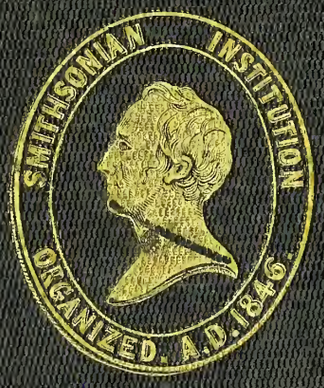
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SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

NEREIS

BOREALI-AMERICANA:

OR,

CONTRIBUTIONS TO A HISTORY OF THE MARINE ALGÆ
OF NORTH AMERICA.

BY

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PART I.—MELANOSPERMEÆ.

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INTRODUCTION.

Among the plants which constitute the ordinary covering of the ground, whether that covering be one of forests, peopled by vegetable giants, or of the herbage and small herbaceous plants that clothe the open country, we observe that the greater number—at least of those which ordinarily force themselves on our notice—have certain obvious organs or parts: namely, a *root* by which they are fixed in the ground, and through which they derive their nourishment from the fluids of the soil; a *stem* or axis developed, in ordinary cases, above ground; *leaves* which clothe that stem, and in which the crude food absorbed by the roots and transmitted through the stem is exposed to the influence of solar light and of the air; and, finally, special modifications of leaf buds called *flowers*, in which seeds are originated and brought to maturity. These seeds, falling from the parent plant, endowed with an independent life under whose influence they germinate, attract food from surrounding mineral matter; digest it; *organize* it, that is, convert it from dead substance into living substance; form new parts or organs from this prepared matter; and, finally, grow into vegetables, having parts similar to those of the parent plant, and similarly arranged.

This is the usual course of vegetation: seeds develope roots, stems, and leafy branches; the latter at maturity bear flowers, producing similar seeds, destined to go through a like course; and so on, from one vegetable generation to another. But, with a perfect agreement among seed-bearing plants in the end proposed and attained, there is an endless variety of minor modifications through which the end is compassed. All degrees of modification exist between the simplest and most complicated digestive organs; in some, the root, stem, and leaves are so blended together, that we lose the notion of distinct organs, and in others the leaves are reduced to scales or spines, while the stem and branches are expanded and become not merely leaf-like, but actually discharge the functions of leaves. In the reproductive organs or flowers, too, we find equal variety; from the most elaborate and often gorgeous structures to the simplest and plainest, till at last we arrive at flowers, whose organization is so low that not only have calyx and corolla disappeared, but the very seed-vessel itself is reduced to an open scale or is wholly absent. Yet in all these modifications it is merely the means that are varied; the

end proposed is as efficiently attained by the simplest agency as by the most complex ; as if the Creator had designed to show us plainly how it is the same to Him to act by many or by few, by the most elaborate arrangement when He wills it, and by the simplest when that is His pleasure.

In all the cases of which we have as yet spoken, *seeds* are the result of the vegetable cycle ; a seed being a compound body, containing an *embryo* or miniature plant, having stem, root, and leaf already organized, and enclosed with proper coverings or seed coats. But some plants do not produce such seeds. At least one-sixth of the vegetable kingdom, perhaps more, are propagated by isolated cells (or *spores*) cast loose from the structure of which they had formed a portion, and endowed thenceforth with independent powers of growth and development. Such are the reproductive bodies of the Ferns, the Mosses, and all plants below them in the vegetable scale, concluding with the large class to which our attention will now be confined—the Algæ—which of all are the lowest and simplest in organization.

The framework of every vegetable is built up of *cells*, little membranous sacs of various forms, with walls of varying tenacity, empty, or containing fluid or granular, organized matter, from which new cells may be developed. Among more perfect plants there is, in different parts of the same individual, considerable variety in the form and substance of the cells ; those of the wood and of the veins of the leaves being different from those of the soft part of the leaves, and these again different from those of the skin which is spread over the whole. But as we descend in the scale of organization, greater and greater uniformity is found. Below the *Ferns*, no vascular tissue and no proper wood-cells occur ; and at last in the Algæ, no cells exist differing from those of ordinary parenchyma or soft cells, such as compose the pulp of a leaf. Algæ, then, together with Mosses, Lichens and Fungi, are termed *cellular* plants, in contradistinction to Ferns and Flowering plants, which are denominated *vascular*. Among the most perfect of the Algæ, however, though the cells are all of the same substance and nature, all *parenchymatic*, they are of various forms and arrangement in different portions of the vegetable, often keeping up a very perfect analogy with the double system of arrangement—the vertical and horizontal, or woody and cellular systems—of higher plants. Thus the cells of the axis of the compound cylindrical Algæ are arranged longitudinally, like the wood-cells of stems, while those of the periphery or outer coating of the same Algæ have a horizontal direction.

In the most perfect of such Algæ the frame still consists of *root*, *stem*, and *leaves*, developed in an order analogous to that of higher plants. Passing from such, we meet with others gradually less and less perfect, until the whole vegetable is reduced either to a root-like body, or a branching naked stem, or an expanded leaf ; as if Nature had first formed the types of the compound vegetable organs so named and exhibited them as separate vegetables ; and then, by combining them in a single framework, had built up her perfect idea of a fully organized plant. But among the Algæ, we may go still lower in vegetable organization, and arrive at plants where the whole body is composed of a few cells strung together ; and finally at others—the simplest of known vegetables—whose whole framework is a single *cell*. These are the true vegetable *monads :* with these we commence the

great series of the Algæ at its lowest point, and proceeding upwards we find, within the limits of this same series, all degrees of complication of framework short of the development of proper flowers. It is this progressive organization of the Algæ, which renders the study of this portion of the vegetable world especially interesting to the philosophical botanist, because it displays to him, as in a mirror, something of that general plan of development which nature has followed in constructing other and more compound plants, in which her steps are less easily traced. From its first conception within the ovule to its full development, one of the higher plants goes through transformations strictly analogous to stages of advancement that can be traced among the Algæ from species to species, and from genus to genus, from the least perfect to the most perfect of the group. Each Alga-species has its own peculiar phase of development, which it reaches, and there stops; another species, passing this condition, carries the ideal plan a step further; and thus successive species exhibit successive stages of advancement.

While their gradually advancing scale of development renders the study of these plants more interesting, it also increases the difficulty of constructing a short and yet definite character, or *diagnosis*, which will include every member of the group, and exclude species more properly referable to the kindred groups of LICHENS and FUNGI. I shall not here attempt any such critical definition, but proceed to trace the gradual evolution of the frond and of the organs of fructification in the Algæ, assuming that with the ALGÆ are to be classed all Thallophytes (or Cryptogamic plants destitute of proper axes, in the more restricted view of that term) which are developed in water, or nourished wholly through the medium of fluids, while all Thallophytes that are ærial and not parasitic are LICHENS, and all that are ærial and parasitic are FUNGI.

Commencing then with Algæ of the simplest structure, a large part of them, belonging to the orders *Diatomaceæ* and *Desmidiaceæ*, consist almost entirely of individual isolated cells. Each plant, or frond, is formed of a single living cell; destitute therefore of any special organs, and performing every function of life in that one universal organ of which its frame consists. The growth of these simple plants is like that of the ordinary cells of which the compound frame of higher plants is composed. Nourishment is absorbed through the membraneous coating of the young plant (or cell), digested within its simple cavity, and the assimilated matter applied to the extension of the cell-wall, until that has reached the size proper to the species. Then the matter contained within the cavity gradually separates into two portions, and at the same time a cell-wall is formed between each portion, and thus the original simple cell becomes two cells. These no longer cohere together, as cells do in a compound plant, but each half-cell separates from its fellow, and commencing an independent career, digests food, increases in size, divides at maturity, &c., going again and again through a similar round of changes. In this way, by the process of self-division, and without any fructification, a large surface of water may soon be covered with these vegetable monads, from the mere multiplication of a single individual.

These minute plants, *(Diatomaceæ* and *Desmidiaceæ)* from their microscopic size and uniform and simple structure, are justly regarded as at the base of the vegeta-

ble kingdom. Notwithstanding which lowly position in the scale of being, they display an infinite variety of the most exquisite forms and finely sculptured surfaces; so that their study affords as much scope for the powers of observation as does that of the creation which is patent to our ordinary senses. These tribes are however omitted from this essay, because they have been made the objects of special enquiry by Professor Bailey of West Point, whose memoir in the second volume of the Smithsonian Contributions is referred to for further information.

But *Desmidiaceæ* and *Diatomaceæ* are not the only Algæ of this simple structure. The lowest forms of the order *Palmellaceæ*, such as the *Protococcus* or *Red snow plant*, have an equally simple organization. The blood-red colour of Alpine or Arctic snow which has been so often observed by voyagers, and which was seen to spread over so vast an extent of ground by Captain Ross, in his first arctic journey, is due to more than one species of microscopic plant, and to some minute infusorial animals which perhaps acquire the red colour from feeding on the *Protococcus* among which they are found. The best known and most abundant plant of this snow vegetation is the *Protococcus nivalis*, which is a spherical cell, containing a carmine-red globe of granulated, semi-fluid substance, surrounded by a hyaline limbus or thick cell-wall. At maturity the contained red matter separates into several spherical portions, each of which becomes clothed with a membranous coat; and thus forming as many small cells. The walls of the parent whose whole living substance has thus been appropriated to the offspring, now burst asunder, and the progeny escape. These rapidly increase in size until each acquires the dimensions of the parent, when the contained matter is again separated into new spheres; giving rise to new cells, to undergo in their turn the same changes. And as, under favourable circumstances, but a few hours are required for this simple growth and developement, the production of the red snow plant is often very rapid: hence the accounts frequently given of the sudden appearance of a red colour in the snow, over a wide space, which appearance is ascribed by common report to the falling of bloody rain or snow. In many such cases it is probable that the Protococcus may have existed on the portion of soil over which the snow fell, and its developement may have merely kept pace with the gradually deepening sheet of snow. That this plant is not confined to the surface of snow is well known; and Captain Ross mentions that in many places where he had an opportunity of examining it, he found that it extended several feet in depth. It has been found both in Sweden and Scotland on rocks, in places remote from snow deposits; and it probably lies dormant, or slowly vegetates in such cases, waiting for a supply of snow in which it grows with greater rapidity.

The structure and developement which I have described as characterizing *Protococcus*, are strikingly similar to those of what are commonly considered minute infusorial animals, called *Volvox*; the chief difference between *Protococcus* and *Volvox* being that the latter is clothed with vibratile hairs, by the rapid motion of which the little spheres are driven in varying directions through the water. Many naturalists, and some of high note, are now of opinion that *Volvox* and its kindred should be classed with the Algæ, and certainly (as we shall afterwards see) their peculiar ciliary motion is no bar to this association. I do not

pronounce on this question, because it does not immediately concern our present subject, and because, in all its collateral bearings, it requires more attentive examination than it has yet undergone.

In *Protococcus* the cell of which the plant consists is spherical or oval; in other equally elementary Algæ the cell is cylindrical, and sometimes lengthened considerably into a thread-like body. Such is the formation of *Oscillatoriæ*. In *Vaucheriæ* there is a further advance, the filiform cell becoming branched without any interruption to its cavity; and such branching cells frequently attain some inches in length, and a diameter of half a line, constituting some of the largest cells known among plants.

In all these cases each cell is a separate individual: such plants are therefore the simplest expression of the vegetable idea. But even in this extremest simplicity we find the first indication of the structure which is to be afterward evolved. Thus in the spherical cell we have the earliest type of the cellular system of a compound plant developing equally in all directions; and in the cylindrical cell, the illustration of the vertical system developing longitudinally. These tendencies, here scarcely manifest, become at once obvious when the framework begins to be composed of more cells than one.

Thus in the genera nearest allied to *Protococcus*, the frond is a roundish mass of cells cohering irregularly by their sides. From these through *Palmella* and *Tetraspora* we arrive at *Ulva*, where a more or less compact membranous expansion is formed by the lateral cohesion of a multitude of roundish (or, by mutual pressure, polygonal) cells originating in the quadri-partition of older cells; that is, by the original cells dividing longitudinally as well as transversely, thus forming four new cells from the matter of the old cell, and causing the cell-growth to proceed nearly equally in both directions. Starting, therefore, from *Protococcus*, and tracing the developement through various stages, we arrive in *Ulva* at the earliest type of an expanded leaf.

In like manner the earliest type of a stem may be found by tracing the Algæ which originate in cylindrical cells. Here the new cells are formed in a longitudinal direction only, by the bipartition of the old cells. Thus, in *Conferva*, where the body consists of a number of cylindrical cells, strung end to end, these have originated by the continual transverse division of an original cylindrical cell. Such a frond will continually lengthen, but will make no lateral growth; and consisting of a series of joints and interspaces, it correctly symbolizes the stem of one of the higher plants, formed of a succession of nodes and internodes. And the analogy is still further preserved when such confervoid threads branch; for the branches constantly originate at the joints or *nodes*, just as do the leaves and branches of the higher compound plants.

We have then two tendencies exhibited among Algæ—the first, a tendency to form membranous expansions, the symbols or types of leaves; the second a tendency to form cylindrical bodies or stems. Among the less perfect Algæ the whole plant will consist either of one of these foliations, or of a simple or branched stem. But gradually both ideas or forms will be associated in the same individual, and exhibited in greater or less perfection. We shall find stems becoming flattened at

their summits into leaves, and leaves, by the loss of their lateral membranes, and the acquisition of thicker midribs, changing into stems ; and among the most highly organized Algæ we shall find leaf-like lateral branches assuming the form, and to a good degree the arrangement of the leaves of higher plants. Not that we find among Algæ proper leaves, like those of phænogamous plants, constantly developing buds in their axils ; for even where leaf-like bodies are most obvious (as in the genus *Sargassum*), they are merely *phyllocladia* or expanded branches ; as may readily be seen by observing a *Sargassum* in a young state, and watching the gradual changes that take place as the frond lengthens. These changes will be explained in the systematic portion of this work.

I shall now notice more particularly the varieties of habit observed among the compound Algæ, and first,

OF THE ROOT.

The *root* among the Algæ is rarely much developed. Among higher plants which derive their nourishment from the soil in which they grow, and in Fungi which feed on the juices of organized bodies, root-fibres, through which nourishment is absorbed, are essential to the development of the vegetable. But the Algæ do not, in a general way, derive nourishment from the soil on which they grow. We find them growing indifferently on rocks of various mineralogical character, on floating timber, on shells, on iron or other metal, on each other,—in fine, on any substance which is long submerged, and which affords a foothold. Into none of those substances do they emit roots, nor do we find that they cause the decay, or appropriate to themselves the constituents, of those substances. They are nourished by the water that surrounds them and the various substances which are dissolved in it. On those substances they frequently exert a very remarkable power, effecting chemical changes which the chemist can imitate only by the agency of the most powerful apparatus. They actually sometimes reverse the order of chemical affinity, driving out the stronger acid from the salts which they imbibe, and causing a weaker acid to unite with the base. Thus they decompose the muriate of soda which they absorb from sea-water, partly freeing and partly appropriating the chlorine and hydrogen ; and the soda is found combined in their tissues with carbonic acid.

A remarkable instance of the action of a minute Alga on a chemical solution was pointed out to me by Prof. Bache, as occurring in the vessels of sulphate of copper kept in the electrotyping department of the Coast Survey office at Washington. A slender confervoid Alga infests the vats containing sulphate of copper, and proves very destructive. It decomposes the salt, and assimilates the sulphuric acid, rejecting (as indigestible !) the copper, which is deposited round its threads in a metallic form. It sometimes appears in great quantities, and is very troublesome ; but the vats had been cleaned a few days before I visited them, so that I lost the opportunity of examining more minutely this curious little plant. Most probably it is a species of *Hygrocrocis*,* a group of Algæ of low organization but strong diges-

* Perhaps the *Hygrocrocis cuprica*, Kütz, or some allied species ; but I had no opportunity of examining a recent specimen, and the characters cannot be made out from a dried one.

tive powers, developed in various chemical solutions or in the waters of mineral springs. All the Algæ however which are found in such localities are not species of *Hygrocrocis*, for several *Oscillatoriæ* and *Calothrices* occur in thermal waters. Species of the former genus are found even in the boiling waters of the Icelandic Geysers. Of the latter, one species at least, *Calothrix nivea*, is very common in hot sulphur springs, and I observed it in great plenty in the streams running from the inflammable springs at Niagara.

But on whatever substance the Alga may feed, it is rarely obtained through the intervention of a root. Dissolved in the water that bathes the whole frond, the food is imbibed equally through all the cells of the surface, and passes from cell to cell toward those parts that are more actively assimilating, or growing more rapidly. The *root*, where such an organ exists, is a mere holdfast, intended to keep the plant fixed to a base, and prevent its being driven about by the action of the waves. It is ordinarily a simple disc, or conical expansion of the base of the stem, strongly applied and firmly adhering to the substance on which the Alga grows. This is the usual form among all the smaller growing kinds. Where, however, as in the gigantic Oar-weeds or *Laminariæ*, the frond attains a large size, offering a proportionate resistance to the waves, the central disc is strengthened by lateral holdfasts or discs formed at the bases of side roots emitted by the lower part of the stem ; just as the tropical Screw-pine *(Pandanus)* puts out cables and shrouds to enable its slender stem to support the weight of the growing head of branches. The branching roots of the *Laminaria*, then, are merely *Fucus*-discs become compound : instead of the conical base of a *Fucus*, formed of a single disc, there is a conical base formed of a number of such discs disposed in a circle. In some few instances, as in *Macrocystis*, the grasping fibres of the root develope more extensively, and form a matted stratum of considerable extent, from which many stems spring up. This is a further modification of the same idea, a further extension of the base of the cone.

In all these cases the roots extend over flat surfaces, to which they adhere by a series of discs. They show no tendency to penetrate like the branching roots of perfect plants. The only instances of such penetrating roots among the Algæ with which I am acquainted, occur in certain genera of *Siphoneæ* and in the *Caulerpeæ*, tropical and sub-tropical forms, of which there are numerous examples on the shores of the Florida Keys. These plants grow either on sandy shores or among coral, into which their widely extended fibrous roots often penetrate for a considerable distance, branching in all directions, and forming a compact cushion in the sand, reminding one strongly of the much divided roots of sea-shore grasses that bind together the loose sands of our dunes. But neither in these cases do the roots appear to differ from the nature of holdfasts, and their ramification and extension through the sand is probably owing to the unstable nature of such a soil. It is not in search of nourishment, but in search of stability, that the fibres of their roots are put forth, like so many tendrils. We shall have more to speak of these roots in the proper place, and shall now proceed to notice some of the forms exhibited by

THE FROND.

The *frond* or vegetable body of the compound Algæ puts on a great variety of shapes in different families, as it gradually rises from simpler to more complex structures. In the less organized it consists of a string of cells arranged like the beads of a necklace; and the cells of which such strings are composed may be either globose or cylindrical. In the former case we have a *moniliform* string or *filament*, and in the latter a filiform or cylindrical one. The term *filament* (in Latin, *filum*) is commonly applied to such simple strings of cells, but has occasionally a wider acceptation, signifying any very slender, threadlike body, though formed of more than one series of cells. This is a loose application of the term, and ought to be avoided. By Kützing the term *trichoma* is substituted for the older word *filum* or filament. Where the *filament* (or *trichoma*) consists of a single series of consecutive cells, it appears like a jointed thread; each individual cell constituting an *articulation*, and the walls between the cells forming *dissepiments* or *nodes*, terms which are frequently employed in describing plants of this structure. Where the filament is composed of more series of cells than one, it may be either *articulated* or *inarticulate*. In the former case, the cells or articulations of the minor filaments which compose the common filament are all of equal length; their dissepiments are therefore all on a level, and divide the compound body into a series of nodes and internodes, or dissepiments and articulations. In the latter, the cells of the minor filaments are of unequal length, so that no articulations are obvious in the compound body. In *Polysiphonia* and *Rhodomela* may be seen examples of such articulate and inarticulate filaments.

By Kützing the term *phycoma* is applied to such compound stems; and when the phycoma becomes flattened or leaf-like, a new term, *phylloma*, is given to it by the same author. These terms are sometimes convenient in describing particular structures, though not yet generally adopted. The cells of which compound stems (or *phycomata*), are composed are very variously arranged, and on this cellular arrangement, or internal structure of the stem, depends frequently the place in the system to which the plant is to be referred. A close examination, therefore, of the interior of the frond, by means of thin slices under high powers of the microscope, is often necessary, before we can ascertain the position of an individual plant whose relations we wish to learn. Sometimes all the cells have a longitudinal direction, their longer axes being vertical. Very frequently, this longitudinal arrangement is found only toward the centre of the stem, while toward the circumference the cells stand at right angles to those of the centre, or have a horizontal direction. In such stems we distinguish a proper *axis*, running through the frond, and a *periphery*, or *peripheric stratum*, forming the outside layer or circumference. Sometimes the axis is the densest portion of the frond, the filaments of which it is composed being very strongly and closely glued together; in other cases it is very lax, each individual filament lying apart from its fellow, the interspaces being filled up with vegetable mucus or gelatine. This gelatine differs greatly in consistence; in some Algæ it is very thin and watery, in others it is

slimy, and in others it has nearly the firmness of cartilage. On the degree of its compactness and abundance depends the relative *substance* of the plant; which is membranaceous where the gelatine is in small quantity; gelatinous where it is very abundant and somewhat fluid; or cartilaginous where it is firm.

The frond may be either cylindrical or stem-like, or more or less compressed and flattened. Often a cylindrical stem bears branches which widen upwards, and terminate in leaf-like expansions, which are of various degrees of perfection in different kinds. Thus sometimes the leaf, or *phylloma*, is a mere dilatation; in other cases it is traversed by a midrib, and in the most perfect kinds lateral nervelets issue from the midrib and extend to the margin. These leaves are either vertical, which is their normal condition, or else they are inclined at various angles to the stem or axis, chiefly from a twisting in their lamina, the insertion of the leaf preserving its vertical position. They are variously lobed or cloven, and in a few cases (as in the *Sea Colander* of the American coast) they are regularly pierced, at all ages, with a series of holes which seem to originate in some portions of the lamina developing new cells with greater rapidity than other parts, thus causing an unequal tension in various parts of the frond, and consequently the production of holes in those places where the growth is defective. Such plants, though they form lace-like fronds, are scarcely to be considered as net works. Net-like fronds are, however, formed by several Algæ where the branches regularly anastomose one with another, and form meshes like those of a net. Most species with this structure are peculiar to the Southern Ocean, but in the waters of the Caribbean Sea are found two or three which may perhaps yet be detected on the shores of the Florida Keys. In one of the Australian genera of this structure (*Claudea*) the net-work is formed by the continual anastomosis of minute leaflets, each of which is furnished with a midrib and lamina. The apices of the midribs of one series of these leaves grow into the dorsal portion of leaves that issue at right angles to them, and as the leaves having longitudinal and horizontal directions, or those that form the warp and weft of the frond, are of minute size and closely and regularly disposed, the net-work that results is lace-like and delicately beautiful.

In the *Hydrodictyon*, a fresh water Alga, found in ponds in Europe and in the United States, where it was first detected by Professor Bailey near Westpoint, a net-like frond is formed in a different manner. This plant when fully grown resembles an ordinary fishing-net of fairy size, each pentagonal mesh being formed of five cells, and one cell making a side of the pentagon. As the plant grows larger, the meshes become wider by the lengthening of the cells of which each mesh is composed. When at maturity, the matter contained within each cell of the mesh is gradually organised into granules, or germs of future cells, and these become connected together in fives while yet contained in the parent cell. Thus meshes first, and at length little microscopic net-works, are formed within each cell of the meshes of the old net; and this takes place before the old net breaks up. At length the cells of the old net burst, and from each issues forth the little network, perfectly formed, but of very minute size, which by an expansion of its several parts will become a net like that

from which its parent cell was derived. Thus, supposing each cell of a single net of the Hydrodictyon were to be equally fertile, some myriads of new nets would be produced from every single net, as it broke up and dissolved. In this way a large surface of water might be filled with the plant in a single generation.

The manner of growth of the frond is very various in the different families. In some, the body lengthens by continual additions to its apex, every branch being younger the further removed it is from the base; that is, the tips of the branches are the youngest parts. This is the usual mode of growth in the Confervoid genera, and also obtains in many of those higher in the series, as in the Fucaceæ and many other Melanosperms. In the Laminariæ, on the contrary, the apex when once formed does not materially lengthen, but the new growth takes place at the base of the lamina, or in the part where the cylindrical stipe passes into the expanded or leaflike portion of the frond. In such plants the apex is rarely found entire in old specimens, but is either torn by the action of the waves, or thrown off altogether, and its place supplied by a new growth from below. In several species this throwing off of the old frond takes place regularly at the close of each season; the old lamina being gradually pushed off by a young lamina growing under it. There are others, among the filiform kinds, in which the smaller branches are suddenly deciduous, falling off from the larger and permanent portions of the trunk, as leaves do in autumn from deciduous trees. Hence specimens of these plants collected in winter are so unlike the summer state of the species, that to a person unacquainted with their habits they would appear to be altogether different in kind. The summer and winter states of *Rhodomela subfusca* are thus different. In *Desmarestia aculeata* the young plants, or the younger branches of old plants, are clothed with soft pencils of delicate jointed filaments, which fall off when the frond attains maturity, and leave naked, thorny branches behind. Similar delicate hairs are found in many other Algæ of very different families, generally clothing the younger and growing parts of the frond; and they seem to be essential organs, probably engaged in elaborating the crude sap of these plants, and consequently analogous to the leaves of perfect plants. This is as yet chiefly conjectural. The conjecture, however, is founded on the observed position of these hair-like bodies, which are always found on growing points, the new growth taking place immediately beneath their insertion. In most cases these hairs are deciduous, but in some, as in the genus *Dasya*, they are persistent, clothing all parts of the frond so long as they continue in vigour. They vary much in form, in some being long, filiform, single cells; in others, unbranched strings of shorter cells, and in others dichotomous, or, rarely, pinnated filaments.

Three principal varieties of

COLOUR

are generally noticed among the Algæ, namely, *Grass-green* or *Herbaceous*, *Olive-green*, and *Red*; and as these classes of colour are pretty constant among otherwise allied species, they afford a ready character by which, at a glance, these plants may be separated into natural divisions; and hence *colour* is here employed in classifi-

cation with more success than among any other vegetables. In the subdivision of Algæ into the three groups of *Chlorosperms*, *Melanosperms*, and *Rhodosperms*, the colour of the frond is, as we shall afterwards see, employed as a convenient diagnostic character. It is a character, however, which must be cautiously applied in practice by the student, because, though sufficiently constant on the whole and under ordinary circumstances, exceptions occur now and then ; and under special circumstances Algæ of one series assume in some degree the colour of either of the other series.

The *green* colour is characteristic of those that grow either in fresh water or in the shallower parts of the sea, where they are exposed to full sunshine but seldom quite uncovered by water. Almost all the fresh water species are green, and perhaps three fourths of those that grow in sunlit parts of the sea ; but some of those of deep water are of as vivid a green as any found near the surface, so that we cannot assert that the *green* colour is owing here, as it is among land plants, to a perfect exposure to sunlight. Several species of *Caulerpa*, *Anadyomene*, *Codium*, *Bryopsis* and others of the Siphoneæ, which are not less herbaceous or vivid in their green colours than other Chlorosperms, frequently occur at considerable depths, to which the light must be very imperfectly transmitted.

Algæ of an *olivaceous* colour are most abundant between tide marks, in places where they are exposed to the air, at the recess of the tide, and thus alternately subjected to be left to parch in the sun, and to be flooded by the cool waves of the returning tide. They extend however to low water mark, and form a broad belt of vegetation about that level, and a few straggle into deeper water, sometimes into very deep water. The gigantic deep-water Algæ, *Macrocystis*, *Nereocystis*, *Lessonia*, and *Durvillæa*, are olive coloured.

Red-coloured Algæ are most abundant in the deeper and darker parts of the sea, rarely growing in tide pools, except where they are shaded from the direct beams of the sun either by a projecting rock, or by over-lying olivaceous Algæ. The red colour is always purest and most intense when the plant grows in deep water, as may be seen by tracing any particular species from the greatest to the least depth at which it is found. Thus, the common *Ceramium rubrum* in deep pools or near low-water mark is of a deep, full red, its cells abundantly filled with bright carmine endochrome, which will be discharged in fresh water so as to form a rose-coloured infusion ; but the same plant, growing in open, shallow pools, near high water mark, where it is exposed to the sun, becomes very pale, the colour fading through all shades of pink down to dull orange or straw-colour. It is observable that this plant, which is properly one of the *red* series (or Rhodosperms) does not become grass-green (or like a Chlorosperm) by being developed in the shallower water, but merely loses its capacity for forming the red-coloured matter peculiar to itself. So also, *Laurencia pinnatifida*, and other species of that genus, which are normally dark purple, are so only when they grow near low water mark. And as many of them extend into shallower parts, and some even nearly to high water limit, we find specimens of these plants of every shade of colour from dull purple to dilute yellow or dirty white. Similar changes of colour, and from a similar cause, are seen in *Chondrus crispus*, the *Carrigeen* or *Irish Moss*, which is properly of a fine deep

purplish red, but becomes greenish or whitish when growing in shallow pools. The *white* colour, therefore, which is preferred in carrigeen by the purchaser of the prepared article, is entirely due to bleaching and repeated rinsing in fresh water.

Many Algæ, both of the *olive* and *red* series, and in a less perfect manner a few of the *grass-green* also, reflect prismatic colours when growing under water. In some species of *Cystoseira*, particularly in the European *C. ericoides* and its allies, these colours are so vivid that the dull olive-brown branches appear, as they wave to and fro in the water, to be clothed with the richest metallic greens and blues, changing with every movement, as the beams of light fall in new directions on them. Similar colours, but in a less degree, are seen on *Chondrus crispus* when growing in deep water; but here the prismatic colouring is often confined to the mere tips of the branches, which glitter like sapphires or emeralds among the dark purple leaves. The cause of these changeable colours has not been particularly sought after. The surface may be finely striated, but it does not seem to be more so than in other allied species, where no such iridescence has been observed. In the *Chondrus* the changeable tints appear to characterize those specimens only which grow in deep water, and which are stronger and more cartilaginous than those which grow in shallow pools.

Fresh water has generally a very strong action on the colours as well as on the substance of marine Algæ which are plunged into it. To many it is a strong poison, rapidly dissolving the gelatine which connects the cells, and dissolving also the walls of the cells themselves ; and that so quickly that in a few minutes one of these delicate plants will be dissolved into a shapeless mass of broken cells and slime. Many species which, when fresh from the sea, resist the action of fresh water, and may be steeped in it without injury for several hours, if again moistened after having once been dried, will almost instantly dissolve and decompose. This is remarkably the case with several species of *Gigartina* and *Iridæa*. The first effect of fresh water on the red colours of Algæ is to render them brighter and more clear. Thus *Dasya coccinea*, *Gelidium cartilagineum*, *Plocamium coccineum*, and others, are when recent of a very dark and somewhat dull red colour ; but when exposed either to showers and sunshine on the beach, or to fresh water baths in the studio of the botanist, become of various tints of crimson or scarlet, according as the process is continued for a less or greater length of time. At length the colouring matter would be expelled and the fronds bleached white, as occurs among the specimens cast up and exposed to the long continued action of the air ; but if stopped in time and duly regulated, the colours may be greatly heightened by fresh water. Some plants which are dull brown when going into the press, come out a fine crimson ; this is the case with *Delesseria sanguinea*, though that plant is not always of a dull colour when recent. Others, which are of the most delicate rosy hues when recent, become brown or even black when dried. This is especially the case in the order *Rhodomelaceæ*, so named from this tendency of their reds to change to black in drying. The tendency to become black, though it cannot be altogether overcome in these plants, may often be lessened by steeping them in fresh water for some time previous to drying. Hot water generally changes the colours of all Algæ to green, and if heat be applied during the drying process, an

artificial green may be imparted to the specimens ; but such a mode of preparation of specimens ought never to be practised by botanical collectors, though it may sometimes serve the purpose of makers of seaweed pictures.

THE FRUCTIFICATION

of the Algæ may be more conveniently described in the systematic portion of this work, when speaking of the various forms it assumes in the different families. I shall at present, therefore, limit myself to a very few general observations. The *spore* or reproductive gemmule of the Algæ is in all cases a simple cell, filled with denser and darker coloured endochrome (or colouring matter) than that found in other cells of the frond. In the simplest Algæ, where the whole body consists of a single cell, some gradually change and are converted into spores, without any obvious contact with others: but far more frequently, as in the *Desmidiaceæ* and *Diatomaceæ*, a spore is formed only by the conjugation of two cells or individual plants. When these simple vegetable atoms are mature, and about to form their fructification, two individuals are observed to approach ; a portion of the cell-wall of each is then extended into a tubercle at opposite points; these tubercles come into contact and at length become confluent ; the dissepiment between them vanishes, and a tube is thus formed connecting the two cavities together. Through this tube the matter contained in both the old cells is transmitted and becomes mixed ; changes take place in its organization, and at length a *sporangium* or new cell filled with spores is formed from it, either in one of the old cells, or commonly at the point of the connecting tube, where the two are soldered together. Then the old empty cells or plants die, and the species is represented by its *sporangium*, which may remain dormant, retaining vitality for a considerable time, as from one year to another, or probably for several years. These sporangia, which are abundantly formed at the close of the season of active growth, become buried in the mud at the bottoms of pools, where they are encased on the drying up of the water in summer, and are ready to develop into new fronds on the return of moisture in spring.

Many of the lower Algæ form fruit in this manner, to which the name *conjugation* is technically given. The thread-like Silk-weeds of ponds and ditches (*Zygnemata* and *Mougeotiæ*, &c.) are good examples of such a mode of fruiting. In these almost every cell is fertile, and when two threads are yoked together, a series of *sporangia* will be formed in one thread, while the other will be converted into a string of dead, empty cells. Before conjugation there was, seemingly, no difference between the contents of one set of cells and of the other ; so that there is no clear proof of the existence of distinct sexes in these plants, however much the process of fruiting observed among them may indicate an approach to it.

The process of fruiting in the higher Algæ appears to be very similar: namely, *spores* or *sporangia* appear to be formed by certain cells attracting to themselves the contents of adjacent cells; and in the compound kinds empty cells are almost always found in the neighbourhood of the fruit cells ; but with the complication of the parts of the frond, the exact mode in which spores are formed becomes more diffi-

cult of observation. At length, among the highest Algæ we encounter what appear to be really two sexes, one analogous to the anther and the other to the pistil of flowering plants. It would seem, however, that it is not each individual spore which is fertilized, as is the case in seed-bearing plants ; but that the fertilizing influence is imparted to the pistil or sporangium itself, when that body is in its most elementary form, long before any spore is produced in its substance, and even when it is itself scarcely to be distinguished from an ordinary cell. *Antheridia*, as the supposed fertilizing organs are called, are most readily seen among the *Fucaceæ*, and will be described under that family.

Besides the reproduction by means of proper spores, many Algæ have a second mode of continuing the species, and some even a third. Among the simpler kinds, where the whole body consists of a single cell, a fissiparous division, exactly similar to the fissiparous multiplication of cells among higher plants, takes place. This cell, as has been already mentioned, divides at maturity into two parts, which, falling asunder, become separate individuals. Similar self-division has been noticed among the lower *Palmellaceæ*, and in other imperfectly organized families. Such a mode of multiplying individuals is analogous to the propagation of larger plants by the process of gemmation, where buds are formed and thrown off to become new individuals. When, as in the *Lemna* or *Duckweed*, the whole vegetable body is as simple as a phanerogamous plant can well be, the new frondlets or buds are produced in a manner very strikingly analogous to the production of new fronds in *Desmidiaceæ*.

The third mode of continuing the species has been observed in many Algæ of the *green* series, in some of which sporangia are also formed, but in others no fructification other than what I am about to describe has been detected. This mode is as follows. In an early stage, the green matter, or *endochrome*, contained within the cells of these Algæ, is of a nearly homogeneous consistence throughout, and semi-fluid ; but at an advanced period it becomes more and more granulated. The granules when formed in the cells at first adhere to the inner surface of the membranous wall, but soon detach themselves and float freely in the cell. At first they are of irregular shapes, but they gradually become spheroidal. They then congregate into a dense mass in the centre of the cell, and a movement aptly compared to that of the swarming of bees round their queen begins to take place. One by one these active granules detach themselves from the swarm, and move about in the vacant space of the cell with great vivacity. Continually pushing against the sides of the cell wall, they at length pierce it, and issue from their prison into the surrounding fluid, where their seemingly spontaneous movements are continued for some time. These vivacious granules, or *zoospores* as they have been called, at length become fixed to some submerged object, where they soon begin to develop cells, and at length grow into Algæ similar to those from whose cells they issued.

Their spontaneous movements before and immediately subsequent to emission lead me to speak of the

MOVEMENTS OF ALGÆ

in general. These are of various kinds, and of greater or less degrees of vivacity

In some Algæ a movement from place to place continues through the life of the individual, while in others, as in the zoospores of which I have just spoken, it is confined to a short period, often to a few hours, in the transition state of the spore, after it escapes from the parent filament and until it fixes itself and germinates. Many observers have recorded these observations, which are to be found detailed in various periodicals.* I shall here notice only a few cases illustrative of the various kinds of movement. The most ordinary of these movements is effected by means of vibratile *cilia* or hairs, produced by the membrane of the spore, and which by rapid backward and forward motion, like that of so many microscopic oars, propel the body through the water in different directions, according as the movement is most directed to one side or the other. Sometimes the little spores, under the influence of these cilia, are seen to spin round and round in widening circles ; but at other times change of direction, pauses, accelerations, &c. take place during the voyage, which look almost like *voluntary* alterations, or as if the spore were guided by a principle of the nature of animal will. Hence many observers do not hesitate to call these moving spores *animalcules*, and to consider them of the same nature as the simpler infusorial animals.

This, as it appears to me, is a conclusion which ought not to be hastily assumed, not merely taking into consideration the extremely minute size of the little bodies to be examined, and the consequent danger of our being deceived as to the cause of movement, and of its interruption and resumption, but also remembering the facts ascertained by Mr. Brown, of the movement of small particles of all mineral substances which he examined. Many of the spores in question are sufficiently small to come under the Brownian law, though others are of larger size. Besides, if we regard the moving spores as animalcules, we must either adopt the paradox that a vegetable produces an animal, which is then changed into a vegetable, and the process repeated through successive generations, every one of these *vegetables* having been *animal* in its infancy ; or else, notwithstanding their strongly marked vegetable characteristics, we must remove to the animal kingdom all Algæ with moving spores.

Neither of these violent measures is necessary, if we admit that mere motion, apart from other characters, is no *proof* of animality. Though motion under the control of a will be indeed one of the charter privileges of the higher animals, we see it gradually reduced as we descend in the animal scale, until at last it is nearly lost altogether. Long before we reach the lowest circles in the animal world, we meet with animals which are fixed through the greater part of their lives to the rocks on which they grow, and some of them have scarcely any obvious movement on their point of attachment. In some the surface, like that of the Algæ-spores, is clothed with cilia which drive floating particles of food within reach of the mouth; in others even these rudimentary prehensile organs are dispensed with, and the animal exists as a scarcely irritable flesh expanded on a framework. This would seem to be the case in the corals of the genus *Fungia*, if the accounts given of those animals be correct ; while in the sponges the animal structure and organization are still further reduced, so as almost to contravene our preconceived notions of animal-will and

* See *Annales des Sciences Naturelles ; Taylor's Ann. Nat. Hist. ;* the *Linnæa*, *&c.* various volumes.

movement. But the sponges can scarcely be far removed from Fungia, nor can that be separated from other corals : so that, though I am aware some naturalists of eminence regard the sponges as vegetables, I cannot subscribe to that opinion, but rather view them as exhibiting to us animal organization in its lowest conceivable type, and parallel to vegetable organization, as that exists in the lowest members of the class of Algæ.

This hasty glance at the animal kingdom teaches us that voluntary motion is a character variable in degree, and at length reduced almost to zero within the animal circle. On the other hand, we know that movements of a very extraordinary character exist among the higher vegetables. Not merely the movement of the fluids of plants within their cells, which has at least some analogy with the motion of animal fluids ; but in such plants as the Sensitive-plant, the Venus's Flytrap *(Dionœa)*, and many others, movements of the *limbs* (shall I call them ?) as singular as those of the Algæ-spores, are sufficiently well known. And these movements are affected by narcotics in a manner strikingly similar to the operation of similar agents on the nervous system of animals. The common sensitive-plant, indeed, only shrinks from the touch, but in the *Desmodium gyrans* a movement of the leaves on their petioles is habitually kept up, as if the plant were fanning itself continually. Such vegetable movements as these strike us by their rapidity, but others of a like nature only escape us by their slowness. Thus the opening of the leaves of many plants in sunlight and their closing regularly in the evening in sleep ; the constant turning of the growing points towards the strongest light, and other changes in position of various organs, are all vegetable movements which would appear as *voluntary* as those of the Algæ spores if they were equally rapid. Their extreme slowness alone conceals their true nature.

So then we find animals in which *motion* is reduced almost to a nullity ; and vegetables as high in the scale as the *Leguminosæ* exhibiting well marked movements, facts which sufficiently establish the truth of our position that *mere motion* is no proof of animality. But subtracting their movements from the Algæ-spores, what other proof remains of their being animalcules ? None whatever. They do not resemble animalcules either in their internal structure, their chemical composition, or their manner of feeding ; and their vegetable nature is sufficiently marked by their decomposing carbonic acid, giving out oxygen in sunlight, and containing starch.

In the *Vaucheria clavata*, one of the species in which spores moved by cilia were first observed, the spore is formed at the apices of the branches. The frond in this plant is a cylindrical, branching cell, filled with a dense, green endochrome. A portion of the contained endochrome immediately at the tips separates from that which fills the remainder of the branch ; a dissepiment is formed, and that portion cut off from the rest gradually consolidates into a spore, while the membranous tube enlarges to admit of its growth. The young spore soon becomes elliptical, and at length, being clothed with a skin and ready for emission, it escapes through an opening then formed at the summit of the branch. The whole surface of the spore, when emitted, is seen to be clothed with vibratile cilia whose vibrations propel it through the water until it reaches a place suitable for germination.

The eilia then disappear, and the spore beeoming quieseent, at length developes into a branching cell like its parent. The history of other moving spores is very similar, the eilia, however, varying much in number in different speeies ; eommonly they are only two, which are sometimes inserted as a pair, at one end of the spore, but in other cases plaeed one at each end.

There are other Algæ in whieh vibratile cilia have not been observed, but which yet have very agile movements. Among these the most remarkable are the *Oscillatoriæ* and their allies, which suddenly appear and disappear in the waters of lakes and ponds, and sometimes rise to the surface in sueh prodigious numbers as to eolour it for many square miles. In *Oscillatoria* eaeh individual is a slender, rigid, needle-shaped thread, formed of a single eell, filled with a dense endochrome which is annulated at short intervals, and which eventually separates into lentieular spores. Myriads of such threads eongregate in masses, eonnected together by slimy matter, in whieh they lie, and from the borders of which, as it floats like a scum on the water, they radiate. Eaeh thread, loosely fixed at one end in the slimy matrix, moves slowly from side to side, deseribing short ares in the water, with a motion resembling that of a pendulum ; and, gradually beeoming detached from the matrix, it is propelled forward. These threads are continually emitted by the stratum, and diffused in the water, thus rapidly eolouring large surfaees. When a small portion of the matrix is placed over-night in a vessel of water, it will frequently be found in the morning that filaments emitted from the mass have formed a pellicle over the whole surface of the water, and that the outer ones have pushed themselves up the sides, as far as the moisture reaches.

