kind has as yet been observed. Both may occur on the same individual and at the same time, but more frequently they are found at different seasons of the year. Although found all over the world, the *Phæosporeæ* particularly affect the temperate and arctic regions, and they fruit more abundantly, as a rule, in winter

and spring than at other seasons, if we except a few genera, like *Ectocarpus*. The conjugation in this suborder was first seen by Areschoug in *Dictyosiphon*, and afterwards by Goebel in *Ectocarpus pusillus*. The zoospores unite in nearly the same way as in the *Chlorosporeæ*. According to Goebel, who studied the zoospores coming from plurilocular sporangia, the conjugation occurs between zoospores coming from different sporangia. The development of the zygospore and the action of the zoospores borne in the unilocular sporangia, except in the genus *Dictyosiphon*, are not yet satisfactorily known. Thuret and Bornet have seen bodies which they consider to be antheridia in several species of *Ectocarpus*, and Pringsheim at one time considered that he had found antheridia in a species of *Sphacelaria*. It is now admitted that the bodies found by Pringsheim belonged to a parasitic species of *Chytridium*, and Thuret and Bornet were unable to ascertain the development of the antheridia in *Ectocarpus*. At any rate, nothing like an oogonium or any female organ to be fertilized by the antherozoids has been found in the *Phæosporeæ*.

As has already been hinted, the genera of *Phæosporeæ* differ from one another very widely in the structure of the frond. From low forms, consisting of short filaments, we pass upwards, through various cylindrical, crustaceous, and globose forms, to the highly developed devil's aprons, *Laminareæ*, the largest of our sea-weeds; and, finally, on the coast of California and in the Antarctic Ocean, we find the perfection of the order in the enormous *Macrocystis pyrifera*, which is several hundred feet long; the *Nereocystis* or bladder-kelp of California; and *Egregia*, in which we have what appears to be a separate stem, leaves, bladders, and fruit-bearing leaves. Janczewski distinguishes three principal modes of growth of the thallus in *Phæosporeæ*. The first consist in growth from a single terminal cell, as in *Sphacelaria*, *Cladostephus*, and *Dictyosiphon*, resulting in the formation of a filamentous solid plant. The second mode consists in the simultaneous growth of several contiguous filaments at their tips, so as to form either a flat expansion, as in *Myrionema* and *Ralfsia*, or a more or less globular body, as in *Leathesia*. The third mode is illustrated by the genus *Laminaria*, in which there is a stalk, a blade, and root-like growths. The place of growth is at the point of union of stem and blade, and the new blade, which begins to form at the tip of the stem, grows upwards from the base and gradually pushes off the old blade. In *Scytosiphon* a similar mode of growth is found only here, there being no stalk, the growth is at the base of the plant. During a certain part of the year, especially in the spring, most of the *Phæosporeæ* are covered with delicate hairs, which disappear as the plant becomes old.

The suborder contains a large number of species, which are divided into several families. Those found on our coast are the following:

SCYTOSIPHONEÆ.—This family includes the two genera *Scytosiphon* and *Phyllitis*, which comprise the old *Chorda lomentaria* and *Laminaria*

fascia, which were placed among the *Laminariæ* in the Nereis Am.-Bor. In *Phyllitis* the frond is membranous, and its whole surface is covered by the plurilocular sporangia which are formed from the superficial cells, which divide so as to form club-shaped filaments consisting of five or six cells, each one of which contains a zoospore. *Scytosiphon* resembles *Phyllitis* except that the frond, instead of being a flat membrane, is a hollow tube. There are no paraphyses in *Phyllitis*, but in *Scytosiphon* there are ovoidal cells interspersed among the plurilocular sporangia, which seem to be of the nature of paraphyses. No true unilocular sporangia are known in this family.

PUNCTARIEÆ.—In this family we find both unilocular and plurilocular sporangia, which are formed in spots on the frond, and arise from the superficial cells. The former are spherical and the latter ellipsoid in outline, and divided into a number of small cells.

DESMARESTIEÆ.—In the two preceding families the fronds were either flat membranes or hollow tubes. In the present there is a solid axis and numerous branches. The cells of the cortical layer are changed into unilocular sporangia. The plurilocular sporangia are unknown.

DICTYOSIPHONEÆ.—In this family the fronds are solid and branching as in the last, and only the unilocular sporangia are known. They are in the form of large spherical cells, imbedded in the cortical layer and opening at the surface. Except that in *Desmarestia* the sporangia are formed directly from the superficial cells, while in *Dictyosiphon* they originate below the surface, this tribe scarcely differs from the last.

ECTOCARPEÆ.—This family comprises a large number of filamentous algæ, upon whose branches are borne the sporangia. The plurilocular sporangia are usually in the form of pod-like branches, composed of a large number of small muriform cells, in each one of which is produced a zoospore. The unilocular sporangia are either globose bodies, borne on a short stalk, or else are formed by the direct enlargement of several contiguous cells of the branches.

SPHACELARIEÆ.—This family is kept distinct from the last by Thuret. Both unilocular and plurilocular sporangia are known, and are similar to those of the *Ectocarpeæ*. If the two families are to be kept distinct, the reason must be that the fronds of the present order are solid, and the growth is by the means of a single terminal cell, which is not the case in the *Ectocarpeæ*.

LEATHESIEÆ.—In the *Leathesieæ* and *Chordarieæ* the sporangia are distributed indefinitely over the frond, but in the succeeding families they are found in separate spots or bands. The *Leathesieæ*, in which we do not include *Myrionema*, are either in the form of small tufts, as in *Elachistea*, in gelatinous expansions of indefinite shape, as in *Petrospongium*, or in vesicular masses, as in *Leathesia*. The greater part of the frond consists of a cellular filamentous mass, upon the surface of which is borne a layer of short filaments composed of smaller cells. The uni-

locular and plurilocular sporangia are borne at the base of the peripheral filaments. In *Elachistea* there are also paraphyses.

CHORDARIEÆ.—In this family the branching frond is filamentous, and consists of an axis of longitudinal filaments and a peripheral series of short filaments, which are given off at right angles to the axis. The sporangia are found amongst the peripheral filaments, the unilocular are ovoidal, and the plurilocular arise from the metamorphosis of the cells at the outer extremity of the peripheral filaments.

ASPEROCOCCEÆ.—The fronds of this family are the counterparts of those in the *Scytosiphoneæ*, but the sporangia, instead of being superficial, are external and do not cover the whole surface, but are found in spots. The spots contain paraphyses and spherical unilocular sporangia.

RALFSIEÆ.—In this family, composed of very few species, the frond is in the form of a crust, resembling a lichen. The fruit is found on the surface in spots, composed of paraphyses and unicellular sporangia.

SPOROCHNEÆ.—Here the frond is a solid branching filament and the fruit is found in spots on the surface. Each spot consists of a number of paraphyses, at the base of which are either oval unilocular sporangia or plurilocular sporangia in the form of short filaments, resembling the sporangia of *Phyllitis*.

LAMINARIEÆ.—The family which includes the devil's aprons and sea-colander of our coast. The fruit either forms long patches or more or less irregular spots along the center of the frond. Unicellular sporangia only are known. The sporangia are separated from one another by peculiar-shaped unicellular paraphyses, which are expanded at the top so as to cover the sporangia.

OOSPOREÆ.—In the order *Zoosporeæ* the sexual reproduction consists in the direct union of two zoospores, which form a zygospore. The two conjugating zoospores, or gameten if we adopt De Bary's nomenclature, are alike in structure, and it is impossible to say which is male and which is female. In the *Cutlerieæ*, of which no representative has as yet been found on our coast, we have algæ resembling the *Phæosporeæ* in habit, but differing from them in that their reproduction is of a higher grade. The *Cutleriæ* have both zoospores and antherozoids, or proper male organs. The zoospores are large, and are born singly in cells, which are united in eights into an oblong body. The antheridia borne on distinct individuals are also oblong in shape, but, instead of being divided into eight cells, they are formed of a much larger number of small cells, in each one of which an antherozoid is produced. The antherozoids are small oval bodies, almost colorless, and provided with two lateral cilia. In *Cutleria collaris* Reinke found that the zoospores after swimming about for some time, lost their cilia and came to rest. While at rest the antherozoids approached them, and he considered that the sexual union then took place. Here, then, we find a clear distinction of the sexes such as is nowhere found in the *Zoosporeæ*, and it is but a step higher to the *Oosporeæ*, in which we have a distinct male

organ, the antherozoid, borne in an antheridium, and a female, called in this order the oogonuim. The order is divided into two suborders, in which, although the general plan of reproduction is the same, the details vary.

VAUCHERIEÆ.—This suborder includes a number of species of green algæ which form dense turfs upon the mud in brackish ditches and rivers, or else loosely floating masses of green filaments. They may generally be recognized at sight by their deep-green shining color and velvety appearance. They consist entirely of long green threads, which occasionally branch, but which are destitute of any cross-partitions except at the time of reproduction. The non-sexual reproduction is by means of zoospores. A cross-partition is formed near the end of a filament, and in the cell thus cut off from the rest of the plant a single very large zoospore is formed. In some species the zoospore escapes through an opening in the apex of the cell, and when free its whole surface is seen to be covered by a large number of vibratile cilia. In other species the cell containing the zoospore breaks off from the rest of the plant and the zoospore remains in a more or less passive condition. The antheridia grow from the sides of the filaments, and are either in the form of oblong, at times nearly sessile, cells, or else a lateral shoot is formed which ends in one or more convolute processes, at the tips of which a cell is cut off from the rest. The antherozoids are very small bodies with two cilia. The *oogonia*, or female organs, are generally situated near the antheridia, and are irregularly ovoid, with a blunt tip. The cell contents collect in a roundish mass at the center, called the *oosphere*, while at the tip of the oogonium is a mass of slimy substance. At the time of fertilization the antheridium opens and discharges the antherozoids and the tip of the oogonium opens to admit the antherozoids, which remain for a short time in the interior of the oogonium and then withdraw. The oogonium is then closed and, the oosphere, which before fertilization was merely a mass of protoplasm, has now formed around it a wall of cellulose, and ripens, forming an *oospore*. The oospore finally escapes from the oogonium and germinates.

FUCACEÆ.—This suborder includes the rock-weeds, *Fuci* and *Sargassum*, of our coast, which constitute the bulk of the olive-brown sea-weeds found between tide-marks. The admirable paper of Thuret on the fertilization of *Fucus* leaves nothing to be desired on that subject, and his observations are now so widely known in this country that little need be said in this connection. In the two common rock-weeds of our coast, *Fucus vesiculosus* and *F. nodosus*, the two sexes are on distinct individuals. In *F. evanescens* and *F. furcatus* they are on the same individual. The *Fuci* fruit principally in winter and spring, but *F. vesiculosus* may be found in fruit throughout the year. In the last-named species, if we examine the swollen tips of the frond, we find certain granular bodies, which on section are seen to be sacks opening outwards. The sacks are called conceptacles. The male plant can generally be distinguished from the

female by the brighter color of the tips which bear the conceptacles. A section through the conceptacles of the male plant, as in Pl. IX, Fig. 2, shows a number of branching filaments which line the interior of the conceptacle. Attached to the filaments are oval bodies, the antheridia. The antheridia contain the antherozoids, which are ovate and provided with two cilia attached at the side. Usually about day-break the antheridia discharge their antherozoids, which then swim about in the water until they reach the female plant. A section through the tip of a female plant shows a number of conceptacles similar in shape to those of the male plant. On the walls of the conceptacle there are paraphyses, and scattered among them are the oogonia, as shown in Pl. IX, Fig. 1. The oogonia are oval and seated on broad short pedicels. In *Fucus vesiculosus* the contents of the oogonia divide into eight oospheres, which are at first angular, but afterwards become spherical. The oogonia become free from their attachments, and the wall, which is really double, ruptures, and the oospheres escape into the water. In this condition they are merely spheres of protoplasm. The antheridia then collect around the oospheres in large numbers, and the mass begins to rotate. The rotation continues for a short time, and when it ceases the antherozoids withdraw and soon perish. It is not yet certain whether one or more of the antherozoids really penetrates into the substance of the oosphere during the revolutions. As soon as it comes to rest the oosphere takes on a cell-wall of cellulose and becomes an oospore, which after an interval of rest begins to divide so as to form eventually a new frond.

DICTYOTEÆ.—Although no members of this order are known on our coast north of North Carolina, the order cannot pass unnoticed in the present article, because it forms a connecting link between the *Fucaceæ* and *Phæosporeæ* on one hand and the *Florideæ* on the other. The species are olive-brown and form expanded membranous fronds. Three kinds of reproductive organs are known, antheridia, spores, and tetraspores. All are formed by outgrowths from the superficial cells. The tetraspores are formed, as the name implies, in fours in a mother cell, from which they escape and then readily germinate. The spores are borne singly in a mother cell. The antheridia are composed of a number of oblong cells, which become divided by numerous longitudinal and transverse divisions into small cells, each of which contains an antherozoid. The *Dictyotaceæ* resemble the *Florideæ* in having tetraspores and spores which germinate without first passing through a zoosporic condition. The action of the antherozoids is at present unknown, and the spores of this order cannot be the product of a fertilization such as we find in the *Florideæ*.

FLORIDEÆ.—This order is the same as the *Rhodospermeæ* of Harvey's Nereis. The species composing it form a very natural group, and are, with the exception of a few genera, entirely marine. Their color is always some shade of red or purple when they are growing in their nor-

mal condition. When, however, they grow in positions where they are much exposed to the light they become green, and in decaying they pass through various shades of orange and yellow to green. Their favorite place of growth is below low-water mark and in deeper water, but some species grow in tide-pools. The fronds vary in structure in the different genera, but as a rule they are less complicated than the fronds of the *Fuci* and *Laminarieæ*. The non-sexual mode of growth is by means of bodies called tetraspores, formed by the division of a single cell into four parts. The divisions may be at right angles to one another, when the tetraspore is said to be *cruciate;* they may be parallel to each other, in which case the tetraspore is said to be *zonate;* or they may be arranged as in Pl. XI, Fig. 1 *a*, when it is said to be *tripartite.* The tetraspores may either be isolated or collected in wart-like masses, called *nemathecia.* The individuals which bear the tetraspores are, with rare exceptions, distinct from those which bear the sexual fruit or cystocarps. Occasionally both kinds are found on the same individual, as sometimes happens in *Callithamnion Baileyi* and *Spyridia filamentosa.* The tetrasporic plants, taking the order as a whole, are decidedly more abundant than those which bear the cystocarps. The sexual fruit, called the cystocarp, is formed by the action of antherozoids upon a structure called the trichogyne, which forms a part of the procarpe. The antherozoids are small colorless spheres, destitute of cilia. They are borne singly in cells, which are agglomerated in various forms, which differ in the different genera, but are usually either in the shape of short, dense tufts, or else are siliculose in outline. In *Chondria* the antheridia cover the surface of irregular disk-like branches, and in membranous genera they form spots on the surface.

The name of *procarpe* was given by Bornet and Thuret to the collection of different cells, of which the female organ is composed before fertilization. The procarpes are borne on the younger parts of the frond generally near the surface. The cells of which they are composed may be divided into two sets—those which take part in the act of fertilization and those from which the spores are formed. The former consists of the *trichogyne*, a long, slender, hyaline hair, at whose base is the *trichophore.* The latter set, called by Thuret and Bornet the *carpogenic cell* or *system*, varies in the different genera, and is in most cases too complicated to be explained in the present article. In the simplest genera, as in *Nemalion* and *Batrachospermum*, the antherozoids come in contact with the extremity of the trichogyne, where they remain fixed for a considerable time. The contents of the antherozoid, or antherozoids—for more than one may be attached to the trichogyne—pass into the trichogyne, and, in consequence of this action, a change takes place in the trichophore, which divides, the divisions growing into short filaments, which are formed into chains of spores by transverse divisions. In this case the trichophore represents the carpogenic cell. In *Nemalion* the cystocarpic fruit is a globular mass of spores, arranged in filaments

and destitute of any general envelope. In by far the greater number of genera the spores are not formed by direct outgrowths from the trichophore. In *Callithamnion*, for instance, the fertilizing influence is propagated from the trichogyne, through the trichophore and the cells below it which constitute the trichophoric apparatus, to certain lateral cells, from which by repeated cell-division the spores are formed. In *Dudresnaya* the cells of the trichophoric apparatus send out a number of lateral tubes, which, in turn, convey the fertilizing impulse to certain modified branches in other parts of the frond, so that, in reality, the cystocarp is formed at some distance from the trichogyne by means of which it has been indirectly fertilized. A similar mode of fertilization is known in *Polyides* and, according to Professor Schmitz, in the *Squamarieæ*. The cystocarps are sometimes naked, that is, without a special membranous envelope, as in *Nemalion*, but they not unfrequently are contained in a conceptacle or pericarp. In the latter case, the development can only be studied with difficulty, because the conceptacle, which originates from some of the cells below the trichophore, develops more rapidly than the rest of the cystocarp, and so shuts out from view the process of the formation of the spores. It is impossible in the present article to enter into the details of the development of the cystocarp in this complicated order, but the reader interested in the subject is referred to the superb work of Thuret and Bornet, *Études Phycologiques*, and the hardly less admirable *Notes Algologiques*, of the same authors, for a masterly exposition of the subject.

MODE OF COLLECTING AND PREPARING SEA-WEEDS.

The collector of sea-weeds should be provided with a pail of tin or wood, or, better still, with one of papier maché if it can be procured, in which he should place a number of large wide-mouthed bottles and several small bottles, and one or two vials filled with alcohol should not be forgotten. A knife is needed for scraping crustaceous algæ from stones, and a geologist's hammer and chisel are often useful. A hand-net, with a long, stout, jointless pole and net with small meshes is a necessity. Clothes for wading are also indispensable, since the best collecting grounds are below low-water mark. If the collector is not already sufficiently encumbered, he may throw a common botanical collecting-box over his shoulder, as it will serve to carry the coarser species. Collecting on sandy or gravelly beaches is very simple. One finds there only the *Florideæ* and larger brown sea-weeds which are washed ashore after a storm. It is only necessary to pull over the heaps of refuse at high-water mark, or to dip up with a net the specimens which are floating at low-water. Collecting on beaches is uncertain, because it is only at certain times that specimens are washed ashore. On rocky shores, on wharves, and on the eel-grass we are always sure to find something. One should examine the surface of rocks wet with the spray, the bases of the stalks of the marsh-grasses, and even the surface of mud which is

overflowed at high tide. Here one will find an abundance of *Cryptophyceæ* and some *Chlorosporeæ*. Pools, more especially rocky pools, are rich in *Chlorosporeæ* and the filamentous *Phæosporeæ*. The richest locality is just beyond low-water mark, especially at the spring tides. One should carefully scrape old wharves and piers. This is best done at low tide from a boat. A long-handled net with a scraper on one side is the best thing, but any stout net will do. By scraping old woodwork which looks very unpromising one sometimes gets the rarer *Callithamnia* and other delicate algæ. A number of interesting species are also to be found growing on eel-grass, which may be reached at low tide by wading, or, better still, by boat.

For botanical purposes the dredge is not of very great service. One sometimes secures by its means rare species, but, as a rule, a day of dredging is a day wasted. Most algæ grow on rocky bottoms where the dredge does not work well, in fact not so well as grappling hooks. The best opportunity for dredging is on a shelly bottom, where several rare species are found. Good specimens are not unfrequently brought up by fishermen on their nets. The different species when collected should be cleaned of sand and small animals and placed in bottles, each species in a separate bottle. This is absolutely necessary in case of genera like *Cladophora* and *Ectocarpus*, which would otherwise be hopelessly entangled. The small specimens and those to be kept for microscopic study should be put into alchohol. The coarse species which are merely to be mounted and are not to be studied should be put dry into the pail. Anything to be studied should be kept in plenty of water, or, if not to be studied in a short time, be put immediately into alcohol. It is, however, useless to put into alcohol large quantities of sterile specimens of genera, like *Cladophora*, the species of which are characterized by their branching and not by microscopic structure. Sea-weeds are best mounted in salt water, that is, in this way they are in a more natural condition for after-study, and if one is able to procure plenty of salt water it is best always to mount in it. However, one may be stopping at a distance from the shore, in which case it is possible to make use of fresh water. Besides, if salt water is used continually the driers become saturated with salt, and it is then impossible to prepare specimens in the damp weather so frequent at the sea-shore. As a matter of economy, one had better mount only the finer and most important specimens in salt water and the rest in fresh water.

The larger sea-weeds, as the rock-weeds and devil's aprons, should be allowed to soak several hours in fresh water before being mounted. They can then be pressed in the same way as flowering plants, and, when dried, mounted on the ordinary herbarium sheets. If a number of large specimens are to be prepared, it is best to hang the plants up as soon as they are gathered and allow them to dry, and they can afterwards be soaked out at leisure in fresh water. The collector should know that there are probably no plants which so quickly spoil driers as the species

of rock-weed. For mounting the smaller species one should have two or three shallow dishes of salt water, in which the plants are to be washed and floated out, and a deep basin of either salt or fresh water, as the case may be, for mounting. A zinc tank, one of whose sides is slanting, is convenient for mounting, but is rather an awkward thing to carry about in travelling. The specimens to be mounted are put into the basin and floated out; a piece of paper is slipped under them and they are lifted out of the water. A moderately thick unglazed paper is best for mounting, although almost any kind will do, provided it is not very thin. Many ladies make use of photographer's cards.

With a little practice it is perfectly easy to remove sea-weeds from the water, but to prevent the specimen slipping off the paper or to one side of the paper it is best to put the middle finger under the center of the paper and raise it so that the water drains off equally on all sides. Some slip a pane of glass under the paper, and lift it out of the water in that way. The papers should then be left in an inclined position for a short time, so that the superfluous water may run off. They are then to be put on the driers and covered with a piece of muslin or other thin white cloth, from which the glazing has been removed by washing. Very gelatinous specimens should be exposed for some time to the air before pressing. The driers should be of bibulous paper and the best material, but unfortunately the most expensive, is thick white blotting-paper. The specimens are to be laid on the paper and covered with a cloth, and then another layer of paper is placed above, and so on. The best form of press is a board with a number of stones for weights. The driers should be changed morning and night until the specimens are dry. Some of the smaller species dry in a few hours; others require two or three days. Great pressure is to be avoided, and the specimens, if prepared in fresh water, should not be allowed to remain long in the water. Most small species adhere to the papers naturally; others require to be fastened with gum. Besides mounting specimens on paper, it is a very good plan to prepare specimens of fruit or any small filamentous species on pieces of mica or glass. Fragments of mica good enough for the purpose can be obtained for a very small sum of those who manufacture air-tight stoves. Specimens prepared on mica can be moistened and at once used for microscopic study. All really microscopic forms, such as *Glœocapsa*, *Clathrocystis*, &c., had better be mounted on mica or glass than on paper. A difficulty is experienced in preparing corallines and other calcareous forms. If prepared in the same way as other sea-weeds, they become very brittle, and are often ruined by transportation. Various means have been devised for making them less brittle—such as painting them with a thin solution of gum. A better method is to paint them with a hot solution of isinglass which has been boiled for a few moments in alcohol. The habit may be preserved, although the structure is somewhat injured, by immersing coral-

lines for a short time in some dilute acid, which, by removing the calcareous matter, renders the specimens more flexible.

As we have said, selected material for future study should be put into alcohol. Several other preserving fluids have been recommended, but none in the long run do as well as alcohol. Some species do well in glycerine, especially parasites like *Streblonema* and *Bulbocoleon*, which grow in the fronds of other species. A one per cent. solution of osmic acid is a favorite preserving fluid of some botanists. Certain sea-weeds, as the *Phæosporeæ*, can be mounted for the microscope in almost any of the ordinary mounting fluids, and keep very well. The *Florideæ*, on the other hand, do not keep at all well, and after a few months the preparations begin to spoil. A saturated solution of calcic chloride, a mixture of glycerine and acetic acid, half and half, boiled and filtered, weak solutions of carbolic acid, or a one per cent. solution of osmic acid are all about equally good for mounting algæ. As we have said, *Phæosporeæ* generally do well and *Florideæ* badly, but one sometimes has success even with the latter.

ORDERS AND SUBORDERS*
OF
MARINE ALGÆ OF NEW ENGLAND.

ORDER I. CRYPTOPHYCEÆ.

Suborder CHROOCOCCACEÆ.
NOSTOCHINEÆ.

ORDER II. ZOOSPOREÆ.

Suborder CHLOROSPOREÆ.
BRYOPSIDEÆ.
BOTRYDIEÆ.
PHÆOSPOREÆ.

ORDER III. OOSPOREÆ.

Suborder VAUCHERIEÆ.
FUCACEÆ.

ORDER IV. FLORIDEÆ.

Suborder PORPHYREÆ.
SQUAMARIEÆ.
NEMALIEÆ.
SPERMOTHAMNIEÆ.
CERAMIEÆ.
SPYRIDIEÆ.
CRYPTONEMIEÆ.
DUMONTIEÆ.
GIGARTINEÆ.
RHODYMENIEÆ.
SPONGIOCARPEÆ.
GELIDIEÆ.
HYPNEÆ.
SOLIERIEÆ.
SPHÆROCOCCOIDEÆ.
RHODOMELEÆ.
CORALLINEÆ.

*An artificial key to the genera of New England algæ will be found at the end of this paper.

Order I. CRYPTOPHYCEÆ, Thuret.

Algæ composed of cells which are either isolated or imbedded in mucus, so as to form colonies, or united in the form of filaments. Color usually bluish green, sometimes brown, purple, or pink. Reproduction by hormogonia or non-sexual spores. Sexual reproduction unknown.

We have retained the name given by Thuret, in Le Jolis's Liste des Algues Marines de Cherbourg, to the group of low algæ in which sexual reproduction is unknown. Our species belong to the *Schizophytæ* of Cohn (Beiträge zur Biologie der Pflanzen, Vol. I, p. 202), which also includes the minute forms commonly known as *Bacteria*. Most of the species here enumerated are bluish green, owing to the presence of phycochrome, and would be placed by some writers in the order *Phycochromaceæ*. Some are destitute of phycochrome and have been placed by different writers in the *Chroococcaceæ* and *Palmellaceæ*. Nægeli, in Die Niederen Pilze, is of the opinion that the *Bacteria* should not be classed with the *Phycochromaceæ*, as in the *Schizophytæ* of Cohn, but one cannot expect to make a satisfactory classification of forms in which no sexual reproduction has, as yet, been discovered. The *Protophytes* of Sachs's Text-Book include all the *Schizophytæ* of Cohn, together with the *Palmellaceæ* and *Saccharomycetes*. From the nature of the plants themselves, none of the above classifications can be considered of decided scientific value, and, regarding the question of convenience alone, we have adopted the name *Cryptophyceæ* as expressing sufficiently well all the marine *Protophytes* of our coast, whether they contain phycochrome or not. The order is divided into two suborders, as follows:

a. Cells free, or united by a gelatinous intercellular substance into families which never form true filaments ..... CHROOCOCCACEÆ.
b. Cells arranged in filaments ..... NOSTOCHINEÆ.

Suborder CHROOCOCCACEÆ.

(*Glœogenæ*, Cohn in part.)

1. Cells free or united in twos or fours ..... *Chroococcus*.
2. Cells united by a mucous intercellular substance into amorphous

[NOTE.—In the following descriptive part of the present paper the synonymy of the species is carried only so far as to enable the reader, in the first place, to recognize the more common synonyms and also the works in which the synonymy is given in full, and, in the second place, to give a reference to the more accessible works in which the different species are figured. Of the latter frequent reference is made to the *Nereis Boreali-Americana* and *Phycologia Brittanica* of Harvey, to the *Études Phycologiques* and *Notes Algologiques* of Bornet and Thuret, and the *Tabulæ Phycologicæ* of Kützing. For a list of descriptive works consulted the reader is referred to the end of this paper.

All microscopic measurements are given in fractions of a millimeter, but gross measurements of objects more than half an inch in diameter are given in feet and inches, as the divisions of the meter are not, in this country, readily applied to objects which can be seen by the naked eye.

Unless otherwise stated, the localities given are those in which the writer himself has collected the species, but in the case of common species it has been considered unnecessary to give special localities.]

colonies. Intercellular substance generally forming concentric layers around the cells ..... *Glœocapsa.*

3. Cells united in colonies of definite shape.

a. Cells arranged in the form of an irregular sphere, which becomes finally hollow and net-shaped ..... *Clathrocystis.*

b. Cells arranged in several layers forming a solid spheroidal body. *Polycystis.*

c. Cells united in branching dendritic masses ..... *Entophysalis.*

CHROOCOCCUS, Næg.

((From *χροος*, the color of the body, and *κοκκος*, a berry.)

Cell division taking place in all directions, cells spherical, solitary, or united in twos or some multiple of two, free, *i. e.*, not united into families by means of an intercellular substance.

According to Nægeli, the principal distinction between *Chroococcus* and *Glœocapsa* lies in the fact that in the former genus the cell-wall is thin, while in the latter it is thick and formed of concentric layers. This difference, however, is not constant, as in *Chroococcus turgidus* the cell-wall is comparatively thick, whereas in *Glœocapsa crepidinum* the cell-wall is reduced to a minimum. A more characteristic distinction seems rather to be the existence of an intercellular substance in *Glœocapsa* which binds the cells together, but which is wanting in *Chroococcus.*

C. TURGIDUS, Næg. (*Protococcus*, Kütz., Tab. Phyc., Vol. I, Pl. 6, Fig. 1.—*Hæmatococcus binalis*, Hassal, Fresh-water Algæ, p. 331, Pl. 82, Fig. 2.)

Cells bluish green, oval, usually single or binate, about .02^{mm} to .025^{mm} in diameter, surrounded by a thick cell-wall.

Cape Ann, *Mrs. A. L. Davis;* Europe. Fresh water and marine.

Found on slimy rocks and piers upon which species of *Calothrix, Lyngbya,* &c., are growing. Probably common throughout New England. The size of the cells varies very much. What we have given above is an average measurement.

GLŒOCAPSA, (Kütz.) Næg.

(From *γλοιος*, sticky, and *καψα*, a box.)

Cell division taking place in all directions, cells spherical, with thick walls, solitary or united in families, which are surrounded by a gelatinous substance which is generally in concentric layers around the cells. Spores known only in *G. stegophila*, Itzigs. (*G. Itzigsohnii*, Bornet mscr.).

This genus, if we adopt the views of the advocates of Schwendener's theory, forms the gonidia of the lichen genera *Synalissa, Omphalaria,* &c.

G. CREPIDINUM, Thuret, Notes Algologiques, p. 2, Pl. I, Figs. 1–3. (*Protococcus*, Thuret, in Mém. Soc. Natur. Cherbourg, Vol. II, p. 388; Le Jolis, Liste des Algues Marines de Cherbourg, p. 25; Farlow, List

of Marine Algæ, 1876.—*Pleurococcus*, Rab., Flora Europ. Alg., Sec. III, p. 25.) **Pl. I, Fig. 1.**

Cells spheroidal, yellow, about .0035^{mm} to .005^{mm} in diameter, imbedded in an olive-brown gelatinous stratum, occasionally single, usually united in twos or some multiple of four.

Eastport, Maine; Gloucester, Mass.; Newport, R. I.; northern coast of France.

We found this species abundant in October, 1875, on the wharves of Eastport, where it formed thin gelatinous layers of a dark-brown color at high-water mark. It probably occurs at high-water mark on wharves along our whole coast. This species is said by Thuret to form the gonidia of *Verrucaria halodytes*, Nyl., a species which we are informed by Prof. Tuckerman is not known to lichenologists in this country. In the present species the concentric layers of the gelatinous envelope of the cells is wanting. The color of the cells is quite constantly brownish yellow, but occasionally they become dark green. The average diameter of the cells in American specimens seems to be slightly less than Thuret's measurement.

POLYCYSTIS, Kütz.

(From *πολυς*, many, and *κυστις*, a bladder.)

Cells spherical, densely aggregated, united by an intercellular mucus into solid masses.

In this genus we include *Microcystis* of Kützing, in which the colonies are isolated and not united in botryoidal masses, one being evidently an immature state of the other.

P. ELABENS, Kütz. (*Microcystis*, Kütz., Tab. Phyc., Vol. I, Pl. 8, Fig. 1.)

Cells bluish green, oblong, about .004^{mm} in diameter, closely packed in solid colonies, which are aggregated in botryoidal masses.

Wood's Holl, Mass.; Europe.

Common in summer on decaying algæ, over which it forms slimy masses, mixed with species of *Lyngbya*, *Microcoleus*, &c.

P. PALLIDA, (Kütz.).

Cells bluish green, oval, .005–7^{mm} × .007–9^{mm}.

Newport, R. I.; Gloucester, Mass.; Europe. On *Cladophoræ* and *Zostera*.

Differs mainly in the size of the cells from the preceding species. Our form agrees closely with European specimens.

CLATHROCYSTIS, Henfrey.

(From *κληθρον*, a lattice, and *κυστις*, a bladder.)

Cells minute, very numerous, imbedded in mucus, forming a colony which is at first solid, then hollow, and finally perforate.

C. ROSEO-PERSICINA, Cohn, in Beiträge zur Biologie, Vol. I, Part III,

p. 157, Pl. VI, Figs. 1–10. (*Microhaloa rosea*, Kütz., in Linnea, VIII, 341.—*Protococcus*, Kütz., Spec. Alg.—*Pleurococcus roseo-persicinus*, Rab., Flora Europ. Alg.—*Cryptococcus roseus*, Kütz., Phyc. Gen.; Le Jolis, Liste des Algues Marines; Crouan, Florule du Finistère; Farlow, List of Marine Algæ, 1876.—*Bacterium rubescens*, Lankaster, in Quart. Journ. Micros. Science, Vol. XII, new series, p. 408, Pl. 22 and 23.)

Cells very small, about .0025 mm in diameter, rose-colored.

Whole New England coast; Europe. Both marine and in fresh water.

Very common on decaying algæ and on the mud, which it covers with a purplish-red film. It is also found on codfish in the Gloucester market, causing what is known as the red fish. This alga, of which the detailed history is given by Cohn and Lankaster, l. c., after having been placed by different writers in several different genera, has finally been associated with *Clathrocystis æruginosa*, Henfrey, a common fresh-water alga of Europe and the United States. Both species are at first minute and solid, but as they grow older become hollow, and at length portions become detached, leaving holes in the circumference. Although in Europe the species is found in fresh water as well as in salt, it has not yet been observed in the interior of this country.

ENTOPHYSALIS, Kütz.

(From *εντος* and *φυσαλις*, a bladder.)

Cells united in colonies, which assume a dendritic form.

The genus is founded on *Entophysalis granulosa*, a species of the Mediterranean, referred by Zanardini to the *Palmellaceæ*, but more correctly by Thuret and Bornet to the *Chroococcaceæ*.

E. Magnolliæ, n. sp.

Cells dark purple, .004–6 mm in diameter, united in twos and fours and imbedded in jelly, which forms a densely branching mass.

Magnolia Cove, Gloucester, Mass. Rare. Autumn.

This alga forms a thin slime on exposed rocks, in company with *Glœocapsa crepidinum*. The ramifications of the frond are visible on careful dissection. The species is much smaller and differs in color from *E. granulosa* of Europe. The cells do not differ much in size from those of the *Glœocapsa*, but they are of an entirely different color and have the concentric arrangement of the cell-wall much better marked than in that species. The cells adhere together in twos, fours, or some multiple of four, and all are held together by a mucous mass, which branches in a very dense fashion. The genus *Entophysalis* is merely a *Glœocapsa*, which instead of being indefinitely expanded is densely ramified.

Suborder NOSTOCHINEÆ.

(*Nematogenæ*, Cohn in part.)

We have followed Thuret's *Essai de Classification des Nostochinées*, Ann. des Sciences, 6 série, Tome I, in the arrangement of the genera.

1. Filaments terminating in a hyaline hair 7
   Filaments destitute of a terminal hair 2

2. Filaments furnished with heterocysts.....10
   Filaments destitute of heterocysts..... 3
3. Filaments spirally twisted.....*Spirulina.*
   Filaments not twisted..... 4
4. Filaments without a distinct sheath 5
   Filaments formed of one or more colored trichomata contained in a transparent sheath..... 6
5. Cells bluish green or purple.....*Oscillaria.*
   Cells colorless, or filled with minute black grains.....*Beggiatoa.*
6. Sheath containing several trichomata.....*Microcoleus.*
   Sheath containing only one trichoma.....*Lyngbya.*
7. Filaments free, forming tufts of indefinite extent.....*Calothrix.*
   Filaments united by a more or less firm gelatinous substance, frond of definite shape and extent..... 8
8. Heterocysts basal, *i. e.*, placed at the base of the principal filaments and branches..... 9
   Heterocysts intercalary.....*Hormactis.*
9. Frond hemispherical or vesiculose, filaments radiating from the base.....*Rivularia.*
   Frond plane, filaments parallel.....*Isactis.*
10. Filaments destitute of a sheath.....*Sphærozyga.*
    Filaments consisting of a trichoma in a sheath.....*Nodularia.*

SPHÆROZYGA, Ag.

(From *σφαιρα*, a sphere, and *ζυγος*, a yoke.)

Filaments free, destitute of sheath. Spores produced in the cells adjacent to the heterocysts.

S. CARMICHAELII, Harv., Phyc. Brit., Pl. 113 *a*. (*Cylindrospermum*, Kütz., Spec. Alg., p. 294.—*Anabaina marina*, Bréb.). **Pl. I, Fig. 3.**

Filaments flexuous, densely interlaced, forming slimy bluish-green expansions, cells cylindro-spherical, about .0035^{mm} in diameter, diminishing in size towards the end of the filament, terminal cell pointed. Heterocysts several in each filament. Spores oblong, usually one on each side of heterocyst, about .018^{mm} in length when ripe, rather more than twice as long as broad, at first green, then yellowish.

Noank, Conn.; Wood's Holl, Gloucester, Cambridge, Mass.; Europe. Summer.

Probably a common alga along our whole coast in midsummer and autumn on decaying algæ, looking like a shining emerald-green film. It occurs most frequently on the surface, but is also found at the depth of several feet. In his work on the Fresh-water Algæ of America, Prof. H. C. Wood, jr., mentions the present species as occurring at Camden, N. J. We cannot, however, agree with him in placing it in

the genus *Dolichospermum* of Thwaites. Ralfs, in Annals and Mag. of Nat. History, Vol. V, 2d series (1850), p. 325, following C. A. Agardh, who first described the genus *Sphærozyga* (Flora, 1827), says that in *Sphærozyga* the spores are first formed from the cells nearest the vesicular cells (heterocysts), as is shown by Professor Wood's figure, Pl. 3, Fig. 3, to be the case with the species from Camden. Neither can we regard *S. Carmichaelii*, Harv., as a synonym of *Cylindrospermum polysporum*, Kütz., as given by Professor Wood. Although we have examined a large number of specimens, in only one instance have we found more than a single spore on each side of the heterocyst, which is quite different from *C. polysporum*, Kütz.

NODULARIA, Mertens.

(From *nodulus*, a little joint.)

Filaments free, trichoma inclosed in a definite sheath, cells discoidal. Heterocysts at regular intervals. Spores numerous, contiguous, not adjacent to the heterocysts.

The genus *Spermosira* of Kützing is included under the above.

N. HARVEYANA, Thuret, Class. des Nostoch. (*Spermosira Harveyana*, Thwaites, Phyc. Brit., Pl. 173*c*.)

Filaments curved, cells discoidal, .0015–20 × .004^{mm}, heterocysts .0035^{mm} in diameter, spores numerous, about 4–8 together, spherical, .005–70^{mm} in diameter.

Charles River, Cambridge, Mass.; Europe.

Found in small quantities, mixed with *Sphærozyga*, in company with *Rhizoclonium*.

SPIRULINA, Turpin.

(From *spirula*, a small spiral.)

Filaments simple, without a proper sheath, oscillating, spirally twisted. Spores unknown.

S. TENUISSIMA, Kütz., Phyc. Brit., Pl. 105, Fig. 3; Farlow, List of Marine Algæ, 1876. **Pl. I, Fig. 4.**

Filaments intricately interlaced, .0035^{mm} in diameter, hyaline, spiral, closely twisted, cell divisions scarcely visible, oscillations rapid.

Eastport, Maine; Gloucester, Cambridge, Wood's Holl, Mass.; Europe.

This species is common at Eastport, where it forms, mixed with species of *Oscillaria*, dark purple-colored patches on the wharves at low-water mark, and it is without doubt to be found in similar localities along the whole coast.

We found at Wood's Holl, in 1876, a species of *Spirulina* which formed a greenish film on decaying algæ five or six feet below low-water mark, and the same species was collected by Mr. F. W. Hooper at Key West. It agrees closely with *S. Thuretii*, Crn., a species which differs from *S. tenuissima*, Kütz., in having slightly smaller filaments, which are also less tightly coiled. It hardly seems to us, however, as though the difference was sufficient to separate the two species. A *Spirulina* with much finer filaments than in *S. tenuissima*, and with a much more open spiral, occurs at Wood's Holl, but we have never found it in sufficient quantity to ascertain the species.

BEGGIATOA, Trevisan.

(Named in honor of *Francesco Secondo Beggiato*, an Italian botanist.)

Filaments simple, hyaline, no proper sheath, rapidly oscillating, cells filled with opaque granules. Spores unknown.

A genus separated from *Oscillaria* only by its color, which is white to the naked eye, and by the granules of sulphur which often make the cell seem quite opaque when viewed with the microscope. The species give off a strong odor of hydric sulphate, and are found in both fresh and salt water, especially in hot springs. The diameter of the filaments, an uncertain mark, is about the only guide to the distinction of the species.

B. ALBA, Treves, var. MARINA (Warming, Videnskab. Middels., 1875, Pl. X, Figs. 6, 7).

Filaments .0036^{mm} in diameter, cell divisions indistinct, granules usually irregularly placed.

Cambridge; Europe.

In brackish ditches.

B. ARACHNOIDEA, Rab. (Warming, l. c., Pl. X, Figs. 2–4).

Filaments .005–7^{mm} in diameter, cells narrower than broad, granules usually in bands parallel to the transverse cell-walls.

Eastport, Maine; Wood's Holl, Mass.; Europe.

On dead algæ.

B. MIRABILIS, Cohn (Warming, l. c., Pl. X, Fig. 5).

Filaments .016^{mm} (20–40, Warming) in diameter, cells a third as long as broad, granules arranged in bands.

Cambridge, Mass.; Europe.

There is a doubt about the accuracy of the determination of the specimens referred to this species. It is much the largest of the genus found on our coast. The only specimens which we have measured were .016^{mm} in breadth, which agrees with the measurement of Cohn, but not with that of Warming. We have the impression, however, that we have seen larger specimens than those measured.

Leptothrix rigidula, Kütz., is found at Wood's Holl, on *Ectocarpus* and other algæ. The genus *Leptothrix* is now limited to small species related to *Bacillus*. The present species is parasitic on *Ectocarpus* and *Cladophora*, on which it forms white fringes in midsummer. The filaments are about .002^{mm} in diameter. The cell divisions are very indistinct. The species may possibly be the same as *Beggiatoa minima*, Warming, l. c., Pl. X, Fig. 10.

OSCILLARIA, Kütz.

(From *oscillo*, to vibrate.)

Filaments simple, destitute of distinct sheath, oscillating, bluish green or dark purple.

The species of this genus are found on mud, wharves, and wood work. They are not usually found pure, but mixed with *Spirulina*, *Lyngbya*, &c. The following are all to which we care to give a name, but not by any means all which occur with us.

O. LIMOSA, Kütz., var. CHALYBEA, Tab. Phyc., Vol. I, Pl. 41, Fig. 3; Le Jolis, Liste des Algues Marines.

Filaments .008–9^{mm} in diameter, flexuous, apex obtuse, oscillations marked, cells about half as long as broad, purplish colored.

Eastport, Maine; Europe.

Forming a slimy layer on piles. Our specimens seem to agree well with specimens from Cherbourg. *O. littoralis*, Harv., of Crouan's Alg. Finistère, No. 325, is apparently very near to this, if not the same.

O. SUBULIFORMIS, Harv., Phyc. Brit., Pl. 251 *b*.

Filaments .006–7½^{mm} in diameter, at the end tapering to an incurved point, cells about one-third as long as broad, bluish green.

Charles River, Cambridge; Europe.

O. SUBTORULOSA, (Bréb.). (*Phormidium subtorulosum*, Bréb., in Kütz. Tab. Phyc., Vol. I, Pl. 49, Fig. 5.)

Filaments .003–4^{mm}, cells nearly cuboidal, with rounded angles, so that the filament appears slightly crenate.

Eastport, Maine; Wood's Holl, Mass.; Europe.

To this species is doubtfully referred a form common on wharves at Eastport and on the government wharf at Wood's Holl, where it forms slimy patches, mixed with *Spirulina*, &c. The filaments of this species bear a decided resemblance to the trichomata of *Microcoleus chthonoplastes*, and it may perhaps be a question whether they are not really a stage of that species in which the trichomata have escaped from the enveloping sheath. Opposed to this view is the large quantity of filaments and apparently an entire absence of empty sheaths. That the trichomata of *M. chthonoplastes* often escape from the sheath can easily be seen, but how long they remain free and how rapidly they increase under such circumstances is uncertain.

MICROCOLEUS, Desmaz.

(From *μικρος*, small, and *κολεος*, a sheath.)

Filaments slowly oscillating, destitute of heterocysts, several united in a single gelatinous sheath, which is either simple or branching.

M. CHTHONOPLASTES, Thuret. (*Oscillatoria chthonoplastes*, Lyngbye—*Chthonoblastus Lyngbei*, Kütz.—*Microcoleus anguiformis*, Harv., Phyc. Brit., Pl. 249; Kütz., Tab. Phyc., Vol. I, Pl. 57.—*Chthonoblastus anguiformis*, Rab., Flora Europ. Alg., Sect. II, p. 133.) Pl. II, Fig. 3.

Sheaths elongated, fusiform, being six or more times broader in the center than at the extremities, simple, several twisted together so as to form a green stratum, filaments dark green, about .005^{mm} in diameter, intricately twisted together, three or four only at the extremity of the sheath, but very numerous at the center, where the sheath is frequently ruptured, allowing the filaments to protrude; cells as long as broad, or a little broader, terminal cell acutely pointed.

Wood's Holl, Mass.; Atlantic shore of Europe. Summer.

A species easily recognized and probably common along the New England coast in summer, but rarely found in sufficient quantities to make herbarium specimens. It is usually found in small streaks, so entangled with other *Nostochineæ* and *Confervæ* as to be quite inextricable. At times it is found tolerably pure on the old stalks of *Spartina*, between tide-marks. Pure specimens may be obtained by allowing specimens in which filaments of this species are entangled to remain overnight in a shallow dish of salt water, when the *Microcoleus* will have freed itself from other substances and come to the surface. As generally found, the plant looks like an attenuated cornucopia, owing to the rupture of the sheath in the middle, allowing the filaments to project. This is shown in Harvey's figure, l. c., and also in Pl. II, Fig. 3, where only half of the plant has been drawn. Normally the sheaths are about a quarter of an inch long, about .075^{mm} broad in the middle, and tapering to about .012^{mm} at the ends. Color a deep bluish green. The filaments readily escape from their sheath, and might in this condition pass for a species of *Oscillaria*.

MICROCOLEUS TERRESTRIS, Desmaz. (*Chthonoblastus repens*, Kütz.), and M. VERSICOLOR, Thuret, are not infrequently found in muddy places in the interior of New England.

LYNGBYA, Ag.

(Named in honor of *Hans Christian Lyngbye*, a Danish botanist.)

Filaments free, each provided with a distinct sheath, simple, destitute of heterocysts, no proper oscillations. Spores unknown.

L. MAJUSCULA, Harv.; *Mermaid's Hair*. (*Conferva majuscula*, Dillw.—*L. crispa*, Ag. in part,—*L. majuscula*, Harv., Phyc. Brit., Pl. 62; Ner. Am. Bor., Part III, p. 110, Pl. 47 *a*.) **Pl. I, Fig. 4**

Filaments long, forming floating tufts, crisped, about .028^{mm} to .032^{mm} in diameter, blackish green, sheath prominent, cells 8 to 10 times as broad as long.

Cape Cod, Mass., to Key West; Europe; Pacific Ocean. Common and widely diffused. Summer.

The largest, most striking, and most common of our marine *Lyngbyæ*, easily recognized by the length and diameter of its filaments and its color, which is a blackish green. It forms during the later summer months large tufts upon *Zostera* and various other algæ, and is often found floating free in considerable quantities. In the center of the masses the filaments are intricately twisted together, but on the surface they float out from one another, so as to deserve the common name of mermaid's hair. In the older specimens the filaments are very much curled and twisted, forming the *L. crispa* of some writers. The sheath is always well marked, although, as is the case in all the species, it varies so much in thickness under different circumstances as to render it impossible to give accurate measurements. The heterocysts, "cellulis interstitialibus sparsis," described by Rabenhorst in this species, Flora Europ. Alg., Part II, p. 142, have, in reality, no existence.

L. ÆSTUARII, Liebm. (*L. æruginosa*, Ag.—*L. ferruginea*, Ag., in Ner. Am. Bor., Part III, p. 102, Pl. 47 *b*; Phyc. Brit., Pl. 311.)

Filaments forming a verdigris green stratum, about .016–18^{mm} in diameter, sheaths distinct.

Gloucester, Mass., *Mrs. A. L. Davis*, and southward; Europe. Summer.

A common species of the New England coast, abundant in shallow, brackish pools, where it covers the exposed algæ and *Zostera*. Much less striking than *L. majuscula*, Harv., from which it is distinguished at sight by its brighter green color, changing to yellowish rather than blackish, by the diameter of its filaments, which is about half that of *L. majuscula*, by its thinner sheath, and by forming thin strata rather than loose tufts. In the Ner. Am. Bor., Part III, the diameter of the filaments of *L. majuscula*, Harv., is given as .05 inch, and that of the filaments of *L. ferruginea*, Ag., as .001 inch, which is evidently incorrect, as one species is not fifty or even five times larger than the other.

L. LUTEO-FUSCA, Ag. (*L. fulva*, Harv., Ner. Am. Bor., Part III, p. 102, Pl. 47 *f.*)

Filaments fasciculate, erect, greenish yellow, .008–10 mm in diameter, sheath distinct.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 48.

Stonington, Conn., *Bailey;* Noank, Conn.; Wood's Holl, Mass., *W. G. F.;* Europe.

Apparently a common alga of Southern New England, differing in its habit from all our other species of the genus, except *L. tenerrima*. It grows in large patches on stones and wood-work between tide-marks. The filaments are erect, from one to three inches high or somewhat higher, when in their best condition olive-colored, but more frequently a pale yellow. The thickness of the sheath, by which Harvey separated his *L. fulva* from *L. luteo-fusca*, Ag., is by no means constant, and the species cannot be kept distinct. As is the case in several of the species of *Lyngbya*, the sheath is sometimes two, three, or even a greater number of times thicker than at others.

L. TENERRIMA, Thuret, mscr.

Filaments slender, fasciculate, erect, bluish green, .0035 mm in diameter, sheaths very thin.

Gloucester, Mass., *Mrs. A. L. Davis;* Newport, R. I.; Europe.

This species was first detected near Gloucester, by Mrs. Davis, growing apparently on sand-covered rocks. The filaments are bluish green, and not over a quarter of an inch high. The species will be easily recognized by the diameter of the filaments, which is decidedly less than that of any other of our species. Dr. Bornet, to whom a specimen was sent, considers our plant the same as that collected by the late M. Thuret, at Biarritz, France, and named by him *L. tenerrima*. I have since found it in considerable quantity at the base of the cliffs near the Winans mansion, at Newport.

L. NIGRESCENS, Harv., Ner. Am. Bor., Part III, p. 102, Pl. 47 *d*.

"Filaments very slender, flaccid, densely interwoven into a fleecy, blackish-green stratum." (Harvey, l. c.)

Canarsie Bay, L. I., *Hooper;* Peconic Bay, *Harvey;* on mud and on *Zostera*, Gloucester, Mass., *Mrs. A. L. Davis.*

Var. MAJOR.

Filaments forming a dark-brown gelatinous stratum, .0152 mm in diameter, sheath thin.

Wood's Holl. Common on *Zostera*. Summer.

From Harvey's description, it would be difficult to recognize this species. From an authentic specimen in our possession, collected by Harvey at Peconic Bay, the filaments are seen to be from .0095^{mm} to .01115^{mm} in diameter. The sheaths are distinct, but less marked than in *L. æstuarii*, from which the present species differs in the shortness and smaller diameter of the filaments, and in the color, which is a dark purple, at times almost black. The filaments differ from those of both *L. majuscula* and *L. æstuarii* in being held together by an amorphous, gelatinous substance, supposed to be characteristic of the genus *Phormidium*. That genus, however, includes plants which are now properly assigned to other genera.

We have often searched for this alga, but have never found a form which seemed to correspond exactly to Harvey's specimen. The same alga has, however, been collected by Mrs. Davis at Gloucester. At Wood's Holl is a *Lyngbya*, distributed in Alg. Am. Bor., Farlow, Anderson & Eaton, No. 47, which is not uncommon, forming patches several inches long on *Zostera*, and which resembles *L. nigrescens* closely in everything but the greater diameter of the filaments. Its sliminess and the delicacy of the filaments cause it at first sight to be mistaken for diatomes. In drying, it becomes somewhat greenish. This species, which resembles closely *L. Kützingiana*, Thuret (*Phormidium*, Le Jolis), we can regard only as a large variety of Harvey's *L. nigrescens*.

CALOTHRIX, (Ag.) Thuret.

(From καλος, beautiful, and θριξ, hair.)

Filaments terminating in a hyaline hair, fixed at the base, free above, occasionally branching, growing in little tufts or strata of indefinite extent, heterocysts present in most of the species, no oscillations. Spores unknown.

We adopt the genus with Thuret's limitations, including, in part, the genera *Schizosiphon*, *Amphithrix*, *Leibleinia*, &c., of Kützing.

a. Species growing in little tufts.

C. CONFERVICOLA, Ag. (*Leibleinia chalybea* and *amethystea*, Kütz.—*C. confervicola*, Ag., Phyc. Brit., Pl. 254; Notes Algologiques, Pl. 3.) **Pl. I, Fig. 6.**

Tufts fasciculate, filaments dark bluish purple, attenuated, .018^{mm} in diameter, heterocysts all basal, generally few in number.

On algæ of all kinds. Summer. Very common. Europe.

C. CRUSTACEA, (Schousb.) Born. & Thur. (*Schizosiphon fasciculatus* and *lasiopus*, Kütz.—*Oscillatoria crustacea*, Schousb.—*Calothrix crustacea*, Bornet & Thuret, Notes Algologiques, p. 13, Pl. IV.)

Tufts fasciculate, filaments bright green, attenuated, .0125^{mm} in diameter, heterocysts intercalary, often very numerous.

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 49.

On algæ of all kinds, and on rocks. Summer. Very common. Europe.

The two species just described are very common, certainly from Wood's Holl to New York, and probably also northward, on all kinds of algæ, on which they form fine tufts or fringes. The two species usually grow mixed together, but may be

easily distinguished under the microscope, *C. confervicola* being darker colored, the filaments thicker, and only furnished with heterocysts at the base, whereas in *C. crustacea* the heterocysts are scattered through the filament, often solitary, but sometimes as many as eight together, and frequently truncate. *C. crustacea* is also common on rocks.

b. Species forming expansions.

C. SCOPULORUM, Ag., Phyc. Brit., Pl. 58 *b;* Ner. Am. Bor., Part III, p. 105.

Filaments forming strata of indefinite extent, flexuous, usually branching, .008–12^{mm} in diameter, heterocysts basal and intercalary, sheaths thick, striate.

Var. VIVIPARA. (*C. vivipara*, Harv., Ner. Am. Bor., Part III, p. 106.)

Nahant, Wood's Holl, Mass., *W. G. F.;* Rhode Island, *Bailey;* Europe. Var. *vivipara* at Nahant, *W. G. F.*, and Seaconnet Point, *Bailey.*

Forming indefinite-shaped patches on rocks, on *Rhizoclonium*, and other prostrate algæ. Apparently much less common than the two preceding species. It differs from *C. crustacea* in the flexuous habit of the filaments, which are loosely twisted around one another, in the much rarer occurrence of intercalary heterocysts, and in the color of the filaments, which is not a bright green, but generally brownish. The sheaths, too, become thick, dark, and striated. As is the case in all species of *Calothrix* where the filaments are closely interwoven, the diameter of the filaments is greater and that of the sheath less, proceeding from within outwards. The variety *vivipara* is only a luxuriant form of the typical species.

C. PULVINATA, Ag. (*C. hydnoides*, Harv.)

Filaments densely packed, forming a dark-green spongy layer, united at the surface in tooth-like masses, flexuous, .006^{mm} to .0115^{mm} in diameter, heterocysts intercalary.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 50.

Wood's Holl, on wharves. Common. Europe.

In this species the filaments are much more densely interwoven and flexuous than in any of the preceding species. It forms patches looking like a honeycomb, or like a small *Hydnum*, and can be torn from its attachment in pieces of considerable size.

C. PARASITICA, Thuret. (*Rivularia*, Chauvin.—*Schizosiphon*, Le Jolis.)

Filaments loosely united, forming a velvety film, bulbous at base, simple or only slightly branching, about .008–10^{mm} in diameter, heterocysts basal, obliquely truncate.

On *Nemalion multifidum*, Newport, R. I.; Europe.

Easily recognized by its bulbous base and obliquely truncate heterocysts, and its peculiar habitat.

RIVULARIA, Roth.

(Named from the fluviatile habitat of many of the species.)

Frond gelatinous, more or less globose, filaments radiating, attenuated, furnished with distinct sheaths, branching, a heterocyst at the base of each branch.

Few genera of algæ have been divided by different writers into so many artificial and unsatisfactory genera as *Rivularia*. Some of the described genera are characterized by striations or alterations of the sheath which arise from age or unfavorable external conditions. Other so-called genera are characterized by the presence of parasitic plants in the thallus of a true *Rivularia*. As understood in the present article, the genus differs from *Calothrix* in the fact that the filaments are imbedded in a mass of jelly and the thallus is of a definite shape and extent. From *Isactis*, which might be perhaps considered a subgenus, *Rivularia* differs in having its filaments radiate from a central point instead of being parallel to one another. From *Hormactis* it abundantly differs in the mode of formation of the filaments. In *Rivularia* the branches are formed by the division of the filament laterally, the upper part of the branch separating from the main filament, and the two being only in contact at the base of the branch, where a heterocyst is always to be found. In *Hormactis* the filaments push out sidewise in the form of an inverted V. The apex of the V then elongates upwards and, at the same time, the sides of the V elongate so that, in passing from the interior of the thallus outwards, instead of finding a series of filaments spreading out fan-shaped, we find the filaments converging two by two, which finally unite into single filaments near the surface of the thallus. Moreover, the heterocysts in *Hormactis* are intercalary, not basal. In none of our marine species of *Rivularia* have spores been seen, but spores are found in some fresh-water species of *Glœotrichia*, a genus closely allied to, if not to be included in, *Rivularia*.

R. ATRA, Roth. (*Zonotrichia hemispærica*, Ag.—*Euactis amœna, atra, confluens, hemisphærica, Lenormandiana, marina*, Kütz.—*Linckia atra*, Lyngb.—*R. atra*, Phyc. Brit., Pl. 239.) **Pl. II, Fig. 2.**

Thallus solid, globose or hemispherical, varying in size from that of a head of a pin to half an inch in diameter, dark glossy black, filaments straight, .0038–45^{mm} in diameter, heterocysts about as broad as or rather broader than the filaments, usually somewhat pointed.

Var. *confluens*, flattish, owing to the coalescence of several individuals.

Common along the whole coast, on stones, algæ, and stalks of *Spartina*, often in company with *Isactis plana*. Distinguished by its dark, shining color and usually hemispherical shape. It is generally minute in size, but occasionally grows as large as a pea or somewhat larger. The variety *confluens* resembles, to the naked eye, *Isactis plana*, but is decidedly thicker. Microscopically the two are quite different.

R. PLICATA, Carm., Phyc. Brit., Pl. 315. (*Physactis*, Kütz.)

Thallus at first solid, soon becoming hollow, plicato-rugose, folds sinuous, filaments flexuous, .003–4^{mm} in diameter, heterocysts nearly spherical, about as broad as the filaments.

On mud and *Spartina* roots. Cohasset Narrows, Wood's Holl, Mass., *W. G. F.* Common.

Although as yet known to occur only at the two above-named localities, this species will probably be found to be common along the whole New England coast, but it is certainly less common than the preceding species. Its favorite habitat is the mud in which *Spartina* is growing, between tide-marks. It attains a larger size than *R. atra*, is almost always hollow, and easily recognized by its cerebriformly plicate surface. The substance is softer than in *R. atra*, the filaments are slightly narrower and less closely packed together, and the heterocysts are rather more spherical than in that species.

R. HOSPITA, Thuret (*Euactis hospita* and *prorumpens*, Kütz.), which differs from the

preceding species in having filaments .008mm to .012mm in diameter, was recognized by Dr. Bornet in company with *R. plicata* in a specimen from Cohasset Narrows. As we have not been able to recognize the species in any of our own specimens from the same locality, the presumption is that it is not very common.

ISACTIS, Thuret.

(From *ισος*, equal, and *ακτις*, a ray.)

Frond plane, composed of parallel filaments, held together by a tough, gelatinous intercellular substance, ending in a hyaline hair, heterocysts basal, ramifications few. Spores unknown.

This genus differs from *Rivularia* only in that the filaments are parallel to one another so as to form a flat frond, whereas in *Rivularia* they radiate from a central point and form more or less spherical fronds. It might with propriety be considered a subgenus under *Rivularia*.

I. PLANA, Thuret, l. c. (*Dasyactis*, Kütz.—*Physactis atropurpurea, obducens*, Kütz.) **Pl. I, Fig. 2.**

Frond flat, thin, dense, dark green, outline irregular, filaments .0076–95mm in diameter, .12–.15mm high sheaths often torn and striate.

Whole New England coast; Europe.

Very common on rocks, *Fucus*, *Punctaria*, and other algæ, forming dark-green spots, scarcely raised above the substance on which it is growing.

HORMACTIS, Thuret.

(From *ὁρμος*, a necklace, and *ακτις*, a ray.)

Frond gelatinous, globose, at first solid, then hollow and plicate, heterocyst intercalary, filaments simple at the surface of frond, bifurcating below. Spores unknown.

H. QUOYI, (Ag.) Bornet, in litt. (*Rivularia nitida*, Farlow, List of Marine Algæ, 1876. **Pl. II, Fig. 1.**

Fronds gregarious, dark green, plicato-rugose, from a quarter of an inch to two to three inches in diameter, filaments .0028–55mm in diameter, tortuous, cells of external part of the frond thick and discoidal, becoming more oval in the interior of the frond heterocysts numerous, scattered, about .0038mm × .0058mm.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 45.

Wood's Holl, Mass., *W. G. F.;* Falmouth, Mass., *Mr. F. S. Collins;* Marianne Islands.

This interesting species, although it has as yet only been found at Wood's Holl and the adjoining coast, will probably also be found at other localities on Long Island Sound. It grows in considerable quantities upon species of Fucus, at half tide, on the inner side of Parker's Point, Wood's Holl, and we have also found it washed ashore on the beaches of Buzzard's Bay, in the same township. It makes its appearance in June, and disappears in the month of September, being in perfection in the month of July. The fronds sometimes acquire a large size, two or three inches in diameter, but usually they are much smaller and densely aggregated, almost covering the Fucus

stalks upon which they are growing. It first appears as solid green spots upon the *Fucus*, which soon swell out into thin bladders, which partly collapse on being removed from the water. The peculiar inverted V-shaped filaments are seen to greater advantage by dissecting with needles small pieces of the frond than by making sections with a razor.

The only other species of this genus is *Hormactis Balani*, Thuret, which grows on barnacles on the coast of France. It is a comparatively minute plant, much less striking than our own species, which seems rather to replace, on our coast, the *Rivularia nitida*, Ag., of the coast of Europe, which it resembles in general appearance and habit. The external resemblance to that species is so great that specimens were sent to Dr. Bornet as *R. nitida*, Ag. (?) By him it was recognized as a new species of *Hormactis*, *H. Farlowii*, under which name it was distributed in Alg. Am. Bor. Since then Dr. Bornet has recognized its identity with *Rivularia Quoyi*, Ag., of the Marianne Islands. It is not a little remarkable that the species is only known in two localities so widely remote from one another.

STIGONEMA MAMILLOSUM, Ag., occurs in a brook which empties into the sea at Rafe's Chasm, Magnolia Cove, in Gloucester; and CALOTHRIX PARIETINA, Thuret, is found in Nobska Pond, close to the sea, at Wood's Holl. The species named all belong in the present order, but are not strictly marine.

ORDER ZOOSPOREÆ.

Algæ either green or olive-brown in color. Reproduction by means of zoospores, which unite in pairs to form a zygospore.

This order includes all the marine *Clorospermeæ* attributed to New England in the Nereis Am. Bor., with the exception of the genus *Vaucheria*, as well as the greater part of the olive-brown sea-weeds, with the exception of the rock-weeds or *Fucaceæ*. The account of the order given in the introduction to the present article should be consulted in the present connection.

a. Green algæ, multicellular, zoospores of two kinds—macrozoospores with four and microzoospores with two terminal cilia.. *Chlorosporeæ*.
b. Green algæ, frond unicellular, branching ..... *Bryopsideæ*.
c. Green algæ, frond unicellular, simple ..... *Botrydieæ*.
d. Olive-brown algæ, zoospores of one kind, with two cilia laterally attached ..... *Phæosporeæ*.

SUBORDER CHLOROSPOREÆ.

1. Fronds membranaceous ..... (*Ulvæ*) 2
   Fronds filamentous 3
2. Cells in a single layer ..... *Monostroma*.
   Cells in two layers ..... *Ulva*.
3. Some of the cells furnished with long hyaline hairs ..... *Bulbocoleon*.
   Cells destitute of hyaline hairs 4
4. Filaments branching throughout ..... *Cladophora*.
   Filaments with short, root-like branches only ..... *Rhizoclonium*.
   Filaments unbranched 5
5. Filaments rigid, setaceous ..... *Chætomorpha*.
   Filaments soft and flaccid ..... *Ulothrix*.

MONOSTROMA, (Thuret) Wittrock.

(From *μονος*, single, and *στρωμα*, a bed.)

Fronds membranaceous, consisting of a single layer of cells, which are either parenchymatous or separated from one another by more or less jelly.

As defined by Thuret, *Monostroma* differed from *Ulva* in having the cells embedded in jelly rather than arranged in the usual form of parenchymatous tissue. Wittrock includes in the genus all the *Ulvæ* consisting of a single layer. In most of the species the frond is at first sack-shape, but soon ruptures, the segments being composed of one layer of cells. The basal cells are prolonged downwards, but they become more or less circular in the upper part.

M. PULCHRUM, n. sp.

Fronds membranaceous, fasciculate, light green, lanceolate or cuneate-lanceolate, attenuated at the base, margin crisped, two to twelve inches long, two inches broad, substance very delicate, about .006 mm in thickness, cells irregular, more or less sinuous, intercellular substance small.

Watch Hill, Conn., *Prof. Eaton;* Gloucester, Mass., *Mrs. Bray;* Portland, Me., *Mr. C. B. Fuller.* Spring.

A beautiful and apparently not uncommon spring plant of New England, distinguished by its outline and delicate substance. When fully grown the fronds are most frequently attenuated at the base and rather obtuse at the summit. When young they are lanceolate, and seem to be always plane, never saccate, as in the next species. The color is a delicate green, and the plant cannot easily be removed from the paper on which it is pressed. This species has sometimes been distributed as *Ulva Linza*, to which it bears more or less resemblance in shape.

M. GREVILLEI, Wittrock. (*Ulva Lactuca*, Grev. *non* Linn.; Harv. Phyc. Brit., Pl. 243, and Ner. Am. Bor., Part III, p. 60.—*Enteromorpha Grevillei*, Thuret.)

Frond at first saccate, then split to the base into irregular segments, color light green, segments plane, unequally laciniate, frond about .012 mm thick, cells angular, intercellular substance small.

Boston Bay (Ner. Am. Bor.); Malden, Mass., *Mr. Collins;* Ives Point, Conn., *Mr. F. W. Hall;* Europe. Spring.

A common spring species of the Atlantic shores of Europe, but apparently not so common in New England. The cells of this species vary considerably, and in some specimens the intercellular gelatinous substance is tolerably prominent.

M. BLYTII, (Aresch.) Wittr. (*Ulva Blytii*, Aresch., Phyc. Scand., p. 186, Pl. 10 *g*.—*M. Blyttie*, Wittrock, Monog. Monostr., p. 49, Pl. IV, Fig. 11.)

Frond membranaceous, subcoriaceous, dark green, irregularly cleft, margin crisped, .028–40 mm in thickness, cells angular, closely packed, intercellular substance small.

EXS.—Nordstedt & Wittrock, Alg. Scand., No. 44; Alg. Am. Bor., Farlow, Anderson & Eaton, No. 98.

Eastport, Maine; Gloucester, Nahant, Mass.; Northern Europe. Autumn.

This, by far the most striking of our *Monostromata*, grows luxuriantly in the large tide-pool at Dog Island, Eastport, where it attains a length of one foot. In habit it resembles *Ulva lactuca* var. *rigida*, but it is of a deeper green. Our specimens were collected in the month of September. As it occurs at Nahant the species is not generally more than two or three inches long, and recalls the figure of *Ulva obscura*, Kütz., Tab. Phyc., Pl. 12, No. 2. It is found in the clefts of exposed rocks, late in the season. Its color is a deep green when growing, which becomes brownish in drying. It does not adhere well to paper.

M. CREPIDINUM, n. sp.

Fronds delicate, light green, one to three inches long, flabellately orbiculate, split to the base, segments obovate, .018–36^{mm} thick, cells roundish-angular, intercellular substance prominent.

Government wharf, Wood's Holl, Mass. August.

This small species is common on the piles of the wharf at Wood's Holl. It is very soft, and collapses on removing it from the water. It preserves its color well on paper. The above name is given provisionally, as we are not able to refer the species to any known form. It resembles *M. Wittrockii*, Bornet, a species, we believe, not yet described. Except in its small size, it is very near *M. orbiculatum*, Thur., but the thickness of that species, as given by Wittrock, is .032–40^{mm}. An examination of a specimen collected by Thuret, however, gives the same measurement as our species. If the species eventually is united with *M. orbiculatum*, the present must be regarded as a small form.

ULVA, (L.) Le Jolis.

(Supposed to be from *ul*, Celtic for water.)

Fronds simple or branching, consisting of two layers of cells, which are either in close contact with one another or else at maturity separate so as to form a tubular frond.

We have followed Le Jolis in uniting the old genera *Ulva* and *Enteromorpha*, and we might perhaps have gone farther and united *Monostroma* with *Ulva*, for if *Monostroma Grevillei* when young resembles an *Enteromorpha*, in its older stages it splits into membranes consisting of a single layer of cells, which are certainly imbedded in a certain amount of gelatinous substance, yet so little as to make it doubtful whether to call the frond parenchymatous or not.

U. LACTUCA, (Linn.) Le Jolis. (*Ulva latissima* and *rigida*, Ag. & Auct. recent.—*U. latissima*, Grev. & Harv.—*Phycoseris gigantea*, *myriotrema*, *australis*, &c., Kütz.) **Pl. III. Fig. 1.**

Frond flat, thick, unbranched, variously more or less ovate in outline, divided, the two layers of cells adherent.

a. Var. RIGIDA, (Ag.) Le Jolis. (*U. rigida*, Ag.—*U. latissima*, Harv., Phyc. Brit., partim.—*Phycoseris australis*, Kütz.)

Frond rigid, rather thick, generally deeply divided, laciniæ irregularly lacerate-erose, the base of frond more dense and deeply colored than the rest.

δ. Var. LACTUCA, Le Jolis. (*U. latissima*, Harv., partim.—*Phycoseris gigantea*, Kütz.)

Frond orbicular, oblong or elongate-fasciate, simple, undivided or scarcely lobed, frequently spirally contorted.

γ. Var. LATISSIMA, Le Jolis.

Frond simple, at first cuneate-substipitate, afterwards broadly expanded.

Very common all over the world, especially in brackish waters.

The present species nearly corresponds to the *Ulva latissima* of the Nereis Am. Bor., but is not the *U. Lactuca* of that work. It is distinguished from the remaining species by being always flat, never tubular at any age, and by its more or less orbicular outline not becoming linear or ribbon-shaped. Var. *α* is the common *Ulva* on rocks and in pools exposed to the action of the waves. The frond, although not very large, is rigid, and does not adhere well to paper in drying. In outline it is orbicular, and is generally deeply incised. Var. *β* has a more elongated shape, and is generally plicato-undulate. Var. *γ* is very common in brackish places on the mud, and attains a very large size. When fully grown it has no definite shape, but is ragged on the margin and often perforated.

ULVA ENTEROMORPHA, Le Jolis.

Frond linear or lanceolate in outline, attenuated at base, the two layers of cells either entirely separating, so as to form a tubular frond, or slightly cohering, forming a flat frond.

α. Var. LANCEOLATA, Le Jolis. (*Ulva Linza*, Greville & Harvey.—*Phycoseris lanceolata* and *crispata*, Kützing.)

Frond narrow, flat, ribbon-shaped, unbranched, much attenuated at base, margin somewhat crisped, sometimes so much so that the frond appears spirally twisted.

β. Var. INTESTINALIS, Le Jolis. (*Enteromorpha intestinalis*, Auct.)

Frond simple, attenuated, and subcompressed at base, above tubuloso-inflated.

γ. Var. COMPRESSA, Le Jolis. (*Ulva compressa*, L.—*Enteromorpha compressa*, Auct.)

Frond tubuloso-compressed, generally proliferously branched, branches uniform, simple, attenuate at the base, broader and obtuse at the apex, color somewhat dingy.

Very common all over the world, particularly in brackish water.

This species includes the *Ulva Linza*, *Enteromorpha intestinalis*, and *Enteromorpha compressa* of the Nereis Am. Bor., which can only be regarded as varieties of one species. The species reaches its highest development in the var. *β* (*Enteromorpha intestinalis*, Auct.), which is excessively common in all shallow water along our coast, and is conspicuously disagreeable by its resemblance in shape to the swollen intestines of some animal. The species approaches *Ulva Lactuca*, L., in var. *α*, which is not so common as the other forms of the species whose long ribbon-like fronds are compressed instead of tubular, as in var. *β*. In var. *γ*, with branching instead of simple fronds, the

species approaches *Ulva clathrata*. Innumerable varieties have been made of the various forms of this species, but an enumeration of them is quite uncalled for in this place.

ULVA CLATHRATA, Ag.

"Frond tubular, filiform, several times branched, branches attenuate at the apex, often very fine, cells arranged in rows." (Le Jolis, Liste des Algues Marines de Cherbourg.)

As usually defined by algologists, *Ulva clathrata* differs from *U. compressa* principally in the smaller size of the branches, a character by no means constant. We quote the specific distinctions as given by Le Jolis, l. c., which express more clearly than the descriptions of other writers the relations between the species:

"I think they (the specific characters) are to be found, first, in the general form of the fronds, which, broadened at the summit in the different varieties of *Ulva enteromorpha*, are, on the contrary, much attenuated at the extremity in *Ulva clathrata*. Secondly, in the ramification. While *Ulva compressa* and *intestinalis* are rather proliferous than branching in the true acceptation of the word—their branches being ordinarily of such a character that when they are given off from the lower part of the frond there does not exist, so to speak, any principal axis, or when borne towards the extremity of the frond reduced to simple proliferations; in *Ulva clathrata*, on the contrary, there exists a well-marked ramification, the fronds or primary axes bearing numerous secondary branches, which in their turn produce branchlets of an inferior order."

Of the species, as defined by Le Jolis, there are several varieties common on our coast, principally to be distinguished by the fineness of the branches and more or less complicated ramification. The variety *Agardhiana* of Le Jolis (*Enteromorpha Linkiana*, Grev.), rather coarse and rigid, is common in shallow water, as is also the form called by Harvey *Enteromorpha ramulosa*. The var. *Rothiana* forma *prostrata* is found in a ditch at Malden, Mass.

ULVA HOPKIRKII, (McCalla) Harv., Phyc. Brit., Pl. 263.

Frond capillary, excessively branched, ramuli ending in a single row of cells.

Greenport, L. I., *Mr. Hooper;* Gloucester, Mass., *Mrs. A. L. Davis;* Europe.

A beautiful species, looking much more like a fine *Cladophora* than an *Ulva*. It is in most cases easily recognized by its tenuity and light-green color. It grows in large tufts on other algæ and is about eight or ten inches long. It is by no means certain that this species should not be regarded as an extreme variety of *U. clathrata* in spite of the fact that the branches usually end in a single row of cells.

ULOTHRIX, (Kütz.) Thur.

(From ὑλη, a forest, and θριξ, a hair.)

Filaments grass-green, soft and flaccid, unbranched, at first forming tufts attached at the base, afterwards becoming more or less entangled, cells never long in proportion to their diameter.

The genus *Ulothrix* here includes all the unbranching marine *Chlorosporeæ* of a delicate texture, and embraces the species included by Harvey in the genus *Hormotrichum* of Kützing, which can hardly be kept distinct from *Ulothrix*, an older genus of Kützing. When young the species of the genus are attached at the base and unbranched, but in some cases, when old, the filaments are twisted together, and it is not always easy to find the point of attachment.

The genus is too nearly related to *Chætomorpha*, from which it differs in substance, the filaments being more or less gelatinous in *Ulothrix* and rigid in *Chætomorpha*. Of all the filamentous marine *Chlorosporeæ* the species of *Ulothrix* are best adapted for the study of zoospores. The conjugation of zoospores in *Ulothrix zonata*, a fresh-water species, has been very fully described by Dodel-Port in Pringsheim's Jahrbücher, Vol. X.

U. FLACCA, (Dillw.) Thuret. (*Lyngbya flacca* and *Carmichaelii*, Harv., Phyc. Brit., Pl. 300 and 186 *a*.—*Hormotrichum Carmichaelii*, Harv., Ner. Am. Bor., Part III, p. 90.)

Filaments fine, lubricous, greenish yellow, one to three inches long, at first tufted, then entangled and forming strata of indefinite extent filaments .014–30^{mm} in diameter, becoming moniliform, cells .003–12^{mm} long, generally narrow, discoidal.

Eastport, Maine., on stones and *Rhodymenia*, August; Nahant, Mass., *Mr. Collins*, spring; Isles of Shoals, N. H., *Mrs. Davis*; Europe.

A species most luxuriant in the spring, but also found in summer. The form found at Eastport was the entangled stage which is common on wood-work at low-water mark.

U. ISOGONA, (Engl. Bot.) Thuret. (*Conferva Youngana*, Harv., Phyc. Brit., Pl. 328.—*Lyngbya speciosa*, l. c., Pl. 186 *b*.—*Hormotrichum Youngaanum*, Ner. Am. Bor., Part III, p. 89.—*Urospora penicilliformis*, Aresch. in part.)

Filaments fine, yellowish green, one to three inches long, at first tufted, afterwards forming strata, filaments .036–58^{mm} in diameter, moniliform, cells .015–50^{mm} long, from cuboidal becoming ovate, constriction at nodes marked.

New York, *Harvey;* Ives Point, Conn., *Mr. Hall;* Gloucester, *Mrs. Davis;* Nahant, *Mr. Collins;* Europe. Spring.

Distinguished from the last by its greater size and by the marked constriction between the cells at maturity. Apparently common on wood-work. Whatever name we may give to this species, it is the same form which is common in the northern part of Europe in spring and summer. It is the *Hormotrichum Younganum* of British authors, and the *U. isogona* of the French. It is the species referred by Areschoug, Observationes Phycologicæ, II, Act. Reg. Soc. Scient., Ser. III, Vol. 9, to *Conferva penicilliformis*, Roth, and made by him the type of the genus *Urospora*. Areschoug unites under the single species *U. penicilliformis* the following species of Phycologia Brittanica: *Lyngbya speciosa, L. Carmichaelii, L. Cutleriæ, L. flacca,* and *Conferva Youngana*. In the present case we have kept *U. flacca* and *U. isogona* distinct, but agree with Areschoug in uniting *U. speciosa* with *U. isogona*. Perhaps a further acquaintance with the species might lead us to unite the present two species under Areschoug's name.

The *Hormotrichum speciosum* of Eaton's list of Eastport algæ belongs to another genus. The *H. boreale*, l. c., is unknown to me.

U. COLLABENS, (Ag.) Thur.? (*Conferva collabens*, Harv., Phyc. Brit., Pl. 327.—*Hormotrichum collabens*, Kütz., Spec. Alg., p. 383.)

Filaments tufted, two to six inches long deep green, cells from .05–

.18mm in breadth, once or once and a half as long as broad, nodes constricted.

To this species is referred, with considerable doubt, a rare *Ulothrix* found by Mr. Collins at Nahant. The filaments are six or seven inches long, very soft, and they can with difficulty be removed from the paper on which they are pressed. The cells average from .035–90mm in breadth by .054–.324mm in length. In Rhode Island Plants, by S. T. Olney, Providence Franklin Society, April, 1847, under No. 1189, is the following: "*Conferva collabens*, Ag.? 'or near it'—Harv. MSS. Sogonnet Point! Narragansett Pier!" In the Nereis Am. Bor., Part III, no reference is made to *C. collabens*, Ag., by Harvey, whom Olney quotes in his list. Harvey, however, in the Nereis, describes a new species, *Chætomorpha Olneyi*, which calls to mind *C. collabens*, and perhaps that is the plant referred to by Mr. Olney.

CHÆTOMORPHA, Kütz.

(From χαιτη, hair, and μορφη, shape.)

Filaments grass-green, coarse and rigid, unbranched, either attached in tufts or floating in masses, cells variable in length, often much longer than broad.

The species of this genus may be divided into two groups. In the first the filaments arise in tufts from a definite base. In the second the filaments are twisted together and form intricate masses, which rest upon stones and other algæ. It may be a question whether the members of the last-named group are not the advanced stage of the species of the first group, which, as they have developed, have become twisted together and torn from their attachments. It would be comparatively a simple matter to classify our own species taken by themselves, but in comparing them with foreign species it becomes very complicated in consequence of the confusion of names applied to some of the common European species. We can only briefly mention the synonyms, which are almost hopelessly confused.

C. MELAGONIUM, (Web. & Mohr.) Kütz. (*Conferva Melagonium*, Phyc. Brit., Pl. 99 *a*.)

Filaments erect, base scutate, coarse and wiry, dark glaucous green, cells .4–5 mm broad by .4–7 mm long.

In tide-pools.

Common from Boston northward; Northern Europe.

The most easily recognized species of the genus with us. It grows in deep tide-pools, attached to pebbles and rocks. The filaments can be recognized at a distance by their dark glaucous-green color and rigidity. It is generally a foot or more in length, and the filaments are usually free, but become more or less twisted together. It does not adhere well to paper in drying, and in spite of its coarseness it does not bear immersion in fresh water.

C. ÆREA, (Dillw.) Kütz. (*Conferva ærea*, Phyc. Brit., Pl. 99 *b*.)

Filaments erect, base scutate, setaceous, yellowish green, cells .25–40mm long by .15–30mm broad.

In high-tide pools.

New York Harbor, *Harvey;* New Haven, *Prof. Eaton;* Newport, *Bailey;* Gloucester; Europe.

This species has a wider range than the last, being found not only in the north of Europe, but also in the Mediterranean and other warm seas. With us it is not un-

common in Long Island Sound, but is little known north of Cape Cod. It grows in pools, sometimes near high-water mark, and resembles in habit *C. melagonium*, from which it differs in color, in being much less rigid, and in the smaller size of its cells. As found on our coast, the filaments are rather more slender than the average of European specimens.

C. PICQUOTIANA, (Mont.) Kütz. (*Conferva Picquotiana*, Ann. Scien. Nat., 3d Ser., Vol. XI, p. 66.—*Chætomorpha Piquotiana*, Ner. Am. Bor., Part III, p. 85, Pl. 46 *c*.)

Filaments prostrate, intricately twisted together in masses, rigid, dark-green, cells .2–4^{mm} broad by .2–1.6^{mm} long, slightly oval in shape.

Deep water, and washed ashore.

Rather common from Boston northward; Staten Island, *Harvey;* Gay Head, Mass.

This species was first described by Montagne from specimens collected by Lamare-Picquot in Labrador. It is the largest of our prostrate *Chætomorphæ*, and north of Boston is not uncommon on beaches after a storm, but it has not been seen in tide-pools. The localities South of Cape Cod perhaps need revision. We have found the species washed ashore at Gay Head, from deep water. It reminds one of *C. melagonium* by its color, rigidity, and size of the filaments, and it seems to us probable that it is merely an advanced stage of that species which has broken from its attachments and become entangled without having lost its power of growth. It is certainly very unlikely that any alga of this suborder is throughout its whole period of existence unattached. The cells differ from those of *C. melagonium* in being sometimes several times longer than broad, but, on the other hand, they frequently are found no longer than broad. If the species is really distinct and not an older stage of *C. melagonium*, as we suspect, it is the largest and coarsest of our species, and is to be compared with *C. torulosa*, Zan, of which we have examined specimens collected by Hauck at Pirano, in the Adriatic. In drying, our species does not adhere to paper, and the cells contract at the joints so as to give a toruloid appearance.

C. LINUM, (Flor. Dan.) Kütz. (*Conferva Linum*, Crouan, Algues Marines du Finistère, No. 353.—*Conferva Linum*, Areschoug, Alg. Scand., No. 183.—*Chætomorpha herbacea*, Kütz., in Hohenacker's Meeralgen, No. 355.—*Chætomorpha Linum*, Kütz., Spec. Alg., p. 378.—*Chætomorpha sutoria*, (Berk.) Harv., Ner. Am. Bor., Part 3, p. 87.—Non *Conferva Linum*, Alg. Danmon., No. 220, nec *Rhizoclonium Linum*, Herb. Thuret.)

Filaments prostrate, intricately twisted together in masses, rigid, bright green, cells .20–25^{mm} broad by .20–30^{mm} long, about as broad as long.

Just below low-water mark.

Common in Long Island Sound; Nahant, Ten Pound Island, Gloucester, Mass.; Europe.

The confusion which has arisen from the application of the name *Conferva Linum* to different species and the useless multiplication of names, especially on the part of Kützing, makes it exceedingly difficult to ascertain the name of this common species on our coast. It forms strata of considerable extent upon rocks and gravel just below

low-water mark. It can be distinguished from the preceding species by its lighter color, by being less rigid, and by the smaller size of the cells, which are rather uniformly as broad as long. If we may suspect that *C. Picquotiana* is only a form of *C. melagonium*, we may also suggest that the present is possibly the corresponding form of *C. ærea*. To unravel the synonymy of the species is quite hopeless. Our specimens agree with No. 353 of Crouan's Algues Marines du Finistère and No. 183 of Areschoug's Algæ Scandinavicæ, both of which are supposed to be the *Conferva Linum* of the Flora Danica. They are also identical with No. 355 of Hohenacker's Meeralgen, which purports to have been determined as *C. herbacea*, Kg., by Kützing himself. Whether they are the same as the *Conferva Linum* of the Phycologia Brittanica we cannot determine. They approach very near to, if they are not identical with, *C. crassa* of the Italian algologists. In fact, Crouan considers *C. Linum*, Fl. Dan., to be the same as *C. crassa*, Ag. The *Chætomorpha sutoria* of the Nereis Am. Bor. seems to us the same thing. We have examined Bailey's specimens, from which Harvey named the species in the Nereis, and have also examined Bailey's locality, at Stonington. To the naked eye, in Bailey's specimens, the filaments appear smaller than the typical form, but a microscopic examination gives the same measurements as specimens we collected ourselves, which agreed precisely with No. 353, Crouan. In saying that the New England specimens of *C. sutoria* should be considered to be rather *C. Linum*, we do not mean to imply that the European *C. sutoria* is not distinct. Whether our species is the same as *Rhizoclonium Linum*, Thuret, is, perhaps, doubtful. In specimens of the last-named species from Cherbourg the filaments appear to be somewhat smaller. The species usually, but not always, loses its color drying, and scarcely adheres to paper unless under considerable pressure.

SPECIES INQUIRENDÆ.

C. OLNEYI, Harv., Ner. Am. Bor., Part III, p. 86, Pl. 46 *d*.

"Filaments tufted, setaceous, straight or curved, soft, pale green; articulations once and a half as long as broad." (Harvey, l. c.)

Rhode Island, *Olney*.

C. LONGIARTICULATA, Harv., Ner. Am. Bor., Part III, p. 86, Pl. 46 *e*.

"Filaments capillary, curved, loosely bundled together, flaccid, soft, pale green; articulations 4–6 times as long as broad, swollen at the nodes; var. *β*, *crassior*, filaments more robust." (Harvey, l. c.)

In rock-pools, between tide-marks. Ship Anne Point, *Mr. Hooper;* Boston Bay, *Mrs. Asa Gray;* Little Compton, *Mr. Olney;* var. *β* in brackish ditches at Little Compton, *Mr. Olney*.

The two last species are only known from the descriptions in the Nereis. No authentic specimens exist in the Olney Herbarium, which is now the property of Brown University. The specimen of *C. Olneyi* mentioned in *Algæ Rhodiaceæ* by Olney was determined by the present writer, not by Harvey himself, and a recent examination of the specimen, for which we are indebted to the kindness of Professor Bailey, lead us to think that the specimen was not correctly determined.

RHIZOCLONIUM, Kütz.

(From *ῥίζον*, a root, and *κλων*, a branch.)

Filaments decumbent, entangled, branches short and root-like.

The genus is easily recognized, as a rule, by the root-like character of the branches. In some species the branches are frequent; in others, however, they are only occa-

sionally found, and in that case the species may easily be mistaken for species of *Chætomorpha.*

R. RIPARIUM, Roth, Harv. Phyc. Brit., Pl. 328. (*R. salinum*, Kütz.)

Filaments decumbent, pale green, forming entangled masses, furnished with numerous short root-like branches, generally consisting of but few cells, but sometimes elongated, filaments from .02^{mm} to .025^{mm} in diameter, cells about as long as broad, or a little longer. **Pl. III, Fig. 2.**

Eastport, Maine; Nahant, Wood's Holl, Mass., *W. G. F.;* New Haven, Conn., *Prof. D. C. Eaton;* Europe.

An alga which is probably common all along the coast on wood-work and sandy rocks between tide-marks. It forms thin light-green masses on the substance on which it is growing. The root-like processes usually consist of not more than three or four cells, and not unfrequently they fork. Distinguished at sight from the next by its yellowish color. It often covers the ground at the base of *Spartina*, and it is found nearer high-water mark than the next species.

R. TORTUOSUM, Kütz. (*Conferva implexa* and *tortuosa*, Harv., Phyc. Brit., Pl. 54 *a* and *b*.—*Chætomorpha tortuosa*, Ner. Am. Bor.)

Filaments dark green, very much curled and twisted, forming prostrate masses, diameter of filaments, .035^{mm} to .058^{mm}, cells about twice as long as broad, branches few, short.

Common all along the New England coast; Europe.

The most common species of our coast, recognized by its dark-green color, and by the very much twisted filaments which form woolly strata over other algæ. Its favorite habitat is in tide-pools, where it is exposed at dead low water.

R. KOCHIANUM, Kütz. (*Conferva arenosa*, Crouan, Algues Marines du Finistère, No. 355.—*Conferva implexa*, var., Alg. Scand., No. 187.—*Rhizoclonium Kochianum*, Kütz., in Le Jolis's Liste des Algues Marines de Cherbourg.)

Filaments pale yellow, forming loose masses of indefinite extent, cells .010–14^{mm} broad by .036–54^{mm} long.

On algæ below low-water mark. Summer.

Gloucester, Mass.; Nahant, Mass., *Mr. Collins;* Europe.

Much finer than any of the species previously mentioned, covering algæ with a delicate pale-yellow fleece. It is apparently less common than our other two species, and we have only found it once growing over *Laminariæ* just below low-water mark, off Niles's Beach, Gloucester. The species agrees with French specimens of *R. Kochianum* in the size and general appearance of the cells, but the root-like processes characteristic of the present genus are not evident in our specimens, and the species is here retained in *Rhizoclonium* on the authority of Kützing, in Le Jolis's Liste des Algues Marines de Cherbourg. *R. Kochianum* is considered by Rabenhorst to be a variety of *R. flavicans*, Jürg., in which he also includes *Conferva arenicola* of Berk. Our specimens agree perfectly with No. 355 of Crouan's Algues Marine du Finistère, but are rather smaller than No. 187 of Areschoug's Algæ Scandinavicæ, which is referred with doubt to *Conferva arenosa.* The name which we have adopted refers our specimens without doubt to French forms, but the identity with the genuine *C. arenosa* of British botan-

ists still remains to be settled. The species does not adhere well to paper, and would probably, at first sight, be referred by collectors to *Chætomorpha* rather than to *Rhizoclonium*.

CLADOPHORA, Kütz.

(From κλαδος, a branch, and φορεω, to bear.)

Filaments firm, not gelatinous, branching throughout.

A genus including the greater part of the branching *Chlorosporeæ*, which are found both in salt and fresh water. It differs from *Ulothrix* and *Chætomorpha* in having branching filaments, and from *Rhizoclonium* in having well-developed branches and not mere rhizoidal growths. The species abound on rocks and in tide-pools, as well as in ditches and shallow bays along the shore, and usually grow in tufts. Some of the species, however, especially those growing in brackish ditches, at maturity form dense layers upon the surface of the water or on the bottom. The number of described species of the genus is immense, but, in all probability, a great part are not distinct. It is at present impossible correctly to refer the New England species to European forms, since European botanists by no means agree as to their own species, and there has been a tendancy on the part of algologists of different countries to ignore the species of other countries in studying their own. The principal specific character is the mode of branching, which, in the present genus, is at best an uncertain mark. The young and old plants of the same species often differ very much in the appearance of the branches, so that the habit varies at different seasons. When old, some species are usually torn from their attachments and washed ashore in large masses, and, in this battered condition, it is often impossible to recognize the species, or perhaps even to distinguish the specimens from *Rhizoclonium* species. Unfortunately, names have been given to the battered forms until there is such a labyrinth of synonyms that one is tempted to reject all but a few well-marked species. In the present instance we have attempted merely to compare our specimens with those in the Algæ Danmonienses, the Algues Marines du Finistère, the Algæ Scandinavicæ of Areschoug, and with specimens received from Dr. Bornet, M. Le Jolis, Dr. Kjellman, and Dr. Wittrock. It is to be hoped that some responsible algologist will undertake the revision of this much-abused genus.

Subgenus SPONGOMORPHA, Kütz.

Plants spongy, at least towards the base, owing to the interlacing of the branches, some of which are strongly recurved and rhizoidal.

C. ARCTA, (Dillw.). (*Cladophora arcta*, Phyc. Brit., Pl. 135.)

Filaments slender, two to eight inches long, tufted and densely matted at base, becoming free and divergent above, color a bright green; branches near the base strongly recurved and interlaced, upper branches erect or appressed, numerous, opposite or scattered, apices obtuse; cells at base about twice as long as broad, cells of upper portion several times longer than broad, average diameter of cells about .08^{mm}.

On rocks between tide-marks. Winter and spring.

Common along the whole coast; Europe.

One of the few species which are recognized without difficulty, although it varies considerably in aspect at different seasons. When young the filaments are but slightly matted together, except at the very base, and the species is then the *C. vaucheriæformis*

of Agardh; but when old they become spongy nearly to the tip, and constitute the *C. centralis* of some authors. The species is, as a rule, easily distinguished by its bright-green color and erect or appressed branches in the upper portion of the plant. The plant preserves its beautiful green color, and adheres to paper except when very old and spongy.

C. LANOSA, (Roth) Kütz. (*C. lanosa*, Phyc. Brit., Pl. 6.)

Tufts more or less globose; filaments one to three inches long, densely matted, color at first bright green, but soon becoming pale yellow; branches long, numerous, irregularly placed, often secund, given off at wide angles; cells .03–4^{mm} in breadth, as long as broad in lower part, becoming in upper part several times longer than broad.

On *Chondrus crispus* and other algæ.

Gloucester, Nahant, Mass.; common. Europe. Spring and early summer.

Var. UNCIALIS, Thuret. (*Cl. uncialis*, Harv., Phyc. Brit., Pl. 207.)

Filaments longer and looser than in the type, and of a lighter color.

On sandy rocks.

Long Island Sound; Nahant and Gloucester, Mass.; common. Spring. Europe.

An easily recognized species, probably common along the whole coast in spring and early summer. It grows attached to sea-weeds or to sand-covered rocks at low tide and below, and is often washed ashore in considerable quantities. It forms globose tufts, which, when growing, are bright green, but which soon lose their color, and, on drying, became pale and silky. The var. *uncialis*, which is more common in Long Island Sound, is less dense and forms looser tufts than the type. It does not adhere very well to paper.

SUBGENUS EUCLADOPHORA.

Plants tufted, or, at times, stratose, not united into spongy masses by rhizoidal branches or recurved branches.

C. RUPESTRIS, (Linn.) Kütz., Phyc. Brit., Pl. 180.

Filaments five to ten inches long, rigid, dark green, tufted; branches crowded, usually opposite or in fours, ultimate branches given off at an acute angle, short, subulate; cells constricted at the joints, average diameter of cells .08–16^{mm}.

On rocks near low-water mark.

Common along the whole coast throughout the year; Europe.

Recognized by its dark green color and rigidity, and by the numerous appressed ramuli which are given off two or three at a joint.

C. ALBIDA, (Huds.) Kütz., Phyc. Brit., Pl. 275.

Filaments slender, silky, forming dense tufts from a few inches to a foot long, color a pale green; branches irregular, often opposite, ulti-

mate branches long, given off at wide angles; cells .02–3^{mm} in diameter, cell-wall delicate, terminal cells blunt.

Staten Island, Beesley's Point, New York Bay, *Harvey;* in pools, Newport, R. I.; Europe. Summer.

Not yet observed north of Cape Cod. The species is recognized by forming dense tufts of a pale color and almost spongy consistency. The sponginess, however, is not, as in the subgenus *Spongomorpha*, due to the interlacing of short recurved branches and rhizoidal filaments, but to the fineness of the filaments, which are densely twisted together. The cells do not vary much in diameter throughout. This species, when dried, loses most of its color, and does not adhere well to paper.

C. REFRACTA, (Roth) Areschoug. (Non *C. refracta*, Alg. Danmon., No. 228, nec Phyc. Brit., Pl. 24.)

Filaments rather rigid, forming tufts from 2–8 inches long, color a glaucous green; branches flexuous, clothed throughout with nearly equal, short, frequently opposite branchlets, which are at first patent and furnished with erect or corymbose, afterwards reflexed, branchlets; cells .03–8^{mm} in diameter, terminal cells blunt.

Common in deep tide-pools and on stones and sea-weeds at low-water mark throughout our limits. Spring and summer. Northern Europe.

We have refrained from quoting any synonyms in the description just given. The species, as we understand it, is one common in rocky places where the water is pure. It forms rather short tufts of a somewhat glaucous green, which is paler when the plant grows exposed to the sun. The branchlets, which are in general short, are at first erect, but, as usually found, are somewhat corymbose and ultimately decompound and reflexed. It is rather rigid and does not collapse when removed from the water. In drying it sometimes retains its color, but usually becomes yellowish and does not adhere well to paper. What we have described seems to be the *C. refracta* of Harvey's Nereis, but we have refrained from quoting the localities given by Harvey. The *C. refracta* of the French coast is considered by Le Jolis to be a variety of *C. albida*. The same is not true of our species, which is certainly distinct from *C. albida*. It may be that we have also the refracted variety of *C. albida* on our coast, but we have never met with it. The present species is much coarser and differs in habit and ramification from the *C. albida* of New England, which agrees well with European specimens. The American *C. refracta* is much nearer to, if not identical with, the species published by Areschoug in the Algæ Scandinavicæ, 2d series, No. 338, as *C. refracta*, (Roth). In coarseness it approaches *C. lætevirens*, but it certainly is not the same as No. 143, Algæ Danmonienses, which Harvey considers to be *C. lætevirens*. In short, we think that the *C. refracta* of New England is not the species to which the French botanists apply that name, but probably the species of Areschoug. Whether it is really the *Conferva refracta* of Roth is a point on which we can only follow the authority of others. At any rate, after the explanation given, the name can be retained without causing greater confusion than has hitherto existed.

C. GLAUCESCENS, (Griff.) Harv. (*Cl. glaucescens*, Phyc. Brit., Pl. 196.—*Cl. pseudo-sericea*, Crouan, Alg. Finist., No. 367.)

Filaments loosely tufted, 3–12 inches long, much branched, color light green; branches erect, pectinate, ultimate branchlets elongated, erect,

given off at an acute angle; cells with delicate cell-wall, .03–6^{mm} in diameter, terminal cells acute.

On stones and wood-work near low-water mark. Summer.

From Halifax, N. S., to Charleston, S. C., *Harvey;* Newport, R. I.; Europe.

A delicate species which is characterized by its light color, loosely tufted habit, and slender branches, which are all given off at uniformly acute angles. When growing in exposed localities the tufts are short, but in quiet bays they become long and loose. This species, which has the light color and slender filaments of *C. albida*, differs from that species in not being spongy in consistence and in the length of the ultimate branchlets, which are always erect. Our Newport species resemble very closely the No. 120 *b* of Wittrock and Nordstedt, Algæ Scandinavicæ, which is considered by them a form of *C. crystallina*, (Roth), but differs from the *Cl. crystallina* of the algologists of Southern Europe. It may be remarked that *Cl. glaucescens*, (Griff.) Harv., has been referred to other older species, but not knowing the limits of *C. crystallina*; (Roth), and *C. sericea*, (Huds.), we have adhered to the latter name, as has also been done by Le Jolis and other French algologists. This species generally becomes very pale in drying and adheres well to paper.

The variety *β, pectinella*, of this species, mentioned by Harvey in the Nereis Am. Bor. as occurring in Charleston Harbor, is not known on our northern coast. In the variety the branches are said to be recurved.

C. LÆTEVIRENS, (Dillw.) Harv., Alg. Danmon., No. 142; Phyc. Brit., Pl. 190.

Filaments much branched, rigid, forming loose tufts 3–6 inches long, color a yellowish green; branches fastigiate, erect, often opposite or in threes, ultimate branches secund, of few cells, apex obtuse; diameter of cells .05-.15^{mm}.

In tide-pools.

New York Bay; Boston, *Harvey;* Gloucester, Mass., *Mrs Davis.*

A rather robust species, recognized by the denseness of the branches, which are crowded at the tips. Less robust and differing from *C. Hutchinsiæ* in having fastigiate branches. We have only seen one specimen, collected by Mrs. Davis, which corresponded exactly to the *C. lætevirens* of Algæ Danmonienses and to the *C. lætevirens* of the Nereis Am. Bor. It is doubtful whether the forms to which the same name has been given by French botanists belong to the same species as our own. Some of them, at least, appear to belong to a more slender and less densely branching species. The species does not adhere well to paper in drying.

C. HUTCHINSIÆ, (Dillw.) Kütz. (*Cl. Hutchinsiæ*, Phyc. Brit., Pl. 124.—*Cl. diffusa*, Harv., Phyc. Brit., Pl. 130.)

Filaments rigid, glaucous green, flexuous, forming loose tufts 6–12 inches long; branches scattered, rather distant; ultimate branches few, short, secund; cells .10–24^{mm} in diameter.

In tide-pools.

Gloucester, Mass., *Mrs. Davis.*

A single specimen which seems unmistakably to belong to this species was collected by Mrs. Davis. The species, which is one of the coarsest on the coast, is distinguished

by the large size of the filaments and remoteness of the branches, together with the shortness of the ultimate branches. The *Cladophora diffusa* of the Phycologia Britannica is now considered, with good reason, to be a form of *C. Hutchinsiæ* in which the branches are very long and nearly destitute of branchlets. Probably the *Cladophora diffusa?* of the Nereis Am. Bor., said by Harvey to be found in "New York Sound," is to be referred to the present species. Specimens which correspond well enough to the *C. diffusa* of the Algæ Danmonienses, No. 144, have been collected by Mrs. Davis and Mrs. Bray at Gloucester.

C. FLEXUOSA, (Griff.) Harv.

"Filaments very slender, pale green, tufted, flexuous, sparingly and distantly branched; branches elongate, subsimple, of unequal length, flexuous, sometimes nearly naked, sometimes ramuliferous; the ultimate ramuli secund or alternate, short or long, curved; articulations of the branches 3–4 times, of the ramuli twice as long as broad." (Nereis Am. Bor., Part III, p. 78.)

Rocks between tide-marks, &c.

Hingham and Boston, Mass.; Jackson Ferry and Hell Gate, N. Y.

We have quoted from the Nereis Am. Bor. the description given by Harvey of the present species, and have purposely refrained from adding any localities of our own. Harvey considers *C. flexuosa* very nearly related to *Cl. glaucescens*, if indeed it is distinct from it. On the other hand, the greater part of the French specimens of *C. flexuosa* which we have seen are quite distinct from *C. glaucescens*, and seem to approach some of the forms of *C. gracilis*. We have frequently seen at Wood's Holl, Newport, and Gloucester specimens which correspond pretty well with the *C. flexuosa* of Alg. Danmon., No. 227. As we understand the species, it is more rigid than *Cl. glaucescens*, and has shorter branches, which are at times refracted. The cells are .02–6^{mm} in diameter and not more than two or three times as long as broad as a rule. Le Jolis states that *C. flexuosa* lines the bottom of pools. The American forms which we would refer to this species are found in pools on rather exposed rocky shores.

C. MORRISIÆ, Harv.

"Tufts elongate, dense, somewhat interwoven, dark green; filaments very slender, much and irregularly branched; the penultimate branches very long, filiform, flexuous, simple, set with alternate or secund, short, erecto-patent ramuli, some of which are simple and spine-like, others pectinated on their upper side; articulations filled with dense endochrome, in the branches 2–3 times, in the ramuli about twice as long as broad, cylindrical, not contracted at the nodes." (Harvey, Nereis Am. Bor., Part III, p. 79, Pl. 45 *b*.)

Elsinborough, Del., *Miss Morris.*

We only know this species from the description and plate of Harvey.

C. RUDOLPHIANA, Ag.

Filaments very long and gelatinous, forming loose tufts one or two feet long, color yellowish green; branches opposite or irregular, very long and flexuous, given off at wide angles, clothed with long, secund,

tapering branchlets; cells .02–8mm in diameter, those of the main branches many times longer than broad.

On stones and covering algæ just below low-water mark. Summer.

Jackson Ferry, N. Y., *Harvey;* Wood's Holl, Mass.; Europe.

One of the longest but at the same time most delicate of the genus. It forms intricately branching tufts, one or two feet long, attached to stones, or covers with a soft fleece algæ and *Zostera* growing in still, shallow bays, like the Little Harbor at Wood's Holl. It is more or less gelatinous and at once collapses on being removed from the water and adheres closely to paper in drying. In drying the cells shrivel very much, and the coloring matter is collected at the ends of the cells, which, in the main branches, are much longer than broad, and on moistening the cells do not recover their shape as readily as in other species.

C. GRACILIS, (Griff.) Kütz.

Filaments loosely tufted, 3–12 inches long, irregularly bent, provided at the angles with rather short branches, which are pectinate, with long recurved or incurved branchlets; color a yellowish green; cells .04–16mm in diameter.

On wharves or in muddy pools.

New Haven, *Prof. Eaton;* Wood's Holl, Mass.

a. Var. EXPANSA.

Very irregularly branched, forming masses one to two feet in extent.

Muddy pools.

β. Gloucester, Nahant, Mass.

Var. TENUIS, Thuret. (*Cl. vadorum*, Aresch.)

Branches remote, filaments more slender than in the type, .04–8mm in diameter.

Growing over *Laminariæ.*

Gloucester.?

A common and variable species, growing in rather muddy sheltered places and not on exposed spots. In its typical form it is recognized by its very irregular branches, which are more divergent than in most other species, and by its pectinate branchlets, which are at times flabellate. The species, although rather delicate in substance, is much stouter than *C. albida* or *C. glaucescens*, and does not adhere well to paper. The form which we have referred to, var. *tenuis*, Thuret, is doubtful. It formed masses of indefinite extent on *Laminariæ* and other algæ below low-water mark off Niles's Beach, Gloucester. What we have called var. *expansa* resembles somewhat *C. expansa*, Kütz., and like it is found in muddy places. It does not, however, form the dense masses of the last-named species, but floats loosely in the water in shallow places. The ordinary forms of the species are recognized without much difficulty, but one sometimes meets forms which are long and almost denuded of branches, in which case determination is difficult.

C. EXPANSA, Kütz.

Filaments of a dull-green color, at first tufted, then matted together, forming extensive strata; main branches irregularly flexuous, .10–15mm

in diameter, clothed with secondary branches, which are divaricately divided and furnished with secund ultimate branches; cells several times longer than broad.

In brackish ditches. Summer.

Wood's Holl; Malden, Mass.

To the present species may be referred the greater part of the New England specimens of brackish water referred to *C. fracta*. It is at first tufted, but soon rises to the top of shallow ditches and coves, and forms an intricately interwoven mass. It is distinguished from *C. fracta* by the greater size of the main branches and the fact that the diameter of the secondary branches is always much less than that of the main branches, whereas in the true *C. fracta* the branches gradually diminish in size. In some specimens the branches are clothed at intervals with very short fasciculated ramuli. The species when in its tufted condition resembles some of the forms of *C. gracilis*. It also approaches the *C. fracta* of the Algæ Danmonienses, said by Harvey to be rather *C. flavescens*.

C. FRACTA, (Fl. Dan.) Kütz.

"Tufts irregular, entangled, often detached, and then forming floating strata, dull green; filaments rather rigid, distantly branched, the lesser branches somewhat dichotomous, spreading, with very wide axils; the ramuli few, alternate or secund; articulations 3–6 times as long as broad, at first cylindrical, then elliptical, with contracted nodes." (Harvey, Nereis Am. Bor., Part III, p. 83.)

Salt-water ditches and ponds.

West Point, *Prof. Bailey;* Beesley's Point, *Ashmead;* New York, *Walters;* Baltimore, Md.

We have quoted from the Nereis the description given by Harvey. It is doubtful whether under the name *C. fracta* he referred to the species of that name as recognized by Scandinavian botanists. The only marine locality of this species which we have examined is in the vicinity of the Marine Hospital, Baltimore. As we understand the species, it is much finer than *C. expansa*, the cells being from .02–8^{mm} in diameter, those of the main branches tapering gradually into those of the secondary branches, while in the last-named species the transition is sudden. The branches are less numerous and more irregular in their mode of branching in *C. fracta* than in *C. expansa*.

C. MAGDALENÆ, Harv., Phyc. Brit., Pl. 335 *a*.

Filaments one to three inches long, decumbent, entangled, coarse, blackish green; branches given off at obtuse angles, flexuous, with very few curved, irregularly-placed branchlets; cells .04–8^{mm} in diamter, about 2–4 times as long as broad.

Napatree Point, R. I., *Prof. Eaton.*

This rather unsightly and insignificant species is recognized by its procumbent habit and dingy green color, and by having but few branches, which are arranged without any definite order, and are given off at very obtuse angles from the main filaments. It may be doubted whether the species is not a reduced form of some other.

BULBOCOLEON, Pringsh.

(From *βολβος*, a bulb, and *κολεον*, a sheath.)

Filaments branching, creeping, composed of two kinds of cells, one producing numerous zoospores, the other bulbous at the base but drawn out into a tube, from the open extremity of which projects a long flexible hair.

This genus, consisting of a single species, was first described by Pringsheim in the Abhandlungen der königl. Akademie der Wissenschaften, Berlin, 1862, who founded it upon a small alga parasitic in the fronds of *Leathesia* and other *Phæosporeæ*, at Helgoland.

The genus resembles *Coleochæte*, a fresh-water genus, in the structure of the hairs, but in *Bulbocoleon* no reproductive bodies, except zoospores produced in the ordinary cells, have as yet been discovered. It is not impossible that oospores may at some time be found, and it will then be necessary to remove the genus from the present order.

B. PILIFERUM, Pringsheim, l. c., p. 8, Pl. I.

Characters same as those of the genus.

Parasitic in the fronds of *Leathesia tuberiformis* and *Chordaria divaricata*. Summer.

Newport, R. I.; Wood's Holl, Gloucester, Mass.; Europe.

This minute species is found creeping among the cortical cells of *Leathesia* and *Chordaria*, generally in company with a *Streblonema*. It forms dark spots on the fronds, and, on microscopic examination, the hyaline hairs are seen projecting above the surface. The species is studied with difficulty when parasitic on *Leathesia*, owing to the density of the cortical part of the frond, but is more easily examined when it grows on *Chordaria*. It was found by Pringsheim on *Chorda filum*, *Chordaria flagelliformis*, and *Mesogloia vermicularis*, as well as on *Leathesia*. It probably will be found on several other *Phæosporeæ* of our coast, where it appears to be common.

The following genus described by Reinsch, including a species of which we have not been able to examine specimens, should be included in the account of the *Chlorosporeæ* of our coast:

ACROBLASTE, new genus of *Chroolepideæ*.

Plants microscopic, marine, forming densely aggregated tufts attached to stones and shells; threads erect, subsimple, branching from the base, arising from procumbent, densely interlaced threads; conceptacles in the upper part of the branches nearly spherical, at first unicellular, afterwards producing 20–35 spherical zoospores; after the discharge of zoospores elliptical, with a wide mouth; development of the branches and growth of the threads as in *Chroolepus* and *Cladophora*.

Acroblaste, spec. Contents of cells finely granular, distinctly circumscribed; color slightly glaucous green; cell-wall thick, sublamellated, twice as long as broad.

Height of plant, .336–.6^{mm}.

Diameter of filaments, .0050–80^{mm}.

Diameter of conceptacles, .0168–196^{mm}.

Diameter of zoospores, .0022^{mm}.

Hab.—Attached to shells and stones, Buzzard's Bay, Mass.

Reinsch., in Botanische Zeitung, 1879, No. 23, Pl. 3 *a*.

Suborder BOTRYDIEÆ.

Fronds minute green unicellar, spherical or pyriform, with a rhizoidal process at the base. Globose bodies produced in the cells, from which, when discharged, there is formed a large number of zoospores, with two cilia, which conjugate.

A small suborder, of which the development is known only in a single species, *B. granulatum*, of which Rostafinski and Woronin have given a full account. Probably the suborder may require to be united with the *Siphoneæ*, a group abundant in the tropics, but not strictly found with us.

CODIOLUM, A. Br.

(Named from the resemblance to species of *Codium*, a genus of marine algæ.)

Frond unicellular, at the base prolonged into a tapering, solid, hyaline stalk, above clavate, containing an oval chloropyllaceous mass, which ultimately is transformed into a large number of spores, development of spores unknown.

The present genus was founded by A. Braun on a species found by him at Helgoland in 1852 and described and figured in his work on unicellular algæ. A second species (*C. Nordenskioldianum*) was described by Kjellman.

The genus is placed by Braun and Kjellman near *Characium*, but until the development of the spores has been made out the position of the genus must remain doubtful. Braun compares the spores to those of *Codium*, but states that he had never seen cilia. In American specimens we have never seen the spores escape from the mother cell and swim about by means of cilia, but, on the other hand, the wall of the mother cell dissolves and the spores thus set free begin to grow at once. It often happens that the spores begin to grow inside the mother cell. The spores are oval and have a thick wall. Each spore either gives off a projection at one end, which grows into a long stalk, or else the contents of the spore become divided into a small number of cells by means of cross-partitions at right angles to its longer axis, thus forming a short filament, each cell of which gives off a stalk as previously described. There results in the last case a dense cluster of individuals, which adhere together by their bases. It may be that what we have seen was only the hypnosporic condition of the plant, and that Braun had examined a stage in which motile spores existed. Occasionally one finds two spore-bearing cells on a single stalk, one always being very much smaller than the other. The second cell is lateral and may be nearly sessile on the stalk or furnished with a short secondary stalk of its own.

Our plant recalls the hypnosporic condition of *Botrydium granulatum*, and in the Algæ Am. Bor. Exs. it was distributed under the name of *B. gregarium*. As the development is so little known, we have now thought best to retain the name *Codiolum*, on the supposition that our species is the same as that of Braun. The study of the development is rendered difficult because the plant grows inextricably entangled with other small algæ.

C. GREGARIUM, A. Br. (*C. gregarium*, Braun, Alg. Unicell., Genera nova et minus cognita, p. 20, Pl. 1.—*Botrydium gregarium*, Farlow, in Alg. Am. Bor. Exs., No. 99.)

Cells densely aggregated, average length of cells, including stalk,

.35–60^{mm}, sporiferous mass .04–8^{mm} broad by .10–15^{mm} long. Spores .015^{mm} by 020^{mm}.

On wharves and rocks between tide-marks, mixed with *Calothrix scopulorum* and *Ulothrix*.

Eastport, Me.; Gloucester, Mass.; Europe.

Probably common in the autumn along our northern coast, and at once recognized by the long terminal stalk, which appears to be an appendage of the cell-wall. The size is so variable that no accurate measurements as to length can be given. Those above stated represent the size of fully-grown sporiferous individuals.

Suborder BRYOPSIDEÆ.

Fronds green, unicellar, filamentous, branching; reproduction by zoospores, with two cilia, formed in the occluded branches.

A small suborder, including with us a single species of *Bryopsis* and a single species of *Derbesia*, a genus whose position is uncertain and which may prove to be more nearly related to *Vaucheria* than to *Bryopsis*, although in the present article we have placed it with the latter.

BRYOPSIS, Lam.

(From *βρυον*, a moss, and *οψις*, an appearance.)

Fronds bright-green, unicellular, branching, usually pinnately divided; reproduction by spores formed in occluded portions of the branches; spores of two (?) kinds—either green zoospores, furnished with two apical cilia, or orange-colored.

The genus *Bryopsis* includes perhaps not far from twenty species, which are characterized by the mode of branching. Most of them are pinnately compound, and the different forms pass so gradually into one another that the species cannot be said to be well marked. The fronds are unicellular except at the period of reproduction, when some of the smaller branches are separated by partitions from the rest of the frond. The position of the genus is still doubtful, as the development is not known. The reproductive bodies generally found are green zoospores which have two terminal cilia. Whether they conjugate or not is not known, although as Thuret reports the occurrence of zoospores with four cilia, such is probably the case. A second form of reproductive bodies was found by Pringsheim in *Bryopsis*, orange-colored motile bodies furnished with two terminal cilia. The development of these bodies has not been observed. Janczewski and Rostafinski have expressed the opinion that they may be parasites, but Cornu confirms the statement of Pringsheim that they are really organs of the *Bryopsis*.

B. PLUMOSA, (Huds.) Ag., Phyc. Brit., Pl. 3. **Pl. IV, Fig. 1.**

Fronds 2–6 inches long, often gregarious, 2–4 times pinnate, pinnules pyramidal in outline, naked at the base, in the upper part clothed with short pinnulæ, which are constricted at base.

On muddy wharves and stones at low-water mark.

A beautiful species, not uncommon along our whole eastern coast, and also frequently

found on the shores of California. It is very widely diffused, being found in nearly all seas. *B. hypnoides*, which occurs at Key West, passes almost insensibly into *B. plumosa*, but the typical *B. hypnoides* is not known in New England.

?DERBESIA, Sol.

(Named in honor of *Prof. Alphonse Derbes*, of Marseilles.)

Fronds green, simple or slightly branching, unicellular, or sometimes with cross-partitions at the base of the branches; fructification consisting of ovoidal sporangia containing zoospores, which are of large size and have a hyaline papilla at one end, at the base of which is a circle of cilia; oospores unknown.

The genus *Derbesia* was founded by Solier on two Mediterranean species, *D. marina* and *D. Lamourouxii*. The position of the genus is doubtful. The *Derbesiæ* resemble in habit the more delicate species of *Vaucheria* and *Bryopsis*, and like them are often unicellular, but it is, however, not uncommon to find at the base of some of the sterile branches a short cell, separated by a wall both from the branch above and the main filament below. A similar cell is always present at the base of the sporangia, and the same cell is found in some species of *Vaucheria*. *Derbesia* differs from *Bryopsis* in having zoospores provided with a circle of cilia, borne around the base of a terminal hyaline papilla as in *Œdogonium*. It differs from *Vaucheria* in not having oospores, so far as is known. The zoospores of *Derbesia*, according to Solier, germinate at once and are apparently of a non-sexual character, so that we may expect that hereafter either oospores or conjugating zoospores will be found. As we have said, the zoospores bear a striking resemblance to those of *Œdogonium*, and perhaps the relationship to the last-named genus is closer than has usually been supposed. In this connection it should be mentioned that, in the formation of the cells sometimes found at the base of the branches, the cell-wall ruptures in the same way as in *Œdogonium*, and if we do not have the same rings forming a cap at the end of the cells as in *Œdogonium* it may be because in *Derbesia* the formation of new cells is very limited.

D. TENUISSIMA (De Not.), Crouan. (*D. marina*, Solier, Ann. Sci. Nat., 3 série, Vol. VII, p. 158, Pl. 9, Figs. 1–17.—*Bryopsis tenuissima*, De Not., Fl. Capr.—*D. tenuissima*, Crouan, Florule du Finistère, non *D. marina*, Crouan, Algues Marines du Finistère, No. 398.—*Chlorodesmis vaucheriæformis*, Harv., Ner. Am. Bor., Part III, p. 30, Pl. 40 *c*.) **Pl. IV, Fig. 4.**

Filaments tufted, bright green, one to two inches long, .04^{mm} in diameter; branches few, erect, constricted, and often with a cuboidal cell at the base; sporangia on short branches, ovoidal or pyriform, .09–.12^{mm} broad by .20–.30^{mm} long, resting on a cuboidal basal cell; spores large, few, about 15 in number.

Forming tufts on algæ.

Eel Pond Bridge, Wood's Holl, Mass.; Key West; Europe.

We have found this species but once on our coast, in May, 1876. With us it is apparently rare, but the species is not uncommon in some parts of Europe, especially on the shores of the Mediterranean. Our form is very well developed and the sporangia are rather longer than in the European specimens which we have seen.

Suborder PHÆOSPOREÆ.

Reproduction by means of olive-brown zoospores which have two laterally attached cilia; sporangia of two kinds—unilocular, containing a large number of zoospores, and plurilocular, compound sporangia, each cell of which contains a single zoospore; conjugation of zoospores known in a few species; marine plants, of an olive-brown color, whose fronds vary greatly in structure, but which all agree in reproducing by zoospores.

A large group, first correctly defined by Thuret. Previous writers had regarded the structure of the frond to the exclusion of the organs of reproduction, and the species here included were placed in different orders. In the Nereis they were placed partly in the *Dictyotaceæ*, *Sporochnaceæ*, *Laminariaceæ*, *Chordariaceæ*, and *Ectocarpaceæ*. The four last orders have been kept as families, but the true *Dictyotaceæ* are a distinct order. All the olive-brown sea-weeds of New England, except the rock-weeds, belong to the present suborder. In no order of plants do the species vary so widely in habit as in the present. A large number, as the *Ectocarpi*, are filamentous and resemble in habit the *Cladophoræ*. The *Lamineriæ* have expanded flat fronds, and in *Macrocystis* and *Egregia*, the most highly organized of the order, there are stems, distinct leaves, and air-bladders, and in *Egregia* special fructiferous leaflets. Many of the species are of microscopic size, but *Macrocystis* grows to be several hundred feet long.

SPHÆNOSIPHON, Reinsch.

(From *σφην*, a wedge, and *σιφων*, a tube.)

Fronds formed of single cells placed side by side so as to form a more or less coherent mass; cells pyriform-cuneate or oblong-elliptical; contents of cells transformed into a number of very small spherical bodies (zoospores?).

In the Contributiones ad Algologiam et Fungologiam, Reinsch places the genus *Sphænosiphon*, of which he describes nine species, in the order *Melanophyceæ*. One of the species occurs in fresh water and the rest are marine. They all form minute spots on other algæ, and consist simply of cells placed side by side, the whole forming a thin membranous expansion. If the small bodies described and figured by Reinsch in the interior of the cells are really zoospores, and if the cells themselves are olive-brown, we must regard the genus *Sphænosiphon* as the lowest of the *Phæosporeæ*. The development of the zoospores has not been observed, and as Reinsch describes the color of some of the species as bluish green and rose-colored, we must consider the position of the genus to be in doubt. Species of *Sphænosiphon* are not unfrequent on our coast, but they have not yet been sufficiently studied. Those which we have seen are more like the *Cyanophyceæ* than the *Phæosporeæ* in color. The following descriptions, which may apply to some of our species, are taken from Reinsch, l. c.

S. SMARAGDINUS, Reinsch, l. c., Pl. 35, Fig. 4.

Cells pyriform or broadly cuneiform, rounded at the apex, prolonged at the base into a hyaline pedicel; cells .0168–333^{mm} long, .0084–112^{mm} broad at apex, .002^{mm} at base; color bluish green; base hyaline.

On *Plocamium coccineum*, Labrador.

On *Polysiphonia*, Anticosti.

S. OLIVACEUS, Reinsch, l. c., Pl. 36, Fig. 2 *a*.

Cells pyriform or cuneiform, broadly rounded at apex, contracted at base; color olive-green; cells .013–24^{mm} long, breadth .0096–168^{mm}.

On *Ceramium rubrum*, Anticosti and Labrador.

S. ROSEUS, Reinsch.

Cells broadly ellipsoidal, placed loosely together, and surrounded by a thick hyaline mucus; rose-colored; .0041–50^{mm} long, .004–5^{mm} broad.

On zoophytes, Labrador.

As an account of the families into which the suborder is divided has already been given on pp. 15–17, it is unnecessary to repeat them here, but the reader will find them briefly described in their order on subsequent pages, together with a synopsis of the genera found on our coast belonging to each family.

Family SCYTOSIPHONEÆ.

Fronds unbranching, either membranous or tubular; plurilocular sporangia in short filaments, densely covering the whole surface of the fronds; unilocular sporangia not well known.

Fronds expanded membranes ..... *Phyllitis.*
Fronds tubular ..... *Scytosiphon.*

PHYLLITIS, (Kütz.) Le Jolis.

(From *φυλλιτης*, a name given by Dioscorides to an unknown plant.)

Fronds olive-brown, simple, membranaceous, composed of a cortical layer of minute colored cells and an internal layer of larger, oblong, colorless cells, which are sometimes prolonged downwards in the form of short filaments; plurilocular sporangia formed from the cortical cells, covering the surface of the fronds, consisting of a few (4–6) cells arranged in short filaments, which are closely packed together at right angles to the surface of the fronds; unilocular sporangia and paraphyses unknown; growth from the base.

A genus consisting of two species, formerly placed in the genus *Laminaria* in consequence of their membranous habit, but differing essentially from the true *Laminariæ* in the structure and disposition of their sporangia.

P. FASCIA, Kütz. (*Laminaria fascia*, Ag.)

Fronds gregarious from a disk-like base, three to six inches long, a quarter to half an inch wide, linear-elongate, contracted at the base into a short stipe.

Var. CÆSPITOSA. (*Phyllitis cæspitosa*, Le Jolis, Études Phycol., p. 10, Pl. 4.—*Laminaria cæspitosa*, Ag.—*Laminaria fascia*, Harv., in Phyc. Brit., Pl. 45.—*Laminaria debilis*, Crouan, Alg. Finist., No. 81.) **Pl. IV, Fig. 3.**

Fronds stipitate, cuneiform, often falcate and undulate.

Very common on stones between tide-marks; widely distributed over all parts of the world.

About the limits of the present species there is a diversity of opinion. Le Jolis regards the *L. fascia* and *L. cæspitosa* of Agardh as distinct species, but by Harvey they were considered as merely different forms of the same species. Harvey's opinion seems to us to be correct, for it is impossible to draw the line between the two forms as found on our coast.

SCYTOSIPHON, (Ag.) Thuret.

(From *σκυτος*, a whip, and *σιφων*, a tube.)

Fronds simple, cylindrical, usually constricted at intervals, hollow, cortex of small colored cells, inner layer of vertically elongated, colorless cells; sporangia as in *Phyllitis;* paraphyses single-celled, oblong-obovate, interspersed among the sporangia.

The present genus is founded on the *Chorda lomentaria* of older writers. The genus *Scytosiphon*, as proposed by Agardh, included both *C. lomentaria* and *C. filum*. The latter species, which is still kept in the genus *Chorda* by most writers, has the surface of the frond covered with club-shaped paraphyses, between which are situated the oval unilocular sporangia. In *S. lomentarius* the bodies called paraphyses are only occasionally found, and their real nature is a little uncertain. Both Bornet and Areschoug consider them to be paraphyses, and the latter has figured them in Observationes Phycologicæ, Part III, Pl. 2, Fig. 1. As at present understood, *Scytosiphon* differs from *Phyllitis* only in the fact that the frond is tubular instead of membranous, and in the presence of paraphyses, which have not yet been found in *Phyllitis*.

S. LOMENTARIUS, Ag. (*Chorda lomentaria*, Lyngb.; Phyc. Brit., Pl. 285.—*Chorda filum* var. *lomentaria*, Kütz., Spec. Alg.)

Fronds gregarious, three to eighteen inches long, attached by a disk-like base, shortly stipitate, expanding into a hollow tube, from a quarter of an inch to an inch in diameter, at first cylindrical, afterwards constricted at intervals.

Very common on stones between tide-marks; found nearly all over the world.

A species easily recognized, except when quite young, by its tubular and constricted frond, but chiefly interesting in consequence of the smaller species of algæ which grow upon it. At Eastport a very large form is found, nearly an inch in diameter, and much twisted.

FAMILY PUNCTARIEÆ.

Fronds unbranching, forming expanded membranes or cylinders; fructification in spots (sori) on the surface of the fronds; plurilocular sporangia ellipsoidal, composed of few cells; unilocular sporangia spheroidal.

PUNCTARIA, Grev.

(From *punctum*, a point, referring to the dots formed by the sporangia and hairs.)

Fronds olive-brown, simple, membranaceous, attached by a discoidal base, composed of several (2–6) layers of cuboidal cells of about the same dimensions in all parts of the fronds; unilocular sporangia immersed in the frond, collected in spots, spherical-cuboid, formed from the superficial cells; plurilocular sporangia collected in spots, immersed ex-

cept at the apex, formed from the superficial cells; fronds covered with clusters of hairs; paraphyses wanting.

A small genus, containing probably not more than half a dozen good species, which are widely diffused. In the Nereis Am. Bor. the genus is placed by Harvey in the *Dictyotaceæ*. That order is now restricted to a group, not represented, as far as is known, on the coast of New England, in which there are quiescent spores, tetraspores, and antheridia, but no zoospores, and *Punctaria* is evidently related to the *Phæosporeæ*, judging by its sporangia. *Litosiphon pusillus*, a small parasite on various algæ, is closely related to *Punctaria*, but differs in having a filamentous frond and more simple sporangia. It probably occurs on our coast, but has not yet been observed.

P. LATIFOLIA, Grev.; Phyc. Brit., Pl. 8; Études Phycol., p. 13, Pl. 5.

Fronds pale olive-green, gregarious, shortly stipitate, lanceolate or obovate, four to twelve inches long, one to five inches broad, substance tender.

Var. ZOSTERÆ, Le Jol. (*P. tenuissima*, Phyc. Brit., Pl. 248.)

Fronds thin, pale, lanceolate at both extremities, narrow, margin undulated.

On different algæ at and below low-water mark. Spring and summer. Europe.

P. PLANTAGINEA, (Roth) Grev.; Phyc. Brit., Pl. 128. **Pl. IV., Fig. 5.**

Fronds deep brown, gregarious, broadly lanceolate, attenuated at base, one to three inches broad, three inches to a foot long, substance somewhat coriaceous.

Orient, L. I.; Point Judith, R. I., *Olney;* Wood's Holl, Gloucester, Mass.; Europe. Summer.