The Oseillatoriæ, though most common in fresh water, are not peculiar to it. Some are found in the sea, and others in boiling springs, impregnated with mineral substances. It has been ascertained that the red eolour which gives name to the Arabian Gulf is due to the presenee of a mieroseopie Alga *(Trichodesmium erythræum)*, allied to Oscillatoria, and endowed with similar motive powers, whieh oeeasionally permeates the surface-strata of the water in sueh multitudes as eompletely to redden the sea for many miles. The same or a similar species has been noticed in the Paeifie Oeean in various places, by almost every eireumnavigator since the time of Cook, who tells us his sailors gave the little plant the name of "sea sawdust." Mr. Darwin compares it to minute fragments of chopped hay, eaeh fragment consisting of a bundle of threads adhering together by their sides.

These minute plants move freely through the water, rising or sinking at intervals, and when closely examined they exhibit motions very similar to those of *Oscillatoriæ*. There are several of such quasi-animal-plants now known to botanists, and almost all belong to the *green* series of the Algæ, which are placed in our system at the extreme base of the vegetable seale of being.

HABITAT.

The *habitat* or plaee of growth of the Algæ is extremely various. Wherever moisture of any kind lies long exposed to the air, Algæ of one group or other are found in it. I have already alluded to the *Hygrocrocis*, so troublesome in vats of

sulphate of copper, and many, perhaps almost all other chemical solutions, become filled in time, and under favorable circumstances, with a similar vegetation. The waters of mineral springs, both hot and cold, have species peculiar to them. Some, like the Red snow plant, diffuse life through the otherwise barren snows of high mountain peaks and of the polar regions; and on the surface of the polar ice an unfrozen vegetation of minute Algæ finds an appropriate soil. There are species thus fitted to endure all observed varieties of temperature. Moisture and air are the only essentials to the development of Algæ. It has even been supposed that the minute *Diatomaceæ* whose bodies float through the higher regions of the atmosphere, and fall as an impalpable dust on the rigging of ships far out at sea, have been actually developed in the air; fed on the moisture semicondensed in clouds; and carried about with these "lonely" wanderers.

When this atmospheric dust was first noticed, naturalists conjectured that the fragments of minute Algæ of which the microscope showed it to be composed, had been carried up by ascending currents of air either from the surface of pools, or from the dried bottoms of what had been shallow lakes. But a different origin has recently been attributed to this precipitate of the atmosphere by Dr. F. Cohn, Professor Ehrenberg, and others, who now regard it as evidence of the existence of organic life in the air itself! This opinion is founded on the alleged fact, that atmospheric dust, collected in all latitudes, from the equator to the circumpolar regions, consists of remains of the same species, and that certain characteristic forms are always found in it, and are rarely seen in any other place. Hence it is inferred that the dust has a common origin, and its universal diffusion round the earth points to the air itself as the proper abode of this singular fauna and flora,—for minute animals would seem to accompany and doubtless to feed upon the vegetable atoms. If this be correct, and not an erroneous inference from a misunderstood phenomenon, it is one of the most extraordinary facts connected with the distribution and maintenance of organic life.

If Algæ thus people the finely divided vapour that floats above our heads, we shall be prepared to find them in all water condensed on the earth. The species found on damp ground are numerous. These are usually of the families *Palmellaceæ* and *Nostochaceæ*. To the latter belong the masses of semi-transparent green jelly so often seen among fallen leaves on damp garden walks, after continued rains in autumn and early winter. These jellies are popularly believed to fall from the atmosphere, and by our forefathers were called *fallen stars*.* If such be their origin, we are tempted to address them, with Cornwall in King Lear,

"Out vile jelly! where is thy lustre now?"

for certainly nothing can well be less star-like than a Nostoc, as it lies on the ground.

An appeal to the microscope reveals beauty indeed in this humble plant, but gives no countenance to the popular belief of its meteoric descent. It is closely related in structure to other species found under dripping rocks and in lakes and ponds,

* Other substances besides Nostocs occasionally get this name. Masses of undeveloped frog-spawn, for instance, dropped by buzzards and herons, pass for meteoric deposits.

and the only reason for regarding it as an aerial visitant is the suddenness of its appearance after rain.

In certain moist states of the atmosphere, accompanied by a warm temperature, the Nostoc grows very rapidly; but what seems a *sudden* production of the plant has possibly been long in preparation unobserved. When the air is dry the growth is intermitted, and the plant shrivels up to a thin skin, but on the return of moisture this skin expands, becomes gelatinous, and continues its active life. And as this process is repeated from time to time, it may be that the large jelly which is found after a few days rain is of no very recent growth. A friend of mine who happened to land in a warm dry day on the coast of Australia, and immediately ascended a hill for the purpose of obtaining a view of the country, was overtaken by heavy rains; and was much surprised to find that the whole face of the hill quickly became covered with a gelatinous Alga, of which no traces had been seen on his ascent. In descending the hill in the afternoon, on his return to the ship, he was obliged to slide down through the slimy coating of jelly, where it was impossible to proceed in any other way. No doubt, in this case, a species of *Nostoc* which had been unnoticed when shrivelled up had merely expanded with the morning's rain.

Where water lies long on the surface of the ground, as happens in cases of floods, it quickly becomes filled with *Confervæ* or *Silk-weeds*, which rise to the surface in vast green strata. These simple plants grow with great rapidity, using up the materials of the decaying vegetation which is rotting under the inundation, and thus they in great measure counteract the ill effects to the atmosphere of such decay. When the water evaporates, their filaments, which consist of delicate membranous cells, shrivel up and become dry, and the stratum of threads, now no longer green, but bleached into a dull white, forms a coarsely interwoven film of varying thickness, spread like great sheets of paper over the decaying herbage. This *natural paper*, which has also been described under the name of *water flannel*, sometimes covers immense tracts, limited only by the extent of the flood in whose waters it originated.

But though Algæ abound in all reservoirs of fresh water, the waters of the sea are their peculiar home; whence the common name "Seaweeds," by which the whole class is frequently designated. Very few other plants vegetate in the sea, seawater being fatal to the life of most seeds; yet some notable exceptions to this law (in the case of the cocoa nut, mangrove, and a few other plants) serve a useful purpose in the economy of nature.

The sea in all explored latitudes has a vegetation of Algæ. Towards the poles, this is restricted to microscopic kinds, but almost as soon as the coast rock ceases to be coated with ice, it begins to be clothed with *Fuci*: and this without reference to the mineral constituents of the rock, the Fucus requiring merely a resting place. Seaweeds rarely grow on sand, unless when it is very compact and firm. There are, therefore, submerged sandy deserts, as barren as the most cheerless of the African wastes. And when such barrens interpose, along a considerable extent of coast, between one rocky shore and another, they oppose a strong barrier to the dispersion of species, though certainly not so strong as the aerial deserts; because

the waters which flow over submarine sands will carry the spores of the Algæ with less injury than the winds of the desert will convey the seeds of plants from one oasis to another. It cannot, however, be doubted that submerged sands do exercise a very material influence on the dispersion of Algæ, or their

GEOGRAPHICAL DISTRIBUTION.

Climate has an effect on the Algæ as upon all other organic bodies, though its influence is less perceptible in them than in terrestrial plants, because the temperature of the sea is much less variable than that of the air. Still, as the temperature of the ocean varies with the latitude, we find in the marine vegetation a corresponding change, certain groups, as the *Laminariæ*, being confined to the colder regions of the sea; and others, as the *Sargassa*, only vegetating where the mean temperature is considerable.

These differences of temperature and corresponding changes of marine vegetation, which are mainly dependent on actual distance from the equatorial regions, are considerably varied by the action of the great currents which traverse the ocean, carrying the waters of the polar zone toward the equator, and again conveying those of the torrid zone into the higher latitudes. Thus, under the influence of the warm waters of the Gulf Stream, Sargassum is found along the east coast of America as far as Long Island Sound (Lat. 44°). And again, the cold south-polar current which strikes on the western shores of South America, and runs along the coasts of Chili and Peru, has a marked influence on the marine vegetation of that coast, where *Lessonia*, *Macrocystis*, *Durvillæa*, and *Iridæa*, characteristic forms of the marine flora of Antarctic lands, approach the equator more nearly than in any other part of the world.

The influence of currents of warmer water is also observable in the submarine flora of the west coast of Ireland, where we find many Algæ abounding in lat. 53°, which elsewhere in the British Islands are found only in the extreme south points of Devon and Cornwall. These, and other instances which might be given, are sufficient to show that average temperature has a marked influence in determining the marine vegetation of any particular coast.

Seasons of greater cold or heat than ordinary have, as might be inferred, a corresponding action. This is particularly noticeable among the smaller and more delicate kinds which grow within tide marks, and are found in greater luxuriance or in more abundant fruit in a warm than in a cold season. And the difference becomes more strongly marked when the particular species is growing near the northern limit of its vegetation. Thus in warm summers, *Padina Pavonia* attains, on the south coast of England, a size as large as it does in sub-tropical latitudes; while in a cold season it is dwarf and stunted.

In speaking of the difference in colour of Algæ, I have already noticed the prevalence of particular colours at different depths of water. A corresponding change of specific form takes place from high to low water mark; and as the depth increases, the change is strikingly analogous to what occurs among land plants at different elevations above the sea. Depth in the one case has a correspondent

effect to height in the other ; and the Algæ of deep parts of the sea are to those of tidal rocks, as alpine plants are to littoral ones. In both cases there is a limit to the growth of species ; each ærial species having a line above which it does not vegetate, and each marine one, a line beyond which it does not descend. And as, at last, we find none but the least perfect lichens clothing the rocks of high mountains, so in the sea beyond a moderate depth are found no Algæ of higher organization than the *Diatomaceæ*.

These latter atomic plants would appear to exist in countless numbers at very extraordinary depths, having been constantly brought up by the lead in the deep sea soundings recorded in Sir James Ross's Antarctic voyage. But ordinary sea plants cease to vegetate in comparatively shallow water, long before animal life ceases. The limits have not been accurately ascertained, and are probably much exaggerated as commonly given in books.

Lamouroux speaks of ordinary Algæ growing at 100 to 200 fathoms, but we have no exact evidence of the existence of these plants at this great depth. The *Macrocystis*, the largest Alga known, has sometimes been seen vegetating in 40 fathoms *(Hook. Fl. Ant. vol. 2, p. 464)* water, while its stems not merely reached the surface, but rose at an angle of 45° from the bottom, and streamed along the waves for a distance certainly equal to several times the length of the " Erebus ;" data which, if correct, give the total length of stem at about 700 feet. Dr. Hooker, however, considers this an exceptional case, and gives from eight to ten fathoms as the utmost depth at which submerged seaweed vegetates in the southern temperate and Antarctic ocean ; a depth which is probably much exceeded in the tropics, and which is at least equalled by Algæ of the north temperate zone.

Humboldt, in his " Personal Narrative" mentions having dredged a plant to which he gave the name *Fucus vitifolius*, (probably a *Codium* or *Flabellaria*) in water 32 fathoms deep, and remarks that, notwithstanding the weakening of the light at that depth, the colour was of as vivid a green as in Algæ growing near the surface. I possess a specimen of *Anadyomene stellata* dredged at the depth of 20 fathoms, in the Gulph of Mexico, by my venerable friend the late Mr. Archibald Menzies, and it is as green as specimens of the same plant collected by me between tide marks at Key West, and is much more luxuriant.

Professor Edward Forbes, whose admirable report on the Ægean Sea should be consulted by all persons interested in the distribution of life at various depths, dredged *Constantinea reniformis*, Post. and Rupr. in 50 fathoms, the greatest depth perhaps on record, as accurately observed, at which ordinary Algæ vegetate. I say, ordinary Algæ, for it will be remembered that Diatomaceæ exist in the profound abysses of the ocean, as far as we are acquainted with them.

And besides these microscopic vegetables, Algæ of a group called *Nullipores* or *Corallines (Corollinaceæ)*, long confounded with the Zoophytes, become more numerous as other Algæ diminish, until they characterize a zone of depth where they form the whole obvious vegetation. These remarkable plants assimilate the muriate of lime of seawater and form a carbonate in their tissues, which from the great abundance of this deposit become stony. The less perfect Nullipores are scarcely distinguishable, by the naked eye, from any ordinary calcareous incrus-

tation, and strongly resemble the efflorescent forms, like cauliflowers, seen so frequently in the sparry concretions of limestone caverns. Others, more perfect, become branched like corals ; and the most organised of the group, or the true corallines, have symmetrical, articulated fronds. This stony vegetation affords suitable food to hosts of zoophytes and mollusca, which require lime for the construction of their skeletons or shells, and it probably extends to a depth as great as such animals inhabit.

When the same species is found at different depths, there is generally a marked difference between the specimens. Thus, when an individual plant grows either in shallower or in deeper water than that natural to the species, it becomes stunted or otherwise distorted. I have noticed in many species (as in *Plocamium coccineum*, *Dasya coccinea*, *Laurencia dasyphylla*, various *Hypneæ*, and many others) that the specimens from deep water have divaricated branches and ramuli, and a tendency to form both hooks and discs or supplementary roots, from various points of the stem and branches. Sometimes the outward habit is so completely changed by the production of hooked processes and discs, that it is difficult to discover the affinity of these distorted forms ; and such specimens have occasionally been unduly elevated to the rank of species.

When water of great depth intervenes, on a coast between two shallower parts of the sea, it frequently limits the distribution of species, acting as a high mountain range would in the distribution of land plants ; but in a far less degree; as it is obviously easier for the spores of the Algæ to be floated across the deep gulf, than for the seeds of land plants to pass the snowy peaks of a mountain.

The intervention of sand, already alluded to, is a far greater barrier, because sandy tracts are usually of much greater extent than submarine obstacles of any other kind. To the prevalence of a sandy coast, in a great measure probably, is owing the very limited distribution of the *Fucaceæ* on the eastern shores of North America, where plants of this family are scarcely found from New York to Florida. Since the erection of a breakwater at Sullivan's Island, S. C., many Algæ not before known in those waters have, according to Professor L. R. Gibbes's authority, made their appearance, but none of the Fucaceæ are yet among them. In due time *Sargassum vulgare* will probably arrive from the south.

Some attempt has been made to divide the marine flora into separate regions, the particulars of which I have detailed elsewhere.* In the descriptive portion of this work I shall notice the distribution of the several families, where it offers any marked peculiarity, and I shall at present confine myself to some remarks on the distribution of Algæ along the eastern and southern shores of the United States ; here recording the substance of some verbal observations which I made at the Meeting of the American Association, held in Charleston, in March, 1850.

EASTERN SHORES OF NORTH AMERICA.

In comparing the marine vegetation of the opposite shores of the northern Atlantic,

* *Manual of British Marine Algæ*, *Introd.*, p. xxxvi. et seq. ed. 2.

a great resemblance is observed between the ordinary seaweeds that clothe the rocks on the eastern and western sides ; with this difference, that the species do not reach so high a latitude on the American shore as on the European. The reason of this will be readily understood by inspecting a physical map of the Atlantic, on which Humboldt's Isothermal lines, or lines of mean annual temperature, are laid down. For then it will at once be seen that there is a very considerable bending of the Isothermal lines in favour of the continent of Europe. Thus the same line that runs through New York, in lat. 41°, strikes the shores of Europe in the North of Ireland, lat. 54°. And though there is less difference in mean temperature in the southern parts of the continents than in the northern, still there is a marked difference throughout.

With respect to vegetation, *Laminaria longicruris* is common on the American shore—at least as far south as Cape Cod (lat. 42°) ; while on the European it has not been found south of Norway, save some stray, waterworn stems occasionally cast on the north of Ireland or Scotland.

Rhodymenia cristata, so very abundant in Boston harbour, (42° 30′), where it enters largely into the composition of *seaweed pictures*, is rarely found in Europe south of Iceland and the northern parts of Norway ; its most southern limit being in the Frith of Forth, (56°), where it has been found but once or twice.

Delesseria hypoglossum has not been observed in America north of Charleston, (lat. 33°), while in Europe it occurs in Orkney, (lat. 59°), and is in great profusion and luxuriance on the north coast of Ireland in lat. 55°. The distribution of this species on the American shore is very anomalous if Charleston be its northern limit, for it certainly extends southward at least to Anastasia Island, (lat. 29° 50′). In the British seas it is most luxuriant on the Antrim shore, (55°), where its fronds are sometimes three feet in length ; southern specimens are generally much smaller, and in Devonshire it rarely measures more than three or four inches, which is the average size of specimens from the south of Europe, as well as of those found in Charleston harbour. If we are correct in limiting the American distribution of this species northward by Charleston, we have the remarkable fact that the greatest latitude attained by *Del. hypoglossum* in the north-western Atlantic is less by about 5° or 6° than the *southern* limit of the same species on the north-eastern, and by about 27° than the northern boundary of its distribution. This indicates a range which the isothermal lines can scarcely explain ; for the line which runs through Charleston strikes the coast of Spain. It is the more remarkable in this species, because the genus *Delesseria* is most numerous in the colder parts of the sea, its finest species being natives of Northern Europe and of Cape Horn and the Falkland Islands ; and, as we have seen, this very *D. hypoglossum* is no where of greater size or in greater plenty than in latitude 55° on the Irish coast.

It is different with *Padina Pavonia*, itself a tropical form, and belonging to a group peculiarly lovers of the sun. We are not surprised that in America this plant should not grow further north than the Keys of Florida, although, under some peculiarly favourable circumstances, it attains a limit 27° further north, on the south coast of England ; for in the land-vegetation of the two coasts there is something like an approach to similar circumstances, *oranges* and *citrons* being

occasionally ripened in the open air in Devonshire, and *Magnolia grandiflora* attaining an arborescent size. The remaining marine vegetation of the Florida Keys, as we shall presently see, has a greater resemblance to that of the Mediterranean than to that of the British coasts ; and this is more in accordance with the land floras, in which palm trees are a feature in both countries.

Probably one half of the species of Algæ of the east coast of North America are identical with those of Europe—a very large portion when we contrast it with the strongly marked difference between the marine animals of the two shores ; the testacea, and to a great extent even the fishes of the two continents, being dissimilar. The European species, on the same length of coast, are greatly the more numerous, which appears to be owing to the prevalence of sands, nearly destitute of Algæ, along so great a length of the American shore, and particularly along that portion which, from its latitude, ought to produce the greatest variety of Algæ, were the local circumstances favourable to their growth.

As Algæ are little indebted for nourishment to the soil on which they grow, merely requiring a secure resting place and a sheltered situation, their number generally bears a proportion to the amount of indented rocks that border the coast. Stratified rocks are more favourable to their growth than loose boulders or stones ; but if the upper surface be smooth without cavities, it is either swept by the waves too rapidly to allow the growth of a vigorous vegetation ; or, in quiet places, it becomes uniformly clothed with some of the Fuci, or other *social* species, which cover the exposed surface with a large number of individuals, to the destruction of more delicate species. The rocks, then, most adapted for Algæ are those in which, here and there, occur deep cavities affording shelter from the too boisterous waves. In these, on the recess of the tide, a *tide pool* or rock basin preserves the delicate fronds from the action of the sun. The rare occurrence of such situations on the American coast is doubtless a reason of the comparative poverty of the marine flora.

This comparative poverty is observable even in the common littoral Fuci or Rock Kelp. In Northern Europe, besides several rarer kinds, six species (namely *Fucus serratus, vesiculosus, nodosus, canaliculatus ; Halidrys siliquosa ;* and *Himanthalia lorea*) are extremely common, four of them at least being found on every coast. In America, *Fucus vesiculosus* and *nodosus* alone are commonly dispersed ; *F. serratus* and *canaliculatus* have not yet been detected ; and the *Halidrys* and *Himanthalia* rest on very uncertain evidence: so that of the *six* common European kinds, only *two* are certainly found in America. This deficiency in *Fucaceæ* is, in degree, made up for in *Laminariaceæ*, of which family several are peculiar to the American shore, the most remarkable of which is the *Agarum* or Sea Colander.

Among the red Algæ (or *Rhodosperms)*, species with expanded, leaf-like fronds are proportionably less numerous than on the European side. *Delesseria sanguinea* is absent on the American shore, where its place is supplied by *D. Americana*, a species of equally brilliant colouring, but lower in organization, connecting *Delesseria* with *Nitophyllum*. This latter genus, of which there are so many fine European species, is scarcely known in North America. A few scraps of *Nitophylla* (almost too imperfect to describe), picked up at the mouth of the Wilmington

River, N. C., and at Key West, are all the evidenee we at present possess of the existence of that type of form on the North American shore. *Plocamium coccineum*, so abundant in Europe, and which is also widely dispersed in the Southern Oeean, extending from Cape Horn eastwards to New Zealand, has not that I am aware of been found on the American Atlantic coast, where its place seems taken by the equally brilliant *Rhodymenia cristata*. *Ceramium rubrum* is as common on the American as on the European coast, and many of the other common American *Rhodosperms* are natives of both continents.

The Green Algæ (*Chlorosperms*) are still more alike; but several of the American Cladophoræ (not yet fully explored) seem to be peculiar. *Codium tomentosum*, which is common to the shores of Europe from Gibraltar, in lat. 36°, to Orkney in lat. 60°, and perhaps further north, has yet been found only on the Florida Keys, (lat. 24°). Judging from its distribution in other parts of the world, particularly in the Pacific and Southern Oceans, one would have expeeted to find it all along the East coast of North America.

Perhaps it would be premature to indieate regions of Algæ into which the Eastern and Southern shores of the North American states may be divided, a few points only having as yet been carefully explored. Halifax Harbour, Massaehussetts Bay, Long Island Sound at several points from Greenport to New York, New York Harbour, and the neighbourhood of Charleston, S. C., are the chief points at which the materials for this essay have been collected on the East eoast. Our knowledge of southern Algæ is at present derived chiefly from a partial examination of the Florida Keys, by Dr. Wurdemann, Professor Tuomey, Dr. Blodgett and myself. I think it probable, however, that future researches will indieate four regions of distribution, as follows :—

1st. Coast north of Cape Cod, extending probably to Greenland. Among the characteristic forms of this region are the great Laminariæ, particularly *L. Longicruris*, one of the largest Algæ on the eoast, and *Agarum Turneri* and *pertusum*. Several of the rarer Fucaceæ seem also to be confined to this district. One of the most abundant and characteristic species of this tract is *Rhodymenia cristata*, which has not to my knowledge been found farther south than Cape Cod. Specimens said to have come from Staten Island have been shown to me, but the evidence on which the habitat of these rests is not satisfactory, and none of the Brooklyn and New York Algologists (a numerous and indefatigable band) have yet detected the plant in their harbour. *Ptilota plumosa* is also a plant of this region, the only speeies (as far as I know) that is met with in Long Island Sound being *P. sericea*, Gm. *Rhodomelæ* are more abundant here than in the Sound, but are not limited to this division; *Odonthalia* (a peculiarly northern form) has been seen only at Halifax. *Dumontia ramentacea*, so abundant at Iceland, is found also at Newfoundland, and near Halifax, where I gathered it plentifully. Of this plant I possess a single specimen, pieked up by Miss Frothingham on Rye Beach, New Hampshire. All the species I have mentioned are Arctic forms confined in the European waters to very high latitudes, and all appear to vegetate nearly as far south as Cape Cod, to which limits they are almost all confined. The Marine flora of this region as a whole bears a

resemblance to that of the shores of Iceland, Norway, Scotland, and the North and North West of Ireland.

2nd. Long Island Sound, including under this head New York Harbour and the sands of New Jersey.

The natural limit of this region on the south is probably Cape Hatteras, but after passing New York the almost unbroken line of sand is nearly destitute of Algæ. I have not received any collection of sea plants made between Long Branch and Wilmington. In comparing the plants of the sound with those of our 1st region, a very marked difference is at once seen. We lose the Arctic forms, *Agarum*, *Rhod. cristata*, *Odonthalia*, *Dumontia ramentacea* and *Ptilota plumosa*, whose place is supplied by *Sargassum*, of which genus two species are found at Greenport and at other points in the Sound; by various beautiful *Callithamnia* and *Polysiphoniæ;* and by abundance of *Delesseria Americana* and *Dasya elegans*. Those two latter plants are not limited to this region, but are greatly more abundant here than north of Cape Cod. *Del. Americana* seems almost to carpet the harbour of Greenport, and is equally abundant in various points in the Sound, and *Dasya elegans* grows to an enormous size in New York Harbour, and is plentiful throughout the region. *Seirospora Griffithsiana* is not uncommon; it grows luxuriantly at New Bedford, whence Dr. Roche has sent me many beautiful specimens of it, and of other *Ceramieæ*. *Rhabdonia Baileyi*, *Gracilaria multipartita*, (narrow varieties) *Chrysymenia divaricata* and *C. Rosea* are also characteristic forms. *Delesseria Leprieurii*, found in the Hudson at West Point, scarcely belongs to this region, but is a tropical form at its utmost limit of northern distribution.

3rd. Cape Hatteras to Cape Florida. Of the Algæ characterizing this region we know little except those found in the neighbourhood of Charleston, and a few specimens collected at Wilmington, N. C. and at Anastasia Island. Many species found within these limits are common to the second region; others are here met with for the first time. Of these the most remarkable are *Arthrocladia villosa* and a *Nitophyllum*, found at Wilmington; a noble *Grateloupia*, probably new *(G. Gibbesii*, MS.*)* found at Sullivan's Island, and *Delesseria hypoglossum*, already mentioned as occurring at Charleston and Anastasia Island. I have seen no Fucoid plant from this region; but if there were a suitable locality, we ought here to have *Sargassa*. None grow at Sullivan's Island, where *Grateloupia Gibbesii* is the largest sea plant, and the one most resembling a Fucus. All the æstuaries of this district produce *Delesseria Leprieurii*, and a *Bostrychia*, either *B. radicans*, Mont. or a closely allied species. These last are tropical forms first noticed on the shores of Cayenne, where the former was found both on maritime rocks, and on the culms of grasses in the æstuary of the Sinnamar river. With us these plants grow on the palmetto logs in Charleston Harbour, and on *Spartina glabra* as far up the river as the water continues sensibly salt. *Del. Leprieurii* was collected by Dr. Hooker at New Zealand, accompanied by a *Bostrychia*. No other habitats for it are known.

4th. Florida Keys, and Shores of the Mexican Gulf. Here we have a very

strongly marked province, strikingly contrasting in vegetation with the East Coast, comprised in the three regions already noticed. As yet the Keys have been very imperfeetly explored, and we are almost unaequainted with the marine vegetation of the main land of Florida, Alabama, Louisiana, and Texas. Of 130 species whieh I collected at Key West in February, 1850, scarcely one eighth are common to the east eoast, seven-eighths being unknown on the American shore to the north of Cape Florida. With this remarkable difference between the Algæ of the Keys and those of the East Coast, there is a marked affinity between the former and those of the South of Europe. The marine vegetation of the Gulf of Mexico has a very strong resemblance to that of the Mediterranean Sea. Nearly one third of the speeies which I eolleeted are eommon to the Mediterranean. Several of them straggle northwards along the eoast of Spain and Franee, and even reach the south of England ; but scareely any of these are seen on the East coast of America. We may hence infer that they are not eonveyed by the gulf-stream. My colleetion at Key West ineluded 10 Melanosperms, 5 of which are eommon to the Mediterranean ; 82 Rhodosperms, 25 of which are Mediterranean ; and 38 Chlorosperms, of whieh 10 are Mediterranean. Besides these identical species, there are many *representative* species closely allied to Mediterranean types. This resemblance is clearly shown in the genus *Dasya*, of which *seven* out of *eleven* European speeies are found in the Mediterranean. At Key West I collected eight species of this beautiful genus. Among these, seven were new, and the eighth (*D. elegans*) is found along the whole eastern coast of North Ameriea. Three-fourths perhaps of the masses of seaweed cast ashore at Key West belong to *Laurencia*, of which genus several species and innumerable puzzling varieties are profusely common. A fine *Hypnea (H. Wurdemanni*, MS.) one of the most striking species of the genus, is also abundant. *Alsidium triangulare*, *Digenia simplex*, *Acanthophora*, *Amansia multifida* and other common West Indian Rhodosperms are abundantly cast ashore. *Sargassum vulgare* and *bacciferum ; Padina Pavonia ; Zonaria lobata ;* and sundry *Dictyotæ* are characteristie melanosperms. But this region is chiefly remarkable for the abundance and beauty of its *Chlorosperms* of the groups *Siphonaceæ* and *Caulerpaceæ*. Ten species of *Caulerpa* were collected, some of which are of eommon occurrence, and serve for food to the turtles, which, in their turn are the staple article of diet of the islanders. *Penicillus* (at least three species) ; *Udotea ; Halimeda ; Acetabularia ; Anadyomene ; Dictyosphæria ; Chamædoris ; Dasycladus ; Cymopolia*, and others, some of which are West Indian, some Mediterranean, are evidence of the high temperature of the sea round the Keys. Many of the plants obtained by me at Key West were cast up from deeper water when the south wind blew strongly, and were not seen at any other time. A visitor, therefore, in the *hurricane months*, would probably obtain many which escaped me. Among the new species two *Delesseriæ*, (D. *involvens*, and *D. tenuifolia*) both belonging to the hypophyllous section, are specially worth notice. These were very plentiful in the beginning of February, but soon disappeared. Two *Bostrychiæ (B. Montagnei*, and *B. filicula*, MS.) and a *Catenella* were found on the

stems of mangroves near high water mark ; but it would extend this notice to too great a length, were I to enumerate all the forms which occur in this prolific region.

COLLECTING AND PRESERVING SPECIMENS.

I shall here reprint, for the convenience of the student, the substance of some directions for collecting and preserving specimens, issued by the Director of the Dublin University Museum.

Marine Algæ, as has already been stated, are found from the extreme of high water mark to the depth of from thirty to fifty fathoms ; which latter depth is perhaps the limit in temperate latitudes ; the majority of *deep water* species growing at five to ten fathoms. Those within the limits of the tidal influence are to be sought at low water, especially the lowest water of spring tides ; for many of the rarer and more interesting kinds are found only at the verge of low water mark, either along the margin of rocks partially laid bare, or, more frequently, fringing the deep tide-pools left at low water on a flattish rocky shore. The northern or shaded face of the tide-pool will be found richest in *red* algæ, and the most sunny side in those of an *olive* or *green* colour. Algæ which grow at a depth greater than the tide exposes, are to be sought either by dredging ; or by dragging after a boat an iron cross armed with hooks, on all shores where those contrivances can be applied ; but where the nature of the bottom, or the difficulty of procuring boats, renders dredging impossible, the collector must seek for deep-water species among the heaps of sea-wrack thrown up by the waves. After storms seaweed sometimes forms enormous banks along the coast ; but even in ordinary tides many delicate species, dislodged by the waves, float ashore, and may be picked up on the beach in a perfect state. The rocky portions of a coast should, therefore, be inspected at low water ; and the sandy or shingly beach visited on the return of the tide. In selecting from heaps we should take those specimens only that have suffered least in colour or texture by exposure to the air ; rejecting all bleached or half melted pieces.

Collectors should carry with them one or two strong glass bottles with wide mouths, or a handbasket lined with japanned tin or gutta percha, for the purpose of bringing home in *sea water* the smaller and more delicate kinds. This precaution is often absolutely necessary, for many of the *red* algæ rapidly decompose if exposed, even for a short time, to the air, or if allowed to become massed together with plants of coarser texture. The cooler such delicate species are kept the better; and too many ought not to be crowded together in the same bottle, as crowding encourages decomposition; and when this has begun, it spreads with fearful rapidity. These Algæ should be kept in sea water until they can be arranged for drying, and the more rapidly they are prepared the better. Many will not keep, even in vessels of sea water, from one day to another.

A common botanist's-vasculum, or an indian rubber cloth bag, will serve to bring home the larger and less membranous or gelatinous kinds ; but even these, if left long unsorted, become clotted together, and suffer proportionably.

In gathering Algæ from their native places, the *whole* plant should be plucked from the very base, and if there be an obvious root, it should be left attached. Young collectors are apt to pluck branches or mere scraps of the larger Algæ, which often afford no just notion of the mode of growth or natural habit of the plant from which they have been snatched, and are often insufficient for the first purpose of a *specimen*, that of ascertaining the plant to which it belongs. In many of the leafy Fucoid plants, *(Sargassa*, &c.) the leaves that grow on the lower and on the upper branches are quite different, and were a lower and an upper branch plucked from the same root, they might be so dissimilar as to pass for portions of different species. It is very necessary, therefore, to gather, when it can be done, *the whole plant, including the root.* It is quite true that the large kinds may be judiciously divided; but the young collector had better aim at selecting moderately sized specimens of the entire plant, than attempt the division of large specimens, unless he keep in view this maxim: every botanical specimen should be an epitome of the essential marks of a species.

Several duplicate specimens of every kind should always be preserved, and particularly where the species is a variable one. Very many Algæ vary in the comparative breadth of the leaves, and in the degree of branching of the stems; and when such varieties are noticed, a considerable series of specimens is often requisite to connect a broad and a narrow form of the same species. A neglect of this care leads to endless mistakes in the after work of identification of species, and has been the cause of burdening our systems with a troublesome number of synonymes.

Where it is the collector's object to preserve Algæ in the least troublesome manner, and in a rough state, to be afterwards laid out and prepared for pressing at leisure, the specimens fresh from the sea are to be spread out and left to dry in an airy, but not too sunny, situation. They are not to be washed or rinsed in fresh water, nor is their natural moisture to be squeezed from them. The more loosely and thinly they are spread out the better, and in dry weather they will be sufficiently dry after a few hours' exposure to allow of packing. In a damp state of the atmosphere the drying process will occupy some days. No other preparation is needed, and they may be *loosely* packed in paper bags or boxes, a ticket of the exact locality being affixed to each parcel. Such specimens will shrink very considerably in drying, and most will have changed colour more or less, and the bundle will have become very unsightly; nevertheless, if thoroughly dried, to prevent mouldiness or heating, and packed *loosely*, such specimens will continue for a long time in a perfectly sound state; and on being re-moistened and properly pressed, will make excellent cabinet specimens.

It is very much better, when drying Algæ in this rough manner, *not* to wash them in fresh water, because the salt they contain serves to keep them in a pliable state, and causes them to imbibe water more readily on re-immersion. All large and coarse growing Algæ may be put up in this manner, and afterwards, at leisure, prepared for the herbarium by washing, steeping, pressing, and drying between folds of soft paper, in the same way that land plants are pressed and dried. But with the membranous and gelatinous kinds, a different method must be adopted.

The smaller and more delicate Algæ must be prepared for the herbarium as

soon as practicable after being brought from the shore. The mode of preparation is as follows, and, after a few trials and with a little care, will soon be learned.

The collector should be provided with three flat dishes or large deep plates, and one or two shallower plates. One of the deep plates is to be filled with sea-water, and the other two with fresh water. In the dish of sea-water the stock of specimens to be laid out may be kept. A specimen taken from the stock is then introduced into one of the plates of fresh water, washed to get rid of dirt or parasites that may infest it, and pruned or divided into several pieces, if the branches be too dense, or the plant too tufted, to allow the branches to lie apart when the specimen is displayed on paper. The washed and pruned specimens are then floated in the second dish until a considerable number are ready for laying down. They are then removed separately into one of the shallower plates, that must be kept filled with *clean* water ; in which they are floated and made to expand fully. Next a piece of white paper of suitable size is carefully introduced under the expanded specimen. The paper then, with the specimen remaining displayed upon it, is cautiously brought to the surface of the water, and gently and carefully drawn out, so as not to disarrange the branches. A forceps, a porcupine's quill, a knitting needle, or an etching tool, or any finely pointed instrument will assist the operator in displaying the branches and keeping them separate while the plant is lifted from the water ; and should any branch become matted in the removal, a little water dropped from a spoon over the tangled portion, and the help of the finely pointed tool, will restore it.

The piece of wet paper with the specimen upon it is to be laid on a sheet of soft soaking paper, and others laid by its side until the sheet is covered. A piece of thin calico or muslin, as large as the sheet of soaking paper, is then spread over the wet specimens. More soaking paper, and another set of specimens covered with cotton, are laid on these ; and so a bundle is gradually raised. This bundle, consisting of sheets of specimens, is then placed between flat boards, under moderate pressure, and left for some hours. It must then be examined, the specimens on their white papers must be placed on dry sheets of soaking paper, covered with fresh cloths, and again placed under pressure. And this process must be repeated every day until the specimens are fully dry.

In drying, most specimens will be found to adhere to the papers on which they have been displayed, and care must be taken to prevent their sticking to the pieces of cotton cloth laid over them. Should it be found difficult to remove them from the muslin, it is better to allow them to dry, trusting to after-removal, than to tear them away in a half-dried state, which would probably destroy the specimens. A few dozen pieces of unglazed thin cotton cloth of proper size should always be at hand, (white muslin, that costs six or eight cents per yard, answers very well). These cloths will be required only in the first two or three changes, for when the specimen has begun to dry on the white paper it will not adhere to the soaking paper laid over it. In warm weather the smaller kinds will often be found perfectly dry after forty-eight hours' pressure, and one or two changes of papers.

USES OF THE ALGÆ.

The uses of the Algæ may be considered under two points of view, namely, the general office which this great class of plants, as a class, discharges in the economy of nature; and those minor useful applications of separate species which man selects on discovering that they can yield materials to supply his various wants.

The part committed to the Algæ in the household of nature, though humble when we regard them as the lowest organic members in that great family, is not only highly important to the general welfare of the organic world, but, indeed, indispensable. This we shall at once admit, when we reflect on the vast preponderance of the ocean over the land on the surface of the earth, and bear in mind that almost the whole submarine vegetation consists of Algæ. The number of species of marine plants which are not Algæ proper is extremely small. These on the American coast are limited to less than half a dozen, only one of which, the common *Eel Grass (Zostera marina)*, is extensively dispersed.

All other marine plants are referable to Algæ; the wide spread sea would therefore be nearly destitute of vegetable life were it not for their existence. Almost every shore—where shifting sands do not forbid their growth—is now clothed with a varied band of Algæ of the larger kinds; and microscopic species of these vegetables *(Diatomaceæ)* teem in countless myriads at depths of the ocean as great as the plummet has yet sounded, and where no other vegetable life exists. It is not, therefore, speaking too broadly to say that the sea, in every climate and at all known depths, is tenanted by these vegetables under one phase or other.

The sea, too, teems with animal life,—that "great and wide sea, wherein are things creeping innumerable, both small and great beasts," affords scope to hordes of animals, from the "Leviathan" whale to the microscopic polype, transparent as the water in which he swims, and only seen by the light of the phosphoric gleam which he emits. Now this exuberant animal creation could not be maintained without a vegetable substructure. It is one of the laws of nature that animals shall feed on organized matter, and vegetables on unorganised. For the support of animal life, therefore, we require vegetables to change the mineral constituents of the surrounding media into suitable nutriment.

In the sea this office of vegetation is almost exclusively committed to the Algæ, and we may judge of the completeness with which they execute their mission by the fecundity of the animal world which depends upon them. Not that I would assert that all, or nearly all, the marine animals are directly dependant on the Algæ for their food; for the reverse is notoriously the case. But in every class we find species which derive the whole or a part of their nourishment from the Algæ, and there are myriads of the lower in organization which do depend upon them altogether.

Among the higher orders of Algæ feeders I may mention the Turtles, whose *green fat*, so prized by aldermanic palate, may possibly be coloured by the unctuous green juices of the *Caulerpæ* on which they browse. But without further notice of those that directly depend on the Algæ, it is manifest that all must ultimately, though

indirectly, depend on whatever agency in the first instance seizes on inorganic matter, and converts it into living substance suitable to enter into the composition of animal nerve and muscle. And this agency is assuredly the office of the vegetable kingdom, here confined in the main to Algæ; we thus sufficiently establish our position that the Algæ are indispensable to the continuance of organic life in the sea.

As being the first vegetables that prey upon dead matter, and as affording directly or indirectly a pasture to all water animals, the Algæ are entitled to notice. Yet this is but one-half of the task committed to them. Equally important is the influence which their growth exerts on the water and on the air. The well-known fact that plants, whilst they fix carbon in an organized form in extending their bodies by the growth of cells, exhale oxygen gas in a free state, is true of the Algæ as of other vegetables. By this action they tend to keep pure the water in which they vegetate, and yield also a considerable portion of oxygen gas to the atmosphere. I have already stated that whenever land becomes flooded, or wherever an extensive surface of shallow water—whether fresh or salt—is exposed to the air, *Confervæ* and allied Algæ quickly multiply. Every pool, every stagnant ditch is soon filled with their green silken threads. These threads cannot grow without emitting oxygen. If you examine such a pool on a sunny day, you may trace the beads of oxygen on the submerged threads, or see the gas collect in bubbles where the threads present a dense mass. It is continually passing off into the air while the Confervæ vegetate, and this vegetation usually continues vigorous, one species succeeding another as it dies out, as long as the pool remains. And when, on the drying up of the land, the Confervæ die, their bodies, which are scarcely more than membranous skins filled with fluid, shrivel up, and are either carried away by the wind or form a papery film over the exposed surface of the ground. In neither case do they breed noxious airs by their decomposition. All their life long they have conferred a positive benefit on the atmosphere, and at their death they at least do no injury. The amount of benefit derived from each individual is indeed minute, but the aggregate is vast when we take into account the many extensive surfaces of water dispersed over the world, which are thus kept pure and made subservient to a healthy state of the atmosphere. It is not only vast, but it is worthy of Him who has appointed to even the meanest of His creatures something to do for the good of His creation.

These general uses of the Algæ, apparent as they are on a slight reflection, are apt to be overlooked by the utilitarian querist, who will see no use in anything which does not directly minister to his own wants, and who often judges of the use of a material by the dollars and cents which it brings to his pocket.

It would be in vain to adduce to him the indirect benefit derived to the rest of creation through the lower animals which the Algæ supply with food; for probably he would turn round with the further demand, "what is the *use* of feeding all these animals?" And he might think, too, that the amount of oxygen in the air was quite enough to last out at least his time, without such constant renovation as the Algæ afford, or that sufficient renovation would come from other sources had the Algæ never been created. "Show me," he would say, "how I can make money

of them, and then I will admit the *uses* of these vegetables." This I shall therefore now endeavour to do, by summing up a few of the uses to which Algæ have been applied by man.

Man, in his least cultivated state, seeks from the vegetable kingdom in the first place a supply for the cravings of hunger, and afterwards medicine or articles of clothing. As *food*, several species of Algæ are used both by savage and civilized man, but more frequently as condiments than as staple articles of consumption. Many kinds commonly found on the shores of Europe are eaten by the peasantry. The midrib of *Alaria esculenta*, stripped of the membranous wings, is eaten by the coast population of the north of Ireland and Scotland ; but to less extent than the dried fronds of *Rhodymenia palmata*, the *Dulse* of the Scotch and *Dillisk* of the Irish. This latter species varies considerably in texture and taste according to the situation in which it grows. When it grows parasitically on the stems of the larger *Laminariæ* it is much tougher and less sweet, and therefore less esteemed than when it grows among mussels and Balani near low water mark. It is this latter variety, which, under the name of " shell dillisk," is most prized. In some places on the west of Ireland, this plant forms the chief relish to his potatoes that the coast peasant enjoys ; but its use is by no means confined to the extreme poor. It is eaten occasionally, either from pleasure or from an opinion of its wholesomeness, by individuals of all ranks, but, except among the poor, the taste for it is chiefly confined to children. It is commonly exposed for sale at fruit stalls, in the towns of Ireland, and may be seen in similar places in the Irish quarters of New York. In the Mediterranean it forms a common ingredient in soups, but notwithstanding M. Soyer's attempt in the famine years to teach this use of it to the Irish, they have not yet learned to prefer it cooked. Occasionally, however, it is fried.

Chondrus crispus, the *Carrageen* or *Irish Moss* of the shops, is dissolved, after long boiling, into a nearly colourless insipid jelly, which may then be seasoned and rendered tolerably palatable. It is considered a nourishing article of diet, especially for invalids, and has been recommended in consumptive cases. At one time, before it was generally known to be a very common plant on rocky coasts, it fetched a considerable price in the market. Though called " Irish moss," it is abundant on all the shores of Europe and of the Northern States of America. It is, perhaps, most palatable when prepared as a blanc-mange with milk, but it should be eaten on the day it is made, being liable, when kept, to run to water. Its nourishing qualities have been tested, I am informed, in the successful rearing of calves and pigs partly upon it.