It is not altogether easy to distinguish our two species in some cases, although as a rule they are sufficiently distinct. *P. latifolia* is much the more delicate of the two, and has a greenish tinge. When in fruit it is punctate, the dots being the sori. Both forms of sporangia are often found simultaneously on the same frond. In *P. plantaginea* the frond is decidedly brown and rather coriaceous, and the punctate spots are caused by the dense clusters of hairs which are often found to correspond on both sides of the frond. Both species are common in spring and summer, and although often washed ashore in considerable quantities on exposed beaches, they prefer quiet bays.

FAMILY DESMARESTIEÆ.

Fronds branching, cylindrical or compressed, with an axis of filaments composed of elongated cells and a cortex composed of spheroidal cells; unilocular sporangia formed by the direct transformation of the cortical cells; plurilocular sporangia unknown.

DESMARESTIA, Lamx.

(In honor of *A. G. Desmarest*, a French naturalist.)

Fronds olive-brown, solid, cylindrical or compressed, much branched, attached by a disk, cortical layer composed of small polygonal cells,

internal portion consisting of an axial filament formed of a single row of rather large cylindrical cells, surrounded by a mass of oblong cells sometimes mixed with smaller winding cells; in the spring fronds covered with branching hairs, which drop off later in the season; unilocular sporangia formed directly from the cortical cells, which do not undergo any change in shape or size; growth trichothallic.

A small genus, consisting of about fifteen described species, a considerable portion of which bear a close resemblance to *D. aculeata*. They are inhabitants of the colder seas in both the northern and southern hemispheres. Our two species are very widely diffused, but *D. ligulata*, a common species of California as well as of Europe, is wanting on our coast. The genus is easily distinguished from its allies by the axial filament and the formation of the zoospores in the unchanged superficial cells.

D. ACULEATA, Lamx., Phyc. Brit., Pl. 49; Ner. Am. Bor., Vol. I, Pl. 4 *b*.

Fronds dark olive-brown, one to six feet long, terete below, compressed above, naked at the base; branches alternate, numerous, long and virgate, lower branches longer than upper, several times pinnate, clothed in spring with hairs, which fall off and leave alternate, distichous, spine-like processes.

Common on exposed shores below low-water mark. Throughout the year. Europe.

A coarse and homely species as usually found; often washed ashore in large masses. Not likely to be confounded with any other of our species. In spring it presents a feathery appearance, owing to the tufts of hairs with which the frond is beset. It is one of the species used as a fertilizer on the northern coast of New England.

D. VIRIDIS, Lam. (*Dichloria viridis*, Grev.—*Desmarestia viridis*, Phyc. Brit., Pl. 312.)

Fronds light olive, one to three feet long, cylindrical or but slightly compressed; branches all opposite, distichous, several times pinnate, ultimate branches capillary.

Common on stones at and below low-water mark. Europe.

A smaller and much more delicate species than the last, for which it can never be mistaken, rather resembling in some of its conditions a *Dictyosiphon*. The name is derived from the fact that on decaying or on being placed in fresh water it turns quickly to verdigris-green. Harvey mentions that air-cavities are to be seen in cross-sections of the filaments. The air-cavities are, however, merely the sections of the larger cells which are surrounded by dense masses of smaller cells, whereas in *D. aculeata* a cross-section shows the axial filament surrounded by a mass of cells of nearly equal diameter.

FAMILY DICTYOSIPHONEÆ.

Fronds branching, filiform, axis composed of elongated cuboidal cells, the cortex of smaller roundish cells; unilocular sporangia spherical, scattered or aggregated, formed from the subcortical cells; plurilocular sporangia unknown.

DICTYOSIPHON, Grev.

(From *δικτυον*, a net, and *σιφων*, a tube.)

Fronds olive-brown, filiform, branching, solid above, becoming hollow below, cortex composed of small, irregularly polygonal cells, interior of larger, colorless, longitudinally elongated cells; branches corticated throughout; growth from an apical cell (scheitel-zelle); unilocular sporangia spherical, scattered, immersed in the cortex; paraphyses and plurilocular sporangia unknown.

The genus was founded on *D. fœniculaceus*, a species placed by C. A. Agardh and Lyngbye in *Scytosiphon*. Under *D. fœniculaceus* were included a number of forms which have since been separated by Areschoug and placed in two different genera, *Phlœospora* and *Dictyosiphon*. In the former the unilocular sporangia are formed directly from the cortical cells and cover the surface in dense patches, at maturity projecting above the surface of the frond. In the latter genus the sporangia are scattered and immersed. In *Dictyosiphon*, moreover, the growth is from an apical cell, but in *Phlœospora* it is trichothallic, and in the former genus the superficial cells are polygonal and irregularly placed, while in the latter they are quadrate and arranged in regular series. The genus is divided by Areschoug into two subgenera, *Dictyosiphon* proper and *Coilonema*, the latter of which is referred by Gobi to *Cladosiphon*, since the cortical layer consists of very short filaments rather than a continuous cellular membrane. Our two species belong to *Dictyosiphon* proper, but species of *Coilonema* and *Phlœospora* are to be expected in the region of Eastport. By Harvey the genus was placed in the *Dictyotacæ*, from which order it was necessarily removed when the true nature of the sporangia was discovered.

D. FŒNICULACEUS, Grev. (*Scytosiphon fœniculaceus*, Ag.—*D. fœniculaceus*, Phyc. Brit., Pl. 326; Areschoug, Phyc. Mar., Pl. 7.)

Fronds yellowish brown, six inches to two feet long, much branched; branches alternate or occasionally opposite; superficial cells angularly quadrate.

Common on stones and algæ at low-water mark. Spring and summer. Europe.

A variable species as found on our coast, but one which cannot well be subdivided at present. Early in the season the fronds are light colored and delicate in substance, but later they become more rigid. Perhaps some of the forms which we have here included may properly be placed under var. *flaccidus* of Areschoug. Such, at least, appears to be the case with some of the specimens collected in May at Wood's Holl.

D. HIPPUROIDES, (Lyngb.) Aresch.? (*Scytosiphon hippuroides*, Lyngb., Hydr., Pl. 14 *b*.—*D. fœniculaceus* *a*, Aresch., Phyc. Mar., Pl. 6 *a* and *b*.—*Chordaria flagelliformis* var. *β* and *γ*, Agardh, Sp. Alg., Vol. I, pp. 66 and 67.)

Fronds dark brown, four inches to two feet long; main branches rather densely beset with flagellate, scattered, subequal secondary branches; superficial cells in the lower part arranged in horizontal series, above irregular.

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 95.

On stones at low tide.

Eastport, Maine; Cape Ann, Mass.

We have referred to the present species a rather large form found abundantly in September, 1877, at Eastport, near Dog Island, where it grows with *Chordaria flagelliformis*, which it somewhat resembles in habit. It is much coarser than *D. fœniculaceus*, and of a darker color, and the branches are long and flagellate, and furnished with comparatively few secondary branches. The Cape Ann specimens are smaller and approach nearer *D. fœniculaceus*. The Eastport form can hardly be regarded as an extreme state of *D. fœniculaceous*, but whether it is really the *D. hippuroides* of Areschoug admits of some doubt, as Areschoug describes his species as being only six or seven inches long. According to Areschoug, the conjugation of zoospores has been observed in this species.

Family ECTOCARPEÆ.

Fronds filamentous, monosiphonous or sometimes partly polysiphonous, cortex rudimentary or wanting; sporangia either in the continuity of the filaments or external, sessile or stalked; unilocular sporangia globose or cuboidal; plurilocular sporangia muriform (formed of numerous small rectangular cells densely aggregated in ovoidal or lanceolate masses); growth trichothallic.

Fronds polysiphonous above, monosiphonous below, densely beset above with very short horizontal branches ..... *Myriotrichia.*

Fronds generally monosiphonous throughout, branches free, opposite or alternate ..... *Ectocarpus.*

MYRIOTRICHIA, Harv.

(From *μυριος*, a thousand, and *θριξ*, a hair.)

Fronds olive-brown, filamentous, at first consisting of a single row of cells, which by transverse and longitudinal division afterwards form a solid axis; branches short, closely approximated, radiating in all directions, formed by outgrowths from the superficial cells of the axis; unilocular sporangia spherical, borne on the axis between the branches; plurilocular sporangia unknown; main axis and branches ending in hyaline hairs.

A genus comprising three species which are hardly distinct. They form small tufts or fringes on different *Phæosporeæ*, especially on *Scytosiphon*, and are recognized by the numerous short branches which in some cases almost cover the main axis and cause it to resemble a *Stigonema*. The development of the frond is given in detail by Nægeli in Die neuern Algensysteme.

M. CLAVÆFORMIS, Harv., Phyc. Brit., Pl. 101. (*M. Harveyana*, Næg. partim.)

Fronds half an inch to an inch in length, club-shaped in outline, axis clothed throughout with branches, upper branches longer than lower and bearing secondary branches.

Var. FILIFORMIS. (*M. filiformis*, Harv., Phyc. Brit., Pl. 156.—*M. Harveyana*, Næg. partim.)

Fronds filiform in outline, axis furnished only at intervals with branches.

On various algæ, especially *Scytosiphon lomentarius*.

Gloucester, Mass., *Mrs. Bray*.

Var. *filiformis*, Penobscot Bay, Maine, *Hooper;* Newport, R. I.; Europe.

A species forming small tufts on different *Phæosporeæ*, probably abundant on our coast, but as yet only recorded in a few localities. Nægeli has shown, l. c., that the two species of Harvey are merely forms of a single species, the variety *filiformis* being less fully developed than *M. clavæformis*, which was first described.

ECTOCARPUS, Lyngb.

(From εκτος, external, and καρπος, fruit.)

Fronds filamentous, monosiphonous or occasionally partly polysiphonous by radial division of some of the cells; plurilocular sporangia ovate, cylindrical or siliculose, consisting of numerous small cells arranged in regular longitudinal and transverse series; unilocular sporangia cylindrical or oval, either stalked or formed by the direct transformation of the cells of the branches.

The genus is here accepted in an extended sense, and includes a number of genera of modern writers which we have preferred to consider subgenera. Perhaps *Pylaiella* should be kept distinct, as in this subgenus both the unilocular and multilocular sporangia are formed by the direct transformation of some of the cells in the continuity of the filaments rather than in special branches. But in *Capsicarpella* we have the multilocular sporangia formed in the continuity of the branches as in *Pylaiella*, while the unilocular sporangia are partly emergent and seem to be intermediate between those of *Pylaiella* and *Ectocarpus* proper. *Streblonema*, if separated from *Ectocarpus* by its creeping habit, resembles it perfectly in its fruit, and, as the different species of *Streblonema* vary considerably as to their procumbent habit, it seems, on the whole, better not to retain the genus. The described species of *Ectocarpus* proper are very numerous, but unfortunately they are not well characterized. The greater part of the species may be grouped around *E. confervoides* and *E. fasciculatus* as types, but exactly how far differences in ramification and dimensions of the sporangia are to be considered specific rather than mere variations is a matter about which botanists do not agree. One thing is certain, that specific analysis has been carried too far in this group, and it is especially true with regard to the species of Kützing. In describing a species of *Ectocarpus* it is important to have both the unilocular and plurilocular conditions. In most of the species, however, only one form is known. The unilocular sporangia are often difficult to determine, because the *Ectocarpi*, especially those growing on dirty wharves, are infested by parasites, *Chytridium*, &c., which produce globular swellings of the cells, which might then, especially in dried specimens, be mistaken for unilocular sporangia.

Besides the two forms of sporangia, Thuret and Bornet have recorded the existence of bodies to which they have given the name of antheridia. It has been suggested that the antheridia were cells distorted by parasites. We have never seen antheridia in American specimens, and are not in a position to express any opinion. The fact that a conjugation of the zoospores has been observed by Goebel in *E. pusillus*

would, however, incline one to consider that the antheridia in this genus were not proper male bodies.

Some of the species of *Ectocarpus* described by Harvey in the Nereis were founded on sterile specimens, but, at the present day, algologists agree in thinking that the presence of sporangia is necessary for the determination of species of *Ectocarpus*, and we have, accordingly, omitted the Harveyan species founded on sterile plants as being inadequate.

SUBGENUS STREBLONEMA, Derb. & Sol. (*Entonema*, Reinsch).

Primary branches procumbent, creeping in or over the substance of other algæ; secondary and fructifying ramuli erect.

E. CHORDARIÆ, n. sp.

Filaments much branched, irregularly nodose, about .02^{mm} in diameter, sunk in the tissue of the host-plant; hairs and fertile branches erect, the former projecting above the surface; unilocular sporangia on short stalks, solitary or clustered, oval, about .07^{mm} broad by .14^{mm} long; plurilocular sporangia unknown.

Parasitic in the fronds of *Chordaria divaricata*, *Leathesia tuberiformis*, and other *Phæosporeæ*.

Wood's Holl, Gloucester, Mass.; Newport, R. I.

A common but insignificant species which grows in the cortical portion of different *Phæosporeæ*, especially *Chordaria divaricata*, and usually in company with *Bulbocoleon*. It forms dark-colored spots on the surface of the plant in which it is growing, and, on a hasty microscopic examination, would pass unnoticed, so great is the resemblance of the sporangia to those of *Chordaria*. Our plant resembles *S. sphæricum*, Thuret, but differs from the Mediterranean forms of that species in having oval, not spherical, sporangia, which are often clustered. The filaments, too, are composed of very irregular-shaped cells, and are never moniliform as in well-developed specimens of *S. sphæricum*. It may, however, be the case that what we have considered specific marks are only local variations. It may also be asked whether the present species is not the form of *S. fasciculatum*, Thuret, which bears unilocular sporangia. At present only the plurilocular form of sporangium is known in that species as it occurs in Europe.

E. REPTANS, Crouan, Florule du Finistère, p. 161; Kjellman, Bidrag till Känn. Skand. Ect. Tilop., p. 52, Pl. 2, Fig. 8.

Filaments forming circular spots on the host-plant, primary branches very densely branching, so that they almost form a membrane, furnished with numerous erect branches, which are .5–7^{mm} high and gradually taper to a hyaline hair; cells at base about .01^{mm} broad; plurilocular sporangia arising from the primary filaments, sessile or on short stalks, ovate-acute, .012–20^{mm} broad by .038–76^{mm} long.

On *Phyllitis* and *Dictyosiphon*. Summer.

Newport, R. I.; Europe.

A larger species than the preceding and growing more superficially, so that the filaments may be said to creep over the surface rather than in the substance of the host-plant. Owing to the dense branching of the prostrate filaments and the abundance

of the erect branches, this species forms a connecting link between *Ectocarpus* and *Myrionema*.

SUBGENUS EUECTOCARPUS.

Filaments monosiphonus, erect, occasionally corticated by the growth of descending filaments which are given off from some of the cells; both unilocular and plurilocular sporangia formed by the transformation of special branches.

E. TOMENTOSUS, (Huds.) Lyngb., Phyc. Brit., Pl. 182. (*Spongonema tomentosum*, Kütz., Spec. Alg., p. 461; Tab. Phyc., Vol. V, Pl. 83 *a*.)

Filaments erect, two to four inches long, densely interwoven into rope-like, spongy masses, irregularly much branched; primary branches scarcely distinct; cells .008–12^{mm} broad by .012–70^{mm} long; plurilocular sporangia linear-oblong, straight or incurved, .010–15^{mm} broad by .025–75^{mm} long, sessile or on short pedicels, which are given off at right angles to the branches; unilocular sporangia "subovate on short pedicels" (Areschoug).

On *Fucus* and other plants.

Boston Bay, *Harvey;* Magnolia, Mass.; Europe.

This species, which is easily recognizable by its spongy, rope-like habit, and by the microscopic characters above enumerated, seems to be rather scarce on our coast. It is not rare, however, on the shores of Europe. The species is to be sought in summer, and it grows attached to the larger algæ. Only the plurilocular sporangia are known on our coast.

E. GRANULOSUS, (Eng. Bot.) Ag.; Phyc. Brit., Pl. 200.

Filaments tufted, rather rigid, two to four inches long, main branches opposite or whorled, corticating filaments often numerous; cells .07–10^{mm} in diameter; secondary branches short, opposite, given off at very wide angles, often revolute at the tip; ultimate branches secund, short, acute; plurilocular sporangia broadly ovate, obliquely truncate on the inner side, .04–6^{mm} broad by .06–8^{mm} long, sessile on the ultimate and penultimate branches; unilocular sporangia?

Var. TENUIS. (*Ectocarpus Durkeei*, Harv., Ner. Am. Bor., Vol. I, p. 142, Pl. 12 *f*.)

Filaments more slender than in the type; cells .05–8^{mm} broad; branches usually alternate; plurilocular sporangia ovate or ellipsoidal, but slightly truncate at the base.

Boston, *Harvey;* Newport, R. I.

Var. *tenuis*, Portsmouth, N. H.; Nantucket, Mass., *Harvey;* Wood's Holl, Mass.

A species not rare in Europe and apparently common on the coast of California, but not often found with us. The species occurs in summer, and forms small tufts on

other algæ. It is distinguished from our other species by the short, broad, and sessile sporangia. In the type the branching is opposite and compact, and the corticating filaments are sometimes so numerous, especially in the Newport specimens, as to lead one to admit the validity of Kützing's genus *Corticularia*. But in other cases the corticating filaments are few in number.

E. CONFERVOIDES, (Roth) Le Jolis. (*Ectocarpus siliculosus*, Phyc. Brit., Pl. 162; Ner. Am. Bor., Vol. I, p. 139.)

Filaments erect, two to twenty inches long, loosely entangled at the base, becoming free and feathery above; branches alternate or secund, gradually tapering; cells of larger branches .04–5^{mm} in diameter; plurilocular sporangia ovate-acute or acuminate, sessile or stalked, sometimes rostrate average size of sporangia .025–40^{mm} broad by .15–40^{mm} long; unilocular sporangia oval or ellipsoidal, .023–30^{mm} broad by .035–50^{mm} long.

α, var. SILICULOSUS, Kjellman. (*Ectocarpus viridis*, Harv., Ner. Am. Bor., Vol I, p. 140, Pl. 12 *b* and *c*.)

Plurilocular sporangia subulate or linear-subulate, sessile or subsessile, frequently rostrate.

β, var. HIEMALIS, Kjellman. (*Ectocarpus hiemalis*, Crouan.)

Plurilocular sporangia elongated, conical or subacuminate, .08–15^{mm} long by .02–3^{mm} broad, generally rostrate.

Very common on algæ and wood work along the whole coast.

Var. *α*, most common south of Cape Cod.

Var. *β*, Wood's Holl, Mass.?

The largest, most variable, and most common summer species of our coast, and found in nearly all parts of the world. It has been subdivided by Kützing into a large number of species, which are scarcely to be recognized from his descriptions and plates. Formerly some of the different forms of *E. littoralis* were referred to the present species, but the true *E. littoralis* is now recognized as belonging to the subgenus *Pylaiella*. Those interested in tracing the synonymy of *E. confervoides* should consult Kjellman's Bidrag till Kännedomen om Skandinaviens Ectocarpeer och Tilopterider, Stockholm, 1872. As seen on our own coast, what we have called the typical *E. confervoides* forms tufts of indefinite extent on wharves, and especially on the larger algæ, varying in length from a few inches to a foot and a half long. It frequently fringes the fronds of *Chorda filum* with its soft, silky tufts. In the type the plurilocular sporangia, which are much more common than the unilocular, are ovate-acuminate, and only occasionally rostrate. In the variety *siliculosus* the plurilocular sporangia are long and comparatively very narrow. The variety *hiemalis* is found in the winter and spring, and has plurilocular sporangia, which are almost always rostrate and somewhat cylindrical in form, so that they may be said to resemble those of the subgenus *Pylaiella*. The color of the present species when growing is a light brown approaching yellowish, which in drying often turns to a yellowish-green, especially in the variety *siliculosus*, of which herbarium specimens might be mistaken for *Cladophoræ*. The winter forms are deeper brown than those found in summer. *E. amphibius*, mentioned in the supplement to the Nereis as occurring near New York in brackish water, is a form of the present species.

E. FASCICULATUS, Harv.

Filaments one to eight inches long, erect, tufted, entangled below but free and feathery above; cells of main branches .05^{mm} in diameter, about as long as broad; secondary branches alternate, short, given off at an obtuse angle; ultimate branches very numerous, secund, ending in a hair; plurilocular sporangia ovate-acuminate or subulate, sessile or on short stalks, borne principally on the upper side of the penultimate branches, very variable in size, but averaging from .018–25^{mm} broad by .070–150^{mm} long; unilocular sporangia sessile, oval, .04–6^{mm} by .03–45^{mm}.

Very common on the larger algæ along the whole coast; Europe.

When found in its typical form the present species is easily recognized, but it varies considerably, so that the extreme forms are not easily determined. It is very common on fronds of *Laminaria* and other large *Phæosporeæ*, on which it forms a dense fringe one or two inches high. The larger forms are much looser and feathery and the tips of the branches are fasciculate when seen with the naked eye. When long and slender it becomes the var. *draparnaldioides* of Crouan. The most puzzling forms are those in which the filaments are short and thick and the rather stout plurilocular sporangia are arranged without order on the branches. In this species the unilocular and plurilocular sporangia are more frequently found growing together on the same individual than in any of the other species found on our coast.

E. LUTOSUS, Harv., Ner. Am. Bor., Vol. I, p. 140, Pl. 12 *a*.

Filaments tufted, two to four inches long, densely interwoven in spongy masses; lower branches opposite, .03–4^{mm} broad; upper branches irregular, ending in long hairs; plurilocular sporangia .04–5^{mm} broad by .15–20^{mm} long, cylindrical in outline, ending in very long hairs, which occasionally fork; unilocular sporangia?

Greenport, L. I., *Harvey;* Wood's Holl, Mass.

The above description is taken from a species common on *Fucus* at Wood's Holl, in May, 1876, which corresponds very well to the *E. lutosus* of the Nereis Am. Bor., a species which Harvey states is not clearly defined. It differs from the description given by Harvey in the fact that the sporangia are not very long, and it is not impossible that our plant may not be the same as that described by Harvey. The present species, as we understand it, is short and tufted and the filaments are densely interwoven into rope-like masses as in *E. tomentosus*,. The species seem to connect *Pylaiella* with *Euectocarpus*, resembling on the one hand *E. siliculosus* var. *hiemalis*, and on the other *E. firmus*. From the former it differs in the branching and the shape of the plurilocular sporangia, which are strictly cylindrical, never being in the least acuminate. From the latter it differs in being more slender and in having the sporangia always at the base of very long hairs, which sometimes branch, and not in the continuity of the branches themselves. The ramification is very like that of *E. firmus*. In drying the species becomes decidedly yellow.

E. MITCHELLÆ, Harv., Ner. Am. Bor., Vol. I, p. 142, Pl. 12 *g*.

"Tufts feathery; filaments very slender, decompoundly much branched; the branches and their lesser divisions alternate; the ultimate ramuli approximated; angles wide, and branches and ramuli patent; ramuli

attenuate; articulations of the branches twice or thrice as long as broad, of the ramuli once and a half as long; propagula elliptic-oblong or linear, quite sessile and very obtuse, transversely striate, several together." (Harvey, l. c.)

Nantucket, *Miss Mitchell.*

Only known from the description and plate in the Nereis.

SUBGENUS PYLAIELLA, Bory.

Both forms of sporangia formed from the cells in the continuity of the branches, and not by a transformation of special branches.

In the present subgenus one might, at first sight, be inclined to include *E. siliculosus* var. *hiemalis* and *E. lutosus*, but in those species the sporangia are rather situated at the end of branches, which are prolonged beyond the sporangia in the form of hairs, than in the continuity of the branches themselves.

E. LITTORALIS, Lyngb. (*Ectocarpus firmus*, Ag.—*Pilayella littoralis*, Kjellman.)

Filaments tufted or irregularly expanded at the base, two to ten inches long; branches numerous, usually opposite, given off at wide angles, erect; cells .02–4^{mm} broad; plurilocular sporangia irregularly cylindrical, very variable in size; unilocular sporangia formed of from two to thirty contiguous cells, .02–3^{mm} broad; fertile branches moniliform.

Var. ROBUSTUS. (*Ectocarpus Farlowii*, Thuret, in Farlow's List of the Marine Algæ of the United States, 1876.)

Filaments three or four inches long, densely branching; branches robust, opposite or irregular; cells .03–5^{mm} in breadth; fertile branches short and rigid, often transformed through nearly their whole length into unilocular sporangia, which are stout and cylindrical, only slightly moniliform at maturity; cells .04^{mm} broad and .03–4^{mm} in length.

Very common along the whole coast.

Var. *robustus* in exposed places from Nahant northward.

A very common species on our coast, which, although offering numerous forms, cannot, as it seems to us, be well specifically divided. When growing on wharves, where it is very common, or on other wood work, it forms expansions of indefinite extent from which rise tufts several inches long. The basal or prostrate portions branch very irregularly, and the cells are infested with *Chytridia* and other parasites. If species of *Ectocarpus* could be formed from sterile specimens, the basal portions of *E. littoralis* would offer a rich field to the species-maker. What is called var. *robustus* has not yet been found south of Cape Cod, but is common on the northern coast on *Fuci* and other algæ exposed to the action of the waves. The original *E. Farlowii* was founded on specimens collected by Mr. Higbee, at Salem, in November, 1874, and pronounced by the late M. Thuret, in a letter dated April 26, 1875, to be distinct from *E. littoralis*. In the Contributiones ad Algologiam et Fungologiam, Pl. 20, Reinsch figures, under the name of *Ectocarpus anticostiensis*, a form which, as far as can be

judged from the figure, is the same as *E. Farlowii*. Although in the present instance we have considered *E. Farlowii* to be a variety of *E. littoralis*, it must be admitted that it differs considerably from the form of *E. littoralis* common on the coast of France and England. Our reason for not considering it distinct is that we have large sets of specimens in which we have been unable to say with certainty whether they should be referred to *E. littoralis* or *E. Farlowii*, and with so many connecting links it seems best to regard *E. Farlowii* as an extreme form found in northern localities. Should the variety be eventually considered distinct the name of *E. anticostiensis* should be adopted, as no description of *E. Farlowii* has been published, and the species would be characterized by the robustness of the filaments and by the unilocular sporangia, which are broader than long, and borne in short, stout, patent branches. It is of frequent occurrence that some of the unilocular sporangia are binate. The plurilocular sporangia are common in spring and early summer, and the unilocular in the autumn.

E. BRACHIATUS, Harv.

"Finely-tufted, feathery, much branched; the branches free, opposite or quarternate; ramuli opposite, very patent; propagula forming oblong or elliptical swellings in the smaller branches, or at the point where two opposite ramuli issue." (Harv., Ner. Am. Bor., Vol. I, p. 138.)

South Boston, Lynn, Mass., *Harvey*.

We have never found this species, which is only known on our coast from Harvey's description. Le Jolis considers that the *E. brachiatus* of the Phyc. Brit., Pl. 4, is not the true *Conferva brachiata*, Engl. Bot., and he gives to the former the name of *E. Griffithsianus*. Never having seen American specimens, we cannot tell whether the American form mentioned by Harvey belongs to the *E. Griffithsianus* or not.

SUBGENUS CAPSICARPELLA, Kjellman.

Filaments erect, monosiphonous or in part polysiphonous; unilocular sporangia partly immersed in the frond; plurilocular sporangia formed by direct transformation of the cells of the branches.

E. SPHÆROPHORUS, Harv., Phyc. Brit., Pl. 126. (*Capsicarpella sphærophora*, Kjellman, Bidrag, p. 20, Pl. 1, Fig. 2.)

Filaments one to three inches long, tufted, densely branching; main branches opposite or whorled, often polysiphonous; secondary branches opposite or alternate, monosiphonous; unilocular sporangia spherical, about .04^{mm} in diameter, solitary, often binate, sometimes whorled, the cell from which the sporangia are formed dividing into at least three cells; plurilocular sporangia ?

On *Ptilota elegans*. May.

Nahant, *Mr. Collins*; Europe.

A rare species which has only been collected by Mr. Collins. The main filaments are at intervals polysiphonous, and remind one of a *Sphacelaria*. In Mr. Collins's specimens the sporangia were numerous and in some cases whorled, as is occasionally seen in European specimens. The species is to be sought in spring and early summer, and may be commoner than is now supposed, having escaped the observation of collectors on account of its small size.

INSUFFICIENTLY DESCRIBED SPECIES.

E. LANDSBURGII, Harvey, Ner. Am. Bor., Vol. I, Pl. 12 *d*.
Halifax, N. S.
E. HOOPERI, Harvey, l. c., Pl. 12 *e*.
Greenport, L. I. (?)
E. DIETZLÆ, Harvey, l. c., p. 144.
Greenport.

FAMILY SPHACELARIEÆ.

Fronds branching, polysiphonous, terminating in a large apical cell, often with a cortex formed of densely interwoven rhizoidal filaments; fructification same as in *Ectocarpeæ*.

Corticating cells wanting or confined to the base of the frond. *Sphacelaria.*
Main branches corticated throughout.
Branches opposite, distichous ..... *Chætopteris.*
Branches whorled ..... *Cladostephus.*

SPHACELARIA, Lyngb.

(From σφακελος, gangrene, referring to the tips of the branches, which are black and shriveled when dried.)

Fronds olive-brown, filamentous, branching; axis and branches terminated by a large apical cell, from which, by transverse, longitudinal, and oblique divisions, a solid frond is formed whose external surface is composed of rectangular cells arranged in regular transverse bands; hairs slightly developed or wanting; rhizoidal filaments few, rarely interwoven so as to form a false cortex; unilocular and plurilocular sporangia spherical or ellipsoidal, on short pedicels; non-sexual reproduction by peculiarly modified branches called propagula.

The old genus *Sphacelaria* was divided by Kützing into a number of genera, and his views have been adopted by many recent writers, especially in Germany. In *Stypocaulon* and *Halopteris* the branches arise from lateral divisions of the apical cell itself, while in *Sphacelaria* proper, *Chætopteris* and *Cladostephus*, the branches arise from cells below the apex. Whether this difference in the apical growth can be considered a generic mark is not altogether certain, and there hardly seems to be sufficient ground for separating *Halopteris* from *Sphacelaria*, and a number of writers, among whom may be named Harvey and Le Jolis, even include *Stypocaulon*. *Cladostephus* is markedly distinct; and *Chætopteris*, which differs from *Sphacelaria* principally in the corti-

GIRAUDIA SPHACELARIOIDES, Derb. & Sol., a common Mediterranean alga, which occasionally occurs as far north as the Scandinavian coast, may perhaps be found on our shore. It resembles a small *Sphacelaria*, but its growth is trichothallic, not from an apical cell, and the small unilocular sporangia cover the frond in dense patches. The plurilocular sporangia resemble those of some *Ectocarpi*, and are found at the base of the plant according to Areschoug.

cation of the main branches, is kept distinct by most writers. We have but a very imperfect representation of the Sphacelarioid group in this country. *Stypocaulon* and *Halopteris* are entirely wanting, and of *Sphacelaria* we have only *S. cirrhosa* and *S. radicans* on the northeastern coast, *S. tribuloides* in Florida, and what is supposed to be *S. fusca* in California. The species of *Sphacelaria* are variable, and the determination sometimes uncertain. The apical cells of our *Sphacelariæ* are frequently attacked by the unicellular parasite, *Chytridium sphacelarum*, Kny.

S. CIRRHOSA, (Roth) Ag.; Phyc. Brit., Pl. 178.

Fronds olive-brown, densely tufted half an inch to two inches high; main filaments erect, several times pinnate with opposite or irregularly spreading branches; rhizoidal filaments few or wanting; unilocular sporangia .06–7^{mm} long, globose; plurilocular sporangia .05^{mm} broad by .08^{mm} long, broadly ellipsoidal, secund on lateral branches, with unicellular pedicels; propagula rather stout, three (2–4) rayed, usually borne on distinct plants.

Common on *Fucus*, on which it forms dense globose tufts. Europe.

A variable species, sometimes with regularly opposite branches, at times with irregularly placed long branches. The propagula vary very much in size, and are generally found on plants which do not bear sporangia. With us they are much more common than the sporangia. An excellent account of the propagula is given by Janczewski in the Annales des Sciences, Series 5, Vol. XVII. In the Nereis Am. Bor. the word propagulum is used by Harvey to signify the contents of the apical cells, and this use of the word should not be confounded with its present application. The word propagulum as used in the Nereis is rather equivalent to the term sphacela of other writers. Sporangia are more common in the winter months, but are found occasionally in summer.

S. RADICANS, (Dillw.) Harv. (*S. olivacea*, var., Ag.; Pringsheim, l. c., Pls. 9 and 10.—*S. radicans*, Phyc. Brit., Pl. 189.)

Fronds olive-brown, half an inch to an inch high, forming dense turfs; filaments erect or prostrate, branches few, somewhat appressed, rhizoidal filaments often numerous; unilocular sporangia globose, .04–5^{mm} in diameter, numerous on the branches, on very short unicellular pedicels; plurilocular sporangia unknown; propagula slender, elongated.

On mud-covered rocks between tide-marks.

Newport, R. I.; Wood's Holl, Mass., and common from Nahant northwards; Europe.

The present species is smaller than the last, and forms small, indefinitely expanded turfs, especially on the under side of mud-covered rocks, often in company with *Ceranium Hooperi*. Numerous rhizoidal filaments are sometimes found at the base, so that different plants are bound together, but the species is without a false cortex. The name originally proposed for the species by Dillwyn was *S. radicans*. Agardh adopts Dillwyn's later name, *S. olivacea*, making of the form with numerous rhizoidal filaments a variety, *radicans*. Apart from their different habit and place of growth, it is difficult to assign exact marks by which to distinguish in all cases *S. cirrhosa* and *S. radicans*. In the latter the secondary branches are few and appressed, irregularly placed, never opposite, while in the former they are numerous, given off at wide

angles, and frequently opposite. In *S. cirrhosa* the sporangia are generally scattered on the secondary branches, while in *S. radicans* they are often clustered on the main branches. In both cases the pedicels are usually one-celled. In both species the propagula are so variable in outline that they cannot be described in few words, but those of *S. cirrhosa* are more robust than those of *S. radicans*.

Sphacelaria dedalea, Reinsch, Contrib. ad Alg. et Fung., p. 22, Pl. 30, described from the coast of Labrador, does not correspond to any form known to us from New England.

CHÆTOPTERIS, Kütz.

(From *χαιτη*, a hair, and *πτερις*, a fern.)

Fronds olive-brown, filamentous, branching; branches opposite, distichous, apical growth as in *Sphacelaria;* rhizoidal filaments very numerous, densely interwoven, so as to form a false cortex; plurilocular sporangia borne on the branches, shortly pedicillate, unilocular sporangia "globose on the tips of short special filaments" (Areschoug).

A genus founded on the old *Sphacelaria plumosa* of Lyngbye. It differs from *Sphacelaria* in the false cortication of the main branches by the interlacing of rhizoidal filaments, and from *Cladostephus* by the opposite, not whorled branches. The genus does not rest on a firm basis, for it occasionally happens in some of the species of *Sphacelaria* that the rhizoidal filaments form a rudimentary cortex. *Chætopteris squamulosa*, Kütz., is made by Geyler the type of a new genus, *Phloiocaulon*.

C. PLUMOSA, (Lyngb.) Kütz. (*Sphacelaria plumosa*, Lyngb., Phyc. Brit., Pl. 87.—*Chætopteris plumosa*, Kütz., Phyc. Gen., p. 293; Tab. Phyc., Vol. 6, Pl. 6, Fig. 1; Areschoug, Obser. Phyc., Part III, Pl. 2, Figs. 4 and 5.)

Fronds two to six inches long, tufted, rigid, attached by a small disk, main branches sparingly branched, secondary branches plumose; plurilocular sporangia numerous, secund on the upper side of short special branches, shortly stipitate, elliptical in outline; unilocular sporangia globose, terminal on short branches. (Areschoug, l. c.)

Prince Edward's Island, *Mrs. Davis*, and northward; Northern Europe.

A beautiful species, common in Northern Europe and Greenland, but not yet found farther south than Prince Edward's Island on the American coast. It may, however, be expected at Eastport and our northern border.

CLADOSTEPHUS, Ag.

(From *κλ δος*, a branch, and *στεφος*, a crown.)

Fronds olive-brown, branching, secondary branches (leaves) whorled, apical growth as in *Sphacelaria;* main stems densely corticated by growth of rhizoidal filaments, secondary branches (leaves) naked, hairs borne in tufts just below the apex of branches; unilocular and plurilocular sporangia on special branches (leaves), stipitate.

A genus comprising eight described species, several of which are undoubtedly merely forms of the common and widely diffused *C. verticillatus*, whose structure is minutely described by Pringsheim, l. c. The term leaves is applied by Pringsheim to the secondary branches. He considers the branching of the axis to be monopodial. The sporangia are produced in the winter months, the two kinds on separate plants or sometimes together.

C. VERTICILLATUS, Ag.; Phyc. Brit., Pl. 33; Pringsheim, l. c., Pls. 1–7.

Fronds four to ten inches high, slender, subdichotomous, secondary branches distinctly whorled, falcate, acute at apex, attenuate at base, furnished externally with a few spine-like branchlets; hairs numerous; unilocular sporangia globose, plurilocular sporangia irregularly ellipsoidal, borne on short pedicels on small special branches, which grow from the axis between the insertions of the secondary branches.

Var. SPONGIOSUS. (*Cladostephus spongiosus*, Ag.; Phyc. Brit., Pl. 38.)

Fronds more compact, whorls approximate, indistinct, secondary branches usually destitute of hairs and spine-like branchlets.

On stones in pools and below low-water mark.

Newport, R. I.; Orient, L. I.; Martha's Vineyard; Cape Ann, Mass.; Europe.

A plant at once recognized by its resemblance to a small *Ceratophyllum*. Rather common in several places south of Cape Cod, but seldom seen on the northern coast. It prefers somewhat exposed shores, and occurs at considerable depths. Although the close resemblance between *C. verticillatus* and *C. spongiosus* has long been noticed, the two species have generally been considered distinct. Geyler says that *C. spongiosus* is characterized by the absence of hairs and the external spines on the branches. Although this is in general true, one not unfrequently finds hairs and small spines on some of the branches, and *C. spongiosus* is evidently merely a variety of *C. verticillatus*. Nor is it the case, as some have supposed, that the verticillate form is confined to deeper water, while the spongiose form is found in tide-pools and near low-water mark.

FAMILY MYRIONEMEÆ.

Fronds minute, forming spots or thin expansions on other algæ, consisting of prostrate filaments united into a horizontal membrane, from which rise short vertical filaments, between which are borne the sporangia; unilocular and pluriocular sporangia as in *Ectocarpeæ*.

MYRIONEMA, Grev.

(From *μυριος*, numberless, and *νημα*, a thread.)

Fronds olive-brown, forming thin expansions on other algæ, composed of a horizontal layer of cells lying on the substratum, from which arise very numerous vertical filaments, closely packed together; unilocular and plurilocular sporangia between the vertical filaments, either sessile on the horizontal layer or on short pedicels; hairs arising from horizontal layer; growth peripheral.

A genus of minute algæ which form small brown spots on other plants. The species are ubiquitous, but the specific characters are not well defined, and a good share of the described species are merely different forms of the very common *M. vulgare*. The two different kinds of sporangia are sometimes found together, but are usually on different plants. The genus is most nearly related to *Ralfsia*, which may be said to be a *Myrionema* in which the horizontal layer has become much thickened, and the vertical filaments, with the interspersed sporangia, instead of covering the surface uniformly, have been confined to certain circumscribed portions. The two genera are closely connected by *Ralfsia clavata*, Crn., which was first described as a *Myrionema* by Carmichael. In *Ralfsia* the vertical filaments must be considered to be paraphyses, and perhaps those of *Myrionema* should also be so considered.

M. VULGARE, Thur. (*M. strangulans*, Grev.; Phyc. Brit., Pl. 280.—*M. punctiforme*, Harv., Phyc. Brit., Pl. 41 *b*.—*M. maculiforme*, Kütz., Tab. Phyc., Vol. VII, Pl. 93, Fig. 2.)

Fronds .04–8^{mm} in thickness, vertical filaments (paraphyses) slightly club-shaped and moniliform, unilocular sporangia oval, .019–27^{mm} broad by .03–4^{mm} long, sessile or borne on short pedicels.

Everywhere common on various algæ.

In Le Jolis's Liste des Algues Marines de Cherbourg, Thuret is quoted as authority for uniting several of the species of *Myrionema* of Harvey and Kützing. The alleged specific distinctions are plainly nothing but modifications of the same species, dependent on the place of growth. When found on small cylindrical fronds, as in some *Enteromorphæ*, the *Myrionema* surrounds the frond and constitutes the *M. strangulans* of Greville, and when growing on flat surfaces the form known as *M. punctiforme* is found. In this country the unilocular sporangia are very common, but we have never seen the plurilocular sporangia, while in the next species the plurilocular sporangia are more numerous, although both kinds are found.

M. LECLANCHERII, (Chauv.) Harv., Phyc. Brit., Pl. 41 *a*. Pl. 6, Fig. 5.

Fronds .06–10^{mm} in thickness, vertical filaments (paraphyses) cylindrical, unilocular sporangia oval, plurilocular sporangia .008–10^{mm} broad by .023–30^{mm} long, ovate, oblong, sessile or on very short pedicels.

On *Rhodymenia palmata*.

Gay Head, Mass.; Europe.

This species forms rather larger spots than the last on the common dulse. That it is really distinct from *M. vulgare* admits of doubt. There appears to be a difference in the paraphyses of the two, but such differences cannot be considered of much value. We have found both unilocular and plurilocular sporangia in the present species, but unfortunately have not preserved measurements of the latter. The plurilocular sporangia are sometimes very numerous and stand side by side without intervening paraphyses.

FAMILY LEATHESIEÆ.

Fronds lubricous or gelatinous, indefinitely expanded or irregularly globose, consisting of a basal portion, composed of irregularly branching filaments formed of large, colorless cells, and a cortical portion of closely packed, short, colored filaments; paraphyses often present;

Fructification borne at the base of cortical filaments; plurilocular sporangia cylindrical, composed of few cells in a row; unilocular sporangia globose.

Fronds forming small tufts on other algæ.
Cortex with a series of exserted colored filaments ..... *Elachistea.*
Cortex destitute of exserted filaments ..... *Myriactis.*
Fronds irregularly globose, hollow at maturity ..... *Leathesia.*

ELACHISTEA, Duby.

(From *ελαχιστα*, very small.)

Fronds olive-brown, tufted or pulvinate, basal portion solid, somewhat parenchymatous, composed of densely packed branching filaments, which become free at the surface and branch corymbosely so as to form a layer of short filaments (paraphyses), at the base of which are borne the sporangia of both kinds and a series of long exserted filaments; hairs formed at the base of the paraphyses, exserted; unilocular sporangia rhombic-ovoid, plurilocular sporangia cylindrical, composed of a few cells in a linear series.

A genus consisting of a few species, all of which form small tufts on other algæ, especially on *Fucaceæ*. They may be recognized by the double series of filaments borne on the surface of the solid and but slightly developed basal portion. The longer filaments and hairs float freely in the water, but the shorter paraphyses are packed rather closely together, forming as it were a definite cortical layer over the basal portion. The unilocular sporangia are common. The more or less solid basal portion of the fronds in some of the species gives off filaments which penetrate into the substance of the algæ on which they are growing, and by the growth and persistence of these filaments it may be that the species are propagated from year to year, as happens in the case of certain fungi. In other species no penetrating basal filaments have as yet been found.

The limits of the species are pretty well defined except in the case of *E. fucicola*, *E. lubrica*, and *E. flaccida*, where it must be confessed the species show a tendency to run into one another. In the present case we have included in *Elachistea* only the species in which, besides the paraphyses which cover the surface, there are long projecting colored filaments as in *E. scutulata*, on which Duby founded his genus *Elachistea* in the Botanicon Gallicon. Here undoubtedly belong *E. fucicola* and its allies, but the same can hardly be said of *E. pulvinata*, which was made by Kützing the type of his genus *Myriactis*. In this species the surface of the frond is covered by the paraphyses, but there is not in addition a series of elongated filaments as in *E. fucicola*, for the exserted hairs in *E. pulvinata* are of a quite different nature. We have referred *E. pulvinata* to the genus *Myriactis*, not, however, limiting the genus as Kützing has done, for some of the forms placed by him in *Phycophila* should be referred to *Myriactis*, although the greater part of them are correctly placed by algologists in *Elachistea*. It may be that there exist forms intermediate between the true *Elachisteæ* and *Myriactis*, but, from the study of dried specimens, we have not been able to come to such a conclusion. It should be remarked that *M. pulvinata* is placed in *Elachistea* by the most prominent algologists, as Thuret and Bornet, Agardh, Harvey, Le Jolis, and others. The unilocular sporangia are most common in summer, and the plurilocular sporangia are more frequent early in the season.

E. FUCICOLA, Fries; Phyc. Brit., Pl. 240; Ner. Am. Bor., Vol. I, Pl. 11 *b*. (*Phycophila fucorum* and *P. Agardhii*, Kütz., Tab. Phyc., Vol. VIII, Pl. 95, Fig. 2, and Pl. 96, Fig. 1.) Pl. 7, Fig. 3.

Fronds tufted, half an inch to an inch in thickness, basal portion distinct, subglobose, exserted filaments about .05^{mm} broad, attenuated at base, obtuse at apex, cells of lower portion broader than long, becoming longer in the upper portion; paraphyses recurved, clavate, submoniliform; unilocular sporangia .07–8^{mm} broad by .15–20^{mm} long, pyriform or obovate-rhombic.

Common on *Fuci* along the whole coast.

On submerged wood work, Eastport, Peak's Island, Maine.

A common parasite, forming small tufts on *Fuci*. There seems to be but one species on the coast of New England, although *E. lubrica*, Rupr., may be expected on *Halosaccion*. According to Areschoug, *E. lubrica* differs from *E. fucicola* in the shorter cells and the decidedly elongated base of the free filaments, but in these respects European specimens of *E. fucicola* vary greatly. Possibly the form occurring on wood at Eastport may be rather referred to *E. lubrica*. Ruprecht, in Phycologia Ochotensis, mentions an *Elachistea* from Canada parasitic on *Halosaccion*, which he considers distinct from both *E. lubrica* and *E. fucicola*, to which he gives the provisional name of *E. canadensis*. It is distinguished from *E. fucicola* "by the thicker filaments, which never give off free branches at the base, by the dense, indistinctly filamentous structure of the basal layer, and by the greater number of short filaments and few long filaments." From Ruprecht's description it is hardly likely that the species will ever be recognized by American collectors. The views of Ruprecht with regard to development in algæ are curiously shown in his remarks on *Elachista*, *Myrionema*, and *Leathesia*. He thinks it very probable that the genera named were "originally organs of fructification of *Halidrys*, *Cystoseira*, &c., which in course of time have not developed, and have in this way formed what appear to be stereotyped species." Although the fact is not as Ruprecht supposed, this pronounced tendency to Darwinism is remarkable when we think that Ruprecht wrote in 1850.

MYRIACTIS, Kütz., emend.

(From *μυριος*, countless, and *ακτις*, a ray.)

Fronds as in *Elachistea*, but destitute of exserted colored filaments.

A comparison of the two admirable plates of *Elachistea scutulata* and *Elachistea* (*Myriactis*) *pulvinata* in the Études Phycologiques of Thuret and Bornet will give a clear notion of the difference of the two genera.

M. PULVINATA, Kütz. Var. MINOR. (*Elachistea pulvinata*, Harv., in Études Phycologiques, p. 18, Pl. 7—*Elachistea attenuata*, Harv., Phyc. Brit., Pl. 28.)

Fronds forming minute tufts, basal portion slightly developed, giving off lateral filaments, which penetrate the substratum; paraphyses slightly curved, fusiform, attenuated at base, somewhat moniliform; cells .0075–180^{mm} broad, two or three times as long; plurilocular sporangia very numerous, clustered at the base of the paraphyses, cylindri-

cal, 0076^{mm} broad by about .057^{mm} long, composed of 8–10 cells in a row; unilocular sporangia.

Parasitic in the cryptostomata of *Sargassum vulgare*. Summer. Wood's Holl, Mass.

This species forms minute tufts on *Sargassum*, and is so small as easily to escape detection. It is furthermore likely to be mistaken for the hairs normally found at certain seasons in the cryptostomata. The description given above applies to the plant found at Wood's Holl, which is smaller than the typical *M. pulvinata* of Europe, which grows in the cryptostomata of various *Cystoseiræ*. In the European specimens examined the paraphyses were decidedly stouter, rarely being less than .018^{mm} in breadth, whereas with us they are seldom more than .010–12^{mm} broad. Our plant is throughbut smaller than the European, but, in proportion, the paraphyses are longer and slenderer. It remains to be seen whether we are correct in considering our form a mere variety, or whether it should be kept distinct. Perhaps it may be the *Phycophila arabica* of Kützing, Tab. Phyc., Vol. 8, Pl. 1, Fig. 2, which grows on *Cystoseira myrica*. The species is not uncommon in summer at Wood's Holl, and both forms of sporangia occur together, the unilocular being much less abundant than the plurilocular.

LEATHESIA, S. F. Gray.

(Named in honor of *Rev. G. R. Leathes*, a British naturalist.)

Fronds olive-brown, gelatino-carnose, forming irregularly globose masses, solid when young, but soon becoming hollow; internal portion composed of radiating, dichotomous filaments, formed of large, irregular, colorless cells, the terminal ones bearing a series of short, simple, colored filaments (paraphyses), which are densely packed together, constituting the cortical layer of the frond; sporangia and hairs borne at the base of the paraphyses; plurilocular sporangia cylindrical, composed of few cells in a single row; unilocular sporangia pyriform or ovoid.

A small genus, comprising not more than half a dozen species, of which *L. difformis* is common in the North Atlantic. *Leathesia Berkeleyi*, Harv., now placed in the genus *Petrospongium*, Næg., although found not rarely in Europe and apparently tolerably common on the coast of California, has not yet been detected in New England, but may be expected. It forms rather leathery expansions on rocks at low-water mark.

L. DIFFORMIS, (Linn.) Aresch. (*Tremella difformis*, Linn., Syst.—*Rivularia tuberifor mis*, Engl. Bot., Pl. 1956.—*Corynephora marina*, Ag., Syst.—*Leathesia tuberiformis*, Gray, in Phyc. Brit., Pl. 324, and Ner. Am. Bor., Vol. I, Pl. 10 *c*; Thuret, in Ann. des Sciences, Ser. 3, Vol. XIV, Pl. 26, Figs. 5–12.) (**Pl. V, Fig. 1.**)

Fronds from half an inch to two inches in diameter, solitary or aggregated, at first globose and solid, becoming irregularly lobed and hollow; plurilocular sporangia produced early in the season, unilocular sporangia in summer.

Common on algæ and on sand-covered rocks at low water along the whole coast.

Not to be mistaken for any other alga on our coast. The gelatinous balls which this species forms are found growing in large quantities at low-water mark, and are sometimes called potatoes by the unromantic dwellers on the shore.

Family CHORDARIEÆ.

Fronds cylindrical, branching, usually gelatinous, with an axis of longitudinal filaments formed of long slender cells, and a cortex composed of short, densely packed horizontal filaments formed of subspherical cells; sporangia borne among the cortical filaments or formed directly from them.

Fronds tough and elastic, cortical filaments densely united to one another ..... *Chordaria.*

Fronds gelatinous, cortical filaments only adhering loosely to one another.

Upper cells of the cortical filaments producing the plurilocular sporangia..... *Castagnea.*

Upper cells of cortical filaments not producing sporangia. *Mesogloia.*

CHORDARIA, Ag.

(From *chorda*, a chord.)

Fronds olive-brown, cartilaginous, filiform, branching; axial layer composed of longitudinally elongated cylindrical cells and smaller winding cells packed closely together in a solid mass; peripheral layer composed of short, simple, horizontal filaments, densely packed together; unilocular sporangia oblong, borne at the base of the peripheral filaments (paraphyses), plurilocular sporangia unknown.

The distinction between the genera *Chordaria* and *Mesogloia*, in the absence of a knowledge of the development of the fronds, must be quite arbitrary. In the present instance we have considered that the genus *Chordaria* should be limited to the forms having a tough cartilaginous substance and solid axis, of which we have only one representative, *C. flagelliformis*. *C. divaricata*, both in its consistency and the development of the frond, seems to belong to *Mesogloia*, accepting that genus in an extended sense as we have done.

C. FLAGELLIFORMIS, Ag.; Phyc. Brit., Pl. 3. **Pl. V, Fig. 2.**

Fronds blackish, solitary or gregarious, attached by a disk, coriaceous, lubricous, one to two feet long, filiform, solid, main axis usually undivided, furnished with numerous long, subequal, flagelliform branches, which are given off at wide angles, simple or with few, irregular, secondary branches; peripheral filaments (paraphyses) few-celled, cylindrical or slightly club-shaped; unilocular sporangia ovoid or pyriform.

Var. DENSA.

Fronds six to eight inches long, main axis densely clothed with very numerous short branches.

Common on stones near low-water mark along the whole coast.

The var. *densa* at Gloucester, Mass., *Mrs. Davis.*

A common species, recognized by its tough, somewhat elastic substance, and reminding one of bunches of small leather shoe-strings. When soaked in water it gives out a large amount of slime, and is not easily mounted. To the naked eye it resembles some of the forms of *Dictyosiphon*, but the microscopic structure is very different. The variety has been collected several times at Gloucester, but has not been received from other localities.

MESOGLOIA, Ag.

(From μεσος, the middle, and γλοιος, slimy.)

Fronds olive-brown, gelatinous, filiform, branching; axial layer composed of filaments rather loosely united into a solid mass, which soon becomes fistulose; peripheral layer of short horizontal filaments, packed in a gelatinous substance; unilocular sporangia oval, borne at the base of peripheral filaments; plurilocular sporangia unknown.

The old genus *Mesogloia* has been divided by modern algologists into a number of genera. In the present instance we have kept in *Mesogloia* the species in which the peripheral filaments are not transformed into plurilocular sporangia, and have placed in *Castagnea* the species in which they are so transformed. The distinction between *Mesogloia* and *Castagnea* is artificial, because the plurilocular sporangia of *Mesogloia* proper are unknown, and it is not impossible that they may be formed from the peripheral filaments themselves, as in *Castagnea*. The development of the fronds is not well known, and the genera founded upon the variations in the mature fronds in the present group are plainly artificial. As regards its development, *M. divaricata* resembles very closely *C. virescens*. From a disk-like expansion, composed of a single layer of cells, which form spots on the substance upon which it is growing, arise vertical filaments, which end in a hair such as is found in *Ectocarpus* and other *Phæosporeæ*. The vertical filaments produce, usually only on one side, fasciculated branches terminated by a hair, beneath which is a cluster of short moniliform filaments. Besides these there arise, at a later period, rhizoidal filaments. The mature fronds of the two species above named may be regarded as a collection of filaments with a trichothallic growth, which have become twisted together and partially united by means of the rhizoidal filaments, and whose fasciculated branches constitute what, in the mature plant, seems to be a distinct cortical layer. In *Castagnea virescens* the separate filaments, with their lateral fasciculate branches, can easily be isolated by dissecting the smaller branches, and the same thing can also be accomplished with *Chordaria divaricata*, although not so easily. The species of *Mesogloia* and *Castagnea* should not be dried under too heavy pressure, and alcoholic specimens are much better for study than those mounted on paper.

M. DIVARICATA, Kütz. (*Chordaria divaricata*, Ag.; Phyc. Brit., Pl. 17; Ner. Am. Bor., Vol. I, Pl. 11 *a*.)

Fronds tufted, lubricous, six inches to two feet long, branching very irregular, generally without a definite main axis; branches flexuous, ultimate branches very numerous, short, and divaricate, at first solid,

afterwards becoming fistulose and tubular; peripheral filaments short, few-celled, the last cell obovate and several times larger than the other cells; unilocular sporangia ovoid.

On algæ and stones near low-water mark.

Very common from Cape Cod southward; Niles Beach, Gloucester, Mass.; Europe.

A characteristic species of Long Island Sound, where it is probably more abundant than in any other part of the world. It abounds in still, shallow bays. North of Cape Cod it is of small size, and is only occasionally met with. It assumes a number of different forms, none of which, however, can be considered as distinct varieties. It first appears in May, and reaches perfection in August and September. At first the fronds are small and solid, but they grow to be two feet long, or even longer, and the main branches become hollow and finally collapsed. Except that they are more luxuriant, our forms agree well with Norwegian specimens.

M. VERMICULARIS, Ag.; Phyc. Brit., Pl. 31.

Fronds tufted, gelatinous, one to two feet long, branches long, irregularly pinnate, thick, vermiform, flexuous; peripheral filaments clavate, somewhat incurved, moniliform cells spheroidal; unilocular sporangia ovoid.

On stones and algæ between tide-marks.

Halifax, N. S., *Harvey;* Europe.

A rather common plant of Europe, and probably occurring within our limits, but as yet only reported at Halifax on the American coast. The species is rather thick and clumsy, and very gelatinous; not at all likely to be confounded with *M. divaricata,* which is less gelatinous, has a different mode of branching, and whose peripheral filaments are terminated by a cell much larger than the others. Dried specimens may be mistaken for *Castagnea virescens,* a more slender plant, with longer and more slender peripheral filaments, the upper cells of which are transformed into plurilocular sporangia. We have only examined dried specimens of this species.

CASTAGNEA, (Derb. & Sol.) Thuret, emend.

(In honor of *Louis Castagne,* a French botanist.)

Fronds and unilocular sporangia as in *Mesogloia;* plurilocular sporangia formed by outgrowths from the uppermost cells of the peripheral filaments.

C. VIRESCENS, (Carm.) Thuret. (*Mesogloia virescens,* Carm., in Phyc. Brit.; Ner. Am. Bor., Vol. 1, Pl. 10 *b;* Ann. Sci. Nat., Ser. 3, Vol. 14, Pl. 27.) Pl. 7, Fig. 1.

Fronds filiform, gelatinous, three inches to a foot and a half long, axis clothed with numerous, irregular, flexuous branches, ultimate branches short, given off at wide angles; fronds at first solid, becoming fistulous; peripheral filaments slender, clustered, recurved or incurved, cylindrical or only slightly moniliform, cells ellipsoidal, .015–20^{mm} in diameter; unilocular sporangia ovoidal or rhombic-ovate; plurilocular spo-

rangia siliculose, composed of three to six cells, formed from the terminal cells of peripheral filaments, often secund on the upper side.

On sand-covered rocks and algæ at and below low-water mark.

Wood's Holl, Nahant, Gloucester, Mass.; Portland, Maine, *Mr. Fuller;* Europe.

A species which is rather common in the spring months, but which disappears with us about the 1st of July. The fronds are more slender than in *M. vermicularis,* but when dried under too great pressure, or when allowed to remain some time in fresh water, they somewhat resemble that species. The distinction is best seen in the peripheral filaments. Those of *M. vermicularis* are shorter, decidedly clavate, less curved, and are formed of spheroidal cells In *C. virescens* they are longer, more nearly cylindrical, recurved, and formed of ellipsoidal cells. The number and size of the plurilocular sporangia vary very much.

C. ZOSTERÆ, (Mohr.) Thuret. (*Myriocladia zosteræ*, Ag.—*Mesogloia vermicularis*, var. *zosteræ*, Kütz., Spec. Alg.—*M. virescens*, var. *zostericola*, Harv., Phyc. Brit., Pl. 82.—*M. zosteræ*, Aresch., in Ner. Am. Bor., Vol. I, p. 127, Pl. 10 *a*.) Pl. 7, Fig. 2.

Fronds filiform, gelatinous, three to eight inches long, subsimple, furnished with a few short, remote branches, given off at wide angles; peripheral filaments erect, rather rigid, cylindrical below, moniliform above; cells spheroidal, .02–4^{mm} in diameter; unilocular sporangia ovate; plurilocular sporangia siliculose, composed of three to six cells, usually forming dense tufts on the upper part of the peripheral filaments.

On eel-grass.

Wood's Holl, Gloucester, Mass.; Europe.

A small species with very few branches, which, although it has been by some considered a variety of *C. virescens,* is sufficiently distinct both in its microscopic structure and the season of growth. *C. virescens* is a spring form, which disappears in early summer, while *C. Zosteræ,* at least on our coast, occurs in summer and autumn. The appearance of the peripheral filaments is different in the two species. In *C. virescens* they are slender and curved and in *C. zosteræ* rather stout and erect and more densely packed together, in this respect resembling *M. vermicularis,* in which, however, the filaments are distinctly clavate and moniliform, and do not produce plurilocular sporangia at the extremity. A section of the frond of a well-developed *C. virescens* shows a circle of roundish cells around a central cavity and on the outside a series of branching filaments, which end in the proper peripheral filaments and sporangia. In *C. Zosteræ* there is also a circle of cells surrounding a central cavity, but the peripheral filaments seem to be given off directly from the circle of cells. The figure in the Nereis Am. Bor. does not correctly represent the structure of *C. Zosteræ,* for the clusters of peripheral filaments are not outgrowths from special colored filaments, but from the uncolored cells. American specimens agree perfectly with the specimens of *Mesogloia zosteræ,* No. 100, of Areschoug's Alg. Scand.

FAMILY RALFSIEÆ.

Fronds horizontally expanded, sometimes crustaceous; fructification in raised spots (sori), composed of few-celled club-shaped paraphyses and spheroidal unilocular sporangia.

RALFSIA, Berkeley.

(In honor of *John Ralfs*, an English botanist.)

Fronds olive-brown, forming flat coriaceous or crustaceous expansions of indefinite extent, composed of a single horizontal layer, from which arise short vertical filaments, which are firmly united to one another so as to form a solid parenchymatous structure; fruit scattered over the surface of the fronds in spots (sori), which are composed of club-shaped, several-celled paraphyses, at whose base are borne the unilocular sporangia; hairs arising from crypts in the frond; plurilocular sporangia unknown; growth peripheral.

A genus containing only about half a dozen species. In its mode of growth the frond resembles that of *Myrionema*, but the vertical filaments are not free, as in that genus, but united so as to form a solid mass. *R. verrucosa*, the typical species, has a well-developed frond, but in *R. clavata* the frond is minute and the fruit-dots are usually confluent, so that the species has by some been placed in *Myrionema*.

R. VERRUCOSA, Aresch. (*R. deusta*, Berk.; Phyc. Brit., Pl. 98.)

Fronds licheniform, adherent throughout, crustaceous or membranaceous, at first orbicular, at length becoming indefinite in outline, one to six inches in diameter, zoned and irregularly tuberculated, the newer lobes overlapping the older; sori scattered; paraphyses .06–12^{mm} long, clavate, few-celled; unilocular sporangia ovoid or pyriform, .038^{mm} long by .019^{mm} broad.

Common on rocks in pools at half-tide from Nahant northward; Europe.

A homely, dark-colored species, which has more the habit of a lichen than an alga. It abounds on the northern coast in shallow exposed pools, and is found at all seasons. At first the crusts are of small size and adhere closely to the rocks, but afterwards, as they increase in size, they become lobulated and rough and are easily detached. The species, contrary to the statement of Janczewski, is furnished with tufts of hairs at certain seasons of the year. It may occur also south of Cape Cod, but, if so, it must be in a reduced form.

R. DEUSTA, J. Ag.

Fronds licheniform, membranaceous, attached at center, margin free, irregularly orbicular, with overlapping marginal lobes, marked with concentric zones and with radiating striæ; spores?

At low water mark.

Eastport, Maine.

A larger and more foliaceous species than the preceding, being about .25–30^{mm} in thickness. Both the concentric zones and radiating striæ are well marked, and the species is comparatively loosely attached to the substratum. On sectioning the fronds of *R. deusta*, the cells are seen to be arranged in lines which curved upwards and downwards from a medial plane, while a section of the frond of *R. verrucosa* shows the cells arranged in lines which curve upwards from the attached base.

R. CLAVATA, (Carm.) Crouan, Florule du Finistère. (*Myrionema clavatum*, Carm., in Phyc. Brit., Pl. 348.)

Fronds thin, forming closely adherent crusts or coriaceous expansions, at first orbicular and afterwards irregular; paraphyses clavate, rather uniformly diffused over the frond; unilocular sporangia pyriform, .06–.7^{mm} broad by .15–.18^{mm} long, attached to the base of the paraphyses.

On stones and wood work

Eastport, Maine; Wood's Holl, Malden, Mass.; Europe.

A small species, whose position is doubtful. It was placed by Harvey in *Myrionema*, from the typical species of which it differs in having a frond composed of several layers of horizontal cells. By Crouan it was placed in *Ralfsia*, but the erect filaments rather resemble the paraphyses in *Myrionema*. In short, the species may be said to be a *Ralfsia* with diffuse fructification and slightly developed frond, or a *Myrionema* with an excessively developed basal portion. American specimens resemble perfectly the No. 56 of Crouan's Algues Marines du Finistère. The alga described by Areschoug under the name of *Lithoderma fatiscens* bears a striking resemblence to the present species. The species is much smaller and thinner than *R. verrucosa*, not exceeding on the average .15^{mm} in thickness, and covers stones and wood work at Eastport, sometimes in company with *R. verrucosa*. Further inquiry will probably show that the plant is common along the whole coast.

FAMILY ASPEROCOCCEÆ.

Fronds tubular or compressed, usually simple, occasionally branched; fructification in external scattered sori, composed of cylindrical few-celled paraphyses and spherical unilocular sporangia.

ASPEROCOCCUS, Lam.

(From *asper*, rough, and κοκκος, a berry.)

Fronds olive-brown, simple or branched, hollow, composed of a few layers of cells, those of the interior being larger and colorless, those of the surface smaller and colored; fruit external, scattered in spots (sori) over the fronds; sori composed of paraphyses and unilocular sporangia, which are formed from the superficial cells of the fronds; paraphyses numerous, cylindrical or club-shaped; unilocular sporangia globose, sessile between the paraphyses; plurilocular sporangia unknown; hairs tufted, arising from the superficial cells; growth of fronds basal.

The genus *Asperococcus* is distinguished by the external scattered fruit, consisting of paraphyses and unilocular sporangia. In the Nereis Am. Bor. it was placed by Harvey in the order *Dictyotaceæ*, but the fructification in that order is now known to be very different. The genus comprises a small number of species, which are widely diffused, although as yet only one has been found on the New England coast. The *Asperococci* resemble, to a certain extent, species of *Phyllitis* and *Scytosiphon*, but are easily distinguished by the fruit, which is almost always present. Plurilocular sporangia are unknown in the true *Asperococci*, and the old *A. sinuosus*, which is found in Florida and California, is considered by Bornet to belong to the genus *Hydroclathrus*, which has plurilocular sporangia of the same type as *Phyllitis* and *Scytosiphon*. *A. compressus*

and *A. bullosus* are to be expected to occur with us. The *A. compressus* of the List of the Marine Algæ of the United States, in the Proc. Am. Acad. Arts and Sciences of March, 1875, is an error. The only specimen seen was collected at Gloucester by Mrs. Lusk, and proves to be a bleached and brownish fragment of *Halosaccion*.

A. ECHINATUS, Grev.; Phyc. Brit., Pl. 194. (Pl. V, Fig. 3.)

Fronds gregarious, simple, attached by a small disk from two inches to a foot and a half long, about half an inch in diameter, tapering at base, often twisted but not constricted, color a dingy brown, spotted with the very numerous sori.

Attached to algæ between tide-marks.

Common along the whole coast; Europe.

A homely species, usually found in tufts four or five inches long, and of about the substance of *Scytosiphon lomentarius*, but usually spotted with the numerous fruit-dots. The diameter, which is nearly uniform throughout, is about that of a clay pipe-stem. *A. bullosus* is much larger and more sack-like and often decidedly constricted.

FAMILY SPOROCHNEÆ.

Fronds cylindrical or tubular, branching, composed within of elongated cuboidal cells, which become smaller and roundish at the surface; fructification in external scattered sori, composed of club-shaped filamentous paraphyses and sporangia; unilocular sporangia spheroidal; plurilocular sporangia cylindrical formed of a single row of cells.

Fronds solid, sori irregularly scattered ..... *Stilophora.*
Fronds hollow, sori arranged in transverse lines ..... *Striaria?*

STILOPHORA, Ag.

(From στιλη, a point, and φορεω, to bear.)

Fronds olive-brown, filiform, branching, solid, becoming hollow, composed internally of elongated colorless cells, which become smaller and colored towards the surface; fruit external, scattered in spots (sori) over the surface; sori hemispherical, consisting of club-shaped filamentous paraphyses, at whose base are borne the sporangia; unilocular sporangia ovoidal; plurilocular sporangia cylindrical, formed of a single row of cells.

A genus placed by Agardh and Harvey in the *Dictyotaceæ*, but by other algologists considered more nearly related to the *Sporochneæ*. It includes only a small number of species, probably not more than eight, and is readily recognized by the external fruit in which the sporangia are borne at the base of clavate few-celled paraphyses. The development of the frond has not been made out, but at the tips of the branches is a complicated mass of filaments ending in hairs like those of *Ectocarpus*, at whose base are borne a few short, incurved, moniliform filaments. At a short distance below the apex of the frond the moniliform filaments disappear and the surface appears to consist of roundish cells where not interrupted by the numerous sori. It is probable that,

as has been suggested by Janczewski in speaking of *Sporochnus*, the frond of *Stilophora* grows in a manner similar to that of *Cutleria*, which may be said to belong to the compound trichothallic type.

S. RHIZODES, Ag. (*Sporochnus rhizodes*, Ag., Spec.—*Spermatochnus rhizodes*, Kütz., Spec.—*Stilophora rhizodes*, J. Agardh; Phyc. Brit., Pl. 70; Ann. Sci. Nat., Ser. 3, Vol. XIV, Pl. 28.) (**Pl. V, Fig. 4, Pl. VI, Fig. 2.**)

Fronds attached by a disk, filiform, solid, becoming somewhat fistulous, six inches to two feet long, branching subdichotomously, destitute of distinct axis, branches becoming attenuated, ultimate divisions erect; sori very numerous, scattered irregularly over the frond; paraphyses few-celled, clavate, somewhat incurved; unilocular sporangia oval; plurilocular cylindrical.

Not uncommon at various points in Vineyard Sound and Long Island Sound on algæ and eel-grass below low-water mark.

The present species is sometimes found at the base of eel-grass and the larger algæ, but it is more commonly found in entangled masses a foot or two long washed ashore in sheltered bays after a heavy blow. The determination is not altogether satisfactory, for our plants are generally coarser than the European forms of the species. Nor do they correspond to *S. Lyngbyei*, which is coarser and more tubular, and has finer ultimate branches and sori which are somewhat remote and arranged in transverse bands, if we follow Harvey's description. Another species, hardly coming within our limits, was found by Bailey in the Chesapeake and referred by Harvey, with considerable doubt, to *S. papillosa*, Ag.

STRIARIA, Grev.

(From *stria*, a ridge, referring to the arrangement of the sporangia in transverse lines.)

Fronds attached by a disk, tubular, branched, cells of the interior large, roundish, of the exterior smaller and subrectangular; fruit consisting of sporangia (or spores?), arranged in transverse lines.

A genus whose position is very doubtful, because the structure of the fruit is not sufficiently well known. By most writers it is placed in the *Dictyotaceæ*, but it is not certain that the typical species, *S. attenuata*, possesses the peculiar antheridia and tetraspores of that order. According to Areschoug, there are two forms of fruit, one immersed, as in *Punctaria*, the other external, as in *Asperococcus*.

S. ATTENUATA, Grev., Phyc. Brit., Pl. 25; Ner. Am. Bor., Vol. III, Suppl., p. 123.

Fronds a few inches to a foot long; branches usually opposite, attenuated to a fine point.

Flushing, L. I., *Bailey*.

The only American specimen known is that mentioned by Harvey in the Supplement to the Nereis Am. Bor. as having been found at Flushing, L. I.

FAMILY LAMINARIEÆ.

Fronds large and coarse; species on our coast usually attached by root-like processes, and with a stipe and expanded lamina, in one genus

cylindrical; fructification in broad bands or large irregular spots, or occasionally covering the whole surface of frond, composed of large broadly clavate or wedge-shaped paraphyses and oval unilocular sporangia.

Fronds cylindrical.....*Chorda.*
Fronds with a midrib.
Fronds perforated with holes.....*Agarum.*
Fronds entire, with lateral leaflets at the base of lamina....*Alaria.*
Fronds destitute of midrib.
Cryptostomata present.....*Saccorhiza.*
Cryptostomata wanting.....*Laminaria.*

CHORDA, Stack.

(From *chorda*, a string.)

Fronds olive-brown, attached by a disk, simple, cylindrical, hollow, with diaphragms at intervals; cells of tubular portion elongated, hexagonal in section, lined on the inside with filaments, which at intervals are woven together so as to form the diaphragms; whole surface of the frond clothed with cuneate-clavate cells (paraphyses), which form a cortical layer; unilocular sporangia ellipsoidal, situated between the paraphyses, growth basal; plurilocular sporangia unknown.

A small genus, consisting of three or four species, which are by some writers placed in the *Chordariaceæ* and by others in the *Laminariaceæ*. The typical species, *C. filum*, may be regarded as the lowest representative of the *Laminariaceæ*, inasmuch as it has the basal mode of growth and the unicellular paraphyses of that order, but a simple frond in which there is no distinction of stipe and lamina. See, also, remarks under *Scytosiphon*.

C. FILUM, Linn. (*Scytosiphon filum*, Ag.—*Chorda filum*, Phyc. Brit., Pl. 107; Annales des Sciences, Ser. 3, Vol. XIV, Pl. 29, Figs. 5–10.) **Pl, VI, Fig. 1.**

Fronds gregarious, cartilaginous-lubricous, quarter of an inch in diameter, from one to twelve feet long, attenuate at base, densely clothed with hyaline hairs; paraphyses cuneate-clavate, slightly longer than the sporangia and overlapping them.

On stones at low-water mark and below.

Common along the whole coast; Europe.

At once recognized by its cord-like appearance. The early form, which is densely covered with hairs, constitutes the *C. tomentosa* of some writers. Areschoug, however, considers that the true *C. tomentosa* of Lyngbye is distinct, and characterized by its elongated linear paraphyses, which are scarcely as long as the sporangia, which ripen early in the season, while those of *C. filum* ripen in the latter part of summer and autumn.

LAMINARIA, Lamx.—*Devil's Aprons.*

(From *lamina*, a plate.)

Fronds attached by a branching base,* stipitate, stipe expanding into a ribless entire or laciniate lamina; fruit forming bands or sori in the central part of the lamina, consisting of unicellular paraphyses and unilocular sporangia densely packed together; cryptostomata wanting.

A genus comprising not far from twenty-five species, which inhabit principally seas in high latitudes. They all grow in pools at low-water mark and in deep water, and some attain a very large size. The limits of the genus are well fixed, but the same can by no means be said of the species, with regard to which writers differ very much. The difficulty arises partly from the fact that the species lose some of their characteristic marks in drying, so that the study of herbarium specimens is unsatisfactory, but still more from the fact that the species vary greatly in outline and habit according to the season and the place of growth, whether at an exposed or sheltered coast or whether submerged or partly exposed at low tide. In general, the species may be classed in two groups, those in which the frond is ribbon-like, that is, long in proportion to the breadth and not split up into segments, and those in which the frond is proportionately broader and fan-shaped and, except when young, laciniate. To the former group belongs the *L. saccharina* of older writers, to the latter *L. digitata*, and it is with regard to the extent to which subdivision shall be carried in the two cases mentioned that recent writers differ very widely. Our species have not been sufficiently studied in situ to warrant us in giving the determinations with any degree of confidence. More information with regard to their winter condition is very much needed. The most detailed account of the *Laminariæ* of the eastern coast is to be found in the paper of De la Pylaie in the Annales des Sciences Naturelles, Ser. 1, Vol. IV, 1824, entitled "Quelques observations sur les productions de l'île de Terre-Neuve, et sur quelques algues de la côte de France appartenant au genre *Laminaire.*" The article is accompanied by a plate in which is sufficiently well shown the habit of our common species. The same writer in 1829 gave a more extended account of his collections in the "Flore de Terre-Neuve et des îles Saint Pierre et Miclon," an incomplete work comprehending the *Laminariaceæ* and *Fucaceæ*, of which, however, the plates were never published. The species of De la Pylaie have not been accepted without question by algologists, and all agree that he was too liberal in the formation of new species. Harvey ignores the greater part of them in the Nereis. Agardh and Le Jolis give them a more respectful consideration, and the former especially is inclined, in his paper on the *Laminariaceæ* and *Fucaceæ* of Greenland, to admit several of De la Pylaie's species. In the present case we do not feel at liberty to make use of the notes with regard to American forms which have been kindly furnished by European correspondents, but must content ourselves with a superficial account of the perplexing forms of this exasperating genus, adding that the identity of our forms with those of Europe is not in all cases proved.

Of the species of *Laminaria* given in the Nereis, *L. fascia* in now placed in *Phyllitis; L. lorea* and *L. dermatodea* refer to the same plant, which is now placed in *Saccorhiza; L. longicruris* is still kept as in the Nereis; *L. saccharina* and *L. digitata* are kept with limitations; and *L. trilaminata* is, as Harvey suspected, merely an abnormal winged form of some other species, corresponding to the trilaminate condition mentioned under *Agarum Turneri.*

The marks used in distinguishing the species are the arrangment of the root-fibers; the structure of the stipe, whether solid or hollow, whether provided with distinct cavities containing mucus (muciparous glands) the shape of the lamina, more particu-

* A few species, as *L. solidungula*, Ag., have a disk-like base, and *L. sessilis*, Ag., including *L. apoda*, Harv., found on our west coast, has no stipe properly speaking.

larly of its basal portion; the presence or absence of a series of alternate depressions and elevations within the margin; and the position of the fruit. The growing portion of the *Laminariæ* is at the base of the lamina, and the apex of the stipe and the old fronds are pushed off by the newly formed ones below. The fruit is perfected in autumn and winter.

L. LONGICRURIS, De la Pyl. (*L. longicruris*, Ann. Sci., l. c., Pl. 9 *a* and *b*; Phyc. Brit., p. 339; Ner. Am. Bor., Vol. I, Pl. 6.)

EXS.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 117.

Fronds solitary or gregarious, attached by numerous long, slender, branching fibers; stipe six to twelve feet long, one to two inches thick, slender and solid at the base, becoming hollow and inflated at the middle and upper part, contracted at the apex; lamina ovate-lanceolate, five to twenty feet long, two to three feet broad; margin very wavy, within the margin two rows of depressed spots; fruit forming a continuous band in the center of the frond; color lightish brown; substance rather delicate.

Common in deep water, and at Eastport at low-water mark.

From Nahant, Mass., northward; North Atlantic and Arctic Oceans.

A striking species, easily recognized when in typical condition, but unfortunately variable, though not so much so as our other species. The root-fibers are long, rather slender, and much branched. The stipe is slender at the base, but expands gradually upwards until it is at times two inches in diameter. The greatest diameter is about two-thirds of the way up the stipe, which is then contracted, sometimes quite suddenly. When young and only a few inches long, the center of the stipe is filled with a solid mass of delicate filaments, but it soon becomes hollow. When torn from their attachments by storms, large specimens, in consequence of the hollow stipes, float in a peculiar way, the upper part of the stipe projecting above the water like an elbow and the lamina dipping below the surface. The lamina is, in comparison with the stipe, shorter and broader than in our other species. This is especially the case in young specimens, where the stipe may be several times longer than the lamina. In mature plants, however, the comparative length of the lamina varies very much with the place of growth. The present species has never been certainly known to occur south of Cape Cod. Specimens resembling *L. saccharina*, but with hollow stipes, have been collected in Long Island Sound. Whether really belonging to *L. longicruris* is doubtful, and the subject requires farther investigation.

L. SACCHARINA, (Linn.) Lam.x.?

Frond attached by numerous branching fibers; stipe solid throughout, terete, somewhat swollen in the middle, three inches to four feet long; lamina elongated, lanceolate, fusiform or cuneate at base, three to thirty feet long, six to eighteen inches wide; margin wavy, a row of depressions on each side of lamina; fruit forming a central band.

Var. PHYLLITIS, Le Jol. (*L. phyllitis*, Phyc. Brit., Pl. 192.)

Fronds small, lamina thin, margin slightly wavy, base of lamina fusiform.

Var. CAPERATA, (De la Pyl.). (*L. caperata*, Ann. Sci., l. c., Pl. 9 *c*.)

Stipe long in proportion to the lamina; lamina thick, one to two feet broad, cuneate at base.

Common on stones at low-water mark along the whole coast; var. *caperata* common north of Cape Cod.

In the present species we include all the New England forms which have a solid stipe and undivided lanceolate or ovate-lanceolate frond. It is very probable that two, or possibly three, really distinct species are thus united, and it is also doubtful whether any of our forms are the same as *L. saccharina* of Europe, as limited by recent writers. Clearly to distinguish them is, however, at present out of the question. In going northward the forms here included become broader, and the base of the lamina is more frequently obtuse, and possibly the extreme forms should be referred to *L. latifolia*, Ag. The exact determination of the New England forms referred to *L. saccharina* cannot be successfully undertaken without an examination of European herbaria. Probably we have most of the forms described by De la Pylaie in the Flore de Terre-Neuve, but that writer has not displayed a commendable caution in the description of new species; and as European botanists differ as to what species the forms of De la Pylaie are to be referred, American botanists would not help the matter by pretending to give accurate determinations. De la Pylaie says that at Newfoundand *L. saccharina* does not occur, but is replaced by *L. longicruris*. The statement is singular, since, from De la Pylaie's own description, *L. caperata* closely resembles *L. saccharina;* and if any species may be said to replace *L. saccharina*, it is *L. caperata*, rather than the abundantly distinct *L. longicruris*.

L. DIGITATA, (Turn.) Lamx. (*L. digitata*, Ner. Am. Bor.—*L. stenoloba*, De la Pyl., Ann. Sci. Nat., l. c., Pl. 9 *k*.)

Exs.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 119, sub. nom. *L. flexicaulis*.

Fronds attached by fibers, which are often arranged in whorls; stipe solid, stout, one to five feet long, more or less round below, compressed above, destitute of muciparous glands; lamina at first oval or lanceolate, afterwards split into digitate segments, two to six feet long, one to three feet wide; base fusiform or ovate; fruit in dispersed patches on the segments.

Montauk, L. I.; Gay Head, Mass.; and common north of Cape Cod.

With regard to the limits of *L. digitata* a difference of opinion prevails; and in the present case we have retained, without criticism, the older name to designate the common digitate form of our coast. Of the two species described by Le Jolis it is probable that we have *L. flexicaulis* comprehended in the present form. The species is common with us in pools at low-water mark and below. The stipe varies considerably in length, according to the place of growth, and when well developed is stout and much compressed above, so that it projects rigidly above the surface of the water at low tide. The lamina is usually more or less fusiform at the base, but is sometimes oval, and the segments vary considerably, sometimes being very numerous.

L. PLATYMERIS, De la Pyl., Ann. Sci. Nat., l. c. Pl. 9 *i*.

Fronds attached by stout, irregularly placed fibers; stipe six inches to a foot long, solid, roundish, compressed, provided with muciparous

glands, passing abruptly into a broadly ovate or cordate lamina, which splits up into a few broad segments; substance thick, color blackish.

Deep water.

Peak's Island, Maine; Gloucester, Mass.

Distinguished from the last by its short, thick stipe, which is furnished with muciparous glands, and which terminates abruptly in a broad, thick lamina, which is usually decidedly cordate at the base. It is an inhabitant of deep water, and is occasionally found washed ashore in the autumn, but is always much less common than the last species. Le Jolis considers that *L. platymeris* is, at least in part, the same as his *L. flexicaulis;* but what seems to us to be the true *L. platymeris* differs from *L. flexicaulis* in having muciparous glands in the stipe, a peculiarity which, according to Le Jolis, is found in *L. Cloustoni*, but not in *L. flexicaulis*.

SACCORHIZA, De la Pyl.

(From σακκος, a sack, and ῥιζα, a root.)

Fronds attached at first by a disk-like base, from which are given off later a few short root-like fibers; stipe compressed, plane, gradually passing into a ribless lamina; cryptostomata scattered on both sides of the frond; fruit as in *Laminaria*.

A genus differing from *Laminaria* principally in the form of the basal attachment and in the presence of cryptostomata on both surfaces of the frond. The typical species, *S. bulbosa*, not found on our coast, is attached by a sack-like base, and the fruit is borne on the marginal upper portion of the stipe. In the present genus were at one time included all the *Laminariæ* whose attachment is discoidal rather than by branching root-like fibers. There are, however, forms still retained in the genus *Laminaria*, as *L. solidungula*, in which the base is a disk, and our own species *S. dermatodea*, although in its younger stages attached by a disk, soon has a series of short fibers, which, as the plant increases in size, become branched. The cryptostomata are small pits sunk in the surface of the frond, from which arise groups of hairs, as in the *Fucaceæ*. They are visible to the naked eye in the young plants, but disappear with age.

S. DERMATODEA, De la Pyl. (*Laminaria dermatodea*, De la Pyl., Ann. Sciences, l. c., Pl. 9 *g*, non Agardh nec Harvey.—*L. lorea*, Ag. Spec.; Harvey, in Ner. Am. Bor.)

Exs.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 120.

Fronds usually gregarious, base at first discoidal, afterwards with a whorl of short, thick, usually simple fibers; stipe six inches to two feet long, compressed, gradually expanding into a thick, coriaceous-lanceolate or lance-ovate lamina, one to six feet long, six to eighteen inches wide, at first entire, but afterwards torn above into several segments; fruit in scattered sori, which become confluent at the base of the frond; paraphyses narrowly club-shaped, about .15^{mm} long; sporangia .12^{mm} long by .02^{mm} broad.

From Marblehead, Mass., northward.

A characteristic species of the North Atlantic. Its southernmost limit is Marblehead, where only one specimen has been collected. It is less rare at Gloucester, and is rather

common on the coast of Maine, but much less abundant than other *Laminariæ*. It is the most easily recognized of our *Laminariæ*, in spite of its great variability in outline. The substance is more tough and leathery than any of our other species and the margin is thick and never wavy. At Eastport it is found in deep pools, but elsewhere it is an inhabitant of deep water. As usually seen washed ashore it resembles one of the digitate forms of *Laminaria*, for it is usually torn into segments, and not rarely split to the very base. It is at once distinguished from our digitate *Laminariæ* by its uniformly flat stipe, very short root-fibers, and cryptostomata. In most cases the stipe expands very gradually into the blade, but occasionally in old specimens the base is cordate. The fruit is found in the autumn and winter. In the specimens which we have examined the paraphyses were very narrowly club-shaped and colored to the tip, being destitute of the hyaline tip found in *Laminaria*.

AGARUM, (Bory) Post. & Rupr.

(From *agar-agar*, a Malayan word referring to some edible sea-weed.)

Fronds stipitate, attached by a branching root-like base; lamina perforated with roundish holes; stipe prolonged into a midrib; fruit scattered in patches (sori) over the fronds, consisting of club-shaped, one-celled paraphyses and ellipsoidal unilocular sporangia; plurilocular sporangia unknown.

A genus differing from *Laminaria* in having the lamina perforated with round holes and furnished with a distinct midrib. It includes four described species, which differ in the size of the perforations, in the shape of the lamina, and the prominence of the midrib, characters which an observation of our common species shows to be very variable. The species inhabit the Arctic Ocean, the northwestern shore of the Atlantic, and the North Pacific. The New England form, *A. Turneri*, also occurs in the Pacific, extending as far south as Japan, and, on the west coast, *A. fimbriatum*, Harv., considered by Agardh to be the same as *Fucus pertusus*, Mertens, extends as far south as Santa Barbara, Cal.

A. TURNERI, Post. & Rupr.—*Sea Colander.* (*Fucus cribrosus*, Mertens.—*F. agarum*, Turner, Hist. Fuc., Pl. 75.—*Laminaria agarum* and *L. Boryi*, De la Pyl., Flore de Terre-Neuve.—*Agarum Turneri*, Post. & Rupr., Illustr. Alg., Pl. 22; Ner. Am. Bor., Vol. I, Pl. 5.)

EXS.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 112.

Base much branched, stipe two inches to a foot long, cylindrical below, flattened above and prolonged into a distinctly marked midrib; lamina membranaceous, one to four feet long, ovate-oblong, cordate and much crisped at base, margin wavy; perforations very numerous, orbicular, irregularly scattered with a smooth or wavy margin; fruit in irregular patches in the central part of the frond; sori .05–6^{mm} in thickness; paraphyses club-shaped, colored below, expanded and hyaline at the top; sporangia narrow, ellipsoidal, .035^{mm} long by .012^{mm} broad.

Common from Nahant northward in deep water and at Eastport in pools; North Pacific.

One of the curiosities of our marine-flora, which is washed ashore from deep water at the southern limit of its growth, but farther north grows in pools at low-water mark.

The plant is perennial and young specimens are entirely without perforations until they have attained a length of two or three inches. The perforations, which are supposed by the fishermen to be the work of animals, are formed in the lower part of the frond and increase in size, as they grow older, so that the perforations are larger in the upper and central parts of the frond. New holes are also formed between those already formed, so that there is a difference in size depending upon the age of the holes in all parts of the frond except the base. The formation of the holes begins by an elevation of small portions of the frond, which appears as if some small point like that of a pencil had been pressed against it; at length the frond ruptures circularly and the hole formed is minute and above the plane of the frond. The margins of the large holes are often wavy, and when dried with a slight pressure the waviness becomes so marked as to lead one to suppose that the specimens belong to a distinct species. The midrib varies considerably in breadth and occasionaly it grows out, forming a lamina at right angles to the frond. The usual perforations are found in the additional lamina, which sometimes grows to be as large as the original lamina. The fruit of *Agarum*, which is incorrectly figured in the Nereis as having a form of tetraspores, resembles very closely that of *Laminaria*. The species apparently does not bear fruit on the Massachusetts coast, at least we have never been able to find any; but at Eastport the fruit is formed as early as September. The sori are scattered irregularly over the central part of the frond and are most easily seen after the frond has been out of the water a short time. The sori are not so thick as in *Alaria* and *Laminaria* and the paraphyses do not have so prominent a hyaline extremity as in those genera. Harvey states that the lamina are sometimes ten or twelve feet long, but this is probably an overestimate.

ALARIA, Grev.

(From *ala*, a wing.)

Fronds attached by a branching root-like base, stipitate, membranaceous, with a distinct midrib; fruit borne in special lateral leaflets below the lamina, consisting of club-shaped, one-celled paraphyses and ellipsoidal unilocular sporangia; plurilocular sporangia unknown.

A genus readily known by the small, ribless leaflets given off from the stipe below the lamina, in which the the fruit is borne in the autumn. The genus inhabits the colder waters of the northern hemisphere and the species sometimes attain a length of fifty feet. The number of species does not exceed half a dozen, and the specific marks, such as the shape of the midrib, the lateral leaflets, and the base of the lamina, are variable, so that all the species cannot be said to be well marked.

A. ESCULENTA, Grev. (*A. esculenta*, Phyc. Brit., Pl. 79.—*Laminaria musæfolia*, De la Pyl., Ann. Sci. Nat., Ser. 1, Vol. IV, Pl. 9 *d*.—*L. linearis*, De la Pyl., l. c., Pl. 9 *f*.)

Stipe cylindrical-compressed, from four inches to a foot long, a quarter to half an inch wide; midrib solid, scarcely wider than the stipe; lamina one to ten feet long or even longer, two to ten inches from side to side, decurrent on the stipe, margin wavy; fructiferous leaflets numerouse, shortly stipitate, three to eight inches long, half an inch to two inches broad, linear-ovate or linear-spathulate.

Var. LATIFOLIA, Post. & Rupr. (*Laminaria Pylaii*, Bory, in Flore

de Terre-Neuve.—*Alaria Pylaii*, Ner. Am. Bor.—*A. esculenta*, var., Post. & Rupr., Illustr. Alg., Pl. 18.)

Base of lamina cuneate, fructiferous leaflets obovate-spathulate.

Common on exposed coasts at low-water mark and below, from Nahant northward. The variety at Eastport, Maine, Northern Europe, and Pacific coast.

As yet no species of *Alaria* has been found south of Cape Cod, although it is probable that they occur at exposed points like Gay Head and Montauk. In the Annales des Sciences, De la Pylaie mentions three varieties of *A. esculenta—platyphylla, tæniata,* and *remotifolia*—as occurring at Newfoundland, and in the Flore de Terre-Neuve he makes two new species—*Laminaria musæfolia*, including *L. esculenta*, var. *platyphylla* and var. *remotifolia*, and *L. linearis*, including *L. esculenta* var. *tæniata*. These species are characterized by the different forms and position of the fructiferous leaflets, which, it must be admitted, are so variable and so constantly pass into one another, that De la Pylaie would have done better in retaining them all as forms of one species. *Laminaria Pylaii*, Bory, founded on a single specimen brought by De la Pylaie from Newfoundland, also seems to be merely a variety of *L. esculenta*, in which the lamina is cuneate at the base. At Eastport the broader forms are common, and one sees all stages from decurrent to cuneate laminæ. Agardh refers to *L. Pylaii*, Bory, the *Alaria esculenta* var. *latifolia*, of Postels and Ruprecht, whose plate represents excellently the extreme forms found at Eastport. The present species is used as food in Scotland and Ireland, where it is called badder-locks, henware, murlins, and also in Iceland, but it is not eaten with us.

Order III. OOSPOREÆ, Sachs.

Male organs (antheridia) composed of sacks borne on simple or branching filaments, sometimes sessile, containing motile antherozoids; female organ (oogonium) in the form of a sack, whose contents change into one or more spherical masses (oospheres), which are directly fertilized by the antherozoids and become oospores.

In the order *Conjugateæ* there was a direct union of similar bodies called zoospores, and no clear distinction of male and female cells. In the *Oosporeæ* the males are small motile bodies (in algæ), which directly impregnate the spherical masses of protoplasm, called oospheres, either before or after they have escaped from the mother-cell, the oogonium. As a result of the impregnation, a wall of cellulose is formed round what was before merely a mass of protoplasm, and the so-called oosphere becomes an oospore and capable of germinating. The marine plants of the order may be divided into two suborders, as follows:

a. Large olive-green plants, having the antheridia and oogonia in nearly closed sacks borne in a definite part of the plant; fronds foliaceous, often provided with air-bladders ..... Fucaceæ.

b. Minute grass-green plants forming turfs or tufts; antheridia and oogonia naked, sessile, or pedicellate, borne laterally on the unicellular branching frond ..... Vaucherieæ.

Suborder FUCACEÆ, C. Ag.

Plants dicœcious or hermaphrodite, fructifying organs borne in conceptacles or cavities lined with sterile filaments and opening outwards by a narrow pore; antheridia in ovoid sacks borne on branching threads and filled with minute antherozoids having two lateral cilia; oospores spherical, borne 1–8 in a mother-cell. Marine plants of an olive-green color, attached by a disk-like base, fronds usually branching dichotomously, rarely indefinitely expanded, often provided with air-bladders and with cryptostomata.

An order characterized by the presence of antherozoids borne in sacks and by oospores, varying in the different genera from one to eight in a mother-cell, both antheridia and oospores being contained in hollow conceptacles, which are produced either in definite parts of the frond or on special branches or rarely indefinitely scattered over the frond. The fertilization in this order was first described by Thuret in the Annales des Sciences, Ser. 4, Vol. 2. The fronds vary very much in the different genera. In *Durvillæa* the frond resembles a large *Laminaria*, and from this simple form there are all degrees of complication, until in *Sargassum*, the most highly developed genus, there are distinct stems, leaves, air-bladders, and branching fructiferous receptacles. In high latitudes the order is chiefly represented by the common rockweeds, *Fuci*, which line the rocks between tide-marks, while in low latitudes the gulf-weeds, species of *Sargassum*, abound. The Southern Ocean abounds in curious and varied forms of this order, Australia being particularly rich in species. The New England coast is especially poor in representatives of the order, the genera *Halidrys*, *Himanthalia*, *Pelvetia*, and *Cystoseira*, common on the coast of Europe, being entirely wanting with us. The fronds are dotted with small pits, called cryptostomata, from which grow tufts of hairs.

SYNOPSIS OF GENERA.

Fronds with distinct stems and leaves ..... *Sargassum.*
Fronds without distinct stems and leaves—
Lamina provided with a midrib, receptacles terminal, continuous with the frond ..... *Fucus.*
Midrib wanting, receptacles on special lateral branches .. *Ascophyllum.*

ASCOPHYLLUM, (Stackh.) Le Jolis, emend.

(From *ασκος*, a sack, and *φυλλον*, a leaf.)

Fronds attached by a disk, linear, compressed, destitute of a midrib, irregularly dichotomous, furnished with air-bladders; receptacles on distinct, simple, lateral branches; spores four in a mother-cell.

A genus including the *Fucus nodosus* of older writers, which differs from the true *Fuci* in having a linear frond destitute of a midrib and spores in fours instead of in eights. The generic name *Ozothallia* proposed by Decaisne and Thuret, who were the first to give a detailed account of the conceptacles of *F. nodosus*, was referred by Le Jolis to the older genus *Ascophylla* of Stackhouse.

A. NODOSUM, Le Jolis. (*Fucus nodosus*, L.; Phyc. Brit., Pl. 158; Ner.

Am. Bor., Vol. I, p. 68.—*Fucodium nodosum*, J. Ag.—*Ozothallia nodosa*, Dcne. & Thuret.—*Ascophyllum nodosum*, Le Jolis; Études Phycologiques, Pls. 18–20.)

Fronds dicœcious, one to five feet long, coriaceous, compressed, subdichotomous, margin distantly toothed; air-bladders oblong, broader than the frond; receptacles ovoid or ellipsoidal, terminating short lateral branches, which are borne either solitary or clustered in the axils of the teeth.

Common between tide-marks from New Jersey northward; Europe; Arctic Ocean.

One of our most common species, easily recognized by the large bladders in the continuity of the frond, which is thick and narrow and entirely destitute of a midrib. The fruit is found in lateral branches in winter and spring, and in June the receptacles fall off and are sometimes found in immense quantities covering the bottoms of tide-pools.

FUCUS, (L.) Dcne. & Thuret.

(From *φυκος*, a sea-weed.)

Fronds dicœcious or hermaphrodite, attached by a disk, plane, costate, dichotomous, margin entire or serrate, often furnished with air-bladders; receptacles terminal, continuous with the frond; spores eight in a mother-cell.

In the beginning of the present century the name *Fucus* was used not only to designate all the plants included in the present order, but was applied to all marine algæ. Since that date the word has been used in a more and more restricted sense, and is now only applied to those members of the *Fucaceæ* in which the spores are in eights and in which the frond is plane and costate. In some of the species, however, the midrib is rather indistinct. Most of our species are very abundant and very variable, and older writers have described as species a good many forms which are now considered to be merely varieties. Hence the synonymy of the species is in confusion, although our species, none of which are peculiar to America, can be referred to definite European forms. The species described by De la Pylaie in the Flore de Terre-Neuve are most of them to be referred to older species. The New England species naturally fall into two different groups. In the first, of which *F. vesiculosus* is the type, the fronds are dicœcious and the midrib distinct throughout. In the second, represented by *F. evanescens*, they are hermaphrodite and the midrib indistinct.

F. VESICULOSUS, L.; Phyc. Brit., Pl. 204; Études Phycol., Pl. 15.

Fronds dicœcious, six inches to three feet long, stipitate, midrib distinct throughout, margin entire, often wavy; bladders spherical or slightly elongated, usually in pairs; receptacles swollen, ellipsoidal or oval, often forked.

Exs.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 109.

Var. LATERIFRUCTUS, Grev.

Lateral branches, which bear the receptacles, narrow and densely dichotomously flabellate.

Var. SPHÆROCARPUS, Ag.

Ultimate divisions of frond repeatedly forked, bearing very numerous small receptacles.

Var. SPIRALIS.

Fronds short and spirally twisted.

Everywhere common between tide-marks.

The varieties of this very common species are so numerous that it is useless to describe the greater part of them. The southernmost limit of the species on the eastern coast is, as far as known, the coast of North Carolina, where it is reported to have been collected by Rev. E. M. Forbes in Curtis's account of the botany in the Geological and Natural History Survey of North Carolina. *Fucus bicornis* and *F. microphyllus* of De la Pylaie appear to be merely forms of *F. vesiculosus*. The species with which the present is likely to be confounded along our northern coast is *F. evanescens*, a broad plant, whose midrib is only distinct in the lower part of the frond, and whose conceptacles are hermaphrodite, not dicœcious, as in the present species. It fruits most abundantly in autumn and winter, but the fructification can be seen at any season of the year.

F. CERANOIDES, L.; Phyc. Brit., Pl. 271.

"Frond plane, coriaceo-membranaceous, linear-dichotomous, midribbed, without vesicles, margin very entire; lateral branches narrower than the principal divisions, repeatedly forked, level topped, bearing fruit at their apices; receptacles spindle-shaped or bifid, acute." (Ner. Am. Bor., Vol. I, p. 70.)

New York, *Agardh;* Europe.

The authority for the existence of this species on our coast is Agardh. Harvey had never seen American specimens, nor have we ever found any. The species, judging from herbarium specimens, resembles very closely *L. vesiculosus*, especially var. *lateri-fructus*, but is said to be thinner and to be destitute of air-bladders. It inhabits rather brackish waters.

F. SERRATUS, L.; Phyc. Brit., Pl. 47; Études Phycol., Pls. 11–14.

Fronds dicœcious, two to six feet long, midrib distinct throughout, margin serrate; bladders wanting; receptacles serrate, flattish, pointed.

Newburyport, Mass., *Captain Pike;* Pictou, N. S., *Rev. J. Fowler;* Europe.

A very common species of Europe, but very rare on our coast, being known in only two localities. In the supplement to the Nereis it is reported from Newburyport, having been once detected by Captain Pike, but not seen there since. The only other locality is Pictou, where it was detected by Rev. J. Fowler, who sent specimens to Professor Eaton in 1869. The species is easily recognized by its serrated margin, and grows lower down in the water than *F. vesiculosus*.

F. EVANESCENS, Ag., Icon. Ined., Pl. 13. (*Fucus platycarpus*, in Farlow's List of the Marine Algæ of the United States.)

Fronds hermaphrodite, one to two feet long, stipitate, midrib distinct below, but widening and scarcely visible in the upper part, margin broad, entire, somewhat wavy; bladders usually wanting, when present much

elongated; receptacles swollen, broad, usually united in pairs, and sometimes with a small margin formed of the unchanged frond.

Exs.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 107.

Eastport, Maine; coast of Massachusetts; Northern Europe; Arctic Ocean.

A species apparently common north of Cape Cod, and at Eastport quite as common as *F. vesiculosus*, for which it might be mistaken. As found with us, it is broader than the last-named species and is usually without bladders, and when these occur they seem more like irregularly inflated portions of the frond than spherical cavities. The receptacles contain both antheridia and oospores, the latter occupying the base and the former the upper part of the conceptacle. The receptacles are broader and less swollen than in *F. vesiculosus* and are often in pairs, the pairs being united below. The whole plant is shorter, stouter, and more foliaceous than *F. vesiculosus*. The species as found in the Arctic regions is variable, and several forms have been described. The form which occurs at Eastport comes very near the typical form. *F. miclonensis* of De la Pylaie is probably a small form of the present.

F. FURCATUS, Ag., Icon. Ined., Pl. 14.

Fronds hermaphrodite, branching very regularly dichotomous, stipitate, one to three feet long, midrib distinct below, scarcely visible above, margin narrow, rigid, entire; bladders wanting; receptacles flat, narrow, linear-fusiform, sometimes forking.

Exs.—Algæ Am. Bor., Farlow, Anderson & Eaton, No. 108.

Peak's Island, Maine; coast of Massachusetts north of Boston; Northern Europe; Arctic Ocean; North Pacific.

A common and beautiful species on exposed coasts north of Boston. It is found lower down than *F. vesiculosus*, at the limit of low-water mark. The frond is narrow, tough, and destitute of bladders, and the branching very regular, almost flabellate. It is easily distinguished by the receptacles, which are not in the least swollen and are narrow and longer than in any other species, being sometimes four inches long. The color is dark. Our form corresponds perfectly to specimens from Spitzbergen. The species is less variable than most of the genus and is found at all seasons of the year.

F. FILIFORMIS, Gmelin. (*F. distichus*, L., in Farlow's List of the Marine Algæ of the United States.)

Fronds hermaphrodite, three to six inches long, flabellately dichotomous, stipitate below, midrib present but indistinct; air-bladders wanting; receptacles linear-oblong, swollen, borne in pairs, sometimes forking.

In pools near high-water mark.

Nahant, Marblehead, Mass.

Our smallest species, found only in spring and in pools where the water is not very pure. Our form is the same as No. 201 of Areschoug's Algæ Scandinavicæ, from Finmark, which Agardh refers to *F. filiformis*. Whether *F. distichus*, L., is not the same as *F. filiformis*, Gmelin, admits of doubt. The present form seems to be the *F. filiformis* of the Flore de Terre-Neuve, mentioned under *F. distichus* in the Nereis Am. Bor.

SARGASSUM, Ag.

(From *sargazo*, the Spanish name for the gulf-weed)

Fronds attached by a disk having branching stems, leaves with a midrib and distinctly stalked air-bladders; fruit in special compound branches; conceptacles hermaphrodite; spores single in the mother-cell.

The most highly organized and by far the largest genus of the *Fucaceæ*, of which at least 150 species have been described. They inhabit the warmer waters of the globe, where they replace the *Fuci*. Australia, Japan, and the adjacent coast of Asia are particularly rich in species. We have one species which does not come north of Cape Cod, but which is common southward. The genus has been subdivided by Kützing, but even with his limitation the species of *Sargassum* are very numerous.

S. VULGARE, Ag. (*Fucus natans*, Turner's Hist. Fuc., Pl. 46, non Linn.—*S. vulgare*, Phyc. Brit., Pl. 343.)

Fronds two to five feet long, stem filiform, smooth, irregularly branching, leaves shortly petiolate, linear-lanceolate or oblong-lanceolate, one to three inches long, a quarter to half an inch wide, sharply serrate, midrib distinct, cryptostomata numerous on both sides of the midrib; air-bladders spherical, quarter of an inch in diameter, stalked, arising from a transformed leaf, the upper part of which often remains as an appendage; stalks naked or slightly winged; receptacles filiform, branching cymosely, one to two inches long.

Var. MONTAGNEI. (*S. Montagnei*, Bailey, in Ner. Am. Bor., Vol. I, Pl. 1 *a*.)

Leaves narrowly linear, elongated, receptacles two to four inches long.

Below low-water mark in warm, shallow bays from Cape Cod southward.

In spite of its variations, with the exception of *S. bacciferum*, which is sometimes washed ashore, we have but one species of *Sargassum* on our coast. As usually found, it is more slender in all its parts than the typical *S. vulgare* of the West Indies, but it is occasionally found of the typical form. In var. *Montagnei*, which is common, we have an extreme form, in which the fructifying branches are much elongated, but one sees all variations from short to long.

S. BACCIFERUM, Ag.—*Gulf-weed.* (*Fucus natans*, L.; Turner's Hist. Fuc., Pl. 47.—*S. bacciferum*, Phyc. Brit., Pl. 109.)

Fronds six inches to a foot and a half long, stems filiform, smooth, leaves linear-lanceolate, two to four inches long, midrib distinct, cryptostomata usually wanting; air-bladders stalked, spherical, tipped with a filiform point; receptacles short, cylindrical, forked.

Washed ashore at Bath, L. I., *Mr. A. R. Young*, and found floating off the coast near the Gulf Stream; West Indies, and floating in the Atlantic.

The common Gulf-weed, which grows attached in the West Indies, where it fruits,

and which is found floating and infertile in the course of the Gulf Stream and in the so-called Sargasso Sea, between 20° and 45° N. and 40° W. It is rarely washed ashore in New England, but is frequently brought in by fishing vessels. It is said that there is a large mass of this sea-weed in the ocean not far from Nantucket, but there is no definite information on the subject. The species in its floating form is distinguished from the last by its narrower leaves, destitute of cryptostomata, its darker color, and denser habit.

Suborder VAUCHERIEÆ.

Comprising a single genus, *Vaucheria*, whose characters are given below.

VAUCHERIA, D. C.

(Named in honor of *Jean Pierre Vaucher*, of Geneva.)

Fronds green, unicellular, composed of long, irregularly or falsely dichotomously branching filaments, monœcious or diœcious; oogonia sessile or stalked, containing a single oospore; antheridia either short ovoid sacks or formed at the tips of branches, which are frequently spirally twisted; antherozoids very small, with two cilia; non-sexual reproduction by very large zoospores, which are covered with cilia, or by motionless spores formed at the ends of short branches.

The *Vaucheriæ* abound both on our coast and in inland waters, and some species grow upon damp ground in gardens and meadows. They either form thick turfs of a dark-green color when growing in places which are not constantly submerged, or else extend in indefinite-shaped masses when growing where there is plenty of water. They are generally easily recognized at sight, and are known under the microscope by the long branching filaments of a deep-green color, destitute of cross-partitions except when the fruit is forming. Although very abundant on our shore, the species are little known, because the specific characters depend upon the fruit. The determination of sterile specimens is out of the question, and, even when fruiting, dried specimens are of comparatively little value. A considerable number of species of *Vaucheria* have been described, but as a great part of them have been described from individuals bearing the non-sexual spores only, recent writers, as Walz and Nordstedt, have reduced the number of species very much by omitting imperfectly characterized forms. Nordstedt admits nineteen species in Europe. The American species have never been critically studied. Specimens should be kept in fluid rather than mounted on paper, and sketches of the fruit should be made at the time of gathering. It should not be forgotten by the collector that some of the species are diœcious, and also that a species is not perfectly known unless the non-sexual spores are described as well as the oospores.

V. Thuretii, Woronin, Beit. zur Kenntniss der Vaucherien, in Bot. Zeit., Vol. XXVII, p. 157, Pl. 2, Figs. 30–32.

Monœcious; filaments .03–8^{mm} in diameter, forming short, dense turfs; antheridia sessile, oval, .05–7^{mm} broad by .10–14^{mm} long; contents of antheridia colorless; oogonia either sessile or on short lateral branches, obovoid or pyriform, inclined, .25–30^{mm} long by 20^{mm} wide; oospores spherical, .15–18^{mm} in diameter, yellowish brown; cell-wall rather thin;

non-sexual spores (?) .08mm broad by .10–12mm long, motionless, borne on short branches, which are at right angles to the main filaments, from which they break off, allowing the spores to escape from the ruptured end.

Exs.—Wittrock & Nordstedt, Alg. Scand., No. 228.

On muddy shores and sides of ditches, where it forms large patches of a dark velvety green. Summer.

Wood's Holl, Mass.; Eastport, Maine; Perth Amboy, N. J., *Wolle;* Europe.

This species, which is apparently common on muddy shores of New England, agrees so well with the description and figure of Woronin, l. c., that there can be no doubt about the identity of our plant with that of the European coast. The non-sexual fruit was unknown to Woronin. At Wood's Holl we found what appeared to be the non-sexual fruit of the species. It consisted of oval spores, smaller than the oospores, borne at the tips of short branches, which were given off at right angles to the main filaments. The branches with the spores fall off, and the latter, after some time, escape from the ruptured end of the cell. The spores are motionless and destitute of cilia, reminding one of the non-sexual spores in *V. geminata*, Walz. During the four or five days which we were able to watch them they underwent no change. In the specimen of Wolle, above mentioned, similar bodies are found, but Nordstedt thinks it probable that they belong to a species different from *V. Thuretii*. He is led to this conclusion apparently from the fact that the filaments bearing the non-sexual spores are rather smaller than those which bear the oospores and antheridia. In the Wood's Holl specimens the filaments were, as a rule, somewhat smaller than those bearing the oospores; but the difference is very slight, and one sometimes finds oosporiferous filaments measuring only .03mm in diameter, while the non-sexual spore-bearing filaments average from .04–5mm in diameter. In one case we found an antheridium on the non-sexual spore-bearing filament, which resembled precisely the antheridia of *V. Thuretii*. We conclude then that the non-sexual spores probably belong to the present species, but the question requires further examination. A specimen of what appears to be the same species exists in the collection of the Boston Society of Natural History. It was collected by Prof. J. W. Bailey from some locality near New York, and is labelled, in his own handwriting, *V. velutina*.

V. LITOREA, Nordstedt (Ag., Spec. Alg., p. 463.—*V. clavata*, Lyngb., Hydrophyt. Dan., p. 78, Pl. 21 *d*.—*V. litorea*, Nordstedt, in Botan. Notiser., 1879, p. 180, Pl. 2, Figs. 1–6.—*V. piloboloides*, Farlow, List of Marine Algæ, 1876.)

Dicœcious; filaments densely tufted, rather rigid, .10mm in diameter; antheridia?; oogonia club-shaped, borne on a short sterile cell at the tips of short recurved branches, .20mm broad by about .35mm long; oospores filling the upper part of oogonium, spheroidal, .18–19mm broad by .23–25mm long; cell-wall dense, .02mm in thickness; non-sexual spores?

At low-water mark in the gravel.

Parker's Point, Wood's Holl, Mass.; Europe.

We refer to the present species a *Vaucheria* much coarser than the species last described, which forms rather bristly tufts of a dingy green, from two to four inches high, in gravelly places. Only one specimen, collected in August, 1876, was in fruit,

and at the time, as there were no antheridia, we hastily inferred that the spores were non-sexual. It now seems probable that the plant is the *V. litorea* of Nordstedt, l. c., a dioecious species. The species was common at Wood's Holl in August, 1879, but constantly sterile. The antheridia of *V. litorea*, Nordstedt, are long and cylindrical and borne on a short sterile cell at the tips of the branches. The antherozoids are discharged by openings at the apex and sides of the antheridium. Our plant will be easily recognized by its habit and the recurved branches bearing the oogonia.

Order IV. FLORIDEÆ.

Algæ of a red or purple color; antheridia containing spherical, hyaline antherozoids, which are without cilia; sexual fruit or cystocarps developed from a procarp, which consists of a trichogyne, at whose base is a trichophore, the spores formed either from the trichophore or the adjacent cells which compose the carpogenic system; spores at maturity either naked or inclosed in a pericarp; non-sexual reproduction by tetraspores, bispores, and seirospores; fronds filamentous, crustaceous, membranaceous, or irregularly expanded, varying from gelatinous to cartilaginous in substance, occasionally calcareous. Principally marine.

The *Florideæ*, which are the same as the *Rhodospermeæ* of Harvey, include a large number of species, all of which have some shade of red, although it may be nearly black on the one hand or approach shades of green on the other. In decay, however, the color becomes orange and finally green. It is not to be inferred, however, that all red algæ belong to the *Florideæ*. There are a few *Cyanophyceæ* in which the color is pink, but in these species the frond is merely an agglomeration of red cells, each of which is practically a distinct individual, whereas in the *Florideæ* the cells are organically united, and constitute a single plant. The structure of the frond in this order varies in the different genera, and we have forms which correspond closely to the fronds of the *Phæosporeæ*, as, for instance, in *Nemalion* we have a frond which, apart from its color, is undistinguishable from that of *Mesogloia*, and so on. The non-sexual reproduction is by tetraspores, cells which divide into four parts—rarely by bispores or two-parted cells—and seirospores, or chains of oblong cells formed directly from the branches. The sexual fruit, known as the cystocarp, is developed from a procarp, as has already been explained. The division into suborders is founded principally on the differences in the cystocarpic fruit, the full development of which is not known in many cases. Differences in the fronds and tetraspores serve to mark the genera. Agardh and Harvey divide the *Florideæ* into two series—the *Desmiospermeæ*, in which the spores are arranged in a definite series with regard to a placenta or common point of attachment, and *Gongylospermeæ*, where the spores are heaped together without order. A study of the development, however, shows that this distinction has not the value which it was formerly supposed to have, and certain suborders with differently arranged spores are by those who lay stress upon the development placed in proximity to others in which the spores are irregularly grouped. Although, owing to modern researches, we know much more about the real nature of the cystocarps than was known a few years ago, it must be admitted that the suborders of *Florideæ* are far from satisfactory. As a matter of fact, the order is a very natural one, and, as is the case with most natural orders, the species and genera pass so gradually into one another that sharply marked divisions are out of the question. At the base of the order is a small number of genera whose position is doubtful, owing to our lack of information about the fructification. Then come the *Porphyreæ*, in which we have fronds of a single layer of cells (*Porphyra*) and certain cells grow out so as to form a very short

trichogyne. After fertilization, the contents of the cell at the base of the trichogyne divide, quadrant fashion, and we have a number of spores produced at once from the original cell. In *Nemalion* the trichophore, or swollen base of the trichogyne, divides, and the divisions grow out laterally and form short filaments, each cell of which becomes a spore, so that at maturity the cystocarpic fruit consists of a dense tuft of radiating, moniliform filaments. In the *Ceramieæ* we have *favellæ*, or cystocarps, in which the carpogenic cells bud out and produce several lobes, each of which divides into a number of very short filaments, which do not separate from one another, but remain adherent. The cells of the filaments are changed into spores, which form irregular groups, but are still held together by the mass of jelly which surrounds them. In the more highly developed suborders the spores either radiate in filaments from a sort of placenta which is produced from the carpogenic cells or else are terminal on short stalks. The pericarps are special sacks or conceptacles, inclosing the spores and developed from the cells below the procarp, or we may have the cystocarps borne in the interior of solid fronds, whose external portion may then be said to form a pericarp around them. It will be seen that the structure of the *Floridieæ* is more complicated than that of the other orders of algæ, and the student cannot expect to obtain a clear idea of the different suborders without considerable study. The following key will aid somewhat, and the reader should consult the plates appended to this paper:

1. Spores formed in the cells of the frond itself ..... *Porphyreæ.*
2. Spores (cystocarps) not formed directly from the cells of the frond, but from a special procarp 3
3. Spores without a special covering or pericarp 4
   Spores with a special covering 10
4. Spores naked 5
   Spores immersed in the frond 7
   Spores immersed in external warts 6
5. Spores free on the surface of a lobulated mass .... *Spermothamnieæ.*
   Spores irregularly grouped in masses which are surrounded by a gelatinous envelope ..... *Ceramieæ.*
6. Fronds erect, cylindrical ..... *Spongiocarpeæ.*
   Fronds horizontally expanded ..... *Squamarieæ.*
7. Spores arranged in dense tufts of radiating moniliform filaments ..... *Nemalieæ.*
   Spores on an axile placenta in swollen branches ..... *Gelidieæ.*
   Spores in numerous radiating tufts around a central placenta or carpogenic cell ..... *Solieriecæ.*
   Spores arranged without order 8
8. Spores forming a single mass or nucleus and entirely buried in the frond 9
   Spores in several masses, separated by the tissue of the internal part of the frond and rising in swellings above the surface... *Gigartineæ.*
9. Fronds hollow and tubular ..... *Dumontieæ.*
   Fronds solid ..... *Cryptonemieæ.*
10. Spores arranged without regular order 11
    Spores in small, scattered tufts, borne on branching filaments— *Hypneæ.*
    Spores in radiating moniliform filaments 12

Spores pyriform, on simple or branching stalks from a basal placenta 13

11. Wall of the conceptacle thin, composed of the divisions of an involucre united by jelly ..... *Spyridieæ.*
Wall of conceptacle thick, sporiferous masses arranged around a placenta ..... *Rhodymenieæ.*

12. Filaments arising from a single cell at the base of a thin membranaceous conceptacle which is sunk in the frond... *Scinaia* (*Nemalieæ*).
Filaments arising from a distinct basal placenta, conceptacles external ..... *Sphærococcoideæ.*

13. Fronds coated with a calcareous incrustation..... *Corallineæ.*
Fronds without incrustation..... *Rhodomeleæ.*

FLORIDEÆ INCERTÆ SEDIS.

TRENTEPOHLIA, (Ag.) Prings.

(Named in honor of *Johann Friederich Trentepohl,* of Oldenburg.)

Fronds arising from a cellular base, filamentous, branching, composed of short cells placed end to end, branches ending in a hair; spores single, borne in oval cells terminating lateral branches; antheridia and tetraspores unknown.

A genus which in the present paper comprises a number of small marine species placed by some writers in *Callithamnion* and by others in *Chantransia.* In the Nereis Am. Bor., Harvey placed *T. Daviesii* and *T. virgatula* in *Callithamnion.* But cystocarps and antheridia are wanting, and according to Thuret and Bornet, Areschoug, and Pringsheim, the spores are undivided, although, on the other hand, Agardh and Harvey state that they are tripartite tetraspores. We have never seen any indication of division in American specimens. The genus *Chantransia* as limited by Thuret included not only marine species, but a number of fresh-water forms. Sirodot, however, in his *Étude sur la Famille des Lémanéacées,* Annales des Sciences, 5th Series, Vol. XVI, has shown that at least some of the fresh-water species of *Chantransia* are nothing but the initial stage of different species of *Lemaneæ.* On the other hand, *Chantransia investiens,* Lenor., a minute fresh-water alga which grows on different species of *Batrachospermum,* and which is made the type of the genus *Balbiania* by Sirodot, has distinct antheridia, trichogynes, and cystocarps, and this is also the case with the marine species *C. corymbifera* described by Bornet and Thuret in Notes Algologiques. The species of *Chantransia,* then, may be divided into two sets. In the first, including *C. investiens* of fresh water and the marine *C. corymbifera,* we have autonomous species related to *Callithamnion,* and differing in the simpler procarp and cystocarp and in the undivided non-sexual spores. In the second set we have the numerous fresh-water *Chantransiæ,* in which there are no cystocarps, in which the species are not autonomous, but merely prothalloid stages of other species.

The question remains as to the relations of the marine *Chantransiæ* in which no cystocarps nor antheridia have been found. Judging from analogy, if they are initial stages of other plants, those plants must be members of the *Nemalieæ.* But the habitat seems to forbid such an assumption, since the marine *Chantransiæ* abound on *Zostera, Rhodymenia,* and other algæ on which certainly no species of *Nemalion* or other related genera occur on our coast. We have thought best, in the absence of direct information with regard to cystocarps and antheridia in the species here included,

to retain the name *Trentepohlia* which was once adopted by Harvey, and at a later date also by Pringsheim, since it sufficiently indicates that the species in question should be kept distinct from *Callithamnion*, and at the same time does not assume the existence of cystocarps like those described by Thuret and Bornet in *C. corymbifera*.

T. VIRGATULA, (Harv.). (*Callithamnion virgatulum*, Harv., Phyc. Brit., Pl. 313; Ner. Am. Bor., Part II, p. 243.) **Pl. X, Fig. 3.**

Fronds minute, tufted, branches erect, straight, alternate or secund; spores sessile or on short stalks, borne either singly or in twos and threes along the branches.

Var. SECUNDATA. (*Callithamnion luxurians*, Ner. Am. Bor.—*C. secundatum*, Lyngb.)

Branches patent, with attenuated, naked, secund, secondary branches.

On *Ceramium*, *Laminaria* stems, and other algæ. The variety especially on *Zostera*.

Common in Long Island Sound; Gloucester, Mass.; Peak's Island, Maine.

A common species found in summer on different algæ. On the filamentous species it forms small tufts, and on *Zostera* it fringes the margins of the leaves with a fine plush scarcely more than a quarter or half an inch high. The synonymy of the species is very complicated, it having been confused with the next by some writers. The variety is common on *Zostera*, and is usually found in American herbaria bearing the name of *C. luxurians*. There is little doubt that it is the *C. luxurians* of the Nereis Am. Bor., but whether it is the species described under that name by Agardh is doubtful.

T. DAVIESII, Harv. (*Conferva Daviesii*, Engl. Bot., Pl. 2329.—*Callithamnion Daviesii*, Phyc. Brit., Pl. 314.)

Fronds minute, tufted, branches scattered, patent, bearing in their axils fasciculated ramuli, at whose tips are borne the spores.

On *Rhodymenia*.

Gloucester, Mass.

The limits of the species are not well marked. The extreme form is found in *C. efflorescens*, Thuret, kept as a distinct species by most writers, in which the branches are few, long, and given off at wide angles, and the spores borne in dense corymbs or heads in the axils. This form has been found on *Cystoclonium purpurascens* at Gay Head.

Among the genera whose relations to the *Florideæ* must be considered doubtful are *Choreocolax* and *Pseudoblaste*, described by Reinsch in *Contributiones ad Algologiam et Fungologiam*. Of the last-named genus a single species, of the former five species, are attributed to the eastern coast of America. The species of *Choreocolax* consist merely of rose-colored filaments, which are parasitic in the fronds of different *Florideæ*, upon the surface of which they produce irregularly swollen masses, composed in part of the threads of the *Choreocolax* and in part of the distorted tissues of the host-plant. The species of *Pseudoblaste* consist of aggregations of cells arranged in longitudinal series, which form hemispherical masses on the surface of different *Florideæ*. In neither genus is any form of reproduction known, and, for this reason, the descriptions of Reinsch must be regarded as inadequate, since it by no means follows that plants consisting of rose-colored filaments belong to the *Florideæ*. One often finds on our coast *Florideæ* whose

Suborder PÓRPHYREÆ.

Fronds brownish purple, composed of cells imbedded in a gelatinous net-work, arranged in filaments or in membranes formed of a single layer of cells; spores formed by the division of a mother-cell into eight cells, arranged by fours in two layers; antherozoids spherical, colorless, destitute of proper motion, formed by division of a mother-cell into 32–64 parts.

The present suborder comprises the genera *Porphyra* and *Bangia*, and perhaps also *Erythrotrichia* and *Goniotrichum*. In *Porphyra* the frond consists of a single layer of cells, of which those near the base send downwards root-like appendages, by means of which the fronds are attached to the substratum. The spores are formed at the marginal portion of the frond by the division of the vegetative cells, at first into two cells by a vertical partition, and the subsequent division of the two cells into four by cruciate partitions. Thus, when mature and seen from above, the eight spores seem to be arranged in two superimposed series of four. The spores escape by the dissolution of the outer part of the frond, leaving behind the empty gelatinous net-work. When free they are found to consist of protoplasm without a cellulose wall, and they move about for a short time with an amœboid motion. The antherozoids are also formed by the division of the vegetative cells, but the division is carried farther than in the production of the spores, for, in addition to the vertical and cruciate partitions described in the latter case, a second vertical and cruciate division takes place, so that the original vegetative cell is divided into 32–64 cells. Janczewski applies the name antheridium to the collective mass of antherozoids formed from a single vegetative cell. As the division takes place the antherozoids lose their color. When mature they are spherical and escape in a manner similar to that of the spores. Bornet and Janczewski state that the antherozoids are destitute of any proper motion, and we can confirm

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fronds are distorted by parasites, which produce deformities like those described by Reinsch as due to species of *Choreocolax*. Such distortions are perhaps most frequently found on *Cystoclonium purpurascens*. In our present ignorance of the fructification, specific identification is out of the question, and, in this connection, it is only necessary to quote the generic descriptions of Reinsch, l. c., with an enumeration of the species attributed to our coast:

CHOREOCOLAX. True vegetable parasites; fronds consisting of two portions, one of which extends through the tissue of the infected plant, the other of which swells above the surface of the infected plant, forming a convex mass, which is hemispherical or spherical, semi-ellipsoidal or irregular in outline; the cells which are contained in the infected plant either more slender than the others or of the same shape, cells of external portion equal or unequal, arranged without order in densely intricate subramose threads, terminal cells sometimes longer and more slender; fructification?; polysporangia?

C. RABENHORSTI. On *Delesseria sinuosa*, Anticosti; Gloucester, Mass.

C. POLYSIPHONIÆ. On *P. fastigiata*, Atlantic shore of North America.

C. MIRABILIS. On *Rhodomela subfusca*, Atlantic shore of North America.

C. AMERICANUS. On *Lophura Royana*, &c., Atlantic shore of North America.

C. TUMIDUS. On *Ceramium involutum*, West Gloucester, Mass.

PSEUDOBLASTE. False vegetable parasites; frond convex, more or less regular in outline, formed of similarly shaped cells, generally arranged in longitudinal series, arising from a densely appressed base (the cells without any organic connection with the cells of the infected plant); propagation?

P. IRREGULARIS. On *Lophura Royana*, Atlantic coast of North America.

this statement by our own observations, although Koschtsug maintains the contrary. The genus *Bangia*, except that the cells composing the frond are arranged in cylindrical filaments instead of expanded membranes, differs in no essential respect from *Porphyra* and the production of spores and antherozoids is the same.

The development and structure of the species of this order have formed the subject of a number of important papers, viz: *Porphyra laciniata*, in Études Phycologiques, by Bornet and Thuret; *Études Anatomiques sur les Porphyra*, by Janczewski, in Annales des Sciences, Ser. 5, Vol. XVII; and *Ueber die Geschlechtspflanzen von Bangia fusco-purpurea*, in Pringsheim's Jahrbücher, Vol. II. In the Nereis. Am. Bor., Harvey placed *Porphyra* and *Bangia* with the *Ulvaceæ*, which they resemble in so far as they consist of simple membranes and filaments some of whose cells change directly into spores. The sporee of the *Porphyreæ*, however, are motionless bodies, not zoospores as in the *Ulvaceæ*, and their color is not green, but brownish red. The systematic position of the order has been in doubt, because, although there were well-known spores and bodies to which the name of antheridia was applied, no one had succeeded in detecting trichogynes and procarps, which must necessarily exist if the *Porphyreæ* are to be classed with the *Florideæ*. Dr. G. Berthold, however, has recently published in the Mittheilungen aus der zoologischen Station zu Neapel a communication in which he claims to have discovered trichogynes in species of *Bangia* and *Porphyra*. According to him, the cells produce short trichogynes to which the antherozoids adhere, and as a result the contents of the cell divide and produce the spores at once. In other words, the *Porphyreæ* are the simplest of the *Florideæ;* a vegetative cell produces a trichogyne and is itself the carpogenic cell from which the spores are formed. Dr. Berthold goes further and says that some of the spores are nonsexual and are true tetraspores, but his article is not accompanied by illustrations. Bornet, to a certain extent following Cohn, suggests a possible connection of the *Florideæ* with the *Phycochromaceæ* by means of the *Porphyreæ*. Admitting that *Erythrotrichia* and *Goniotrichum* are related to *Porphyra* and *Bangia*, we have in *Goniotrichum* algæ composed of rose-colored discoidal cells packed in a thick gelatinous tube, from which they escape much as in some of the *Phycochromaceæ*.

PORPHYRA, Ag.

(From πορφυρα, a purple dye.)

Fronds gelatinous, membranaceous, composed of a single layer of brownish-red cells, those near the base sending out root-like processes; spores borne near the margin of frond, eight arising from a single mother-cell; antheridia marginal, consisting of 32–64 spherical, colorless antherozoids.

A small genus, the species of which are characterized by the relative position of the spores and antheridia and by the shape of the frond. Most of the species have been founded on variations in the outline of the frond, and recent writers agree in uniting many of the species of the older algologists.

P. LACINIATA, Ag.—*Laver.* (*P. linearis*, Grev.; Phyc. Brit., Pl. 211, Fig. 2.—*P. vulgaris*, Harv., Phyc. Brit., Pl. 211, Fig. 1.—*P. laciniata*, Harv., Phyc. Brit., Pl. 92; Études Phycol., Pl. 31.)

Fronds three inches to a foot and a half long, persistent throughout the year, color livid purple, substance gelatinous but firm, at first linear, but becoming widely expanded and finally much lobed and laciniate; antheridia and spores forming a marginal zone, usually borne

on different individuals, or when borne on the same individual not intermixed, but on separate portions of the frond.

Common on stones near low-water mark.

Found in all parts of the world.

This common species abounds on rather smooth stones and pebbles, and when the tide falls covers them with slimy films, which make walking over them difficult. The shape of the fronds is very variable, but as generally found they are much folded and laciniate. The species is used for making soups in Europe, but is not used in this country, except by the Chinese, who import it from China, not knowing that it occurs abundantly on our own coast. *P. leucosticta* probably occurs in New England, but has not yet certainly been observed. It is a spring species, softer and brighter colored than *P. laciniata*, and the antheridia and spores are found on the same individual, forming spots within the margin rather than a marginal zone.

BANGIA, Lyngb.

(Named in honor of *Niels Hofmann Bang*, of Copenhagen.)