Many other species, particularly various kinds of *Gigartina* and *Gracilaria*, yield similar jellies when boiled, some of which are excellent.

Gracilaria lichenoides, the *Ceylon Moss* of the East, where it is largely used in soups and jellies ; and *G. Spinosa*, the *Agar-Agar* (or Agal-Agal) of the Chinese, are among the most valuable of these. They are extensively used and form important articles of traffic in the East. Another species of excellent quality, the *Gigartina speciosa* of Sonder, is collected for similar purposes by the colonists of Swan River.

It was at one time supposed that the famous edible birds' nests of China, the

finest of which sell for their weight in gold, and enter into the composition of the most luxurious Chinese dishes, were constructed of the semi-decomposed branches of some Alga of one or other of the above named genera ; but it has since been ascertained that these nests consist of an animal substance, which is supposed to be disgorged by the swallows that build them.

Nearly all the cartilaginous kinds of Rhodospermeæ will boil down to an edible jelly. One kind is preferred to another, not from being more wholesome, but from yielding a stronger and more tasteless gelatine. The latter quality is essential ; for though the skill of the cook can readily impart an agreable flavour to a tasteless substance, it is more difficult to overcome the smack of an unsavoury one. And the main quality which gives a disrelish to most of our Algæ-jellies and blanc-manges, is a certain bitterish and sub-saline taste which can rarely be altogether removed.

Very few Algæ have been found agreeably tasted when cooked, though *Dillisk* and others are pleasantly sweet when eaten raw. Many which, when moistened after having been dried, exhale a strong perfume of violets, are altogether disappointing to the palate.

Perhaps, after all, the most valuable as articles of food are the varieties of *Porphyra vulgaris* and *P. laciniata*, which in winter are collected on the rocky shores of Europe, and by boiling for many hours are reduced to a dark brown, semi-fluid mass, which is brought to table under the name of *marine sauce*, *sloke*, *slouk*, or *sloucawn*. It is eaten with lemon juice or vinegar, and its flavour is liked by most persons who can overcome the disgust caused by its very unpleasant aspect. At some of the British establishments for preserving fresh vegetables, it is put up in hermetically sealed cases for exportation and use at sea, or for use at seasons when it cannot be obtained from the rocks. It is collected only in winter, at which season the membranous fronds, which are found in a less perfect state in summer, are in full growth. Both species of *Porphyra* grow abundantly on the rocky shores of North America. They not only furnish an agreeable vegetable sauce, but are regarded as antiscorbutic, and said to be useful in glandular swellings, perhaps from the minute quantity of iodine which they contain.

As articles of food for man, other seaweeds might be mentioned, but I admit that none among them furnish us directly with valuable esculents ; though many less nauseous than the hunter's "*Tripe de Roche*," are sufficiently nourishing to prolong existence to the shipwrecked seaman; and others, like the *Porphyræ* just mentioned, are useful condiments to counteract the effects of continued subsistence on salt-junk.

But if not directly *edible*, there are many ways in which they indirectly supply the table. As winter provender for cattle, some are in high esteem on the northern shores of Europe. In Norway and Scotland the herds regularly visit the shores, on the recess of the tide, to feed on *Fucus vesiculosus* and *F. serratus*, which are both also collected and boiled by the Norwegian and Lapland peasants, and when mixed with coarse meal given to pigs, horses, and cattle. These Fuci are both grateful and nourishing to the animals, which become very partial to such food. Yet, perhaps, they are only the resources of half-fed beasts, and would possibly be

blown on by a stall-fed "short-horn" that looks for vegetables of a higher order.

To obtain such food for the high bred cow, the Algæ must be applied in another way—namely, as manure. For this purpose they are very largely used in the British Islands, where "sea-wrack" is carried many miles inland, and successfully applied in the raising of green crops. On the west coast of Ireland the refuse of the sea furnishes the poor man with the greater part of the manure on which he depends for raising his potatoes. All kinds of seaweed are indiscriminately applied; but the larger kinds of *Laminariæ* are preferred. As these rapidly decompose and melt into the ground, they should, in common with other kinds, be used fresh, and not suffered to lie long in the pit, where they soon lose their fertilizing properties. The crops of potatoes thus raised being generally abundant, but the quality rarely good, sea-wrack is more suitable to the coarser than to the finer varieties of the potato. It is, however, considered excellent for various green crops, and a good top dressing for grass land, and its use is by no means confined to the poorer districts. The employment of sea-wrack is limited only by the expense of conveying so bulky a material to a distance from the sea or a navigable river.

Though the agricultural profits derived from the Algæ are considerable, a still larger revenue was once obtained by burning the *Fuci*, and collecting their ashes as a source of carbonate of soda, a salt which exists abundantly in most of them. *Fucus vesiculosus*, *nodosus* and *serratus*, the three commonest European kinds, yielded, up to a recent period, a very considerable rental to the owners of tidal rocks on the bleakest and most barren islands of the north of Scotland, and on all similar rocky shores on the English and Irish coasts. A single proprietor (Lord Macdonald) is said to have derived £10,000 per annum, for several successive years, from the rent of his *kelp* shores; and the collecting and preparation of the *kelp* afforded a profitable employment to many thousands of the inhabitants of Orkney, Shetland, and the Hebrides.

During the last European war, when England was shut out from the markets from which a supply of soda was previously obtained, almost the whole of the alkali used by soap-boilers was derived from the *kelp* or sea-weed ashes collected in Scotland. The quantity annually made in favourable years, between 1790 and 1800, amounted on the authority of Dr. Barry* to 3,000 tons, which then fetched from £8 to £10 sterling per ton; but at a later period of the war rose from £18 to £20. It is also stated by the same author that within the 80 years, from 1720 to 1800, which succeeded the first introduction of the kelp trade, the enormous sum of £595,000 was realized by the proprietors of kelp shores and their tenants' and labourers.

Yet so great was the prejudice of the islanders against this lucrative trade, when first proposed to them, "and," to quote Dr. Greville, "so violent and unanimous was the resistance, that officers of justice were found necessary to protect the individuals employed in the work. Several trials were the consequences of these outrages. It was gravely pleaded in a court of law, 'that the suffocating smoke that issued from the kelp kilns would sicken or kill every species of fish on the

* History of the Orkney Islands, p. 383 (as quoted by Greville, see Alg. Brit. Introd. p. xxi. et seq.)

coast, or drive them into the ocean far beyond the reach of the fishermen ; blast the corn and grass on their farms ; introduce diseases of various kinds ; and smite with barrenness their sheep, horses and cattle, and even their own families.'" We smile at the ignorant bigotry of these poor people ; but have we never heard as great misfortunes predicted of almost every new improvement of the age we live in, and that not by unlettered peasantry, but by persons calling themselves wise, learned, and refined? As sad stories have been told against temperance, free trade, or even against the exhibition in the Crystal Palace.

The Orkney islanders were not long in finding the golden harvest which had thus in the first instance been forced upon them, and within a few years "Prosperity to the kelp trade!" was given as the leading toast on all their festive occasions. This state of prosperity lasted until the general peace, when the foreign markets being thrown open, *barilla* came into competition with the home produce. The manufacture of kelp gradually declined as the price fell, and now it has nearly ceased altogether, for besides the competition with *barilla*, the modern process by which soda is readily procured from rock-salt has brought another rival into the field, and one against which it seems in vain to contend.

Kelp is still made on a small scale for local consumption, and is sometimes exported as manure, but at a very low price. It is not likely ever to rise again into importance, except as a source of *Iodine*, which singular substance was first discovered in a soap-ley made with kelp ashes. Iodine has now become almost indispensable, from its medicinal value, as well as from its use in the arts and manufactures, and has been found in greater quantity in the fronds of certain littoral Algæ than in any other substances. It is therefore possible that for producing this substance these kelp-weeds may again become of mercantile importance. As a remedy in cases of glandular swellings, the use of Iodine is now well established, and it is a singular fact that several littoral Fuci have been from early times considered popular remedies in similar affections. *Fucus vesiculosus* has long been used by the hedge-doctors to reduce such swellings ; and Dr. Greville mentions, on the authority of the late Dr. Gillies, that the "stems of a seaweed are sold in the shops, and chewed by the inhabitants of South America wherever goitre is prevalent, for the same purpose. This remedy is termed by them Palo Coto (literally Goitre-stick)," and Dr. Greville supposes, from the fragments which he had seen, that it is a species of Laminaria.

Iodine however, though the most important, is not the only medicinal substance obtained from the Algæ. *Gracilaria helminthochorton*, or *Corsican Moss*, has long held a place in the pharmacopœia as a vermifuge. What is sold under this name in the shops is commonly adulterated with many other kinds. In samples which I have seen, the greater part consisted of *Laurencia obtusa*, through which a few threads of the true *Corsican Moss* were dispersed. Possibly, however, the *Laurencia* may be of equal value.

Mannite also has been detected by Dr. Stenhouse in several Algæ, to which it imparts a sweetish taste. The richest in this substance appears to be *Laminaria saccharina*, from a thousand grains of which 121.5 grains or 12.15 per cent. of mannite were obtained. The method of extracting is very simple. The dried weed

is repeatedly digested with hot water, when it yields a mucilage of a brownish red colour and of a sweetish but very disagreeable taste. When evaporated to dryness, this mucilage leaves a saline semicrystaline mass. This being repeatedly treated with boiling alcohol, yields the mannite in "large hard prisms of a fine silky lustre." *Halidrys siliquosa*, *Laminaria digitata*, *Fucus serratus*, *Alaria esculenta*, *Rhodymenia palmata*, &c. are stated by Dr. Stenhouse, from whose memoir this account is condensed, to contain from 1 to 5 or 6 per cent. of mannite.

In summing up the economic uses to which Algæ have been applied, I must not omit to mention their application in the arts. The most valuable species, in this point of view, with which we are acquainted, is the *Gracilaria tenax* of China, under which name probably more than one species may be confounded. Of this plant, on the authority of Mr. Turner, (Hist. Fuc. vol. 2, p. 142,) "the quantity annually imported at Canton is about 27,000 lbs., and it is sold in that city at about 6d. or 8d. per lb. In preparing it, nothing more is done than simply drying it in the sun ; after which it may be preserved, like other Fuci, for any length of time, and improves by age, when not exceeding four or five years, if strongly compressed and kept moist. The Chinese, when they have occasion to use it, merely wash off the saline particles and other impurities, and then steep it in warm water, in which, in a short time, it entirely dissolves, stiffening as it cools into a perfect gelatine, which, like glue, again liquefies on exposure to heat, and makes an extremely powerful cement. It is employed among them for all those purposes to which gum or glue is here deemed applicable, but chiefly in the manufacture of lanthorns, to strengthen or varnish the paper, and sometimes to thicken or give a gloss to gauze or silks." Mr. Turner derived the above information respecting *G. tenax* from Sir Joseph Banks ; but recent travellers tell us that *Gracilaria spinosa*, known colloquially as *Agal-agal*,* yields the strongest cement used by the Chinese, and that it is brought in large quantities from Sincapore and neighbouring shores to the China markets. Probably both species are esteemed for similar qualities.

Several Algæ are used in the arts in a minor way. Thus, according to Dr. Patrick Neill, knife-handles are made in Scotland of the stems of *Laminaria digitata*. "A pretty thick stem is selected, and cut into pieces about four inches long. Into these, when fresh, are stuck blades of knives, such as gardeners use for pruning or grafting. As the stem dries, it contracts and hardens, closely and firmly embracing the hilt of the blade. In the course of some months the handles become quite firm, and very hard and shrivelled, so that when tipped with metal they are hardly to be distinguished from hartshorn."

On the authority of Lightfoot,† the stems of *Chorda filum*, which often attain the length of thirty or forty feet, and which are popularly known in Scotland as "Lucky Minny's lines," "skinned, when half dry, and twisted, acquire so considerable a degree of strength and toughness," that the Highlanders sometimes use them as fishing lines. The slender stems of *Nereocystis* are similarly used by the fishermen in Russian America. In parts of England bunches of *Fucus vesiculosus* or *F.*

* See, the Voyage of H.M.S. *Samarang*.

† Fl. Scot. vol. 2, p. 964.

Serratus are frequently hung in the cottages of the poor as rude barometers, their hygrometric qualities, which arise from the salt they contain, indicating a change of weather.

In our account of the artistic value of Algæ, we ought not to pass unnoticed the ornamental works which the manufacturers of "sea-weed pictures," and baskets of "ocean-flowers," construct from the various beautiful species of our coasts, and which are so well known at charity bazaars, accompanied by a much-hackneyed legend, commencing,

"Call us not weeds, we are flowers of the sea," &c.

Some of these "works of art" display considerable taste in the arrangement, and the objects themselves are so intrinsically beautiful that they can rarely be otherwise than attractive. During the recent pressure of Irish famine, many ladies in various parts of the country employed a portion of their leisure in the manufacture of these ornamental works, and no despicable sum was raised by the sale.

Other sums, for charitable purposes, have been realized in a way which a botanist would deem more legitimate, by the sale of books of prepared and named specimens; and my friend, the Rev. Dr. Landsborough,* I am told, has in this manner collected money which has gone a considerable way towards building a church. There seems no good reason why missionaries in distant countries might not, either personally or through their pupils or families, collect these and other natural objects, and sell them for the benefit of their mission; by which means they would not only obtain funds for pursuing the work more immediately committed to them, but would have the satisfaction of knowing that in doing so they were unfolding to the admiration of mankind new pages of the wide-spread volume of nature.

Unfortunately, it happens that in the educational course prescribed to our divines, natural history has no place, for which reason many are ignorant of the important bearings which the book of Nature has upon the book of Revelation. They do not consider, apparently, that both are from God—both are His faithful witnesses to mankind. And if this be so, is it reasonable to suppose that either, without the other, can be fully understood? It is only necessary to glance at the absurd commentaries in reference to natural objects which are to be found in too many annotators of the Holy Scriptures, to be convinced of the benefit which the clergy would themselves derive from a more extended study of the works of creation. And to missionaries, especially, a minute familiarity with natural objects must be a powerful assistance in awakening the attention of the savage, who, after his manner, is a close observer, and likely to detect a fallacy in his teacher, should the latter attempt a practical illustration of his discourse without sufficient knowledge.† This subject is too important for casual discussion, and deserves the careful consideration of those in whose hands the education of the clergy rests. These are not days in which persons who ought to be our guides in matters of doctrine can afford to be behind the rest of the world in knowledge; nor can they safely

* Author of "A Popular History of British Seaweeds."

† See some excellent observations on this subject in "Foot-prints of the Creator: or, the Asterolepis of Stromness," by Hugh Miller. London, 1849.

sneer at the "knowledge that puffeth up," until, like the Apostle, they have sounded its depths and proved its shallowness.

Why should the study of the physical sciences be supposed to have an evil influence on the mind—a tendency to lead men to doubt every truth which cannot be made the direct subject of analysis or experiment ? I can conceive a one-sided scientific education having this tendency. If the mind be propelled altogether in one direction, and that direction lead exclusively to analytical research, it is possible that the other faculties of the individual may become clouded or enfeebled—and then he is the unresisting slave of analysis—not more a rational being than any other monomaniac. And yet, paradoxical though the assertion seem, he may be all his life a reasoner, forming deductions and inductions with the most rigid accuracy, in his beaten track.

I can conceive too the astronomer, conversant with the immensity of space and its innumerable systems of worlds, so prostrated before the majesty of the material creation, as not only to lose sight of himself and of the whole race to which he belongs, but of the world or even of the solar system, and be led to doubt whether things so poor, and mean, and small can have any value in the sight of the Lord of so wide a dominion. I can conceive him, too, observing the uniformity and the harmony of the laws that govern the whole system of the heavens ; the undeviating course of all events among the stars coming round as regularly as the shadow on the dial ; and the little evidence there is that this uniformity has ever suffered any disturbance that cannot be accounted for by the law of gravitation, and made the subject of calculation by the mathematician, who, working an equation in his closet, shall come forth and declare the cause of irregularity, though that cause may be acting at thousands of millions of miles distance—I can conceive him inferring from a uniformity like this the absence of a superintending Providence in human affairs. If the Creator, he will say, have given up the very heaven of heavens to the immutable laws of gravitation, can I believe that he interferes by his Providence to superintend the puny matters of this lower world?

His reasons seem plausible while the mind is pointed in that one direction. But they lose all their force when, laying aside for a moment the telescope, the philosopher investigates with his microscope the structure of any *living* thing, no matter how small and how seemingly simple the organism may be. Let the object examined but have *life*, and it will soon lead him to understand a little of the meaning of God's glorious title, *Maximus in minimis*. And the further he carries his researches, the more the field of research opens, until, extending from the speck beneath his lens, it spreads wider and wider, and at length blends with infinity at the " horizon's limit." Here his boasted analysis can afford him no help. He has laid bare the " mechanism of the heavens ;" he has weighed the sun and the planets ; he has foretold with unerring certainty events which shall happen a thousand years after he shall be laid in the dust ;—and yet he cannot unravel the mystery that shrouds the seat of life, even as it exists in the meanest thing that crawls. And if the life of this poor worm be thus wonderful, what is that spirit which animates the human frame ? What is that humanity which, but a moment ago, seemed like the small dust in the balance compared with the multitude and the

masses of the stars ? His conceptions of his own true position in the scale of being become more rational. For a moment he views from a new position the distant stars, as the peasant views them in a clear night :—points of light spangling the blue vault above. And he reflects, " How do I *know* that those shining ones are other than they seem ; how do I *know* their size, their distance, the laws by which they are governed ; the reins by which the " coursers of the sun" are held in their appointed track ? How ?—but by the intellectual powers of that human spirit which but now I deemed so poor and mean :—so unworthy of the very thought of the Almighty—much more, so unworthy of the price which He has paid for it."

Thus the mind, turned back upon itself, begins to discover that, after all, it is not " of the earth, earthy," but derived from a higher source and reserved for a higher destiny. And strange to say, this altered and bettered opinion of itself is traceable to the first check which it feels—the first baffling of its analytical powers. So long as the mind was extending the sphere of its researches into the material universe, weighing, and numbering, and tabulating all nature seemed to move in blind obedience to a force whose influence might be calculated ; every world being found to act upon its fellow in exact proportion to its position and its weight, and *our* world to be but a part, and a small part of one vast machine. And with such a view of the relation of the earth to the universe, might not unnaturally come a lower estimate of man, the dweller on the earth. " Is he too but a part in the house in which he dwells ? Is his course also subject to those immutable laws which bind the universe together ? And if so, where is his individuality ? Where the reflex of that image in which he is said to have been created ?" But the moment that the mind apprehends the action of the inexplicable laws of life, and is certified of the *individuality* of every living thing however small ;—and compares these microscopic " wholes" with the " whole" that it feels itself to be, that moment it begins to see that the human soul is a something apart from the world in and over which it is placed.

Galileo in his cell was bound in fetters, but his spirit could not be bound. His thoughts were as free and his mind had as wide a range as if he could have flown through all space on the wings of light. And thus it is with man : prisoned for a short time in this lower world, he belongs to an order of being that no world can confine. He cannot continue stationary, nor plod for ever a dull round in the treadmill here. He must either rise above all height into communion with the Deity ; or fall, bereft of hope, for ever. We must not estimate such a being by the narrow bounds of the cell which he now inhabits. We must judge of him by his intellectual powers, his aspirations, his intuitive conceptions of his own nature ; and, as a spirit, all these place him, in his *individuality*, far above any plurality of mere material worlds.

I may seem to be wandering from my proper theme, but my object is to vindicate the teaching of the Book of Nature from the aspersions of the ignorant and the prejudiced. Whilst I admit that half views of natural science may lead men astray ; and whilst I deplore the infidelity of scientific men, whose minds are absorbed in the material on which they work ;—I deny that the study of nature has, in itself, an evil tendency. On the contrary, the study of organic nature, at least, ought to

be one of the purest sources of intellectual pleasure. It places before us structures the most exquisite in form and delicate in material; the perfect works of Him who is Himself the sum of all perfections :—and if our minds are properly balanced, we shall not rest satisfied with a mere knowledge and admiration of these wonderful and manifold works ; but, reading in them the evidence of *their* relation to their Maker, we shall be led on to investigate *our own.*

I do not assert that this study is, of itself, sufficient to make men religious. But as the contemplation of any great work of art generally excites in us a two-fold admiration—admiration of the work itself, and of the genius of its author—so a true perception of the wonders of nature includes a certain worship of the author of those wonders. Yet we may study natural objects, and admire them, and devote our whole life to elucidate their structure ; and after all may fail to recognize the being of Him who has fashioned them. Such blindness is scarcely conceivable to some minds ; yet to others, the opposite appears but the effect of a warm imagination. So inexplicable is the human mind ! The moral evidence which stirs one man to his centre brings no conviction to another. Physical truths, indeed, cannot be rationally denied ; but there is no metaphysical truth which may not be plausibly obscured or explained away by self-satisfied prejudice. Hence the inconclusiveness of all reasoning against infidelity. The failure is not in the reasons set before the mind, but in the non-acknowledgment of the imperative force of moral reasons. No man can be convinced of any *moral* truth against his will ; and if the will be corrupt, it is possessed by a blind and deaf spirit, which none can cast out until a "stronger than he" shall come.

Here I pause ; but I cannot conclude this Introduction without expressing my warm thanks to the kind friends who have aided me in my researches, both with specimens and with sympathy. To some of them I am personally unknown, and with others I became acquainted casually, during my recent tour along the shores of the United States. From all I have received unmixed kindness, and every aid that it was in their power to render. Indebted to all therefore, I am more especially bound by gratitude to my friend, Professor J. W. Bailey, of West Point, the earliest American worker in the field of Algology. Well known in his own peculiar branch of science, he has found a relaxation from more wearing thought, in exploring the microscopic world, and his various papers on what may be called "vegetable atoms" *(Diatomaceæ)* are widely known and highly appreciated. From him I received the first specimens of United States Algæ which I possessed, and, though residing at a distance from the coast, he has been of essential service in infusing a taste for this peculiar department of botany among persons favourably situated for research ; so that either from him or through him I have obtained specimens from many localities from which I should otherwise have been shut out. To him I am indebted for an introduction to a knot of Algologists who have zealously explored the south-western portions of Long Island and New York Sounds, Messrs. Hooper, Congdon, Pike, and Walters of Brooklyn, from all of whom I have received liberal supplies of specimens ; and through him Professor Lewis R. Gibbes, of Charleston, whose personal acquaintance I had afterwards the happiness of making, first communicated to me the result of his explorations of

Charleston harbour, as well as the first collection of Florida Algæ which I received, and which Dr. Gibbes obtained from their collector, the late Dr. Wurdemann. Through Professor Asa Gray, of Cambridge, Mass., long before it was my good fortune to know him personally and intimately, I received collections of the Algæ of Boston Harbour made by Mr. G. B. Emerson, Miss Morris, and Miss Loring, (now Mrs. Gray) ; also of the Algæ of Rhode Island, made by Mr. S. T. Olney, who has done so much to illustrate the botany of that State, and by Mr. George Hunt. My gatherings from the same coasts have since been much enriched by specimens from Dr. Silas Durkee, of Boston, Dr. M. B. Roche, of New Bedford, and Mrs. P. P. Mudge, of Lynn.

To Professor Tuomey, of the University of Alabama, I feel especially indebted for the care and kindness with which he formed for me an interesting collection of the Algæ of the Florida Keys, and the more so because this collection was made purposely to aid me in my present work. My friend Dr. Blodgett, of Key West, also, since my return to Europe, has communicated several additional species, and is continuing his researches on that fertile shore. To the Rev. W. S. Hore, now of Oxford, England, (a name well known to the readers of the Phycologia Britannica) I am indebted for a considerable bundle of well preserved specimens, gathered at Prince Edward's Island, by Dr. T. E. Jeans ; and to the kindness of my old friend and chum, Alexander Eliott, of the Dockyard, Halifax, I owe the opportunity of a fortnight's dredging in Halifax harbour, and many a pleasant ramble in the vicinity.

My personal collections of North American Algæ have been made at Halifax ; Nahant beach ; New York Sound ; Green Port, Long Island ; Charleston harbour ; and Key West; and are pretty full, especially at the last named place, where I remained a month.

The few Mexican species which find a place in this work have been presented to me by Prof. J. Agardh of Lund, and were collected by M. Liebman. Those from California are derived partly from the naturalists of Capt. Beechey's voyage ; a few from the late David Douglas ; and a considerable number brought by my predecessor, Dr. Coulter, from Monterey Bay. I have received from Dr. F. J. Ruprecht of St. Petersburgh several Algæ from Russian America ; from Sir John Richardson a few Algæ of the polar sea ; and various specimens of these plants, which have found their way from the North West Coast to the herbarium of Sir W. J. Hooker, have, with the well-known liberality of that illustrious botanist, been freely placed at my disposal.

But I should not, in speaking of the North West Coast, omit to mention a name which will ever be associated in my mind with that interesting botanical region, the venerable Archibald Menzies, who accompanied Vancouver, and whom I remember as one of the finest specimens of a green old age that it has been my lot to meet. He was the first naturalist to explore the cryptogamic treasures of the North West, and to the last could recal with vividness the scenes he had witnessed, and loved to speak of the plants he had discovered. His plants, the companions of his early hardships, seemed to stir up recollections of every circumstance that had attended their collection, at a distance of more than half a century back from the

time I speak of. He it was who first possessed me with a desire to explore the American shores, a desire which has followed me through life, though as yet it has been but very imperfectly gratified. With this small tribute to his memory, I may appropriately close this general expression of my thanks to those who have aided me in the present undertaking.

W. H. H.

Trinity College, Dublin,
August 6th, 1851.

DIVISION INTO GROUPS OR SERIES.

For purposes of classification the Algæ may be conveniently grouped under three principal heads or sub-classes, which are, for the most part, readily distinguishable by the colour of the frond. They are named and defined as follows, viz.

1. Melanospermeæ. *Plants* of an olive-green or olive-brown colour. *Fructification* monœcious or diœcious. *Spores* olive-coloured, either external, or contained, singly, or in groups, in proper conceptacles; each spore enveloped in a pellucid skin (*perispore*), simple, or finally separating into two, four, or eight *sporules*. *Antheridia*, or transparent cells filled with orange-coloured, vivacious corpuscles, moving by means of vibratile cilia. *Marine.*

2. Rhodospermeæ. *Plants* rosy-red or purple, rarely brown-red, or greenish-red. *Fructification* of two kinds, diœcious:—1, *Spores* (*gemmules*, Ag.) contained either in external or immersed conceptacles, or densely aggregated together and dispersed in masses throughout the substance of the frond: 2, *Spores*, commonly called *tetraspores* (*gemmules*, Thw.), red or purple, either external or immersed in the frond, rarely contained in proper conceptacles; each spore enveloped in a pellucid skin (*perispore*), and at maturity separating into four *sporules*. *Antheridia* (not observed in all) filled with yellow corpuscles. *Marine, with one or two exceptions.*

3. Chlorospermeæ. *Plants* grass-green, rarely a livid purple. *Fructification* dispersed through all parts of the frond; every cell being capable of having its contents converted into spores. *Spores* (*Sporidia*, Ag.) green or purple, formed within the cells, often (always ?) at maturity vivacious, moving by means of vibratile cilia. *Gemmules* (*Coniocystæ*, Ag.) or external vesicular cells, containing a dense, dark-coloured, granular mass, and finally separating from the frond. *Marine, or, more frequently, living in fresh-water streams, ponds, and ditches, or in damp situations.*

MELANOSPERMEÆ, OR OLIVE-COLOURED ALGÆ.

SYNOPSIS OF THE ORDERS OF MELANOSPERMEÆ.

* *Frond leathery or membranaceous, forming a compact cellular substance.*

1. Fucaceæ. *Spores* contained in spherical cavities of the frond.
2. Sporochnaceæ. *Spores* attached to external, jointed filaments, which are either free, or compacted into knob-like masses.
3. Laminariaceæ. *Spores* forming indefinite, cloudlike patches, or covering the whole surface of the frond.
4. Dictyotaceæ. *Spores* forming definite groups (*sori*) on the surface of the frond.

** *Frond formed of jointed filaments, which are either free, or united into a compound body.*

5. Chordariaceæ. *Frond* cartilaginous or gelatinous, composed of vertical and horizontal filaments interlaced together. *Spores* immersed.
6. Ectocarpaceæ. *Frond* filiform, jointed. *Spores* external.

Order I.—FUCACEÆ.

J. Ag. Sp. Alg., vol. 1, *p.* 180 ; *C. Ag. Syst. Alg. p.* xxxvii, *(in part) ; Endl. Gen. Pl., Suppl.* 3, *page* 29 *(excl. gen.). Harv. Man. Br. Alg., ed.* 2, *p.* 11. Fucoideæ, *Grev. Alg. Brit. p.* 1 ; *Harv. Man., ed.* 1, *p.* 1. Fuceæ, Cystoseireæ, Sargasseæ, *and* Halochloæ, *Kütz. Phyc. Gen., p.* 349, *et seq.* Fucidæ and Cystoseiridæ, *Lindl. Veg. King., p.* 22.

Diagnosis. Olive-coloured, inarticulate seaweeds, whose *spores* are contained in spherical cavities of the frond. *(Plants of large size, tough, of leathery texture, becoming dark-coloured in drying.)*

Natural Character. *Root* almost always a conical holdfast, adhering by its base to rocks and stones, usually simple and undivided ; in a few instances sending off lateral creeping branches, and forming a mat, from which many upright fronds arise.

Fronds of large size, inarticulate, leathery or rarely in parts thin and membranaceous ; tough, tearing with facility in a longtitudinal direction ; of an olive-brown or olive-green colour, becoming foxy in age, and changing to a dark brown or black in drying ; composed of minute, coloured, or colourless cells arranged in filaments, and closely united together by a very firm intercellular substance.

The *habit* is very various. In the least perfect genera *(as Splachnidium)* there is no distinction of stem, leaves, and organs of fructification, but the frond consists of a leathery bag, filled with loose jelly, through which a few longitudinal filaments pass. The spore-cavities are dispersed beneath the pores of the whole surface, and the frond is thus reduced to a root, and a universal receptacle of fructification.

In others *(Durvillæa, Sarcophycus)* there is a stem which gradually expands at the summit into a leaf-like, cloven lamina, through which the spore-cavities are scattered ; these genera have the habit of *Laminariæ*, but the fructification of Fucaceæ.

In the next stage of development *(Myriodesma, Carpoglossum,)* the frond becomes more leaf-like, but the spore-cavities are still dispersed equally through all its divisions.

To such forms succeeds *Himanthalia*, in which there is a clear distinction between the frond and the receptacle of fructification, but wherein the former is reduced to a cup-like air-vessel, while the latter is much branched and constitutes the bulk of the plant. In this case the true relations of the parts are determined by the

development; the cup-like frond being wholly formed and perfected before the branching fructification begins to be evolved.

Rising to still higher types of the Order we find (in *Fucus*, *Halidrys*, *Cystoseira*, &c.,) plants with branching, pinnate, or more commonly, dichotomous stems, either filiform or imperfectly leafy, having usually their leaf-like portions strongly midribbed, and forming their fructification in portions of the branches; generally in the extremities, which at first resemble ordinary parts of the frond, but afterwards swell, become succulent, and are converted into more or less distinct *receptacles*.

Lastly, (in *Sargassum*, and its allies,) there is a branching stem; distinct midribbed, rarely ribless, leaves, which are, in a few instances, decurrent, developed in a distichous or subspiral order; and receptacles which are, from their origin, set apart as organs of fructification (not formed by swellings of the branches,) and placed, either in the axils or along the edges of the leaves or branches.

In a large number of the plants of this Order, *air vessels (vesiculæ)* or floats designed to give buoyancy to the stem and branches, are present. In the least perfect, (as in *Himanthalia*, *Fucus*, and *Cystoseira)* the air vessels are formed by simple swellings of portions of the branches, the swollen portion becoming hollow and filled with air. In *Halidrys* several of these hollow swellings placed close together in the ramuli become confluent into a compound moniliform vesicle, which is evidently only an extreme development of the chained vesicles of *Cystoseira*. In *Phyllospora* the air vessel is formed in the leaf-stalk, the lamina being a crest to its summit. Such is likewise the case in *Sargassum*, the highest type in the order, but in this genus the lamina of these vesicular leaves is either wholly abortive or reduced to a slender mucro; so that here the air vessel appears like a distinct organ. It usually accompanies the receptacles of fructification, and is, in fact, properly a floral leaf or bract, interposing between the ordinary leaves and those appropriated to the fructification.

On most parts of the frond, but especially on the expanded portions of the stem in the less organized types, and on the leaves in the more fully developed ones, will be found minute dot-like *pores*, from which, while the plant is under water and in a growing state, a pencil of delicate, colourless, jointed hairs is seen to protrude. These pores, called the *muciferous pores* by early writers, are found in all the *Fucaceæ*, and are one of their most definite characters. Under each pore is placed a minute hollow chamber, of a spherical form, from the inside of whose walls the colourless fibres originate. It is possible that these hairs may exercise an important physiological office, acting on the aerated water as the stomates of aerial leaves do upon the air; nothing, however, has been ascertained on this point. But whatever be the use of these hollow chambers and their contents in the vegetating parts of the frond, in those appropriated to fructification they are enlarged, and transformed into the *spherical cavities* within which the *spores* and *antheridia* are lodged.

In the less organised genera, as has been already mentioned, the *spore-cavities (scaphidia*, Ag.—*conceptacula*, Mont.—Endl.—*angiocarpia*, Kütz,) are dispersed over the whole frond; in the more perfect, they are confined to limited portions of the.

branches or leaves, which then become succulent and full of slimy mucus; and in the highest types, small metamorphosed branchlets are from the beginning set apart as organs of fructification. These metamorphosed branchlets, or the swollen parts of ordinary branches which are filled with spore-cavities, are called *receptacles*; (*receptacula*, Ag.—Endl. —*carpomata*, Kütz.)

Each *spore cavity*, placed immediately beneath the outer wall of the frond, and communicating freely with the water through its pore, is a hollow, spherical, membranous, bag-like chamber, whose inner surface is clothed with pellucid hairs *(paranemata)*, among which organs of fructification of two kinds (male? and female) are placed. Sometimes both kinds or sexes are found in the same cavity; sometimes all the cavities of one plant produce one kind only, and all those of another plant the other kind. (A vertical section of one of the female spore-cavities of *Fucus furcatus*, figured at our Plate III. A, fig. 4, will show the general appearance of the fructification.)

The *spores* are lodged within colourless, glassy *perispores*, or large, swollen, membranous, closed cells, attached to the walls of the cavity; each perispore containing from one to eight, and most commonly four *spores*. The *perispore* originates, like the hairs or paranemata, from the wall of the cavity, and appears to be formed from one of these hairs, which, having been fertilized at an early period of its development, instead of continuing to grow by the production of new cells at its apex, like an ordinary hair, has been arrested at the first or second cell; and this cell, becoming enlarged, has an endochrome gradually elaborated within it, and finally either condensed into a single spore or divided into several. In an early stage the colouring matter, or endochrome, is of a very fluid substance, and pale olive hue. Gradually it becomes darker and more opaque, its particles lying closer together, and at length is partially solidified and invested with a delicate membranous envelope, which constitutes the testa of the spore. In *Halidrys*, *Cystoseira*, and several other genera, each perispore contains at maturity but a single spore; in *Fucus* and others, the number of spores varies from two to eight, or perhaps a larger number.

The paranemata are either simple or branched. Those which produce *Antheridia* are always branched, and the antheridia are formed from the terminal cell of each branchlet, which is enlarged and ovate, obovate, or club-shaped. This *Antheridium*, or supposed male, is a pellucid, enlarged, closed cell, containing a multitude of minute *corpuscles (sporidia*, Ag.), which are supposed to represent the pollen, if not to fulfil its office in fertilizing the spore. They are oval, somewhat pointed at one end, and contain a reddish-orange granule; and they are furnished with two extremely slender vibratile hairs or *cilia*, one of which issues from the narrow extremity of the corpuscle; the other, which is of greater length, from the coloured granule. The corpuscles, at first contained within the antheridium, at length issue from it, escaping into the surrounding water, and immediately commence a succession of rapid movements to and fro, and in circles and curved lines, strikingly similar to the ciliary movements of some of the Infusoria, or of the spores of some of the fresh water Algæ of the *Green* series. These movements depend on the rapid vibrations of the cilia. During progression, the narrow end of the cor-

puscle is always in front; while the cilium, rising from the coloured granule, trails behind like a tail.

Messrs. Decaisne and Thuret, from whose memoir *(in Ann. des Sc. Nat.* 1845, *p.* 5 *et seq.)* this description is mostly taken, point out the strong analogy between these vivacious corpuscles of the *Fucaceæ* and the so-called spermatozoa of the Characeæ, Mosses, and Hepaticæ, and argue from this similarity of structure a similarity of function. They are, therefore, of opinion that the corpuscle-bearing cells are properly organs of a similar nature to the antheridia of other cryptogamic plants; and not, as is supposed by Agardh, analogues of the sporidia of the lower Algæ, and like them capable of germination. From my own investigations, I am disposed to agree with the opinion which regards them as male organs. They may readily be seen with the higher powers of the compound achromatic microscope; and are easily found in the ordinary shore Fuci, *(Fucus vesiculosus* and *F. nodosus)*, in winter or early spring, on specimens bearing bright yellow or orange coloured receptacles. Some of the most deeply coloured should be selected and placed in the air till partially dry. As the frond dries, little drops of a sliny, bright orange fluid will ooze out from the pores of the receptacle; and if one of these drops be removed, and placed in a little sea water on the stage of the microscope, it will be found to consist of multitudes of detached antheridia. If these be watched for a short time, the vivacious corpuscles may be seen to issue from them and perform their singular dances.

The *Fucaceæ* are readily known from all other orders of Melanosperms, by having their *spores* contained in those little spore-cavities, which we have already described. In no other order do such cavities exist.

The group of plants defined by this character is a very extensive one, comprising, perhaps, one-half of the known Melanosperms. If we view it as also composed of an aggregate of individuals of each species, its relative importance will appear very much greater, for most of the plants of which it consists are *social* ones, and clothe very large portions of the submarine soil. About 230 species are described by Agardh in his last work, while Kützing, (who has introduced many species which are not admitted by other writers) enumerates upwards of 300. Of this large number, however, I am only able to claim 20 as inhabiting the American shores, and six of these are known only on the Pacific coasts.

The deficiency of *Fucaceæ* is a very remarkable feature of the American marine flora, the *common* fuci of the eastern coasts being only *two*, (*Fucus vesiculosus* and *nodosus*) and these two scarcely growing south of New Jersey. No doubt the long line of sandy shore which extends from New York Bay southward forbids the production of plants whose natural habitat is on tidal rocks and boulders; but it is remarkable that on the rock-bound coasts of the North Eastern States, there is no trace of the *Fucus serratus* or *F. canaliculatus* which are so widely dispersed on the European side of the Atlantic. We should not consider this absence of common European forms remarkable, if the Fuci found on the American coasts were *peculiar* to them. It is because the two species so abundant in America are also common in Europe, that we wonder at the absence, in the western waters of the Atlantic, of the equally common forms with which they are associated in the eastern.

The *Fucaceæ* are rarely deep-water plants. One species *(F. canaliculatus)*, common in Europe, begins to grow at the extremity of high water mark, in places where it is exposed to the atmosphere during the greater part of the twenty-four hours, and only submerged by the highest tide waves. In such places, though its growth is dwarfish, it frequently produces fruit. As it descends in depth toward mid-tide level, the frond becomes larger and more luxuriant, and in the space between this limit and that of quarter-tide, the greater number of individual plants occur. Few straggle into deeper water. This species, of all others, is best fitted to resist drought, its fronds being peculiarly dense and leathery ; and in a warm day it frequently becomes crisp and dry, and to all appearance baked to death, during the recess of the water ; and yet, on the return of the tide, the withered fronds expand and become flexible and juicy. Perhaps the non-occurrence of this plant on the American coasts may be owing to the fiercer heats which it would be subjected to, in the exposed places that it would naturally occupy.

With the slight exception of this semi-aerial species, all the ordinary Fucaceæ are characteristic of the space strictly defined by the tide marks, extending through the whole range of exposed rock ; over which in temperate latitudes they usually spread so densely, that the colour of the sea-shore is as clearly characterised by them, as is the colour of the ground by the species of grasses which constitute its green mantle.

A few of the most highly developed genera *(Cystoseira, Sargassum, &c.)* are productions of deeper water, commencing to grow at depths at which the *Fuci* cease, and extending into a zone of depth where they are constantly submerged. I am not aware that any species has been traced into a deeper zone than that occupied by *Laminariæ*.

One remarkable species of the genus *Sargassum* has long been famous by the name of *Gulfweed* or *Sargazo (sea-lentils)*, under which most voyagers since the days of Columbus have spoken of it. That great discoverer was the first to encounter it in modern times, (16th September, 1492) and with his account we are therefore most familiar ; but possibly the weedy sea which Aristotle speaks of as having been met with by the Phœnicians, at the termination of their voyage, may have been an early discovery of the same bank. It is curious that the great bank which extends between the 20th and 45th parallels of north latitude, and in 40° W. from Greenwich, appears to occupy the same position at the present day as it did in the days of Columbus. Between this bank and the American shores, various smaller strata and detached masses of seaweed occur, being thrown into this portion of the ocean by the eddy caused by the sub-circular motion of the great oceanic currents. The whole of this immense space of ocean, which is reported to be thickly covered with seaweed, is computed by Humboldt at upwards of 260,000 square miles, an area almost six times as large as Germany ;* but it is not to be supposed that all this space is *equally* clothed with floating verdure. In many places the weed occurs in distant and narrow ridges, leaving spaces of clear water between. This portion of the Atlantic seems to be the chief *settlement* of the

* Johnst. Phys. Atlas. *Atlantic*, p. 5.

Sar. bacciferum, but straggling specimens occur in the Pacific and Indian Oceans, and on the shores of Australia and New Zealand ; and some few, carried northward by the Gulf stream, reach the northern shores of Europe in safety.

Naturalists have been puzzled to account for the origin of the Gulfweed, and formerly it was supposed to be altogether derived from the Gulf of Mexico ; being torn off the shores of the Florida reefs and keys, and carried to sea with the great current. It is possible (and indeed probable) that the *origin* of the present floating banks may have been partly of this nature, but it is most certain that the great masses of the weed that are at present found floating have had no such immediate parentage, but are produced on the surface of the ocean on which they float. Whoever has picked up the plant at sea, on any genuine portion of the bank, must have seen that it was in a perfectly fresh and growing state, and if he have looked at his specimen carefully, he will probably have observed, that different parts of the same specimen were of very different ages ; that though there was no apparent root, yet that toward the centre of the mass a small portion of stem was of a much darker colour than the rest, and possibly covered by parasitic incrustations ; and that all the branches springing from this central piece were successively more and more delicate and of paler colour, and evidently in a young and sprouting state. Such a specimen is clearly in vigorous life, yet it has no *root*. But the absence of root is a matter of very trivial moment in a seaweed ; for we must bear in mind that the roots of Algæ are merely holdfasts, intended to keep them from being washed off the rocks on which they grow. And in a plant capable of enduring extensive change of place, like this *Sargassum*, the root is the part which may be most readily dispensed with. No doubt the specimen under examination originated in a little branch accidentally broken from a neighbouring mass, and which being thus cast adrift, continued to push out new branches and leaves. In this manner, by the continual breaking up of old fronds and the continued growth of their broken parts, the floating masses spread over the surface of the sea.

In this floating state the species never forms proper fructification. There is, therefore, no growth from spores. The supply of plants is consequently kept up and extended by the constant development of buds or *gemmæ*, originating in broken fragments of branches. I have taken some pains to examine numerous specimens, picked up on various parts of the bank, while fresh from the sea, and have in general been able to convince myself that the tuft under examination had originated in a fragment of an older tuft.