Fronds gelatinous, simple, filamentous, cylindrical, densely tufted, composed below of a single row of cells, which, by repeated vertical division, become densely cellular above; antheridia and spores formed by transformation of the cells of the upper part of the filaments.

A small genus, of which most of the species are marine, but some are found in fresh water. The species are not well characterized, for the differences in the length of the filaments, color, and number of cells seen in cross-section, marks upon which most writers have relied, depend to a great extent upon the age of the plant and its place of growth.

B. FUSCO-PURPUREA, Lyngb.; Phyc. Brit., Pl. 96; Reinke, l. c., Pls. 12, 13.

Filaments blackish purple, two to six inches long, clustered in dense masses, lubricous; antheridia and spores usually on different individuals.

On wharves and rocks between tide-marks.

Rather common along the whole coast.

Easily recognized by the fine, soft, dark-purple filaments, which cover rocks and wood work in patches of considerable size with a dense gelatinous fleece. Although found on wharves in sheltered localities, it also occurs on rocks exposed to the waves.

ERYTHROTRICHIA, Aresch.

(From *ερυθρος*, red, and *τριχιον*, a small hair.)

Fronds rose-colored, simple, filamentous, composed of a single row of similar cells placed end to end; cell contents discharged in a spherical mass, which forms a spore.

A small genus, whose principal representative, *E. ceramicola*, is by many writers placed in *Bangia*. As we understand the genus, it differs from *Bangia* in that there are no antheridia or tetraspores, the reproduction being accomplished by the discharge of the cell contents in a single mass or spore. If *Bangia ciliaris* of the Nereis, which

occurs at Charleston but is not known farther north, is also to be included in the present genus, then the definition given above will have to be modified so as to include plants having more than one row of cells, an extension of the genus apparently adopted by Thuret, but not originally adopted by Areschoug.

E. CERAMICOLA, (Lyngb.) Aresch. (*Bangia ceramicola*, Chauvin, Phyc. Brit., Pl. 317.—*E. ceramicola*, Le Jolis, Liste des Algues Marines de Cherbourg, Pl. 3, Figs. 1, 2.)

Filaments diffuse, forming a web or fringe on algæ, cells about as long as broad.

On algæ, especially the smaller *Florideæ*, in tide-pools. Late summer and autumn.

Gloucester, Mass., *Mrs. Davis*, *Mrs. Cochrane;* Peak's Island, Maine, *W. G. F.;* Europe.

In examining with the microscope the filamentous *Florideæ* one often meets with a few filaments of this species. It is not, however, common to find it in such abundance on the shore as to attract the eye of the collector who is not especially in search of it. It attains its full size in the month of September.

? GONIOTRICHUM, Kütz.

(From *γωνια*, an angle, and *τριχιον*, a small hair.)

Fronds filamentous, branching, composed of rose-colored, disk-shaped cells, embedded in jelly.

A genus composed of only two or three species. Kützing describes two species, but his limitation of them is not now kept by algologists. Zanardini describes and figures a *G. cærulescens*, which is not red in any sense. The systematic position of the genus is very doubtful, and were it not for the color of the cells, *G. elegans* would probably be placed in the *Nostochineæ*. The only reproduction known consists in the escape of the cells from the gelatinous sheath and a division into two new cells, then into four, and so on until a new filament is formed.

G. ELEGANS, Zanard. (*Bangia elegans*, Chauv.; Phyc. Brit., Pl. 246.)

Filaments about .02^{mm} in diameter; cells cuboidal or ovate, about .009–10^{mm} in diameter.

On *Dasya elegans*.

Cotuit Port, Mass., *Mrs. J. T. Lusk;* Europe.

A small and rare plant, growing in tufts scarcely a tenth of an inch high. We have only one American specimen, collected by Mrs. Lusk, of Gloucester. The locality was incorrectly given in the *List of the Marine Algæ of the United States*, Proc. Am. Acad., 1875, the specimen not having been found by Mrs. Lusk at Gloucester, but at Cotuit, Mass.

SUBORDER SQUAMARIEÆ.

Fronds forming horizontally expanded crusts, usually membranaceous, occasionally somewhat incrusted with lime, composed of closely packed vertical filaments arising from a horizontal stratum of cells; fructification either in external protuberances composed of parallel fila-

ments or immersed in the frond; antherozoids formed from the cells of the protuberances or the superficial cells of the frond; cystocarps composed of few spores arranged end to end in a few rows, or in filaments which branch slightly; tetraspores zonate or cruciate, stalked or attached laterally to the filaments of the frond or protuberances.

A small order, more abundant in tropical seas than on our coast, comprising species which in habit resemble lichens rather than algæ. A few species, as *Peyssonnelia squamaria* and *P. australis*, attain a considerable size, and are distinctly foliaceous. The greater part of the species, however, form closely adherent crusts, which are sometimes more or less gelatinous and sometimes slightly calcareous. The structure of the fronds is simple. From a horizontal base, composed of a single layer or a few layers of cells, arise vertical filaments, which in some genera are densely united so as to form a parenchymatous frond, or in others are only slightly held together by a gelatinous intercellular substance. The fructification is found either in external raised spots or sunk in the frond. The antheridia are either formed directly from the cells of the filaments which constitute the protuberances or from the external cells of the fronds themselves. The tetraspores are either cruciate or zonate, and their position constitutes an important generic mark. The development of the systocarps is known in only a few species. In *Peyssonnelia*, according to Dr. Bornet, the procarp is formed from the cells of the filaments, which form the protuberances. The upper cell elongates and forms the trichogyne, and the fertilization consists merely in the change of the cells of the procarp into spores, thus constituting a very simple form of cystocarp, to which Zanardini has given the name of *cystidie*. According to Prof. Fr. Schmitz, in *Cruoriopsis cruciata*, Dufour, there are winding filaments like those described by Thuret and Bornet in *Dudresnaya*. We have but few *Squamarieæ* on our coast, and the study of the suborder cannot easily be pursued with us.

PEYSSONNELIA, Decaisne.

(Named in honor of *J. A. Peyssonnel.*)

Fronds horizontally expanded, attached by the under surface; substance parenchymatous throughout; fructification in external convex protuberances (nemathecia) composed of slender parallel filaments, on which are borne the antheridia, cystocarps, and tetraspores; antherozoids produced in all the cells of the nemathecial filaments; tetraspores cruciate, oblong, sessile or shortly stalked; cystocarps composed of few spores, placed one over another in one or two rows or in short, branching filaments.

A small genus, comprising probably not more than twelve or fifteen good species. *P. squamaria*, common in Southern Europe, is not known with us. It may be that several of the species described by Crouan in the Annales des Sciences and the Florule du Finistère occur with us; but it must be confessed that from the description given by Crouan it would be by no means an easy matter to recognize them. Those who have an opportunity for dredging on shelly bottoms at localities like Gay Head, Block Island, Montauk, or Eastport should make a careful search for species of the present genus.

P. DUBYI, Crouan; Phyc. Brit., Pl. 71; Florule du Finistère, Pl. 19, Fig. 130; Proc. Am. Acad. Arts & Sciences, 1877, p. 239.

Fronds dark purple, thin, completely adherent to the substratum, somewhat calcareous beneath; cystocarpic spores few in number (4–6), arranged in one or two rows.

On shells and stones at low-water mark and in deep water.

Eastport, Maine; Magnolia, Mass.; Europe; California.

As yet only found in a sterile condition, apparently not common. The species might possibly be mistaken for *Petrocelis cruenta* at first sight. It is, however, more decidedly reddish and thicker. Under the microscope the structure of the frond is seen to be parenchymatous throughout, while in *Petrocelis* the vertical filaments are nearly free from one another. *P. imbricata*, Kütz., Tab. Phyc., Pl. 90, from Newfoundland, is a doubtful species, which is not likely to be recognized by future botanists.

PETROCELIS, J. Ag.

(From πετρος, a stone, and κηλις, a stain.)

Fronds gelatino-coriaceous, horizontally expanded, indefinite in outline, adhering closely to the substratum, vertical filaments united below, but above rather loosely held together by a gelatinous substance; antheridia and cystocarps unknown; tetraspores spherical, cruciate, formed directly from some of the cells of the vertical filaments.

A genus represented by a single species, which is widely diffused in the North Atlantic. At once recognized by the peculiar position of the cruciate tetraspores, which are in the continuity of the vertical filaments. There is usually only a single tetraspore in each filament, but Ruprecht, in Phycologia Ochotensis, figures a form in which several contiguous cells are transformed into tetraspores.

P. CRUENTA, J. Ag. (*Cruoria pellita*, Harv., in Phyc. Brit., Pl. 117, non *C. pellita*, Lyngb.) Pl. 14, fig. 1.

Covering rocks and stones near low-water mark with a dark purple, velvety stain.

Common from Nahant northward; Europe.

The present species often accompanies *Hildenbrandtia rosea*, from which it is distinguished at sight by its darker color and velvety gloss when moist. It is also decidedly thicker and more easily scraped from the rocks. The species is not yet known south of Cape Cod, but may be expected. The fronds of the present species are infested by a green unicellular parasite, which is frequently seen in the shape of ovoid sacks, drawn out at the lower end into a slender stalk amongst the vertical filaments. It is, in all probability, the parasite mentioned by Cohn, in Ueber einige Algen von Helgoland, as occurring in *Cruoria pellita*, to which, as far as we know, no name has as yet been given.

HILDENBRANDTIA, Nardo.

(Named in honor of *Prof. Franz Edler Hildenbrandt*, of Vienna.)

Fronds crustaceous, without calcareous deposit, forming thin, reddish, horizontal expansions of indefinite extent, composed of cuboidal cells arranged in vertical lines and arising from a horizontal basal layer;

tetraspores lining the walls of immersed conceptacles, zonate, cruciate, or irregularly placed; cystocarps unknown.

A small genus, comprising half a dozen species, which form thin crusts on rocks and stones both in salt and fresh water. The systematic position of the genus is doubtful, and must remain so until the cystocarps are known. Since the tetraspores are borne in special conceptacles, the genus has been placed by some writers with the *Corallineæ*, although the species are not strictly calcareous. By others it is placed with the *Squamarieæ*. Antheridia are only known in *H. rivularis*, where they are said by Borzi to be long cylindrical cells formed from the superficial cells of the thallus, each cell containing a number of spherical antherozoids arranged one above another.

H. ROSEA, Kütz. (*H. rubra*, Harv., Phyc. Brit., Pl. 250; Farlow, in Report of U. S. Fish Comm. for 1871.)

Fronds thin, closely adherent to the substratum, cells of nearly the same size in all parts of the frond; conceptacles numerous, completely immersed, spherical; tetraspores either zonate or irregularly divided, lining the walls of the conceptacles and mixed with filiform, slender paraphyses.

On stones and rocks near low-water mark.

Everywhere common.

One of our commonest species, which forms continuous thin crusts, often of considerable extent, tinging the rocks with a pinkish or somewhat brownish color; not easily mistaken for any other alga on our coast, except possibly young forms of *Petrocelis*, which is, however, thicker, more velvety in appearance, and darker in color.

Suborder NEMALIEÆ.

(*Helminthocladieæ*, Agardh & Harvey.)

Fronds more or less gelatinous or occasionally coated with a calcareous deposit, filamentous, branching, formed of an axial portion composed of elongated longitudinal filaments, which give off short, corymbose, horizontal branches, which constitute the cortical portion; antheridia in tufts on the superficial cells; cystocarps immersed in the frond, borne on the peripheral filaments, composed of densely packed chains of spores radiating from a central cell, either without any proper envelope, or with a filamentous involucre or surrounded by a proper membranous pericarp; tetraspores?

A comparatively small suborder, comprising species whose fronds, except in color, resemble the fronds of the *Chordarieæ* in the *Phæosporeæ*, since they consist of an axis composed of longitudinal filaments and a cortex of short, much-branched horizontal filaments. All our species are soft and somewhat gelatinous, but the species of *Liagora*, which abound in the tropics and are found in Southern Europe and in this country in Florida and California, have a more or less distinct coating of carbonate of lime. The procarps and cystocarps in this suborder are very simple. There are a few species belonging to the genus *Batrachospermum* which occur in fresh water. In that genus the formation of the cystocarps is very simple. The trichogyne and trichopore are represented by a single large cell, constricted near the base. After fertilization the chains of spores are formed directly from the part below the constriction. In

Nemalion the procarp consists of a short branch composed of a few cells, the upper of which enlarges and bears a hair-like trichogyne. The fruit in *Nemalion* has no special covering, but in *Helminthora* and *Helminthocladia* the lower cells of the procarp produce whorls of filaments which form an involucre around the spores, and in *Scinaia* they produce a membranous sack which opens at the apex, so that when ripe the fruit consists of a conceptacle opening outwards, at whose base is borne a tuft of spores arranged in filaments. With regard to the tetraspores in the present suborder, a difference of opinion exists. Contrary to what is found in other *Florideæ*, the cystocarpic individuals are common, whereas tetrasporic individuals are unknown except in *Nemalion*, in which genus, on the authority of Agardh, they are borne in the superficial cells and are tripartite.

NEMALION, Duby.

(From *νημα*, a thread.)

Fronds gelatinous, cylindrical, solid, repeatedly dichotomous, cortical filaments corymbose, giving off descending branches, which unite with the axial filaments; antheridia in tufts on the superficial cells; procarps borne at the base of the corymbose branches, consisting of few cells; cystocarps immersed, without special covering, sporiferous filaments radiating from the trichophore; "tetraspores tripartite in the superficial" cells. (Agardh.)

A small genus, comprising seven or eight species, only one of which, *N. multifidum*, is widely diffused.

N. MULTIFIDUM, Ag., Phyc. Brit., Pl. 36. (*Mesogloia multifida*, Ag., Syst.) **Pl. 12, Fig. 1.**

Fronds brownish purple, lubricous, two to eight inches long, cylindrical, several times dichotomous, axils obtuse.

On exposed rocks at low-water mark. Summer.

From Watch Hill, R. I., northward; Europe.

Not uncommon on rocks exposed to the action of the waves. Commonly found with cystocarps, but no tetraspores have been seen on American specimens. In the Nereis the species is said to have been collected at Bangor, Maine, by Mr. Hooper. This must be an error, however, since Bangor is on the Penobscot River, above the limit of salt water. Specimens of the present species are so gelatinous as to dry with difficulty. They should be exposed in the air for two or three hours before pressing.

SCINAIA, Bivona.

(In honor of *Domenico Scina*, of Palermo.)

Fronds subgelatinous, dichotomous, cylindrical or compressed, axis small, composed of slender colorless filaments, horizontal filaments ending in short corymbs of small, round, colored cells, the centers of all the corymbs bearing large, colorless, cylindrical cells, which by their juxtaposition form an epidermis over the whole frond; antheridia in small tufts on the superficial cells; cystocarps borne just below the cortical layer, consisting of membranous sacks opening externally, with a tuft of spore-bearing filaments attached to the base; tetraspores unknown.

A small genus, containing at the most only four or five species, of which *S. furcellata* is widely distributed. The genus is unmistakable on microscopic examination by the slender axis and large colorless cylindrical cells which cover the surface of the fronds, and by the peculiar cystocarps which are visible to the naked eye as dark red grains just under the surface. The species should be studied from living or alcoholic specimens, since, owing to the delicate substance, pressed specimens are badly distorted.

S. FURCELLATA, Bivona. (*Ginannia furcellata*, Mont.; Phyc. Brit., Pl. 69.—*S. furcellata*, Notes Algologiques, Pl. 6.)

Fronds solitary or clustered, cylindrical, rising from a disk-like base, several times dichotomous, divisions regular, apices obtuse.

On stones and shells in five to ten fathoms.

Newport, R. I., *Bailey;* Gay Head, Mass., *W. G. F.*

A rare species with us, but widely distributed throughout the world, being found in most warm seas. In size and regularity of its dichotomous branching it resembles *Polyides rotundus*, but is much more delicate in substance and brighter colored. With us it is only known at a considerable depth and in rather cold waters, but in the Mediterranean it is frequent in warm shallow waters. It is not uncommon on shells of *Mytilus* near the Devil's Bridge, Vineyard Sound, Mass., and is found washed ashore in the neighboring beach of Gay Head. The Californian form of what is supposed to be the same species is much more robust, and the var. *undulaa*, which Montagne considered a distinctspecies, is somewhat compresed and constricted at intervals. When pressed the specimens are quite flat and the axis is plainly seen, giving the appearance of a membranous frond with a midrib.

SUBORDER SPERMOTHAMNIEÆ.

Fronds filamentous, monosiphonous, branching; antheridia tufted; cystocarps involucrate, spores borne free on the surface of a lobulated mass produced by the carpogenic cells.

In this suborder we would place *Spermothamnion* and *Bornetia*, separated from *Callithamnion* and *Griffithsia*, respectively, in consequence of the spores being borne free.

SPERMOTHAMNION, Aresch.

(From σπερμα, a seed, and θαμνιον, a small bush.)

Fronds tufted, composed of procumbent monosiphonous filaments attached to the substratum by disk-shaped cells and vertical branching filaments; antheridia sessile on the inner side of the branches, composed of oval or cylindrical masses of small cells; cystocarps terminal on the branches, surrounded by an involucre of short incurved branchlets, spores free from one another and not surrounded by a gelatinous envelope; tetraspores tripartite, single or aggregated, borne on the inner side of the branchlets.

A small genus, comprising, as far as known, less than half a dozen species, separated from *Callithamnion* because the spores at maturity are borne free on the surface of a lobulated mass which arises from the development of the carpogenic cells, and not, as

in *Callithamnion*, held together by a gelatinous envelope. The trichophoric apparatus and the early stages of the development of the cystocarps, however, scarcely differ in the two genera. The species of *Spermothamnion* have been considered related to *Wrangelia*, but if we are to regard *W. penicillata* as the type of the last-named genus, as has been done by Thuret and Bornet in Notes Algologiques, the resemblance is not close. In spite of the fact that the fruit of *Spermothamnion* is not a true favella, there is little doubt that the genus should be placed in the *Ceramieæ*, near *Callithamnion*. The development of the genus has been very thoroughly studied and has formed the subject of several admirable papers, among which may be mentioned Pringsheim's account of *S. roseolum*, in his Beiträge zur Morphologie der Meeres-Algen; Nægeli on *S. Turneri* and *hermaphroditum*, in Beiträge zur Morphologie und Systematik der Ceramiaceæ; and Thuret and Bornet on *Spermothamnion flabellatum*, in Notes Algologiques.

S. TURNERI, Aresch. (*Callithamnion Turneri*, Ag.; Phyc. Brit., Pl. 179; Ner. Am. Bor., Part III, p. 241.—*S. roseolum*, Pringsh., l. c.?—*Herpothamnion Turneri*, Næg.)

Fronds forming densely matted tufts, procumbent filaments branching, attached by disk-like cells, vertical filaments one to three inches high, simple or slightly branching, naked below, pinnate above with opposite or sometimes alternate spreading pinnate branches, ultimate branches long and slender, often ending in a hair; antheridia ovate or cylindrical, sessile on the upper side of the branches; cystocarps involucrate, terminal on the branches; tetraspores tripartite, borne on the upper side of the ramuli, either solitary and pedicellate or clustered and sessile on short fastigiate branches.

Var. VARIABILE, Harv.

Branches and branchlets alternate or secund.

In very dense tufts on algæ at low-water mark or in deep water.

Common in Long Island Sound; var. *variabile*, Boston, *Dr. Durkee.*

A species which is often found washed ashore in dense globose tufts from our southern limit to Nantucket. At the latter locality it is often found in very large quantities washed from deep water by the surf on Siasconsett Beach. The filaments are delicate and of a pleasant lake color. North of Cape Cod the species is hardly known with certainty. Specimens collected at Noank, Conn., have both tetraspores and young cystocarps on the same individual, but we have never seen antheridia on American specimens. Our plant seems to be the same as that figured by Pringsheim under the name of *S. roseolum*, and also corresponds closely to the species of that name in Algæ Scandinavicæ, No. 83. It appears without doubt to be the *C. Turneri* of the Phycologia Britannica and the Nereis, but we are unable to say whether it is the true *C. roseolum* of Agardh.

SUBORDER CERAMIEÆ.

Fronds filamentous or compressed, either monosiphonous or with a more or less corticated monosiphonous axis; antheridia in sessile tufts or patches or in a series of whorls; cystocarps (favellæ) composed of spores arranged without order and surrounded by a gelatinous envelope, naked or involucrate.

A large order of filamentous algæ, many of which are monosiphonous throughout, while others are corticated either throughout or partially. The position of the antheridia and tetraspores varies in the different species. The cystocarp is a favella, which is either naked or surrounded by an involucre arising from the cells below the carpogenic cells. In cases where the frond consists of an axis with dense whorls of branches the favellæ may be partly concealed but not really immersed in the frond. The order is tolerably distinct. The fronds resemble closely those of the *Wrangelieæ*, and on the other hand the order passes gradually into the *Cryptonemieæ* by the genera *Gloiosiphonia, Calosiphonia,* and *Nemastoma,* in which the fruit is properly a favella, but is immersed in the comparatively dense outer portion of the frond instead of being free as in the *Ceramieæ*. In fact, it is difficult to say in which suborder *Gloiosiphonia* should be placed.

1. Tetraspores external, occupying the place of a branchlet or ultimate cell 3
2. Tetraspores wholly or partly immersed, formed from the corticating cells 4
3. Fronds filamentous, monosiphonous, or with a false cortex composed of descending filaments, favellæ naked or with only a rudimentary involucre ..... *Callithaminon.*
   Fronds filamentous, monosiphonous, dichotomous, favellæ involucrate ..... *Griffithsia.*
   Fronds filamentous, branches densely whorled on the axis, favellæ involucrate ..... *Halurus.*
   Fronds compressed, corticated, decompound-pinnate, favellæ involucrate ..... *Ptilota.*
4. Fronds filamentous, monosiphonous, corticications at the nodes and extending over the internodes ..... *Ceramium.*

CALLITHAMNION, Lyngb.

(From *καλλος*, beauty, and *θαμνιον*, a small shrub.)

Fronds filamentous, branching, filaments either monosiphonous throughout or becoming corticated by the growth of descending, rhizoidal filaments; antheridia forming hemispherical or ellipsoidal tufts on the branches; cystocarps composed of irregular masses of roundish spores covered by a gelatinous envelope (favellæ); tetraspores tripartite, cruciate, or polysporic; seirospores present in some species.

A large and beautiful genus, of which nearly 150 species have been described. Although the genus has been divided into a number of smaller genera, the number of species still retained in *Callithamnion* proper is large. Nægeli, in his paper on the Morphology of the Ceramiaceæ, divides *Callithamnion* into a number of genera and subgenera, but we have thought best to retain the genus in an extended sense, regarding Nægeli's division as subgenera. *Spermothamnion,* included by Nægeli in *Herpothamnium,* has been separated because the cystocarpic fruit is not strictly a favella as in *Callithamnion* proper. *Seirospora* is still retained, although it is possible that it could safely be separated as a distinct genus. The frond in *Callithamnion* is composed, in the beginning, of rows of cells arranged in branching filaments. In the subgenus *Rhodochorton,* whose relative position is doubtful because the cystocarps have not yet been observed, there are procumbent filaments, from which arise vertical branching filaments. In the other

species of *Callithamnion*, as here understood, the procumbent filaments are wanting or imperfectly developed, and the erect filaments either remain throughout monosiphonous, that is composed of single rows of cells, or become corticated by the growth of descending filaments, which proceed either from the base of the branches or from the cells of the main filaments. The false cortication formed by the interlacing of these filaments is precisely analogous to what is found in some species of *Ectocarpus* and related genera. The filaments in *Callithamnion* are either all indeterminate in growth, or else, as in the subgenus *Antithamnion*, they are of two kinds; the main filaments being indefinite and the branches definite, so that we have indefinitely elongating stems clothed with short, definite branches, or, to use the expression of Nægeli, with leaves. The antheridia are generally in the form of short tufts of hyaline cells, situated on the upper branches. In the present genus it is not rare to find species in which antheridia, cystocarps, and tetraspores are borne on the same individuals, a union rarely to be seen in the *Florideæ*. The cystocarps are often binate, which is easily understood if one considers the structure of the procarp, which is formed as follows: One of the cells of the young branches enlarges and is then divided by partitions parallel to the length of the branch into a central or axial cell and a number of peripheral cells, generally four. One of the peripheral cells is then divided into an upper and one or more lower cells by a transverse partition, and the upper cell then loses its color and grows upwards into a very long trichogyne. The antherozoids unite with the tip of the trichogyne, and the fertilizing influence is propagated through the trichogyne and the cells at its base to the two lateral peripheral cells, which then enlarge and divide on opposite sides of the axis and form eventually a bipartite favella. The tetraspores are either tripartite or cruciate. In the subgenus *Seirospora* there is a form of non-sexual spore known as seirospores, in which at the extremity of the branches are formed tufts composed of chains of oval bodies, each one of which is capable of germinating.

As is apt to be the case in a large genus, the species of *Callithamnion* are not well defined. Certain groups of species are distinct, but writers are not agreed as to the limits of the species in each group. By some a great many species are allowed which others regard as mere varieties. On our coast *C. Baileyi*, *C. byssoideum*, *C. corymbosum*, and perhaps others might be indefinitely split up, but we have preferred to adopt the opposite view. Within certain limits collectors may be expected to make out our species of *Callithamnion*, but it must often happen that forms are found which cannot with certainty be referred to any of the described species. That such forms are, as a rule, new species cannot be accepted, but botanists having large sets of species of the present genus soon become very liberal in the interpretation of specific limitations.

Subgenus RHODOCHORTON, Næg.

Fronds composed of procumbent filaments, from which arise vertical monopodial filaments; corticatons wanting; tetraspores cruciate.

C. Rothii, Lyngb. (*Rhodochorton Rothii*, Næg.—*Thamnidium Rothii*, Thuret, in Le Jolis's Liste des Algues Marines de Cherbourg, Pl. 5, Figs. 1–2.—*C. Rothii*, Phyc. Brit., Pl. 120 *b*.)

Fronds forming indefinite patches half an inch high, vertical filaments slender, naked below, bearing a few erect, appressed branches above, which become at the time of fructification congested and corymbose, bearing at their tips cruciate tetraspores; antheridia and cystocarps unknown.

Forming dense velvety patches on rocks between tide-marks.

Common from New York northward; California; Europe.

A common species, especially frequenting the under surface of rocks and stones near low-water mark. It has not yet been found with us in fruit, but Californian specimens bear tetraspores. In Europe the time of fructification is the spring, and the species should be examined at that season on our own coast. Harvey states that the tetraspores are tripartite, but other writers—as Thuret, Agardh, and Nægeli—agree in asserting that they are cruciate. In Californian specimens the formation of the tetraspores is somewhat irregular, and although in most cases the cruciate division is plain enough, in others it seems to be rather tripartite.

SUBGENUS ANTITHAMNION, Thuret.

Branches opposite or whorled, without cortication; tetraspores cruciate.

C. CRUCIATUM, Ag. (*Antithamnion cruciatum*, Næg.—*C. cruciatum*, Phyc. Brit., Pl. 164.)

Fronds tufted, one or two inches high, main branches sparingly and irregularly branched, secondary branches short, borne in twos or fours just below the nodes, always regularly opposite, and when in twos the succeeding pairs at right angles to one another, below subdistant, at the apex densely approximate and corymbose, pinnate with erect, alternate, distichous branchlets; tetraspores cruciate, sessile, or shortly stalked at the base of the secondary branches.

On wharves at low-water mark and on algæ in shallow water.

Red Hook, N. Y., *Harvey;* Orient, L. I.; Noank, Conn.; Wood's Holl and several localities in Vineyard Sound, *W. G. F.;* Europe.

Not common, but, on the other hand, not rare south of Cape Cod. It is a small and not very beautiful species when growing, but rather pretty when pressed. It is distinguished from the following species by its small size and sparingly branched main branches and by its tetrastichous, not distichous, secondary branches, which are densely approximate at the tips, so that in dried specimens the plant is rather pale except at the tips. Cystocarps and antheridia have never been found on our coast. Crouan states that the cystocarps, which are rare, are large, rounded, and slightly lobed. The branches of the present species, as well on our own shore as in Europe, are beset with small cysts with oily contents—the *Chytridium plumulæ* of Cohn. The same parasite is also found on the branches of *C. Pylaisæi* and *C. plumula* on the New England coast.

C. FLOCCOSUM, Ag. (*C. floccosum*, Phyc. Brit., Pl. 81.—*Pterothamnion floccosum*, Næg.)

Fronds three to six inches long, capillary, main branches irregularly and sparingly branched below, above with numerous alternate branches, which give the tips of the frond a rhombic-ovoid outline, clothed throughout with short, simple, opposite, distichous, subulate, secondary branches; tetraspores cruciate, sessile or on short stalks on the lower part of the secondary branches.

On submerged algæ.

Eastport, Maine, *W. G. F.;* Portland, Maine, *C. B. Fuller;* Gloucester, Mass., *Mrs. Bray* and *Mrs. Davis;* South Boston, *Dr. Durkee;* Northern Europe.

A beautiful and easily distinguished species, found only in the colder waters of the Atlantic, a variety occurring as far south as South Barbara, on the coast of California. It is apparently not uncommon in spring from Boston northward, sometimes occurring in company with *C. Pylaisæi.* It is rare, however, on the northern coast of Scotland. It is easily distinguished from its allies in this latitude by the simple, subulate, secondary branches with which the main branches are clothed throughout.

C. PYLAISÆI, Mont. (*Wrangelia Pylaisæi*, Ag. Sp.—*C. Pylaisæi*, Ner. Am. Bor., Part II, Pl. 36 *b.*—*Pterothamnion Pylaisæi*, Næg.)

Fronds three to six inches long, main branches alternately decompound, secondary branches short, rather stout, opposite, distichous, once or twice pinnate with short subulate ramuli; tetraspores cruciate, sessile on the ramuli; favellæ binate on the upper branches.

On wharves and algæ below low-water mark.

Orient, L. I., *Miss Booth;* Wood's Holl, Mass.; and common from Nahant northward.

A common species of the Atlantic coast from Boston northward, but much less abundant southward. It is found early in the spring on wharves and washed ashore with other algæ, but in the summer it is only seen in a dwarfed and battered condition. It is sometimes found in company with *C. Americanum,* and it is by no means beyond a doubt that the two species are really distinct. In *C. Pylaisæi* the filaments are more robust, and the cells themselves shorter and broader than in *C. Americanum,* the main branches are less decompound and spreading, and the apical branches are more erect and compact. It is, however, in the secondary branches that the difference is best seen. In *C. Pylaisæi* they are short and thick, and the ultimate divisions are broadly subulate. In *C. Americanum* they are long, slender, and flexuous. Those who have only seen the typical forms of the two species would scarcely believe that they were not very distinct species. The collector, however, especially on our northern coast, often finds transitions between the two. At the time the Nereis was written the cystocarpic fruit was unknown, and the species seemed to Agardh to belong rather to the genus *Wrangelia.* The fruit, which is not uncommon in the spring, is distinctly the same as in *Callithamnion,* and is a true favella. The antheridia differ from those of *C. corymbosum* and its allies. Instead of forming sessile, hemispherical tufts on the internodes of the branches, as in the last-named species, the antheridia of *C. Pylaisæi* are in the form of rather loosely branching tufts inserted at the nodes of the secondary branches, and occupy the position of the ultimate branches, reminding one somewhat of the antheridia of *C. graniferum,* Menegh., figured by Zanardini in Phycologia Adriatica, Pl. 11, or the figure of *C. polyspermum* in Phycologia Britannica. As far as our observations go, the antheridia and cystocarps of the present species are on different individuals. The color, when dried, is usually somewhat brownish, and decidedly less rose-colored than in *C. Americanum.*

C. AMERICANUM, Harv., Nereis Am. Bor., Part II, p. 238, Pl. 36 *a.* (*Pterothamnion Americanum*, Næg.)

Fronds three to six inches long, capillary, main branches alternately many times branched, ultimate divisions plumose, secondary branches

rather long and slender, opposite, in twos or occasionally in fours, generally distichous, widely spreading, once or twice pinnate, ultimate divisions opposite or secund, long and slender; tetraspores cruciate, sessile on the upper side of the secondary branches; favellæ binate.

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 89.

On wharves and algæ below low-water mark. Spring.

From New Jersey northward.

A common and very beautiful species, more abundant in Long Island Sound than farther northward. It varies considerably in the compactness of the branching and the tenuity of the cells. The species with which it is likely to be confounded is *C. Pylaisœi*, as already indicated. The long and slender secondary branches are less regularly placed than in some other species of the subgenus, and they are not always distichous nor opposite, although that is generally the case. We have also seen a specimen on which both tetraspores and cystocarps were found together.

C. PLUMULA, Lyngb., Phyc. Brit., Pl. 242.

Fronds two to four inches long, main branches alternately decompound, secondary branches opposite or in fours, distichous, short, recurved, pectinate on the upper side with 1–3 pinnated branchlets; tetraspores cruciate, shortly pedicellate on the branches.

On wharves and on shells in deep water.

Long Branch, N. J., *Harvey;* Orient, L. I., *Miss Booth;* on steamboat wharf, Newport, R. I.; dredged in 8–10 fathoms, Gay Head, *W. G. F.;* off Block Island, *Professor Eaton.*

A rare species on the American coast, and known in but few localities. It is found occasionally on wharves just below low-water mark, but more frequently on shells in from five to ten fathoms. It is tolerably abundant off the Devil's Bridge, near Gay Head, where it is found in company with *Lomentaria rosea.* It is one of the most easily recognized species of the genus found on our coast. The branches are beautifully symmetrical and distichous, two opposite branches being given off from each cell, or occasionally there are four in a whorl, two being smaller than the others. The branches are recurved and furnished on the upper side only with 1–3 pinnate branchlets.

SUBGENUS PLEONOSPORIUM, Næg.

Fronds erect, pinnate, cortication wanting; antheridia cylindrical on the upper branches; favellæ terminal, involucrate; tetraspores polysporic.

C. BORRERI, Ag., Phyc. Brit., Pl. 159.

Fronds dicœcious, densely tufted, monosiphonous, with a few rhizoidal filaments at the base, filaments one to four inches long, capillary, main branches several times pinnate, branches beset in lower part with usually simple, elongated branchlets, distichously pinnate above, ultimate ramifications broadly ovate or triangular in outline, branchlets naked below; antheridia cylindrical; tetraspores sessile on the upper

branchlets, numerous, tripartite or polysporic; favellæ terminal on lateral branches, usually composed of several distinct lobes, furnished with an involucre by the growth of a few incurved accessory branches below.

On wharves and *Fuci*.

New York, *Harvey;* New Haven, *Professor Eaton;* Newport; New Bedford; Wood's Holl; Europe.

Apparently rather a common species, especially on wharves and *Fuci* at low-water mark. The species is easily recognized, when in fruit, by the polysporic tetraspores and by the favellæ, which are terminal, not lateral, as in the rest of our species, and have a sort of involucre formed by the growth of accessory ramuli from the cells just below the favellæ. When sterile the species may be recognized by the regular, broadly pinnate tips, at the end of nearly naked branches. We have found both polyspores and favellæ on American specimens; and in spite of the fact that our plants are always more slender than European forms of the species, there can be almost no doubt that we have the true *C. Borreri*. Whether all the sterile forms referred by American botanists to *C. Borreri* are correctly determined is doubtful. Some perhaps belong rather to *C. roseum*. The present species is placed by Bornet in the genus *Corynospora*, because of the terminal and involcurate favellæ and polysporic tetraspores. As writers differ about the limits of *Corynospora*, we have kept the species in *Callithamnion*, although in some respects it differs from the rest of the genus, and the young stages of the cystocarps remind one strongly of *Spermothamnion*. The fruit is, however, a true favella. The number of spores in the polyspores in American specimens rarely exceeds 8 or 10, whereas Nægeli puts the number as high as 20–28 in European specimens. As usually found in early summer, the species is small and delicate, but later it becomes coarse. Specimens collected as late as possible in the autumn are to be desired, and the number of spores in a polyspore should be ascertained more definitely. In Contributiones ad Algologiam et Fungologiam, p. 44, Pl. 23, Fig. 1, Reinsch describes and figures a *Callithamnion Labradorense*, which is said to have polyspores—whether a polysporic condition of *C. floccosum* or not can hardly be determined from the description.

SUBGENUS EUCALLITHAMNION.

Fronds erect, corticated generally present; antheridia in tufts, either on the nodes or internodes of the branchlets; tetraspores tripartite; favellæ usually binate, lateral.

Sect. I. PENNATÆ.

Growth monopodial, fronds distichously pinnate, pinnæ alternate, corticated rudimentary or wanting.

C. ROSEUM, (Roth), Harvey. (*C. roseum*, Phyc. Brit., Pl. 230.—*Phlebothamnion roseum*, Kütz.)

Fronds capillary, two to four inches high, filaments diffusely branched below, main branches slightly corticated, secondary branches long, flexuous, distichously pinnate, pinnæ crowded at the ends of the branches, long, spreading or slightly incurved; antheridia in tufts on the nodes of the branchlets; tetraspores tripartite, sessile on the branchlets; favellæ binate on the upper branches.

New York Harbor, *Mr. A. R. Young;* Wood's Holl, Mass.

There must remain some doubt as to the correct determination of American specimens of the present species in the absence of fruit of any kind. Sterile specimens of *C. roseum* are likely to be mistaken for varieties of *C. polyspermum* or *C. Borreri.* In *C. polyspermum* the pinnæ are short and subequal, so that the outline of the tips of the branches is linear or oblong, while in *C. roseum* the pinnæ, which are crowded at the ends of the branches are long, gradually diminishing in size towards the apex, so that the plumose tips are pyramidal or broadly ovate in outline. The filaments of *C. roseum* are finer and more nearly rose-colored than those of *C. Borreri,* and the pinnæ are less regularly distichous. Furthermore, there are no polyspores in *C. roseum,* and the favellæ are not terminal and subinvolucrate as in *C. Borreri.* All three of the species above named are distinct from the species of the following group in their distichously pinnate ramification, and all three are reddish, inclining to a brownish color. They collapse when removed from the water, but are hardly gelatinous, although all adhere well to paper in drying.

C. POLYSPERMUM, Ag. (*C. polyspermum,* Phyc. Brit., Pl. 231.—*Phlebothamnion polyspermum,* Kütz.)

Fronds capillary, corticating wanting, two to three inches high, main branches irregularly divided, with few secondary branches below, distichously pinnate above, branches linear or oblong in outline, simply pinnate, pinnæ alternate, short, subequal, incurved, upper pinnæ sometimes pinnulate; tetraspores tripartite, sessile on the upper side of branchlets; favellæ binate near the ends of the branches.

Hell Gate, N. Y.; Jackson Ferry, *Harvey;* Europe.

The only localities for this species within our limits are the two given by Harvey. We have seen Californian specimens collected by Mr. Cleveland near San Diego, but have never found the plant on the New England coast. The species is related to *C. roseum* and is distinguished from it by the short, subequal ultimate branches.

Sect. II. FRUTICOSA.

Growth sympodial, main axis and branches densely corticated: branchlets pectinate or pinnate, ultimate divisions alternate or secund.

C. TETRAGONUM, Ag. (*C. tetragonum,* Phyc. Brit., Pl. 136.—*C. brachiatum,* Harv., l. c., Pl. 13.—*Dorythamnion tetragonum,* Næg.)

Fronds monœcious, two to six inches high, coarse and spongy, shrublike, pyramidal in outline, color dark purple, main filaments densely corticated, smaller filaments monosiphonous; main axis percurrent, attached by a disk, pinnate with long, undivided, alternate branches, which are once or twice pinnate, the ultimate divisions beset on all sides with short, stout, incurved, acutely pointed, fasciculate branchlets; cells stout, not much longer than broad; antheridia in tufts on the upper internodes; tetraspores tripartite, sessile on the upper branchlets; favellæ binate.

Common on stones and algæ below low-water mark.

Long Island Sound; Europe.

Our most robust and coarsest species, not uncommon in Long Island Sound, but not yet recorded north of Cape Cod. The color is dark, and in the water almost black, and the substance is rather spongy, the plant not collapsing when removed from the water, as do most of the New England species of the genus.

C. BAILEYI, Harv. (*C. Baileyi*, Harv., Ner. Am. Bor., Part III, Pl. 35 *b*.—*Dorythamnion Baileyi*, Næg.) **Pl. XI, Figs. 1–2.**

Fronds monœcious, two to four inches high, setaceous, shrub-like, pyramidal in outline, color purplish red, main filaments densely corticated, the rest monosiphonous; main axis percurrent, attached by a disk, pinnate with long, undivided, alternate branches, which are once or twice pinnate, the ultimate divisions beset on all sides with rather slender, flexuous, recurved or incurved, fasciculate branches; cells several times longer than broad; tetraspores tripartite, sessile on the upper branchlets; antheridia in tufts on the upper internodes; favellæ binate.

Var. LAXA.

Corticationsless marked than in the type, branchlets long and slender, divisions widely spreading below, fastigiate at the apex.

On *Zostera*, stones, sponges, and algæ below low-water mark.

Common from New Jersey to Cape Cod; Boston Bay, *Harvey;* Portland, *C. B. Fuller.*

As is suggested by Harvey in the Nereis Am. Bor., the present species is not only very variable in habit, but it is also difficult to distinguish some of the forms from *C. tetragonum*. We are inclined to believe that it would be better to consider the present species as a delicate form of *C. tetragonum*, in which the cells are longer and more slender, the branchlets less dense and robust, the color less inclined to blackish, and the substance more delicate. If we are to unite *Rhodomela subfusca*, *R. gracilis*, and *R. Rochei* in one species, as has been done by Agardh, with good reason as it seems, it would be equally correct to unite *C. Baileyi* and *C. tetragonum*, since the difference in habit might result from variations of habitat and season. With us, the form here referred to the typical *C. Baileyi* is more common than *C. tetragonum*, and is found on wharves, on *Zostera*, shells, and stones in rather warm waters and sheltered places, while *C. tetragonum* frequents places where there is a current of water, or grows on algæ in somewhat exposed pools. The var. *laxa* has a diffuse ramification and the cortications are not prominent, and we at one time supposed that it might be the *C. Dietziæ* of the Nereis, as far as we could recollect the specimens of that species in the Harveyan Herbarium at Dublin. In such cases, however, it is not safe to trust to one's memory, and in the present article we are unwilling to express an opinion about *C Dietziæ*.

Sect. III. BYSSOIDÆ.

Branching monopodial or dichotomous, cortications present at the base, ultimate branches decompound, very delicate, usually ending in a hyaline hair.

C. BYSSOIDEUM, Arn. (*C. byssoideum*, Phyc. Brit., Pl. 262.—*Phlebothamnion byssoides*, Kütz.—*Pœcilothamnion byssoideum*, Næg.)

Fronds globosely tufted, one to three inches high, filaments very delicate, slightly corticated at base, main branches many times divided, secondary branches long and flexuous, pinnate with numerous pinnately compound branchlets; antheridia sessile in tufts at the nodes of the branchlets; tetraspores tripartite, sessile on the upper side of branchlets; favellæ binate on the upper branches.

Var. UNILATERALE, Harv.

Fronds small and very delicate, branches and branchlets often secund.

Var. FASTIGIATUM, Harv.

Branches fastigiate, the lesser ones densely ramulose at the tips.

Var. WALTERSII, Harv.

Upper branches distichously compound-pinnate, branchlets patent.

On *Zostera* and different algæ.

Common in Long Island Sound; Gloucester, Mass.

The forms which have been referred on our coast to *C. byssoideum* and *C. corymbosum* are hopelessly confused. Although as described by algologists the two species are sufficiently distinct, in practice it is difficult to say where one begins and the other ends. According to the books, the ramification of the upper branches is dichotomous in *C. corymbosum*, whereas it is always alternately pinnate in *C. byssoideum*. In some of the forms of the last-named species, however, the tips are corymbose and the cells of the axis are short and zigzag to such a degree that the tips at least appear to be dichotomous. Of the two species in question, *C. corymbosum* is the less delicate and gelatinous, and is not so decidedly rose colored as *C. byssoideum*, but, as far as our present information goes, although in its typical form *C. byssoideum* is not only common—apparently more common than in Europe—but also easily recognizable, its extreme forms are not sufficiently well known. The Kützingian method would be to split the species up into four or five new species. According to Crouan and Bornet, this species has seirospores.

C. CORYMBOSUM, (Engl. Bot.) Lyngb. (*C. corymbosum*, Phyc. Brit., Pl. 272; Études Phycol., Pls. 32–35.—*Pœcilothammion corymbosum*, Næg.)

Fronds tufted, two to three inches high; filaments very delicate, corticated wanting except at base, main branches several times pinnately or irregularly divided, secondary branches pinnate with dichotomously-multifid, fastigiate branches which end in hyaline hairs; tetraspores tripartite sessile at the nodes of the branchlets, occupying the place of an ultimate branchlet; antheridia in tufts, sessile on the upper internodes; favellæ binate on the upper part of the branches.

Var. SECUNDATUM, Harv.

Lesser branches frequently secund, ultimate branchlets irregular, scarcely corymbose.

On *Zostera*.

Halifax, Boston Bay, New London, Providence, *Harvey*. The var. *secundatum*, Massachusetts Bay, Greenport, *Harvey*.

We have only quoted the localities given by Harvey, although we have found what we take to be *C. corymbosum* at Newport, Wood's Holl, and in considerable abundance at Nahant, always growing on *Zostera*. An examination of the different published exsiccatæ of European writers would lead one to think that several different species had been included under the name of *C. corymbosum*. One might doubt whether the form of Crouan, No. 139, and Areschoug, No. 15, belong to the same species. At Nahant the same form occurs as that distributed by French algologists.

C. DIETZIÆ, Hooper.

"Fronds capillary, pellucidly-articulate nearly to the base, the lower part percurrent, distichously-pinnate, stem veiny, branches alternate, simple, set at each node with short, alternate, subsimple or pinnato-dichotomous plumules, and often terminated by a dense fascicle of ramuli, rachides zigzag; articulations of the stem six or eight times, of the rachides three or four times, of the ramuli eight or ten times as long as broad; apices subattenuate, obtuse, or subacute; tetraspores elliptical, tripartite, solitary on the uppermost ramuli." (Ner. Am. Bor., Part II, p. 236.)

Greenport, *Mrs. Dietz.*

Only known through the description given by Harvey in the Nereis. Harvey states that it is related to *C. corymbosum* and *C. versicolor*. The specimens referred to Wood's Holl in Proc. Am. Acad., 1875, p. 376, were probably incorrectly determined.

SUBGENUS SEIROSPORA, Harv.

Fronds erect, main branches corticated; antheridia in tufts on the outer side of short branches; tetraspores tripartite; bispores and seirospores present; cystocarps destitute of enveloping jelly.

C. SEIROSPERMUM, Griff. (*Seirospora Griffithsiana*, Harv., Phyc. Brit., Pl. 21.—*Phlebothamnion seirospermum*, Kütz.—*C. versicolor*, var. *seirospermum*, Harv., in Hooker's Journ. Bot.; *Pœcilothammon seirospermum*, Næg.)

Fronds dicecious, capillary, two to six inches high, pyramidal in outline, main axis percurrent, pinnate with alternate, undivided, lateral, branches, which bear secondary branches beset with delicate, erect, dichotomo-multified, corymbose branches, main branches corticated, smaller branches monosiphonous and byssoid; antheridia in tufts on the outside of short branchlets; tetraspores tripartite, sessile on the upper branchlets, sometimes replaced by bispores; seirospores oval, in moniliform tufts at the ends of the branches; cystocarps composed of radiating chains of spores without gelatinous envelope (Bornet.)

On *Zostera*, shells, and stones below low-water mark.

Common throughout Long Island Sound; Salem, Mass., *Harvey.*

One of the commonest and most beautiful of the genus south of Cape Cod, but only known in one locality north of the Cape. It is often brought up on fishermen's nets, and, as a rule, inhabits deeper water than most of the genus. It often attains the height of four or five inches, and is broadly pyramidal in outline. The main branches are rather stout and distinctly corticated, but the ultimate ramifications are very soft and flaccid. With us seirosporic specimens are very common, making the species easily distinguishable, but no form of tetraspore or bispore has been observed on American specimens. According to Bornet, tetraspores, bispores, and seirospores sometimes occur on the same individual. From a comparison of our plant with authentic European specimens there can be no doubt of the specific identity of the two. Accepting the account of the cystocarps given by Bornet, it is extremely doubtful whether the species should be kept in the present genus, and perhaps the genus *Seirospora* should be restored, not, however, as originally adopted by Harvey.

SPECIES INQUIRENDÆ.

C. TENUE, Harv., Ner. Am. Bor., Part III, p. 130. (*Griffithsia tenuis*, Ag.)

"Filaments tufted, ultra-capillary, irregularly much branched, diffuse, flexuous, the branches and their divisions very generally secund, springing from the middle of the internodes; ramuli few and distant, patent, filiform, beset toward the attenuated apices with whorls of minute byssoid fibers; articulations cylindrical, those of the branches 4–6 times, those of the ramuli 3–4 times as long as broad, and gradually shorter towards the extremities."

Beesley's Point, N. J., *Harvey.*

Two specimens which can probably be referred to the present species have been received from Nantucket, one presented by Mrs. Lusk, the other by Mr. Collins. In the absence of fruit the genus cannot be determined. Nægeli, in Beiträge zur Morphologie und Systematik der Ceramiceæ, says that the tetraspores are terminal on a single-celled pedicel. According to Harvey, the species is distinguished by the branches, which are all given off from the middle of the internodes of the branches of the preceding grade. Nægeli says that this species has normal branches like those of *Griffithsia barbata*, and he regards those given off from the internodes as adventive branches.

C. TOCWOTTONIENSIS, Harv. MSS., *fide* Bailey.

Providence, *Bailey;* Warwick, *Hunt.*

As far as we know, this species, mentioned by S. T. Olney in his List of Rhode Island Plants, fortunately for printers and the throats of American algologists, has never been described.

GRIFFITHSIA, Ag.

(Named in honor of *Mrs. Griffiths*, of Torquay.)

Fronds filiform, monosiphonous, without corticating, dichotomously branching, branches of two kinds, the vegetative of indeterminate, the fructiferous of determinate growth; antheridia sessile and covering the upper surface of the terminal cells in tufted whorls at the nodes, or in densely whorled pyramidal tufts on involucrate branches; tetraspores

tripartite, clustered in involucrate whorls at the nodes or on the inner side of short fascicled branches; cystocarps (favellæ) involucrate.

A beautiful genus, comprising between 30 and 40 species, but only represented on our Eastern coast by a single species and on the Western coast by two doubtfully determined species. The genus is distinguished from *Callithamnion* by the involucrate favellæ and by the disposition of the tetraspores. As we have *Spermothamnion* separated from *Callithamnion* in consequence of the absence of the gelatinous envelope found in true favellæ, so we have *Bornetia* separated in a similar way from *Griffithsia*. The genus can generally be recognized at sight by the rather large but very delicate cylindrical, oval, or, at times, globose cells, which do not bear immersion in fresh water even for a short time, and by the branching, which is dichotomous or a modification of the dichotomous type. The accurate specific determination from sterile specimens alone is generally impossible, so great is the resemblance of the fronds in the different species. The antheridia vary very much in the different species. In our only species they are sessile on the upper half of the globose terminal cells; in *G. corallina* they surround the nodes in tufts; and in *G. setacea* they are in dense approximate whorls, attached to the inner side of incurved branchlets. The tetraspores also vary in the different species. In *G. Bornetiana* and *G. corallina* they are in whorls at the nodes, and are attached to the inner side of short simple branches, which form a whorl around the node. In *G. setacea* the tetraspores occupy a position which corresponds to that of the antheridia. The favellæ are always truly involucrate and, as far as is known, terminal, in our species occupying the place of a suppressed dichotomy. The development of the procarp of *C. corallina* has been fully studied by Janczewski. In that species he found two trichogynes to each carpogenic system, as is also the case in the genus *Ceramium*. A non-sexual mode of propagation, by means of cells which give off root-like processes, has been described by Janczewski in *G. corallina*, and a similar process takes place in *G. Bornetiana*.

G. BORNETIANA, Farlow. (*G. corallina ?* Harv., Ner. Am. Bor., Part II, p. 228, non Agardh.—*G. globulifera*, Kütz., Tab. Phyc., Vol. XII, Pl. 30.—*G. globifera*, J. Ag. in part.—*G. Bornetiana*, Proc. Am. Acad., 1877.)

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 88.

Fronds dicœcious and dimorphous.

MALE PLANT.—Globosely tufted, one to three inches high; filaments repeatedly dichotomous; lower cells cylindrical-obovoid, several times longer than broad, becoming shorter and broader above; terminal cells globose-pyriform; antheridia sessile, densely covering the upper half of terminal cell. **Pl. X, Fig. 4.**

FEMALE PLANT.—Two to five inches high, loosely tufted, filaments repeatedly dichotomous; lower cells cylindrical-obovoid, becoming broadly pyriform above and then gradually diminishing in size toward the tip; favellæ solitary on the upper part of the superior cells; cells of involucre 10–20, unicellular, club-shaped, somewhat incurved. **Pl. XI, Fig. 3.**

TETRASPORIC PLANT.—More slender than the female plant; tetraspores tripartite, densely clustered around the nodes of special branches; cells of involucre short and suberect. **Pl. X, Fig. 5.**

On wharves, sponges, shells, and occasionally on *Zostera*.

Common from Nantucket southward.

A summer plant which attains perfection during the month of July, disappearing later in the summer. It is sometimes found washed ashore in large quantities after a storm. The species has been known for some time, but until recently it has passed for a form of *G. corallina*, a species common in Europe. It differs from that species in several respects. The antheridia form a sort of cap over the top of the terminal cells of the male plant, which is considerably smaller than the female plant and has a different habit, in consequence of which it was called a variety, var. *globifera*, by Harvey. The female and tetrasporic plants more closely resemble the true *G. corallina*. They do not end in large globose cells, as in the male plant, but the largest cells are below the tip, which is tapering and acute. When the tetrasporic plant has narrower and more acute cells than usual it constitutes the var. *tenuis* of the Nereis. The slenderest specimens, however, are usually sterile. In the structure of the procarp this species differs considerably from *G. corallina* as described by Janczewski. There is only one trichogyne instead of two, as in the last-named species. The procarp begins by the growth of a hemispherical cell at the upper part of an articulation. The cell is then divided into two parts by a partition parallel to the base. It is from the lower cell thus formed that the involucre is formed, and from the upper arise the carpogenic cells in the following way: By usually four oblique partitions there are formed four external hemispherical cells and a central pyramidal cell with a broad base. By subsequent division of one of the hemispherical cells, generally of the one lying nearest the axis of the plant, there is cut off a cell which divides into three smaller granular cells, the upper of which grows into a trichogyne. The spores are formed by the subsequent growth of the other three hemispherical cells. There are two sets of hair-like organs which arise from the upper border of the cells in this species; one set is short and granular, consisting of a cuboidal basal cell with short corymbose filaments; the other set occupies a similar position, but the hairs are long and hyaline, consisting of a long basal cell, which bears at its apex a whorl of three or more cells, which in turn bear other whorls, the whole hair being several times compound.

HALURUS, Kütz.

(From *αλς*, salt, and *ουρα*, a tail.)

Fronds monosiphonous, branching, beset throughout with short, approximate, incurved, di-trichotomous, whorled, secondary branches; tetraspores tripartite, attached to the inner side of special branches, arranged in whorls one above another; antheridia in similar position, forming closely verticillate tufts; favellæ terminal on short branches.

A genus composed of one, or according to some writers two, species, separated from *Griffithsia* principally by the character of the frond.

H. EQUISETIFOLIUS, Kütz. (*Griffithsia equisetifolia*, Ag.; Phyc. Brit., Pl. 67.)

Fronds four to eight inches long, arising from a disk, irregularly branching, secondary branches trichotomous below, dichotomous above, much incurved, densely covering the branches, rhizoidal descending filaments given off from some of the lower branches.

Brooklyn, N. Y.?

A plant resembling a *Cladostephus*, except that its color is a dirty red. The species is very doubtfully known on our coast. It is mentioned in the Nereis as having been sent to Harvey by Mr. Hooper, of Brooklyn, but there is no definite information as to the locality where the plant was collected.

PTILOTA, Ag.

(From πτίλωτος, feathered.)

Fronds compressed, ancipital, decompound, branches distichous, pectinate-pinnate, composed of a monosiphonous pinnate axis of larger quadrate cells and a cortex of smaller cells; antheridia terminal on short corymbose branches; tetraspores tripartite; cystocarps (favellæ) terminal on the branches, usually involucrate.

An easily recognized genus, comprising about twenty species, of a deep red or reddish-brown color, only scantily represented on our coast, but represented on the Californian coast by a number of beautiful species. The genus reaches its greatest development in Australia. The growth is by an apical cell, from which arises a monosiphonous axis of indefinite growth and short secondary branches. The origin of the corticationshas been fully explained by Nægeli in Die neuern Algensysteme, page 206. The monosiphonous axis is clearly seen on holding specimens up to the light, and is also visible at the growing tips where the corticationsare wanting. The corticationsdo not form a true solid tissue, but rather, as shown by Nægeli, densely interwoven branching filaments. A detailed account of the development of the frond in different species is given by Cramer in Physiologisch-systematische Untersuchungen über die Ceramiaceen. The development of the procarp is given by Bornet in Notes Algologiques, page 15. The position of the tetraspores is variable, and serves as a specific mark.

P. ELEGANS, Bonnem. (*Ptilota sericea*, Harv., Phyc. Brit., Pl. 191.—*P. plumosa*, var. *tenuissima*, Ag.)

Fronds brownish red, three to six inches high, main branches filiform, irregularly branching, secondary branches compressed, closely pinnate, with opposite pinnate branchlets, ultimate divisions without cortication; favellæ terminal on the branches, irregularly lobed, naked or with a short involucre; tetraspores solitary on the ends of the branchlets, at first tripartite, becoming polysporic.

On the under side of rocks between tide-marks and on shells and algæ in deep water.

Throughout our whole limit; Europe.

A much more delicate species than the next, and recognized at once by the fact that the younger parts of the branches are without corticationsi, whereas in the next species the corticationsextend nearly to the apex. It also differs in the position of the tetraspores, and the favellæ are usually naked, while in the following species they are surrounded and almost concealed by a well-marked involucre. The usual color is a grayish black, but in fading it often becomes pinkish. North of Cape Cod the species is usually found clinging to the under surfaces of rocks at low-water mark, in company with *Ceramium Hooperi*, *Rhodochorton Rothii*, and *Sphacelaria radicans*. In such situations the specimens are small. At Newport and Gay Head the plant attains a much larger size, and is abundantly washed ashore from deep water.

P. SERRATA, Kütz.

Fronds dark red, three to six inches long, compressed, ancipital, decompound-pinnate, pinnæ opposite, one pinna being short, undivided,

straight or falcate, sharply serrate, especially on the lower side, and the opposing pinna pinnately divided or compound; pinnæ nearly at right angles to the axis, apices acute; tetraspores borne in dense ellipsoidal cluster either at the ends of the simple pinnæ or on the serrations and tips of the compound pinnæ; tetrasporic masses interspersed with monosiphonous incurved branches; favellæ in similar position to the tetraspores, nearly concealed by the large, incurved, usually serrate divisions of the involucre.

On algæ, especially on stems of *Laminaria*, below low-water mark.

Common north of Boston; Thimble Islands, near New Haven, and dredged off Block Island, *Prof. Eaton.*

A common and characteristic alga of our northern coast, extending through Greenland to the northern coast of Europe, and also found in the North Pacific. The present species, together with *Euthora cristata* and *Delesseria sinuosa*, form the greater part of the specimens collected for ornamental purposes by ladies on the Northern New England coast. *P. serrata*, when dried, is usually very dark colored, unless it has previously been soaked for some time in fresh water, and it does not adhere well to paper unless under considerable pressure. It cannot be mistaken for any other species growing on our coast. Whether it is a variety of *P. plumosa* is a question about which writers do not agree, but, although in this connection our form has been kept as a distinct species, it is highly probable that it is really nothing more than a coarser northern form of *P. plumosa*. The typical form of *P. plumosa* is certainly unknown in New England. The type is more slender, and the pinnæ are pectinate, not serrate. The position of the fruit is the same, the principal difference being in the more strongly marked involucre of the favellæ and in the tetraspores, which are borne on densely fastigiate branches, which have no corticationS, and some of which are incurved and project beyond the general sporiferous mass. In *P. plumosa* the tetraspores are also borne on the tips of monosiphonous branches, but they are not densely conglomerate, nor are the projecting incurved ramuli prominent. The present species is very rare south of Cape Cod, being known in only two localities and in a much reduced form.

CERAMIUM, Lyngb.

(From *κεραμιον*, a small pitcher.)

Fronds filiform, dichotomous or occasionally subpinnate, monosiphonous, composed of a series of large ovate or quadrate cells, with bands of small corticating cells at the nodes, and in some species also extending over the internodes; antheridia forming sessile patches on the upper branches; tetraspores tripartite, formed from the corticating cells; cystocarps (favellæ) sessile at the nodes, usually involucrate.

A universally diffused and easily recognized genus, of which, however, the species are by no means easily recognized. The genus is distinguished by the monosiphonous, dichotomous frond, with bands of small corticating cells at the nodes, or, in some cases, covering the internodes as well. The tips of the filaments are forked and usually decidedly incurved, whence the generic name is derived. The apical growth and formation of the cortex is fully detailed by Nægeli and Cramer in Pflanzenphysiologische Untersuchugen, Part IV. The procarp in *Ceramium* is furnished with two trichogynes and a single carpogenic cell formed from the cortical cells on the convex side of the

tips of the branches. The genus has been split up into a number of different genera by Kützing, but by most writers his divisions are only accepted as subgenera. Sterile specimens are not easily determined and it is always desirable to have tetrasporic plants. Although we have an abundance of the genus on our coast, the number of species is comparatively small, and the group of species having spines at the nodes is, as far as is known, quite wanting.

SECT. I. *Fronds without spines, cortical cells decurrent from the nodes and more or less completely covering the internodes.*

C. RUBRUM, Ag. (*C. rubrum*, Phyc. Brit., Pl. 181.)

Fronds robust, dichotomous, subfastigiate, branches erect, apices incurved or forcipate, nodes contracted below; tetraspores in irregular series at the nodes, immersed; favellæ lateral, solitary, with a short involucre.

Var. PROLIFERUM, Ag. (*C. botryocarpum*, Phyc. Brit., Pl. 215.)

Fronds beset on all sides with numerous, lateral, simple or forked branchlets.

Var. SECUNDATUM, Ag.

Branchlets generally secund.

Var. SQUARROSUM, Harv.

Fronds small, regularly dichotomous, fastigiate, with very few, short, lateral branchlets, lower divisions distant, spreading, upper divisions close together, widely spreading, apices often revolute.

Everywhere common; var. *squarrosum* on *Zostera*, Massachusetts Bay.

A ubiquitous and variable species, of which we have enumerated only the principal forms. The typical form is easily recognized, and the same is true of most of the varieties. The var. *decurrens* has the internodes partly naked, especially in the upper part. The var. *decurrens* of the Nereis is referred by Agardh to the next species, and is distinguished from the true var. *decurrens* of *C. rubrum*, which has immersed tetraspores, by the large tetraspores arranged in a regular circle at the nodes and projecting decidedly above the surface.

C. CIRCINNATUM, Kütz.

Fronds setaceous, dichotomous, fastigiate, divisions erect, patent, apices forcipate, internodes partly corticated by the cells which are decurrent from the nodes; tetraspores large, projecting in a ring around the upper nodes.

Glencove, L. I., *Mr. Young;* Dartmouth, Mass., *Miss Ingraham;* Magnolia, Mass., *Mrs. Bray.*

Agardh, in his Epicrisis, refers to the present species the *C. decurrens* of Harvey (Phyc. Brit., Pl. 276), which in the Nereis Am. Bor., is made a variety of *C. rubrum*. There is a var. *decurrens* of *C. rubrum* which is admitted by Agardh, which, if we understand correctly, has small immersed tetraspores. This form occurs also with us, but we have no notes as to the locality. To the present species we refer forms in which the upper internodes are scarcely corticated at all and in which the large, projecting tetraspores are in a single ring at the upper nodes.

SECT. II. *Fronds without spines, cortical cells confined to a definitely limited band round the nodes, the internodes diaphanous.*

C. DIAPHANUM, Roth; Phyc. Brit., Pl. 193.

Fronds brownish red, filaments two to four inches high, loosely tufted, main branches setaceous, rather stout, distantly forking, beset with short, lateral, dichotomous branchlets, apices incurved; tetraspores immersed, in whorls at the nodes; favellæ lateral, involucrate.

Nahant, New Bedford, Mass.; Providence, R. I.; New York Bay, *Harvey;* Europe; California.

The localities given are quoted from the Nereis. As far as our own experience goes, the present species is of very infrequent occurrence on the New England coast, although we have specimens collected at Lynn, Mass., and others from the vicinity of New York, collected by Mr. A. R. Young, which may possibly be referred to *C. diaphanum*. In almost all cases the *C. diaphanum* of American collectors is the *C. strictum* of the Phycologia Britannica a species closely related to the present, and agreeing with it in the fructification, but differing in ramification. *C. diaphanum* has rather stout leading branches, which are beset with secondary dichotomous branches which are alternately given off from the main branches, and which are much finer than the main branches, the tips being capillary. The general outline of the frond is pyramidal, and that of the principal branches and their ramifications is oval-elongated. In *C. strictum* there are no leading branches, but the filaments are of a pretty nearly uniform diameter, regularly dichotomous throughout, and form globose tufts. Both species differ from our other species, except *C. Hooperi*, in being of a brownish-purple rather than of a distinctly rose-colored tint, and both adhere closely to paper in drying.

C. STRICTUM, (Kütz.) Harv. (*C. strictum*, Phyc. Brit., Pl. 334.—*Gongroceras strictum*, Kütz.)

Fronds brownish red, filaments capillary, two to six inches high, densely tufted, branches uniformly dichotomous throughout, divisions erect, fastigiate above, apices forcipate; tetraspores immersed, whorled at the nodes.

On *Zostera* and other marine plants.

Common from New York to Cape Cod.

This species forms large tufts at the base of *Zostera* in warm, shallow bays, and is often in company with *Polysiphonia Olneyi*. In the Little Harbor at Wood's Holl it is found in large quantities, after a heavy blow, lying unattached on the mud, just below low-water mark.

C. HOOPERI, Harv. (*C. Hooperi*, Harv., Ner. Am. Bor., Part II, p. 214.—*C. Deslongchampsii*, Farlow, in Report U. S. Fish Comm., 1875.)

Fronds dark purple, one to four inches high, filaments procumbent and densely interwoven at base, above dichotomous, with short, erect, irregularly placed lateral branches, apices straight, erect, cortical cells forming a sharply defined band at the nodes, axile cells short above, becoming twice as long as broad below; rhizoidal filaments unilateral,

single at the nodes, numerous, usually unicellular, often ending in irregular disks; tetraspores in a circle at the nodes, immersed in the cortical cells; favellæ?

Forming tufts on mud-covered rocks at low tide.

New Haven, *Prof. Eaton;* near New York, *Mr. Young;* Newport, R. I.; common from Nahant to Eastport.

This species is not, as Harvey and Agardh supposed, very distinct, but, on the contrary, can scarcely be distinguished from *C. Deslongchampsii*, except in the tetraspores, which are immersed, not projecting as in that species. Both species inhabit similar localities, both are deep purple in color, are procumbent at the base, and have numerous rhizoids; the branching and erect tips are the same in both. Furthermore, as it occurs with us, *C. Hooperi* not unfrequently bears precisely such irregular botryoidal masses as are found on *C. Deslongchampsii* in Europe, and which are figured in the Phycologia Britannica. Harvey, as well as Nægeli and Cramer, doubts whether these masses are really favellæ, and, judging from American specimens, they are more probably monstrosities. In one case we found the distortions on a specimen bearing tetraspores, and Nægeli and Cramer have observed a similar case, a presumption against the favelloid nature of the swellings. Fully-matured tetraspores are to be desired, and it may be that they will be found to be prominent, as in *C. Deslongchampsii*, in which case the validity of the species would be more than doubtful.

C. FASTIGIATUM, Harv., Phyc. Brit., Pl. 255.

Fronds lake-red, densely tufted, two to five inches high, filaments capillary, dichotomous throughout, divisions erect, level-topped, apices erect or slightly incurved; tetraspores secund on the outer side of the branches, prominent; favellæ small, lateral, with a short involucre.

On *Zostera.*

Massachusetts Bay; Greenport; Newport; Long Branch, *Harvey.*

This species is at present a puzzle. In American herbaria one frequently finds specimens labelled *C. fastigiatum*, and some specimens bear Harvey's own handwriting. Unfortunately, the species is persistently sterile, for we have only twice found tetraspores in what seemed to be this species, and sterile specimens are hardly sufficient for determination in the genus *Ceramium.* What was apparently considered by Harvey to be his *C. fastigiatum* is common south of Cape Cod and forms beautiful tufts on *Zostera.* The color is a lake-red, the filaments are all capillary and regularly dichotomous, the upper segments being level-topped, so that when spread on paper the species has a regular outline. The apices are erect, not rolled inwards at the tip, and short rhizoidal processes are given off from some of the nodes. Harvey states that the tetraspores are prominent and secund on the outer edge of the branches, while Agardh says they are whorled at the nodes. In one specimen we found them as described by Harvey. It must be admitted that when sterile the species approaches too near *C. tenuissimum*, and it is much to be desired that a large set of fruiting specimens be examined to settle the disputed question of the tetraspores. *C. fastigiatum* is a species apparently not well known to continental botanists, who seem to have at times included it in other species without reference to British specimens. With us it is common, although, considering that there may be a doubt about the determination, we have only quoted the localities given by Harvey. By Agardh *C. fastigiatum* is considered closely related to *C. Deslongchampsii*, but judging by Harveyan specimens, both from Ireland and New England, we can hardly think that the two species are immediately related.

C. CORYMBOSUM, Ag.

"Fronds capillary, rather regularly decompound-dichotomous, branches erecto-patent, corymbose, fastigiate, apices forcipate, lower joints four to five times longer than broad, upper joints subequal; tetraspores naked, emergent, secund on the outer side of the branches, lower portion resting on the cortical layer." (Agardh, Epicrisis, p. 93.)

Atlantic coast of North America.

This species is said by Agardh to resemble *C. fastigiatum* in its ramifications, but with more expanded branches, and to differ in having a violet color and a different arrangement of the tetraspores. From this it would appear that the two species are practically distinguished by the different position of the tetraspores. With regard to their position in *C. fastigiatum*, as has already been said, Agardh and Harvey do not agree.

C. TENUISSIMUM, (Lyngb.) Ag.

Fronds rosy-red, two to four inches high, densely tufted, capillary, decompound-dichotomous, branches erect, patent, apices forcipate; tetraspores borne on the swollen nodes, usually on the outer side, often several together; favellæ lateral, involucrate.

Var. ARACHNOIDEUM, Ag.

Fronds more slender than in the type, tetraspores exserted, secund on the outer side of the branches, solitary or several together.

Var. PATENTISSIMUM, Harv.

Fronds small, dichotomies distant and patent, the branches ending in dichotomo-multifid, divaricating, corymboso-fastigiate branchlets.

On *Zostera* and algæ.

Common in Long Island Sound; Gloucester, Mass., *Mrs. Davis;* Europe.

The present species, according to Agardh, includes the *C. nodosum* of the Phycologia Britannica, but Harvey's plate certainly does not correctly represent the tetraspores of the typical form of the species. In the type the nodes are swollen, especially on the upper margin, and the rather large tetraspores project beyond the cortical cells, usually on the outer side of the node, and there are frequently from two to four together. In the var. *arachnoideum* the tetraspores become almost naked, being only slightly covered by the cortical cells in their lower part. The var. *patentissimum* of Harvey has a somewhat different ramification from the type. It must be admitted that the limits of *C. tenuissimum* are not well marked, and it may be that in the present case we have confused two distinct species.

C. CAPRI-CORNU, (Reinsch). (*Hormoceras Capri-Cornu*, Reinsch, Contrib. ad Alg. et Fung., p. 57, Pl. 47.—*C. Youngii*, Farlow, Rept. U. S. Fish Comm., 1875.)

Fronds brownish purple, one to three inches high, filaments setaceous, repeatedly dichotomous, divisions erecto-patent, ultimate divisions sub-

fastigiate, apices much incurved, branches beset throughout with very short incurved or recurved branchlets, cells in upper part scarcely as long as broad, two to three times as long below, corticating cells forming a sharply defined band at the nodes; tetraspores and favellæ?

In eight feet of water.

Canarsie, L. I., *Mr. A. R. Young.*

This curious species has unfortunately never been found in fruit. We have only seen three specimens, which were all collected by Mr. Young. The largest was about three inches high and the filaments were coarser than those of *C. diaphanum* and *C. strictum*. It is easily recognized by the numerous short incurved branchlets which arise singly or in twos and threes at the nodes. It is possible that a large series of specimens would have shown that the present is a form of some other species, but when received from Mr. Young in 1875 it seemed so distinct that the name *C. Youngii* was given to it, and under that name it was mentioned in the Report of the U. S. Fish Commission for 1875, but without any description. The *Hormoceras Capri-Cornu* of Reinsch, from Anticosti, judging from the plate and description in the Contributiones, published in 1874–75, is apparently the same as *C. Youngii*, and the name of Reinsch has the priority.

Suborder SPYRIDIEÆ.

Fronds filiform, monosiphonous, formed of longer branching filaments of indeterminate growth, from which are given off short, simple branches of determinate growth, cells of main filaments corticated throughout, the secondary branches corticated only at the nodes; antheridia borne on the secondary branches, arising from the nodes and finally covering the internodes; tetraspores tripartite, borne at the nodes of secondary branches; cystocarps subterminal on the branches, consisting of obovate masses of spores in dense whorls around the central cell, with a pericarp formed of monosiphonous filaments packed together in a gelatinous substance.

An order consisting of a single genus and a small number of species, most of which are tropical. The systematic position of the order is a matter of dispute. The fronds resemble closely those of the *Ceramiœ*, as do also the tetraspores, but the cystocarps are peculiar and not closely related to those of any other order. A section of the mature fruit, which is usually either two or three parted, shows a monosiphonous axis, around the upper cells of which the spores are arranged in irregularly whorled groups. The whole is surrounded by a wall, which is formed by the union, by means of a jelly, of the elongated tips of subdichotomous filaments which arise from the cortical cells of the nodes just below the sporiferous cells. The antheridia are first formed at the nodes, but soon extend over the internodes for a considerable distance. The development of the frond is fully given by Cramer, l. c. In the Nereis the order is placed next to *Ceramiaceæ*, and in the Epicrisis of Agardh between the *Dumontiaceæ* and the *Areschougieæ*.

SPYRIDIA, Harv.

(From σπυρις, a basket.)

Characters those of the genus.

S. FILAMENTOSA, Harv., Phyc. Brit., Pl. 46. **Pl. X, Fig. 1, and Pl. XII, Fig. 2.**

Fronds filamentous, in expanded tufts four to eight inches high, branches irregularly placed, spreading, repeatedly divided, secondary branches subequal, spirally inserted, ending in a mucronate tip composed of two or three hyaline cells; tetraspores tripartite, sessile at the nodes of branchlets, solitary or clustered; cystocarps two or three lobed.

Var. REFRACTA, Harv., Ner. Am. Bor., Part III, Pl. 34 *a*.

Fronds robust, subdichotomous, the branches naked, divaricating, with very wide axils, arched, the terminal ones frequently revolute.

On *Zostera*, wharves, and mud below low-water mark.

Common from Cape Cod southward; Massachusetts Bay, *Harvey;* most warm seas.

Rather a beautiful species when growing, but which becomes brownish in drying and does not adhere very well to paper. It does not collapse when removed from the water, but remains covered with drops which adhere to the branchlets. The branches, although rather coarse, are brittle. The species is more common in Long Island Sound than in Europe, certainly than on the Atlantic coast. It may be recognized under the microscope by the monosiphonous corticated branches and hyaline branchlets, corticated only at the nodes and with a mucronate tip. The antheridia, of which, so far as we know, no description has hitherto been given, surround the branchlets, covering several cells near the base. They arise from divisions of the cortical cells, which form closely packed, short filaments, and extend over the internodes, those from the different nodes becoming confluent. The individuals which bear the cystocarps are distinct from those which bear the antheridia, and may be recognized by their more dense habit.

SUBORDER CRYPTONEMIEÆ.

Fronds solid or becoming hollow with age, cylindrical, compressed or membranaceous; antheridia forming superficial spots or small tufts; tetraspores usually cruciate and scattered in the cortical layer, sometimes in localized spots; cystocarps consisting of a single mass of irregularly placed spores surrounded by a gelatinous envelope, but not provided with a special cellular pericarp, immersed in the substance of the frond, spores discharged by a narrow passage formed between the cells of the cortex.

An order comprising about 14 or 15 genera and between 125 and 150 species, most of which are inhabitants of warm seas, and vary in consistency from subgelatinous to coriaceous and cartilaginous. Our only two species belong to the tribe *Nemastomeæ*. There are numerous species on the Californian coast, nearly all difficult of determina-

tion owing to the great variation in shape. The suborder approaches very closely to the *Ceramieæ*, since the cystocarps are in many of the species true favellæ, which, instead of being naked, are concealed in the fronds. It is in fact merely an arbitrary matter whether one places *Gloiosiphonia* in one suborder or the other. The fronds are more complicated than those of the *Ceramieæ*. In genera like *Gloiosiphonia* and *Nemastoma* there is an axis formed respectively of a monosiphonous filament or bundle of filaments, and an ill-defined cortex formed simply of the loosely united lateral filaments. In other genera, as in *Halymenia*, the cortex is more distinctly marked, and in *Prionitis* and *Cryptonemia* the frond is dense and coriaceous.

GLOIOSIPHONIA, Carm.

(From γλοιος, sticky, and σιφων, a tube.)

Fronds monœcious, gelatinous, cylindrical, branching, solid above, and formed of a monosiphonous axis, whose cells in their central portion bear whorls of four secondary branches, which divide so as to form umbels, which collectively form the cortex; descending filaments formed from the lower part of secondary branches; lower portion of fronds hollow; tetraspores cruciate, borne at the summit of the cortical filaments; antheridia forming spots on the surface of the fronds; cystocarps borne on the lower part of the cortical filaments, consisting of tufts of branching, radiating filaments densely packed in a single mass and surrounded by jelly.

A genus containing but a single certainly known species, found both in Europe and this country. The genus has been placed by some writers in the *Cryptonemieæ* and by others in the *Ceramieæ*. It in fact connects the two suborders, the fruit being a favella in which the spores all arrive at maturity at the same time, forming, in the terminology of some algologists, a simple nucleus. The ripe cystocarps are concealed in the frond, as in the *Cryptonemieæ*, but, on the other hand, the structure of the so-called cortical layer is like the outer portion of *Dudresnaya*, which is generally placed in the *Ceramieæ*. A detailed account of the development of the cystocarp in *G. capillaris* will be found in Notes Algologiques, p. 41.

G. CAPILLARIS, Carm. (*G. capillaris*, Carm., Phyc. Brit., Pl. 57; Notes Algologiques, Pl. 13.)

Fronds gelatinous, four inches to a foot long, solid above, hollow below, main branches subsimple, terete, naked below, densely beset above with decompound lateral branches, branchlets tapering at both extremities; cystocarps abundant, frequently forming nodosities.

In pools below low-water mark.

New London, *Harvey;* Nahant, *W. G. F.;* Chelsea, *Miss Brewer;* Gloucester, *Mrs. Bray* and *Mrs. Davis;* Hampton Beach, *Dr. Durkee;* Peak's Island, Maine, *Prof. Goode.*

A widely diffused but locally rare species, found in early summer and disappearing in August. It is easily recognized at sight by its delicate gelatinous substance and brilliant rose color and by the tapering branchlets. Cystocarpic specimens are not unfrequently found, but tetrasporic plants are rare and have never been observed in this country. The species shrinks very much in drying and adheres closely to paper.

NEMASTOMA.

(From *νημα*, a thread, and *στομα*, a mouth.)

Fronds gelatino-carnose, compressed-cylindrical or plane, dichotomous or subpinnate, composed of an axial layer of densely woven longitudinal filaments, from which are given off short, lateral, dichotomous, fastigiate filaments, which are united by a gelatinous substance to form a peripheral layer; tetraspores cruciate, borne in the peripheral layer; antheridia borne on the superficial cells of the periphery; cystocarps (favellæ) buried in the peripheral layer, spores escaping by a narrow opening between the peripheral filaments.

A genus comprising not far from a dozen species, which inhabit principally the warmer waters of the globe, the genus being particularly well represented in Australia. The fronds of the different species vary from only slightly compressed and linear to broad and palmate, and in *G. marginifera* the frond resembles in shape that of *Rhodymenia palmata*. The substance is rather gelatinous and the microscopic structure resembles very closely that of the fronds of some of the *Nemalieæ*. The fruit of *N. marginifera* is described by Bornet, in Notes Algologiques, as being a true favella like that of *Callithamnion*. The genus is generally placed near *Gloiosiphonia*, and, like that genus, closely connects the *Ceramieæ* with the *Cryptonemeæ*.

N. (?) BAIRDII, Farlow, Proc. Am. Acad. Arts and Sciences, 1875, p. 351.

Fronds purplish-rose colored, gelatinous, four inches long, one inch wide below, vermiform, once or twice dichotomously divided, axils acute, apices attenuated; tetraspores cruciate, borne on the tips of the peripheral filaments; cystocarps

Washed ashore at Gay Head, *W. G. F.*

A very rare species, of which only a single specimen is known. It was found on the beach near the light-house at Gay Head, Mass., in company with *Scinaia furcellata*, in August, 1871. The specimen was a fragment, without the base of the plant, but with abundant tetraspores, which were borne on the tips of the peripheral filaments. In the absence of cystocarpic specimens the genus cannot be ascertained with certainty, and botanists who visit Gay Head, should seach for the plant by dredging off the Devil's Bridge in five to ten fathoms. The specimen collected was at first supposed to be a portion of a broad specimen of *Nemalion purpureum*, a species not yet known on our coast. The peripheral filaments are loosely united together by a gelatinous mass, as in the subgenus *Gymnophlœa* of Agardh.

SUBORDER DUMONTIEÆ.

Fronds tubular, branching or proliferous; cystocarps immersed in the frond, composed of a single mass of irregularly placed cells, similar in most respects to those of the *Cryptonemieæ*.

A small suborder, included by Harvey in the *Cryptonemieæ*. The development of the cystocarps is not well known, and on our coast there is no material to be obtained for the study of the suborder. The common *Dumontia filiformis* of Northern Europe is wanting with us, and the genus *Halosaccion*, of which we have one representative,

has never yet been found with cystocarpic fruit, the genus being referred to the present suborder in consequence of the resemblance of the frond to that of *Dumontia*. According to Bornet, the spores in *D. filiformis* are borne directly on the carpogenic cell, whereas in the nearly related genera of *Cryptonemieæ* there are sterile cells between the spores and the carpogenic cell.

HALOSACCION, Kütz.

(From *αλς*, the sea, and *σακκιον*, a small sack.)

Fronds hollow, tubular or sack-shaped, simple or proliferously branched, consisting of an internal layer of large, roundish, angular, colorless cells, usually arranged in linear series and packed closely together by a gelatinous substance; tetraspores cruciate, immersed in the cortical layer; cystocarps?

A small genus, including about ten species, of which *H. ramentaceum* is common in the North Atlantic, the other species being confined to the North Pacific and extending as far south as California on the east coast and Japan on the west coast. The species are all coarse and somewhat cartilaginous, and are either in the form of elongated obovate sacks or tubular and proliferous. The cystocarpic fruit is unknown, and the genus is placed conjecturally near *Dumontia* in consequence of the structure of the frond.

H. RAMENTACEUM, (L.) Ag. (*H. ramentaceum*, Ner. Am. Bor., Part II, Pl. 29 *a*.—*Ulva sobolifera*, Fl. Dan., Pl. 356.)

Fronds brownish purple, six to fourteen inches high, cylindrical-compressed, attenuated at the base, simple or irregularly branched, more or less densely beset with scattered or crowded, simple or forked, lateral proliferations; tetraspores large, spherical, cruciate; cystocarps?

Var. GLADIATUM, Eaton, Trans. Conn. Acad., Vol. II, p. 347.

Proliferations long, simple, somewhat incurved, inflated.

On algæ in deep pools and on mud-covered rocks at low-water mark.

From Gloucester, Mass., northward; North Atlantic and Pacific. The variety at Eastport.

A characteristic species of our northern coast, occasionally found at Gloucester and becoming very common at Eastport. The fronds are very variable in shape, yet, on the whole, easily recognized. The most marked form is the var. *gladiatum*. The robustness depends a good deal on the place of growth. In exposed pools the fronds are short and very densely proliferous; in sheltered harbors, like that of Eastport, the proliferations grow long, and are of rather delicate texture, approaching *H. microsporum*, which hardly seems a distinct species. Kjellman, in Spetzbergens Marina klorofyllförande Thallophyter, mentions certain hemispherical protuberances on the fronds of this species, and the same are found on our coast. As before stated, the specimen of *Asperococcus compressus* credited to Gloucester, Mass., was an error, the specimen being in reality a sterile and partly bleached *Halosaccion*.

SUBORDER GIGARTINEÆ.

Fronds terete, compressed or membranaceous, fleshy or cartilaginous; antheridia in superficial spots or sunk in small crypts; tetraspores

cruciate or zonate, usually collected in nemathecia or in superficial spots (sori), sometimes scattered; cystocarps composed of numerous masses of irregularly placed spores, between which are found portions of the tissue of the interior of the frond, the whole sporiferous mass being covered by the swollen surfaces of the frond, which are sometimes raised in subspherical conceptacles; spores discharged through special carpostomes.

A large suborder, comprising species which are sometimes more or less cylindrical in shape, but which are more frequently expanded and of a coarse, subcartilaginous consistency. Some of the largest *Florideæ* are found among the *Gigartineæ*, and perhaps no other suborder contains so many ill-defined species as the present. Owing to the thickness and opacity of the fronds, the study of the development of the cystocarps is attended with very great difficulty, and as yet no full account of the formation of the fruit of any of the species has been published. In the Notes Algologiques, Bornet, however, gives a brief account of the formation of the cystocarp in *Gymnogongrus patens*. In all the species the spores are irregularly grouped in several distinct masses, which are imbedded in the tissue of the frond, the cells of which undergo a change as the spores ripen, their walls becoming thick and lamellated, and traversed by numerous small canals. In *Callophyllis* and some other genera the sporiferous mass and the enveloping tissue of the frond form subglobose swellings external to the surface of the fronds, but in other genera, as *Gymnogongrus*, the sporiferous mass occupies the central part of the frond, which swells on all sides. The cystocarps discharge their spores through carpostomes or narrow canals formed in the cortex of the fronds. Sometimes there is a single carpostome, but in some genera, as *Gymnogongrus* and *Ahnfeldtia*, there are several.

1. Fronds terete 3
2. Fronds compressed 4
3. Substance rigid, horny ..... *Ahnfeldtia.*
   Substance soft, succulent ..... *Cystoclonium.*
4. Fronds thin, leaf-like ..... *Phyllophora.*
   Fronds cartilaginous or subcartilaginous 5
5. Cystocarps external in special leaflets ..... *Gigartina.*
   Cystocarps immersed 6
6. Central part of frond composed of roundish polygonal cells. *Gymnogongrus.*
7. Central part of frond formed of slender anastomosing filaments. *Chondrus.*

PHYLLOPHORA, Grev.

(From φυλλον, a leaf, and φερω, to bear.)

Fronds stipitate, stipes expanding into a rigid-membranaceous, flat, simple or cleft lamina, proliferous from the disk or margin, composed internally of oblong polygonal cells, with a cortical layer of minute, colored, vertically seriated cells; antheridia contained in small cavities; tetraspores cruciate, arranged in moniliform filaments, which are packed together in external excrescences (*nemathecia*); cystocarps ex-

ternal, globose, sessile or pedicellate, containing within a thick pericarp several irregular masses of spores imbedded among the cells of the frond; spores discharged by a narrow carpostome.

The genus comprises eight or nine species of the North Atlantic and Mediterranean, one species, *P. Clevelandii*, being found on the coast of California. The species are dark red, rather coarse and rigid, not adhering to paper, and are very apt to be covered with *Bryozoa*. They inhabit rather deep water, and are characterized by their external fruit, the tetraspores being arranged in nemathecia or warts composed of densely packed filaments, each cell of which becomes a cruciate tetraspore. Some of the broader forms pass with collectors for species of *Rhodymenia*.

P. BRODIÆI, Ag.; Phyc. Brit., Pl. 20.

Stipes cylindrical at base, compressed upwards, branched, the branches expanding into oblong or wedge-shaped, simple or forked, membranaceous laminæ, often proliferous at the summit; cystocarps globose, sessile on the laminæ; nemathecia spherical, pedunculate, at the tips of the laminæ.

In five to ten fathoms of water.

Newport, R. I.; Wood's Holl, Mass.; and common from Nahant northward.

P. MEMBRANIFOLIA, Ag.; Phyc. Brit., Pl. 163.

Stipe cylindrical, filiform, branched, the branches expanding into broadly wedge-shaped bifid or dichotomous laminæ; cystocarps ovoid, stipitate, rising from the branches or laminæ; nemathecia forming broad, dark-colored, convex patches in the center of the laminæ.

In deep water on stones.

Common from Long Island Sound northward; North Atlantic.

Our two species of *Phyllophora* are perfectly easy to identify when tetrasporic specimens are obtained. *P. Brodiæi* is a larger plant than *P. membranifolia*, and the laminæ are longer and larger and less broad at the base than in *P. membranifolia*. *P. Brodiæi* varies considerably, however, and in the spring the bright-red broad laminæ are often broken from the stipes and washed ashore, when they might be mistaken for some species of *Rhodymenia*.

GYMNOGONGRUS, Mart.

(From γυμνος, naked, and γογγρος, an excrescence.)

Fronds dark red or purple, carnoso-coriaceous, terete, compressed or flat, dichotomous, composed of a medullary stratum of roundish, angular, colorless cells and a cortical stratum of closely packed short filaments formed of small colored cells; tetraspores cruciate, borne in hemispherical nemathecia; cystocarps immersed in the swollen frond, consisting of several irregular masses of spores imbedded among the cells of the frond; spores discharged by a carpostome.

A genus of about thirty species, found principally in the warmer parts of the world, all rather coriaceous, but not attaining any great size. The genus is distinguished

from *Chondrus*, to which several of the species were formerly referred, by the structure of the frond and the arrangement of the tetraspores; from *Phyllophora* by the absence of a stipe and the immersed cystocarps.

G. NORVEGICUS, J. Ag. (*Sphærococcus Norvegicus*, Ag.—*Chondrus Norvegicus*, Lyngb.; Phyc. Brit., Pl. 187.—*Oncotylus Norvegicus*, Kütz.)

Fronds deep red, two to four inches high, linear, dichotomous, flat, fastigiate, axils rounded, patent, apices obtuse; cystocarps immersed in the upper segments projecting on both sides of the frond; nemathecia sessile, hemispherical, on both sides of the frond.

In deep pools on rocks.

Penobscot Bay, *Mr. Hooper;* Peak's Island, Maine, *W. G. F.;* Nahant, *W. G. F.;* Beverly, Mass., *Miss Alexander.* Europe.

Our plant, which is apparently rather rare, is the same as that of Europe, although narrower forms are sometimes seen which perhaps might be referred to the *G. Torreyi* of Agardh. *G. Griffithsiæ* is to be expected with us, as it is common in Europe. The present species is found only in the autumn and winter, either in deep cold pools or below low-water mark. Its resemblance to the simpler forms of *Chondrus crispus* is so great that it is perhaps mistaken for that species by amateur collectors. Its color, however, is red rather than purple, and the whole plant is thinner and more delicate than *C. crispus*, which, moreover, has quite a different microscopic structure.

G. TORREYI, Ag.

Frond compressed, flattish, dichotomous, fastigiate, segments linear, very narrow, the axils rounded.

New York, *Prof. Agardh.*

A species known only by the above description of Agardh. Bailey, in Am. Jour. Sci., Vol. VI, 1848, p. 39, makes the singular statement, in speaking of *Dasya elegans*, Ag., that he has examined a fragment of the original specimen of *Sphærococcus Torreyi* in the Torrey Herbarium, "which," he says, "unless I am greatly mistaken, was founded on a battered specimen of this plant."

AHNFELDTIA, Fries.

(Named in honor of *Nils Otto Ahnfeldt*, of Lund.)

Fronds cartilagineo-corneous, subterete, dichotomous or irregularly branched, composed of densely packed elongated cells within and a horizontal layer of closely packed short filaments formed of small colored cells; cystocarps immersed in the fronds; tetraspores in nemathecia which surrounded the branches (?).

A small genus, comprising stiff, wiry, or cartilaginous algæ, whose fructification is not well known. As it is, the genus is distinguished from *Gymnogongrus* rather by the rigidity and terete character of the fronds than by any more definite character, since the fact that the tetraspores in the present genus are in the nemathecia which surround the branches, even if fully proved, which is not the case, would hardly constitute sufficient ground for the separation of the genera. In the only common species of the North Atlantic cystocarps have never been seen and the nemathecia have not been satisfactorily examined. In *Ahnfeldtia gigartinoides* of the west coast the cystocarps form nodose swellings in the upper part of the branches, and there are numerous car-

postomes by which the spores are discharged. However ill defined the present genus may be, there is no difficulty in recognizing at sight our only species.

A. PLICATA, Fries. (*Gymnogongrus plicatus*, Kütz.; Phyc. Brit., Pl. 288.—*Gigartina plicata*, Lam.x.—*Sphærococcus plicatus*, Ag.)

Fronds horny, terete, filiform, very irregularly branched, entangled, branches di-trichotomous, with lateral, often secund, branches, axils rounded, terminal divisions elongated; cystocarps and tetraspores?

Var. FASTIGIATA.

Fronds regularly dichotomous, terminal segments equal.

On rocks and algæ in exposed tide-pools.

From New York northward; Europe; North Pacific.

Forming very irregularly branched, rigid tufts several inches in diameter. The color is usually nearly black, becoming on exposure yellowish or greenish. More wiry and rigid than any of our other *Florideæ*.

CYSTOCLONIUM, Kütz.

(From *κυστις*, a bladder, and *κλωνιον*, a small twig.)

Fronds fleshy, succulent, terete, decompoundly branched, composed of three strata of cells, an axile series of loosely interlaced filaments formed of delicate elongated cells, surrounding which is a layer of large rounded cells and a cortical layer of small roundish-angular cells; antheridia in spots on the upper part of the fronds, interspersed among the unchanged cortical cells; tetraspores zonate, scattered in the cortical layer; cystocarps large, immersed in the frond, usually prominent at one side, with a single carpostome.

The account given above of the structure of the frond refers to the appearance presented in sectioning the mature plant. A study of the development shows that the external and medial layers really are derived from the axial filaments, or rather that all three are formed from a common set of filaments at the apex of the frond. The frond of *Cystoclonium* might be mistaken for that of *Rhabdonia*, but the fruit is very different. The genus comprises about half a dozen described species, but only one is at all well known.

C. PURPURASCENS, Kütz. (*Hypnea purpurascens*, Harv., Phyc. Brit., Pl. 116.)

Fronds brownish rose-colored, six inches to two feet long, an eighth to a quarter of an inch in diameter, terete, subpinnately decompound, much branched, branches alternate, elongate, beset with alternately decompound branchlets which taper at each end; cystocarps numerous, large, often forming nodose swellings in the branches.

Var. CIRRHOSA.

The branches drawn out into long, twisted tendrils.

In tide-pools and just below low-water mark.

Very common from New York northward; Europe.

With the exception of *Ceramium rubrum*, the present is probably the most common species of *Florideæ* found on our coast. It not unfrequently attains a length of a foot and a half, and when washed from its attachment and exposed to the sunlight assumes a bright orange color, which is attractive to many collectors. The *Solieria chordalis*, said by Mr. Samuel Ashmead* to have been collected in Greenland by the Hayes Arctic expedition, was probably a sterile plant of *Cystoclonium purpurascens*.

GIGARTINA, Lam.x.

(From γιγαρτον, a grape-stone.)

Fronds fleshy, cartilaginous, compressed, composed of an internal layer of longitudinal, slender, anastomosing filaments, which pass horizontally outwards and divide dichotomously into short moniliform filaments, the whole set in a gelatinous substance; antheridia in superficial spots; tetraspores cruciate, densely aggregated, forming spots just below the surface; conceptacles external.

A genus of which nearly fifty species have been described, but some of which are of doubtful value. They abound in the Pacific Ocean, several species being found in California, but we have only one species.

G. MAMILLOSA, Ag.; Phyc. Brit., Pl. 199.

Fronds dark purple, three to six inches high, half an inch to two inches broad, flattish, channelled, linear, decompound, dichotomous, fastigiate, upper segments wedge-shaped, bifid; cystocarps borne in short papillæ given off from the surface and margin of the frond.

On rocks at low-water mark, in company with *Chondrus crispus*.

Common from Boston northward; Europe.

Bearing some resemblance to the common Irish moss, with which it usually grows, but distinguished by the numerous papillæ which cover the surface of the fronds and bear the fruit. The present species may occur in California, but most of the specimens of *G. mamillosa* from the west coast belong rather to *G. papillata*, Ag.

CHONDRUS, Stack.

(From χονδρος, cartilage.)

Fronds and tetraspores as in *Gigartina;* cystocarps immersed in the frond.

A small genus as limited by modern writers, but formerly made to include a large number of forms. The three genera *Gigartina, Chondrus,* and *Iridæa* are very nearly related. In the first-named genus the cystocarps are borne in external conceptacles, and in the last two they are immersed.

C. CRISPUS (Linn.), Stack.; Phyc. Brit., Pl. 63.—*Irish moss.*

Fronds purple, three to six inches high, stipitate, flabelliform, dichotomous, fastigiate, flat, the segments linear-cuneate; cystocarps immersed in the frond and usually projecting on one side.

*Proceed. Acad. Nat. Sci. Philadelphia, Vol. XV, p. 93.

On rocks at low-water mark.

Common from New York northward.

The common Irish moss which is used for culinary purposes, and also for clarifying beer. It is also said to be used in the manufacture of cheap cotton cloths. Although very variable in shape, it is not likely to be mistaken for any other species, except possibly sterile specimens of *Gigartina mamillaris* or *Gymnogongrus Norvegicus*, which is, however, a rare species. When growing exposed to the light, the color is a yellow-green.

Suborder RHODYMENIEÆ.

Fronds membranaceous or filiform, solid or tubular; antheridia forming superficial patches; tetraspores tripartite, cruciate, or zonate, either scattered in distinct spots or sometimes sunk in crypts; cystocarps external, containing densely packed subdichotomous filaments, arranged in distinct masses around a basal placenta with a thick pericarp, which is connected by numerous filaments with the placenta.

The present suborder is exceedingly ill-defined, and no two writers agree exactly as to its limits. In the typical genera we find a distinct basal placenta on which are borne masses of spores, which when young are seen to be formed of subdichotomous filaments, but which when mature are arranged without order and held together by a gelatinous envelope. Diverging from the type, we have genera like *Cordylecladia*, in which, even at maturity, the spores preserve to a certain extent a moniliform arrangement, and we then have a cystocarp but little different from that of *Gracilaria*, which belongs to the *Sphærococcoideæ*. On the other hand, we have the order connected with the *Cryptonemieæ* by *Chrysymenia*, which is now placed by Agardh in the *Rhodymeniaceæ*. The position of *Rhodophyllis* and *Euthora* is doubtful. Here we have no distinct basal placenta, but rather a central placenta or carpogenic cell, reminding one somewhat of the genus *Rhabdonia* and its allies, which have been included in the *Soliericeæ*. *Euthora*, at any rate, demands a more accurate study, and our own species of *Rhodophyllis*, *R. veprecula*, does not well correspond with the typical members of the suborder in relation to its cystocarpic fruit. *Lomentaria* and *Champia* agree with the *Rhodymenieæ* in their fruit, although the fronds are peculiar, and we have kept them as a division of the present.

Tribe I. Rhodymenieæ proper.

Cystocarps with a basal placenta, fronds solid.

Fronds dichotomous or palmate ..... *Rhodymenia.*
Fronds pinnately compound ..... *Plocamium.*
Fronds filiform ..... *Cordylecladia.*

? Tribe II. Rhodophylleæ.

Cystocarps with a central placenta, fronds membranaceous.

Tetraspores zonate, fronds dichotomous or pinnate ..... *Rhodophyllis.*
Tetraspores cruciate, fronds dentato-pinnate ..... *Euthora.*

Tribe III. Lomentarieæ.

Cystocarps with a basal placenta, fronds tubular.

Fronds constricted at the joints, but with no proper diaphragms, tetraspores sunk in depressions of the frond ..... *Lomentaria.*
Fronds with numerous diaphragms, tetraspores superficial .... *Champia.*

RHODYMENIA, (Grev.) J. Ag.

(From *ροδεος*, red, and *υμην*, a membrane.)

Fronds flat, membranaceous, dichotomous or palmate, composed of an internal layer of large roundish-angular cells and a cortical layer of smaller cells, in some cases arranged in short horizontal filaments; tetraspores cruciate, either collected in superficial spots (sori) or scattered in the cortex; cystocarps external, sessile, with a distinct carpostome, spores irregularly grouped in masses attached to a basal placenta and surrounded by a gelatinous envelope.

A genus which formerly was made to include a large number of flat membranous species, a large part of which have by recent writers been removed to other genera. We have but one species on our coast, *Rhodymenia palmata*, the common dulse, of which, unfortunately, the cystocarpic fruit is unknown, and the study of the fruit of the genus is out of the question with us.

R. PALMATA, (Linn.) Grev.; Phyc. Brit., Pls. 217, 218; Ann. Sci. Nat., Vol. III, Ser. 4, Pl. 3, Fig. 8.—*Dulse.*

Fronds purplish red, broadly wedge-shaped, six to twelve inches long and four to eight inches broad, irregularly cleft, palmate or dichotomous, sometimes repeatedly laciniate, the margin often winged with leaflets; tetraspores cruciate, scattered in patches over the frond, immersed in the cortex; cystocarps?

Var. SARNIENSIS.

Divisions very numerous, narrow, sublinear.

On *Fuci*, *Laminariæ*, and other algæ, between tide-marks, and extending into deep water.

Common from New York northward; North Atlantic; California?

This, with *Chondrus crispus*, forms the only species eaten in New England. The present species, although one of the commonest red sea-weeds in the North Atlantic, has never been known to bear cystocarps, and hence the generic position is doubtful. The description given applies to the typical form, and although the fronds are very variable in outline, the species is easily recognized. It is sold in the seaport towns, where it is to be found dried on the fruit-stands of the women who sell green apples, corn-balls, and other dainties. It is said to possess anthelmintic properties, which, if one can judge by its disagreeable taste, is very probable.

PLOCAMIUM, Lyngb.

(From *πλοκαμος*, a lock of hair.)

Fronds compressed, membranaceous, pinnately decompound, the pinnules alternately secund in twos, threes, fours, or fives, composed of an inner layer of longitudinal, oblong cells and a cortical layer of smaller polygonal cells; tetraspores zonate borne in special branchlets; cysto-

carps external, sessile or pedicellate, with a distinct carpostome, spores in several masses composed of closely packed radiating filaments borne on a basal placenta.

A beautiful genus, comprising about twenty-five species, the most striking of which are found in Australia, New Zealand, and at the Cape of Good Hope. *P. coccineum* is very widely diffused in the North Atlantic and Pacific, and possibly also in the southern hemisphere; but it has only been observed once on the coast of New England, and that perhaps requires verification. The genus is at once recognized by the branching. The frond is linear and distichously pinnated, the pinnules, which are always alternately secund in groups of from two to five, being of two kinds; the lowest pinna is short, simple, and acute, while the remaining pinnæ are pinnulate or pectinato-decompound. The cystocarps of *Plocamium* are similar to those of *Rhodymenia*, and the zonate tetraspores are in special branchlets or leaflets, known as stichidia.

P. COCCINEUM, Lyngb.; Phyc. Brit., Pl. 44.

Fronds narrowly linear, without a midrib, decompound pinnate, pinnæ alternately secund in threes or fours, the lowest subulate and entire, the upper pectinate on the upper side; conceptacles marginal, solitary, sessile; tetraspores zonate on divaricately branching processes borne on the inner side of the pectinated branchlets.

Boston Bay, *Miss Hawkshurst.*

The above-named locality, given in the Nereis, is the only one known on the New England coast, for this widely diffused species, if we except the vague statement of Bailey in the American Journal of Science, Vol. III, 1847, p. 84, that it has been found by Rev J. L. Russell on the coast of Massachusetts. One sometimes finds forms of *Euthora cristata* labelled *P. coccineum* in American herbaria. The common Californian form of the species is coarser than the European, and has been named by Kützing *P. Californicum.* It is not, however, distinct.

CORDYLECLADIA, J. Ag.

(From *κορδυλη*, a club, and *κλαδος*, a branch.)

Fronds filiform, irregularly branched, carnoso-cartilaginous, formed of two strata of cells; medullary layer of oblong, longitudinal cells, cortical of roundish, colored, subseriated, vertical, minute cells; conceptacles sessile on the branches, subspherical, furnished with a cellular pericarp at length perforate, containing a densely packed globular mass of roundish-angular spores, formed by the evolution of much-branched filaments issuing from a basal placenta; tetraspores immersed in the periphery of pod-like ramuli, oblong, cruciately parted.

? C. HUNTII, Harv.

"Fronds densely tufted, springing from a common, expanded, crust-like disk, livid purple, tereti-compressed, once or twice forked or secundly branched; branches subulate, alternate, acute; fruit?" (Ner. Am. Bor., Part II, p. 155.)

Narragansett Bay, *Mr. George Hunt.*

A species only known from the description in the Nereis, which is quoted above, and from the specimen in Herb. Harvey for an examination of which we are indebted to Prof. E. Perceval Wright. In the absence of fruit, the genus must remain in doubt, and it is hardly likely that the species, as described by Harvey, will be again recognized by American algologists.

RHODOPHYLLIS, Kütz.

(From *ροδον*, a rose, and *φυλλον*, a leaf.)

Fronds membranous, dichotomously compound, with proliferous or pinnatifid margins, composed of an internal layer of large roundish-angular cells and a cortical layer of smaller cells; tetraspores zonate, immersed in the cortex of the frond or marginal processes; cystocarps external, subspherical, borne usually on the margin of the frond or on lateral processes, spores arranged around a central carpogenic cell in masses composed of densely packed radiating filaments, whose cells at maturity become irregularly placed.

A genus comprising about twenty species, which mostly inhabit the Australian coast. They have membranously expanded fronds resembling those of the genus *Rhodymenia*, but they are as a rule smaller and thinner, the internal layer consisting of usually two series of cells. The genus is distinguished from *Rhodymenia* by the zonate tetraspores, and by having the carpogenic cell or placenta in the center of the conceptacle instead of at its base. In the typical species of Kützing, *R. bifida*, there is, according to Dr. Bornet, a large carpogenic cell at the center of the conceptacle, around which the sporiferous masses are gathered, and the same is true with regard to our own *Rhodophyllis veprecula*.

R. VEPRECULA, J. Ag. (*Ciliaria fusca*, Rupr.—*R. veprecula* and *Calliblepharis ciliata*, Harv., Ner. Am. Bor., Part II, pp. 105, 152, non *Calliblepharis ciliata*, Kütz.)

Fronds deep red, attached by a branching base, two to five inches long, a quarter of an inch to an inch and a half broad, decompoundly dichotomous, margin pinnate, pinnæ linear-lanceolate, ciliate, with short subulate or forked teeth; tetraspores zonate, borne in the cortex of the cilia; cystocarps subglobose, usually borne at the base of the cilia, often densely aggregated, sometimes borne on the surface of frond.

Var. CIRRHATA, Harv.

Fronds very narrow, dichotomous, the apices cirrhiform, repeatedly forked.

On the larger algæ in five to ten fathoms, and rarely in deep tide-pools. Autumn and winter.

Campobello Island, Grand Menan, Maine, *Prof. Eaton;* Gloucester, Mass., *W. G. F.;* Arctic Ocean.

The present species is a characteristic Arctic form which occurs as far south as Cape Ann, where it is not rare although hardly common. It is usually found washed ashore late in the autumn or in winter. It is recognized by its beautiful red color and frond

destitute of a midrib and with a ciliated margin. It bears a close resemblance to *Calliblepharis ciliata*, Kütz., which is a common European species, and it was introduced under that name in the Nereis, in which work *Rhodophyllis veprecula* was cited on the authority of Agardh. But subsequent observation and examination of the cystocarpic fruit has shown that the *C. ciliata* of the Nereis is the same as *Rhodophyllis veprecula*, Ag. Gobi states that *R. veprecula* of Agardh is the *Fucus dichotomus* of Lepechin, and he considers that *C. ciliata*, Kütz., should also be included with it under the name of *Rhodophyllis dichotoma* (Lepechin). We have retained the name of Agardh because we only wish to assert that our plant is a *Rhodophyllis* already described by Agardh, but do not wish to go so far as to express an opinion with regard to the identity of the two European plants, since we have never been able to examine the fruit of *C. ciliata* in good condition. Our form, as found on the Massachusetts coast, is well developed and agrees perfectly with specimens collected by Dr. Kjellman in Greenland. The narrow variety was found by Harvey at Halifax. In Herb. Gray is a narrow specimen from Labrador, marked *Calliblepharis jubata*, apparently in Lenormand's handwriting.

EUTHORA, Ag.

(Derivation uncertain.)

Fronds membranaceous, subdichotomously pinnate, formed internally of large oblong cells, between which is a network of slender branching filaments with a cortical layer of small cells; tetraspores cruciate, immersed in the cortex of the thickened apices; cystocarps external, subspherical, marginal, containing a central nucleus attached to the walls of the conceptacle composed of tufts of radiating sporiferous filaments around an ill-defined cellular placenta.

A small genus of only two species, one of which is found in the North Atlantic and the other in the North Pacific. The structure of the frond in our species is peculiar and is the same as that of the genus *Callophyllis*. Between the rather large cells of the interior run small branching filaments, best seen in longitudinal sections. The genus is separated from *Rhodymenia*, in which it was formerly included, in consequence of the peculiar frond and cystocarp. The structure of the latter is not at all well known and should be studied on our coast, where there is an abundance of material. The conceptacles are small and are borne on the margin of the frond, and the carpostome is not at all prominent. The arrangement of the spores is complicated and not easily described. They are arranged in tufts of short filaments, radiating from a common point, and the different tufts, which are very numerous, apparently surround a central cellular placenta, not at all sharply defined. At any rate, there is no large carpogenic cell, either at the center, as in *Rhodophyllis*, or at the base, as in *Rhodymenia*, and it is by no means certain that the genus should be placed in the present suborder.

E. CRISTATA, J. Ag. (*Sphærococcus cristatus*, C. Ag.—*Rhodymenia cristata*, Grev.; Phyc. Brit., Pl. 307.—*Callophyllis cristata*, Kütz.)

Fronds rosy-red, one to five inches high, membranaceous, flabellately expanded, main divisions widely spreading, alternate, repeatedly subdivided, upper divisions alternate, linear, laciniate at the tips, with a fimbriated margin; tetraspores cruciate, in the thickened tips of the frond; cystocarps small, marginal, nearly spherical.

On algæ, especially on *Laminariæ*, in deep water.

Staten Island; Newport, R. I., *Bailey;* dredged off Napatree Point, R. I., *Prof. Eaton;* Gay Head, in eight or ten fathoms; and common from Nahant northward.

Together with *Delesseria sinuosa*, this species forms the bulk of the membranaceous red sea-weeds collected by ladies on our northern coast for ornamental purposes. Probable in no part of the world are more beautiful and luxuriant specimens found than at Magnolia Cove, Gloucester, Mass. Specimens vary very much in breadth. Some have the main divisions an inch wide and the terminal divisions are densely flabellate. Others are scarcely an eight of an inch wide and the terminal divisions are rather diffuse, the fimbriations being prolonged into sharp teeth. The first-mentioned form approaches the figure in the Phycologia Britannica, while the last resembles *Sphærococcus coronopifolius*. The Long Island forms are scarcely an inch high. The species is found at all seasons of the year, and inhabits rather deep water, its favorite habitat being the roots of *Laminariæ*.

LOMENTARIA, (Gaill.) Thuret.

(From *lomentum*, a pod with constricted joints.)

Fronds filamentous, branching, hollow, with constricted nodes, formed of one or more layers of roundish-angular cells with a few longitudinal filaments in the interior; tetraspores tripartite, borne in cavities formed by the infolding of the cortex; cystocarps external, sessile, containing a nucleus composed of oblong masses of irregularly radiating spores attached to a placenta surrounding a large basal carpogenic cell, which is connected with the pericarp by filaments.

A small genus, containing species which have been placed by some writers in *Chylocladia* and *Chrysymenia*. As limited by Thuret, the genus includes species in which the tetraspores occupy small cavities hollowed out in the cortex. The development of the fronds has not been fully studied. They are hollow and much constricted at the joints, but in our species there are no distinct diaphragms as in *Champia*. The walls of the filaments are composed of a membrane consisting of a single layer of roundish-angular cells, or there are two or three layers, the outer cells being smaller than the rest. The inner side of the wall is traversed by long, slender filaments, to which are attached, laterally, small round cells, by which the filaments are attached to the walls. The cystocarps are external, and, in section, one sees a large basal triangular-ovoid carpogenic cell surrounded by closely packed sporiferous lobes, in which the cells are at first arranged in the form of densely radiating filaments, but at the time of maturity become irregularly placed. The pericarp is rather broadly ovate, with a distinct terminal carpostome, and its walls are connected with the carpogenic cell by filaments, between the bases of which lie the sporiferous masses, around which is a gelatinous envelope.

L. UNCINATA, Menegh., in J. Ag., Spec. (*Chylocladia Baileyana*, Harv., Ner. Am. Bor., Part II, p. 185, Pl. 20 *c*.—*Chylocladia uncinata*, Ag., Zan. Icon. Adr., Pl. 43.—*Chondrosiphon uncinatus*, Kütz.)

Fronds brownish red, densely tufted, two to five inches high, tubular, irregularly much branched, branches about one-tenth of an inch in diameter, divaricated, secund or scattered, often recurved, branchlets narrowly fusiform, much contracted at base, secund; tetraspores tripartite

in cavities on the branchlets; cystocarps sessile on the branches, ovoid, with a distinct terminal carpostome.

Var. FILIFORMIS, Harv., l. c.

Slender, elongate, with longer and less arching branches.

On wharves, sponges, &c., below low-water mark.

Quincy, Mass., *Harvey;* common from Cape Cod southward.

A common and characteristic species of Long Island Sound, forming very densely branching tufts. The branches are usually arched backwards and bear secund branchlets which are much constricted at base. The arrangement of the tetraspores in cavities can easily be seen in fresh or alcoholic specimens, but not well in pressed plants. It is principally on the authority of Zanardini that our species is united with his *C. uncinata*, and as he had plenty of material for comparison his opinion is probably correct. The Adriatic specimens of *C. uncinata* which we have examined corresponded better with the var. *filiformis* than with the more common secund form of Long Island Sound.

L. ROSEA, (Harv.) Thuret. (*Chrysymenia rosea*, Harv., Phyc. Brit., Pl. 358 *a.*—*Chylocladia rosea*, Harv., Ner. Am. Bor., Part II, p. 186.)

Fronds rose-colored, compressed, hollow, triangular in outline, main divisions simple or once or twice forked, one and a half to three inches long, an eighth to a quarter of an inch broad, tapering at the apex, pinnate with simple or pinnate, opposite, distichous branchlets, which are much contracted at the base; tetraspores tripartite, sunk in cavities in the cortex of branches.

On stones and shells in ten fathoms.

Portsmouth, N. H.; Newport, R. I., *Harvey;* Gay Head, *W. G. F.;* Northern Europe.

A rare and beautiful species, easily distinguished from the last by being broader and flattened, with beautifully regular, opposite, distichous pinnæ. As far as we know, the cystocarpic fruit of this species has never been seen. It is tolerably abundant on shells of *Mytilus*, in company with *Scinaia furcellata*, off Gay Head.

CHAMPIA.

(In honor of *M. Deschamps*, a French botanist.)

Fronds filamentous, branching, hollow, nodose, formed of one or more layers of roundish-angular cells with cellular diaphragms at the nodes, traversed internally by a few longitudinal filaments; tetraspores tripartite, scattered in the cortex; cystocarps as in *Lomentaria*.

A small genus, comprising about a dozen species, most of which are tropical or Australian, our species, *C. parvula*, being the most widely diffused. The genus resembles *Lomentaria* very closely in the cystocarpic fruit. The fronds, however, are not only constricted at the joints, but are nodose throughout, a diaphragm composed of a single layer of cells extending across the nodes. The tetraspores are not contained in sunken cavities as in *Lomentaria*. A section of the cystocarps of *C. parvula* and *L. uncinata* shows the same arrangement of the spores, but in the first-named species the carpogenic cell is larger and projects further into the conceptacle.

C. PARVULA, (Ag.) Harv. (*Chylocladia parvula*, Phyc. Brit., Pl. 210.—*Champia parvula*, Ner. Am. Bor., Part II, p. 76.) **Pl. XV, Figs. 2, 5.**

Fronds brownish red, globosely tufted, two to four inches high, intricately branching, branches opposite, alternate, or whorled, nodose, joints once or twice as long as broad, apices obtuse; tetraspores tripartite, scattered in the cortex; conceptacles scattered, sessile, ovoid, with a distinct carpostome.

On *Zostera* and algæ below low-water mark.

Common from Cape Cod southward; Europe; Pacific Ocean.

A homely species, which does not collapse when removed from the water. The conceptacles are larger than in our species of *Lomentaria*, and better adapted for the study of the arrangement of the spores.

SUBORDER HYPNEÆ.

Fronds filiform or subcompressed, branching; tetraspores zonate; cystocarps external or partly immersed, filled with a spongy cellular mass, in which the spores are borne in small, scattered tufts on a branching filamentous placenta.

A small suborder, in which the cystocarpic fruit is peculiar. Sections of the cystocarps show a loose cellular structure which fills the interior, and scattered through the mass are small tufts of spores which remind one of the cystocarps of the *Gigartineæ*. In the present instance, however, the spores are not arranged irregularly in globose groups, but they are attached to filaments which branch among the general cellular mass which fills the conceptacle. In the Notes Algologiques an account of the development of the fruit in *H. musciformis* is given by Bornet.

HYPNEA, Lam.x.

(From *Hypnum*, a genus of mosses.)

Fronds filiform, virgately or divaricately branched, with subulate branchlets, composed of an internal layer of large roundish-angular cells, which become smaller outwards, and a cortex of small, colored, polygonal cells; tetraspores zonate, borne in swollen branchlets; cystocarps external, subglobose, borne on the branchlets, containing a placenta composed of filaments which form a network, to which are attached at intervals tufts of spores.

A genus of about twenty-five or thirty species, most of which are tropical and rather ill-defined, since the sterile and fertile plants of the same species vary considerably in aspect. Most of the species have the tips of the branches swollen and rolled inwards. The cystocarps are peculiar, and in sections one sees small tufts of pyriform spores, scattered through a nearly solid tissue composed partly of a network of branching filaments which form a sort of placenta and partly of the cells of the frond itself.

H. MUSCIFORMIS, Lam.x.

Fronds filiform, purplish red, tufted, virgately branched, six to twelve

inches long, branches elongated, irregularly placed, clothed below with numerous, short, subulate branchlets, thickened and nearly naked near the apex, which is often much incurved; tetraspores zonate, borne in somewhat swollen branchlets; cystocarps subglobose, numerous, on divaricately branched spinescent branchlets.

New Bedford, Mass., *Harvey;* Wood's Holl, *W. G. F.;* Orient, L. I., *Miss Booth;* and southward to the West Indies.

In four or five fathoms of water.

A common species of the West Indies, and probably not rare in Long Island Sound, although not very common. It is usually found washed ashore in sheltered places like the Little Harbor, Wood's Holl, after a heavy blow, where one sometimes finds intricately twisted tufts two feet in diameter. With us cystocarps have not been seen, but the frond is very well developed on our coast. It may be recognized by the yellowish-purple color, by the long branches covered with short, subulate branchlets, and especially by the swollen, naked apices, which are rolled strongly inwards or almost circinate. Fertile specimens from the West Indies are more robust and do not so frequently have inrolled apices. The species does not adhere well to paper in drying.

Suborder GELIDIEÆ.

Fronds of a dense cartilaginous structure, filiform or compressed, branching; antheridia in superficial patches; tetraspores cruciate, borne in the cortical layer; cystocarps formed in swollen branches and composed of spores arranged singly or in short filaments on the surface of an axile or parietal placenta, carpostomes present, often two in number;

Rather a small order of dark-colored, rigid sea-weeds, whose fronds are formed of densely packed cells, and whose cystocarps are born in swollen terminal branches, but are not strictly external. In *Gelidium* the spores are sessile on an axile placenta, and there are two carpostomes on the opposite surfaces of the fronds. In *Pterocladia* the placenta is attanched to the lateral wall of the cystocarp, the spores are borne few in a row, and there is but one carpostome.

GELIDIUM, Lam.x.

(From *gelu*, frost, and, secondarily, gelatine.)

Fronds cartilaginous, terete or compressed, decompound-pinnate, formed of long cylindrical cells in the axis, surrounded by roundish cells which become small and polygonal at the surface; antheridia in superficial patches; tetraspores cruciate, scattered in the cortex; cystocarps immersed in swollen branchlets, containing oblong or pyriform spores borne on an axile placenta which is attached by filaments to the walls of the cystocarp; carpostomes usually one on each side of the frond.

A genus of narrowly linear or nearly terete algæ of a dense structure, found in nearly all parts of the world. The limits of the species are not well marked, because the ramifications on which the principal specific distinctions depend are very variable. The genus is recognized on our coast by the peculiar cystocarps, which are formed in

small branchlets, which become swollen and usually have an opening on each side for the escape of the spores. A longitudinal section shows an axile placenta which passes through the cystocarp, on which the spores are borne, not in chains but singly. Numerous filaments connect the placenta with the wall of the cystocarp. The account given above of the frond applies merely to what one sees in sections of the mature branches. A section of the younger portions shows that there is originally an axile filament, from which are given off other filaments which are nearly parallel to the axis, and which afterwards turn outwards and form the cortical layer, the cells of which they are composed becoming rounder and short. The genus differs from *Pterocladia* merely in the position of the placenta, which in the last-named genus is not central, but is attached laterally to the wall of the cystocarp.

G. CRINALE, J. Ag., Epicr. (*Gelidium corneum*, var. *crinale*, auct.—*Acrocarpus lubricus* and *crinalis*, Kütz., Tab. Phyc., Vol. XVII, Pls. 32, 33.)

Fronds cæspitose, dark purple, setaceous, one to three inches high, primary axis procumbent, from which arise erect, subterete, once or twice pinnate branches, pinnæ distichous, alternate, short, patent, acute, often pinnatifid; tetraspores cruciate, borne in thickened subspathulate or pinnatifid apices.

Forming tufts on mud-covered rocks and stones at low-water mark.

Portland, Maine; Red Hook, N. Y., *Harvey;* New Haven; Wood's Holl, *W. G. F.;* Malden, Mass., *Mr. Collins;* Europe; California.

We have followed Agardh in separating the var. *crinale* from the polymorphic and very widely diffused *G. corneum*. The typical form of the latter occurs in Florida and on our west coast. *G. crinale* has been as yet recorded in but few localities, but it is probably common along our whole coast. It is a homely, insignificant species, usually not much thicker than a bristle, and forms small blackish patches on mud-covered rocks.

SUBORDER SOLIERIEÆ.

Fronds filiform or compressed; tetraspores cruciate or zonate; cystocarps immersed in the frond, usually prominent at one side, spores arranged in short filaments and arranged in tufts around a large central carpogenic cell or a central placenta, which is attached to the wall of cystocarp by filaments; carpostome distinct.

A small suborder, of which we have but a single species. It is characterized by having the spores produced few in a row and attached either, as in *Solieria* and *Eucheuma*, to a large central cell, or, as in *Rhabdonia*, to a large cellular placenta at the center of the cystocarp. Whether *Rhabdonia* should be united in a suborder with *Solieria* is perhaps doubtful. By some the genus is considered to be related to the *Rhodymenieæ*, and its affinity to *Rhodophyllis* and perhaps *Euthora* is not remote.

RHABDONIA, Harv.

(From ραβδος, a wand.)

Fronds deep red, cylindrical or nodose, branching, formed of an axis composed of slender, branching, longitudinal filaments surrounded by

a layer of large roundish-angular cells and a cortical layer of smaller cells; tetraspores zonate, scattered, immersed in the cortex; cystocarps immersed in the frond, and projecting at one side, opening by a distinct carpostome, inclosing tufts of spores arranged in short, dense filaments, surrounding a globose, cellular, central placenta, connected by filamentous bands with a plexus of the axial filaments which surrounds the sporiferous mass.

A genus comprising from fifteen to twenty species, the greater part of which are confined to Australia, divided by Agardh into two subgenera, in one of which the frond is cylindrical and in the other constricted at intervals. Our species belongs to the first division, and the frond resembles closely that of *Cystoclonium purpurascens*, and the same is true of the tetraspores. The cystocarps are large, and project on one side. The genus is placed by Agardh near *Solieria*, but in that genus the spores are placed around a very large central carpogenic cell, while in *Rhabdonia* they are attached to a large, solid, central placenta formed of cells. The placenta is attached to the walls of the cystocarp by numerous bands of interwoven filaments, between which are the sporiferous masses, which consist at maturity of short filaments, whose cells are changed into spores, which are not held together by a gelatinous envelope as in *Champia*.

R. TENERA, Ag. (*Gigartina tenera*, J. Ag., Symb.—*Solieria chordalis*, Harv. (non Ag.), Ner. Am. Bor., Part II, p. 121, Pl. 23 *a*.—*Rhabdonia tenera*, J. Ag., Spec.—*R. Baileyi*, Harv. MSS., Am. Journ. Science, Vol. VI, p. 39.) **Pl. XIV, Fig. 2.**

Fronds deep red, from six inches to a foot and a half long, cylindrical, attached by a small disk, simple below, above densely branched, alternately decompound, branches long, virgate, erect, tapering at the base and apex, and furnished with numerous, linear, fusiform branchlets; tetraspores zonate, scattered in the cortex; cystocarps numerous, immersed, but projecting at one side.

In warm, quiet bays, in shallow water.

Common from Cape Cod southward; Goose Cove, Gloucester, Mass., *W. G. F.*

A characteristic species of Long Island Sound, and only known in one locality north of Cape Cod, but extending southward to the West Indies. It forms beautiful tufts often two feet long, in muddy places around wharves and in sheltered places, and is not likely to be mistaken for any other plant, except possibly for a large form of *Cystoclonium purpurascens*. The procarps consist of three cells, and from the innermost or that nearest the axis grows a long trichogyne, which curves round in a tortuous fashion, and makes its way to the surface, reminding one of the trichogynes of *Halymenia ligulata*, figured by Bornet. The section of the cystocarp given by Harvey in the Nereis does not pass through the center, and the cystocarp is not a closed cavity, as supposed by Harvey, but has a distinct carpostome; nor are the spores pyriform and attached to separate pedicels, but they are formed from the cells of short filaments.

Suborder SPONGIOCARPEÆ.

Fronds solid, cylindrical, branching; antheridia in spots on upper part of fronds; tetraspores cruciate, immersed in the cortical filaments; cystocarps in external wart-like protuberances, composed of parallel filaments, spores obovate, densely packed around the surface of a cellular mass which surrounds the tip of a short pedicel.

The present suborder was made by J. G. Agardh and Harvey to include a single species, *Polyides rotundus*, a species in several respects anomalous. The development of the cystocarps of that species was first made out by Thuret and Bornet, and a detailed account was published in the Études Phycologiques. In its development the cystocarp of *Polyides* resembles that of the genus *Dudresnaya*. There is produced from the cells at the base of the trichogyne a number of filaments which wind amongst the short filaments, of which the wart-like bodies near the tips of the fronds are formed. These filaments come in contact with certain cells of the protuberances, which then divide and produce the spores. Although this indirect fertilization of the carpogenic cells by means of winding filaments is the same as is found in *Dudresnaya*, the mature cystocarp is different in the two genera. In *Polyides* the ripe spores are arranged in a regular layer around a small placenta, which is borne on a short pedicel produced from the carpogenic cell. In *Dudresnaya coccinea* the spores are irregularly grouped around a placenta surrounding the carpogenic cell itself. In *D. purpurifera*, however, according to D. Bornet, the cystocarps more nearly resemble those of *Polyides*, and he thinks it not impossible to unite the two genera in one suborder.

POLYIDES, Ag.

(From πολυς, many, and ιδεα, form.)

Fronds cylindrical, dichotomous, composed of interlaced branching filaments, consisting of elongated cells and curving outwards at the surface so as to form a cortical layer of horizontal filaments; antheridia in patches on the upper part of frond, consisting of short, densely packed filaments bearing clusters of antherozoids; tetraspores cruciate, immersed in the cortical layer; cystocarps in wart-like protuberances on the upper part of the frond.

P. ROTUNDUS, Grev.; Phyc. Brit., Pl. 95.

Fronds blackish red, cylindrical, cartilaginous, three to six inches long, attached by a disk, with an undivided stipe, which becomes above repeatedly dichotomous, apices obtuse; warts flesh-colored, numerous on the upper divisions of the frond.

On stones in deep pools and in deep water.

Common from New York northward; Europe.

A species easily recognized by its regularly dichotomous, cylindrical frond, by its dark, almost black, color, and dense cartilaginous substance. When sterile it might be mistaken for *Furcellaria fastigiata*, a common species of Northern Europe, which may be expected to occur on our coast. In fruit, however, they are easily distinguished, since the cystocarps of *Polyides* are borne in external warts, while those of *Furcellaria*

are in the somewhat swollen tips of the frond. The present species is usually found washed ashore from deep water, but on the northern coast is found also in deep tide-pools. When dried it becomes brittle and does not adhere to paper.

Suborder SPHÆROCOCCOIDEÆ.

Fronds cylindrical or membranaceous, substance often very delicate; antheridia forming superficial patches or occasionally contained in sunken cavities; tetraspores cruciate, zonate, or tripartite, often collected in spots (sori) on the surface; cystocarps external, hemispherical or flask-shaped, spores arranged in moniliform filaments, which radiate from a basal placenta, carpostome distinct.

The present suborder is by Agardh and some other writers divided into two, the *Sphærococcoideæ*, which include rather coarse cartilaginous algæ, which are cylindrical or somewhat compressed, but hardly membranaceous, and the *Delesserieæ*, which are rosy-red and of delicate texture and distinctly membranaceous. The fruit, however, is very similar in both groups. The spores are arranged in subdichotomous filaments, which radiate from a basal placenta, which in some genera, as *Gracilaria*, projects far into the cavity of the cystocarp. The suborder differs from the *Rhodymenieæ* in that the moniliform arrangement of the sporiferous filaments is preserved even at maturity, and the filaments are distinct from one another and not held together by a gelatinous envelope. It must, however, be admitted that there are genera which seem to indicate a close relation between the two suborders.

GRINNELLIA, Harv.

(Named in honor of *Mr. Henry Grinnell*, of New York.)

Fronds rosy-red, occasionally purple, delicately membranaceous, with a slender percurrent midrib, composed of a single layer, at the midrib of several layers, of large polygonal cells; antheridia in tufts on both sides of the frond; tetraspores tripartite, in swollen spots on the frond; cystocarps sessile on the frond, flask-shaped, spores in dichotomously branching filaments arising from a basal placenta.

A genus comprising a single species, which is found from Cape Cod to Norfolk, separated from *Delesseria* because the tetraspores are formed in incrassated spots on the frond. The genus is too near *Delesseria*, of which it should perhaps form a subgenus.