This process of growth by breakage must have gone on for ages ; from that early time when the first individuals were brought from some unknown rocks by the currents of the ocean. Humboldt indeed conjectures that between the parallels of 20° and 45° there is an immense bank from which the supply of *Sargassum* is constantly derived ; but such a bank, if covered by only as much water as the *greatest* depth at which any Fucaceous plant is known to grow, could scarcely have escaped the notice of voyagers. And the aspect of this *Sargassum*, with its innumerable floating-bladders, shews that it was not intended to vegetate at any great depth ; for we invariably find the air-vessels most numerous in species which rise to the surface, and altogether absent in those which are deeply submerged.

The geographical range of the Order *Fucaceæ* is very extensive. The great bulk of the species occur within 35° of the equator on either side, within which limits also the generic types are most varied. To the north of 35° *Sargassa* become rare, and on the American shore the highest limit attained by any of this genus is in Long Island Sound, about 44°. Beyond this limit the genus *Fucus* becomes the prevalent form, and in the extreme north *Himanthalia* appears. *Cystoseira*, which has many representatives in the south of Europe, four of which extend as far as Great Britain, is not found on the eastern shores of America, and but slightly, represented on the north western. It forms an intermediate link, in structure and distribution, between the tropical and arctic forms of the order. Very few species have been traced into the Antarctic Ocean, where the most remarkable form is the gigantic *Durvillæa*, which has a stipe and habit resembling a *Laminaria* ; or it may be likened to a great Palm-leaf. The shores of Australia are peculiarly prolific in plants of this order, and the species of that sea are remarkable as well for their beauty, as for the large number of generic types which they exhibit. It is on those shores that the most fully organised types of the olive-coloured Algæ are met with.

In an economic point of view, the *Fucaceæ* take a high place among sea-plants. Their ashes contain a large quantity of carbonate of soda, for which the Fuci were formerly very much sought after, and even *cultivated* on some parts of the coasts of Scotland where they did not grow naturally ;—rocks being deposited to attract them to pebbly or sandy shores. At one time the proprietors of sea-shores on the most barren islands of Scotland drew a very large revenue from the sale of the *wrack* (varec) or sea-ware, which was then burned and its ashes sold under the name of Kelp:* but improvements in chemistry, by which carbonate of soda is now cheaply obtained from other sources, have almost destroyed the kelp trade. These seaweeds are now collected chiefly for manure, for which purpose they are often very valuable.

Iodine is their most remarkable constituent, and is found in their tissues in greater quantity than in any other of its known sources. The increasing demand for this valuable substance may, therefore, be expected to cause a partial revival of the kelp trade.

The ordinary species, *F. vesiculosus*, is eagerly eaten in winter by Scotch and Norwegian cattle, which regularly come down to the shore to browse on it at the recess of the tide ; and Linnæus tells us that in Gothland the peasantry boil it, and adding some coarse flour, give it to their hogs.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond branched, leafy. Air-vessels stalked, separate.*

I. Sargassum. *Receptacles* racemose, in the axils of the upper leaves.

* See Introduction, supra, p. 35.

** *Frond branched, imperfectly leafy or pinnatifid. Air-vessels formed in certain parts of the leaves or branchlets.*

II. PHYLLOSPORA. *Leaves* distichous, nerveless. *Air-vessels* formed in the petioles of the leaves.

III. HALIDRYS. *Frond* pinnatifid, leafy below, filiform above. *Air-vessels* formed in the ultimate branchlets, podlike, of several air-cells.

*** *Frond branched, imperfectly leafy or filiform. Air-vessels either absent, or formed irregularly by the occasional swelling of the branches.*

IV. CYSTOSEIRA. *Frond* much branched, bushy; the branches filiform. *Receptacles* filiform, slender, terminal; their substance formed of small cells.

V. FUCUS. *Frond* dichotomous, flat or compressed. *Receptacles* filled with mucus, which is traversed by a net-work of jointed filaments.

**** *Frond reduced to a top-shaped, or cup-shaped vesicle.*

VI. HIMANTHALIA. *Receptacles* strap-shaped, dichotomously branched.

I. SARGASSUM, *Ag.*

Root a conical disc. *Frond* much divided; having a distinct stem, branches, leaves, air-vessels, and receptacles. *Branches* filiform or flat, alternate, lateral, more or less distinctly pinnate. *Leaves* horizontal, or very rarely vertical and decurrent, mostly furnished with a midrib, and muciferous pores. *Air-vessels* stalked, axillary, formed from transformed leaves, pointless or tipped with a slender process. *Receptacles* small, linear, tuberculated, axillary, racemose or dichotomous, composed of a densely cellular substance; having numerous pores, beneath which are placed the spherical conceptacles (or spore cavities.) *Spore-cavities* mostly diœcious. *Spores* one or more in each conceptacle, to whose walls they are attached, obovoid, subsessile, having a hyaline perispore. *Antheridia* roundish, on branched filaments, racemose. *Paranemata* simple or forked, clothing the walls of the conceptacle.

The frond originates in a single leaf, having a lamina and midrib. This first leaf lengthens, and either continues undivided or becomes forked at the extremity. Afterwards the lamina gradually disappears from the lower portion, while the midrib thickens and becomes the commencement of the future stem; and the upper portion, still extending, is again divided and each of its divisions forms the starting point of a branch. All the young stems and branches, which in this manner are formed out of the midrib of the first formed leaves, are in their early growth winged with the remains of the lamina of the transformed leaf; but as this soon decays away and is not renewed, the branches as they extend upwards become

quite filiform, and their upper divisions are, in the majority of species, never winged. In a few species, the wing-like border is continued through all portions of the frond. The *leaves* which clothe the branches, the only leaves generally seen on full grown plants, are formed by dilatations of ultimate barren branchlets, and therefore arise in a manner the reverse of the primary leaves which spring from the root. The root-leaves, by losing their lamina, form the commencement of the filiform stem and branches ; and again, the barren apices of the stem and branches, by acquiring a lamina, become ordinary leaves. The branching throughout the frond, which at a hasty inspection seems to be alternate, or repeatedly pinnate, is in truth but a concealed form of dichotomous division, in which every alternate prong of the fork is stopped, while the twin prong is lengthened and again forked at its extremity. It is easy to see how an alternately pinnate frond, with a zigzag rachis, would result from the continual repetition of such a system of branching. In some species with zigzag stems and branches this mode of division is very evident throughout ; but in ordinary forms, as in our *S. Montagnei* (Plate I. f. A. 1.) the truly dichotomous division of the frond is only to be clearly perceived in the lesser fertile branches. If, however, these be carefully traced back to older portions, or the development of a young plant from its first leaf watched, the alternate suppression of parts will be very evident. From the same figure it may be seen, that the air-vessels are nothing but *leaves* in which the lamina has become inflated, while the apex of the midrib is prolonged into a mucro. In other species the transformation of the vesicated leaf is less complete, and then a wing-like border surrounds the inflated portion. These vesicles are usually placed between the ordinary leaves and the receptacles of fruit, and are, therefore, to be regarded as a form of bracts, or appendages to the inflorescence. They are most numerous in species which grow in shallow water, and serve to buoy up the branches. The *receptacles* of the fructification are, in like manner, but altered leaves ; and, as in flowering plants, they are the *ultimate* leaves. The frond which originated in a *spore* has passed through the various stages of its development, and at the end of its upward growth it again forms *spores* from which new plants may germinate.

The number of species of the genus Sargassum is very considerable ; upwards of 120 have been described, and probably many more remain uncharacterised in various herbaria. They are chiefly tropical and sub-tropical, and are found in the oceans of both the eastern and western hemispheres, but seem to be most numerous in the former. The following are all that I have been able to ascertain as natives of North America :—

1. SARGASSUM *vulgare*, Ag. ; stem filiform, smooth or nearly so ; leaves linear or oblong-lanceolate, serrated, ribbed, brownish-olive, with evident glands ; air-vessels pointless, spherical, on compressed stalks which are as long as the air-vessel ; receptacles axillary, repeatedly forked, filiform, tuberculated, twice as short as the subtending leaf.—*J. Ag. Sp. Alg. vol.* 1, *p.* 342 ; *Grev. Alg. Brit. t.* 1 ; *Harv. Phyc. Brit.* t. 343. Fucus natans, Turn. Hist. Fuc. t. 46 (excl. vars.) *Eng. Bot. t.* 2114.

HAB. On rocks and stones near low-water mark. Perennial. Summer. Common on the Florida Keys ; thrown up from deep water abundantly at Key West ; growing within tide marks at Sand Key. At Green Port, Long Island, *Prof. Bailey.* Also at Seaconnot, Bristol Ferry and Stone Bridge, Rhode Island, *Prof. Bailey, and Mr. Thurber.* Narragansett Pier, Newport, and Seaconnot Point, Rhode Island, *Mr. S. T. Olney* (v. v.).

Stem from one to two feet long or more, generally undivided, but densely clothed throughout its length with lateral branches, the lowermost of which are longest, the upper gradually shorter, and those near the summit but rudimentary ; terete, from a quarter to half a line in diameter, unarmed, and usually quite smooth. *Branches* similar to the main stem, either leafy, or furnished with a set of alternate secondary branches, similar to the primary. *Leaves* of a thickish substance and coriaceous texture, having many evident glandular pores, sharply serrate, or rarely repando-dentate or subentire : slightly narrowed at the base, and usually tapering to the point, but very variable in size, and in proportionate length and breadth ; sometimes oblong, sometimes linear-lanceolate, and sometimes broadly lanceolate : furnished with a strong, percurrent mid-rib, which becomes less evident just below the apex. *Air-vessels* numerous, particularly on the upper branches, and beneath the fructification, spherical, pointless, (or rarely with a small mucro), from two to three lines in diameter, raised on compressed or flattened, sometimes winged petioles of their own length. *Receptacles* axillary, linear, repeatedly forked, shorter than the subtending leaf, tuberculated. *Colour* varying from a dark, brownish olive to a foxy or tawny bay. *Substance* tough and leathery.

2. SARGASSUM *Montagnei*, Bailey MSS. ; stem filiform, slender, smooth ; leaves very narrow, linear-lanceolate, attenuate, repando-dentate or subentire, ribbed, pale-greenish olive, membranaceous, glandular-dotted ; air-vessels spherical, furnished with long, filiform or foliaceous points, raised on square petioles of their own length ; receptacles axillary, tuberculated, more or less forked, and generally shorter than the subtending leaf.—(TAB. I. FIG. A.)

HAB. On rocks and stones, near low-water mark. Perennial. Summer. At Greenport, Long Island, growing with *S. vulgare, Prof. Bailey and W. H. H.* ; Little Compton, Rhode Island, *Mr. Olney* (v. v.).

Root a conical disk. *Radical* and primary leaves oblong or lanceolate, 2-3 inches long and 3-4 lines in diameter, sharply serrate or unequally dentate, membranaceous. *Stems* from two to three feet long, filiform, smooth, very slender, undivided, set throughout with lateral branches, the lowest of which are twelve or fourteen inches in length, and the upper gradually shorter and less compound. The longer branches give off alternate branchlets, at intervals of half an inch to an inch. *Leaves* of the branches very narrow, usually two inches or more in length, and only a line or two in breadth, linear-lanceolate, attenuate, sometimes nearly entire,

sometimes remotely dentate or merely repand, delicately membranaceous, of a very pale greenish olive colour, minutely glandular, furnished with a percurrent midrib. *Air-vessels* globose or slightly oval, on slender, square stalks, tipped either with a long filiform point or with a linear-lanceolate leaf, either of which is often deciduous. *Receptacles* axillary, filiform, tubercular, more or less forked, sometimes attenuate. *Colour* pale. *Substance* delicate.

My specimens, from which the plate has been drawn, were gathered in August, when many of them had formed receptacles. The fruit figured is scarcely mature. The receptacles eventually become more filiform, and repeatedly forked. I have received from Professor Bailey a fragment of a fertile branch of a Sargassum, destitute of leaves and therefore doubtful, but which probably belongs to this species. In it the receptacles are very much lengthened, slender, tassel-like, an inch and half long and repeatedly forked, and have something the aspect of the fructification of *Lycopodium Phlegmaria*. Should future observations on the spot, made later in the season, show that these very long receptacles are the ordinary state of the ripe fruit, it will materially strengthen the specific character. Professor J. Agardh mentions a var. of *S. vulgare*, which he calls *trichocarpum*, distinguished by similar tassel-like fruit. This species is dedicated by Professor Bailey to our mutual friend and fellow student, Dr. Montagne, of Paris. The *S. vulgare var. tenuifolium* of Mr. Olney's list ought, at least in part, to be referred to *S. Montagnei*.

3. SARGASSUM *affine*, J. Ag.; "stem filiform, smooth, leaves lanceolate-linear, acutely serrate, with a single row of glandular pores at each side of the midrib; air-vessels spherical, pointless, on subterete stalks of their own length; receptacles axillary, forked, racemose, cylindraceo-lanceolate, warted, unarmed." *J. Ag. Sp. Alg. vol.* 1. *p.* 343.

HAB. In the West Indian Sea. *J. Agardh.* (v. s. in Herb. Trin. Coll. Dublin.)

I introduce this, as it may probably be found on some of the Florida Keys. It seems to be intermediate in character between *S. vulgare* and *S. bacciferum*.

4. SARGASSUM *bacciferum*, Ag.; stem filiform, smooth; leaves linear-lanceolate, attenuate, sharply serrate, ribbed, usually destitute of glandular pores; air-vessels on subterete stalks, spherical, tipped with a filiform point; receptacles axillary, forked, cylindrical, warted, unarmed. *J. Ag. Sp. Alg. vol.* 1. *p.* 344; *Kütz. Sp. Alg. p.* 609; *Harv. Phyc. Brit. t.* 104. *Fucus bacciferus, Turn. Hist. Fuc. t.* 47.

HAB. Floating in the Gulf-stream, and thrown up abundantly on the Florida Keys, and on other parts of the coast. (v. v.)

The floating fronds generally grow from a central point, from which branches

extend in all directions. In such specimens the base appears to be a fragment of broken branch, rather than a true disciform root. *Branches* smooth, zigzag, or angularly bent, once or twice divided in an alternate manner, the lesser branches set with distichous leaves, having a vesicle in the axil of each. *Leaves* from two to three inches in length and from one to three lines in width, coriaceous, sharply serrate, tapering to each end, furnished with a strong midrib, but usually destitute of glandular pores. The serratures are often duplicate. *Air-vessels* very numerous, about as big as peas, spherical, mostly mucronate, tipped with a longish bristle; their stalks about as long as the inflated part, and roundish. *Receptacles* rarely found. *Colour* when quite fresh a pale and beautifully clear olive; but soon changing and becoming foxy in age and very dark in drying. *Substance*, when living, brittle.

This is the common *Tropical Sea-grape*, whose air-vessels, resembling berries, are popularly taken for fruit. It has already been spoken of as the famous *gulfweed* of navigators.*

5. SARGASSUM *Liebmanni*, J. Ag.; "stem filiform, subterete, branched on all sides; leaves lanceolate, acuminate, ribbed, without glands, spinuloso-dentate, waved and twisted; air-vessels spherical, somewhat margined, pointed, on filiform stalks shorter than themselves; receptacles two-edged or triquetrous, serrato-dentate, forked, their branches at length subpedicellate, agglomerated in the axil." *J. Ag. Sp. Alg. vol.* 1. *p.* 326.

HAB. On the Pacific coast of the Mexican Republic, *Leibman.* (v. s. in Herb. T.C.D.)

Stems or primary branches numerous, from a short stipe, a foot or more in length, filiform, slightly flexuous, smooth, closely set with short, alternate, spirally disposed, spreading branchlets. These branchlets in my specimen are an inch or two in length, the lowest not longer than the upper, and issue at intervals of half to three-quarters of an inch. *Leaves* an inch to an inch and half long, three or four lines in breadth, somewhat lanceolate, obtuse, thick, leathery, waved and curled, midribbed, almost destitute of glandular pores, sharply spinuloso-dentate, the teeth deltoid-acuminate, patent, with rounded sinuses between. *Air-vessels* few, and only on the uppermost branchlets, on very short stalks, spherical, with a narrow leafy border, and a small point or leafy mucro. *Receptacles* axillary, densely tufted, repeatedly forked, three-sided, sharply spinoso-dentate, much shorter than the subtending leaf. *Colour* dark brownish olive. *Substance* leathery, dense.

6. SARGASSUM *hystrix*, J. Ag.; "Stem filiform, subterete, branched on all sides;

* Page 53.

leaves oblong-elliptical, acuminate, ribbed, obsoletely glandular, serrate or subentire; air-vessels spherieal, pointless, on very short stalks; receptaeles warted, two-edged, twisted, spinous-toothed, forked, their braneles at length pedieellate, erowded in the axils." *J. Ag. Sp. Alg. vol.* 1, *p.* 322.

HAB. In the Atlantie, from the shores of Mexieo to those of Newfoundland. *J. Agardh.*

I am not aequainted with this speeies.

7. SARGASSUM *filipendula*, Ag; "stem filiform, very smooth; leaves narrow-linear, ribbed, with a single row of glands at each side the rib, serrated, the uppermost very narrow and nearly entire; air-vessels spherieal, pointless, nearly without glands, on eompressed stalks longer than themselves; reeeptaeles eylindrieal, warted, unarmed, panieulate on a long axillary ramulus, the lowermost stalked, the upper eonfluent." *J. Ag. Sp. Alg. vol.* 1, *p.* 314.

HAB. The Gulf of Mexieo, *J. Agardh.*

Unknown to me.

II. PHYLLOSPORA. *Ag.*

Root braneling. *Frond* distichous. *Branches* flat or eompressed, fringed with marginal leaves. *Leaves* nerveless, undivided, tapering at base into sub-distinet petioles, marginal, distiehous, vertieal. *Air-vessels* formed by transformation of a portion of the leaf into a bladdery vesiele. *Receptacles* leaf-like, having numerous pores beneath whieh are placed the spherieal eonceptacles (or spore cavities). *Spore-cavities* diclinous. *Spores* several in each coneeptaele, to whose walls they are attached, obovoid, subsessile, having a hyaline perispore. *Antheridia* ellipsoidal, racemose. *Paranemata* long, simple, elothing the walls of the eoneeptaele.

A genus consisting of two speeies formerly plaeed in *Macrocystis*, of whieh they have in some respeets the habit, but from whieh they essentially differ in fructifiea-tion. The type of strueture is in many respects lower than that of *Sargassum*; the fruit-leaves or receptaeles seareely differing from the ordinary leaves, exeept in being of somewhat smaller size, and thicker substanee. The disposition of the branches and leaves is so unlike that of any other N. American Alga, that there

can be no difficulty in recognising our only species. Its congener *(Ph. comosa)* is a native of the shores of New Holland and New Zealand, and is distinguished by having serrated leaves.

1. PHYLLOSPORA *Menziesii*, Ag.; stem flat, rough, especially below, with prominent points; the margin at each side densely fringed with spathulate or obovate, obtuse, entire, nerveless leaves; air-vessels large, ellipsoid, pyriform or spindle-shaped, tipped with a leafy crest. *J. Ag. Sp. Alg. vol.* 1, *p.* 254. *Harv. in Bot. Beechey Voy. p.* 163. *Kütz. Sp. Alg. p.* 592. *Phyllospora Chamissoi, J. Ag. l. c. Macrocystis obtusa, Harv. in Bot. Beech. Voy. p.* 163. *Fucus Menziesii, Turn. Hist. t.* 27. (TAB. III. FIG. B.)

HAB. In deep water on the shores of California at Monterey (*Dr. Coulter*, *Capt. Beechey*, and *Capt. Wilkes*); and on the coasts to the northward as far, at least, as Nootka Sound, where it was first gathered by *Mr. Menzies* when sailing with Vancouver. (v. s. in Herb. T.C.D.)

Root branching. *Stems* (according to Turner, who cites Mr. Menzies' MS. notes) "twenty fathoms and more long, rising with a short rounded stipes, divided into several long simple branches, of almost equal height." These branches, portions of which, and the base of a young frond, are now before me, vary from a quarter inch to more than an inch in breadth, are strap-shaped, and roughened with minute spinelike or tubercular prominences, and preserve their breadth pretty evenly, except toward the tips, where they become gradually narrower, and pass off into a long slender point. The roughness varies considerably; some specimens are densely erinaceous throughout; others are so only in the lower part, with a few scattered spinular or subfoliaceous prominences above; and others are quite smooth in the upper part. In all, the margins of the branch are set with distichous, vertical leaves, sometimes issuing at intervals of an inch apart, but much more frequently densely crowded, and forming a leafy fringe. They are of various sizes; some reduced almost to bristles, and others being from two to three inches in length. The shape is also subject to great irregularity, the wide portion being sometimes three-fourths of an inch in width, in others scarcely two lines; so that the leaf in some cases is narrowly spathulate, at others obovate: in all it tapers greatly to the base, and generally ends in a blunt point. The margin is more or less waved and curled, but destitute of any indentations. The *air-vessels* are formed by an inflation of the lower half, or imperfect petiole of the leaf, or else of a greater portion; sometimes, therefore, they are tipped by a long leafy crest, at others by a short and narrow point. They vary much in shape; being globose, ellipsoid, ovoid, pyriform, or spindle-shaped, and from half an inch to an inch and half in length. I have not seen fertile specimens.

AGARDH'S *P. Chamissoi* is said to be characterised by its *pyriform* air-vessels; but on numerous specimens of the ordinary *P. Menziesii*, now before me, there are

seareely two in which the vesicles are of the same size and shape. On a specimen from Mr. Menzies, they are very small and spindle-shaped; on Dr. Coulter's, some are globose and some ellipsoid and ovoid; and on Captain Beechey's, some are pyriform and others spindle-shaped, and of large size. The only valid reason for regarding *P. Chamissoi* as a species, is its habitat, should it really be, as is said, a native of the Atlantic.

In the Botany of Beechey's Voyage I distinguished a variety with leaves much broader than usual, under the name of *Macrocystis obtusa*, but I have long ceased to regard it as anything more than a form of *P. Menziesii*. At that time I had seen but few and imperfect specimens of this plant, and was not aware how greatly it varied in the shape and size of its leaves.

III.—HALIDRYS. *Lyngb.*

Root, a conical disc. *Frond* much divided, distichous, pinnatifid below, pinnated above, without distinct leaves; and forming its air-vessels and receptacles from transformed portions of the upper branchlets. *Branches* alternate, the lowest flattish or somewhat leaf-like, the upper narrow, repeatedly compound and sub-filiform. *Air-vessels* petiolate, siliquæform, acuminate, articulated, divided by transverse septa into numerous loculi. *Receptacles* formed by transformation of the terminal ramuli, pedicellate, lanceolate or pod-like, tuberculated, unarmed, of a densely cellular substance; having numerous pores, beneath which are placed the spherical conceptacles (or spore-cavities). *Spore-cavities* containing both spores and antheridia in the same loculus. *Spores* numerous, oblong, sub-sessile, having a hyaline perispore. *Antheridia* on branching filaments, densely racemose. *Paranemata* simple or forked, clothing the walls of the conceptacle.

The frond originates in an oblong, alternately-toothed root-leaf. As this increases in size, the marginal dentations lengthen out into lateral lobes, and the leaf becomes pinnatifid. Soon the uppermost lobes are found to elongate and become again pinnatifid. Some of the laciniæ are afterwards changed into articulated air-vessels, and of course rendered abortive; others become branches, margined with similar air-vessels and ramuli; and the apex of the developing lacinia is eventually drawn out into a sub-filiform or compressed branch, which is repeatedly divided in a pinnate manner. The fruit is formed by a change of the ultimate divisions of the upper branches, and the receptacle, which is distinctly pedicellate, sometimes springs from the rachis of the branch, and sometimes crowns a vesicular ramulus or air-vessel.

The genus contains but two known species, both of which come within the limits of the North American flora, and one of them is peculiar to our shores. Both are

handsome shore-plants, and readily known by their articulated, many-celled air-vessels.

1. HALIDRYS *siliquosa*, Lyngb., frond compressed, narrow, repeatedly pinnate; air-vessels compressed, oblong or linear-lanceolate, mucronate, slightly constricted at the septa; receptacles lanceolate. *J. Ag. Sp. Alg., vol.* 1, *p.* 236; *Kütz, Sp. Alg., p.* 604; *Grev. Alg. Brit. t.* 1.; *Harv. Phyc. Brit. t.* 66; *Cystoseira siliquosa, Ag. Syst.*, p. 287; *Fucus siliquosus, L.—Turn. Hist. Fuc. t.* 159.; *E. Bot. t.* 474.

HABITAT. On rocks near low-water mark. Shores of Newfoundland, *Herb. Banks (fide Turner).* (v. v.)

Fronds from one to four feet long or more, linear, compressed, two edged, from one to two lines broad, distichous, repeatedly pinnate. *Pinnæ* alternate, the lower ones much lengthened, and either naked below or furnished with a few small branchlets and air-vessels, pinnate or bi-tripinnate above, each successive division becoming narrower. *Air-vessels* linear-oblong, or lanceolate, supported on slender stalks, and tipped by a slender acumination of various lengths, which sometimes ends in a receptacle. The air-vessels are internally divided by transverse membranes into numerous compartments or chambers, and externally marked at each partition by slight constrictions, most visible after the plant has been dried. *Receptacles* usually forming racemes, which terminate the branches, pedicellate, lanceolate, compressed. *Colour*, when young a greenish olive; becoming a rich, glossy brown in age. *Substance* tough and leathery.

This plant is very common on the Atlantic shores of Europe, and is said, by Turner, to extend south as far as the Canary Islands. On the same authority we claim it as a native of Newfoundland, but I have never seen any American specimens. The above description is taken from British ones.

2. HALIDRYS *osmundacea*, Harv. frond simply pinnatifid below, with broadly linear, subacute midribbed laciniæ; decompound above, the pinnæ and pinnulæ slender, sub-filiform; air-vessels moniliform, deeply constricted at the septa; receptacles small, forked, crowning the air vessels. *Harv. in Bot. Beechey's Voy., p.* 407. *J. Ag. Sp. Alg., vol.* 1, *p.* 237. *Kütz. Sp. Alg., p.* 604. *Cystoseira osmundacea, Ag. Syst., p.* 287. *Fucus osmundaceus, Menz. in Turn. Hist. Fuc. t.* 105. (TAB. II.)

HAB. Rocks near low-water mark. At Port Trinidad, on the N. W. coast, *Archibald Menzies, Esq.* California, *Mr. D. Douglas.* Monterey, *Dr. Coulter*, (v. s. in Herb. T.C.D.)

Root discoid. *Frond* of unknown length, but probably many feet long when

when full grown. It originates in a pinnatifid, midribbed, flat leaf, six or eight inches in length, whose lowest laciniæ are short and deltoid; the upper gradually longer, broadly linear, from three lines to half an inch in breadth, and from one to three inches in length. As the plant grows older, the midrib of the first leaf becomes slightly bordered with a thick lamina, and thus forming a two-edged stem, is developed upwards; and new laciniæ, which are successively more compound as they are more distant from the root, are formed along it. The lowest of these divided laciniæ are simply pinnatifid; the next more deeply cut, and their laciniæ changed into vesicles. Those next in order are longer, more slender and more compound; and finally the upper branches of the fronds are slender and filiform, from one to two feet in length, and twice or thrice pinnate. The *air-vessels* begin to be formed on the first divided laciniæ of the young plant, and are produced in great abundance on all the upper branches, sometimes every ramulus, and always several of those nearest the base of the branch being changed into air-cells. On old plants, when the upper branches have reached their excessively divided condition, the apices of the air-vessels frequently are extended into ramuli, which become again branched, and even develop small air-vessels along their branches. The *receptacles* are of small size, short, thickish, simple or forked, tuberculated, and spring from the tips of the uppermost air-cells on fully developed plants. The colour when dry is a dark rich brown, and the substance is thick and leathery.

Turner's figure is taken from a young, undeveloped specimen. In our plate we have shown the appearance of a young stem, and the base of an older one, which would have extended nearly thrice as high as the portion admitted into the figure; the upper secondary branches becoming longer and more compound. Some of these upper branches are indeed so much divided, that, apart from their bases, they may be mistaken for parts of a *Cystoseira*, and have much resemblance to *C. expansa*, but are more robust.

IV. CYSTOSEIRA. *Ag.*

Root a conical disc. *Frond* much divided, either in a pinnate or dichotomous manner, the upper branches and ramuli filiform; forming receptacles by transformations of the ultimate ramuli, and air-vessels by swellings of the branches or ramuli. *Branches* alternate, naked or clothed with spine-like ramuli (or leaves). *Air-vessels* usually several together, forming a moniliform chain in some part of the branch. *Receptacles* formed by the transformation of the terminal ramuli, terete, tuberculated, smooth or thorny, of a densely cellular substance; having numerous pores, beneath which are placed the spherical conceptacles (or spore-cavities). *Spore-cavities* containing both spores and antheridia in the same loculus. *Spores* numerous, oblong or obovoid, subsessile, having a hyaline perispore. *Antheridia* on branching filaments, racemose. *Paranemata* simple, clothing the walls of the conceptacle.

Nearly related to the preceding genus, from which it differs in the air-vessels, which do not here run together into a compound vessel of many cells, though they form little chains, one inflation of the branches succeeding another but remaining separate. Upwards of twenty species are described, of which thirteen or fourteen are found in the Mediterranean, and four occur on the Atlantic shores of Europe as far north as Great Britain, reaching their highest latitude on the western coast of Ireland. The group is scarcely represented in the New World. One or two of the European species are stated, on doubtful authority, to occur on the shores of Guiana and Brazil, where probably something else has been mistaken for them ; but there is no record of any having been detected on the eastern shores of America, where European forms might, more naturally, have been anticipated. The only North American species with which I am acquainted is the following from California.

1. Cystoseira *expansa*, Ag. ; frond (its base unknown) very long, filiform, slender, smooth, repeatedly pinnate, distichous, the ultimate ramuli simple or forked ; air-vessels ellipsoidal, chained, several together in the lower half of the penultimate and ultimate branchlets ; receptacles " cylindrical, warted, paniculate, subconfluent with the tops of the branches." *J. Ag. Sp. Alg., vol.* 1, *p.* 226. *Cystoseira Douglasii, Harv. in Bot. Beechey, p.* 407. *Sirophysalis Douglasii, and S. expansa, Kütz. Sp. Alg., p.* 603. (Tab. I. B.)

Hab. Probably in deep water. At Monterey, California, *Mr. Douglas ; Dr. Coulter.* (v. s. in Herb. T.C.D.)

The root and lower part of the stem are unknown. Our specimens consist of portions of stems (or branches) from two to three feet in length, and about half a line in breadth, compressed, becoming narrower and more filiform toward the extremities ; and thrice or four times divided in an alternately pinnate manner. The ultimate ramuli show a disposition to become dichotomous. *Air-vessels* from one to two lines long, ellipsoidal, in strings of four to eight, forming swellings in the smaller branches and ramuli ; the string of swellings generally commencing near the base of the ramulus, and extending at least through its lower half. In the ultimate and smaller divisions the inflations are proportionally fewer and are sometimes solitary. I have not seen the receptacles which J. Agardh describes as being " 6—8 lines long, everywhere of equal thickness, warted, and nearly all pedicellate."

This is probably a species of very great length, the portions of branches which are alone known to us being evidently only the upper divisions. There is a striking resemblance in habit between these and the most branching forms of *Halidrys osmundacea*, but in the present species each vesicle stands perfectly apart from its neighbour, however closely they may approximate.

DOUBTFUL SPECIES.

2. CYSTOSEIRA *(Phyllacantha) oligacantha*, Kütz. "Of large size; branches filiform, bipinnate, slender; pinnæ very patent, alternate, sometimes opposite; pinnules erecto-patent, sparingly spinous; air-vessels chained, elliptic oblong; receptacles nodoso-tuberculate, cuspidate." *Kütz. Sp. Alg. p.* 596.

HAB. Newfoundland, *Lenormand (fide Kützing).*

Possibly this may be a form of *C. fibrosa*; but without seeing specimens it would be rash to decide.

V. FUCUS. *L. (in part.) Grev.*

Root a conical disc. *Frond* linear, compressed or flat, in the latter case traversed by a midrib, dichotomous, rarely pinnated: forming receptacles by transformations of the tips of the branches; and vesicles (when present) by inflations in the substance of the stem or branch. *Branches* mostly fastigiate, in some species winged with lamina, in none having separate leaves. *Air-vessels* often absent, simple, innate in the branches. *Receptacles* terminal or lateral, oblong or ovate, filled with mucus through which a net-work of jointed filaments extends; having numerous pores beneath which are placed the spherical conceptacles (or spore cavities). *Spore-cavities* generally diclinous, monœcious or mostly diœcious. *Spores* from two to eight in the same hyaline perispore, several such perispores rising from the walls of the cavity. *Antheridia* on branching filaments, ovoid, racemose or tufted. *Paranemata* simple, lining the cell.

A genus of *social* plants occupying the space between tide-marks, and contributing, on the shores where they grow, fully three-fourths of the vegetable clothing of the tidal rocks. Almost all the species are natives of the Northern Hemisphere, and chiefly of the Atlantic basin, where there are seven species on the European and five on the American shore; one of the latter being peculiar to America, and two of the former to Europe; the rest common to both. One species, allied to *F. nodosus*, is found at the Cape of Good Hope.

As already noticed in our Introduction, (p. 36), these common shore-plants yield, on incineration, a considerable per centage of carbonate of soda, to obtain which salt they were formerly largely collected and burnt. Iodine and mannite are also among their secretions.

By J. Agardh, in his recent work, this genus is divided into two, *Fucodium* and *Fucus*, the first of which, excluding some species, is identical with our first section.

Sect. 1. Fucodium, J. Ag. *Frond compressed or subterete, without a midrib.*

1. Fucus *fastigiatus*, J. Ag. ; frond terete below, compressed above, linear, very narrow, many times dichotomous, fastigiate ; the angles rounded and branches widely spreading ; air-vessels none ; receptacles terminal, simple or forked, oblong. *J. Ag. Sp. Alg. vol.* 1, *Sp.* 203. *Kütz. Sp. Alg. p.* 591. *Fucus furcatus, Harv. in Bot. Beechey, p.* 163 *(not of Ag.)* (Tab. III. A.).

Hab. On rocks within tide marks (probably above half tide level). Monterey, *Douglas! Coulter!* St. Francisco, *Capt. Wilkes!* (v. s. in Herb. T.C.D.)

Root a conical disc. *Frond* rising with a short terete stem, which becomes forked at about half an inch from the base. The two primary divisions are generally much divaricated, making a very wide angle, and the frond is repeatedly forked at intervals of from half an inch to an inch, till it attains the length of six or eight inches. There are frequently as many as twelve furcations in plants of this size. The lower parts of the stem are from one to two lines in diameter ; the upper are gradually more and more slender, and at length the extreme forkings are often not a quarter line in breadth. The branches spread widely, so that the general outline of a frond is much broader than its length. There are no air-vessels. The branches are of nearly equal height, and in full grown specimens their tips are almost all enlarged into oblong or fusiform, simple or forked, tuberculated receptacles. *Spores* two in each perispore, a great number of which are attached to the walls of the spore-cavity.

My description and figure are made from Dr. Coulter's specimens ; those brought by Douglas and Wilkes (that I have seen) being of smaller size, and apparently gathered in shallower water. This species is, in many respects, allied to the European *F. canaliculatus*, and probably occupies similar ground, near high-water mark. My specimen from Douglas has altogether the dwarfed appearance which indicates such a locality.

2. Fucus *nodosus*, Linn. ; frond compressed, coriaceous, subdichotomous ; the branches linear, somewhat pinnated, attenuated at the base, remotely toothed, here and there swelling into oblong air-vessels ; receptacles lateral, globose, stalked, springing from the axis of the marginal teeth. *J. Ag. Sp. Alg. vol.* 1, *p.* 206. *Har. Phyc. Brit. t.* 158. *E. Bot. t.* 570. *Turn. Hist. t.* 91. *Ozothallia vulgaris, Dne.—Kütz. Sp. Alg. p.* 591. *Physocaulon nodosum, Kütz. Phyc. Gen. p.* 352.

Hab. On submarine rocks, between tide-marks. Abundant on the Atlantic shores of North America from Halifax to New York. Newfoundland, *De la Pylaie.* (v. v.)

Fronds densely tufted, from one to three or four feet long or more, compressed, linear, much branched, more or less pinnate ; the branches long and subsimple,

tapering to the base and here and there toothed, secondary branches and receptacles springing from the axil of the tooth. *Air-vessels* elliptical, from half an inch to two inches in length, occurring at irregular intervals in the substance of the stem or branches, and much wider than the parts around them. *Receptacles* lateral, pedicellate, ovate or globose, yellow when ripe. *Spores* four in each perispore. *Colour* varying from a greenish to a fulvous olive. *Substance* tough and leathery.

This species varies much in size, and in the comparative robustness of the branches. When growing on the open sea shore, far removed from the influence of fresh water, it attains the length of several feet, and a breadth of nearly half an inch, the colour being of a dark bottle green. In deep bays or arms of the sea, it is much less luxuriant, and more tawny. When growing in æstuaries it becomes of still smaller and feebler growth. I am indebted to Mr. Nicholas Pike of New York for specimens gathered in Chelsea River, Boston Bay, in which the whole frond, though bipinnate and in fruit, is not more than six inches long, and scarcely a line in diameter at the widest part. These specimens are without air-vessels, but have all the other characters of the species.

Another singular form, the *Fucus scorpioides* of Flora Danica, t. 1479, has been sent to me by Mr. Hooper from Fort Hamilton, New York Bay. This is nearly as slender as that just mentioned, but is much more irregularly branched, having a tendency to dichotomous division, with many irregularly placed, divaricating lateral branches. I have compared it with a Norwegian specimen of *F. scorpioides*, with which it agrees very nearly. I was at first disposed to consider it identical with the *F. Mackaii* of British authors, but it is less regular in its branching than that (supposed) species. Both are regarded by J. Agardh, and perhaps justly, as varieties of *F. nodosus*.

Sect. 2. Fucus, J. Ag. *Frond flat, with a midrib.*

3. Fucus *distichus*, Linn. ; stipes filiform, expanding into a very narrow, linear, dichotomous ribbed frond ; the margin very entire ; air-vessels none ; receptacles terminal, subsimple, in pairs, elongate-linear, compressed. *J. Ag. Sp. Alg. vol.* 1, *p.* 209. *Kütz. Sp. Alg. p.* 590. *Turn. Hist. t.* 4. *Fl. Dan. t.* 351. *Lyngb. Hyd. Dan. t.* 1.

Hab. Rocks between tide-marks. Shores of Greenland and Newfoundland, *De la Pylaie.*

Frond 3—6 inches long, rising from a filiform stipe, which gradually expands into an obsoletely ribbed, thickish lamina about a line in breadth and repeatedly forked. Axils acute. *Receptacles* scarcely wider than the segments which they terminate, linear, tapering to each end, from half an inch to an inch in length. *J. Ag. l. c.*

I am not acquainted with this species.

4. Fucus *furcatus*, Ag. ; stipes compressed, expanding into a linear, dichotomous, ribbed frond ; the margin very entire ; air-vessels none ; receptacles elongate, linear, flattish, repeatedly forked. *J. Ag. Sp. Alg. vol.* 1, *p.* 209. *Ag. Ic. Ined. t.* 14. *Kütz. Sp. Alg. p.* 591.

Hab. Newfoundland, *De la Pylaie.*

Frond a foot or more in length, and nearly four lines wide, with a less evident midrib than allied species, and which is altogether obsolete below the receptacle, dichotomous and fastigiate. *Vesicles* none. *Receptacles* three inches long, scarcely thicker than the frond and nearly flat, linear, tapering towards the apices, obtuse, rarely simple, generally once or twice forked. *J. Ag. l. c.*

I am unacquainted with this species.

5. Fucus *ceranoides*, Linn. ; frond plane, coriaceo-membranaceous, linear, dichotomous, midribbed, without vesicles ; the 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. *J. Ag. Sp. Alg. vol.* 1, *p.* 209. *Kütz. Sp. Alg. p.* 591. *Turn. Hist. t.* 89. *E. Bot. t.* 2115. *Harv. Phyc. Brit. t.* 271.

Hab. On rocks and stones between tide-marks, chiefly where fresh water mixes with the sea. Rare on the American coast. New York, *J. Agardh.* (v. v.)

Frond resembling *F. vesiculosus* in aspect, but of thinner and more transparent substance, destitute of air-vessels, though portions of the frond occasionally puff out into irregular distensions ; and having numerous lateral, many-forked, narrow segments, whose tips are at length transformed into fruit. *Receptacles* commonly in pairs, sometimes confluent, bright yellow, or greenish, pointed.

I have not seen any American specimen of this species, which has been sent to Professor Agardh from New York.

6. Fucus *Harveyanus*, *Dne.* ined. (*cum Icone eximia*).

Hab. Monterey, California, *Herb. Paris*, (v. s. in Herb. T.C.D.)

I forbear to describe this species, named and figured by my friend M. Decaisne, some years ago, but of which no specific character has, I believe, yet appeared. It is very closely related to *F. ceranoides*, and I am not certain by what characters it is proposed to be distinguished from that species.

7. Fucus *vesiculosus*, Linn., frond flat, leathery, thick, linear, dichotomous, quite entire at the margin, midribbed ; air-vessels globose or elliptical, mostly in pairs, (often absent) ; receptacles terminal, turgid, ellipsoid, ovoid, or spindle-shaped. *J. Ag. Sp. Alg., vol.* 1, *p.* 210. *Kütz. Sp. Alg. p.* 589. *Turn. Hist. t.* 88. *E. Bot. t.* 1066. *Harv. Phyc. Brit. t.* 204. *Fucus divaricatus, F. inflatus, F. spiralis, F. volubilis, F. Sherardi, Auct. F. bicornis, and F. microphyllus, De la Pylaie, &c.*

Hab. On rocks and stones between tide-marks. Very common on all rocky shores from Greenland to New York. Also on the N. W. coast ; in California, and northward. (The southern limit on the east coast not ascertained.) (v. v.)

Fronds from two inches to two feet long, or more ; varying from a line to nearly an inch in breadth, flat, midribbed, many times forked ; often spirally twisted. *Air-vessels* generally in pairs, one at each side of the midrib, spherical or oval, their size varying with the breadth of the frond. *Receptacles* very turgid, and filled with a lax, watery jelly, through which a network of delicate filaments extends. *Colour* olive or brown. *Substance* coarse and thick.

Very variable in size and degree of ramification, according to the locality in which it grows. When destitute of air-vessels, it may be mistaken by the student for *F. ceranoides*, but the frond is much thicker and more opaque than in that species, and contains a far greater proportion of alkaline matter. The earlier writers on marine plants made a great number of species out of this ; but its varieties only appear different when isolated specimens are examined in the cabinet. On the sea shore all the various forms may be seen passing into one another at different tidal levels. *F. vesiculosus* is distributed in the northern Atlantic from the Arctic coasts to the Canary Islands ; and in the Pacific, from Kamtschatka to California. It is reported to have been brought from the Cape of Good Hope and from Australia, but these localities want confirmation. On the east coast of America it and *F. nodosus* constitute at least three fourths of the covering of tidal rocks.

VI.—HIMANTHALIA. *Lyngb.*

Root a disc. *Frond* at first top-shaped, then cup-shaped, vesicular, unbranched. *Receptacles* very long, strap-shaped, repeatedly forked, springing from the centre of the cup-shaped frond, filled with mucus, traversed by jointed fibres, and pierced by numerous pores, beneath which are placed the spherical conceptacles (or spore-cavities). *Spore cavities* diclinous. *Spores* four within the same hyaline perispore, several perispores attached to the walls of the cavity. *Antheridia* on branching filaments, racemose. *Paranemata* simple, lining the cavity.

A remarkable plant, common on the coasts of Northern Europe, where, in England, it has the popular name "Sea-thongs," which is nearly a literal translation of the sounding Greek imposed by Lyngbye. The view here taken of the frond and receptacles is that first given by Greville and Wahlenberg, and more recently adopted by Agardh; and I have no doubt but that it is the correct view. Dr. Greville has well observed that the pezizæ-form or cup-shaped base, here called the *frond*, attains its full size before any portion of the strap-shaped branches containing fruit, and here called *receptacle*, makes its appearance. The branching receptacle then grows with rapidity, and after it has ripened spores, falls away. The plant is biennial, and, like all biennials, the first year is wholly occupied with the formation of the top-shaped *frond*; the receptacle is rapidly produced in the second season. Late in the autumn, when the old ripe receptacles are thrown off and drifted ashore in large banks, the young fronds for the next season may be seen sprouting in myriads round the dying ones of the last year. Carmichael says that the old fronds sprout again the second season, but I have never observed them do so, though I have repeatedly sought for such second growth.

1. HIMANTHALIA *lorea*, Lyngb.; frond top-shaped, at length collapsing, plano-convex, stipitate; receptacles repeatedly dichotomous, linear, tapering to the extremity. *J. Ag. Sp. Alg., vol.* 1, *p.* 196. *Harv. Phyc. Brit. t.* 78. *Fucus loreus*, *Turn. Hist. t.* 196. *E. Bot. t.* 569. *Fl. Dan. t.* 710.

HAB. Rocks near low-water mark. Biennial. "Coast of North America," *fide J. Agardh.* (v. v.)

Fronds an inch in height, top-shaped, the centre of the disc becoming depressed, and at maturity throwing out a strap-shaped receptacle from two to ten or even twenty feet in length, from a quarter to half an inch in width, tapering to the apices, and many times forked. *Conceptacles* scattered in myriads through the whole length of this gigantic receptacle.

I have seen no American specimen of this plant, and am not aware on what part of the shore it has been gathered, or by whom communicated to Professor Agardh. Judging from probabilities, I should suppose that it may have been found at Newfoundland, or to the north of that island. It is much more abundant in Europe, on the northern coasts, though said to extend southward as far as Spain.

Order II.—SPOROCHNACEÆ.

Harv. Man. Br. Alg. Ed. 2, *p.* 21. *Sporochnoideæ, Grev. Alg. Brit. p.* 36. *J. Ag. Sp. Alg. vol.* 1, *p.* 160. *Kütz. Phyc. Gen. p.* 342. *Kütz. Sp. Alg. p.* 567. *Endl.* 3*rd. Suppl. p.* 28. *Chordarieæ, in part Ag. Syst. p.* xxxvi. *Sporochnideæ and part of Dictyotidæ, Lindl. Veg. Kingd. p.* 22.

Diagnosis. Olive-coloured, inarticulate seaweeds, whose spores are attached to external, jointed filaments, which are either free or compacted together into knob-like masses. (*Plants of mediocre size, soon becoming flaccid in the air, and then changing to a verdigris-green colour*).

Natural Character. *Root* usually a small, naked disc or point of attachment; in *Carpomitra*, bulbous and coated with woolly threads. *Fronds* of mediocre size, and much branched, frequently bushy, having, whilst living, a clear and rather bright brownish olive or chestnut colour, and a cartilaginous, firm, crisp substance; but rapidly becoming flaccid and changing to a verdigris green colour on exposure to the air, and possessing, after this change, the faculty of rapidly decomposing any small Algæ with which they may come in contact. *Stems* and *branches* uniform, destitute of any separate, leaf-like expansions, inarticulate; sometimes cylindrical and filiform, often exceedingly slender; sometimes compressed; and sometimes flattened, leaf-like, and furnished with a distinct midrib, occasionally throwing off lateral nervelets. The branching is frequently opposite, and almost always distichous. *Air-vessels* none. Almost all bear, at some period of their growth, pencils of delicate, jointed, confervoid filaments. In some, as in *Desmarestia* and *Arthrocladia*, these filaments are found on the growing apices, and on all the younger portions of the frond, and appear to be intimately connected with the process of cell-division then going on; and they gradually fall away after the part has attained its full size. In *Arthrocladia* a portion of them remains, and eventually supports the fructification. In others, as in *Sporochnus* and *Carpomitra*, similar filaments spring from and crown the receptacles of the fructification, and fall away when the spores have arrived at maturity.

The outward appearance of the fructification varies in the different genera of this Order, but the differences are of a minor character. In all, the spores are attached to branching, articulated filaments which issue from some part of the branches, and are, therefore, external to the substance. But in some, as in all the American genera, these filaments are free, either clothing the branches or forming pencil-like

tufts along them; while, in others (*Sporochnus* and *Carpomitra*) the fertile filaments are closely packed together and combined into knob-like receptacles, in whose substance the spores are hidden. On dissection these receptacles are seen to be made up of branching filaments, of some of whose branches the spores are formed; and they are either borne on minute, lateral ramuli (or peduncles), or terminate the larger branches of the frond.

A small group of plants, of which five or six genera, comprising about 24 species, are at present known to botanists. They are all plants of deep water, none growing in places where they are left dry at the recess of the tide, and very few being found much above low-water mark, and then only in deep and shady tide-pools. They increase in numbers and in luxuriance of development at three or four fathoms depth, and extend to fifteen or twenty fathoms, often constituting at the bottom of the sea submarine fields of considerable extent. This is the case on the North American coast with respect to *Desmarestia aculeata*, which, in deep enclosed bays, like that of Halifax, is often the only plant that comes up in the dredge after five fathoms of depth, and in many places it seems to choke all other vegetation. A similar prevalence of two other species of this genus (*D. chordalis* and *D. Rossii*) in the deeper parts of the Laminarian zone, has been noticed by Dr. Hooker in the Antarctic Ocean.

Several of the plants of this Order are widely distributed. All the American species of *Desmarestia* have a range almost as wide as that of the ocean; being found in the temperate and colder regions at both sides of the torrid zone, and extending almost to the limit of marine vegetation towards either pole. Their reputed absence in the tropical waters is perhaps owing to a failure of observation. *Arthrocladia villosa*, recently discovered in North Carolina, had been until then supposed to be confined to the shores of Europe, where it almost always accompanies *Sporochnus pedunculatus*, a species not yet added to the American Flora. The genus *Chnoospora* is entirely tropical, but is found both in the eastern and the western hemisphere.

Although the different aspect of the fruit in this Order forces us to group the genera under two families, yet there is such a peculiar habit common to all the individuals of the group, that authors scarcely differ in the limits they assign to it. Agardh and Kützing coincide with the original view of Greville, which is that here adopted; but Endlicher and following him, Lindley, reject *Arthrocladia* and refer it to the neighbourhood of *Cutleria* in Dictyotaceæ. A comparison of the respective structure and development of *Arthrocladia* and *Desmarestia viridis* will I think show that these plants cannot well be far separated. There is something so distinctive in the colour of the Sporachnaceæ when fresh, and the very remarkable change which they undergo on exposure to the air, that these peculiarities alone seem to point, as Mr. Dawson Turner has long since noticed, to a natural affinity among them.

All the following genera belong to the sub-order ARTHROCLADIEÆ.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

I. ARTHROCLADIA. *Frond* pinnate, filiform, nodose, hollow; the tube articulated within. *Nodes* whorled with delicate filaments.
II. DESMARESTIA. *Frond* pinnate, either filiform, compressed, or flat, solid.
III. CHNOOSPORA. *Frond* dichotomous, flat.

I. ARTHROCLADIA, *Duby.*

Frond cylindrical, pinnated, traversed by a wide, empty tube which is interrupted at short intervals by transverse, membranous septa that divide it into a number of vertically seriated air-cells. *Walls* of the frond composed of several rows of cells, arranged in longitudinal series, and diminishing in size from the central tube outwards. Externally the surface is marked at short intervals by nodose swellings, which are clothed with a whorl of numerous confervoid repeatedly pinnate articulated filaments. *Spores* formed from the cells of moniliform, podlike filaments borne along the inner faces of the lower divisions of the whorled filaments, oblate-spheroidal, minute.

A genus consisting of but one species, a native also of the shores of Europe, where it is found from Italy to Scotland, generally in deep water. It is a slender, filiform, distantly branched plant, delicately beautiful when its branches are young, and the pencils of filaments that whorl them uninjured.

1. ARTHROCLADIA *villosa*, *Duby*. *J. Ag. Sp. Alg.*, *vol.* 1, *p.* 162. *Kütz. Sp. Alg.*, *p.* 573 (*A. septentrionalis and A. australis*, *Kg.*) *Harv. Phyc. Brit. t.* 64. *Conferva villosa*, *Huds.*—*E. Bot. t.* 546. *Dillw. Conf. t.* 37. (PLATE IV. A.)

HAB. On submarine substances, in five (or more?) fathoms; very rare. Cast ashore at Smithville, near Wilmington, N. C., *Mr. Charles Congdon.* (v. v.)

Root a small disc. *Fronds* generally tufted, from six inches to nearly three feet in length, very slender, once, twice, or thrice pinnated, filiform; the pinnæ distant, opposite, or rarely alternate, patent, simple or again pinnulated with similar, simple pinnules; all the divisions furnished at intervals of from half a line to a line, with minute knoblike swellings which produce whorls of very delicate, byssoid, repeatedly pinnate jointed filaments of a pale green colour. The frond is traversed by a wide tube, divided by transverse membranes at short intervals into joints or chambers, four or five of which intervene between every whorl of filaments. This tube is surrounded by several series of cylindrical cells, placed end to end

vertically, the innermost of which are of largest size, and the cells of each row to the circumference of less and less dimensions. The substance of the frond when quite fresh is cartilaginous, but it soon becomes flaccid in the air; and the colour, which at first is a bright bay, rapidly changes to verdigris green. The *fructification* is borne on the lowermost divisions of the whorled filaments, and forms moniliform strings of spores springing from the inner faces of the branch. These are developed by the metamorphosis of secund ramuli, and consist of a large number of very minute, oblate spores, which fall asunder when mature. In drying, the plant adheres firmly to paper.

I am indebted to Mr. Congdon for one of the few specimens of this rare plant, which he succeeded in saving during a very hasty visit to the shore near the mouth of the Cape Fear River. It is roughly dried, and I have, therefore, been obliged to use more carefully preserved (British) specimens to give an idea of the natural appearance of the species *(at Pl. IV. fig. A* 1.*)*, but I have drawn the magnified figures (2, 3, 4, 5, 6) from Mr. Congdon's specimen, so that there can be no doubt of their identity. The description of the species given above is mostly copied from the Phycologia Britannica. The magnified figures in Pl. 64 of that work, especially figs. 2 and 4, are much less correct than the corresponding one (2 and 5) now given.

II. DESMARESTIA, *Lamouroux.*

Frond linear, either cylindrical, compressed or flat, pinnated, solid, traversed by a slender articulated filament (or axis); the solid parts composed of several rows of small cells. *Branches* when young producing along the margin, and from the tips, tufts of byssoid, articulated, repeatedly pinnate filaments. *Fructification* unknown.

This genus, of which the fruit is at present unknown, is readily distinguished from *Arthrocladia*, by the structure of the frond. Here there are not the knots along the stem and branches, whorled with delicate filaments, which mark that genus; and moreover the frond, in the present group, is destitute of a tubular axis of large calibre. It is true that the articulated filament which traverses the stem and branches in *Desmarestia* may be compared with the articulated tube of *Arthrocladia*, but the former consists of a string of single cells, placed end to end; the latter is a compound structure, whose walls and septa are both made up of a great number of cells.

The manner in which the frond is developed may be readily seen by examining, under the microscope, any tip of a young branch in process of formation; particularly in the young points of *D. viridis* and *D. ligulata*, in which species the frond is more transparent than in *D. aculeata*. In *D. viridis* the young branch is prolonged, at its apex, into a confervoid filament, formed of a row of cylindrical

cells, lengthening by division of the terminal cell, and becoming branched at intervals by the development of opposite budding cells from the shoulders of the older ones. Thus we have in its simplest form the type of the growth of the species; namely, a repeatedly pinnate division, with opposite pinnules. These pinnated confervoid apices become gradually clothed with a stratum of minute cellules, which may be observed commencing to be formed on the lowermost cells (those nearest the compound portion of the branch), and gradually extending upwards. Thus at length the confervoid filament is completely enclosed in a cellular coating; new coats are continually added to this;—until the frond becomes a cylindrical, compound-cellular body, through the centre of which runs an articulated filament; which filament was the earliest part formed, and the axial nucleus round which the other parts grew.

The manner of growth in *D. ligulata* is precisely similar, except that in that species the new cellular integument to the primary filament is not developed equally on all sides, but extends chiefly laterally, so as to form at first a two-edged and then a flat or even leaf-like stem. In this process of lateral extension, or widening of the stem, the lower portions of the pinnæ of the primary filament being enclosed within the cellular wings of the flattened branch, become the lateral nerves of the frond. Some of these merely reach the margin of the flat stem, or extend slightly beyond it, as a tooth, tipped with a pencil of fibres; others, continuing to vegetate, become the nuclei of the young lateral branches. In the broad forms of *D. ligulata*, constituting *D. herbacea* of authors, the nervation and its origin are both very clearly seen.

1. DESMARESTIA *viridis*, Lamour. frond cylindrical, filiform, repeatedly pinnate; pinnæ and pinnulæ capillary, exactly opposite, patent. *Kütz. Sp. Alg. p.* 570. *Harv. Phyc. Brit. t.* 312. *Dichloria viridis, Grev. Alg. Brit. t.* 6. *J. Ag. Sp. Alg. vol.* 1, *p.* 164. *Fucus viridis, Fl. Dan. t.* 886. *Turn. Hist. t.* 97. *E. Bot. t.* 1669.

HAB. On rocks, stones, and the larger Algæ in tide-pools, near low-water mark, and extending into deep water. Annual. Abundant on the shores of British America, and extending south to Boston Bay; Cape Anne, Connecticut; and Hell-gate, New York, *Mr. J. Hooper*. Unalaschka, *Chamisso*. (v. v.)

Fronds from one to three feet in length, cylindrical, from a quarter line to half a line, or sometimes a line in diameter below, gradually attenuated upwards to a hairlike fineness, excessively branched, having an ovate outline when the branches are freely displayed. All the branches, and every one of the lesser divisions, down to the most minute ramulus, are exactly opposite and distichous; the larger divisions are patent, or nearly horizontal, the lesser more erect. In a vegetating state the branches and ramuli terminate in extremely slender, articulated, byssoid filaments, which gradually become coated with cellules; and then the imbedded filament becomes the axis of the compound frond. *Structure* densely cellular, with numerous large air-cavities dispersed through the cellular

substance. *Colour*, when growing, a fine chesnut-olive, quickly changing to verdigris green when removed from the water. *Substance* tender, soon decomposing.

2. DESMARESTIA *aculeata*, Lamour. ; stipes short, cylindrical ; stems (or primary branches) elongate, flattish, bi-tripinnate ; pinnæ and pinnulæ alternate, very narrow, tapering to the base, either fringed with opposite tufts of bright green filaments or margined with awl-shaped, alternate spines. *J. Ag. Sp. Alg. vol.* 1, *p.* 167. *Kütz. Sp. Alg. p.* 571. *Harv. Phyc. Brit. t.* 49. *Grev. Alg. Brit. t.* 5, *f.* 2, 3. *Fucus aculeatus*, *Linn. Turn. Hist. Fuc. t.* 187. *Eng. Bot. t.* 2445. (TAB. IV. B.)

HAB. On submerged rocks and stones at low-water mark and at a greater depth. Very abundant on the east shores, from our northern limits to Long Island Sound (at least). Probably also on the N.W. coast (being found at Kamtschatka). (v. v.)

Fronds from one to six feet in length, about half a line in width, compressed or flattish, excessively branched and bushy ; the branches usually alternate, rarely opposite, erect, tapering to their base and apex, as do also all the lesser divisions. When young the branches are of a tender substance, soft to the touch, and clothed at intervals of about a line with opposite pencils of finely divided byssoid filaments of a beautiful yellow green colour. In older fronds these delicate filaments fall away, and the branches become rigid and tough, while subulate spinelike alternate teeth are developed from the margin at every three or four lines apart. In transition specimens both spines and filaments are found together, the former being comparatively soft. *Colour* pale olive when young, foxy brown or sometimes very dark when old.

At different ages this plant may readily be taken by a student for two species, as indeed it was by Linnæus himself.

3. DESMARESTIA *ligulata*, Lamour. ; frond flat, with a slender, more or less evident midrib, repeatedly pinnate ; pinnæ and pinnulæ opposite, oblong or lanceolate, tapering to both ends. *J. Ag. Sp. Alg. vol.* 1, *p.* 169. *Kütz. Sp. Alg. p.* 572. *Harv. Phyc. Brit. t.* 115. *Fucus ligulatus*, *Turn. Hist. t.* 98. *E. Bot. t.* 1636. *Fucus herbaceus*, *Turn. Hist. t.* 99. *Desmarestia herbacea*, *Auct.*

HAB. North West Coast, *Mr. Menzies.* (v. v.)

The ordinary European form of this species, figured in *Phyc. Brit. t.* 115, has not yet been noticed on the American coast, except at Cape Horn (!), but may be expected to occur on the shores of some part of British America. The plant recorded above as having been found by Mr. Menzies on the N. W. coast has broader leaves, but, to judge by Mr. Turner's figure, is scarcely otherwise to be distinguished. The following is his description of Mr. Menzies' specimens :—

"*Frond* flat, two feet or more long, rising with a single, undivided *stem*, at its base nearly cylindrical, and as thick as a crow's quill, but almost immediately becoming flat, and gradually widening to the height of a few inches, where it acquires a width of half an inch, or three quarters of an inch, after which it becomes linear, till, on approaching the extremity, it is again slightly narrowed and terminates in a rounded apex; the margins are throughout the whole length serrated with small, spiniform, rather remote teeth; the stem, from root to summit, is pinnate with opposite, distichous branches, of the same substance as itself, between horizontal and patent, separated by intervals of about half an inch, a foot or a foot and half long, and the middle ones, apparently, longest, their greatest width nearly an inch, attenuated at their bases into very short, subcylindrical petioli, rounded at their apices, toothed at their margins, and in their turns pinnated with a series of others, similar to them in every particular, except their small size:—throughout the whole frond runs a midrib, thick and rather wide in the stem, but in the branches thin and faint, so as scarcely to be visible, unless the plant is held to the light, and appearing only like a dark line. *Colour* grass-green, with a faint tinge of brown, transparent. *Substance* membranaceous, extremely thin and tender, but somewhat thickened in the stem, near the root."

I have not seen any American individuals of this variety, but have gathered an equally broad-leaved form at the Cape of Good Hope, having, however, acute pinnæ, and a firmer and more coriaceous substance than Turner describes. On the whole I agree with Prof. J. Agardh in uniting, as one species, the broad leaved and narrow leaved forms.

III. CHNOOSPORA, *J. Ag.*

Frond compressed, repeatedly dichotomous, ribless; its substance composed of elongate prismatic cellules, scarcely denser in the centre. *Fructification*, densely tufted, clavato-moniliform, articulated, spore-bearing filaments, surrounded by sterile, branching filaments (*paranemata*), both aggregated together in wartlike excrescences near the middle of the frond. *Spores* (?) formed in the articulations of the sporiferous filaments, rounded.—*(J. Ag.)*

A small genus of tropical Algæ, readily known by its dichotomous branching. It seems to connect together, naturally, the two sub-orders of which the Order consists. In the structure of its masses of fructification there is an evident passage between those genera with dispersed spore-filaments and those in which these organs cohere together into definite receptacles.

1. CHNOOSPORA *fastigiata*, J. Ag.; "fronds tufted, several rising from the same

callus, erect, many times forked, fastigiate; segments compressed above, patent, with acute axils." *J. Ag. Sp. Alg. vol.* 1, *p.* 171. *Kütz. Sp. Alg. p.* 569. *Ch. Pacifica* and *Ch. Atlantica*, *J. Ag. Liebm. p.* 7. (Tab. IV. C.)

Hab. On the Pacific coast of the Mexican Republic, *Liebman.* (v. s. in Herb. T. C. D.)

Fronds many, from the same scutate base, 2-3 inches long, stipitate, soon forked, and then repeatedly divided dichotomously, the forks being closer and closer upwards; equal in diameter throughout, subcylindrical below, compressed above, with acute apices. The *axils* of the forks are narrow and acute. *Colour* in a dried state very dark, brownish. I have not seen perfect fructification.

I have not been able on the specimens which I have had an opportunity of examining, to make out the structure of the fructification with sufficient accuracy to authorize my introducing the cushions of spore-filaments into the plate. The above description is therefore chiefly translated from Prof. J. Agardh's account of the genus. In aspect the plant resembles a very narrow *Dictyota*, but its substance is very much thicker, and a section under the microscope shows it to be composed of a much greater number of rows of cells. The surface cellules are very minute, and the cells increase in length and breadth as they lie more towards the centre of the flesh.

Order III.—LAMINARIACEÆ.

Laminarieæ, *Grev. Alg. Brit.*, *p.* 24. *J. Ag. Symb. p.* 4. *Sp. Alg. p.* 121. *Endl. 3rd, Suppl. p.* 26. *Kütz. Phyc. Gen. p.* 344, *and part of Chordeæ*, *p.* 333. *Sp. Alg. p.* 573. *Laminaridæ*, *Lindl. Veg. Kingd. p.* 22.

Diagnosis.—Olive-coloured, inarticulate seaweeds, whose spores are superficial, either forming indefinite, cloudlike patches, or covering the whole surface of the frond. *(Plants of large size, not much divided, usually stipitate, foliaceous.)*

Natural character.—*Root* rarely a simple, undivided disc; commonly much branched, or only simple and disc-like when young. As the plant advances in growth, new accessory holdfasts are formed toward the base of the stipe round the primary one, and these, lengthening and branching, unite into a conical mass of rootlets (or cables), which together make up the compound root. *Fronds* of an olive-brown or an olive-green colour, mostly becoming darker on exposure to the air, in some cases turning green in drying; usually tough and leathery in substance,

but in some delicately membranaceous ; the internal structure fibroso-cellular, the flesh being chiefly composed of interlacing threads, formed of strings of cylindrical cells, placed end to end. The plants of this Order are almost all of large, frequently of gigantic size, either tubular or furnished with a *stipe* which expands at the summit into a leafy frond. In the least developed genus *(Adenocystis)* the frond consists of a hollow, membranous bag, contracted at the base into a little stalk, and gradually tapering to the apex into a simple point. At the next stage (*Chorda)* the form is still tubular, but the tube becomes cylindrical, or filiform, and is divided internally into several compartments, by transverse membranes stretched across its cavity. In the more perfect genera we clearly recognise a cylindrical solid stem or *stipe*, occasionally vesicular in its upper portion, and bearing at its summit an expanded leaf. This stem is in most cases simple ; in the most perfect genera alone it becomes branched, its divisions being repetitions of the primary idea. The leafy expansion crowning the stem or branches is sometimes ribbon-shaped, quite simple and tapering to its extremity ; sometimes it is cloven vertically into many narrow laciniæ, by a process of natural splitting which takes place in a very irregular manner ; sometimes it is regularly pinnatifid (as in *Ecklonia*) and lastly (in *Agarum* and *Thalassiophyllum*) the whole expansion is perforated with holes, like a sieve. In the majority of cases the leaf is ribless ; but in the more fully organized a midrib, formed of a prolongation of the apex of the stipe, traverses its substance. *Air-vessels* are very often wanting ; where they are found, they are formed either by distensions of the upper portion of the stipe, or (in *Macrocystis*) by vesications of the petioles of the leaves.

In those species that are perennial the stipe lasts for several years, but the leaf is changed at the end of each season. The process for effecting a change of leaf is gradual, and commences long before the fall of the previous leaf. The new leaf is not formed, however, in the axil of the old one, but begins at the apex of the stipe, or in that portion where the stipe, or common petiole, passes into the leaf. At that point, new and vigorous tissue is always found ; there a new lamina begins to expand, and as it elongates it gradually pushes before it the older part of the leaf, which for a long time adheres to the apex of this new part, and falls away only when the new leaf has reached the normal size.

The fructification of this Order is on a very simple type of development. Innumerable minute *spores*, each contained within a hyaline perispore, are formed out of the surface cells either of the whole frond, or of some large and imperfectly defined portions of it. In the highest types only (as in *Alaria*) are spores found in spaces definitely limited, or in proper leaflets. In the lowest (*Chorda*) they clothe the whole surface, and in most other cases (*Laminaria*, *Agarum*, *&c.*) they form cloud-like, dark-coloured patches of considerable extent and uncertain limits. Usually but one spore is found in each perispore, but in some each perispore contains four sporules. Barren filaments, or *paranemata*, occasionally accompany the spores, and in some cases *Antheridia* are found attached to them. These last are oval cells, filled with minute corpuscles.

The *Laminariaceæ*, though formed on a much less fully organised type than the

Fucaceæ, are of much larger dimensions. The number of species under twelve inches in length is very small; almost all, when mature, exceed twelve feet in length, and when we light upon the real giants of the Order, the frond is measured by fathoms and not by feet. The ordinary *Oarweeds*, *Tangle*, *Devil's-apron* and *Sea-colander* of the American shores, which are familiar examples of these plants, are frequently seen ten, twelve, or even twenty feet in length, with immense fronds or aprons terminating their stems; but these are mediocre indeed, compared to some of their co-ordinals in the Pacific. The *Nereocystis* of the North West Coast is said, when fully grown, to have a stem measuring 300 feet in length, which bears at its summit a huge air-vessel, six or seven feet long, shaped like a great cask, and ending in a tuft of upwards of fifty forked leaves, each of which is from thirty to forty feet in length. The cask-like air-vessel buoys up this immense frond, which, like Milton's hero, lies

> Prone on the flood, extended long and large,
> (And) floating many a rood.—

Here the Sea Otter (*Lutra marina*) has his favourite lair, resting himself on the vesicle, or hiding among the leaves while he pursues his fishing. The stem which anchors this floating mass of fronds, though no thicker than whip-cord, must be of considerable strength and flexibility; and accordingly we find it employed as a fishing line by the rude natives of the coast. But great as is the length of this seaweed, it is exceeded by the *Macrocystis*, whose stems are calculated by Dr. Hooker* occasionally to reach 700 feet, while Bory St. Vincent attributes to them a length of 1500 feet. These are the longest fronded of the Order, and indeed the longest vegetables that are known. Others, as the *Lessoniæ* of the Pacific and Southern Oceans, though of less height have stems of much greater bole, and a habit that reminds us of some large endogenous arborescent plants, as the *Aloe dichotoma* or as the *Dracæna Draco*. These gigantic Algæ have trunks of considerable diameter and height, branched dichotomously, each branch bearing at its summit bunches of long ribbon-like leaves. Torn from the submerged rocks on which they grow, these marine trees are driven ashore on the rocky coasts of the Falkland Islands in great numbers, and lie, as Dr. Hooker well describes, rotting for many a mile, in banks several yards in breadth and three or four feet in depth. The trunks, from which the leaves have been washed, resemble drift-wood, and "on one occasion" (as related by Dr. Hooker) "no persuasion could prevent the captain of a brig from employing his boat's crew, during two bitterly cold days, in collecting this incombustible weed for fuel." Another noble genus of the Southern Ocean *(Ecklonia)* may be compared to the Palm in habit, having pinnated fronds of large size. One of the best known species, the *Trumpet-weed (Ecklonia buccinalis)* of the Cape of Good Hope, has a stem often more than twenty feet in height, crowned with a fan-shaped cluster of leaves, each twelve feet long or more. The stem of this seaweed which is hollow in the upper portion is, when dried, often used in the colony as a siphon; and by the native herdsmen is formed into a trumpet for collecting the cattle at evening. But perhaps the most curious plants of the Order

* Fl. Antarct. vol. 3, p. 464.

are the Arctic genera *Agarum* and *Thalassiophyllum*, both found within our limits and described below.

The Order contains some fifty species, about half of which are natives of the western world, and the largest portion of these of the northern continent. They are plants of deep water, rarely vegetating within tide-marks, or barely reaching a few inches above low water mark, and characterise a broad zone of depth extending from low water to four or five fathoms below it; while the larger species straggle into deeper water, to an unknown distance from the surface. Many of these probably first vegetate on detached masses of rock at a moderate depth, and are afterwards drifted, carrying their rocky anchors with them, into the deeper sea. They are mostly plants of high latitudes, to which the greater number are confined. *Macrocystis* and *Ecklonia* are characteristic of warmer climates, and extend, as well as some species of *Laminaria*, into the tropical zone.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

1. *Frond having a stem, furnished with definite leaves.*

I. Macrocystis. Stem filiform, branched. *Leaves* simple, secund along the stem, each leaf rising from a stalked air-vessel.

II. Nereocystis. *Stem* filiform, unbranched, bearing at its summit an air-vessel, from which many forked leaves spring.

III. Lessonia. Stem dichotomous (or simple?). *Leaves* terminating the branches. *Air-vessels* none.

2. *Frond stipitate, the stipes expanding at the summit into a simple or cloven lamina.*

* *Lamina midribbed.*

IV. Alaria. *Lamina* traversed by a single rib.

V. Costaria. *Lamina* traversed by several parallel ribs.

** *Lamina without midrib.*

VI. Laminaria. *Lamina* either simple or cloven.

3. *Frond flat, pierced, like a colander, with holes.*

VII. Agarum. *Lamina* midribbed.

VIII. Thalassiophyllum. *Lamina* without midrib, spirally developed round a (branching) stipe.

4. *Frond cylindrical, tubular or bag-shaped.*

IX. Chorda. *Frond* filiform, septate within.

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1. MACROCYSTIS, *Ag.*

Root branching extensively. *Stem* filiform. *Leaves* simple, formed by the continual splitting of a primary terminal leaf; developed in secund order along the lengthening stem, petiolate, having an *air-vessel* in the petiole. *Spores* forming irregular, superficial, cloudlike patches on small radical leaves, ellipsoidal, with hyaline perispore, surrounded by densely packed, inarticulate, clavate paranemata.

When fully grown the frond in this genus consists of a much branched root, from which rise many filiform, simple or branched stems, naked below; but furnished above with numerous, unilateral, lanceolate, petiolate leaves, having their petioles enlarged into pear-shaped or oblong air-cells. The lateral leaves have their edges directed toward the stem and are so far vertically disposed; and the stem itself, when unbroken, always terminates in an oblique leaf, broader than the rest, and having one or more slits in its base. This terminal leaf is the growing apex, and from the development of the slits in its base new lateral leaves are gradually separated. The whole frond, indeed, much divided as it eventually becomes, has been developed from the continual splitting of such a leaf. The young stem as it first rises from the root bears at its summit a single vertical leaf, destitute of vesicle, serrated, except at a short distance above the base, and having the apex generally a little hooked in: its outline is therefore somewhat scymetar-shaped. In this leaf, commencing within the margin of its lowest edge, are gradually formed a series of splits, proceeding from the base and extending upwards towards the apex. As each split increases in length, it widens by the onward growth of the common base; and air-vessels begin to be formed in the lower and slender part of the segments, which are gradually separated. The splitting process continues until the split reaches the margin, at which time the air-vessel is completely formed, and the margin of the young segment furnished with ciliæform teeth; and its apex being at length free, it becomes a leaf, only differing in size from those lower down on the stem, and which have had a similar origin.

The fructification is found only on root-leaves which never rise to the surface and are destitute of air-vessels. It forms cloudy patches, and contains myriads of extremely minute spores.

The student will find an interesting history of this genus, illustrated by an excellent figure showing the development of the leaves, in Dr. Hooker's *Flora Antarctica, vol.* 2, *p.* 461—466, *tab.* 169, 170, 171.

1. Macrocystis *pyrifera;* Ag. *Hook. and Harv. in Hook. Fl. Antarct. vol.* 2, *p.* 461. *Macrocystis Humboldtii, planicaulis, angustifolia, tenuifolia, pyrifera, pelagica, luxurians, latifolia, Orbigniana, Auct.—J. Ag. Sp. Alg. p.* 155—158. *Kütz. Sp. Alg. p.* 582—583 *(also M. Dubenii, Aresch., latifrons, Bory, &c.). Lessonia ciliata, Post. and Rupr. Illust. p.* 9, *t.* 38, *f.* 9.

HAB. Shores of California, *Beechey, Coulter, Wilkes, &c.* Unalaschka and Sitcha, *Postels and Ruprecht.* (v. v. ad C. B. S.)

Root much branched. *Stems* from five feet to several hundred feet long, filiform or flattish, eventually subdichotomously branched. *Leaves* lateral, secund along the branches, lanceolate, varying much in length and breadth, membranaceous or coriaceous, smooth or wrinkled, bordered with slender cilia or subulate teeth; each leaf rising from an air-vessel. *Air-vessels* as variable in form and size as the leaves, globose, ellipsoidal, pear-shaped or fusiform, or long and narrow-club-shaped.

I fully concur with my friend Dr. Hooker in the view of this species which we have jointly taken in another place. (*Fl. Ant. vol.* 2, *p.* 461.) We have together carefully examined specimens representing most of the forms distinguished as species by authors, and still retained by Prof. J. Agardh ; and each of us,—Dr. Hooker very extensively,—has had an opportunity of verifying opinions arrived at in the study by observations made from the living plants on the sea-shore ; and we have both, independently, arrived at the conclusion that all the forms separated by authors are referable to a single, and not *very* variable species. Many of these reputed species may indeed be found growing together on different parts of the same stem ; the differences observed being either the result of age, or of a different degree of submersion, or other modifying cause.

II. NEREOCYSTIS, *Post. and Rupr.*

Stem filiform, simple, terminating in a club shaped air-vessel, from which springs a tuft of dichotomously divided leaves, formed by the continual splitting, from the base upwards, of an original, simple, terminal leaf. *Root* branching. *Fructification* unknown.

NEREOCYSTIS *Lütkeana, Post. and Rupr. Illustr. p.* 9. *t.* 8. 9. *Endl. Gen. Pl.* 3*rd Suppl. p.* 27. *J. Ag. Sp. Alg., vol.* 1, *p.* 148. *Kütz. Sp. Alg. p.* 584. *Fucus Lütkeanus, H. Mert. in Linn.* 1829. *p.* 48. *Hook. Bot. Misc. vol.* 3, *p.* 3.

HAB. North West Coast, at Norfolk Sound, *Dr. Henry Mertens.* (v. s. in Herb. T. C. D.)

I copy the following account of this remarkable plant from the paper of Dr. Henry Mertens, its discoverer :—

" A root, ramified in the manner of the *Laminarias* produces a stipes like packthread, and everywhere of uniform thickness, about two or three feet long, and suddenly swelling at the end into a perfectly round, large, bladder-nut. The upper portion of this hemispherical body bears a tuft of geminate leaves, mostly rising on

five petioles: but in the division of these petioles, there never exists such a symmetry as that the fifth is found exactly in the centre and opposite to the point of insertion of the stipes at the vesicle ; rather, there are three on one side, and two only on the other. In some rare instances I noticed but four leaf-stems, two on either side. The summit of the vesicle always presented an open space: the leaves are lanceolate, sharply attenuated at both extremities, their substance like the frond of *Laminaria Phyllitis*, about one and a half to two feet long, and measuring two inches in their greatest breadth ; some longitudinal nerves appear, of uncertain number, running from the base of the leaf to the middle, where they are lost in the substance. Such is the configuration of this fucus in a young state ; when older it alters so as to be scarcely recognisable, and then only acquires that remarkable appendage, which I shall now proceed to explain. In advanced age, the stipes becomes immensely long, without however increasing proportionably in thickness ; for whilst it remains at the base of the stoutness of packthread, its diameter, at ten or fifteen fathoms' distance, scarcely measures two and a half lines. Gradually the vesicle changes into a turnip-shaped or retort-like cylinder, more than a fathom long, measuring at its broadest dimension that supports the leaf near the end, 4—6 inches or even more in diameter, while the lower end gradually, and quite imperceptibly, loses itself in the stipes. The formation of the frond keeps an equally gradual advance : the leaves described above are numerously divided in their length, the nerves of the young leaves indicating their future points of separation. Entangled at their bases by matting together, these attain a very great length and an equal increase of breadth ; the tuft now covering an immense surface with its crowded masses. In one specimen, by no means the largest, which I examined, I calculated that there were upwards of fifty leaves, each twenty-seven feet long. The Russians call this fucus (to which I had previously given the name of *Lutkeanus*, in honour of our worthy commander, who daily shows himself more zealous in favouring our natural history labours) *See Otter Kohl*, or the Sea Otter's Cabbage. The valuable animal, *Lutra marina*, makes particular choice of this seaweed as its favourite refuge and residence; delighting to rock and sleep on the long cylindrical bladders, which, like enormous sea-serpents, float on the surface of the water, and individually sweep between the little islands, rendering the channels impassible, even for boats. From the information that I collected from various Russians and Aleutians concerning its duration, this fucus is annual. In autumn it is cast in great quantities on shore by the then prevalent storms, where it soon decays, and in spring not the least trace of it is to be seen. The Aleutians employ the stipes, which are said sometimes to be forty-five fathoms long, for fishing lines : I purchased one of them. I once saw the Kadiakensers, in Sitcha, make use of the cylinder as a siphon, for pumping the water out of their Beidarkas ; a use to which it is well known that the *F. buccinalis* is often applied at the Cape of Good Hope. Owing to the moist climate of Sitcha, the drying of this sea-weed is attended with considerable difficulty. I hardly ever succeeded in preserving a tolerable specimen of the cylinder or bladder, though I bestowed much pains and labour on the operation, for this part generally dissolves completely, or if dried, the leaves then become brittle as glass, and fall to pieces with the slightest touch. The opening of the bladder and

discharging the water which it uniformly contains, only hastens the process of decomposition."—*H. Mert.* (*translated*) *in Hook. Bot. Misc.* 3, *p.* 3-5.

Little is known of this singular Alga beyond the above graphic description, and the figure of Postells and Ruprecht. I earnestly recommend it to the notice of all collectors of plants on the North West Coast ; though it would appear to be confined to Russian America.

III. LESSONIA, *Bory.*

Stem cylindrical, solid, dichotomously branched, each branch terminating in a pair of lanceolate leaves. *Air-vessels* none. *Spores* collected in a thickened portion of the lamina of the leaves, and there forming a subdefined, dark-coloured patch, ellipsoidal, with hyaline perispore, and lying among densely packed, inarticulate paranemata.

Species of this genus probably exist on the North West Coast, but as yet I have received no certain information on this subject. The *Lessonia Sinclairii* from California, mentioned by Dr. Hooker, *Fl. Antarct. vol.* 2, *p.* 460, must for the present remain undescribed. The name was given in MSS. to a specimen existing in Sir William J. Hooker's herbarium, having the habit of *Laminaria saccharina*, but a central patch or *sorus* of fructification, like that of the ordinary Lessoniæ. I have no means, at present, of referring to the original specimen, and neglected to make an accurate examination of it when it was named. It was gathered by Dr. Sinclair at San Francisco, and is the *Lam. saccharina* of *Harv. in Hook. and Arn. Bot. Beechey*, *p.* 407.

IV. ALARIA, *Grev.*

Root branching. *Frond* stipitate, membranaceous, with a percurrent cartilaginous midrib (a continuation of the stipes) ; the lower part of the stipe pinnated with ribless leaflets. *Spores* collected in a thickened, central portion of the leaflets, forming a definite, dark coloured patch, four spores contained within each pear-shaped perispore, myriads of which are vertically packed together among inarticulate paranemata.

A small genus inhabiting the colder regions of the Northern Atlantic and Pacific. The *lamina* which forms the wing, at either side of the midrib, or

prolonged apex of the stipes, is of a delicately membranaceous substance, and tears easily in an oblique direction from the margin to the midrib, and it is rare to find specimens of large size in which the upper half of the leaf is not reduced to tatters. During the growing season new ribbed membrane is, however, constantly developed at the base of the old winged portion, and by its upward growth supplies the place of the apex which is destroyed by the waves. In the young plant the stipes is very short and has no pinnæ. As the growth proceeds, it gradually lengthens and becomes much thicker and stronger, throwing out along its margin in the upper half, and immediately below the base of the leafy portion, narrow spathulate ribless leaflets. These are destined to contain the fructification, and are the nearest approach to a proper *receptacle* of fruit that is found within the limits of the Order. The barren leaflets are membranaceous, and not very different in substance from the ribbed leaf, except in being a little thicker; but those in which fruit is formed have their lower half, at least, incrassated, and gradually changed to a dark brown. The thickening is sometimes confined to the lower half of the leaflet, and sometimes extends to the whole surface. A vertical section through this mass of fructification shows it to be composed of innumerable *perispores*, formed out of the enlarged surface-cellules of the frond. Each perispore, at maturity, contains four spores. Numerous barren filaments or *paranemata* accompany the fertile perispores.

The midrib of *Alaria esculenta*, when stripped of the membrane, is eaten by the peasantry on the shores of Scotland and Ireland under the various names *Badderlocks*, *Henware*, *Honeyware*, and *Murlins*. If the first of these names signify that this esculent is *far from good*, it is perhaps the most appropriate of the whole; but I do not vouch for the authenticity of this derivation.

1. Alaria *esculenta*, Grev.; midrib solid, scarcely wider than the stipes; lamina ovate at the base, decurrent along the stipe; pinnæ linear or cuneate. *J. Ag. Sp. Alg.* 1, *p.* 143. *Kütz. Sp. Alg. p.* 579. *Harv. Phyc. Brit., t.* 79. *Fucus esculentus, Turn. Hist., t.* 117. *E. Bot. t.* 1759. *Fl. Dan. t.* 417. *Laminaria musæfolia, and L. linearis, De la Pyl. Fl. Terr. Neuv. p.* 31 *and* 37.

Hab. On rocks about low water mark. On the eastern coast, as far south as Cape Cod. Newfoundland. Also on the N.W. Coast, at least in Russian America. (v. v.)

Root of many grasping branches. *Stipe* naked at the base, cylindrical, from two to eight or ten inches long, and from two to four lines in diameter, pinnated in its upper half with numerous ribless, linear-spathulate leaflets, which at length become crowded together; above these leaflets the stipe is winged at each side with membrane, and passes gradually into the cartilaginous midrib of the foliaceous frond, which is from three to twenty feet long or more, and from two inches to eight or ten inches or more in width. This leafy portion is very thin and easily torn, of a clear olive when growing, becoming greener and more transparent when dried.

The masses of fructification are reddish brown, much thicker than the leaves in which they lie.

2. ALARIA *Pylaii*, Grev. ; midrib solid, scarcely wider than the stipes, lamina cuneate at the base, decurrent along the stipes for a considerable space ; pinnæ obovato-spathulate. *J. Ag. Sp. Alg. vol.* 1, *p.* 143. *Kütz. Sp. Alg. p.* 579. *Laminaria Pylaii, Bory. De la Pyl. Fl. Ter. Neuv. p.* 29.

HAB. On rocks near low-water mark. Newfoundland, *De la Pylaie.* (v. s. in Herb. T.C.D.)

Scarcely differing from the preceding, with which it has probably been sometimes confounded. It is chiefly marked by the broader and more obovate pinnæ ; the cuneate base of the frond is a very indefinite character.

3. ALARIA *fistulosa*, Post. and Rupr. ; "Midrib fistular, inflated, at intervals constricted and septigerous ; lamina delicately membranaceous ; pinnæ linear, rounded at the apex, attenuated at base, sessile."—*Post. and Rup. Illustr. p.* 11, *t.* 16.

HAB. Illuluk Bay, Unalaschka, *Postells and Ruprecht, l. c.*

4. ALARIA *marginata, Post. and Rupr.* ; "Midrib solid, rather broad ; lamina thin but leathery," (chartaceo-coriacea) ; "pinnæ linear, rounded at the base and apex, stipitate, coriaceous, entire at the margin, plane, bordered by a shining stripe (fascia nitida cinctis)."—*Post and Rupr. Illus., p.* 11.

HAB. At Unalaschka, *Postells and Ruprecht, l. c.*

V.—COSTARIA, *Grev.*

Frond stipitate, undivided, flat, three to five ribbed, the ribs sub-parallel, radiating from the apex of the stipe. *Fruit.* . . . ?