G. Americana, Harv., Ner. Am. Bor., Part II, Pl. 21 *b*. (*Delesseria Americana*, Ag.—*Aglaiophyllum Americanum*, Mont.—*Cryptopleura Americana*, Kütz.) **Pl. XIII, Figs. 2–4.**

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 64.

Fronds dicœcious, four inches to a foot and a half long, one to four inches wide, lanceolate, tapering at the extremities, occasionally bifid or proliferous, margin smooth or wavy; antheridia in small spots on both sides of the frond; tetraspores scattered over the frond in thickened spots; cystocarps scattered, sessile, flask-shaped.

On wharves, shells, stones, and sponges below low-water mark, and extending to several fathoms.

Cape Cod, southward.

This, with the exception perhaps of *Dasya elegans*, is the most beautiful alga of Long Island Sound. It is often found in tufts on wharves below low-water mark, and it flourishes in rather warm, shallow bays. It is met with at all seasons of the year; and, according to Miss Fisher, of Edgartown, the ladies of Martha's Vineyard collect it in winter, when it is found in considerable quantities on the ice. The male plant is smaller than the cystocarpic, and the antheridia may be detected by the naked eye in the form of small, whitish, glistening spots. The walls of the conceptacles are thinner than those of *Delesseria*. The swellings in which the tetraspores are borne can hardly be called warts, and the figure given by Harvey in the Nereis is somewhat exaggerated. The surface of the frond is raised, and becomes more or less convex, but there are no such irregular projections as represented in Harvey's figure.

DELESSERIA, Lam.x.

(In honor of *Baron Benjamin Delessert.*)

Fronds bright red, thin, membranaceous, laciniate or branched, costate, and often with lateral veins, composed of a single or a few layers of large polygonal cells; antheridia in spots on the frond; tetraspores tripartite, grouped in spots (sori) on the frond or on marginal leaflets; cystocarps external, sessile, with a basal placenta, from which radiate the numerous subdichotomous, sporiferous filaments.

A beautiful genus, comprising fifty or more species, distributed all over the globe. They are of delicate texture and rosy-red color, and are generally leaf-like in appearance, although some are narrowly linear. The genus is not likely to be mistaken for any other on our coast, unless it be *Grinnellia*, in which the tetraspores are borne in thickened portions of the frond. The fronds, when young, are more or less leaf-like and provided with a midrib, and generally also with lateral nerves; and, as they grow older, they become more or less stipitate by the wearing away of the blade of the leaf, which leaves the thickened midrib either naked or with a small winged margin. When still more advanced, owing to the growth of the laciniæ and the wearing away of the lateral nerves, the stipes appear to branch and to bear several leaf-like fronds. In some species the membranous portion of the fronds consists of a single layer of cells, which are rectangular when seen in section and polygonal seen from above. At the veins the cells form several layers, and in some species it is only at the tip that the fronds are formed of a single layer. When the cystocarps are formed, the cells are divided by numerous partitions parallel to the surface of the frond, and the wall of the conceptacle, when mature, consists of several layers of cells, all of about the same size and smaller than the cells of the frond.

D. SINUOSA, Lam.x.; Phyc. Brit., Pl. 259.

Fronds four to eight inches long and two to four broad, stipitate below, stipe often elongated and branched, with oblong or obovate, deeply sinuate or pinnatifid toothed leaves, midrib percurrent, lateral veins opposite, extending to the laciniæ; tetraspores tripartite, either borne in small lateral leaflets or in patches following the veins; cystocarps sessile, generally on the veins, hemispherical, with a distinct carpostome.

On algæ, generally in deep water.

From New Haven northward.

One of the more common *Florideæ* north of Cape Cod, and not rare in the colder waters of Long Island and Vineyard Sounds. It is found all the year, but especially in the autumn and winter. It is at once recognized by the presence of a midrib and lateral veins and by its general resemblance in outline to an oak-leaf.

D. ALATA, Lam.x.; Phyc. Brit., Pl. 247.

Fronds two to four inches long, an eighth of an inch wide, stipitate below, above pinnately decompound, divisions linear, margin entire, costate, lateral veins scarcely visible; tetraspores tripartite, borne in the apices of the segments or in special leaflets; cystocarps hemispherical, on the upper veins.

Var. ANGUSTISSIMA, Harv., Phyc. Brit., Pl. 83.

Fronds very narrow, blade of the leaflets almost wanting.

From Boston northward, with the last; Europe.

A common species of Northern New England, but not yet found south of Cape Cod. Our form is uniformly narrower than the common European form, and there is scarcely a trace of lateral veins. *Hypoglossum Grayanum*, Reinsch, Contributiones ad Algologiam et Fungologiam, p. 55, Pl. 42, appears to be the same as *D. alata* of the New England coast.

D. LEPRIEURII, Mont.; Ner. Am. Bor., Part II, Pl. 22 *c*. (*Hypoglossum Leprieurii*, Kütz.—*Caloglossa Leprieurii*, J. Ag., Epicr.)

Fronds purple, one to two inches high, about a tenth of an inch wide, dichotomous, articulato-constricted, costate, proliferous from the costa, segments linear-lanceolate, attenuate, rhizoids and new leaflets formed at the constrictions; tetraspores tripartite, in oblique lines extending from the midrib to the margin; cystocarps sessile on the midrib.

West Point, *Bailey;* Fort Lee, N. Y., *Mr. Averill;* Harlem River, *C. H. Peck;* and common southward.

This small species inhabits tidal rivers where the water is warm, and is found on wood-work, stones, and water-plants. It is probably not rare near New York, and on our Southern Atlantic coast it is common. It extends to the West Indies, and is also found in the warmer waters of both hemispheres. It is distinguished at once from our other species by its small size, purple color, and very thin constricted fronds. The species was placed by Harvey in the subgenus *Caloglossa*, which is separated as a distinct genus by Agardh in his Epicrisis.

GRACILARIA, Grev.

(From *gracilis*, slender.)

Fronds filiform or compressed, carnoso-cartilaginous, dichotomous or irregularly decompound, composed of an inner layer of large angular cells, which become smaller outwards, and a cortical layer of small colored cells; antheridia in cavities sunk in the cortex or superficial; tetraspores cruciate, dispersed in the cortical layer; cystocarps external, sessile, spherical or conical, with a large cellular placenta at the

base, from which radiate the sporiferous filaments, pericarp thick and connected with the placenta by slender filaments.

A genus containing not far from forty species, none of which really deserve the generic name, for they are usually coarse and often decidedly cartilaginous. The specific distinctions are principally derived from the branching, which in the present genus is very variable. Some of the species, as *G. lichenoides*, are used as food.

G. MULTIPARTITA, J. Ag.; Phyc. Brit., Pl. 15.

Fronds purplish red, four to twelve inches long, compressed or submembranaceous, deeply cleft vertically in an irregularly dichotomous or palmate manner, divisions linear wedge-shaped, acute; cystocarps large, conical, scattered over the frond.

Var. ANGUSTISSIMA, Harv.

Fronds narrow, nearly filiform below, compressed above, irregularly dichotomous, the apices frequently palmately divided.

On stones and on muddy bottoms below low-water mark.

Massachusetts Bay, *Harvey*, and common from Cape Cod southward; Europe; California.

A coarse and variable species, which is generally of a dingy purple color. The limits of the species are difficult to fix. Occasionally one finds with us specimens as broad as the common European form, but on the coast of California, and especially of Florida, one finds forms which look like large *Rhodymeniæ*. Most of our specimens are narrower than the type, and the var. *angustissima* of Harvey, it must be confessed, has more the habit of *G. compressa* than of *G. multipartita*. At Orient we have seen what we supposed was *G. confervoides*, but unfortunately our specimens were misplaced.

SUBORDER RHODOMELEÆ.

Fronds usually filiform and branching, sometimes membranaceous or (in exotic genera) reticulate; antheridia ovate or lanceolate in outline, formed by the transformation of monosiphonous branchlets, occasionally covering the surface of discoidal branches; tetraspores generally tripartite, borne either in localized portions of the fronds or in specially modified branches (stichidia); cystocarps external, with a distinct ovate or urceolate conceptacle or pericarp, spores pyriform, borne on short stalks given off from a basal placenta.

The largest suborder of the *Florideæ*, and one containing many of the most beautiful sea-weeds. The suborder is mainly characterized by the cystocarpic fruit, which is external, and has the spores borne separately on short stalks which arise from a placenta which surrounds the carpogenic cell at the base of the conceptacle. In the *Dasyæ*, however, the filaments which bear the spores branch and fill the larger portion of the conceptacle, but we have not thought it advisable to separate them as a suborder. The antheridia, except in the genus *Chondriopsis*, where they assume a peculiar shape, form ovate or siliculose tufts, generally developed from monosiphonous branchlets or rather hairs. The position of the tetraspores varies in the different genera. In some cases the branchlets become broadly ovate and the tetraspores are

borne in parallel rows. Such collections of tetraspores are called stichidia. The fronds in the present suborder vary greatly. In the more beautiful genera of tropical regions they are in the form of complicated net-works or in membranes in which the cells are arranged in regular order, but in the majority of the genera the fronds are filiform and branching and generally beset, at least at some seasons, with delicate hairs. In most of the genera represented on our coast the fronds have a polysiphonous axis, that is, on cross-section there is seen to be a central cell surrounded by a circle of large cells, and in longitudinal sections there is a central filament composed of large cells, and on each side a lateral filament whose cells correspond in length to those of the central filament, the upper and lower walls of the three cells forming two parallel lines.

Fronds flattened ..... *Odonthalia.*
Fronds filiform 1
1. Tetraspores borne in the smaller branches 2
   Tetraspores borne in stichidia 4
2. Superficial cells small, irregularly placed 3
   Superficial cells, at least in the younger branches, in transverse bands ..... *Polysiphonia.*
3. Branches filiform throughout ..... *Rhodomela.*
   Ultimate branches club-shaped, much attenuated at base. *Chondriopsis.*
4. Fronds beset with monosiphonous branchlets ..... *Dasya.*
   Fronds without monosiphonous branchlets, superficial cells quadrate ..... *Bostrychia.*

CHONDRIOPSIS, J. Ag.

(From χονδρος, cartilage, and οψις, an appearance.)

Fronds brownish red, terete or subcompressed, pinnately decompound, branches virgate, much constricted at the base, composed of a monosiphonous axis surrounded by a few (4–6) siphons and surrounded by secondary siphons, cortex of small polygonal cells; antheridia borne in short disk-like branchlets covering both surfaces except at the margin; tetraspores tripartite, in club-shaped branchlets; cystocarps sessile, ovate, with a distinct carpostome, spores pyriform, on short pedicels from a basal placenta.

A genus of which about twenty species have been described, which inhabit principally the warmer parts of the world, some being widely diffused. They are as a whole difficult to distinguish, the specific marks being principally the ramification and shape of the branchlets, points in which the different species vary very much. The antheridia are very peculiar. On the upper branches are borne flattened, more or less incurved, disk-shaped branches, whose margin is wavy. The antheridia cover both sides of these discoidal branches, except at the margin, which is composed of large hyaline cells. The fronds are intermediate between those of *Rhodomela* and *Laurencia*, and the branchlets are always much constricted at the base. Most of the species were formerly included by Lamouroux and others in the genus *Laurencia*. By C. A. Agardh they were, in the Species Algarum, placed in *Chondria*, a genus retained by Harvey in the Nereis. Since as originally defined the genus *Chondria* embraced algæ of rather remote relationship to one another, J. G. Agardh, in the third volume of his Species Algarum, separated the present group, under the name of *Chondriopsis*, the name *Chondria* being

abandoned altogether. The habit of the species of the present genus is much like that of *Laurencia*, but the polysiphonous character of the fronds is more evident, the substance more delicate, and the branchlets more distinctly club-shaped than in that genus. As in *Laurencia*, the apices are all depressed, the growing point being sunk in a hollow concavity, from which, as well as from the younger part of the fronds, project numerous tufts of hyaline, dichotomous, monosiphonous filaments.

C. DASYPHILA, Ag. (*Laurencia dasyphila*, Phyc. Brit., Pl. 152.)

Fronds dicœcious, four to eight inches high, broadly pyramidal in outline, cylindrical, robust, densely branched, generally with a percurrent axis and alternate, spreading, pinnately decompound branches, ultimate divisions short, club-shaped or top-shaped, very obtuse at apex and much constricted at base; cystocarps sessile on very short branchlets.

Var. SEDIFOLIA, Ag. (*Chondria sedifolia*, Ner. Am. Bor., Part II, Pl. 18 *g*.)

Branches fasciculate, approximate, branchlets obovate-oblong.

On rocks and stones at low-water mark, and on *Zostera*.

Common from New York to Cape Cod; Europe.

A rather coarse species which does not collapse when removed from the water, but which glistens on account of the water held by the tufts of hyaline filaments at the tips of the branches. The species is recognized by its coarseness and broadly pyramidal outline and by its club-shaped ultimate divisions. The variety has rather less obtuse tips and is not uncommon. In spite of its coarseness, the species quickly decays in fresh water.

C. TENUISSIMA, Ag. (*Laurencia tenuissima*, Phyc. Brit., Pl. 198.—*Chondria tenuissima*, Ner. Am. Bor., Part II, Pl. 18 *f*; Études Phycol., Pls. 43–48.)

Fronds dicœcious, four to eight inches high, narrowly pyramidal in outline, cylindrical, slender, rather loosely branched, with a percurrent axis and long, suberect, alternate, virgate, pinnately decompound branches, ultimate branchlets narrowly fusiform, attenuated at both extremities.

Var. BAILEYANA. (*Laurencia Baileyana*, Mont., Ann. Sci. Nat., Ser. 3, Vol. II, p. 63.—*Chondria Baileyana*, Harv., Ner. Am. Bor., Vol. II, Pl. 18 *a*.—*Chondria striolata*, Farlow, List of Marine Algæ.)

Branches erect, subsimple, beset with slender curved branchlets, which are much attenuated at base and blunt at the apex.

On stones at low-water mark.

Squam, Mass., and common in Long Island Sound; Europe.

A variable species, distinguished from the last by its lighter yellowish color, less dense branching, and slender fusiform branchlets. The typical form is common with us, but not so common as variety *Baileyana*, which was considered by Agardh to be the same as *C. striolata* Ag. The species seems to us rather to be a form of *C. tenuis-*

sima, but it must be confessed approaching *C. dasyphylla*. Bailey was inclined to refer it to *C. dasyphylla*. He quotes Montagne, who first described the species, as *Laurencia dasyhhylla*, as follows: "Notwithstanding the close affinity of this alga to *Laurencia tenuissima* and to *L. dasyphylla*, it cannot be confounded with either of them. The absence of ramification distinguishes it sufficiently from the first, and the form of the ramenta does not permit it to be referred to the second, from which it is in other respects quite distinct." Just what is meant by the "absence of ramification," by which *L. Baileyana* is to be distingished from *L. tenuissima*, is not easy to see.

C. LITTORALIS, (Harv.) J. Ag. (*Chondria littoralis*, Ner. Am. Bor., Part II, p. 22.)

"Fronds robust, elongate, subdichotomous or irregularly much branched, branches flexuous, attenuated, with rounded axils, ramuli scattered or crowded, fusiform, attenuated at the base and apex, simple or pinnulated, acute." (Harvey, l. c.)

Wood's Holl, Mass., *W. G. F.*

The description taken from the Nereis applies pretty well to a specimen collected at Wood's Holl. We have seen several specimens of the species collected at Key West. It is dark colored and coarse, but has the branching and habit of *C. tenuissima*. The Key West specimens are reddish yellow, perhaps owing to exposure to the sun. Species of the present genus vary so much in appearance, according as they are more or less thoroughly "squashed" in pressing, that the determination of dried specimens frequently has but little value.

C. ATROPURPUREA, (Harv.) J. Ag. (*Chondria atropurpurea*, Harv., Ner. Am. Bor., Part II, Pl. 18 *e*.)

Fronds four to six inches high, robust, very densely branched; branches patent, secondary branches tapering at the base and apex, beset with scattered fusiform ramuli.

Var. FASCICULATA, Farlow.

Secondary branches borne in clusters; cystocarps broadly ovate, sessile on short lateral branchlets.

From Charleston, S. C., southward, *Harvey*. Var. *fasciculata*, Fort Hamilton, N. Y.

The characters of the present species are not well defined. Specimens from Charleston, determined by Harvey himself, are robust and have the ultimate branches scattered, but unfortunately they are without fruit. What has been supposed to be a variety of the same species occurs rather commonly on the coast of California, and was distributed in the Alg. Am. Bor., No. 57. It is, however, not beyond question whether the form distributed should not rather have been referred to *C. nidifica*, Harv., described in the Supplement to the Nereis The plant which is here described as var. *fasciculata* is less robust than specimens from California and Charleston, but resembles them in the dark color and secondary branches which taper at both extremities. It differs from Charleston specimens in having the branches in tufts, in which respect it resembles some Californian specimens. Whether the New York form should be considered a variety of *C. atropurpurea* rather than *C. nidifica* is perhaps doubtful.

ODONTHALIA, Lyngb.

(From *οδους*, a tooth, *αλς*, the sea.)

Fronds dark purple, plane, deeply distichously pinnatifid, with a rudimentary midrib, margin alternately toothed, formed of oblong internal cells and small irregularly shaped cortical cells; tetraspores tripartite, arranged in two rows in short, corymbose, stipitate, lanceolate branchlets (stichidia), which are marginal and generally axillary; cystocarps similarly placed, ovate, with a distinct carpostome and pyriform spores borne on a basal placenta.

A small genus of seven or eight species, which are confined mainly to the colder waters of the northern hemisphere. *O. dentata* occurs in the North Atlantic, extending as far south as Halifax. Several other species inhabit the North Pacific, especially the vicinity of Kamtschatka, one species occurring as for south as Japan and another in California. The species are dark and opaque, and the polysiphonous structure is scarcely visible in the older parts of the fronds, but is clearly seen in young shoots, especially in adventitious growths.

O. DENTATA, Lyngb.; Phyc. Brit., Pl. 34.

Exs.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 56.

Fronds four to twelve inches long, quarter of an inch broad, decompoundly pinnate, branches oblong, deeply pinnatifid or bipinnatifid, laciniæ alternate, linear, sharply inciso-dentate toward the truncated extremities; tetrasporic and cystocarpic branchlets clustered, axillary.

Halifax, N. S., and several localities on the Saint Lawrence River.

This species has not yet been found within our limits, but may be expected on the Maine coast. It is easily recognized by its color and ramification, and does not adhere to paper in drying. As a rule, American forms of this species are narrower than the common British form, but they are not distinct, and at Halifax the common British form was dredged by Professor Hyatt in abundance. The *O. furcata* of Reinsch, Contributiones ad Algologiam et Fungologiam, p. 58, Pl. 42 *a*, is apparently the common narrow form of the present species.

RHODOMELA, J. Ag.

(From *ῥοδεος*, red, and *μελας*, black.)

Fronds dark red, filiform or subcompressed, pinnately decompound, branches filiform, not contracted at base, composed of a monosiphonous axis surrounded by several siphons and a thick cortex of small, irregularly placed, polygonal cells; tetraspores tripartite, borne in the ultimate branches; cystocarps sessile or pedicellate, spores pyriform, on short stalks from the basal placenta.

A small genus of dark-colored algæ, confined to rather high latitudes in both hemispheres. It is connected by the genus *Rytiphlæa* with *Polysiphonia*. The polysiphonous character of the frond is seen at the tip, and in most species cross-sections of the stem show a circle of large cells surrounding the axial cell and a thick cortical layer. When young the species are covered with dichotomous hairs. The genus is distinguished at sight from *Chondriopsis* by not having branchlets constricted at the base.

R. SUBFUSCA, Ag.; Phyc. Brit., Pl. 264.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 55.

Fronds six inches to a foot and a half long, terete, pinnately decompound, branches virgate, lower branchlets patent, subulate, the upper fasciculato-corymbose; tetraspores prominent in subtorulose branchlets; cystocarps sessile, ovato-globose.

Var. GRACILIOR, J. Ag. (*Rhodomela gracilis*, Harv., Ner. Am. Bor., Part II, Pl. 13 *c*.)

Fronds slender; tetrasporic branches distinctly torulose.

In deep tide-pools and at a depth of several fathoms.

Throughout our whole limits; Europe.

A species which varies very much with the time of year and the place of growth. It is usually common in the spring months, when it is often washed ashore, and in the summer and autumn it is occasionally found, especially in dredging, in a denuded form, nothing remaining but the older branches, which are perennial and which give rise the following season to rather delicate new branches. As usually seen on Cape Ann the fronds are short, robust, and dark colored, even in early spring, while at Wood's Holl and in Long Island Sound the common spring form is much attenuated, delicate, and of a brighter red color, forming the *Rhodomela Rochei* of the Nereis. In spite of the difference in aspect, the extreme forms are connected by numerous transitional stages which make it impossible to admit a specific distinction. By Agardh *R. Rochei* is considered to be the spring form of the typical *R. subfusca*, but we are more inclined to regard it as the young of the var. *gracilior*, which is more common south of Cape Cod, the type occurring northward. The species does not adhere well to paper.

POLYSIPHONIA, Grev.

(From πολυς, many, and σιφων, a tube.)

Fronds filamentous or subcompressed, distichously or irregularly branching, formed of a monosiphonous axis and several (4–20) siphons, often with secondary siphons, and either naked or with a cortical layer of irregular cells, furnished with numerous tufts of hyaline, monosiphonous, dichotomous filaments; antheridia lanceolate in outline, borne on the dichotomous filaments; tetraspores tripartite, in one, rarely in two, rows, in the slightly altered upper branches; cystocarps ovato-globose or urceolate; spores pyriform, on short pedicels borne around a basal carpogenic cell.

The largest genus of *Florideæ*, of which more than two hundred species have been described, but not all of which can be considered valid. They abound in all parts of the world, especially in warm, shallow waters. Some are perennial, but the majority are annual and disappear during the winter. They are easily recognized at sight by the structure of the frond and the tetraspores, which are almost always in a single row in the upper branches, rarely in a double row, and not in swollen special branches or stichidia, as in *Bostrychia*, which is nearly related to *Polysiphonia*. The growth is from a single apical cell, from which is formed a monosiphonous axis. By tangential divisions of the upper cells there is formed a number of peripheral cells and a central

cell. The peripheral cells are similar to one another and of the same length as the central cell, and, as the successive secondary cells lie exactly or nearly exactly over one another, the mature frond appears to be composed of a central filament or axis surrounded by a number of secondary filaments or siphons, as they are termed in speaking of the present genus and its allies. There is formed in some species a second set of cells alternating with the siphons, and also corticating, generally irregularly sinuous cells, which cover the surface. The tetraspores, according to Prof. E. P. Wright, are formed by out-growths from the axial cell. The antheridia are borne on the delicate, colorless filaments which form tufts on the younger parts of the frond. The filaments are dichotomous and the antheridia cover the lower cells of one of the forkings, the branch sometimes being prolonged beyond, when the antheridia are said to be mucronate. The cystocarps are terminal on short branches, and contain within a pericarp, whose cells are arranged in longitudinal series, pyriform spores on short stalks around a small basal placenta. Some of our species are not well defined, and a prolonged observation on the shore, especially during the spring months, is necessary before the limits of some species can be accurately fixed.

SECT. I. *Siphons four, cortications wanting.*

P. URCEOLATA, (Dillw.) Grev.; Phyc. Brit., Pl. 167.

Fronds deep red, becoming blackish, cæspitose, three to ten inches high, setaceous, branches subdichotomous, with short, alternate, patent or recurved, decompound branchlets, siphons four, cells below 4–5 times longer than broad, becoming shorter above; cystocarps on short lateral branches, urceolate, with a distinct neck; antheridia linear-oblong, mucronate.

Var. FORMOSA, Ag. (*Polysiphonia formosa*, Phyc. Brit.)

Filaments soft and flaccid, branches long, flexuous, branchlets somewhat attenuated, cells 5–10 times as long as broad.

Var. PATENS, Grev. (*P. subcontorta*, Peck, Twenty-third Report New York State Botanist.)

Branches numerous, recurved or revolute.

On wharves and rocks at low-water mark.

From New Jersey northward; Europe; California.

A common perennial species, most abundant in the spring, when it has a deep blood-red color. It is frequent on old wharves and wood-work and on the under surface of rocks near low-water mark, where it forms small turfs, in company with *Callithamnion Rothii*. The var. *formosa* is found only in the spring, and is softer, forms longer tufts, and has longer cells than the type. It is the only form of the species which adheres well to paper or which can lay claim to beauty. It is especially luxuriant in April at Wood's Holl and the region of New Bedford, and forms dense tufts sometimes a foot long. As usually seen in summer, the species is blackish and setaceous and covered with diatomes. The var. *patens*, which differs somewhat in general habit from the type, is not uncommon with us. Through the kindness of Mr. Peck, we have been able to examine a specimen of his *P. subcontorta*, which, judging from the description in the Twenty-third Report, seemed to be closely related to, if not a form of, *P. Harveyi*. An examination of the specimen, however, seems to us to show that it is var. *patens* of the present species, which it resembles in microscopic characters.

P. SUBTILISSIMA, Mont.

Filaments densely tufted, two to four inches long, purplish brown,

rising from a creeping base, capillary, alternately decompound, branches multifid, attenuate, branchlets filiform, internodes once and a half as long as broad.

Var. WESTPOINTENSIS, Harv.

More slender and delicate.

Jackson Ferry, N. Y.; Newburyport, Mass., *Harvey;* Providence, R. I., *Mr. Olney;* Gloucester, Mass.? *W. G. F.* The variety at West Point.

The present species is with difficulty distinguished from *P. Olneyi*, which, in its turn, too closely approaches *P. Harveyi*. The two last-named species are attached by a small disk, and the filaments do not rise from a creeping base, as in the present species. The vertical filaments of *P. subtilissima* are of a purple color, and are fine and soft, and the cells are not much longer than broad. We have seen specimens collected by Mr. Olney near Providence which may with certainty be referred to the present, and have found floating in ditches at Gloucester tufts of a very dark, delicate species which may probably be referred to it. The specimens were apparently washed from some muddy shore, but the creeping basal filaments could not be seen. Gloucester collectors should search for the plant in muddy ditches towards Little Good Harbor.

P. OLNEYI, Harv., Ner. Am. Bor., Part II, Pl. 17 *b*.—*Dough Balls.*

Fronds brownish red, densely tufted, from two to five inches high, filaments capillary, much branched, branches patent or divaricate, decompound, attenuated above, with scattered slender branchlets, internodes three or four times as broad below, becoming shorter above; antheridia ellipsoidal, not mucronate; cystocarps broadly ovate, nearly sessile.

On *Zostera.*

From New York to Halifax, most common south of Cape Cod.

The present species passes by numerous forms into *P. Harveyi*, and in spite of the marked difference in the typical forms of the two species, the question remains to be settled whether *P. Olneyi* is not a slender variety of *P. Harveyi*. In its typical form *P. Olneyi* forms dense soft tufts, sometimes called dough-balls by the sea-shore population. The filaments are divaricately branched below, but the upper branches are slender and erect and beset with fine byssoid branchlets. When old, however, the lower branches become rigid, and the branchlets rather spine-like, as in the next species. Both *P. Olneyi* and *P. Harveyi* are very common from Cape Cod to New York, growing usually on *Zostera* in shallow, quiet bays. As they mature they fall from the *Zostera* and are blown into small coves, the bottoms of which are sometimes almost carpeted with the globose tufts of these two species, which lie loosely on the bottom. The typical forms of the present species collapse at once when removed from the water.

P. HARVEYI, Bail.; Ner. Am. Bor., Part II, Pl. 17 *a*.—*Nigger Hair.* **Pl. XV, Figs. 3, 4.**

Fronds blackish red, globosely tufted, filaments two to six inches high, setaceous, when young with a leading axis, becoming divaricately much branched, branches alternately decompound, patent, often angularly bent, beset with numerous short, simple or forked, spine-like

branchlets, internodes all short, never more than twice as long as broad; antheridia ellipsoidal, not mucronate; cystocarps broadly ovate, on short pedicels.

On *Zostera* and other plants.

Common in Long Island Sound and found in several place in Massachusetts Bay; Goose Cove, Squam, Mass.

The typical form of the species is closely related to *P. spinulosa*, Grev., found in Scotland and in the Mediterranean and Adriatic Seas, where, however, it does not appear to be at all common. We once collected specimens at Antibes, France, and certainly at first sight it could not be distinguished from *P. Harveyi*. In the typical *P. Harveyi* the branches are rather rigid and the branchlets are spine-like and sometimes revolute. As the plant grows old the finer branchlets disappear, and there is left an irregular mass of coarse filaments beset with revolute branchlets, forming the *P. arietina* of Bailey, which is in the Nereis considered a variety of *P. Harveyi*. It is, however, rather an autumnal condition than a proper variety. The upper portion of the fronds of *P. Harveyi* are sometimes slender and byssoid, and as it is a well-known fact that the branchlets of *Polysiphoniæ* have the power of falling from their attachments and producing new plants, it may be, as has already been suggested, that *P. Olneyi* is the byssoid condition of *P. Harveyi*.

Polysiphonia Americana, Reinsch, Contrib. ad Algolog. et Fungolog., p. 50, Pl. 33 *a*, as far as can be judged by the plate, closely resembles some forms of *P. Harveyi*, except in the color, which as given by Reinsch is bright pink. It is said by Reinsch to resemble *P. arietina*, Bailey, in general appearance, but to differ in the erect, subdichotomous filaments, whose joints are bicellular.

SEC. II. *Siphons four, main branches corticated, ultimate branches without cortication.*

P. ELONGATA, Grev.; Phyc. Brit., Pls. 292, 293.—*Lobster Claws.*

Fronds dark red, six to twelve inches long, robust, cartilaginous, irregularly branched, lower branches naked, upper beset with closely set, alternately multifid branchlets, which taper at the base and apex, corticications covering all but the younger portions of frond, section of branches showing four large siphons, with secondary siphons and a rather thick cortex; cystocarps ovate.

Gloucester, Lynn Beach, Squam, Wood's Holl, Gay Head, Mass.

One of the largest but less common *Polysiphoniæ*, which is more abundant in the spring than at any other season. The species is perennial and in late summer and autumn the branchlets fall off, leaving the lower and coarser branches, which persist through the winter, and in the following spring produce at the apices tufts of delicate, deep-red branchlets. It is recognized by its long cartilaginous main branches, which are nearly naked, and which bear tufts of filaments at the apex. The popular name of lobster claws is tolerably appropriate.

P. FIBRILLOSA, Grev.; Phyc. Brit., Pl. 302.

Fronds brownish yellow, four to ten inches high, broadly pyramidal, rather robust below, becoming slender above, with an undivided axis or divided near the base into several long, main branches, secondary branches alternate, several times pinnate, fibrillose, with short, scattered,

simple branchlets, ultimate divisions capillary, tufted; antheridia oblong, terminal; cystocarps ovate.

On stones and *Zostera* at low-water mark.

Lynn, Mass., *Harvey;* Wood's Holl, Noank, Orient Point, Newport, and several places in Long Island Sound; Europe.

Rather a common species in sheltered places south of Cape Cod, but only known northward from the reference of Harvey. It is smaller and more slender than the last species and the branches are not naked, but fibrillose. The present species is more nearly related to *P. violacea*, of which Harvey suggests that it may be a variety. The last-named species is more decidedly red in color, is a larger plant, and although the ultimate branches are in tufts, as in *P. fibrillosa*, the larger branches are destitute of the fibrillose branchlets characteristic of the latter species.

P. VIOLACEA, Grev.; Phyc. Brit, Pl. 209.

Fronds brownish red, six inches to two feet long, elongated, pyramidal, usually with an undivided main axis, which has several long, widely spreading branches near the base, main divisions robust, becoming capillary at the tops, branches rather naked below, bearing above numerous multifid branchlets, ultimate branchlets densely tufted; antheridia? cystocarps broadly ovate, sessile or shortly pedicelled.

Var. FLEXICAULIS, Harv.

Branches very long, slender, angularly bent, much divided, divisions patent and sometimes secund.

In deep tide-pools on exposed shores and on *Zostera* in deep water.

Common from New York northward. Var. *flexicaulis*, Cape Ann; Portland, *C. B. Fuller;* and northward.

One of the commonest species of the genus, frequenting cold, exposed tide-pools, where it has a dense habit and rarely exceeds a foot in length. When growing in deep water it is long and slender. In spring it has a pink color, but late in the season it becomes dark colored, almost blackish. Specimens of the present species are sometimes found in American herbaria bearing the name of *P. Brodiæi*, a species having six siphons, which has not as yet been detected with certainty on our coast. The *P. Brodiæi* of Bailey's List of United States Algæ is, according to Harvey, *P. fibrillosa.*

SECT. III. *Siphons more than four, corticating cells wanting.*

P. VARIEGATA, Ag.; Phyc. Brit., Pl. 155; Ann. Sci. Nat., Ser. 3, Vol. XVI, Pl. 6.

Fronds purplish brown, densely tufted, four to ten inches high, filaments setaceous and rigid below, capillary above, dichotomo-multifid, the lower axils patent, branches above somewhat zigzag, elongated, with alternately decompound, flaccid branchlets, siphons six in number, cortications wanting, internodes not much longer than broad; antheridia linear-oblong, mucronate; cystocarps ovate, short-stalked.

At the foot of wharves, on *Zostera*, &c.

Massachusetts Bay, *Harvey;* common from Cape Cod to the West Indies; Europe.

A beautiful summer species, forming large purple tufts on wood-work and various substances a short distance below low-water mark in warm, sheltered waters. The lower branches are rigid and widely spreading, but the tips are byssoid and collapse on being removed from the water. When mounted on paper small specimens have a slight resemblance to *P. Olneyi*, but the species is coarser, and the siphons are six instead of four in number.

P. PARASITICA, Grev.; Phyc. Brit., Pl. 147.

Fronds dark brownish red, one to three inches high, filaments compressed, decompound-pinnate, branches alternate, distichous, 2–3 pinnate, ultimate divisions erecto-patent, subulate, acute, internodes about as long as broad, siphons 8–9, corticationes wanting; cystocarps ovate, on short stalks.

Providence, R. I., *Harvey;* Europe; California.

A small species, said to have been collected by Mr. Hooper on the authority of Harvey. It differs from our other species in the compressed frond and uniformly distichous arrangement of the branches. In aspect it looks more like a fine *Ptilota* than a *Polysiphonia*. In drying it does not adhere well to paper. In California the species is rather common, especially the large variety *dendroidea*.

P. ATRORUBESCENS; Grev.; Phyc. Brit., Pl. 172.

Fronds tufted, dark red, two to twelve inches long, filaments setaceous, rather rigid, branches long, erect, alternately decompound, with scattered, simple or virgately tufted branchlets, which taper at the base and apex, siphons usually 12, spirally twisted, articulations generally 2–3 times as long as broad; antheridia oval, terminal; cystocarps broadly ovate, sessile.

In deep water and washed ashore.

Gloucester, *Mrs. Davis;* Gay Head, Mass., *W. G. F.;* Fisher's Island, *Prof. Eaton;* Orient, L. I., *Miss Booth;* Noank, *W. G. F.;* Little Compton, R. I., and Long Branch, N. J., *Harvey;* Europe.

One of our less common species, recognized by the number of siphons, which are usually spirally twisted, and by the long branches, which bear small branchlets that taper at both extremities. Late in the season one finds denuded, rigid specimens, which bear little resemblance to the form found early in the season. It does not adhere well to paper in drying, and becomes quite black in the herbarium.

P. NIGRESCENS, Grev.

Fronds dark brown, three to twelve inches long, rigid below, becoming flaccid and much divided above, branches alternate, decompound-pinnate, ultimate branches subulate, siphons 12–16, articulations about $1\frac{1}{2}$–3 times as long as broad; antheridia lanceolate, mucronate; cystocarps ovate, subsessile.

Var. FUCOIDES, Ag.; Phyc. Brit., Pl. 277.

Fronds robust and naked below, upper branches pectinate or corymbose, articulations but slightly longer than broad.

Var. AFFINIS, Ag.; Phyc. Brit., Pl. 303.

Fronds elongated, diffusely branching, branches distant, undivided below, densely pinnate at the tip, articulations two or three times as long as broad.

In tide-pools and below low-water mark on stones and algæ.

Common along the whole coast.

One of our commonest and least beautiful species, which, although very variable, is generally easily recognized. In the Nereis, Harvey describes seven forms found on our eastern coast. Practically, the species as found with us is recognized under two principal forms. The first is rather robust, and has branches which are more or less pectinate or corymbose, and in the extreme forms, as var. *Durkeei*, Harv., l. c., Pl. 17 *c*, they are compressed, and the pinnæ are distichous and abbreviated. The second form of the species is represented by the *P. affinis* of the Phycologia Britannica, in which the main branches are much elongated and more delicate than in var. *fucoides*, and the ultimate divisions are arranged in pyramidal tufts. Between the two types described occur innumerable forms which hardly require a further description.

P. FASTIGIATA, Grev.; Phyc. Brit., Pl. 299.

Fronds dark brown, forming globose tufts one to three inches in diameter, filaments rigid, of nearly the same diameter throughout, repeatedly dichotomous, fastigiate, apices subulate, spreading, occasionally forcipate, siphons averaging about 20, articulations decidedly broader than long; antheridia oval, in dense terminal tufts; cystocarps ovate, taking the place of a terminal dichotomy.

On *Ascophyllum nodosum*.

Common from New York northward; Europe.

A very common species, at once recognized by its form and place of growth. It forms tufts on *Fucus* (*Ascophyllum*) *nodosus* and, according to Harvey, on *F. vesiculosus*. Its color is so dark that one at first sight would hardly suppose it to be one of the *Florideæ*. The filaments are rigid, and the plant does not collapse in the least when removed from the water, nor does it adhere to paper in drying. The antheridia are very abundant early in the season. The species, like most of the genus found on our coast, is diœcious, but occasionally one finds both sexes on the same individual. In this connection, it would be well to inquire if there is not a proterandrous condition among the *Florideæ*, as in the higher plants. It has seemed to us that such a condition may exist in *P. variegata*, and possibly in the present species. *P. fastigiata* is said to have been collected in California, but the locality is doubtful. It has been found also in Australia and New Zealand.

BOSTRYCHIA, Mont.

(From *βοστρυχιον*, a small curl.)

Fronds dark purple, compressed or filiform, distichously or irregularly branching, composed of several (4–11) cells (siphons) arranged around a central filament, the siphons either naked or corticated with subcubical cells, apices usually monosiphonous; tetraspores tripartite,

in a double row in terminal fusiform branches (stichidia); cystocarps terminal on the branches, ovate, with a distinct carpostome, spores pyriform, attached to short filaments which are given off from a basal placenta.

A genus of about twenty species, characterized by their lurid purple color and by growing in places where the water is not very salt, some species, it is said, even growing in fresh water. They inhabit principally the tropics. The genus is intermediate between *Polysiphonia* and *Dasya*, and some species have been previously referred to *Rhodomela*. The tetraspores are in stichidia, as in *Dasya*, but the cystocarpic spores seem to us more nearly like those of *Polysiphonia*. The frond is originally monosiphonous, and soon becomes polysiphonous, the number of siphons not being as constant as in *Polysiphonia*. The corticating cells, when present, are regularly arranged in transverse bands. The development of the frond has been studied in detail by Dr. Ambronn in *B. scorpioides*.

B. RIVULARIS, Harv., Ner. Am. Bor., Part II, Pl. 14 *d*.

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 54.

Fronds an inch high, capillary, rising from a procumbent base, branches flexuous, bipinnate, pinnæ distichous, alternate, patent, loosely pinnulate, pinnules subulate, section of main branches showing about seven siphons; tetraspores cruciate, in two rows in oblong stichidia below the tips; cystocarps ovate, terminal on the shortened, naked, lower pinnæ.

On submerged logs in patches.

Hell Gate, N. Y., *Harvey;* Fort Lee, N. Y., *Mr. Averill;* College Point, Astoria, *C. H. Peck;* common southward; Australia.

A common species from Charleston, S. C., southward, but only occasionally found with us. The only certain localities are near New York City, and it is extremely doubtful whether it was ever found in the arctic waters of the Isle of Shoals, where it was reported by Captain Pike. The species is small and rather insignificant, but is easily recognized by its polysiphonous structure and ramification. There are no corticatations, and the species belongs to the subgenus *Stictosiphonia*.

DASYA, Ag.

(From δασυς, hairy.)

Fronds bright red, filiform or compressed, distichously or irregularly branching, composed of a monosiphonous axis surrounded by several (4–12) siphons, often corticated with irregularly shaped cells, clothed in the upper part or throughout with colored, monosiphonous, dichotomous branchlets; antheridia in siliculose tufts on the branchlets; tetraspores tripartite, borne in regular rows in lanceolate or ovate-lanceolate enlargements of the branchlets; cystocarps ovate, acuminate, sessile or pedicellate, spores terminal on branching filaments arising from a basal placenta.

A large and beautiful genus, including about seventy species, of which the greater part

are tropical, Australia being especially rich in species. The genus is divided into a number of subgenera, and is connected by *Bostrychia* and *Tænioma* with *Polysiphonia*. The tetraspores are in stichidia borne on the hair-like branchlets, while in *Bostrychia* they are in the polysiphonous branches, and in *Tænioma* the stichidia are formed from the flattened and scarcely altered branches. The cystocarps are borne on short lateral branches, which are usually slightly prolonged beyond the base of the cystocarp. The placenta of *Dasya* differs somewhat from that of *Polysiphonia* and our other genera of *Rhodomeleæ*. The spores are pyriform, but are borne on rather long branching filaments which surround the carpogenic cell at the base of the conceptacle, and which rise high up in its interior instead of being nearly sessile around the carpogenic cell, as in *Polysiphonia*. The development of the cystocarp has been studied in detail by Janczewski in *D. coccinea*. The fronds are either filamentous or more or less flattened, and, as in the case with most of the suborder, are formed from a monosiphonous axis, from the cells of which whorls of filaments are given off, which in the older parts of the frond become parallel to the axis and replace the siphons of *Polysiphonia*. In most of the genus there are also secondary siphons and corticating cells, and either at the tip or throughout the frond tufts of delicate, dichotomous, monosiphonous branchlets, which are colored and not hyaline, as in the hairs of some other genera.

D. ELEGANS, Ag., Sp. Alg. (*Rhodonema elegans*, Martens.—*Dasya pedicellata*, Ag., Syst.; Bailey, in Am. Journ. Sci., Vol. III, p. 84.)—*Chenille*. **Pl. XV, Fig. 1.**

EXS.—Alg. Am. Bor., Farlow, Anderson & Eaton, No. 51.

Fronds dicœcious, villous, lake-red, six inches to three feet long, cylindrical, attached by a small disk, alternately 1–3 pinnate, with a percurrent axis, densely clothed throughout with tufts of purple, capillary, monosiphonous, dichotomous branchlets, sections of branches showing five cells around the axial cell; antheridia densely covering the lower cells of one of the divisions of the branchlets; tetraspores in two or three rows in linear-lanceolate or ovate pointed stichidia on the branchlets; cystocarps sessile on very short branches (pedicels) which are borne on the main branches.

On *Zostera*, wharves, &c., below low-water mark.

Common from Cape Cod southward; Adriatic Sea.

A beautiful species, known to lady collectors by the name of *chenille*, at once recognized by its long, cylindrical, branching fronds, densely fringed with fine lake-colored filaments. It is found throughout the year. In drying it adheres closely to paper. The antheridia are much like those of *Polysiphonia variegata*, but are longer. The species extends to the West Indies, but appears to be more common in Long Island Sound than elsewhere. There is in the collection of the Peabody Academy of Salem a very large specimen, said to have been collected at Ipswich Beach, Mass., but the locality must be regarded as doubtful. At any rate, the species is quite unknown elsewhere north of Cape Cod.

SUBORDER CORALLINEÆ, Decaisne.

Fronds rose-colored or purple, calcareous, horizontally expanded or erect and branching, crustaceous, foliaceous, or filiform, continuous or

articulated; antheridia, carpospores, and tetraspores borne in distinct cavities (conceptacles), which are either external or immersed in the fronds; antherozoids spherical, attenuated at one end, or provided with two short projections borne on short filaments at the base of the male conceptacles; carpospores pyriform, terminating short filaments which surround a tuft of paraphyses at the base of the female conceptacles; tetraspores zonate, occasionally binate.

The present order includes all the calcareous *Florideæ* except a comparatively few species which belong to the *Nemalieæ* and *Squamarieæ*. Although classed by the earlier writers with the corals rather than plants, the species of *Corallineæ* are now placed at the head of the *Florideæ*, in consequence of their highly differentiated organs of fructification. Our knowledge of the fructification of the *Corallineæ* is derived principally from the Études Phycologiques of Thuret and Bornet and the Recherches Anatomiques sur les Melobésiées of Rosanoff. Thuret and Bornet describe three different forms of conceptacle, containing, respectively, the antheridia, the carpospores, and the tetraspores, the last only being mentioned by Harvey in the Nereis. The tetraspores, which are much more common than the carpospores, are usually zonate, although occasionally binate, and from the fact that they are borne in distinct conceptacles, which is not the case with the other *Florideæ*, it had erroneously been considered that the carpospores of the *Corallineæ* were four-parted. The cystocarpic spores, or carpospores, are always pyriform and undivided, and accompanied by paraphyses. The number of trichogynes is large, and they project in a tuft at the orifice of the conceptacle at the time of fertilization. The antherozoids differ from those of the other *Florideæ* in having appendages.

The *Corallineæ* abound in the tropics, and but few representatives are found in northern seas. Our own coast is especially poor in species. The study of the development of the plants of this order is difficult, owing to the calcareous deposit, and soaking in acid injures the more delicate parts. The species are nearly all fragile when dried, and it is not easy to preserve herbarium specimens in good condition. The suborder may be divided into two tribes. The *Corallineæ* proper have articulated fronds, which rise vertically from the substratum, as is seen in our common Coralline. The *Melobesieæ* are not articulated, but form irregular horizontal crusts, which sometimes rise in irregular erect branches.

Fronds erect, filiform, articulated ..... *Corallina.*
Fronds horizontally expanded or vertical and inarticulate.
Fronds horizontal ..... *Melobesia.*
Fronds rising in irregular protuberances from a horizontal base, *Lithothamnion.*

CORALLINA, Lam.x.

(From κοραλλιον, a coral.)

Monœcious or diœcious, fronds arising either from a calcareous disk or from interlaced filaments, erect, terete or compressed, articulated, branched, branches opposite, pinnate; conceptacles terminal, naked or occasionally with two horn-like appendages.

A genus comprising about thirty to thirty-five species, mostly tropical, *C. officinalis, C. squamata,* and a few others extending high northward. The fronds of *Corallina* are formed of a bundle of dichotomous parallel filaments, whose external branches grow

obliquely outwards to form the cortical layer. The increase in the length of the frond arises from the elongation of the central bundle of filaments. The whole plant is covered by a dense cuticle. The conceptacles are formed from the terminal cells of the filaments just mentioned, which cease elongating and lose their calcareous incrustation, the cuticle also falling away. The peripheral filaments, at the same time, continue to elongate and project beyond the central bundle of filaments, thus forming the wall of the conceptacle.

C. OFFICINALIS, L.; Phyc. Brit., Pl. 222.—*Common Coralline.*

Dicœcious, fronds two to six inches high, arising in dense tufts from a calcareous disk, decompound-pinnate, lower articulations cylindrical, twice as long as broad, upper articulations obconical or pyriform, slightly compressed, edges obtuse; conceptacles ovate, borne on the ends of the branches, or some of them hemispherical and sessile on the articulations.

Var. PROFUNDA, Farlow.

Fronds elongated, with few, irregular branches.

Common in tide-pools; the variety in deep water.

Europe; North Pacific?

The only species known on our coast, often lining the bottoms of pools, and when exposed to the sun becoming white and bleached. *C. squamata*, which is monœcious, and has a filamentous base, and whose upper articulations are compressed with sharp edges, especially on the upper side, is a common species of Northern Europe, and may be expected with us.

MELOBESIA, Aresch.

(Possibly from *μελιβοια* or *μηλοβοσις*, the daughter of *Oceanus.*)

Fronds calcareous, horizontally expanded, orbicular, becoming confluent and indefinite in outline, conceptacles external or immersed; antherozoids spherical, furnished with one or two short projections; tetraspores either two or four parted, borne sometimes in conceptacles having a single orifice, at other times in conceptacles having several orifices.

The limits of the three genera *Melobesia*, *Lithophyllum*, and *Lithothamnion* are not well defined. In *M. Thuretii*, Bornet, the plant consists merely of a few short filaments, which are buried in the substance of *Corallina squamata* and several species of *Jania*, upon whose surface the conceptacles of the *Melobesia* are alone visible. From this species, in which the frond may be said to be rudimentary, we pass through forms in which the frond is in the form of calcareous crusts or plates till we meet heavy, irregularly branching forms, which resemble corals much more than plants. In the present paper, *Melobesia*, including *Lithophyllum* of Rosanoff, comprehends all the smaller and thinner forms in which the frond does not rise in the form of irregular tubercles or branches, while in *Lithothamnion* are placed the branching and heavier species, referred by the older writers, as Linnæus, Ellis and Solander, Lamarck, and others, to *Millepora* or *Nullipora*, and by Kützing to *Spongites*. Our common species, *L. polymorphum*, which does not often branch, shows the insufficient basis on which the genera of this group rest. Although there is considerable diversity in the structure of the fronds, the organs of fructification, with some slight modifications of the antherozoids and tetraspores, are the same as in *Corallina* and *Jania*. The most detailed account of the

frond in the Melobesioid group is that given by Rosanoff in his work already referred to. According to Bornet, however, the cystocarpic fruit of the *Melobesiæ* escaped the observation of Rosanoff, and what the latter called cystocarps were only a form of the non-sexual or tetrasporic fruit. The tetraspores are found in two different forms—either in hemispherical conceptacles, which have a single central orifice of good size, at whose base the spores are borne around a central tuft of paraphyses, or else in truncated conceptacles, whose flattened upper surface is perforated with numerous orifices, beneath each one of which is a tetraspore, separated from its fellows by a large, colorless cell.

The fronds of the smaller species of *Melobesia*, as *M. Lejolisii* and *M. farinosa*, consist of two portions, the basal and the cortical. The former consists of a single layer of cells, which arise from the division of the spore into four cells and subsequent marginal growth. The cortical layer in the smaller species is composed of small cells cut off by oblique partitions from the upper part of the basal cells. In the larger species of *Melobesia*, more particularly those placed in the subgenus *Lithophyllum*, the cortical layer is much more marked, and the cells of which it is composed seem to be arranged in lines which are curved at the base, but are straight above and at right angles to the direction of growth. In some of the small species of *Melobesia* certain of the basal cells elongate and swell at the summit, so that when seen from above they look larger than the neighboring cells. Rosanoff applied to such cells the name of heterocysts, a word badly chosen, since the heterocysts in the *Nostochineæ*, where the term was first employed, cannot well be compared with the heterocysts in *Melobesia*. The conceptacles in all our species of *Melobesia* are external. The form generally found is that which contains the tetraspores. Our species all occur in Europe, and it is very probable that the remaining Northern European forms not yet recorded with us will be found on further search.

a. Species small, growing on plants, basal stratum well marked, cortical layer imperfectly developed.

M. LEJOLISII, Rosanoff. (*M. membranacea*, Aresch., in Agardh's Spec. Alg.; Harvey, Phyc. Brit., Pl. 347, in part.—*M. farinosa*, Kütz., Spec. Alg.; Le Jolis's Liste des Algues.—*M. Lejolisii*, Rosanoff, l. c., p. 62, Pl. 1, Figs. 1–12.)

Fronds thin and brittle, at first orbicular but soon densely confluent, forming scaly patches of indefinite extent; heterocysts wanting, basal cells squarish, cortical cells few and indistinct; tetrasporic conceptacles very numerous, approximate, flattened-convex, orifice ciliated; tetraspores four-parted; antheridia and cystocarps?

On leaves of *Zostera*.

Wood's Holl, Mass.; common from Nahant northward; Europe.

A species which is certainly common on eel-grass on the northern coast and probably equally abundant in Long Island Sound, although definite information on this point is wanting. This is the form which is found in American herbaria bearing the name usually of *M. farinosa* or *M. membranacea*. The orbicular character of the fronds soon disappears, as they are found in great numbers, and at an early stage become confluent. The conceptacles are so numerous that at times very little of the fronds themselves can be seen. The latter easily crumble and fall from the plant on which they are growing.

M. FARINOSA, Lamx. (*M. farinosa*, Aresch., in Agardh's Spec. Alg., non Le Jolis's Liste des Algues.—*M. farinosa* and *M. verrucata?* Harvey, in part.—*M. farinosa*, Lamx., in Rosanoff, l. c., p. 69, Pl. 2, Figs. 2–13.)

Fronds thin, orbicular, becoming confluent, distinctly zonate; heterocysts present, basal cells elongated-rectangular, cortical cells semicircular or triangular seen from above; tetrasporic conceptacles small, hemispherical, orifice not plainly ciliate; tetraspores four-parted; antheridia and cystocarps?

On *Fucus vesiculosus*.

Wood's Holl, Mass; in all parts of the world.

Although only one locality is mentioned, the species probably occurs throughout our limits. It is distinguished from the last by the shape of the conceptacles and the absence of a circle of cilia around the orifice. The fronds are larger and more frequently orbicular, although scarcely thicker than in *M. Lejolisii*. In both species the calcareous incrustation is somewhat farinaceous as compared with the following, in which the incrustation is smoother and solid. *M. membranacea*, Lam.x. related to *M. farinosa*, but destitute of heterocysts and having tetrasporic conceptacles with several orifices, is to be expected on algæ of our coast.

M. PUSTULATA, Lam.x. (*M. pustulata*, Phyc. Brit., Pl. 347 *d*; Rosanoff, l. c., Pl. 4, Figs. 2–8.)

Fronds rather thick, circular, becoming reniform or orbicular, indistinctly zoned; heterocysts wanting, basal cells elongated vertically, cortical cells squarish; conceptacles large, hemispherical, orifice naked; tetraspores four-parted.

Probably common on the larger algæ along the whole coast, but being undistinguishable from the next species when sterile, one cannot be sure of the species unless it is in fruit. The tetraspores of *M. pustulata* are zonately four-parted, while those of *M. macrocarpa* are merely two-parted at maturity. In both species the fronds are rather thick and solid and do not crumble, as in the two preceding species, and the orbicular shape is preserved for a longer time.

M. MACROCARPA, Rosanoff. (*M. macrocarpa*, l. c., p. 74, Pl. 4, Figs. 2–8 and 11–20.)

Fronds as in *M. pustulata*; tetraspores large, two-parted.

On *Chondrus*.

Gloucester, Mass.; Europe.

b. Species rather large, growing on stones and shells, cortical stratum well developed.

M. LENORMANDI, Aresch. (*Lithophyllum Lenormandi*, Rosanoff, l. c., p. 85, Pl. V, Figs. 16, 17; Pl. VI, Figs. 1, 2, 3, 5.)

Fronds saxicolous, closely adherent to the substratum, suborbicular, becoming squamulose-imbricate, slightly zonate, margin crenate, lobed; tetraspores four-parted, in compressed, hemispherical conceptacles, with numerous orifices; antheridia and cystocarps?

On stones.

Gloucester, Mass.; Europe.

Apparently common in many places, but fruiting specimens were only collected at

Gloucester. The fronds form rose-colored crusts of considerable extent, and are so closely adherent that they can scarcely be removed. The tetrasporic conceptacles are large, but very much flattened.

LITHOTHAMNION, Phil.

(From λιθος, a stone, and θ μνιον, a bush.)

Fronds calcareous, thick, at first horizontally expanded, but afterwards producing erect knobs or coralloid branches; otherwise as in *Melobesia*.

A genus comprising probably not more than twenty or twenty-five good species, most of which are tropical. The larger and more solid forms inhabit deep water. In *Lithothamnion* the cortical portion is markedly developed, and it not rarely happens that new lobes are produced which overlap the older ones and form an imperforate layer over the older conceptacles, which are thus occluded before the spores are ripe. In such cases sections show conceptacles which are apparently buried in the central part of the frond.

L. POLYMORPHUM, (L.) Aresch. (*Millepora polymorpha*, L.; Sp. Alg.—*Millepora* (*Nullipora*) *informis*, Lamarck.—*Melobesia polymorpha*, Harvey, Phyc. Brit., Pl. 345.)

Fronds thick and stony, purplish, becoming whitish, forming incrustations of indefinite extent and occasionally rising in thick clumsy lobes, punctate throughout with the very numerous, small, immersed conceptacles; antherozoids spherical, with an appendage at one end (Bornet); tetraspores two-parted; cystocarps?

On rocks and stones in deep pools and below low-water mark.

Common from Nahant northward.

Not known with certainty south of Cape Cod, but very common northward, where it forms stony, purplish incrustations on rocks. As usually seen, it adheres closely to the rocks, covering patches of indefinite extent, and would be mistaken for a species of *Melobesia*. It is so hard and adherent that it is mistaken by persons on the shore for a part of the rock itself. Although the determination of the present species admits scarcely a doubt, the form usually found with us is smoother and less lobed than European specimens of the same species. In the description given above the tetraspores are said to be two-parted. This is true of all the American specimens examined, but it may be that what we have seen were immature spores, which, when ripe, are four-parted.

L. FASCICULATUM, (Lamarck) Aresch. (*Millepora fasciculata*, Lamarck.—*Melobesia fasciculata*, Harv., Phyc. Brit., Pl. 74.)

Fronds purple, stony, attached, afterwards becoming free, very irregular in outline, densely branching, branches fastigiate, subcylindrical, apices generally depressed; tetrasporic conceptacles densely covering the branches, flattened, hemispherical; tetraspores two-parted.

On stones or in free globose tufts at low-water mark and in deep water.

Eastport, Maine; Europe.

Rather common at Eastport, where it is often dredged. It is also found at low-water mark during the spring tides, especially on Clark's Ledge. Small forms of what may be the same species are occasionally washed ashore after storms as far south as Nahant. The species is at once distinguished from all our other forms by the very numerous, short, stout, cylindrical branches. The conceptacles are external and contain two-parted spores, which may possibly be later four-parted, although in the specimens we have examined they seemed to be quite mature. The conceptacles, as far as could be made out, had no distinct orifice, and were very much flattened externally.

ADDENDA.

To follow *Stilophora*, page 89:

ARTHROCLADIA, Duby.

Fronds olive-brown, filiform, branching, composed of a large central filament formed of cylindrical cells and a series of polygonal cortical cells, which become smaller towards the surface; plurilocular sporangia moniliform, borne on branching monosiphonous filaments which form tufts on the branches.

A small genus, consisting of a single species, which has been divided by Kützing into three, characterized by the tufts of monosiphonous filaments which bear the sporangia, and which are arranged in whorls, giving the fronds a nodose appearance. Harvey and Agardh place the genus in the *Sporochnaceæ*, while Le Jolis places it in a special suborder of *Phæosporeæ*.

A. VILLOSA, Doby. (*Sporochnus villosus*, Ag., Sp.—*Elaionema villosum*, Berk.)

Fronds six inches to three feet long, delicately filiform, with a percurrent axis and usually opposite, widely spreading, 1–2 oppositely pinnate branches; fructiferous filaments byssoid, in dense penicillate tufts which form irregular whorls; plurilocular sporangia moniliform, composed of numerous cells, about 15–20 in a row, generally secund on the branches of fructiferous filament; unilocular sporangia?

Washed ashore at Falmouth Heights, Mass., *Mr. F. T. Collins;* Cape Fear.

A rare species, only known on the New England coast from the specimens collected by Mr. Collins, which were rather smaller than European specimens. The species bears a more or less considerable resemblance to *Desmarestia viridis*, but the penicillate tufts are more regularly arranged in whorls, and bear the sporangia, which is not the case in the genus *Desmarestia*.

To follow *Lyngbya*, page 34:

SYMPLOCA, Kütz.

Filaments as in *Lyngbya*, but adhering to one another in fascicles.

Scarcely distinct from *Lyngbya* except in the existence of a mass of jelly, by means of which the filaments adhere to one another in meshes. In habit the species of the

present genus resemble the species of *Calothrix* rather than *Lyngbya*, but the filaments are not prolonged in a hair-like extremity as in the first-named genus.

S. FASCICULATA, Kütz.

Filaments a quarter to half an inch high, united in tooth-like masses from a gelatinous base, .009–12^{mm} broad, sheaths thin, cells broader than long.

On rocks between tide-marks.

Newport, R. I.; Europe.

Table of comparative distribution of New England species.

	Number of New England genera.	Number of New England species.	Number of species north of Cape Cod.	Number of species south of Cape Cod.	Common to Northern Europe.	Common to Mediterranean and Adriatic.	Common to Pacific coast of United States.	Arctic.	Peculiar to New England.	Peculiar to coast north of Cape Cod.	Peculiar to coast south of Cape Cod.
Cryptophyceæ	17	32	24	24	26	20				1	2
Chroococcaceæ	5	6	5	4	5	3				1	
Nostochineæ	12	26	19	20	21	17					2
Zoosporeæ	36	88	71	65	77	34	15	33	3	2	3
Chlorosporeæ	7	36	28	27	30	15	7	6	2	1	1
Bryopsideæ	2	2	1	2	2	2	1				
Botrydieæ	1	1	1		1						
Phæosporeæ	26	49	41	36	44	17	7	27	1	1	2
Oosporeæ	4	11	7	7	11	2	2	7			
Vaucherieæ	1	2	1	2	2	1					
Fucaceæ	3	9	6	5	9	1	2	7			
Florideæ	50	99	69	87	71	48	14	34	7	1	12
Total	107	230	171	183	185	104	31	74	10	4	17

Besides the genera and species, enumerated above, there are 4 genera and 10 species described, but not considered to be sufficiently well known. If these are counted, the total number of genera is 111, and 240 species. The comparison with Mediterranean and Adriatic species is imperfect, because there is no complete list of the algæ of those seas, and our Pacific coast has not as yet been sufficiently well explored to make it possible to give approximately the number of our species found there. In the table the species marked peculiar to New England are those which extend along our whole coast, those of more limited range being kept distinct. The table shows plainly the general fact that the total number of species increases as one goes southward, and that the increase is mainly due to the relative increase in number of the *Florideæ*. It also shows the close resemblance of our marine flora to that of Northern Europe, and although the number of species common to Arctic waters is not large, as far as the numbers themselves are concerned, yet, if we consider the absolutely small total of species found in Arctic regions, the number of species common to our coast is relatively very large. The general poverty of our flora may be seen in comparing the number of genera and species found in New England with the number of species and genera in Harvey's Phycologia Britannica and Le Jolis's Liste des Algues Marines de Cherbourg. The number given by Harvey is 110 genera and 388 species; that given by Le Jolis is 137 genera and 316 species. The Phycologia was published in 1846–'51, and Le Jolis's Liste in 1863. In both works, more especially in the Phycologia, a number of species which we have in the present article united were kept distinct; but as additional species have been discovered since the appearance of the two works above named, the total number of species is not probably much less, or may even be greater, than the figures given by Harvey and Le Jolis. In Phyceæ Scandinavicæ Marinæ, published in 1850, Areschoug describes 68 genera and 175 species. Since that date numerous additions have been made to the Scandinavian marine flora, and the total number of species is probably not far from that of the species of our own coast.

ARTIFICIAL KEY TO GENERA.

NOTE.—The following key is intended to enable persons who are not at all acquainted with our sea-weeds to ascertain with a partial degree of accuracy the genera to which specimens which they may collect are to be referred. For this purpose the characters used are, as far as possible, those which can be seen by the naked eye, but, as in many cases, the generic distinctions absolutely depend on microscopic characters, one must not expect to be able to recognize all of our forms without making a more or less careful microscopical examination, especially in the case of the *Cryptophyceæ* and *Phæosporeæ*. It should of course be understood that the key is entirely artificial, and does not represent the true botanical relations of our genera; since in many cases the characters refer only to species of our Atlantic coast and would mislead a student having a specimen from other waters.

1. Color bluish or purplish green,* algæ of small size, usually more or less gelatinous ..... (*Crytophyceæ*) 5
2. Color grass green 18
3. Color from yellowish brown to olive green or nearly black 26
4. Color red or reddish purple, rarely blackish, in fading becoming at times greenish ..... (*Florideæ*) 48
5. Cells arranged in filaments 9
   Cells in colonies, but not forming filaments 6
6. Cells grouped in twos or some multiple of two 7
   Cells solitary, not adherent in twos 8
7. Groups free, not united with one another by a gelatinous envelope. *Chroococcus.*
   Groups united by a gelatinous substance so as to form irregularly-shaped colonies ..... *Glœocapsa.*
   Groups united by a gelatinous substance so as to form colonies of a dendritic shape ..... *Entophysalis.*
8. Cells imbedded in a gelatinous substance, forming colonies of indefinite shape ..... *Polycystis.*
   Cells imbedded in a gelatinous mass, which forms at first ovoidal and afterwards net-shaped colonies ..... *Clathrocystis.*
9. Filaments ending in a hyaline hair 16
   Filaments not ending in a hair 10
10. Filaments provided with heterocysts † 11
    Filaments destitute of heterocysts 12
11. Filaments with a thin gelatinous sheath, spores not adjacent to the heterocysts ..... *Nodularia.*

* Our marine species of *Clathrocystis* and the genus *Beggiatoa* are exceptions. The former is pinkish, and covers the mud and algæ between tide-marks with a very fine gelatinous film. The species of *Beggiatoa* are whitish to the naked eye, and form very delicate films over decaying algæ.

† Vid. page 11.