The stipe is simple, solid, flattened, and marked with numerous elevated longitudinal striæ, and so continued through a simple, linear, or ovate lamina, that the striæ of the stipe are produced in ribs. These ribs are three or five ; they are united in the stipe ; separated, they run through the lamina sub-parallelly, and approach again at the apex. The lamina is mostly wrinkled and bullated, often perforated between the ribs, the perforations irregular. *J. Ag. l. c.*

1. Costaria *Turneri*, Grev. ; stipes flat, expanding into a linear-lanceolate five-ribbed lamina. *J. Ag. Sp. Alg. vol.* 1, *p.* 139. *Kütz. Sp. Alg.* 580. *Fucus costatus*, *Turn. Hist. t.* 226.

Hab. On the North West Coast, *Mr. Menzies.*

" *Frond* solitary, rising with a stipe about an inch in length, marked from top to bottom with prominent, nearly parallel striæ, cylindrical, and of the size of a crow's quill at its origin, but almost immediately becoming compressed, and soon after flat, gradually expanding, too, as it rises, but so slowly that at the top it is scarcely above a line in diameter ; it here suddenly expands into a single, flat, undivided leaf, a foot and a half or more long, nearly linear, about two inches wide, quite entire, and slightly waved at the margin, at the base attenuated ; the surface marked all over with irregular transverse wrinkles, and having five parallel ribs running through it from top to bottom. *Colour* a pale, dirty yellow in the stipe, in the leaf olive-brown, and semi-transparent. *Substance* of the stem woody, of the leaf membranaceous."—*Turn. Hist.* 4, *p.* 72.

2. Costaria *Mertensii*, J. Ag. ; " stipes flat, expanding into a cordato-ovate five-ribbed lamina."—*J. Ag. Sp. Alg.* 1, *p.* 142. *Costaria Turneri*, *Post. and Rupr. t.* 24.

Hab. North West Coast, *Dr. H. Mertens.*

I think this must be merely a broad leaved form of the last.

VI. LAMINARIA, *Lamour.*

Frond stipitate, coriaceous or membranaceous, flat, ribless, undivided or irregularly cleft. *Fructification*, cloud-like patches of *spores*, imbedded in the thickened surface of some part of the leafy expansion.

The plants commonly known as *Oarweed, Tangle, Devil's Apron, Riband-weed, Sole-leather-kelp, &c.* belong to this genus, which is more numerous in species, and possessed of a wider geographical range than any other of the Order. With the exception of *L. Fascia*, which is only a few inches long, they are all plants of a large size, varying from three to twelve, or twenty feet in length. They commence to grow about low-water mark, and descend, beyond that limit, to the depth of five to ten fathoms.

Many are perennial ; the stipe remaining from year to year and the frond falling away. The new frond is developed between the apex of the stipe and the base of the old frond, and at first appears like a flattening and widening of the apex of the

stipe. This flattened portion gradually lengthens, assuming the normal form of the species, and carries at its apex the old leaf, which is about to be changed. The point of cohesion of this leaf becomes less firm, and gradually the now decayed lamina falls off, leaving the young frond to crown the stipe in its place.

1. LAMINARIA *Fascia*, Ag.; stipe very short, slender, flattened, expanding gradually into a membranaceous, broadly oblong, wedge-shaped, lanceolate, or linear frond. *Harv. Phyc. Brit. t.* 45. *Lam. Fascia, cæspitosa et debilis, J. Ag. Sp. Alg. vol.* 1, *p.* 129-130. *Phyllitis Fascia et debilis, Kütz. Sp. Alg. p.* 566.

HAB. On rocks and stones, near low-water mark. Fort Hamilton, N. Y. *Capt. Pike and Mr. Hooper.* Halifax, *W. H. H.* (v. v.)

Root, a small disc. *Stipe* as thick as hog's bristle, half an inch long, filiform at base, compressed upwards and gradually widening into the cuneate base of the frond. *Lamina* very variable in form, 2—12 inches long, from a quarter inch to two inches broad, sometimes abruptly cuneate at the base, sometimes much attenuated, either lanceolate, oblong, or linear, or oblong-ovate; in some specimens remarkably obtuse, in others tapering more or less to the point. Margin waved or flat. *Colour* when growing a clear chestnut brown, changing to greenish olive in drying.

I can by no means distinguish from one another the three species of Prof. Agardh, above referred to this. The form of the frond is most variable, even in the same tuft, and the gradations between the several forms so complete, that if you examine a sufficient number of specimens not specially selected as typical, there can be no difficulty in tracing the narrowest and most cuneate into the widest and most ovate. *L. Fascia* is widely distributed, being found also on the Atlantic and Mediterranean shores of Europe; and at the Falkland Islands in the Southern Atlantic.

2. LAMINARIA *lorea*, Bory; stipes rising from a branching root, flat, winged above, dilating into a linear-ensiform, membranaceous, very long frond, entire or cleft at the apex. *J. Ag. Sp. Alg. vol.* 1, *p.* 130. *L. tæniata, Post. and Rupr. t.* 38, *f. (fide Ag.). L. saccharina, var. Kütz. Sp. Alg. p.* 574.

HAB. Shores of Newfoundland, *Despreaux.*

Stipe 3—4 inches long, flat from its origin, dilated above, and winged with a thinner margin. The wing of the stipe is expanded into the lamina of the frond, the stipe itself (or its thickened portion) being continued in furrows through the lower part of the lamina. *Lamina* several feet long, an inch and a half wide, at each end much attenuated. *J. Ag. l. c.*

I am not acquainted with this plant, said to be a very distinct species by Agardh, from whom I copy the above description.

3. LAMINARIA *dermatodea*, De la Pyl. ; stipes rising from a branching root, terete below, compressed or flattened above, dilating into a cuneate-oblong simple frond afterwards becoming cordate at base, and palmately cleft from the apex. *J. Ag. Sp. Alg.* 1, *p.* 131. *Phyllitis dermatodea*, *Kütz. Sp. Alg. p.* 567.

HAB. On rocks, at and below low-water mark. Newfoundland, *De la Pylœie.* (v. s. in Herb. T.C.D.)

Stipe 3-4 inches long, in the young plant compressed, in the full-grown altogether flat, passing into the base of an oblong or lanceolate frond, which in the young plant is entire, but which at last, becoming more dilated and with a more cordate base, is cloven into several segments and assumes the habit of *L. digitata.*

I have seen only young specimens of this species, and in them the apex is imperfect. They were collected by Despreaux and communicated to me by *M. Lenormand.*

4. LAMINARIA *saccharina*, Lamour. ; stem cylindrical, solid, short, expanding into a cartilaginous or submembranaceous, lanceolate or oblong, undivided frond. *J. Ag. Sp. Alg. vol.* 1, *p.* 132. *Kütz. Sp. Alg. p.* 574. *Harv. Phyc. Brit. t.* 289. *Fucus saccharinus*, *L. E. Bot. t.* 1376. *Turn. Hist. t.* 163. *Lam. Lamourouxii ? Bory*, *Dict. Cl. Hist. Nat.* 9, *p.* 189.

HAB. On rocks in the sea, from low-water mark to four or five fathoms. Common on rocky shores, from Greenland to New York ; and cast up from deeper water on the New Jersey coast. (Its southern limit not ascertained beyond Long-branch, N. J.). (v. v.)

Root of several branching fibres, forming a conical holdfast. *Stem* from a few inches to a foot or more in length, from a quarter to half an inch in diameter, terete, compressed at its upper end, and gradually dilating into the base of the terminal, undivided lamina. *Lamina* very variable in its proportionate length and breadth, sometimes linear-lanceolate, sometimes ovato-lanceolate, sometimes elliptical, acute or obtuse, or drawn out at the apex into a long caudate prolongation, from one to six or ten feet in length, and from one to twelve inches in breadth, flat, or very much curled at the margin, and at length over the whole surface ; sometimes regularly transversely wrinkled through the middle of the lamina, sometimes irregularly bullated. *Substance* in some varieties membranous, in others cartilaginous or leathery, or even horny in some. *Colour* of the leaf when young a greenish olive, browner as it grows old.

Numerous varieties, which perhaps demand future study, occur on the American coast. The *Laminaria Lamourouxii* of Bory, which has been sent me from Boston Harbour by Prof. Asa Gray, and of which I also possess an authentic specimen from Newfoundland, looks almost like a species, with its thickish, broadly elliptical, scarcely waved frond, and its slightly branching root ; but I am not sufficiently

acquainted with it to say whether it has claims to be regarded as anything more than a form. Prof. J. Agardh refers it unhesitatingly to *L. saccharina*, and it must be confessed, that if we separate it on the mere characters assigned by M. Bory, we must be prepared to admit to specific rank many other forms now referred to *L. saccharina*.

5. Laminaria *longicruris*, De la Pyl. ; Stipes very long, slender at the base, hollow and inflated in the middle, and gradually tapering to the apex ; frond undivided, ovato-lanceolate, membranaceous, obtuse. *J. Ag. Sp. Alg. vol.* 1, *p.* 135. *Kütz. Sp. Alg. p.* 576. *Harv. Phyc. Brit. t.* 339. (TAB. VI.)

HAB. In deep water, from five to ten fathoms (or more?). Very abundant on the American shores, from Greenland to Cape Cod. Newfoundland, *De la Pylœie.* Bahama Islands, *Chauvin.* (v. v.)

Root of many slender and much branched, clasping fibres, which issue at irregular intervals from the lower part of the stipe. *Stipe* from eight to twelve feet in length, very slender at the base, and there solid, gradually widening upwards, and soon becoming hollow ; at length, toward the middle, widened to upwards of an inch in diameter, and thence tapering to the apex, and terminating in the broadly cuneate base of the lamina. *Lamina*, when full grown, 6 to 8 feet in length, and from two to three feet in width, oblong-lanceolate or oval, very much waved at the margins, and obtuse at the apex, of a thinner substance than in *L. saccharina*. *Colour* of the stem yellowish brown, pale ; of the lamina a beautiful pale greenish olive.

This noble species, though having much general resemblance to the preceding, is at once distinguished from every form of it by the very long, hollow stem, tapering to both extremities. It is by far the most abundant species on the northern coasts, and gradually diminishes, in the number of individuals, and in the size and luxuriance of growth, as it extends southward. In Boston Bay it is still plentiful, though of much smaller dimensions than at Halifax, where it is the chief ornament of the sub-marine flora. I have seen no specimen from a more southern locality than Cape Cod ; but M. Chauvin is said to have received it from the Bahamas. In Europe it is scarcely known to grow beyond the limits of the Arctic Sea, whence water-worn specimens occasionally reach the coasts of Scotland, and of the north of Ireland.

PLATE VI. *Fig.* 1. A young frond of LAMINARIA *longicruris* ; one third of the natural size ; *fig.* 2. part of the hollow stipes of a full grown plant, the *natural* size.

6. LAMINARIA *trilaminata*, Harv. MSS.—Olney, in Proceedings of Providence Franklin Society, vol. 1, p. 39.

HAB. Floating near Narragansett Pier, R. I. *Mr. Olney.* (v. s.)

I introduce this undescribed and scarcely known plant, because it has already obtained publicity in Mr. Olney's list of Rhode Island plants, quoted above ; but I am unable to give a satisfactory description from the few fragments that have reached me ; and probably, after all, these may belong to some strangely anomalous form of *L. saccharina.* The fragments sent me by Mr. Olney and Professor Bailey are labelled as part of a large Alga resembling *L. saccharina* in appearance, but having a trilaminate frond ; that is, from the centre of the lamina, along its whole (?) length, there projects a wing or additional lamina, making, with the two halves of the true leaf, a third lamina. Nothing is known of the stipes.

7. LAMINARIA *digitata*, Lam. ; stem robust, woody, terete below, compressed above, expanding into a leathery, oblong, or ovate frond, which is deeply cleft into many linear segments of irregular breadth. *J. Ag. Sp. Alg. vol.* 1, *p.* 134. *Harv. Phyc. Brit. t.* 223, *and t.* 338. *Hafgygia digitata, Kütz. Sp. Alg. p.* 577. *Phyc. Gen. t.* 30, 31. *Fucus digitatus, L. Turn. Hist. t.* 162. *E. Bot. t.* 2274.

HAB. On rocks, at and below low-water mark. Common as far south as Cape Cod. Narragansett Pier, R. I., *Mr. Olney. (floating only).* (v. v.)

Root formed of many stout branching holdfasts united together in a conical mass. *Stipe* from two to six feet long, cylindrical below, from a quarter inch to an inch in diameter at base, solid, tapering, and becoming compressed upwards, and terminating in the base of a standard-like broad lamina. *Lamina* from one to five feet long, or more, from one to three feet wide, deeply cleft from the apex to near the base into many linear strap-shaped segments of uncertain breadth. *Substance* of the stem woody, but flexible, horny when dry ; of the lamina leathery. *Colour* olive, becoming dark in age.

Possibly more than one species is here confounded. Some varieties, like that figured in *Phyc. Brit. t.* 338, are very narrow, with very much compressed, or even flattened stipes, and of a dark blackish-brown colour and glossy surface. Others, which I have from Boston Bay, have dried extremely pale, and though I have not seen perfect specimens of these, I remember to have noticed on the beach near Nahant some forms of pale colour and with very flat stems, which may belong to a peculiar species. The limits of species among these gigantic Algæ can rarely be determined from Herbarium specimens alone, and should be fixed by persons familiar with the plants in their places of growth, and who have watched the development of the frond through all its stages.

VII. AGARUM, *Bory.*

Frond stipitate, coriaceous, flat, pierced in all parts with roundish holes, and traversed by a cartilaginous midrib which is a prolongation of the stipes. *Fructification*, cloudlike patches of *spores*, imbedded in the thickened surface of some part of the perforated expansion.

A remarkable genus peculiar to the northern parts of the Atlantic and Pacific Oceans, on the American and Asiatic shores. The common American species (*A. Turneri*) is well known in the north eastern states as the *Sea Colander*, a name aptly expressive of the perforated frond. The holes in the membrane exist at all ages, but increase in size and circularity, as well as in numbers, as the growth proceeds. They are at first merely narrow slits, and commence to be formed near the midrib, where the active cell-division seems to take place. As in Laminaria, the newest portion of the leaf is at the base, where the stipes enters ; and the apex is continually worn out and thrown off. The *fructification* is found on old fronds late in the autumn, or early in winter, and forms very dark coloured patches of uncertain extent on the pierced membranes.

1. AGARUM *Turneri*, Post. and Rupr. ; stipes compressed, coriaceous, continued as a flattened midrib through the frond ; lamina membranaceous, its nearly circular holes with flat margins, and of various sizes intermixed. *J. Ag. Sp. Alg. vol.* 1, *p.* 141. *Kütz. Sp. Alg. p.* 580. *Fucus Agarum, Turn. Hist. t.* 75. *Fl. Dan. t.* 1542. (TAB. V.)

HAB. On rocks and stones, &c., from low-water mark to a depth of 5—10 fathoms. Very abundant on the Eastern Coasts, from Greenland to Cape Cod. North West Coast, at least in Russian America. (v. v.)

Root much branched, formed of many clasping, dichotomous fibres, interwoven together. *Stipe* from one to four lines wide, and from two inches to a foot in height, compressed, coriaceous, becoming flattened and sensibly widened where it meets the lamina, through which it is then continued as a midrib. The width of this midrib varies much in different specimens of the same age ; in some being scarcely wider than the stipe, and in others three or four times that width. *Lamina* oblong, at first elliptical, then becoming ovate, and at length deeply cordate at the base, the margin at the same time being changed from nearly flat to be very much waved and curled, this portion of the frond continuing to be developed after growth has nearly ceased within it. The whole lamina is pierced, at short distances, with roundish holes, which commence of small size and gradually widen ; these are irregularly mixed together, large and small, in all parts of the leaf, the smaller holes being of later formation than the larger. The new growth of membrane chiefly takes place where the stipe enters at the base, but also for a considerable time near the margin of the lower half of the leaf. The substance of the leaf is membra-

naceous, soon drying ; that of the stipe and midrib more coriaceous, or cartilaginous. The colour is a darkish olive-green, becoming brown in age. The leaves, when full grown, are often ten or twelve feet in length, and two or three feet wide.

PLATE V. *Fig.* 1. A young frond of AGARUM *Turneri*, the *natural* size ; *fig.* 2, part of a thin vertical slice, through a *sorus* and the outer coats of the frond ; *fig.* 3, *spores*, in their *perispores*, from the sorus ; *fig.* 4, a *spore* isolated :—all the latter figures more or less highly *magnified*.

2. AGARUM *pertusum*, Mert. ; "stipes compressed, coriaceous, continued as a scarcely widened midrib ; lamina membranaceous, its holes when young furnished with a margin raised at one side, and formed by openings in the bullated membrane." *J. Ag. Sp. Alg. l. p.* 142. *Kütz. Sp. Alg. p.* 580. *Post. and Rupr. t.* 23.

HAB. Newfoundland, *De la Pylœie* (fide J. Ag.)

I am not acquainted with this species, which is said to have the holes much more irregular in shape and fewer in number than those of the preceding species ; also of more equal size, and smaller, rarely two lines in width ; and that they arise from the bursting of a bullated membrane.

A third species *(A. Gmelini Post. and Rupr. p.* 11. *t.* 20, 21,*)* is described from the Northern Pacific, characterised chiefly, as it would seem, by having a midrib twice as wide as the stipes, and holes with undulated margins ; but I fear these characters can hardly be considered as alone sufficient to distinguish a species, for I find among a number of specimens picked up on Nahant Beach, great diversity in the comparative breadth of the midrib, and form of the holes. In some of my specimens, where the leaf measures 26 inches in length, the midrib is but two lines wide ; and in others of somewhat inferior superficies, it is at least five lines, the stipe being in the same specimens but two lines wide. I find similar variations in specimens collected at Halifax, and that it is impossible to fix limits between those with narrow, and those with wide stipes. It will remain to be seen whether observers on the shore can detect characters, existing at all ages, between those specimens with wide midribs and those with narrow. In many that I possess, the apex of the frond, both midrib and lamina, is strongly curved or hooked to one side, and this seems generally to occur in those with wide ribs.

VIII. THALASSIOPHYLLUM. *Post. and Rupr.*

Frond with subdistinct leaves ; the leafy expansions formed by the evolution of a lamina, spirally developed round a branching stipe ; each leafy-lobe ribless,

reniform, undivided, pierced in all parts with roundish holes. *Fructification*, cloud-like patches of *spores*, imbedded in the thickened surface of some part of the perforated leaf-lobes.

This genus is very nearly related to the preceding, from which it differs in having a branching stipe, round which a perforated lamina, partially divided into definite leaves, is spirally coiled. There is but one species yet known, viz:—

THALASSIOPHYLLUM *Clathrus*, Post. and Rupr. Illustr. t. 18, and t. 19. *J. Ag. Sp. Alg.* 1, *p.* 139. *Kütz. Sp. Alg. p.* 581. *Fucus clathrus*, *Grev. Hist. Fuc. t.* 33.

HAB. On the shores of Russian America. (v. s. in Herb. T. C. D.)

My specimens of this are so imperfect, that I prefer copying the following account given by Dr. H. Mertens of its appearance in a living state :—

" The ocean hardly boasts a more beautiful production than this ; it is generally about the height of a man, very bushy and branched, each branch bearing a broad leaf at its extremity, which unfolds spirally, and by this gradual development produces the stipes with its branches and lateral divisions. A spiral border, wound round the stipes, indicates the growth of the frond. The frond presents a large, convex, bent lamina, without nerves ; or to a certain degree a leaf, of which one half is wanting, for the stipes may be considered as an excentric nerve. A number of rather long, narrow perforations, arranged in a radiate form, give the frond the appearance of a cut fan ; these foramina being coeval with the formation of the frond, and apparently not owing to inequalities of substance. At first, these foramina, which are situated near the stipes, and where the frond is bent in, are round, and have their margins turned outwards ; but by the subsequent growth of the frond they become longer, and their margins disappear ; in the middle of the frond they are like true clefts, but nearer the margins, from the greater development of the leafy substance, they are more contracted in their breadth and therefore seem round. The frond has a complete and entire margin, but is frequently torn ; its substance is coriaceous. I have never detected any fructification. The root resembles that of the larger *Laminarias*, but is more woody. This fucus is very plentiful in the bay of Illuluk, and round the whole island of Amaknak. It clothes the rocky shore, like a thick hedge, for a space of 60 or 80 feet, forming, at a little distance, a very pleasing feature in the scenery." *H. Mert. in Hook. Bot. Misc.* 3, *p.* 5, 6.

IX. CHORDA, *Stack.*

Root scutate. *Frond* simple, cylindrical, tubular; its cavity divided by transverse membranes into separate chambers. *Fructification* a stratum of obconical spores, covering the whole external surface of the frond.

1. Chorda *filum*, Stack. ; frond cartilaginous, lubricous, clothed with pellucid hairs, filiform, very long, tapering to each extremity, not constricted at the dissepiments. *Grev. Alg. Brit. t.* 7. *Harv. Phyc. Brit. t.* 107. *Kütz. Sp. Alg. p.* 548. *Scytosiphon filum, Ag.—J. Ag. Sp. Alg.* 1, *p.* 126.

Hab. On rocks, etc. in the sea, between tide-marks, and extending to 4—10 fathoms depth, especially in deep, quiet bays. Common on the northern shores. (v. v.)

Root a minute disc. *Fronds* from one to ten, twenty, or even forty feet in length, according to depth of water, scarcely twice as thick as hog's-bristle at the base, gradually increasing in thickness to the middle and there from a quarter inch to nearly half an inch in diameter, and again gradually diminishing toward the apex, which is of equal tenuity with the base. This threadlike frond is cylindrical, hollow, divided at short intervals by very thin membranes, into chambers or joints, which are not visible externally; it is slimy to the touch, and clothed, at an early stage, with very dense, slender, gelatinous filaments, which generally disappear as the plant advances to maturity, but may sometimes be found on old plants, especially on such as grow in quiet, deep bays where they are little exposed to the action of waves. The *substance* is cartilaginous and firm, and very tough when recent. The *fructification* covers the whole external surface of old plants, and consists of obconical, vertical spores, supported on long pedicels, by which they are attached to the outer row of cellular tissue. Mixed with these are found numerous, narrow, elliptical, transversely striated cells, which may be antheridia. The walls of the tubular frond are formed of several rows of hexagonal, elongate cells, placed end to end, and forming longitudinal threads, glued together by the sides. Of these the inner ones are of large size ; the outer, minute and more densely packed together.

2. Chorda *lomentaria*, Lyngb.; frond membranaceous, constricted at distant intervals ; the interstices inflated. *Lyngb. Hyd. Dan. p.* 74, *t.* 18. *Harv. Phyc. Brit. t.* 285. *Chorda filum, ζ. lomentaria, Kütz. Sp. Alg. p.* 548. *Scytosiphon lomentarium, J. Ag. Sp. Alg. vol.* 1, *p.* 126.

Hab. On rocks and stones, &c. in tide pools. On the eastern coast, from British America to Charleston, S. C. (v. v.)

Root a small disc. *Fronds* from eight to twelve or eighteen inches in length, tapering at the base to the diameter of horse hair, attenuated upwards, either to a bluntish or a very fine point, from two to four lines in diameter at the greatest breadth, cylindrical, constricted at irregular intervals and furnished with a transverse septum at each constriction. The walls of the tube are composed of a thick layer of large, polygonal cells, of which the outer ones are gradually smaller; on the outside of which, forming the periphery, is a stratum of radiating, close-packed, moniliform

filaments. These are only found in their full development on mature specimens. *Colour* a brownish or greenish olive. *Substance* membranaceous and soft.

In habit this plant has more resemblance to *Asperococcus echinatus* than to the preceding species, but the structure of the walls is more in accordance with *Chorda*. There is also considerable affinity with the Antarctic *Adenocystis*, a little group that scarcely differs essentially from *Chorda*, with which Kützing unites it. I cannot agree so well with that author in making *C. lomentaria* merely a variety of *C. filum*, from which it has latterly been kept separate by most authors, and from which it differs in many essential characters.

Order IV.—DICTYOTACEÆ.

Dictyoteæ, Grev. Alg. Brit. p. 46. *J. Ag. Sp. Alg, vol.* 1, *p.* 68. *Endl. 3d. Suppl., p.* 24. *Dictyoteæ, Encœlieæ, and part of Chordeæ and Phycoserideæ, Kütz., Phyc. Gen. pp.* 337, 336, 333, 296. *Dictyotidæ, Lindl. Veg. Kingd. p.* 22.

Diagnosis. Olive-coloured, inarticulate seaweeds, whose *spores* are superficial, and disposed in definite spots or lines (*sori*). (*Frondose, or rarely filiform plants of small or mediocre size, and membranaceous texture; their surface reticulated with large cells.*)

Natural Character. *Root* usually a minute membranous disc or holdfast; sometimes a conical fleshy mass of large size, densely clothed with curled, wool-like jointed hairs. *Fronds* of an olive-green or olive-brown colour, mostly becoming paler on exposure to the air; of a membranaceous, flexible substance, rarely leathery or cartilaginous, and scarcely at all juicy: composed of two or more strata of cells, of which the inner ones are largest, usually empty, and either quadrate or appear so in profile. These large cells, seen through the smaller superficial and coloured cells which form the actual coating of the frond, give to its surface, when examined under a lens of moderate power, a netted appearance which is highly characteristic, and has suggested the name by which the Order is distinguished. In some, these internal cells form a regular honey-combed tissue of twelve-sided cells; but in others they are cylindrical, arranged in longitudinal series or filaments which, however, cohere closely throughout their length, forming a membrane, and are not separable without laceration.

In external habit the plants of this Order exhibit considerable variety. In some of the humblest, the frond is an unbranched thread formed of numerous cells concentrically disposed round an imperfectly hollow axis. Then we have bag-like, simple fronds, as in *Asperococcus*, formed as it were by the inflation of such a

thread, accompanied by the expansion of the walls into thin membranes. Next, in *Punctaria*, the bag becomes flattened into a nerveless leaf. In higher groups the tubular or flattened frond is divided into a branching stem, which, however, does not develope any separate leafy organs. In one case *(Haliseris)* this stem is winged throughout with membrane, or may be described as a midribbed branching frond. Among the most highly developed genera *(Zonaria* and *Padina)* the frond shows a tendency to assume a fan-shaped outline, having a definite, subcircular margin at the summit, and gradually widening from the base upwards. Such fronds are usually marked at regular intervals with concentric lines, and are formed of longitudinal rows of cells collaterally united in membranes ; the rows diverging as they grow, and new rows of cells being introduced in the interspaces. In many, and perhaps in all, the growing frond is clothed with exceedingly slender, jointed, and often colourless hairs, which sometimes, whilst expanded under water, decompose the rays of light, and cause the frond to display brilliant prismatic colours. These hairs are prolongations of the surface-cells, or issue from their sides, and are probably organs of the same kind as the pencilled fibres already noticed in the *Sporochnaceæ*.

The fructification exhibits considerable diversity of aspect in the various genera, but the characters are of minor value, chiefly relating to the form and position of the masses of fruit. In all, the *spores* are developed externally, either being formed from the surface-cells, which, when fertilized, stand out prominently from the ordinary cells ; or from those cells immediately beneath the epidermis, in which case the spore-cell bursts through the external coat, carrying it outwards as a separated membrane. Usually each perispore contains but a single sporular mass, but in *Padina*, four spores are found at maturity in each perispore ; and in *Cutleria*, eight spores. In some genera the spores are scattered singly over the surface of the frond ; but in by far the greater number they are collected into definite spots, or *sori*, which are round, oblong, or linear, and are either dispersed irregularly over the whole surface, or confined to a certain part of it ; or else ranged in transverse, horizontal, or concentric bands. In some, both scattered and aggregated spores are found on the same individual, or on different individuals of the same species. In such cases, the scattered spores are usually of larger size and paler colour than the aggregated ones, and their contents appear to be different. They have sometimes been supposed to be *antheridia*, but have not, as yet, been examined with sufficient care. The spores in most cases are accompanied by barren, jointed hairs, or *paranemata*, which appear to be formed from the same parts as the fertile spores, but to have developed into numerous cells. In *Stilophora* these paranemata compose the greater part of the warts of fructification. In some of the more perfect forms, as in *Cutleria* and *Padina*, *antheridia* have been noticed ; these are sometimes found on the same individuals as the spores, and sometimes on different individuals.

This Order is of decidedly rare occurrence on the American coast, and scarcely attracts much notice, from the amount of individuals representing the species,

until we proceed as far south as Florida, where, on the Keys, several kinds occur in such abundance as to be conspicuous among the ordinary shore plants. This increase in numbers to the southward is characteristic of the Dictyotaceæ in general. Very few are found in high latitudes, and they gradually become more numerous, and of higher type of structure, the nearer we approach the torrid zone. Those which occur in temperate waters show their propensity for warmth by growing in shallow tide-pools near high-water mark, where they can enjoy a warm bath for many hours of a summer's day. Thus *Padina Pavonia*, which, on the American shore, is not found farther north than the Florida Keys, in lat. 25°, where it inhabits a region extending below low-water mark, reaches the latitude of 51° on the south coast of England, its farthest observed northern limit ; but there it is found only in warm pools near high-water mark, and in sheltered situations. This plant has a very wide distribution, being a native of all the warmer parts of the Atlantic, Pacific, and Indian Oceans, as well as one of the most abundant shore-plants in the Mediterranean. It is possible that more than one species may be confounded under this name, but no satisfactory diagnostic characters have yet been pointed out. *Dictyota dichotoma* is equally cosmopolitan, and has been noticed in the cold waters of the Antarctic Ocean, as well as on the shores of New Zealand, the Cape of Good Hope, and on the western coast of South America. Of the genus *Haliseris*, which is scarcely represented on the North American coasts, ten species are known, all of them tropical or sub-tropical ; although one (*H. polypodioides*) extends far to the north, and has been traced from the Canary Islands (lat. 28°) along the Atlantic shores of Europe, as far as lat. 53° 45′ on the west of Ireland : and if the Tasmanian specimens and those reported from the Brazilian shores really belong to the same species, it has a nearly equal dispersion in the Southern Ocean.

None of the Dictyotaceæ are used in the arts.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond flat, dichotomous, traversed by a midrib.*

I. Haliseris.

** *Frond flat, without midrib.*

† *Frond fan-shaped, vertically cleft.*

II. Padina. *Sori* linear, concentric, bursting through the epidermis.

III. Zonaria. *Sori* roundish, scattered.

IV. Taonia. *Sori* linear, concentric, superficial, alternating with scattered solitary spores.

†† *Frond linear, dichotomous.*

V. Dictyota.

†† *Frond undivided.*

VIII. Punctaria.

IX. Soranthera, Post. and Rupr. *(I do not see how this differs from Punctaria.)*

*** *Frond cylindrical, or bag-like.*
† *Branched.*

VI. Stilophora. *Sori* wart-like, composed of spores and moniliform threads.

VII. Dictyosiphon. *Spores* either solitary and scattered, or collected into dot-like sori.

†† *Unbranched, bag-like.*

X. Asperococcus.

**** *Frond pierced with round holes, lace-like.*

XI. Hydroclathrus.

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1. HALISERIS. *Tozzetti.*

Root coated with woolly hairs. *Frond* flat, linear, membranaceous, traversed by a cartilaginous midrib. *Spores* collected in naked *sori*, disposed in longitudinal lines at either side of the midrib, and rising from both surfaces of the membranous frond. *Paranemata* forming groups separate from the sporiferous sori.

This is the only genus in the Order in which the frond is traversed by a midrib; and one species (*H. Areschougia*, J. Ag.) is described as being nerveless. In most species the membranous border of the frond tears with ease in an oblique direction toward the midrib; so that it is rare to find specimens of full size in which the lower part of the fronds is not much jagged. The margin is either entire, or minutely denticulate, and is sometimes thicker than the rest of the membrane. In two species the midrib throws off lateral secondary nerves which traverse the frond toward the margin, ascending obliquely. Of the ten species known, four are American, four South African, one Australian and Indian, and one a native of the tropical and temperate regions of the Eastern Hemisphere. The name, derived ἁλς and σερις, is spelled *Halyseris* by Agardh, &c.

1. HALISERIS *delicatula*, Lamour. ; frond delicately membranaceous, winged from the base, dichotomous ; with very patent linear segments and rounded angles ; the margin very entire, somewhat thickened. *J. Ag. Sp. Alg.* 1, *p.* 116. *Kütz. Sp. Alg. p.* 562. (TAB. VII. A.)

HAB. On the shores of Mexico, *J. Agardh.* (v. s. in Herb. T.C.D.)

Fronds densely tufted, three or four inches long, and from one to two lines in breadth, thrice or four times forked, the forkings an inch or more apart, widely spreading or divaricate, and somewhat flexuous. *Segments* linear, obtuse, with an entire, slightly thickened margin, distinctly marked by a depressed line, and formed of smaller and more vertical cells than the interior portion of the membrane. *Sori* minute, oblong, forming a line at each side of the midrib. *Substance* very thin and delicate, composed of oblong cells, ranged in series proceeding obliquely from the midrib to the margin. *Colour* very pale, greenish-olive. I have not seen Mexican specimens, and have taken this description and prepared the figure given, from specimens collected at Pernambuco, and presented by Dr. Areschoug, to the Herbarium of the University of Dublin.

PLATE VII. A. *Fig.* 1. Plant of HALISERIS *delicatula;* the *natural* size ; *fig.* 2, a segment, slightly *magnified ; fig.* 3, a small portion of the same, with a *sorus ; fig.* 4, *spores :* both more or less highly *magnified.*

II. PADINA. *Adans.*

Root coated with woolly hairs. *Frond* flat, ribless, fan-shaped, marked at regular distances with concentric lines, and fringed with articulated hairs ; the apex involute. *Fructification*, linear, concentric *sori*, formed beneath the cuticle of the upper surface of the frond, and bursting through it ; and containing at maturity, numerous obovate, hyaline perispores fixed by their bases, each perispore enclosing four spores. *Paranemata* club-shaped, articulate, disposed in concentric lines alternating between the sori.

Four species of this genus are retained by Agardh, who admits the difficulty of distinguishing them by exact characters. All have very similar fronds, all inhabit the warmer parts of the sea, and *P. Pavonia* at least is subject, even in the same locality, to variations almost as great as those which have been fixed on by authors, as characteristics of the several supposed species. But if there be a difficulty in distinguishing these plants, supposing them to be really different in specific character one from another, there is none in recognising our common species among all

other Algæ ; for its form and substance are strikingly peculiar. Its fan-like shape, and its property of reflecting prismatic colours whilst growing under water, have won it the popular name of *Peacock's-tail.*

1. PADINA *Pavonia*, Lamour. ; frond between membranaceous and coriaceous, broadly fan-shaped, entire or deeply and variously cleft, each lacinia being then fan-shaped, powdery on its outer surface ; concentric lines numerous. *Harv. Phyc. Brit. t.* 91. *J. Ag. Sp. Alg.* 1, *p.* 113. *Zonaria Pavonia*, *Kütz. Phyc. Gen. t.* 22. *f.* 1. *Sp. Alg. p.* 565. *Ulva Pavonia*, *Linn. E. Bot. t.* 1276. (TAB. VII. B.)

HAB. On stones, &c. about low-water mark. Annual. Spring and early summer. Abundant on some of the Keys at Florida, as at Sand Key in February, *W. H. H.* Later in the season it appears at Key West, *Dr. Blodgett*, &c. Conch Key, *Prof. M. Tuomey.* (v. v.)

Root densely coated and cushioned with woolly hairs. *Fronds* tufted, from two to five or six inches in height, cuneate at the base, rapidly expanding into a broadly fan-shaped lamina, whose upper margin forms constantly a circular arc. This lamina, which is at first simple, is at length, as the plant advances in growth, cloven into numerous lobes, by splits arising in some point of the margin and proceeding downward toward the base : each lobe, at first cuneate, soon becomes, by the rapid lateral development of its arched margin, fan-shaped like the primary frond. The whole fronds of young plants, and the several laciniæ of older, are, when the plant is growing, rolled up in little conical or funnel-shaped cups. At distances of one or two lines, the frond is marked with concentric bands, more or less evident, according to age, along each of which is developed a fringe of extremely slender, orange coloured, jointed hairs. These hairs, which in young plants are found on every band, are limited on older specimens to the last formed bands, and at length disappear. The *margin* at the summit of the frond is always strongly rolled inwards ; the outer or lower surface of the lamina is whitened with a variable quantity of chalky powder ; the inner surface, except for the fringes of hairs, is smooth, olive-coloured, greenish towards the summit. The *sori* of fructification form concentric bands, alternating between the fringed bands. They are at first concealed beneath the surface-cells, but burst through in lines, raising the membranous skin of the frond, which then folds over them like the indusium of a fern. At maturity, the sorus consists of numerous obovate, hyaline perispores, fixed to a linear receptacle, each containing four sporules. *Paranemata*, club-shaped, articulated filaments, are found also in concentric bands, parallel to those which produce spores, and placed at short distances from them.

PLATE VII. B. *Fig.* 1. Plant of PADINA *Pavonia ;* the *natural* size ; *fig.* 2, part of the surface, showing portions of the band-like *sori* of *spores*, and of *paranemata* respectively ; *fig.* 3, vertical section of the frond, showing *spores* in situ ; *fig.* 4,

spores, each containing four sporules in the *perispore ; fig.* 5, section through one of the concentric bands of paranemata ; *fig.* 6, *paranemata :* the latter figures more or less highly *magnified.*

III. ZONARIA, *Ag.*

Root coated with woolly hairs. *Frond* flat, ribless, coriaceo-membranaceous, flabelliform, entire or vertically cleft, the segments radiating ; the surface cellules disposed in distinct longitudinal lines flabellately radiating from the base. Concentric lines indistinct. *Fructification* roundish or linear *sori*, formed beneath the cuticle of the frond, and bursting through at either surface ; and composed at maturity, of *spores* furnished with hyaline perispores, and of *paranemata* which are mixed with the perispores. *Paranemata* club-shaped, articulated, numerous.

In the more or less fan-shaped frond this genus approaches *Padina*, but differs in the more opaque substance, only obscurely marked with concentric zones ; and in the fructification, which is not disposed in regular, concentric lines. Here, too, the spores and paranemata occupy the same sorus, while in *Padina* they are separated. Under a pocket lens the surface appears to be finely striated longitudinally, an appearance caused by the disposition of the superficial cellules, which are ranged in lines proceeding from the base, slightly diverging one from another, and admitting the introduction of new series of cells between each original row, as the frond advances in growth. From this peculiarity results the fan-like form of the mature frond.

Ten or twelve species of this genus, from various parts of the world, are known to botanists. All are natives of the warmer parts of the sea, with the exception of *Z. parvula*, which by some authors is rejected from the genus.

1. ZONARIA *lobata*, Ag. ; frond erect, coated with woolly hairs at the base only, membranaceo-coriaceous, broadly flabelliform, at first with a nearly entire margin, then palmately cloven, or divided nearly to the base ; laciniæ eventually elongate, wedge-shaped, simple or again divided, concentrically zoned ; sori linear, formed along the concentric lines. *J. Ag. Sp. Alg. vol.* 1, *p.* 109. *Stypopodium fuliginosum*, *Kütz. Sp. Alg. p.* 663. (TAB. VII. C.)

HAB. On stones about low-water mark. Annual ? Keys of Florida : abundant at Sand Key in February ; and sparingly, at the same season, at Key West, *W. H. H.* Sand Key, *Prof. M. Tuomey.* (v. v.).

Root clothed with entangled and curled woolly hairs, which extend a short way from the base, covering from half an inch to an inch square of the lower part of the frond. The frond, which eventually becomes a foot or more in length and divided nearly to the base into many narrow lobes, originates in a sessile or nearly sessile, broadly reniform, membranaceo-coriaceous lamina. This lamina has at first a circumscribed margin, forming a somewhat cycloidal curve, and is nearly undivided. When it attains an inch or two in height, vertical slits, commencing in the margin, extend downwards, dividing it in a pedate or palmate manner, into a great number of narrow, wedge-shaped laciniæ, placed side by side in digitate order. These, as they grow, become flabellate above, from the divergence of the rows of cells of which they are composed, and are again cleft and re-cleft, until often the originally reniform leaf becomes a bunch of narrow ribbons growing from a central point. In all these changes the apical margin remains truncate, and circumscribed by a curved line. It is perfectly flat, not inrolled. Radiating striæ, or inequalities in texture, proceeding from the base upwards towards each lobe, are more or less obvious in various specimens; and faint concentric lines, paler than the rest of the frond, are seen here and there crossing the lobes, at distances of a quarter to half an inch. These are more evident on older and more divided specimens, though they occur on the upper or newer portions of their fronds. The radiating longitudinal bands or striæ are sometimes very faint, and sometimes strongly marked. I have not seen *fructification* on any specimen collected at Sand Key.* The colour when growing is a dark olive, reflecting prismatic colours, chiefly vivid greens and blues, from the striated surface. In fresh water a good deal of dark colouring matter is given out; yet in drying the frond becomes exceedingly dark. In this state it adheres, but not very strongly, to paper, and shrinks very considerably.

Not having seen authentically named specimens of *Zonaria variegata*, Ag., it would be rash to say that that species may be only an undeveloped or small state of the present. Some of my Sand Key specimens are so remarkably striated, or marked with darker and paler longitudinal bands, and others so obscurely banded, and there are such insensible gradations between the banded and unbanded individuals, that I fear a character derived from these bands will not stand good. If *Z. variegata*, then, be distinguishable from our *Z. lobata*, it will probably be by a character taken from the different form of the sori, which are said to be "elliptical and scattered" in that species.

PLATE VII. C. *Fig.* 1, plant of ZONARIA *lobata;* the *natural* size: *fig.* 2, small portion of the summit of a segment, *magnified*, to show the surface cellules.

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* The *sori*, on West Indian specimens, form dark lines at both sides of the pale, concentric band; but, besides these linear sori, others of irregular form are scattered between the bands.

IV. TAONIA, *J. Ag.*

Root coated with woolly hairs. *Frond* flat, ribless, vaguely cleft, reticulated ; the surface-cellules equally distant, in the apices of the laciniæ in parallel or subdivergent series. Concentric lines more or less evident. *Fructification* : linear, wavy, concentric, superficial *sori*, on both surfaces of the frond, destitute of indusium, and consisting of *spores*, furnished with hyaline perispores, and unaccompanied by paranemata.

This genus is formed for the reception of the old *Ulva atomaria*, Good. and Woodw., which has been variously referred to *Zonaria*, *Dictyota*, and *Padina*. To this typical species, whose character is chiefly embodied in the above generic diagnosis, Prof. Agardh has added, doubtfully, two other species, one of which falls within our limits. Perhaps it would have been better to have retained Kützing's genus, *Spatoglossum*, for these two, whose relation to *T. Atomaria* is rather doubtful.

1. TAONIA? *Schrœderi*, J. Ag. ; frond decompoundly cleft, irregularly dichotomous ; laciniæ broadly linear, toothed above, and bordered with marginal processes or lobules ; "antheridia ? scattered over the whole surface," (fructification unknown). *J. Ag. Sp. Alg. vol.* 1, *p.* 102. *Dictyota Schroederi, Kütz. Sp. Alg. p.* 566. *Aresch. Ic. t.* 9. *Ulva Schroederi, Mart. Fl. Braz. p.* 21. *Ic. Select.* 1, *t.* 2, *f.* 3.

HAB. At Vera Cruz, Mexico, *Liebman!* (v. s. in Herb. T.C.D.)

Frond rising from a shaggy base, ten to twelve inches in length, somewhat fan-shaped in the general outline of its laciniæ, irregularly dichotomous ; the principal laciniæ from half to three-quarters inch in breadth, the upper ones gradually narrower. In the lower part of the principal laciniæ the margin is either entire or obscurely denticulate ; in the upper half it is either strongly toothed, or the teeth lengthen out into linear or subulate, simple or slightly compound lobules. Sometimes the margin is flat, sometimes undulated or even curled. The apices are often irregularly jagged. The sinuses between the laciniæ are rounded, and the laciniæ themselves diverge at wide angles. The substance is thin and membranous, shrinking much in drying ; and the colour is a brownish or a greenish olive. No fructification has yet been observed, but the frond is commonly dotted over with minute, dark, prominent cells, which Agardh supposes may contain antheridia.

V. DICTYOTA. *Lamour.*

Root coated with woolly hairs. *Frond* flat, ribless, membranaceous, dichotomous or sub-pinnatifid, reticulated; the surface cellules minute, equidistant, converging at the ends of the laciniæ and ending in a single cellule. Concentric lines none. *Fructification*; roundish, scattered *sori*, bursting through the cuticle of both surfaces of the frond, consisting at maturity of numerous obovate, tufted *spores*, with hyaline perispores. *Paranemata* in sori distinct from those containing spores, clavate, articulate, filled with grumous matter.

This genus, as recently reformed by Prof. J. Agardh, is easily known from any of the preceding by the mode of development of the frond, each of whose laciniæ is seen to terminate in a single cellule, by the constant division of which at its lower side the other cells of the frond are formed, the terminal cell being thus continually pushed onwards. From this mode of growth it results that the longitudinal lines of superficial cells, which in the flabellate genera already described diverge from one another, in this converge: thus affording a ready method of ascertaining the genus in default of fructification.

1. Dictyota *Fasciola*, Lamour. (?); fronds densely tufted, very narrow, membranaceous, linear, many times dichotomous; axils obtuse; laciniæ patent, very entire; apices acute; sori forming a medial line, and often accompanied by filiform processes. *J. Ag. Sp. Alg.* 1, *p.* 89. *Kütz. Sp. Alg. p.* 555. *Roth. Cat. Bot. vol.* 1, *p.* 7, *f.* 1. *Esp. Fuc. t.* 44. (?). (Tab. VIII. B.)

Hab. On rocks and stones, and corals near low-water mark. Annual. Abundant on the Florida Keys. Key West, Feb., *W. H. H.* (v. v.)

Fronds forming large and dense tufts, matted together at the base, six to ten inches in length, scarcely a line in breadth, of nearly equal breadth from the base to the apex, many times dichotomous. The axils are conspicuously rounded and the laciniæ thus diverge one from another, particularly the upper ones. Sometimes the forking proceeds with equal arms throughout the tuft, and then the plant forms round, fastigiate masses, the individual fronds not having any leading stem. In other specimens one arm of the fork, at alternate sides of the growing branch, is constantly shorter than the other; thus a frond with leading stems, bordered with short, simple or forked laciniæ, is formed. The substance of the frond is membranaceous, thickish and subopaque below; the surface cells are about four times as long as broad; and the largish, hexagonal cells of the interior of the frond may be seen through the exterior cells in the younger parts at least. The apices are more or less acute, but not acuminate. The sori are disposed in a line through the centre of the lamina. Those formed of *paranemata* are most

abundant in my specimens, between which scattered spores are often found. In very many specimens the position of the sori is occupied by a line of proliferous papillæ or cilia of greater or less length.

I have some doubts whether I am correct in referring the Florida plant to *D. Fasciola*, Lam., to which, if it be different, it approaches very closely. I have compared it with Mediterranean specimens, but not with very well preserved or sufficiently developed ones; and the agreement in most respects is very great. But there is considerable difference in aspect among the Key West specimens, so much that at first I referred them to two species, in one of which the frond is fastigiate, and regularly dichotomous; in the other, having more virgate branches, pinnatifido-dichotomous. On comparison of a great number of specimens, I do not find this difference in branching sufficiently constant. The figures of Roth and Esper, quoted above, are very rude. The present species is what was formerly doubtfully referred, on my authority, to *D. linearis*, *Ag.*, and published by Prof. J. W. Bailey, as such, in his list of North American Algæ.

PLATE VIII. B. *Fig.* 1, Plant of DICTYOTA *Fasciola*; the *natural* size; *fig.* 2, portion of a segment, with *spores*, and tufts of *antheridia*; *fig.* 3, portion of a similar segment with papillæ; both *magnified*; *fig.* 4, small portion of a segment, with scattered *spores* and tufts of *paranemata*; showing also the surface cellules, and the lines defining the large internal cells; highly *magnified.*

2. DICTYOTA *dichotoma*, Lamour.; frond repeatedly dichotomous, broadly-linear, (1—4 lines broad) membranaceous; the axils narrow and subacute; laciniæ erecto-patent, gradually narrower towards the extremities; the margin entire; the apices obtuse or emarginato-crenate; sori and scattered spores dispersed over the medial region of the segments, leaving an unoccupied space within each margin. *J. Ag. Sp. Alg. vol.* 1, *p.* 92. *Harv. Phyc. Brit. t.* 103. *Ulva dichotoma*, *Huds.*—*E. Bot. t.* 774. *Dictyota vulgaris, and D. dichotoma*, *Kütz. Sp. Alg. p.* 553, 554. *Dichophyllum*, *Kütz. Phyc. Gen. p.* 337.

HAB. On stones and sea plants in tide pools. Rare. At Charleston, growing on old submerged wood-work at Sullivan's Island, *Prof. Lewis R. Gibbes*, Key West, *W. H. H.* (v. v.)

Fronds tufted, but not very densely clustered, from three to six inches long or more, varying much in breadth; ordinarily three or four lines in breadth, but sometimes much narrower and occasionally wider, several times dichotomous; the segments at each successive forking becoming narrower. In some varieties, the ultimate segments are very narrow and constantly spirally twisted; in the ordinary forms they are flat, and not much narrower than the lower ones. The axils are narrower than in the preceding species and the segments less widely spreading; and the apices are decidedly obtuse. The substance is thin and membranous, semi-

transparent, and the areolations visible with a moderately powerful pocket lens; they vary in shape and in size in different parts of the membrane, and I fear scarcely afford a satisfactory specific character. I have not seen *fruit* on American specimens. On the European plant two sorts of fruit have been noticed, on different individuals: first, oval clusters of spores, covered at first by a common vesicular membrane; each spore when ripe containing four sporules in a hyaline perispore; second, solitary, roundish, simple spores scattered over the surface. The colour is olivaceous, sometimes greenish and sometimes brownish.

3. Dictyota *ciliata*, J. Ag.; frond woolly at the base, repeatedly dichotomous, broadly linear, membranaceous; the axils rounded; laciniæ patent, linear, gradually narrower towards the extremities; the margin ciliate, with distant, awl-shaped, slender teeth; the apices obtuse; spores forming minute sori scattered over the middle region of the lamina, leaving an unoccupied space within each margin. *J. Ag. Symb.* 1. *p.* 5. *Sp. Alg. vol.* 1. *p.* 93. *Kütz. Sp. Alg. p.* 556. (Tab. VIII. A.)

Hab. On Algæ and corals near low-water mark. Florida Keys, abundant at Key West, *Dr. Wurdemann*, *Dr. Blodgett*, *W. H. H.*, *&c.* (v. v.).

Root and lower part of the frond coated with curled, woolly hairs. *Fronds* densely tufted, six to eight or ten inches in length, from an eighth to a quarter-inch in breadth, many times dichotomous; the laciniæ gradually narrower in the upper dichotomies, ciliated at intervals of a few lines with slender, subulate, tooth-like processes. These are more abundant in some specimens than in others. The axils are rounded; the lower ones spread widely and the upper are gradually narrower. The apices are subacute, or blunted. The *sori* consist of a few spores, irregularly grouped together, and scattered over three-fourths of the surface of the laciniæ, leaving a narrow unoccupied portion down each margin. Sometimes the frond is pitted, (as shown at fig. 4,) the pits apparently caused by the falling off of the sori, carrying with them the surface cells. The colour is a clear brown olive, greener toward the tops; and the substance is membranaceous, shrinking in drying. Readily known, in most cases, by the ciliate margins; but sometimes nearly entire, in which case it may be mistaken for *D. dichotoma*.

Plate VIII. A. *Fig.* 1. Plant of Dictyota *ciliata;* the *natural* size; *fig.* 2, part of a segment, with sori, and *fig.* 3, part of a segment from which the *spores* have fallen, leaving pits; both *magnified; fig.* 4, small portion of the surface, with *sorus*, showing the small surface cellules, and the lines defining the large internal cells: highly *magnified.*

4. Dictyota *Bartayresiana*, Lamour.; frond scarcely woolly at the base, repeatedly dichotomous, linear, coriaceo-membranaceous, very entire; the axils rounded;

laciniæ spreading, especially the upper ones; apices divaricate, the younger ones sharply bifid, each lobe acuminate; spores forming minute sori scattered over the whole surface of the lamina.—*J. Ag. Sp. Alg. vol.* 1, *p.* 94. *Kütz. Sp. Alg p.* 554. (TAB. VIII. C.)

HAB. Tropical. Coast of Mexico, at Vera Cruz, *Liebman!* (v. s. in Herb. T.C.D.).

Frond three or four inches long, one or two lines in diameter, of nearly equal breadth throughout, many times dichotomously divided, with rounded axils and spreading segments. The uppermost divisions are more or less divaricated. The margin is entire and flat. The young apices are sharply notched or bifid; each notch deltoid-acuminate, ending in a sharp point. The *sori* are minute and densely dotted over the whole surface. In our specimen they have fallen away, leaving cavities in their place. The substance of the frond is thickish, somewhat coriaceous, and the structure is denser than in some other species. The surface cellules are minute; the areolations beneath them not much longer than their breadth. In drying, this plant does not adhere to paper. Known by its sharply bifid apices from any state of *D. fasciola* or *D. dichotoma*. Distinguished from *D. acutiloba* by the widely scattered fructification.

PLATE VIII. C. *Fig.* 1, Plant of DICTYOTA *Bartayresiana;* the *natural* size; *fig.* 2, apex of a segment, *magnified; fig.* 3, extremity of the same, with depressions from which *sori* have fallen, and showing the surface cellules and internal cells; highly *magnified.*

5. DICTYOTA *crenulata*, J. Ag.; frond woolly at the base, repeatedly dichotomous, coriacco-membranaceous, with patent, but not very blunt axils; laciniæ linear, undulate; the margin eroso-dentate, the toothlets close together and of unequal size; apices very blunt, lingulate; sori at length occupying the whole surface. *J. Ag. Sp. Alg. vol.* 1, *p.* 94. *Kütz. Sp. Alg. p.* 558.

HAB. Tropical. At St. Augustin, on the Pacific coast of the Mexican Republic, *Liebman!* (v. s. in Herb. T. C. D.).

Fronds tufted, 2—4 inches high, about one and half or two lines in breadth, gradually wider from the base upwards, many times closely dichotomous; the segments spreading, the whole frond having a fan-like outline. The sinuses betwen the laciniæ are rounded, though not conspicuously so, and the upper ones are rather narrow. The margin is undulated, and closely eroso-denticulate, or jagged with unequal, deltoid, or subulate, tooth-like processes. The apices are rather wider than the portions below them, and so blunt as to be almost truncate. The young ones are obtusely emarginate. The sori are small, at first forming patches here and there, but eventually

occupying the whole superficies. The dentation of the margin is of the same nature as that of *D. ciliata*, but the teeth are very much closer and more irregular in form than in that species.

VI. STILOPHORA. *J. Ag.*

Root a small, naked disc. *Frond* cylindrical, branched, solid, or imperfectly tubular; composed of two strata of cells, the inner stratum of many rows of colourless cells, of which those nearest the centre become ruptured in age, leaving a cavity traversing the frond; the outer stratum of one or two rows of minute, coloured cells. *Fructification*, convex, wart-like *sori*, scattered over the branches, composed of obovate *spores*, nestling among moniliform, simple, densely packed *paranemata*.

The frond is described by Agardh as being at first tubular, but gradually becoming solid with advancing age. The contrary of this structure has always appeared to me to be the case, the older parts being more empty than the younger.

1. STILOPHORA *rhizodes*, J. Ag.; frond subsolid, much and irregularly branched, subdichotomous; the apices scarcely attenuate, acute; ramuli scattered, forked; sori densely covering the branches and ramuli. *J. Ag. Sp. Alg. vol.* 1, *p.* 85. *Harv. Phyc. Brit. t.* 70. *Spermatochnus rhizodes*, *Kütz. Sp. Alg. p.* 549. (TAB. IX. B.).

HAB. Near low-water mark, on other Algæ in tide pools. Rare. Newhaven, *Dr. Durkee.* Greenport, Long Island, *W. H. H.* Oyster Bay, N. Y. *Mr. Walters.* (v. v.)

Frond, in the American specimens, from four to five inches long, as thick as hog's bristle, much branched, irregularly dichotomous, with rounded axils. Branches flexuous, variously divided, furnished with a few latera ramuli which are either simple or forked above their middle. The apices are acute, but not much tapered. The whole frond, in fertile specimens, is densely covered with the prominent, wart-like fructification; each wart composed of a great many moniliform vertical filaments, packed together. Among these the obovate spores are found lying, being attached to the bases of the filaments. The colour is a greenish olive; and the substance cartilaginous and elastic when fresh, but soon becoming soft and gelatinous, and in drying the branches shrink considerably and adhere strongly to paper.

PLATE IX. B. *Fig.* 1. Frond of STILOPHORA *rhizodes*, the *natural* size ; *fig.* 2, a small portion of a branch, with its wart-like sori, *magnified ; fig.* 3, section of a sorus, and of a portion of the frond ; *fig.* 4, a *spore* and *paranema ;* the latter figures highly *magnified.*

2. STILOPHORA *papillosa*, J. Ag. (?) ; frond cylindrical, many times dichotomous, with very patent angles and divaricating, attenuated apices ; the dichotomous branches and their lesser divisions clothed with very many slender-horizontal, hair-like ramuli. *J. Ag. Sp. Alg. vol.* 1, *p.* 84. (?)

HAB. Chesapeake Bay, *Prof. J. W. Bailey.* (v. s.).

I am not satisfied that the plant from the Chesapeake, which I introduce more on my friend Prof. Bailey's authority than my own, is the same as the Mediterranean species described by Agardh ; nor, indeed, am I quite certain that it belongs to this genus. I have examined one of the original specimens, presented to me by Prof. Bailey, and had intended figuring it, but have not been able to make out the microscopical characters to my satisfaction. The above specific diagnosis applies very well to the specimen. But Meneghini's figure, (*Alg. Ital. t.* 3, *f.* 2,) quoted by Agardh for his species, is very unlike our plant. I have seen no authentic example of the Mediterranean *S. papillosa*, and thus am unable fully to decide on the identity of the American ; and, in this uncertainty, think it better to place the species on record, in the hope that future observation may clear the subject in one way or other. My specimen is about four inches square in the spread of the branches, and it scarcely adheres to the paper on which it has been dried.

VII. DICTYOSIPHON. *Grev.*

Root a small, naked disc. *Frond* filiform, tubular, much branched ; its walls composed of several rows of cells, of which the inner are elongated, and connected into longitudinal filamentous series ; the outer or superficial small, coloured, polygonal, forming a membrane. *Fructification :* solitary or aggregated, naked *spores*, scattered irregularly over the surface.

When young the frond is solid, but the cells forming the axis, which are of larger size than the rest, are also weaker and soon perish, leaving the stem and branches fistular. In a growing state every branch is clothed with long, slender, pellucid, jointed hairs, which give the plant, when seen under water, a beautifully feathery character. Similar hairs are seen on many others of the Order, and are doubtless connected with the development of the frond. The walls are composed

of many rows of elongated cells, disposed longitudinally and firmly united into a compact cellular substance. The innermost of these are very long, the outer proportionably shorter. All, except those that compose the outermost row or circle, are colourless, and nearly empty.

1. DICTYOSIPHON *fæniculaceus*, Grev. ; frond setaceous, very much branched ; the branches capillary, decompound ; ramuli subulate, alternate or scattered, rarely opposite.—*J. Ag. Sp. Alg. vol.* 1, *p.* 82. *Kütz. Sp. Alg. p.* 485. *Harv. Phyc. Brit. t.* 326.

HAB. In rock pools, between tide-marks on stones and the smaller Algæ. Sea shores from New Brunswick to Long Island Sound. Prince Edward's Island, *Dr. Jeans.* Halifax, *W. H. H.* Boston Bay, *G. B. Emerson* and *Mrs. Asa Gray, &c.*, Rhode Island, *Mr. Geo. Hunt, Mr. Olney, &c.* Arctic Coast, *Mr. Seeman.* (v. v.)

Fronds from six inches to one or two feet long, about as thick, or sometimes twice as thick, as hog's-bristle, much branched and bushy ; usually having an undivided stem, set with many lateral branches, which are furnished with one or two series of lesser branches, also lateral, and very unequally and irregularly placed. *Primary* branches as long as the leading stem, or longer, very numerous. The spores are plentifully scattered over the branches, and are usually solitary. *Colour* a greenish or a brownish olive. *Substance* membranous, soft, but not gelatinous, adhering to paper in drying.

VIII. PUNCTARIA. *Grev.*

Root a small naked disc. *Frond* flat, ribless, membranaceous, undivided. *Fructification*, minute, dot-like *sori*, scattered over the whole surface, and containing roundish, sessile *spores*, accompanied by a few short, club-shaped, jointed *paranemata*.

The species comprising this group have the leaf-like habit of the smaller Laminariæ, such as *L. Fascia ;* or of the restricted genus *Ulva*, in which, by the older botanists, they would all have been placed. From Laminariæ they differ in being of a more reticulated structure, formed of larger cellules, and in the very different fructification ; and from the Ulvæ in colour as well as structure. To the genus *Asperococcus*, which immediately follows in order, *Punctaria* is very closely related, and only to be distinguished by the flattened, not tubular frond. But in *Asp. compressus* we find a strictly intermediate form, nearly as flat as a *Punctaria*, but evidently composed of two separable membranes.

1. PUNCTARIA *tenuissima*, Grev.; frond very thin, linear or linear-lanceolate, much attenuated to base and apex, flat or undulated. *Grev. Alg. Brit.* (1830) *p.* 54. *Harv. Phyc. Brit. t.* 248. *Punctaria undulata, J. Ag. Sp. Alg. vol.* 1, *p.* 72. *Diplostromium tenuissimum et D. undulatum, Kütz. Sp. Alg. p.* 483.

HAB. Parasitical on various Algæ near low-water mark; as *Zostera marina*, *Chorda filum*, *&c.* Annual. Spring and Summer.—Halifax, *W. H. H.* Boston Harbour, *G. B. Emerson.* Little Compton, R. I., *Mr. Olney, and Prof. J. W. Bailey.* Fort Hamilton, N. Y., *Mr. Hooper, &c., W. H. H.* (v. v.)

This forms dense tufts extending for several inches along the leaves of the *Zostera* or the fronds of the *Chorda* on which they grow. The *fronds* are from two to eight or ten inches in length, and from a line to four or five lines in width, broadest in the middle, and tapering to both extremities. Some specimens are nearly linear throughout, except at the base or apex where they fine off; but others are strictly lanceolate, very much attenuated from the middle towards the apex and the base. The margin in the young plant is quite flat; and often remotely, but irregularly denticulate. In older specimens the frond is undulated, or crisped and often twisted spirally. The membrane is very thin, semitransparent, and delicate; and the colour which is at first a pale greenish olive, becomes brownish or rather horn-colour in old plants. The fructification has not been observed.

I retain Dr. Greville's name for this plant, as being of earlier date than that assigned by Prof. J. Agardh; who rejects Dr. Greville's epithet from grounds which appear to me to be insufficient. The *Zonaria tenuissima* of the elder Agardh, which Dr. Greville takes as the type of his species, appears to have been founded (*Sp. Alg.* 1. *p.* 138, *and Syst. Alg. p.* 268) on *Ulva plantaginifolia var. tenuior*, *Lyngb. Hyd. Dan.*, *p.* 31, *t. b.;* and from Lyngbye's figure and description there can be little doubt that Lyngbye's and Greville's plants were identical in species. Nay, this is admitted by Prof. J. Agardh, who quotes both these authors under his *P. undulata;* but for some cause which I do not understand, he at the same time refers the synonym, "*Zonaria tenuissima*, *Ag.*" to *Laminaria Fascia.* Yet, on referring to the Syst. Alg. where that name was first published, and from which Dr. Greville adopted it, we find the only synonym quoted is "*Ulva plantaginea var. tenuior*, *Lyngb. t. b.*" but with a mark of doubt. On referring back to Agardh's earlier work, the Sp. Alg. this same synonym is quoted without any doubt as the authority for Agardh's "*Zonaria plantaginea var. tenuior*," which is evidently the type of the subsequent "*Z. tenuissima.*" Whether Agardh confounded young *Laminaria Fascia* also under this name is not to the point, as it is evident from his description and quotation that he intended by the name "*tenuissima*," the "*U. plantaginifolia var. tenuior*" of Lyngbye; and that is also the plant intended by Dr. Greville, and here described. I see no reason therefore for changing the older and very appropriate specific name into "*undulata.*"

2. PUNCTARIA *plantaginea*, Grev.; frond dark brown, coriaceo-membranaceous,

obovate, much attenuated at the base. *Harv. Phyc. Brit. t.* 228. *J. Ag. Sp. Alg. vol.* 1, *p.* 73. *Phycolapathum plantagineum, Kütz. Sp. Alg. p.* 483.

Hab. On stones and Algæ between tide-marks. Annual. Summer. Prince Edward's Island, *Dr. Jeans.* Boston Harbour, *G. B. Emerson, Esq.* (v. v.)

Tufted. *Fronds* from 6 to 12 inches long, an inch to an inch and half in breadth in the widest part, generally blunt, obovate or cuneate, tapering considerably to the base from near the middle of the membrane. The substance is thicker and more coriaceous than in *P. latifolia* and the colour always darker. But specimens occur which are almost intermediate in character between the two. There is also danger of confounding *P. plantaginea* with *Laminaria Fascia*, which has a very similar appearance.

Punctaria *latifolia*, Grev. ; frond pale olive green, thickish, membranaceous, soft and tender, oblong or obovate, suddenly tapering at the base. *Harv. Phyc. Brit., t.* 8. *J. Ag. Sp. Alg. vol.* 1, *p.* 73. *Phycolapathum debile, Kütz. Sp. Alg.* 483.

Hab. On stones and Algæ between tide-marks. Annual. Summer. Halifax, *W. H. H.* Boston Harbour, *G. B. Emerson.* Flushing Bay, Long Island, *Prof. J. W. Bailey and Mr. Hooper.* Fort Hamilton, N. Y. *Mr. Hooper*, &c. (v. v.)

Tufted. *Fronds* eight to twelve inches long, and from one to three inches wide in the broadest part, oblong or obovate, or somewhat ovate, generally obtuse, and suddenly tapering at the base into a short cuneate stem, a line or two in length. The margin is undulate, sometimes much crisped and curled. The substance is thin, membranaceous, soft, and almost gelatinous to the touch when young, at which time it is clothed with pellucid hairs ; afterwards it is more rigid, and at length so coarse that it will not adhere to paper when drying. The colour, when young, is an extremely pale olive, inclining to green, and specimens are often found that retain this colour at their full size, but now and then others accompany them in which the colour is much darker. These approach *P. plantaginea*, and are then only to be known by the less tapering base. I retain the three species as published by Greville, though I admit that it is sometimes difficult to distinguish between them in every case. There are *three* principal typical forms, and a number of intermediate links. The present is much the commonest on the American shore, and after it that called *P. tenuissima.* I shall not be surprised if future botanists, when the rage for species-making has exhausted itself, and the tide sets in an opposite direction, shall re-unite these three under the old name *plantaginea.*

IX. SORANTHERA, *Post. and Rupr.*

"*Frond* membranaceous, olive-green, simple, flat, dilated, entire. *Fructification : Antheridia* pear-shaped, vaginate, mixed with club-shaped jointed threads, and aggregated in roundish sori scattered over the whole frond."

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1. SORANTHERA *ulvoidea*, Post. and Rupr. Illustr. p. 19. *J. Ag. Sp. Alg. vol.* 1, *p.* 120. *Kütz. Sp. Alg. p.* 556.

HAB. Island of Sitcha, Russian America, parasitical on *Rhodomela larix. (Postells and Ruprecht).*

"Lamina membranaceous, olive-green, sub-rotund, plaited, in the two specimens seen not more than an inch in breadth ; the margin very entire, not thickened, nor distinctly revolute. The whole lamina so densely covered with roundish tubercles, a quarter of a line in diameter, and prominent on both surfaces, that scarcely any intersticial spaces of more than a line in breadth remain sterile. The tubercles are composed of an assemblage of heterogeneous antheridia, and considered as sori ; in the dry state they collapse and become harder and brown. The dried lamina is thinly membranous, scarcely loses colour, and does not adhere to paper."—*Post. and Rupr.* Of this plant I know nothing. It seems, to judge by the above description, to be related to *Punctaria*, if distinguishable from that genus.

X. ASPEROCOCCUS, *Lamour.*

Root a small, naked disc. *Frond* tubular, cylindrical or inflated, rarely compressed, membranaceous, unbranched and inarticulate. *Fructification* minute, dot-like *sori*, scattered over the whole surface, and containing roundish, sessile *spores*, accompanied by a few short, club-shaped, jointed paranemata.

This genus differs from *Punctaria* in having a tubular or inflated, instead of a flat frond. *Asperococcus sinuosus* departs in habit from the typical species, but seems to be identical in structure or nearly so. *A. clathratus* of authors is, in my opinion, sui generis.

1. ASPEROCOCCUS *echinatus*, Grev. ; frond cylindrical, club-shaped, obtuse, much attenuated at the base. *Harv. Phyc. Brit. t.* 194. *Grev. Crypt. Fl. t.* 290. *J. Ag. Sp. Alg. vol.* 1. *p.* 76. *Encœlium echinatum, Ag.—Kütz. Sp. Alg. p.* 552.

Hab. Rocks, &c. between tide-marks. Annual. Boston Bay, *G. B. Emerson* (fide Prof. J. W. Bailey.) (v. v.)

Very variable in size. *Fronds* from a few inches to two feet in length, and from the thickness of hog's-bristle to half an inch in diameter, linear-club-shaped, tapering to the base. The apex is either obtuse, or somewhat attenuated. The dots of fructification are crowded, and often entirely cover the surface.

I have not seen American specimens, but give this species on the authority of my friend Prof. Bailey, merely remarking that *Chorda lomentaria* is often mistaken for it, and has been sent to me from America for the Asperococcus. The true *A. echinatus* is however so common in the Northern Atlantic, that it is most probably to be found on many parts of the American coast. It may be known from *Ch. lomentaria* by being never constricted into joints.

2. Asperococcus *sinuosus*, Bory ; fronds globose, or irregular, heaped together, sessile, inflated, at length irregularly distorted and torn. *J. Ag. Sp. Alg. vol.* 1. *p.* 75. *Encœlium sinuosum, Ag.—Kütz. Sp. Alg. p.* 552. (Tab. IX. C.)

Hab. On rocks, corals and Algæ between tide-marks. On the Florida Keys. Very abundant at Sand Key, and washed ashore at Key West, *W. H. H.* (v. v.)

Fronds growing in dense clusters which cover spaces of many inches or some feet square. Each individual frond is globose, one or two inches in diameter, or larger, becoming much inflated and irregular in outline as it advances in age, and is then often ruptured, and pierced here and there with holes of irregular shape and size. The frond is membranous, thin, soft, but not very tender, having a reticulated appearance, from the large interior cells composing the inner lining of the membrane ; and with a smooth uniform surface, from the minute cells which compose the superficial coating : it thus follows that with lenses of different powers the frond appears either areolated or of densely cellular structure. Such *fructification* (?) as I have seen consists in minute *sori*, dotting over the surface, and composed of linear, moniliform *paranemata*, formed at first under the membranous coating of the frond, and bursting through it :—but I have not detected any *spores*. *Colour* a brownish olive.

In habit this plant strongly resembles *Leathesia tuberiformis* (common on the shores of the Northern States) but is of a totally different structure, and can only be confounded with that plant through carelessness or inattention

Plate IX. C. *Fig.* 1. Cluster of Asperococcus *sinuosus* ; the *natural* size ; *fig.* 2, a minute portion of the surface ; *fig.* 3, vertical section of a sorus ; *fig.* 4, *paranemata* from the same ; the latter figures highly *magnified.*

SPECIES OF DOUBTFUL AFFINITY.

3. ASPEROCOCCUS *intricatus*, J. Ag., "frond tubular, branched, sub-hemispherically expanded, subrepent; branches intricate, gradually attenuated, decompound-dichotomous; the apices forked." *J. Ag. Sp. Alg. vol.* 1, *p.* 77.

HAB. Tropical. At Vera Cruz, Mexico. *(Liebman).*

I am not acquainted with this plant, which scarcely seems to fall naturally under this genus.

XI. HYDROCLATHRUS, *Bory.*

Frond membranaceous, convex, hemispherical, bag-shaped, regularly pierced with orbicular holes, which gradually dilate more and more, until the plant becomes a clathrate net, eventually mishapen and ruptured. *Margin* of the apertures involute. "Spores minute, globose, collected into dot-like, scattered, innate *sori*, accompanied by club-shaped, jointed filaments." (*Mont.*)

This is a very remarkable plant, and of so peculiar a habit, as well as distinct structure, that I can hardly imagine any person who has had an opportunity of seeing it alive on its native rocks, placing it in the same genus with *Asperococcus sinuosus;* although my valued friend Prof. J. Agardh even doubts its specific diversity from that species. I must suppose that Prof. Agardh has formed his judgment from an examination of dried specimens, which are so wholly unlike the living plant in appearance, and can be so imperfectly examined when remoistened, that a satisfactory opinion can scarcely be formed from them. I regret that the microscope which I had with me at Key West was not of sufficient power to enable me to make out the anatomical structure perfectly, and the plant decomposed so rapidly that it was difficult to obtain good slices of the membrane sufficiently thin for examination. When fresh from the sea, the frond was quite crisp, and could readily have been cut, but my specimens (collected at Sand Key) had to be brought a long way in an open boat, under a hot sun; and although every care was taken to keep them cool, and though they were brought in buckets of water, decomposition had commenced long before they reached Key West, and then, in the attempt to save from destruction a large gathering of other Algæ, the fruit of the same excursion, only very imperfect notes could be made on the present curious plant. Such sections as I was able to make through the membrane showed me that it was composed of several rows of cells; the inner rows, occupying almost the whole thickness, being formed of large, colourless cells, filled with fluid, distended,

and having thin walls. The outer stratum in which the colour resides is very thin, composed of exceedingly minute cells, with square ends, but whose exact shape I could not well determine. Dr. Montagne, in his splendid work on Algerian Algæ, says that they are parallelipipeds, placed, with their smaller ends to the circumference. With the views respecting this species entertained by Dr. Montagne and expressed in that work I fully concur, and now proceed to describe this curious vegetable in detail.

1. HYDROCLATHRUS *cancellatus*, Bory.—*Mont. Alg. Algier. p.* 36. *Asperococcus clathratus*, *J. Ag. Sp. Alg., vol.* 1, *p.* 75. *Encœlium clathratum*, *Ag.—Kütz. Sp. Alg. p.* 552. *Halodictyon cancellatum*, *Kütz. Phyc. Gen. p.* 338. (TAB. IX. A.)

HAB. Subtropical. On rocks, etc., in tide pools near low-water mark. Annual. Sand Key, Florida, abundant in February. *W. H. H.* (v. v.)

Fronds of irregular form, oblong or sinuous, two to three inches in length and about an inch high, heaped together in wide-spreading patches, adhering to the rocks by the lower surface, and to each other by their sides. The young fronds, in the earliest stage at which they were found, are pierced by rounded holes, of small size and somewhat pressed together. As the membrane expands, the original holes expand also, and grow wider, and new holes are formed in the interspaces, until the whole membranous wall of the bag-like body is converted into a delicate, lace-like network. The *margin* round each hole is strongly involute, which gives the appearance of a thickened rim, when the membrane is viewed vertically. The substance is thick, crisp to the touch at first, but very fragile, and it soon changes colour and loses rigidity on exposure to the air. The surface-cells are exceedingly minute, filled with colouring matter; those that compose the thickness of the membrane are of large size, hexagonal, with thin walls and full of watery juice. No fructification was observed on my specimens. The colour when growing was a very pale, yellowish-olive, somewhat ochraceous. This rapidly changes, and the plant becomes dark brown in a dried state.

Our figure gives a tolerable idea of the Sand Key plant, as to size of individual fronds and mode of composition of the patches: but I have failed in making it sufficiently lace-like, and in giving the effect of depth to the holes which pierce it in every direction. I have some doubts whether all the plants known under the name *H. cancellatus* are identical. The beautiful figure in the great French work on Egypt, would not at all answer any specimen of the Sand Key plant which fell under my notice. But it must be borne in mind that my specimens were gathered early in the season, and were comparatively young; and, therefore, it is possible that later in the year they might have put on a very different aspect. If all the clathrate Algæ referred to this place by botanists belong to the present species, it has a wide range; being found through the warmer parts of the Atlantic at both sides; in the Mediterranean; the Red Sea; on the shores of the Mauritius, and

of those of New Holland. It would be difficult to determine from dried specimens whether the specimens from these various places were identical or not. The living plant has the aspect of a very open sponge, and is so frail that it cannot be raised from the rocks without laceration, and so weak that it cannot support its own weight when lifted from the water.

Plate IX. A. *Fig.* 1. Several fronds of Hydroclathrus *cancellatus*, growing together, the *natural* size ; *fig.* 2, a portion of the perforated frond, *magnified ; fig.* 3, minute piece of the same, showing the surface-cellules, *highly magnified.*

Order V. CHORDARIACEÆ.

Chordarieæ, *Harv. in Mack. Fl. Hib. part* 3, *p.* 183. *Harv. Man. Br. Alg. Ed.* 1, *p.* 45. *Ed.* 2, *p.* 44. *J. Ag. Sp. Alg. vol.* 1, *p.* 45. Chordarieæ, *(excl. gen.) J. Ag. Alg. Medit. p.* 31. *Endl.* 3*rd*, *Suppl. p.* 23. *Dne. Ess. p.* 33. Mesogloiaceæ, *Kütz. Phyc. Gen. p.* 329. *Sp. Alg. p.* 539. Chordaridæ (*excl. gen.) Lindl. Veg. Kingd. p.* 22.

Diagnosis. Olive-coloured seaweeds, with a gelatinous or cartilaginous frond composed of vertical and horizontal filaments (or strings of cells) interlaced together. *Spores* attached to the filaments, and concealed within the substance of the frond.

Natural Character. *Root* rarely more than a disc of attachment ; in the more perfect kinds it forms a point of fixture, at the base of the stem ; in the less perfect, the whole under-surface of an expanded frond adheres to the object on which the plant grows. *Frond* very variable in form, but in all cases composed of articulated threads or cells strung together in vertical and horizontal series, variously combined among themselves, but easily separable under the microscope, and either accompanied by mucus or lying in a transparent gelatine. The gelatine varies both in quantity and in degree of tenacity. When little developed, it is also more tenacious, and then the fronds are firmly cartilaginous, or somewhat coriaceous, and highly elastic. But more generally the gelatine is abundant in quantity and very loose in substance, and then the threads composing the frond lie considerably apart one from another, and the common substance becomes soft and gelatinous. The least organised plant of the order (*Ralfsia*) has a crust-like frond spreading over the surface of rocks, like one of the *Lichens*, in circular or oblong patches, and bearing on its surface small prominences which eventually contain *spores*, mixed with paranemata. Next in development is *Leathesia*, whose frond is either a shapeless or lobed roundish mass, or a cluster of such growing together like so

many small potatoes. This genus, lumpy as it is, is closely allied in structure to *Mesogloia*, from which it is chiefly distinguished by the shapeless frond. The frond in the latter group is branching, with a pinnate habit. A further advance in structure is made in *Chordaria*, where the axis becomes very compact; and in *Scytothamnus*, a genus found at New Zealand, the frond attains its maximum of structure. In that group the substance is as tough and leathery as it is among the *Fucaceæ*, yet an appeal to the microscope shows a filamentous structure not essentially differing from that found in *Chordaria* or *Mesogloia*. The genera *Elachista* and *Myrionema* are a little different in structure from the other genera of the order, and indicate a passage into *Ectocarpaceæ*. In them some of the filaments composing the frond are free, or not enclosed in gelatine; but as the spores are lodged among the filaments which are compacted together into the base of the fronds, I prefer retaining these genera in the present order. By Prof. J. Agardh, *Elachista* is referred to Ectocarpaceæ, and *Myrionema* retained in Chordariaceæ, but both are so closely allied to each other, and also to *Leathesia*, that I am unwilling to separate them.

The *spores* of the Chordariaceæ are very generally obovate, obtuse at the apex and narrowed to the base, and in many they taper so considerably as to become almost club-shaped. They are enclosed in pellucid perispores, and attached to some portion of the filamentous structure of the frond, generally to the filaments forming the *periphery* or outer stratum. They are usually accompanied by paranemata. In *Ralfsia* alone they form prominent, wart-like *sori*, not unlike those of *Stilophora* among Dictyotaceæ. The colour of the frond varies from a greenish to a brownish olive, and is sometimes very dark. It is not much altered in drying.

About forty-five species of this Order have been described from various parts of the world. The majority are natives of the colder portion of the temperate zone, both north and south; and some species, such as *Leathesia tuberiformis* and *Chordaria flagelliformis*, are equally common in the Northern and Southern Hemispheres.

I have found the gelatine of *Chordaria flagelliformis*, extracted by allowing the fronds to remain a day or two in fresh water, useful in causing small Algæ, which are not of themselves sufficiently gelatinous, to adhere to paper. It is however too weak for any except very slender kinds. With this exception, none of the species are used in the arts.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

* *Frond cylindrical, branching.*

I. Chordaria. *Axis* cartilaginous, dense, solid (at length hollow in the centre) Filaments of the periphery unbranched.

II. Mesogloia. *Axis* gelatinous, laxer in the centre, composed of a network of filaments. *Filaments* of the periphery branched.

III. Liebmannia. *Axis* gelatinous, denser in the centre, composed of longitudinal, approximated filaments. *Filaments* of the periphery forked.

** *Frond either tuber-shaped or crust-like.*

IV. Leathesia. *Frond* tuber-shaped, cartilagineo-gelatinous.

V. Ralfsia. *Frond* crust-like, spreading in round patches.

*** *Parasites, consisting of densely tufted filaments, connected at the base, and free above.*

VI. Elachista. *Filaments* pencilled, rising from a common tubercle composed of vertical fibres.

VII. Myrionema. *Filaments* pulvinate, rising from a flat base composed of decumbent fibres.

I. CHORDARIA. *Ag.*

Frond cylindrical, branched, cartilaginous, solid, at length hollow in the centre, coated with a pile of radiating, horizontal, peripheric filaments. *Axis* formed of oblong cells, connected by their ends into anastomosing, longitudinal filaments, forming a compact network. Filaments of the *periphery* at first deficient, gradually evolved, and at length coating the axis in a continuous pile, densely set, club-shaped, simple, moniliform, composed of spherical cells. *Spores* clavate or obovate, arising from the base of the radiating peripheric filaments, and concealed among them.

It is stated by Prof. J. Agardh that the axis of the frond is at first hollow, and that it gradually becomes solid in age, from the tube being filled up with cells. I find the reverse of this to be the case. In carefully made cross sections of the young frond of *Ch. flagelliformis* taken when the plant is an inch or two in height, and long before the evolution of the peripheric filaments, I find the axis quite as solid as at more advanced periods; and I also find in old plants, but more especially in *Ch. divaricata*, that the central cells of the axis disappear in old age, leaving the frond quite fistular. This also takes place in *Mesogloia*, particularly in *M. vermicularis*. In *Ch. divaricata* this hollowing of the frond of old specimens is very obvious.

1. Chordaria *flagelliformis*, Ag.; stem subsimple, densely set with long, lateral, filiform, simple branches, which are either naked or sparingly furnished with ramuli;

filaments of the periphery club-shaped. *J. Ag. Sp. Alg. vol.* 1, *p.* 66. *Kütz. Sp. Alg. p.* 546. *Harv. Phyc. Brit. t.* 111. *Fucus flagelliformis, Turn. Hist. t.* 85. *E. Bot. t.* 1222.

Hab. On rocks, stones, and the smaller Algæ between tide-marks. Common on the shores of the Northern States. Newfoundland, *Lenormand.* Halifax, *W. H. H.* Newport, R. I., *Prof. Bailey*, *Mr. Olney*, &c. Boston, *G. B. Emerson.* Staten Island, N. Y. (v. v.)

Fronds 1—2 feet long, as thick as bristle, mostly with an undivided leading stem, which is densely set throughout its whole length with crowded or fasciculate lateral branches. These branches are several inches long, of the same thickness as the stem, straight or nearly so, and usually unbranched and quite naked : sometimes they have each a few distant, spreading, straight ramuli ; and sometimes they are as densely beset as the stem with such ramuli. The substance is firmly cartilaginous and elastic, the surface lubricous, and if the plant be allowed to remain some hours in fresh water, a very considerable quantity of mucus and some colouring matter will be given off. The colour is always very dark olivaceous brown. In young specimens, the whole frond consists of the cellulo-fibrous axis, composed of a dense network of anastomosing threads ; there is then no *periphery*, or merely an outward coating of dark-coloured cells. As the plant enlarges, the surface-cells grow out, by repeated cell-division, into moniliform peripheric threads, which form a complete covering or pile to the frond. These peripheric filaments are club-shaped, the cells of which they are composed gradually increasing in size, from the base to the apex of the filament. *Spores*, concealed among the threads of the periphery, are abundantly produced by almost every full-sized individual. When growing, the whole frond is clothed with fine, colourless, jointed hairs, which give the branches, as seen through the water, a feathery appearance.

2. Chordaria *divaricata*, Ag. ; frond irregularly divided ; branches divaricating, subdichotomous, flexuous, furnished with scattered, short, very patent, mostly forked ramuli ; filaments of the periphery capitate. *J. Ag. Sp. Alg. vol.* 1, *p.* 65. *Harv. Phyc. Brit. t.* 17. *Mesogloia divaricata, Kütz. Sp. Alg. p.* 545. (Tab. XI. A.)

Hab. On the smaller Algæ, etc., at and below low-water mark. Shores of Long Island Sound, Stonington, *Prof. J. W. Bailey.* Newport, R. I., *Mr. S. T. Olney. Dr. Durkee.* Green Port, Long Island, *Prof. J. W. Bailey and W. H. H.* New Bedford, *Mr. Congdon.* (v. v.)

Fronds tufted, one or two feet long or more, not a line in diameter, very much, but irregularly branched. Sometimes there is a leading stem, with lateral branches, and sometimes the frond is broken up from the base into many principal divisions. The branches are of various lengths, subsimple or repeatedly forked. They spread at wide angles, and their divisions are equally patent, the intermediate spaces being

curved or flexuous. In some specimens these forked branches are quite naked ; in others furnished with patent simple or forked ramuli from half an inch to an inch in length ; and in others beset with a multitude of such ramuli, or of more compound ones. In these last the frond becomes excessively branched, with all its divisions divaricated and beset with irregular branchlets. When young, the axis is solid, firmly cartilaginous and cellular, but with advancing age the central cells die out, and the stems and branches become fistular, or even somewhat inflated. Such specimens also lose much of their original lubricity, and may readily be mistaken for a different species—or even for a *Stilophora*, if care be not taken to observe the filaments of the periphery. These filaments afford a tolerably definite specific character in being slender, with a large terminal cell ; but in individuals of different ages the size of the terminal cell varies considerably. The colour is a greenish olive, paler than in the former species, but becomes dark brown in old age and in drying, in which latter state the plant adheres to paper and shrinks very considerably.