Filaments without a gelatinous sheath, spores next to the heterocysts ..... *Sphærozyga.*
12. Filaments with a gelatinous sheath 15
Filaments without a gelatinous sheath 13
13. Filaments spirally twisted ..... *Spirulina.*
Filaments not spirally twisted 14
14. Cells bluish or purplish green ..... *Oscillaria.*
Cells colorless or containing opaque granules ..... *Beggiatoa.*
15. Filaments free ..... *Lyngbya.*
Filaments adherent in meshes ..... *Symploca.*
Filaments united in bundles and surrounded by a general gelatinous sheath ..... *Microcoleus.*
16. Filaments free ..... *Calothrix.*
Filaments imbedded in a dense mass of jelly 17
17. Filaments nearly parallel, fronds forming a thin expansion... *Isactis.*
Filaments diverging from the base of the hemispherical or somewhat flattened fronds ..... *Rivularia.*
Filaments simple at the surface and forking in the interior of the vesicular fronds ..... *Hormactis.*

18. Fronds unicellular 19
Fronds multicellular 20
19. Cells small, ovoidal, prolonged into a long, root-like process at the base ..... *Codiolum.*
Cells large, filamentous, pinnately branching ..... *Bryopsis.*
Cells large, with few, erect, alternate branches, some of which swell at the end and bear numerous spores ..... *Derbesia.*
Cells very long, cylindrical, with irregular or subdichotomous branches, spores large, solitary, in special lateral or terminal cells. *Vaucheria.*
20. Fronds membranaceous 21
Fronds filamentous 22
21. Fronds formed of a single layer of cells ..... *Monostroma.*
Fronds composed of two layers of cells, which in some cases separate so as to form tubular fronds ..... *Ulva.*
22. Filaments simple 23
Filaments branching 24
23. Small algæ, filaments soft and flaccid ..... *Ulothrix.*
Rather coarse algæ, filaments more or less rigid, often twisted together ..... *Chætomorpha.*
24. Some of the cells bearing long, hyaline hairs ..... *Bulbocoleon.*
Hairs wanting 25
25 Branches small and root-like ..... *Rhizoclonium.*
Branches distinct ..... *Cladophora.*
26. Fronds irregularly globose, hollow, gelatinous ..... *Leathesia.*
Fronds forming crusts or expanded pellicles 27

Fronds small, tufted, composed of a dense basal portion and an outer portion composed of free filaments 28
Fronds tubular, unbranched 29
Fronds filamentous 31
Fronds membranaceous, expanded 41

27. Fronds densely parenchymatous throughout, fruit in external spots ..... *Ralfsia.*
Fronds minute, thin, formed of a basal horizontal layer of cells and short vertical filaments, between which the sporangia are borne. *Myrionema.*

28. Free filaments all alike ..... *Myriactis.**
Free filaments of two kinds, one short and the other exserted. *Elochistea.*

29. Fronds simple, hollow throughout, substance thin 30
Fronds simple, cylindrical, somewhat cartilaginous, with numerous diaphragms ..... *Chorda.*
Fronds branching, substance thin, sporangia large, arranged in transverse lines ..... *Striaria.*

30. Sporangia densely covering the surface ..... *Scytosiphon.*
Sporangia external in scattered spots ..... *Asperococcus.*

31. Fronds capillary, branching, formed of single rows of cells (monosiphonous) ..... *Ectocarpus.*
Fronds cylindrical, solid or occasionally becoming partially hollow with age 32

32. Fronds slimy, composed of an axial layer of elongated filaments and a distinct cortical layer of short, horizontal filaments 33
Fronds composed of elongated internal cells, which become smaller and polygonal at the surface 35
Fronds, at least in the younger portions, formed of cells of nearly uniform length, arranged in transverse bands, without any proper cortical layer 38

33. Fronds tough and dense ..... *Chordaria.*
Fronds soft and flaccid 34

34. Outer cells of cortex producing plurilocular sporangia .. *Castagnea.*
Outer cells of cortex not producing plurilocular sporangia. *Mesogloia.*

35. Fronds traversed by a central filament formed of large cylindrical cells placed end to end 36
Fronds destitute of distinct axile filament 37

36. Sporangia in branching, monosiphonous filaments, which form tufted whorls on the branches ..... *Arthrocladia.*
Sporangia inconspicuous, formed from the cortical cells. *Desmarestia.*

37. Sporangia globose, prominent in the cortical layer .... *Dictyosiphon.*

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* When reference is made in *Myriactis* and the following genera of *Phæosporeæ* to free external filaments, it should be understood that only filaments whose cells contain coloring matter are meant, and that no account is to be taken of the numerous hyaline hairs with which most of the species of *Phæosporeæ* are covered at certain seasons.

Sporangia at the base of filaments, which form scattered external tufts ..... *Stilophora.*

38. Fronds minute, ending in a hyaline hair, monosiphonous below, densely beset above with very short branches, between which are the sporangia ..... *Myriotrichia.*

Fronds ending in a large, single cell, the cells of the lower part giving off descending filaments, which become interwoven and form a false cortex 39

39. Rhizoidal filaments few and limited to the base of the plant, branching, irregularly pinnate ..... *Sphacelaria.*

Rhizoidal filaments numerous 40

40. Branches distichously pinnate ..... *Chætopteris.*

Branches whorled ..... *Cladostephus.*

41. Fronds simple or occasionally proliferous 42

Fronds branching 47

42. Midrib present 43

Midrib wanting 44

43. Fronds stipitate, perforated with numerous holes ..... *Agarum.*

Fronds entire, with a few separate leaflets on the stipe below the lamina ..... *Alaria.*

44. Fronds thin, subsessile 45

Fronds thick and coriaceous, distinctly stipitate 46

45. Sporangia densely covering the surface of frond ..... *Phyllitis.*

Sporangia external in scattered spots ..... *Punctaria.*

46. Cryptostomata present, fronds attached by short, nearly simple rhizoids ..... *Saccorhiza.*

Cryptostomata wanting, fronds attached by prominent, branching rhizoids ..... *Laminaria.*

47. Fronds without distinction of midrib and lamina, fruit borne on short lateral branches ..... *Ascophyllum.*

Blade distinct from the midrib, bladders borne in the laminæ, fruit terminal ..... *Fucus.*

Bladders and fruit borne on special stalks ..... *Sargassum.*

48. Fronds calcareous 49

Fronds not calcareous 50

49. Fronds erect, filiform, articulated ..... *Corallina.*

Fronds thin, horizontally expanded ..... *Melobesia.*

Fronds thick, horizontally expanded, but rising at intervals in irregular protuberances ..... *Lithothamnion.*

50. Fronds horizontally expanded, crustaceous or membranaceous .. 51

Fronds erect or umbilicate 52

51. Fronds parenchymatous, spores in external warts ..... *Peyssonnelia.*

Fronds parenchymatous, spores in cavities sunk in the frond ..... *Hildenbrandtia.*

Fronds parenchymatous below, but above formed of loosely united filaments, tetraspores formed in the filaments ..... *Petrocelis.*

52. Fronds tubular 53
Fronds filamentous 54
Fronds membranaceous 75

53. Fronds cartilaginous, hollow throughout, rigid, proliferous, tetraspores cruciate ..... *Halosaccion.*
Fronds slender, much contracted at the joints, but without diaphragms, tetraspores tripartite in depressed cavities .. *Lomentaria.*
Fronds slender, nodose, with diaphragms at the nodes, tetraspores tripartite in the cortical layer ..... *Champia.*

54. Fronds monosiphonous, without proper cortex 55
Fronds with distinct axial and cortical layers 62

55. Fronds monosiphonous throughout 56
Fronds at first monosiphonous, becoming polysiphonous above, spores formed by divisions of any of the cells, filaments simple, gelatinous, dark purple ..... *Bangia.*
Fronds monosiphonous above, but below with a false cortex formed by descending filaments given off from the cells 60
Fronds formed of large cells placed end to end, with bands of smaller cells at the nodes, in some cases the nodal cells extending in a thin layer over the internodal cells 61

56. Spores (as far as known) formed directly from the contents of any of the cells 57
Spores on short pedicels, distinct, undivided ..... *Trentepohlia* (?).
Tetraspores and cystocarps present 58

57. Filaments simple, forming a fine web over other algæ. *Erythrotrichia.*
Filaments dichotomously branching, minutely tufted .. *Goniotrichum.*

58. Fronds formed of prostrate filaments, from which arise erect pinnate filaments, cystocarps terminal, involucrate, spores irregularly grouped, not surrounded by a common gelatinous envelope when mature ..... *Spermathamnion.*
Cystocarps terminal or lateral, spores irregularly grouped at maturity, covered by a general gelatinous envelope 59

59. Fronds dichotomous, formed of delicate vesicular cells, tetraspores in whorls at the joints, involucrate ..... *Griffithsia.*
Fronds dichotomous or pinnate, tetraspores scattered on the branches, solitary or aggregated, cystocarps lateral, usually binate ..... *Callithamnion*, in part.
Fronds with a monosiphonous axis, nearly concealed by the densely whorled branches, cystocarps terminal on short branches, tetraspores in whorls one above another on special branches .. *Halurus.*

60. Fronds capillary or bushy, densely branching, corticated confined to the larger branches, and evidently formed of vein-like descending filaments ..... *Callithamnion*, in part.

Fronds compressed, ancipital, branches pectinate-pinnate, covered everywhere, except at the tips, by polygonal, arealated cells. *Ptilota.*

61. Fronds dichotomous, tips usually incurved ..... *Ceramium.*
Fronds pinnate, main branches corticated throughout with cells arranged in transverse bands, secondary branches corticated only at the nodes ..... *Spyridia.*
62. Fronds nearly black, substance dense 63
Fronds rose-colored or purple, gelatinous or rather succulent, sometimes capillary 64
63. Fronds dichotomous, cylindrical, cartilaginous, spores borne in external flesh-colored warts ..... *Polyides.*
Fronds filiform, rigid, wiry, irregularly branching, forming dense, intricate bunches ..... *Ahnfeldtia.*
Fronds small, compressed, pinnate, forming small turfs, spores borne on an axile placenta in the enlarged terminal branches .. *Gelidium.*
64. Cystocarps immersed in the fronds 65
Cystocarps external, ovate or urceolate 70
65. Fronds gelatinous, composed internally of a dense mass of slender longitudinal filaments, which give off short, corymbose, lateral branches, which form the cortex 66
Fronds succulent, consisting of an internal layer of slender longitudinal filaments and a cortex composed of roundish polygonal cells, which become smaller towards the surface 69
66. Spores arranged in regular radiating lines 67
Spores in an irregular mass 68
67. Cystocarps naked, cortical filaments free, often ending in hairs. *Nemalion.*
Cystocarps surrounded by a delicate membranous sack, cortical filaments ending in large hyaline cells, which are adherent to one another ..... *Scinaia.*
68. Fronds dichotomous, subcompressed, central filaments fine and numerous ..... *Nemastoma.*
Fronds filiform, pinnate, central filaments few, rather large. *Gloiosiphonia.*
69. Spores arranged in groups around a central placenta .... *Rhabdonia.*
Spores grouped in several irregular masses in the interior of the fronds ..... *Cystoclonium.*
70. Fronds traversed by a distinct central filament or siphon 72
Fronds without a distinct central filament 71
71. Fronds succulent, brownish purple, cylindrical, beset with subulate branchlets, apices generally hooked, tetraspores zonate .. *Hypnea.*
Fronds red, somewhat rigid, filiform, tetraspores cruciate. *Cordylecladia.*
72. Branches much contracted at base ..... *Chondriopsis.*
Branches not contracted at base 73

73. Fronds long, cylindrical, densely clothed with lake-red hairs.. *Dasya.*
Fronds purple or dark red, occasionally blackish, superficial cells either throughout or at least in the young branches arranged in transverse bands 74
Fronds dark red, much branched, rather robust, superficial cells small, irregularly placed ..... *Rhodomela.*
74. Tetraspores borne in the younger branches ..... *Polysiphonia.*
Tetraspores borne in swollen, pod-like branches (stichidia). *Bostrychia.*
75. Fronds cartilaginous, dense, spores immersed in the substance of frond 76
Fronds delicate or somewhat coriaceous 79
Fronds gelatinous, livid purple, composed of a single layer of cells, spores in marginal bands or spots ..... *Porphyra.*
76. Fronds formed internally of numerous anastomosnig filaments which divide corymbosely at the surface 77
Fronds formed of roundish angular cells throughout 78
77. Fronds plane or slightly channelled ..... *Chondrus.*
Fronds beset with small papillæ, in which the spores are borne. *Gigartina.*
78. Fronds with a prominent stipe, which passes into a proliferous lamina, cystocarps external, globose ..... *Phyllophora.*
Fronds linear, regularly dichotomous, cystocarps immersed. *Gymnogongrus.*
79. Midrib present 80
Midrib wanting 82
80. Fronds rosy red, leaf-like 81
Fronds dark brownish purple, narrow, dentate, midrib scarcely distinct ..... *Odonthalia.*
81. Tetraspores in spots on the fronds, lateral veins usually present. *Delesseria.*
Lateral veins wanting, tetraspores in thickened portions of the fronds ..... *Grinnellia.*
82. Fronds narrow, much divided 84
Fronds palmately or dichotomously divided 83
83. Fronds deep red, broadly palmate, margins proliferous, tetraspores cruciate in patches ..... *Rhodymenia.*
Fronds dark red, margins ciliate, tetraspores zonate.. *Rhodophyllis.*
Fronds dark purple, deeply divided, tetraspores scattered, cruciate. *Gracilaria.*
84. Branches alternately secund in threes or fours, the lowest undivided and spine-like, the rest pinnate ..... *Plocamium.*
Fronds subflabellate, upper divisions divaricately toothed. *Euthora.*

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EXPLANATION OF PLATES.

PLATE I.

J. H. Blake and W. G. Farlow.

Fig. 1. *Glœocapsa crepidinum*, Thuret. 600 diam.
2. *Isactis plana*, Thuret. 600 diam.
3. *Sphærozyga Carmichaelii*, Harv.: *a*, heterocyst; *b*, *b*, spores. 600 diam.
4. *Lyngbya majuscula*, Harv. 400 diam.
5. *Oscillaria subuliformis*, Harv. 500 diam.
6. *Calothrix confervicola*, Ag.: *a*, *a*, hormogonia; *b*, *b*, heterocysts; *c*, cell of host-plant. 400 diam.

PLATE II.

J. H. Blake and W. G. Farlow.

Fig. 1. *Hormactis Quoyi*, (Ag.) Bornet: *a*, *a*, heterocysts. 600 diam.
2. *Rivularia atra*, Roth: *a*, *a*, heterocysts; the cross-lines represent the gelatinous matrix. 500 diam.
3. *Microcoleus chthonoplastes*, Thuret: *a*, free trichomata projecting beyond the ruptured sheath. 500 diam.
4. *Spirulina tenuissima*, Kütz. 900 diam.

PLATE III.

J. H. Blake and W. G. Farlow.

Fig. 1. *Ulva Lactuca*, (L.) Le Jolis: *a*, microzoospores which have escaped from marginal cells; *b*, cells in which zoospores are forming; *c*, cells from which zoospores have escaped. 500 diam.
2. *Rhizoclonium riparium*, Kütz. 20 diam.
3. *Cladophora lætevirens*, (Dillw.) Harv. 20 diam.

PLATE IV.

J. H. Blake and W. G. Farlow.

Fig. 1. *Bryopsis plumosa*, (Huds.) Ag.; portion of upper division of the unicellular frond. 10 diam.
2. *Vaucheria Thuretii*, Woronin: *a*, *a*, young antheridia; *a'*, antheridium which has discharged its antherozoids; *c*, *c*, oogonia with oospores. 100 diam.
3. *Phyllitis fascia*, Kütz; section of frond with plurilocular sporangia, *a*, covering the surface. 500 diam.
4. *Derbesia tenuissima*, (De Not.) Crouan: *a*, spores (zoosporangia?) nearly mature; *b*, *b'*, cross-partitions forming cell at base of sporangium. 100 diam.
5. *Punctaria plantaginea*, (Roth) Grev.; transverse section of frond: *a*, plurilocular sporangia with zoospores; *a'*, the same when old, after the zoospores have been discharged and the internal cell-walls obliterated.

PLATE V.

J. H. Blake and W. G. Farlow.

Fig. 1. *Leathesia difformis*, (L.) Aresch.; dissection showing a portion of cortical layer: *a*, *a*, unilocular sporangia; *b*, *b*, hairs. 400 diam.

2. *Chordaria flagelliformis*, Ag.; longitudinal section of outer part of frond showing cortical filaments with unilocular sporangia, *a*, and a few cells of internal layer. 500 diam.

3. *Asperococcus echinatus*, Grev.; transverse section of frond: *a*, unilocular sporangia; *b*, hairs. 150 diam.

4. *Stilophora rhizodes*, Ag.; longitudinal section of outer part of frond showing sorus with paraphyses and unilocular sporangia. 400 diam.

6. *Ralfsia verrucosa*, Aresch.; vertical section of frond with a sorus containing unilocular sporangia.

6. *Sphacelaria cirrhosa*, (Roth) Ag.; a portion of frond with propagulum. 200 diam.

PLATE VI.

J. H. Blake and W. G. Farlow.

Fig. 1. *Chorda filum*, L.; transverse section of portion of a frond showing paraphyses, *b*, and unilocular sporangia, *a*. 200 diam.

2. *Stilophora rhizodes*, Ag.; portion of sorus taken from Pl. V, Fig. 4, more highly magnified to show unilocular sporangia, *a*, *a'*, and paraphyses, *b*. 600 diam.

3. *Ectocarpus littoralis*, Lyngb., var. *robustus*, Farlow; plurilocular sporangia. 200 diam.

4. The same with unilocular sporangia.

5. *Myrionema Leclancherii*, (Chauv.) Harv.; vertical section showing plurilocular sporangia. 400 diam.

PLATE VII.

J. H. Blake and W. G. Farlow.

Fig. 1. *Castagnea virescens*, (Carm.) Thuret; unilocular sporangium and hair, *b*. 400 diam.

2. *Castagnea Zosteræ*, (Mohr.) Thuret; transverse section of outer portion of frond showing plurilocular sporangia, *a*, *a'*, and hair, *b*. 400 diam.

3. *Elachistea fucicola*, Fries; dissection of superficial part of frond, showing unilocular sporangia, *a*, *a'*, and colored exserted filaments, *b*. 300 diam.

PLATE VIII.

J. H. Blake and W. G. Farlow.

Fig. 1. *Fucus vesiculosus*, L.; fructifying tip of frond: *a*, air-bladder; *b*, conceptacles. Natural size.

2. *Laminaria longicruris*, De la Pyl.; section through fructiferous portion of frond showing unilocular sporangia, *a*, and paraphyses, *b*. 400 diam.

PLATE IX.

J. H. Blake and W. G. Farlow.

Fig. 1. *Fucus vesiculosus*, L.; section through a female conceptacle showing oospores and paraphyses. 200 diam.

2. The same; section through male conceptacle showing antheridia. 200 diam.

PLATE X.

J. H. Blake and W. G. Farlow.

Fig. 1. *Spyridia filamentosa*, Harv.; axis with branch bearing antheridia, *a*. 200 diam.
2. *Callithamnion corymbosum*, Lyngb.; branch with antheridia. 200 diam.
3. *Trentepohlia virgatula*, Harv.; showing the undivided spores, *a*, *a*. 200 diam.
4. *Griffithsia Bornetiana*, Farlow; tip of male plant with antheridia. 400 diam.
5. The same; portion of tetrasporic plant with tetraspores, *a*, and involucre, *b*. 200 diam.

PLATE XI.

J. H. Blake and W. G. Farlow.

Fig. 1. *Callithamnion Baileyi*, Harv.; plant with tetraspores: *a*, before separation from the mother-cell; *á*, free from the mother-cell. 200 diam.
2. The same; plant bearing binate cystocarp.
3. *Griffithsia Bornetiana*, Farlow; plant bearing cystocarp (favella). 200 diam.

PLATE XII.

J. H. Blake and W. G. Farlow.

Fig. 1. *Nemalion multifidum*, Ag.; dissection of outer part of the plant to show the cystocarp. 400 diam.
2. *Spyridia filamentosa*, Harv.; tip of female plant with a double cystocarp, the right-hand portion of figure representing the cystocarp and branch in section; the left-hand cystocarp being seen superficially. 400 diam.

PLATE XIII.

J. H. Blake and W. G. Farlow.

Fig. 1. *Polysiphonia Olneyi*, Harv.; branch with antheridium, *a*. 200 diam.
2, 3, and 4. *Grinnellia Americana*, Harv.: Figs. 3 and 4 represent the antheridia seen from above and in section, *a*; Fig. 2, section through a cystocarp. 400 diam.

PLATE XIV.

J. H. Blake and W. G. Farlow.

Fig. 1. *Petrocelis cruenta* J. Ag.; dissection of frond showing the tetraspores, *a*, *á*. 400 diam.
2. *Rhabdonia tenera*, J. Ag.; transverse section of frond showing cystocarp and carpostome. 200 diam.

PLATE XV.

J. H. Blake and W. G. Farlow.

Fig. 1. *Dasya elegans*, Ag.; branch with stichidium bearing tetraspores. 300 diam.
2 and 5. *Champia parvula*, Harv.: Fig. 5, portion of frond bearing a cystocarp, *a*; slightly enlarged; Fig. 2, section through *a*, showing arrangement of spores, carpogenic cell, and carpostome. 400 diam.
3 and 4. *Polysiphonia Harveyi*, Bail.: Fig. 4, branch with cystocarp; Fig. 3, section through the same, showing spores and carpogenic cell. 400 diam.

INDEX OF GENERA AND SPECIES.

[The synonyms and species incidentally mentioned are in italics. **The larger-sized figures indicate the page where the description is given.**]

F.

G.

R.

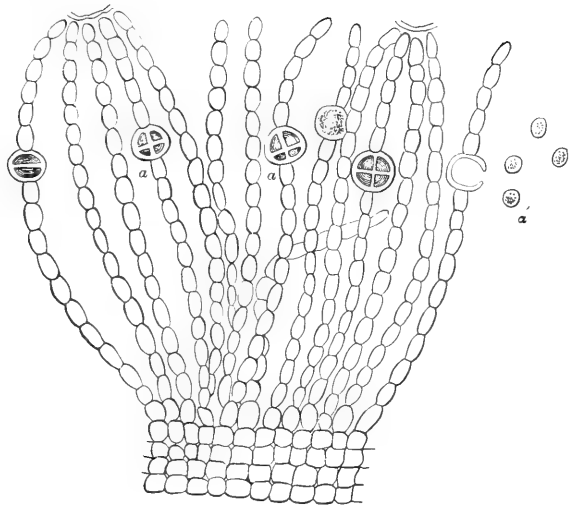
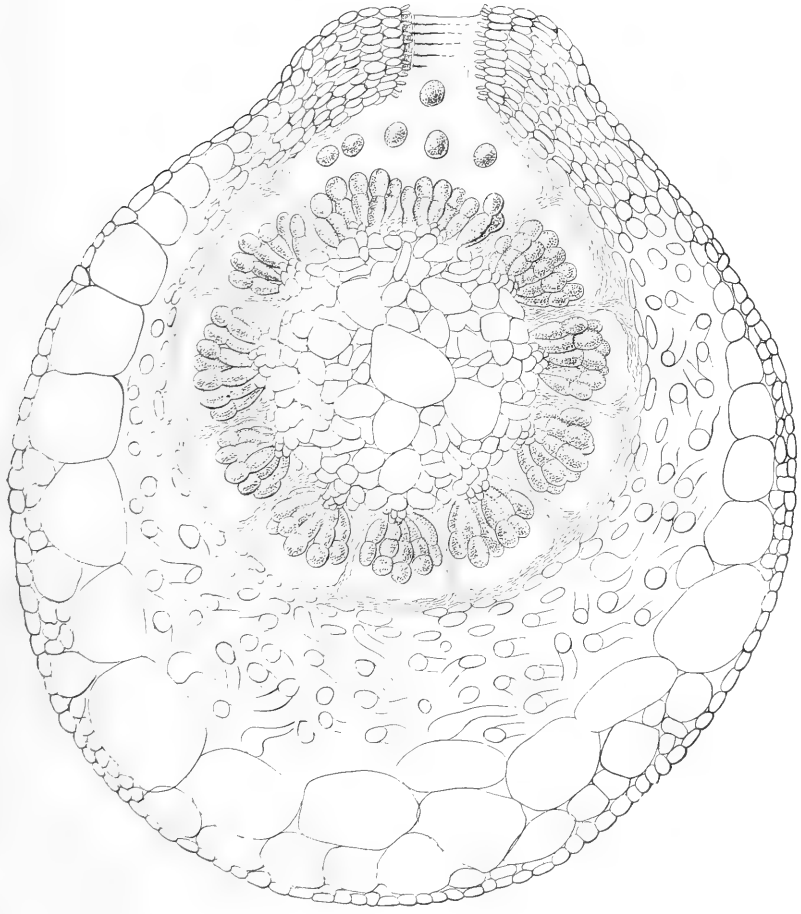


FIG. 1.



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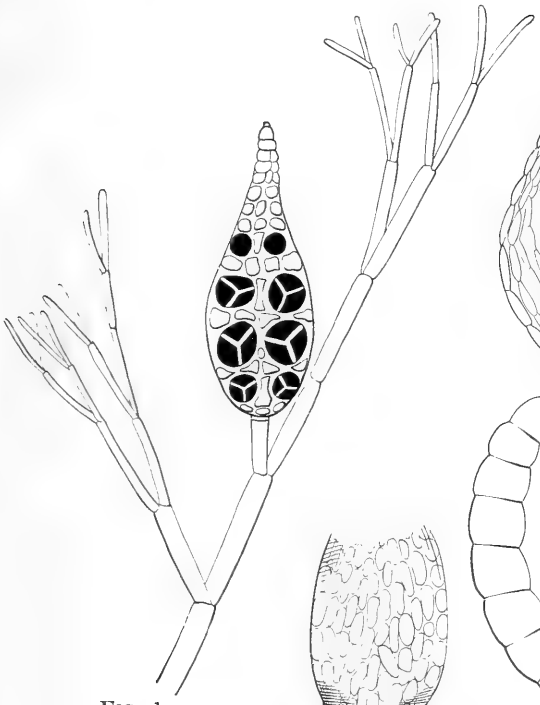
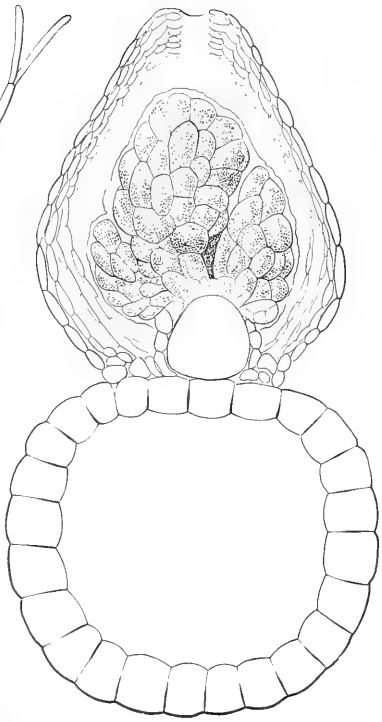


FIG. 1.



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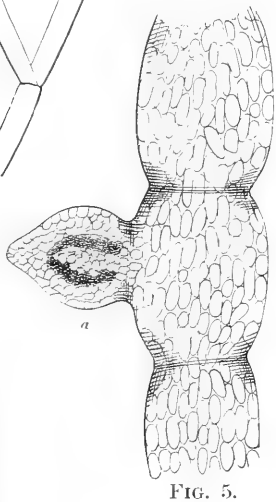

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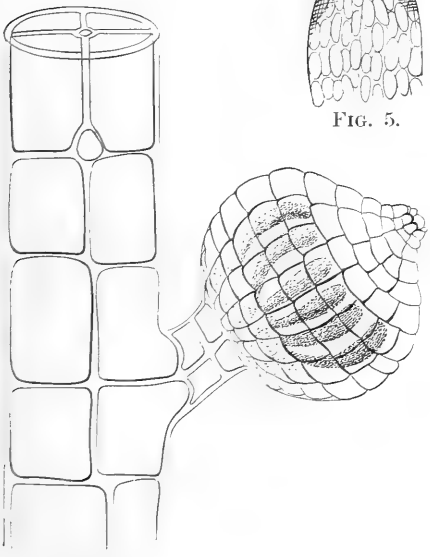

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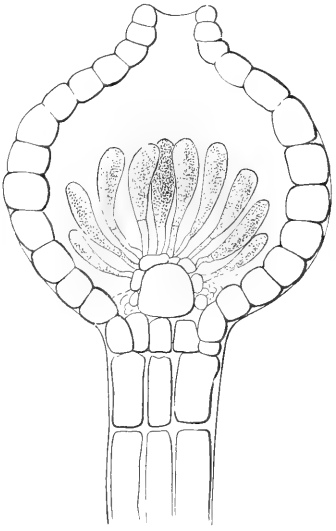
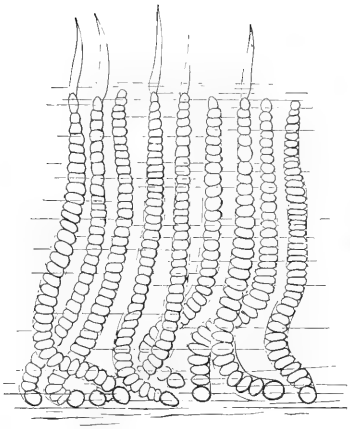


FIG. 3.

FIG. 1.



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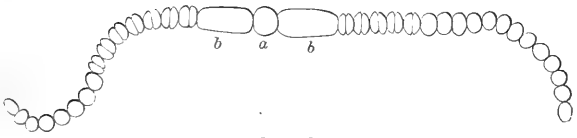


FIG. 3.

FIG. 4.

FIG. 5.

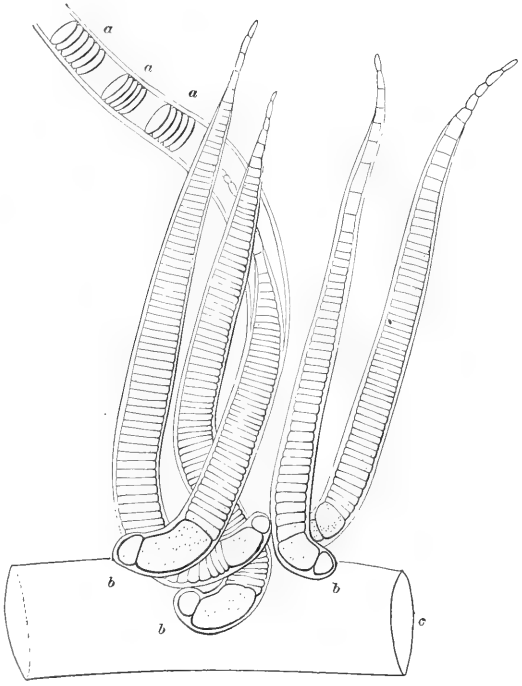


FIG. 6.

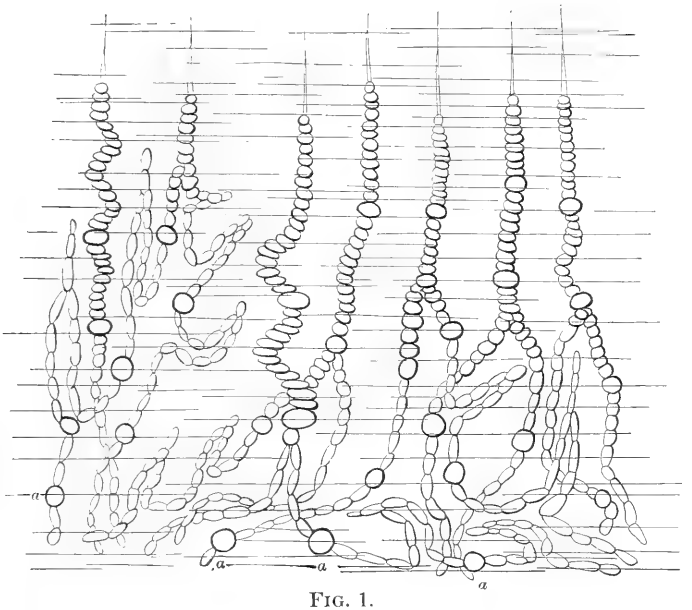
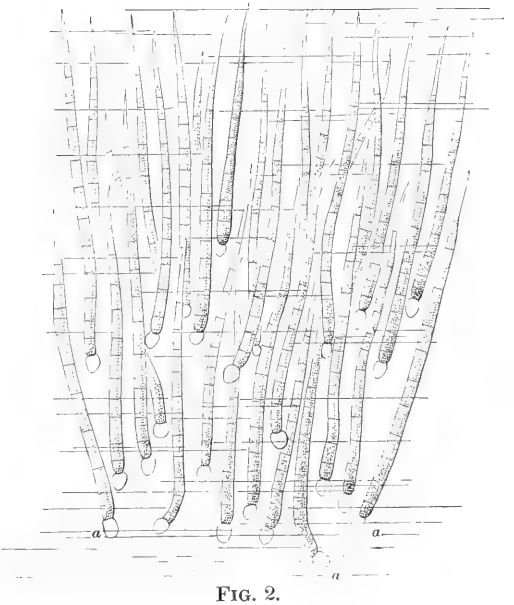


FIG. 1.

FIG. 3.

FIG. 4.



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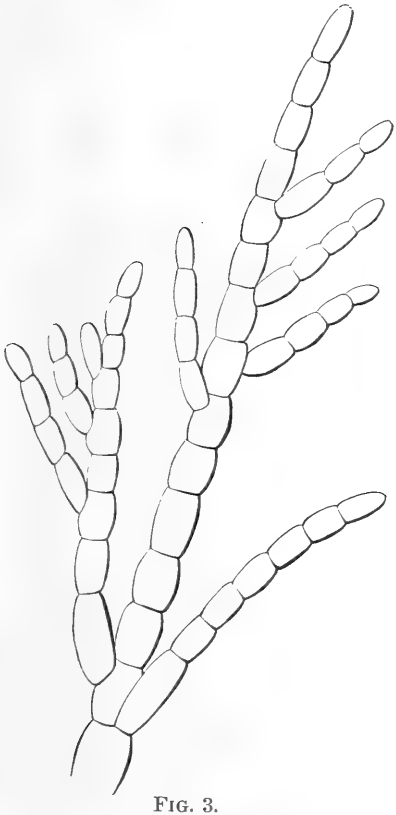

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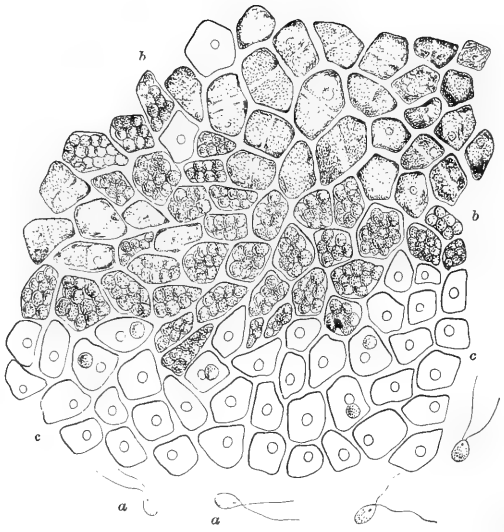
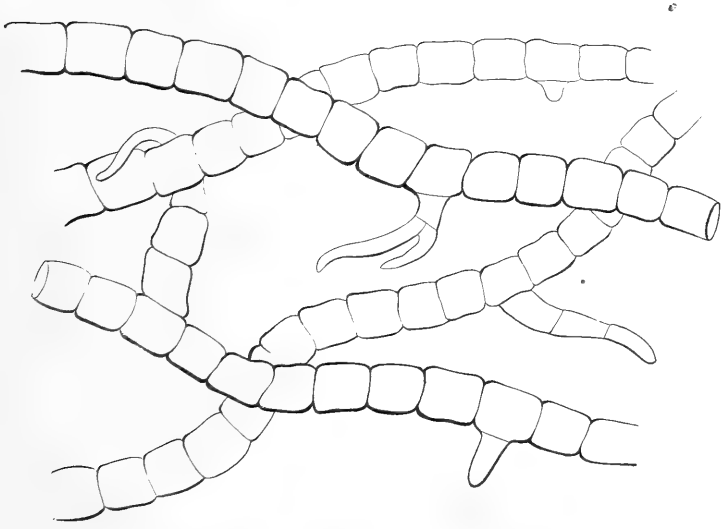


FIG. 1.



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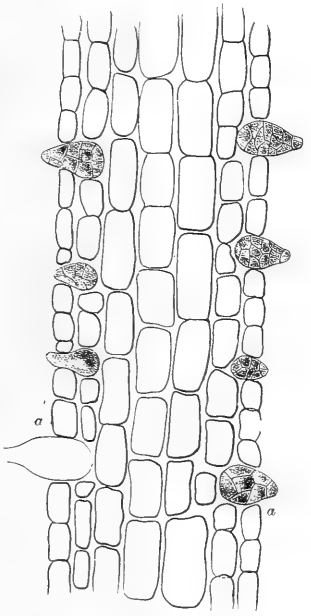

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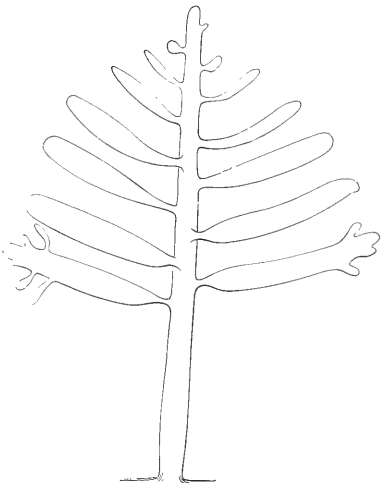
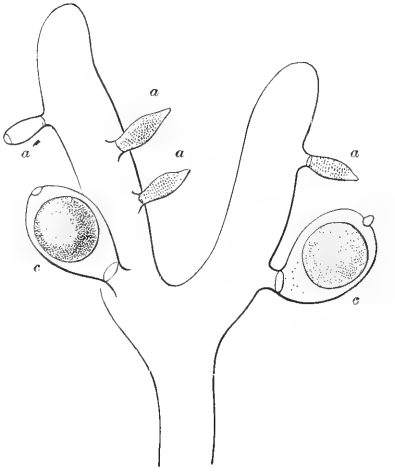


FIG. 1.



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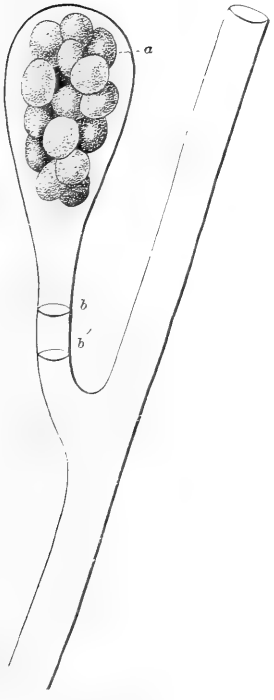

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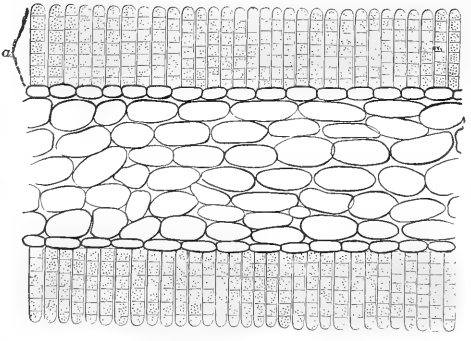

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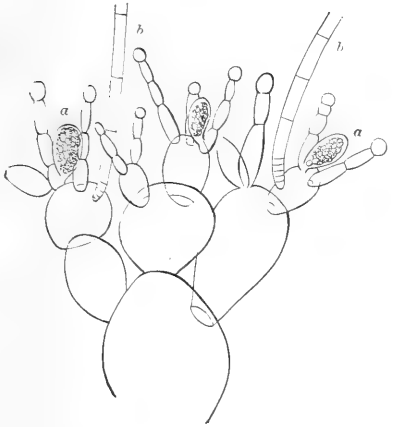
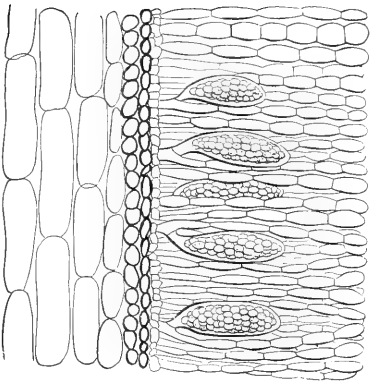


FIG. 1.



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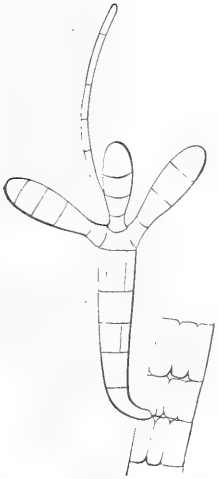

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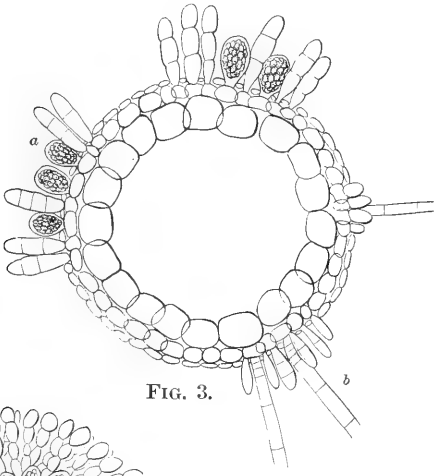

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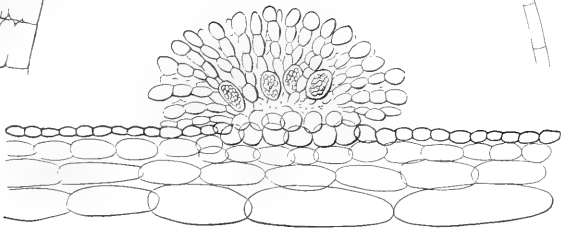

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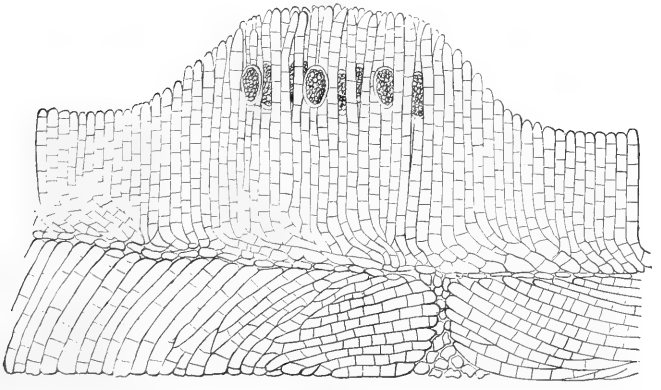


FIG. 5.

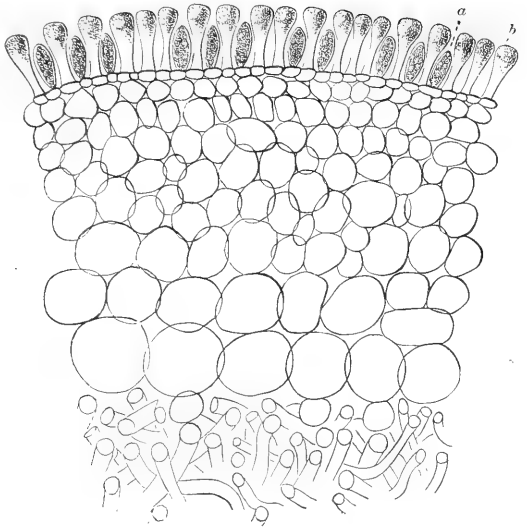
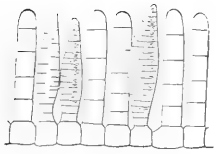


FIG. 1.



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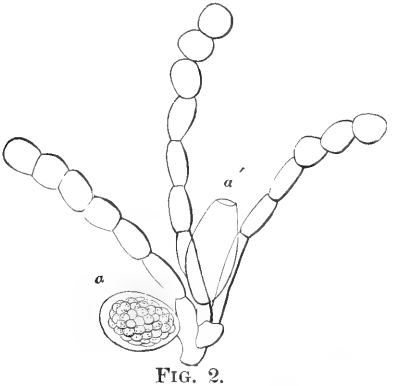

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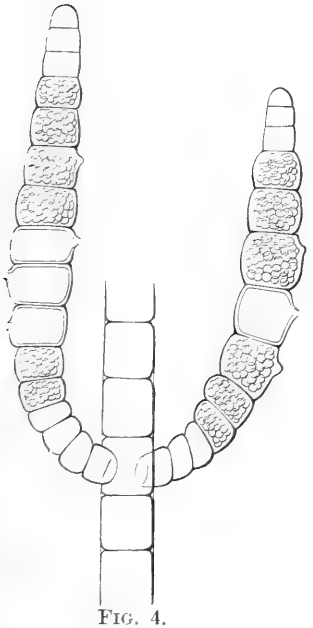

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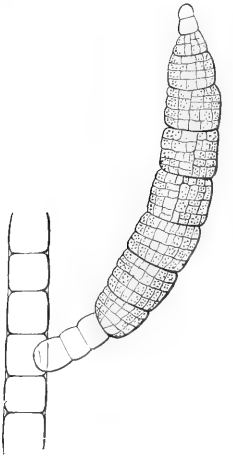


FIG. 3.

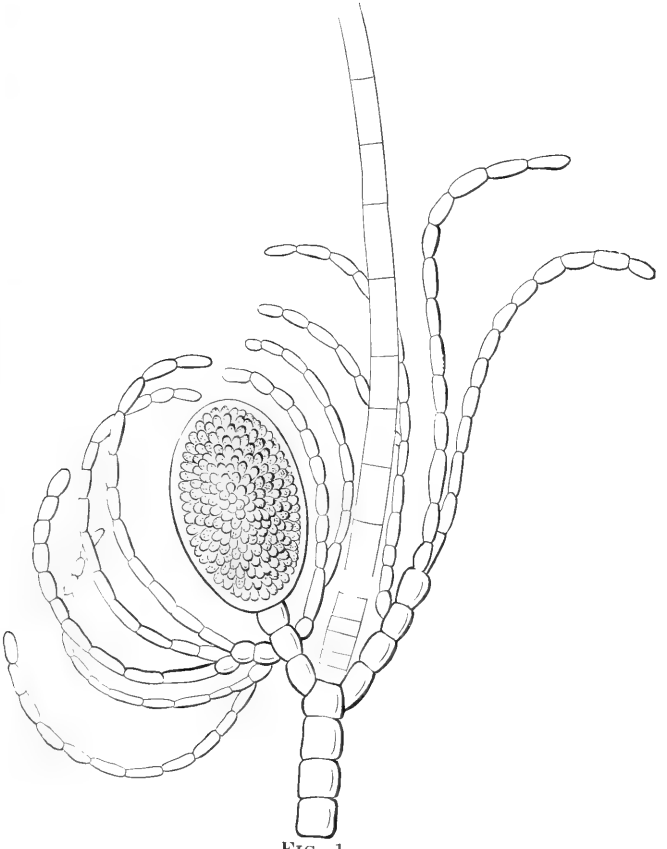
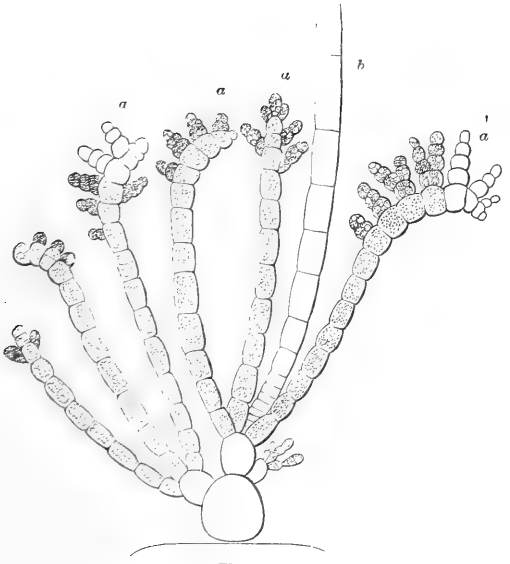


FIG. 1.



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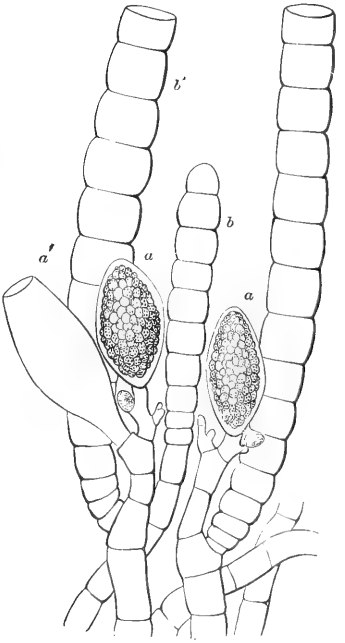

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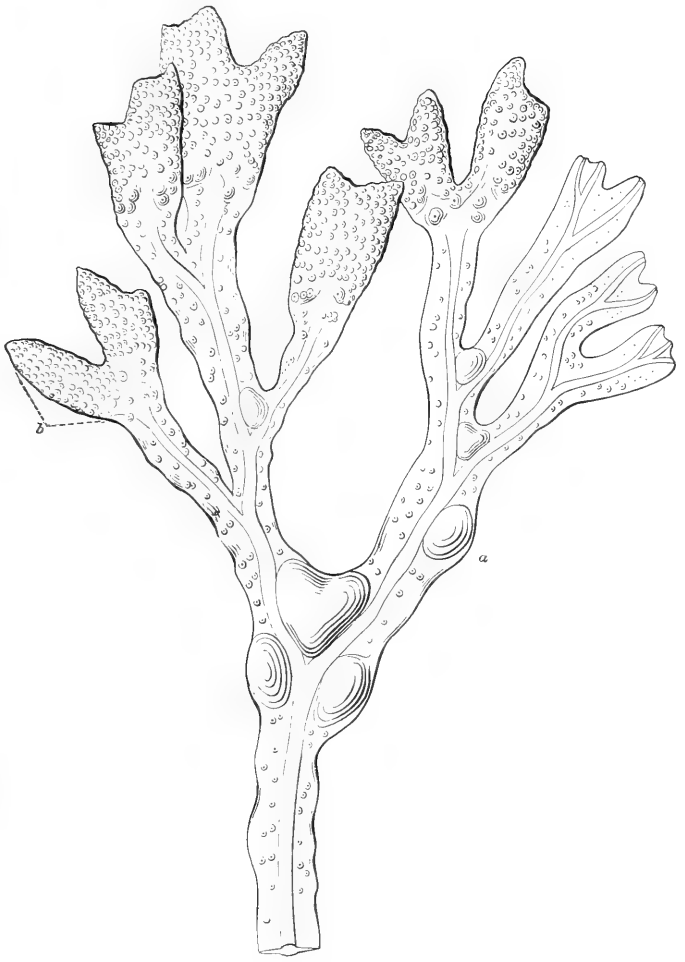


FIG. 1.

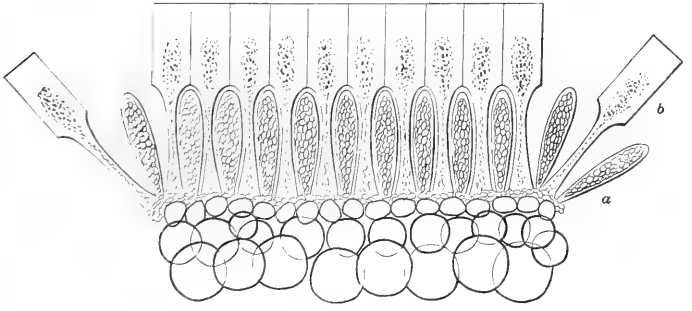


FIG. 2.

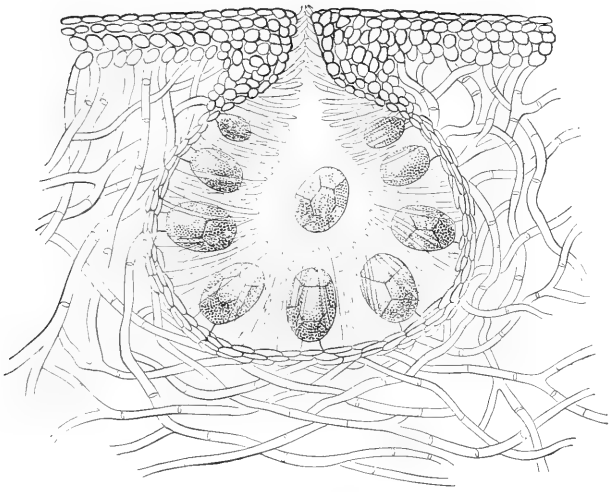


FIG. 1.

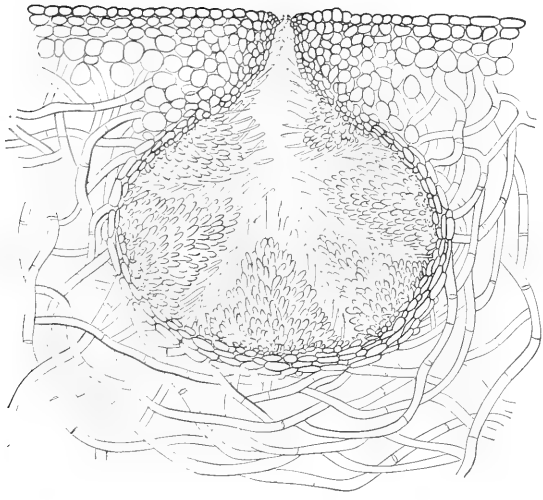


FIG. 2.

PLATE X.

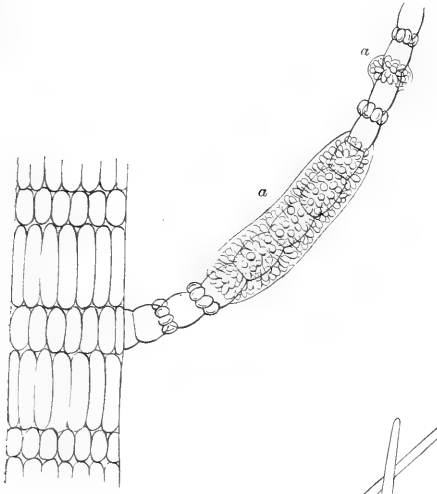
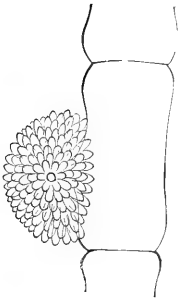


FIG. 1.



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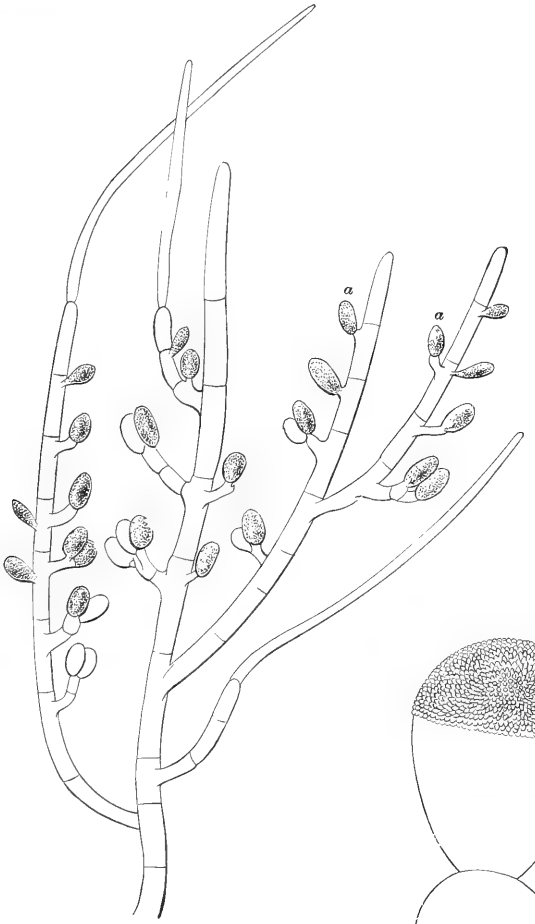


FIG. 3.

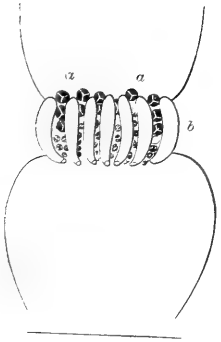
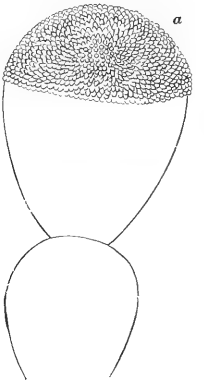


FIG. 5.



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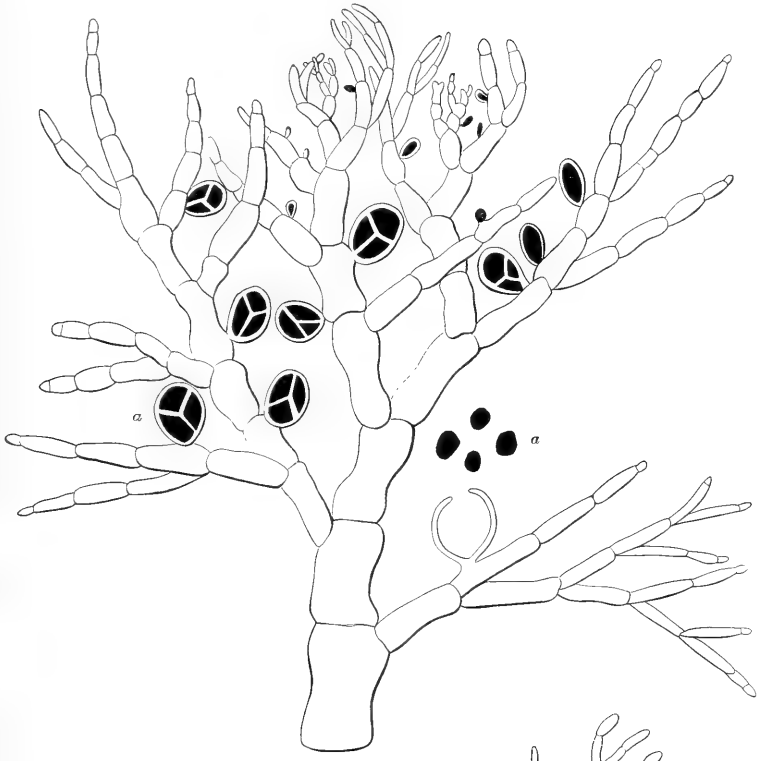


FIG. 1.

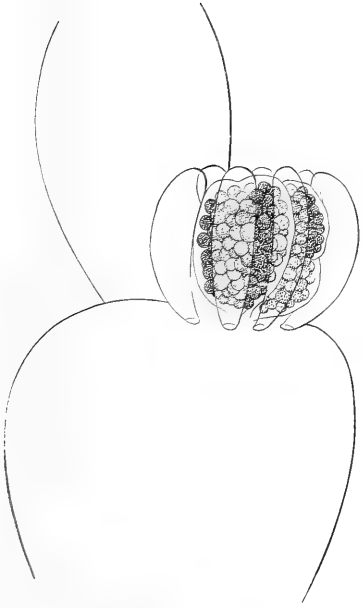
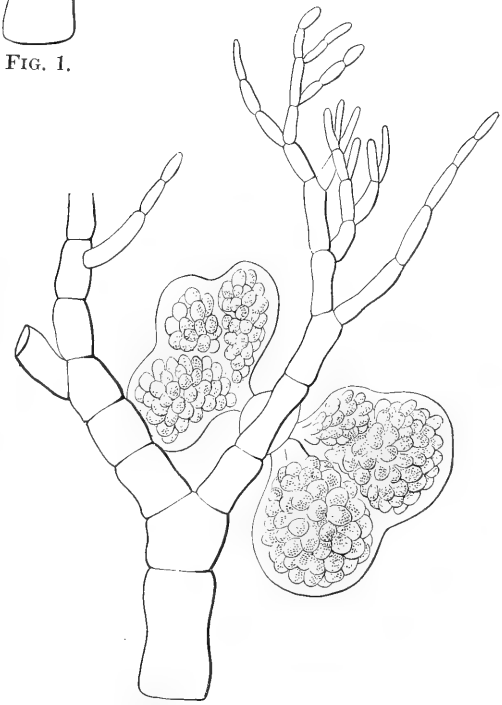


FIG. 3.



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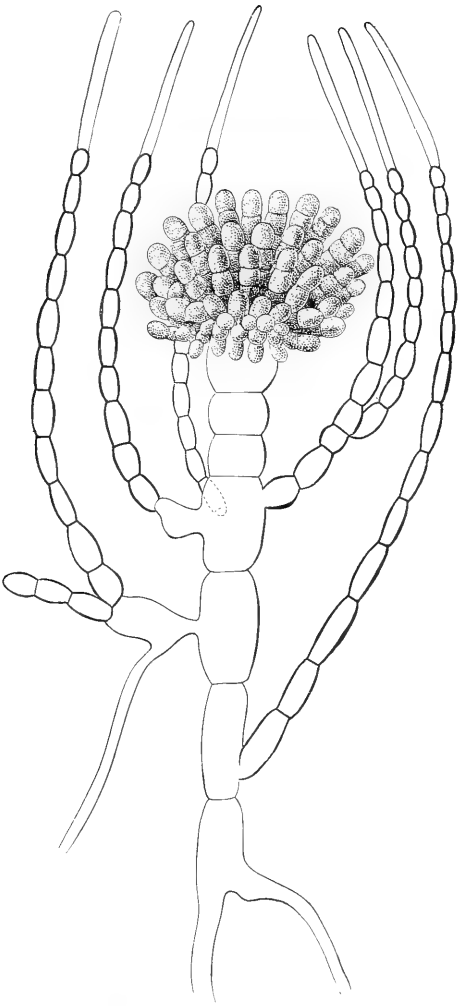
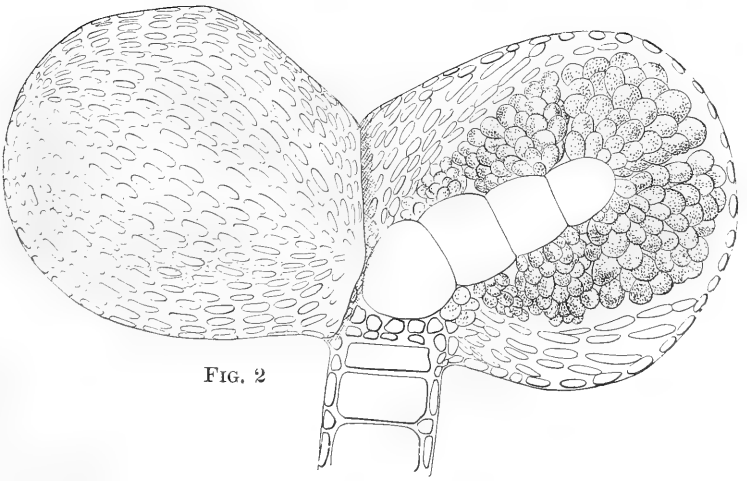


FIG. 1.



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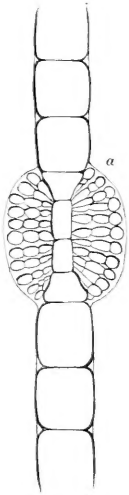

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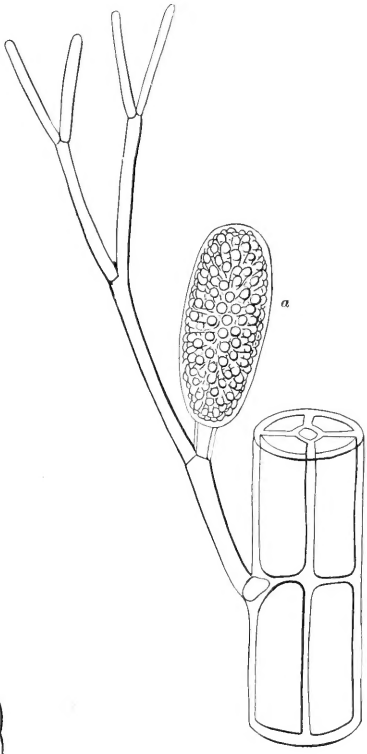
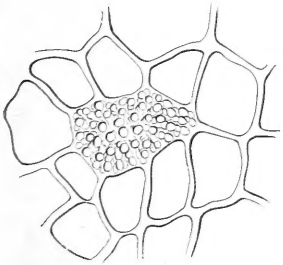


FIG. 1.



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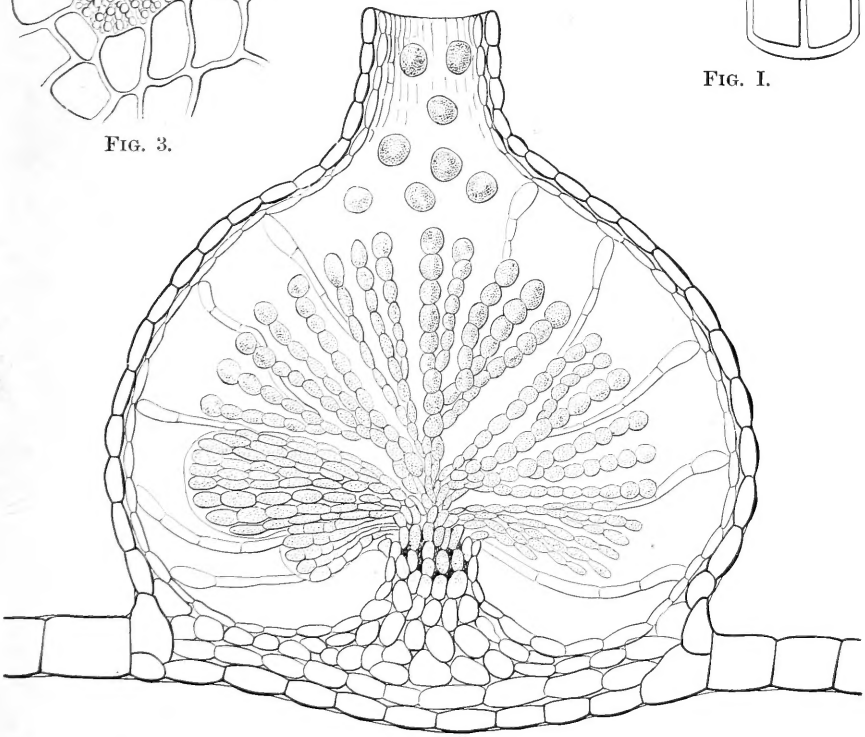

FIG. 2.