PLATE XI. A. Frond of CHORDARIA *divaricata*, the *natural* size ; *fig.* 2, cross section of a young branch; and *fig.* 3, the same of an older branch, both equally *magnified ; fig.* 4, a spore and two peripheric filaments, *highly magnified.*

II. MESOGLOIA, *Ag.*

Frond cylindrical, branched, cartilagineo-gelatinous, solid, at length partially hollow in the centre, coated with a pile of radiating, horizontal, branched peripheric filaments. *Axis* composed of longitudinal, articulated, anastomosing filaments, connected together into a network, which is laxer toward the centre ; the cells of the inner filaments long, those of the outer shorter. Filaments of the *periphery* rising from the outer layer of axial filaments, moniliform, composed of ellipsoidal cells, fasciculate, frequently dichotomous. *Spores* obovoid, attached to the base of the peripheric filaments, and concealed among them.

Plants with the habit and much of the structure of *Chordaria*, but of a more gelatinous substance and looser texture. In this group I propose to include *Myriocladia* of J. Agardh, the structure of which does not appear to me to be essentially different from that of ordinary *Mesogloiæ*, while the external habit is so similar that even the specific diversity of the species of *Myriocladia* from species referred by Agardh to *Mesogloia* is variously held by different authors. Careful analyses of recent specimens in various stages have still to be made ; for though these plants can be tolerably well observed in a dried state, it is not easy in that state to isolate the filaments of the axis so as to show the structure perfectly. For

this reason, among others, I prefer retaining *Mesogloia Zosteræ*, Aresch. and *M. Lovenii*, J. Ag. in the same genus as *M. virescens*.

1. Mesogloia *vermicularis*, Ag. ; frond clumsy ; branches irregularly pinnate, thick, worm-like, lineari-fusiform ; ramuli copious, long, flexuous, resembling the branches ; filaments of the periphery moniliform, clavate, with spheroidal cells. *J. Ag. Sp. Alg. vol.* 1, *p.* 58. *Kütz. Sp. Alg. p.* 544. *Harv. Phyc. Brit. t.* 31. *E. Bot. t.* 1818.

Hab. On stones and Algæ between tide-marks. Annual. Halifax, *W. H. H.* (v. v.)

Frond a foot or more in length, with a subsimple leading stem set with lateral branches, which are either simple and naked, or furnished with secondary, worm-like branchlets. The principal divisions are two or three lines in diameter, irregularly swollen here and there, often contracted at the base, curved or flexuous, and taper to a bluntish point. The filaments of the periphery are densely set, shorter than the diameter of the branches, and rise from the inflated, colourless, external cells of dichotomous intra-peripherial filaments, which branch off from the longitudinal filaments composing the axis. The peripheric filaments are coloured, tufted, clavate, and bear *spores* in the centre of the tuft. In old age the stem and branches become hollow, and the substance less gelatinous. This takes place most frequently when the plant grows in deep water, beyond the influence of the tide. The colour is a brownish olive.

I collected only a single specimen of this plant at Halifax.

2. Mesogloia *virescens*, Carm. ; frond filiform, gelatinous ; branches long, erecto-patent, slender, villous ; ramuli more or less numerous, very patent, short, obtuse ; filaments of the periphery as long as the diameter of the axis, dense, moniliform, with spheroidal cells rather longer than their breadth. *J. Ag. Sp. Alg. vol.* 1, *p.* 56. *Harv. Phyc. Brit. t.* 81. *Kütz. Sp. Alg. p.* 545. (Tab. X. B.).

Hab. On Zostera at Nahant, Massachussetts, *Miss E. H. Brewer*. On small Algæ at Sand Key, Florida, *W. H. H.*

Frond in the American specimens already seen, which are not of full size, two to three inches long, in full grown (European) specimens 8—12 inches or more, slender, branched in a pinnated or irregular manner, usually with a leading undivided stem, set with patent, lateral branches. *Branches* horizontal or widely spreading, short, or more generally elongated, filiform, of nearly equal diameter throughout, appearing villous to the naked eye from the length and projection of the peripheric filaments. Secondary branches resembling the primary, but shorter, increasing in number with the age of the specimen. The peripheric filaments are

beautifully beaded; more slender and much longer than in *M. vermicularis;* but shorter, and with more globose joints than in *M. Zosterœ.* The colour is an olivaceous green, becoming rather greener after the specimen has been dried. The substance is very soft and gelatinous.

My figure is taken from one of the Sand Key specimens. These are less *villous*, owing to youth, than most specimens of the species, and have more the aspect of *M. Griffithsiana*, but on a close microscopic examination they appear to have all the characters proper to *M. virescens.* Miss Brewer's specimens are still younger, but, though growing on Zostera, appear to belong to *virescens* and not to the following.

PLATE X. B. *fig.* 1. Fronds of MESOGLOIA *virescens*, the *natural* size; *fig.* 2, small portion of a branch, *magnified*; *fig.* 3, peripheric filaments, attached to the axial; *fig.* 4, a peripheric filament removed, the latter figures *highly magnified.*

3. MESOGLOIA *Zosterœ*, Aresch. (?); frond filiform, gelatinous, flexuous, slightly branched; branches very short and subsimple, distant, villous, patent, with rounded angles; filaments of the periphery much longer than the diameter of the axis, lax, submoniliform, with ellipsoidal cells, twice as long as their diameter. *Mesogloia Zosterœ, ?; Aresch. Pug. t.* 8, *f.* 1, *a.* 6. *Myriocladia Zosterœ ? or M. Lovenii ? J. Ag. Sp. Alg. vol.* 1, *p.* 53. (TAB. X. A.).

HAB. On Zostera in deep water. Annual. Halifax, *W. H. H.*

Fronds 6–8 inches long, very slender, filiform, flexuous or angularly bent, either without lateral branches, or furnished at distant intervals with a few very short, patent, or divaricating, simple or forked ramuli, from a line to an inch in length, but seldom longer. These branchlets issue at very wide angles, and sometimes at the point where they arise the main stem takes a bend in the opposite direction, as if the proper mode of branching were dichotomous, but that one of the forks were perpetually aborted into a ramulus. The peripheric filaments are much longer than the diameter of the axis which they clothe, and are laxly set, surrounded by a loose jelly. They are dichotomous, and spring from slender longitudinal filaments coating the internal filaments of the axis, but which I have failed to detect anastamosing into a net work, as described by J. Agardh (if we are really speaking of the same plant). The articulations of the radiating filaments are fully twice as long as broad, and but slightly contracted at the dissepiments. The colour in my specimens is a yellowish olive.

Few plants have been more confused by authors than the *Linckia Zosterœ* of Lyngb., *Mesogloia Zosterœ*, Aresch.; and I hope I am not farther confusing synonyms by referring to this place the plant now described and figured. Lyngbye's figure is certainly very unlike my plant, and is referred by J. Agardh to the young of *Mesogloia virescens*, which it much more nearly resembles. But Areschoug, whose figure accords more nearly with that now given than with the previous figure of Lyngbye, has examined a specimen of Lyngbye's plant, and declares it

the same as his own. J. Agardh, taking up Areschoug's *M. Zosteræ*, as identical with his own *Myriocladia Zosteræ*, states that the cells of the peripheric filaments are subspherical; and describes a new species, *M. Lovenii*, in which they are twice as long as broad. In my specimens now described I find the peripheric cells of the length attributed to those of *M. Lovenii*, and yet I hesitate whether to refer them to that species. I have not seen any authentic specimen of either Agardh's or Areschoug's plant, and must leave the final determination of the difficulty to those who have such specimens to compare.

Plate X. A. *Fig.* 1. Fronds of Mesogloia *Zosteræ*, growing on *Zostera marina*, the *natural* size; *fig.* 2, small portion of a branch, *magnified; fig.* 3, some of the axial and peripheric filaments of the same; *fig.* 4, portion of one of the peripheric filaments; the latter figures highly *magnified.*

III. LIEBMANNIA. *J. Ag.*

"*Frond* cylindrical, branched, filamentous, solid, clothed with radiating peripheric filaments. *Axis* composed of oblong, approximated cells, cohering in longitudinal filaments; the filaments toward the centre narrower, and there collected into a peculiar dense stratum. Peripheric filaments arising from the outermost axial cells, mucous, moniliform, forked. *Spores* obovoid, seated in the axils of the radiant filaments, girt with a hyaline perispore. *Propagula* at the apex of the radiating fibres lancioid, one, two or four, sessile within a hyaline, inflated, obpyriform perispore, sub-articulate-constricted, and longitudinally divided."—*J. Ag.*

Liebmannia *Leveillei*, *J. Ag. Alg. Medit. p.* 35. *Sp. Alg. vol.* 1, *p.* 61. *Mesogloia Leveillei*, *Menegh. Alg. Ital. p.* 283, *b.* 5, *t.* 2.

Hab. Parasitical on Zostera. At Vera Cruz., Mexico, *Liebman.* (v. s. in Herb. T.C.D.)

I give the characters of this genus as nearly as possible in Prof. J. Agardh's words. I have not seen an American specimen, but possess an Adriatic one from Prof. Meneghini. This has the outward characters of *Mesogloia vermicularis.*

IV. LEATHESIA. *S. F. Gray.*

Frond globose or lobed, solid or at length hollow, consisting of filaments radiating to all sides from a central point. *Axis* composed of oblong colourless cells, united in dichotomous threads which issue from a common base ; the uppermost cells half-moon shaped. *Peripheric* filaments issuing from the outermost axial cells, simple, moniliform, strongly glued together, with globose articulations. *Spores* obovoid or pyriform, affixed at the base of the peripheric filaments (with which they have a common origin) and concealed among them.

Very unlike the preceding genera in external characters, but closely allied in structure to *Mesogloia*, particularly to *M. vermicularis*. Leathesia indeed chiefly differs from Mesogloia in having the frond irregularly lumpy or tuberous, instead of cylindrical and branching. The following species has a very wide geographical range, being a common inhabitant of the shores of both hemispheres, East and West, and also of the Southern Ocean. It abounds at least at the Cape of Good Hope.

1. Leathesia *tuberiformis*, Gray ; fronds olivaceous, tuberous, when young stuffed with cottony fibres (the axis), at length hollow. *Harv. Phyc. Brit. t.* 324. *Leathesia marina, Endl.—J. Ag. Sp. Alg. vol.* 1, *p.* 52. *Kütz. Sp. Alg. p.* 543. *Corynephora marina, Ag.—Rivularia tuberiformis, E. Bot. t.* 1956. (Tab. X. C.)

Hab. On rocks and Algæ between tide marks. At Halifax, *W. H. H.*, (v. v.)

Fronds clustered together, varying in size from the bigness of a pea to that of a large walnut, irregularly lobed and bullated ; at first solid but becoming hollow from the perishing of the cottony axial filaments. The frond then consists merely of the peripheric filaments, which are strongly glued together and constitute the whole substance of the walls of the then hollow tuber. They can be separated only by using considerable pressure. The plant makes its first appearance in April or May, and in August or September attains its full size and produces fruit, decaying soon after.

Plate X. C. *Fig.* 1. Cluster of fronds of Leathesia *tuberiformis*, on a piece of rock, the *natural* size ; *fig.* 2, vertical section of a frond, showing a small portion of the periphery, and some of the axial filaments, *magnified* ; *fig.* 3, peripheric filaments supported on the apical cells of the axial filaments ; *fig.* 4, a *spore* and two peripheric filaments, both the latter figures *highly magnified*.

V. RALFSIA. *Berk.*

Frond coriaceo-crustaccous, fixed by its inferior surface, orbicular, concentrically zoned, composed of densely packed, vertical, simple filaments, agglutinated together into a crust. *Fructification*, depressed warts, scattered over the upper surface, containing obovate *spores*, attached at the bases of vertical filaments or *paranemata*.

The plants included in this group resemble the crustaceous lichens in outward characters, and, like them, spread over the face of rocks in varying patches. In the character of the fructification there is an approach to *Dictyotaceæ*, but the genus is retained in *Chordariaceæ* on account of the structure of the frond, and a supposed affinity with *Leathesia*.

1. RALFSIA *expansa*, J. Ag. ; frond orbicularly expanded into a crust, lobed at the margin, flattish (?) in the middle, here and there raised in tubercles. *J. Ag. Sp. Alg.* 1, *p.* 63.

On Madrepores in the Gulf of Mexico. Vera Cruz, *Liebman*.

I have not seen this plant, and am uncertain whether I have correctly translated Prof. J. Agardh's specific character, which is as follows :—"Fronde orbiculariter expansa in crustam margine lobatam, medio subcontinuam hic illic in pustulas elevatam."

2. RALFSIA *deusta*, Ag., (not Berk.) ; frond concentrically lobed, the lobes subreniform, imbricated, longitudinally striate, concentrically zoned. *J. Ag. Sp. Alg.*, 1, *p.* 63. *Fucus fungularis*, *Fl. Dan. t.* 420.

HAB. On the shores of Greenland, *Vahl*. Unalaschka, *Tilesius*.

Frond orbicular, 1—2 inches in diameter, adhering to the rocks, constituted of numerous lobes, one imbricating on the other. *Colour* chestnut brown.

I am not acquainted with this plant.

VI. ELACHISTA. *Duby.*

Fronds parasitical, penicillate, composed of axial and peripheric filaments. *Axial* filaments dichotomously branched, cohering together into a tubercular common base. *Peripheric* filaments, simple, free, penicillate, radiating from the base, coloured, articulate. *Fructification* : pear-shaped spores attached to the axial filaments, and hidden within the tubercular common basis.

ELACHISTA *fucicola*, Fries.; tufts pencilled ; filaments elongate, flaccid, membranaceous, attenuated upwards ; articulations once or twice as long as broad ; tubercle spherical. *J. Ag. Sp. Alg.* 1, *p.* 12. *Harv. Phyc. Brit.*, *t.* 240. *Phycophila fucorum*, *Kütz. Sp. Alg. p.* 541. (TAB. XI. B.)

HAB. Parasitical on the fronds of *Fucus nodosus* and *F. vesiculosus*. Narragansett Pier, *Mr. Olney*. Halifax, *W. H. H.* (v. v.)

A common parasite on littoral fuci, forming brown or foxy-coloured pencils of filaments. I am acquainted only with the two American stations recorded above, but most probably this parasite will be found all along the shores of the Northern States.

PLATE XI. B. *Fig.* 1. Tufts of ELACHISTA *fucicola*, growing on *Fucus nodosus*, the *natural* size ; *fig.* 2, a small portion of a tuft *magnified ; fig.* 3, a *spore* with paranemata ; *fig.* 4, 5, portions of the pencilled filaments, the latter figures *highly magnified.*

VII. MYRIONEMA. *Grev.*

Fronds minute, parasitical, cushion-like, composed of axial and peripheric filaments. *Axial* filaments decumbent, branched, spreading as a thin expansion on the surface to which the parasite adheres. *Peripheric* filaments short, erect, simple, springing from the decumbent expansion, and united by interposed gelatine into a cushion-like frond. *Spores* oblong, affixed either to the erect or to the decumbent filaments.

A genus of minute parasites which annually attack the smaller *red* and *green* Algæ in old age, and hasten their decay. The following is so common on old fronds of *Ulva latissima* and *Enteromorpha compressa*, both common American shore plants, that I

venture to introduce it into this work, though I have not received it from any correspondent in America.

Myrionema *strangulans*, Grev.; patches convex, confluent, brown; vertical filaments clavate, densely set; spores obovoid, on short stalks, attached to the decumbent filaments. *Grev. Crypt. Fl. t.* 300. *Harv. Phyc. Brit. t.* 280. *J. Ag. Sp. Alg.* 1, *p.* 48. *Kütz. Sp. Alg. p.* 540.

Hab. Parasitical on the fronds of *Ulvæ* and *Enteromorphæ;* common on the shores of Europe. (v. v.)

This parasite first appears like a dark brown stain, spotting the plant on which it grows, and at this stage consists of little more than an imperfect membranous expansion, composed of prostrate filaments. Afterwards, by the growth of the erect filaments, the spots become convex and gelatinous, and the plant is matured. The spores are of large size (for the plant), and arise, like the vertical filaments, from the upper face of the decumbent ones.

M. Leclancherii, and *M. punctiforme* are, with the preceding, *probably* to be found on the American shores.

Order VI. ECTOCARPACEÆ.

Ectocarpeæ, *C. Ag. Sp. Alg. vol.* 2, *p.* 9. *(excl. gen.) Harv. Man. Ed.* 1, *p.* 38. *Ed.* 2, *p.* 52. *Kütz. Sp. Alg. p.* 449. Ectocarpeæ *and* Sphacelarieæ, *J. Ag. Alg. Medit. p.* 26. *Sp. Alg. vol.* 1, *p.* 6, 27. *Dne. Ess. p.* 33, 42. *Kütz. Phyc. Gen. p.* 287, 291. Ectocarpidæ, *(in part) and* Sphacelaridæ, *Lindl. Veg. Kingd. p.* 22.

Diagnosis. Olive-coloured, articulated, filiform seaweeds, whose spores are (generally) external, attached to the jointed ramuli, or formed in a swelling of the ramulus.

Natural Character. *Root* commonly a small disc, or point of attachment, occasionally accompanied by woolly fibres. *Frond* filiform and slender, (or *filamentous*) often capillary, or of extreme tenuity, more or less conspicuously articulated, each articulation composed either of several cells of equal length disposed in a ring round an axis, or of a single cell. In the latter case the frond is said to be a *filament* (*filum*, Ag. *trichoma*, Kg.) and is formed of a series of cells, placed end to end, and strung together. In some of the higher forms, as in *Cladostephus* and *Chætopteris*, the main stem and the larger branches are inarticulate, formed of

a multitude of minute cells, the central ones of which are frequently cubical, closely compacted together into a firm, somewhat horny, rigid substance. In a few cases the frond is unbranched (as in the genus *Myriotrichia*) ; very generally it is much divided, either pinnated, alternately branched, or more rarely subdichotomous. In *Cladostephus* the ramuli are short, subsimple, whorled round the branches, and deciduous at the close of each season. In *Sphacelaria* and *Chætopteris* the ramification is distichous, the lesser divisions being simply or doubly pinnated. In *Ectocarpus* the frond is occasionally subsimple, or but slightly branched ; but in by far the larger number it is much divided, either dichotomous or distichous, and alternately or oppositely branched, but the branches rarely approach so nearly together as to be *pinnated* ; this is however the case in *E. Mertensii*. In some few the thread-like fronds are bundled together into branching ropes, forming a sub-definite, sponge-like, compound frond.

The *fructification* appears under two forms, sometimes both found in the same or on different individuals of the same species ; in other cases but one kind of fruit has been noticed on all the individuals of a species, and hence has been employed as a specific character. The *spores* are less commonly formed than *propagula*, by which name the secondary fruit is known, and are oval or spheroidal, dark coloured, dense, furnished with a hyaline perispore, and attached to the sides of the ramuli, scattered and without paranemata. The *propagula*, which are chiefly characteristic of *Ectocarpus*, where their modifications often afford the best specific characters, are lanceolate, linear or conical, sessile or pedicellate, or immersed in the substance of the branches, transversely striate and filled with dense endochrome. In *Sphacelaria* they are lodged in the distended tops of the branches.

In *substance*, the plants of this Order are rarely gelatinous ; those of the first sub-order are rigid, in some almost horny ; of the latter sub-order soft, and soon decomposing after removal from the water. The colour varies from dark brown to pale greenish-olive, and is subject to little change in drying except on the application of artificial heat, when the olive tints are brightened into more or less vivid greens.

This Order is closely connected with the last, from which it is known by the absence of a gelatinous matrix connecting the filaments into a compound frond, and by the *spores* being external, scattered, and unaccompanied by paranemata. The genus *Elachista* is in some respects intermediate, and has been referred by Prof. J. Agardh to the present Order ; but appears to me to be too intimately connected with *Myrionema* and *Leathesia*, both clearly belonging to Chordariaceæ, to be separated from them.

By Agardh, Endlicher, and formerly by Kützing, the two sub-orders defined below are separated as distinct Orders ; and by Endlicher they are placed widely apart one from the other. To me their connection appears to be close, and their difference chiefly technical,—one being a rather simpler expression of the other—and therefore I am unwilling to multiply needlessly the number of Orders ; particularly when I find, in such plants as *Ectocarpus Mertensii*, an obvious passage from one sub-order into the other.

These plants are most numerous in the temperate waters of the ocean, diminishing toward the warmer and the colder zones. On the American coast they are more frequent on the shores of the northern and midland States; and in Europe on the coasts of Britain and France. Several are, however, found in the Mediterranean and Adriatic. They are all plants of small size, though few come within the limits of strictly microscopic objects. The genera are widely dispersed, all nearly cosmopolitan.

SYNOPSIS OF THE NORTH AMERICAN GENERA.

Suborder 1. SPHACELARIEÆ. *Frond* rigid; each articulation composed of numerous cells.

I. CLADOSTEPHUS. *Stems* inarticulate. *Ramuli* whorled.

II. CHÆTOPTERIS. *Stems* inarticulate. *Ramuli* pinnated.

III. SPHACELARIA. Whole *frond* articulate, pinnately branched.

Sub-order 2. ECTOCARPEÆ. *Frond* flaccid; each articulation composed of a single cell.

IV. ECTOCARPUS. Capillary, soft, much branched.

I. CLADOSTEPHUS, *Ag.*

Frond cylindrical, inarticulate, densely clothed with whorled, articulate, short, subsimple ramuli. *Stem* cellular, composed of a triple stratification of cellules; the central portion of longitudinal prismatical cells horizontally connected; the intermediate of roundish cells; the outer of minute cellules. *Fructification*, ellipsoidal *spores*, having a hyaline perispore, and borne on little stalks on accessory ramuli. The sphacelate tips of the whorled ramuli also contain a sporaceous mass or *propagulum* (?).

Readily known from the rest of the order by the densely-set, quadrifarious, whorled and imbricated ramuli. The two following species are very closely allied to each other, and perhaps not permanently distinct, the differences indicated arising from difference of locality.

1. CLADOSTEPHUS *verticillatus*, Ag. ; branches slender, ramuli mostly forked, regularly whorled ; the whorls at short intervals. *J. Ag. Sp. Alg.* 1, *p.* 43. *Harv. Phyc. Br. t.* 33. *Cl. Myriophyllum*, *Ag. Kütz. Sp. Alg. p.* 468. *Conferva verticillata*, *E. Bot. t.* 1718, *and t.* 2427, *f.* 2. (TAB. XI. C.)

HAB. On tidal rocks, in pools near low water mark. Perennial. Newport, R. I., *Mr. Olney* and *Prof. Bailey*. Lynn, Mass., *Mr. Hooper*. (v. v.)

Fronds 3—6 or 8 inches high, irregularly dichotomous, innovations springing here and there along the principal divisions. Occasionally a large tuft of such irregular branches issues from a single incrassated portion of the main stem, and is either simple or forked. The whorls of ramuli are about a line asunder, the apices of the lower whorl lying over the bases of that next above ; each ramulus is incurved, tapering to the base, and acute at the extremity, and bears above its middle one or two subulate processes on the outer margin. The articulations are shorter than their diameter, and longitudinally striate, each stria composed of numerous seriated cellules. The fructification is formed in winter, at which season most of the verticillate ramuli fall away, and their place is supplied by short, densely set, accessory ramuli which bear the *spores*. These have been described by authors as a parasitical *Sphacelaria*, and the name *S. Bertiana* bestowed on them.

PLATE XI. C. *Fig.* 1, a frond of CLADOSTEPHUS *verticillatus*, the *natural* size ; *fig.* 2, small portion of a branch, *magnified ; fig.* 3, two of the whorled ramuli, *highly magnified.*

2. CLADOSTEPHUS *spongiosus*, Ag. ; branches thick and clumsy ; ramuli mostly simple, irregularly whorled, densely imbricated. *J. Ag. Sp. Alg.* 1, *p.* 43. *Kütz. Sp. Alg. p.* 469. *Harv. Phyc. Brit. t.* 138. *Conferva spongiosa*, *E. Bot. t.* 2427. *f.* 1.

HAB. On tidal rocks, at about half tide level. Perennial. With the preceding, *Mr. Olney*. (v. v.).

Smaller than the preceding, with thicker and more clumsy branches, and longer and denser ramuli. I am not certain that the American specimens above quoted have been rightly named, or are anything more than a variety of *C. verticillatus*. The British plant looks something different ; but the technical characters by which it is known are not always constant.

II. CHÆTOPTERIS. *Kütz.*

Frond filiform, compressed, inarticulate, distichously pinnate. *Stem* cellular, omposed of a triple stratification of cellules; the central portion of longitudinal, prismatic cells, horizontally connected; the intermediate of roundish cells; the outer of minute cellules. *Fructification:—spores* (unknown). The sphacelate tips of the pinnated ramuli contain a sporaceous mass or propagulum.

This genus has the habit of *Sphacelaria*, with which it has until recently been associated by authors, and a structure of stem similar to that of *Cladostephus*. It is therefore exactly intermediate between these genera.

1. CHÆTOPTERIS *plumosa*, Kütz.; stems naked at the base, elongated, irregularly branched; branches pectinato-pinnate; pinnæ opposite, simple, very long, closely set. *Kütz. Sp. Alg. p.* 468. *J. Ag. Sp. Alg.* 1. *p.* 41. *Sphacelaria plumosa, Ag. Harv. Phyc. Brit. t.* 87. *Conferva pinnata, E. Bot. t.* 2330, (*left hand fig.*)

HAB. On the shores of Greenland, *J. Agardh.* Arctic Coast, *Mr. Seeman.* (v. v.)

Fronds from two to four or six inches long, setaceous, naked below, irregularly and much branched above. *Branches* alternate or secund, or frequently tufted, one or two inches long, simple, closely pectinated along their whole length with slender, articulated, distichous ramuli. These ramuli are from one to three lines long, opposite, a pair growing from every joint of the branch.

This beautiful plant is peculiarly a northern form, and though it reaches the south of England, is there of much smaller size than on the shores of Scotland. The branches resemble delicate feathers.

III. SPHACELARIA. *Lyngb.*

Frond filiform, articulated, distichously branched, rigid, pinnated, rarely subdichotomous. *Articulations* of the stem and larger branches composed of several cells radiating from a central point. *Apices* of the branches distended, membranous, containing a sporaceous mass or *propagulum*. *Spores* ovoid, having a pellucid *perispore*, affixed to the branches.

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1. SPHACELARIA *cirrhosa*, Ag. ; stems naked at the base, short, densely tufted, simple or branched, pinnate or bipinnate ; pinnæ opposite, alternate or irregular, simple ; spores globose, scattered, sessile or shortly stalked. *J. Ag. Sp. Alg.* 1, *p.* 34. *Kütz. Sp. Alg. p.* 464. *Harv. Phyc. Brit. t.* 178. *Conf. pinnata*, *E. Bot. t.* 2330. *(right hand fig.)*

HAB. On the small Algæ between tide-marks. Long Island Sound, *Captain Pike.* Ship Ann Point, Con. *Messrs. Walters*, *Hooper*, *and Congdon.* New Bedford, Mass. *Mr. Congdon.*

Fronds forming globose, fastigiate tufts, an inch or rather more in diameter ; more or less densely tufted, scarcely fastigiate, and only a quarter inch in height. *Filaments* capillary, of equal diameter throughout, straight, once or twice pinnated, the pinnæ very irregular ; in some specimens closely set, opposite and plume-like, in others distant, alternate, variable in length on the same branch ; either erecto-patent or spreading horizontally, simple, naked, blunt. The *spores* are not uncommon, and are found scattered along the pinnæ. *Colour* a foxy brown or olive. *Substance* rigid, scarcely adhering to paper in drying.

Probably common on the shores of the Northern and Midland States. Numerous specimens that I have received are very similar to European forms of this variable plant.

2. SPHACELARIA *radicans*, Dillw. ; filaments decumbent, sending out fibrous radicles in the lower part, with a few irregular, simple, straight, naked branches ; spores clustered, sessile. *Harv. Phyc. Brit. t.* 189. *S. olivacea*, *J. Ag. Sp. Alg. vol.* 1, *p.* 30. *S. radicans and S. olivacea*, *Kütz. Sp. Alg. pp.* 463, 466. *Conf. olivacea*, *E. Bot. t.* 2172 ; *and C. radicans*, *t.* 2138.

HAB. On sand-covered rocks, between tide-marks. (I gathered on rocks at Beverley, on Boston Bay, what I supposed to be this species ; but have mislaid my specimens. *W. H. H.*).

A small plant, forming spreading patches half an inch in height, and two inches or more in diameter. The specific name *radicans*, though not adopted by Prof. Agardh in his recent work, has evidently the claim of priority, having appeared in English Botany 34 plates earlier than the rival name *olivacea*—a name moreover, equally applicable to any other species of the genus, all being *olive-coloured.*

IV. ECTOCARPUS. *Lyngb.*

Frond capillary, articulated, variously much-branched, flaccid. *Articulations* composed of a single cell, short, rarely twice or thrice as long as broad. *Apices* attenuated. *Spores* spherical or ellipsoidal, scattered (rarely produced.) *Propagula*, or pod-like bodies, oblong, conical, linear or lanceolate, transversely striate, and celluloso-granulated, formed either of transformed ramuli, or of some portion of a ramulus, or of portions of the main and secondary branches.

A large genus of confervoid Algæ, usually much branched, and forming fine, feathery tufts of slender, soft, brownish or olive green filaments. The articulations are always very short, and nearly of equal size in all parts of the plant. They are usually filled with endochrome, which is sometimes pellucid, sometimes granulated, and sometimes condensed into a dark spot in the middle of the cell. The species are difficult to determine or fix limits to, owing to the uncertain nature of the ramification, which it is by no means easy to characterise, and which appears to vary in different specimens collected together and seemingly of one species. The best characters are derived from the *propagula*, or "silicules," as they have been called; podlike bodies regarded as fructification. These are either formed in the substance of the branches, or of the whole substance of a shortened branchlet. They contain a darker endochrome than the unchanged branches, and are divided at minute intervals by transverse lines. The spaces between the lines are broken up into granular cells disposed in transverse bands, and supposed to be reproductive.

The American species are not yet fully worked out, and though I have proposed some new ones below, I am by no means certain that they ought all to be retained. Some are but partially known, and all require a careful investigation on the sea shore. Solitary specimens of these plants are by no means sufficient, and when any seemingly *new* form is observed among them, numerous specimens ought not only to be collected, but the collector should notice what other seemingly different Ectocarpus was growing with the supposed novelty; and should carefully compare one form with the other before assuming that he has a new species to describe. This cannot be done at a distance, and in many cases I have had to decide from very insufficient materials.

* *Propagula short or elongated, formed in some portion of the larger or lesser branches, (not in the ultimate ramuli).*

1. Ectocarpus *brachiatus*, Harv.; finely tufted, feathery, much branched; the branches free, opposite or quaternate; ramuli opposite, very patent; propagula forming oblong or elliptical swellings in the smaller branches, or at the point where two opposite ramuli issue. *Harv. Phyc. Brit. t.* 4. *J. Ag. Sp. Alg.* 1, *p.* 20.

HAB. Parasitical on the smaller Algæ. Prince Edward's Island, *Dr. Jeans.* South Boston, *Dr. Durkee.* Lynn, *Mrs. Estes.* (v. v.).

Tufts feathery, 2—4 inches high, the main stems slightly entangled at the base, the lesser branches quite free, spreading. *Filaments* much branched, all the branches and their divisions either opposite or in fours, widely spreading, almost horizontal, the larger divisions subdistant, the lesser gradually nearer. *Ramuli* filiform, patent, mostly opposite. *Propagula* (or perhaps *spores ?)* immersed in the lesser branches, often bipartite. *Colour* a pale olive green.

2. ECTOCARPUS *littoralis*, Lyngb.; tufts dense, interwoven, olive-brown, or olive-green ; filaments capillary, much and irregularly branched, the ultimate divisions erecto-patent, alternate or opposite ; angles acute ; propagula forming elongated, linear swellings in the substance of the greater and lesser branches. *Harv. Phyc. Brit. t.* 197. *J. Ag. Sp. Alg.* 1, *p.* 18 (?) *and E. firmus, p.* 23.

HAB. Very abundant on littoral *Fuci;* also attached to various substances between tide-marks. Shores of the Northern and Midland States. (v. v.)

Tufts 6—12 inches long, dense and bushy, sometimes bundled together in ropes, sometimes untangled and feathery. *Branches* mostly alternate, repeatedly divided, the divisions issuing at acute angles, the upper ones opposite. *Articulations* of the branches almost as long as broad. *Propagula* elongated, many times longer than their breadth, at first transversely striate, (like an *Oscillatoria),* afterwards moniliform. *Substance* soft, but not glutinous, closely adhering to paper. The colour varies from olive-green to brown ; and if dried by artificial heat, the tints may be much vivified and made more green.

This is the commonest form on the American coasts.

* * *Propagula linear or lanceolate, formed of or in the ultimate ramuli.*

3. ECTOCARPUS *siliculosus*, Lyngb. ; tufts yellowish or pale olive-green, gelatinous, soft ; filaments very slender, excessively branched ; ultimate branchlets alternate or secund, attenuated ; propagula pedicellate, subulato-lanceolate, attenuated to a fine point. *Harv. Phyc. Brit. t.* 162. *J. Ag. Sp. Alg. vol.* 1, *p.* 22.

HAB. On various substances between tide-marks. Shores of Long Island Sound, and Hudson River at West Point, *Prof. Bailey.* Prince Edward's Island, *Dr. Jeans.* Charleston, S. C., *W. H. H.* (v. v.)

Tufts 3—6 inches long or more, not entangled. *Filaments* excessively branched, and very slender, all the divisions usually alternate and erecto-patent, with acute

axils. The *propagula* are generally formed of the upper half of the ramuli, leaving an unchanged portion or pedicel at the base of the propagulum : they taper to a fine point, and are sometimes prolonged into ramuli, or tipped with an unchanged mucro. *Colour* mostly yellowish olive, but variable.

4. Ectocarpus *viridis ;* tufts feathery, loose, expanding, olive-green ; filaments slender, much branched, very flexuous, dichotomous, the lower forkings distant, the upper approximated, having a few lateral ramuli ; axils rounded ; apices alternate, articulations of the branches once and half as long as broad ; propagula sessile or pedicellate, elongate, tipped with a long mucro or unchanged portion of ramulus. (Tab. XII. B. C., *two varieties.)*

Hab. On Algæ between tide-marks. Charleston, *Prof. L. W. Gibbes.* Providence, R. I., *Mr. Olney.* Bergen Island, *Mr. Walters* and *Mr. Hooper.* Hellgate, *Mr. C. Congdon.* (v. s.)

I fear this is too nearly related to the preceding, notwithstanding the apparently different mode of branching. Dried specimens have the ramuli at the tips of the divisions of the tufts dense, or slightly fastigiate or corymbose, and are of a very green olive. The propagula are more frequently formed in the basal half of the ramulus, and are therefore sessile ; but sometimes are found in the middle portion also. The very patent, rounded axils I once thought a good mark, but fear that it is hardly constant enough.

Plate XII. B. *Fig.* 1, Part of a filament of Ectocarpus *viridis, magnified ; fig.* 2, minute portion, with *propagula, highly magnified.*

Plate XII. C. *Fig.* 1, Portion of a filament of Ectocarpus *viridis, var., magnified ; fig.* 2, minute portion, with *propagula, highly magnified.*

5. Etocarpus *lutosus ;* tufts somewhat entangled and rope-like ; filaments intricately branched, decompound, the branches spreading, opposite or alternate, with few, distant, scattered ramuli ; angles very wide ; articulations of the branches once and half as long as broad ; propagula very long, linear, formed in the middle of short, spreading or reflexed ramuli whose base forms a pedicel, and whose apex a long excurrent mucro. (Tab. XII. A.)

Hab. Greenport, Long Island, *Mr. J. Hooper.* (v. s.)

This has the habit of *E. tomentosus*, but branching more like *E. littoralis.* I have seen but a solitary specimen, and though I give it a *name*, not knowing how to

dispose of it otherwise, I must consider it for the present as a doubtful species ;—*muddy* in more respects than one. Its colour in the dry state is brownish.

PLATE XII. A. *Fig.* 1, Part of a filament of ECTOCARPUS *lutosus*, *magnified ; fig.* 2, minute portion, with *propagula*, *highly magnified.*

**** Propagula oval, ellipsoidal or conical, sessile or pedicellate, scattered.*

6. ECTOCARPUS *tomentosus ;* Lyngb. ; filaments very slender, flexuous, irregularly branched, interwoven into a dense, sponge-like, branching tuft ; propagula ellipsoidal, obtuse, pedicellate. *Harv. Phyc. Brit. t.* 182. *J. Ag. Sp. Alg.* 1, *p.* 23.

HAB. On various substances between tide-marks. Prince Edward's Island, *Dr. Jeans.* Boston Bay, *Mrs. Asa Gray.* (v. v.)

The sponge-like tufts of this plant, composed of innumerable densely matted, flexuous, branching filaments, are from two to six inches long or more, and divided into several branches, which are either simple or furnished with lesser divisions. The filaments are very slender, and most irregularly branched, the branches flexuous, secund or alternate, and of various lengths. *Articulations* twice or thrice as long as broad, pellucid. *Propagula* pedicellate, linear-oblong or ellipsoidal, very obtuse. *Colour* varying from yellowish olive to dark brown.

The densely interwoven, rope-like, branching tufts at once mark this species from most others.

7. ECTOCARPUS *fasciculatus*, Harv. ; tufts olivaceous, dense ; main filaments not much divided ; the branches distant, set throughout with alternate or secund fascicles of subulate ramuli, the ramuli secund in each fascicle ; propagula sessile, secund, several together, ovato-acuminate or subulate. *Harv. Phyc. Brit. t.* 273. *J. Ag. Sp. Alg.* 1, *p.* 22.

HAB. On the larger Algæ between tidemarks, generally on the Laminariæ. Rhode Island, *Mr. Olney*, *Prof. Bailey*, and *Mr. G. Hunt.* Also in *Herb. J. Hooper.* (v. v.)

Tufts dense, 3—6 inches long, entangled and rope-like at the base, free and feathery above ; the ultimate ramuli densely aggregated ; appearing under a pocket-lens to be fasciculate, but not strictly so, being only placed in secund series close together. *Articulations* once-and-half to twice as long as broad. *Colour* varying from olive green to dull brown or rusty. *Substance* soft, adhering to paper.

8. ECTOCARPUS *granulosus*, Ag. ; tufts olivaceous, lax, feathery ; filaments capillary, elongate, much branched : branches free, opposite, spreading ; ramuli opposite

or rarely alternate ; propagula (spores?) elliptical, dark coloured, sessile. *Harv. Phyc. Brit. t.* 200. *J. Ag. Sp. Alg.* 1, *p.* 21.

Hab. On Algæ, etc. between tide-marks, in rock pools. Boston, *Dr. Silas Durkee.* (v. v.)

Filaments capillary, not very densely tufted, from four to eight inches long much branched, with a principal stem and lateral decompound branches. All the divisions mostly opposite and spreading. *Propagula* ellipsoidal, dark-coloured, plentifully scattered on the ramuli.

9. Ectocarpus *Durkeei* ; tufts not very dense ; filaments robust, decompound, much branched, the branches and the lesser divisions alternate ; the angles acute and ramuli erecto-patent, attenuated, alternate or secund ; articulations of the branches shorter than their breadth ; propagula elliptic-oblong, obtuse, subsessile, constricted at the base, transversely striate. (Tab. XII. F.)

Portsmouth, New Hampshire, *Dr. Durkee* (No. 35). (v. s. in Herb. T. C. D.)

Tufts two inches long, hair-like, spreading. *Filaments* much branched, with an evident leading stem, and decompound, alternately divided branches ; the main stem and larger branches much more robust than the branches of second or third order, and remarkable for the shortness of their articulations, whose dissepiments are somewhat constricted. The angles are all acute, and the branches and ramuli consequently erect. The propagula are borne toward the base of the smaller branches, and several are generally found together on the same branch. *Colour* olive-green.

The ramification of this plant is most like that of *E. Littoralis*, but the fruit is nearer in form to that of *E. granulosus*. It seems a distinct species, so far as I can judge from the examination of a single specimen.

Plate XII. F. *Fig.* 1, Portion of a filament of Ectocarpus *Durkeei, magnified* ; *fig.* 2, minute portions with propagula ; *fig.* 3, a propagulum ; the latter figures *highly magnified.*

10. Ectocarpus *Mitchellæ ;* 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 half as long, propagula elliptic-oblong or linear, quite sessile and very obtuse, transversely striate, several together. (Tab. XII. G.)

Nantucket, Mass., *Miss A. Mitchell.* (v. s. in Herb. T. C. D.)

Tufts 2—3 inches long, loose, plumy, the ultimate divisions subcorymbose or fastigiate. *Filaments* very slender and much divided, the divisions alternate and patent. *Propagula* abundant on the lesser branches, several together in secund order near the base of the branch, at first ellipsoidal, then linear-oblong, then elongating and linear, always very obtuse and quite sessile, scarcely narrower at the base than above it, sometimes slightly obovoid. *Colour* a yellowish green. To the naked eye this pretty species looks like *E. siliculosus* or *E. viridis*, but the difference in fructification at once separates it from those species. It comes nearer in character to *E. Durkeei*, but is a much more delicate plant, with longer articulations, more patent branching and differently shaped fruit.

PLATE XII. G. *Fig.* 1, Portion of a filament of ECTOCARPUS *Mitchellæ*, *magnified* ; *fig.* 2, minute portion, with propagula ; *fig.* 3, a propagulum ; the latter figures *highly magnified.*

**** *Propagula unknown (probably of the same form as in last section.)*

11. ECTOCARPUS *Landsburgii*, Harv. ; filaments dark brown, tenacious, intricate, much branched ; branches irregularly forked, divaricated, zig-zag, bristling with numerous, short, spine-like, horizontal ramuli ; articulations short, the endochrome filling the cell, and recovering shape on being moistened, after having been dried. *Harv. Phyc. Brit. t.* 233. (TAB. XII. D.)

HAB. Dredged in deep water. Halifax bay, *W. H. H.* (v. v.)

Filaments 1—2 inches long, capillary, forming small, intricate tufts, tangled round the branches and roots of various Algæ, and on other submerged substances. *Branches* very widely spreading, often at right angles, variously curved, bent, and divided, almost every articulation emitting a minute spine-like, horizontally patent ramulus. *Colour* dark brown. *Substance* firm, and rather rigid. *Propagula* unknown.

PLATE XII. D. *Fig.* 1, Portion of a filament of *Ectocarpus Landsburgii*, *magnified ; fig.* 2, minute portion, *highly magnified.*

12. ECTOCARPUS *Hooperi* ; tufts rope-like ; filaments entangled, flexuous, sparingly and irregularly branched ; branches distant, elongate, subsimple, set at subdistant intervals, with short, horizontal, spine-like ramuli ; articulations of the branches twice or thrice as long as broad. (TAB. XII. E.)

In *Mr. Hooper's* Herbarium, without habitat (probably Greenport ?). (v. s.)

This forms dark brown, rope-like tufts, not unlike some states of *E. tomentosus*, but the filaments are much more robust than in that species. The numerous spine-like ramuli resemble those of *E. Landsburgii*, but are less abundant; and the articulations are much longer than those of that species. It appears to me to be sufficiently characterized, and I hope its discoverer may be able to ascertain the place where his specimen was obtained, and may find it again. At present I have seen but one specimen; Mr. Hooper informs me that he has no duplicate.

Plate XII. E., *Fig.* 1. Portion of a filament of *Ectocarpus Hooperi*, *magnified*; *fig.* 2, minute portion, *more highly magnified.*

13. Ectocarpus *Dietziæ;* tufts entangled, floccose; filaments robust, very flaccid, elongate, slightly and distantly branched, subdichotomous (?), flexuous, here and there emitting dichotomous branches; ramuli few, subulate; articulations of the branches once and half as long as broad.

Greenport, *Herb. J. Hooper.* (v. s.)

Forming a pale green, entangled, very flaccid tuft, 4—5 inches long, with the habit of *E. pusillus* or of *E. crinitus*. It seems different from any species of North America with which I am acquainted, but is not sufficiently defined by the above diagnosis. I have seen but one specimen, which adheres so closely to the paper, that it is difficult to remove fragments for examination, and I have found it impossible to display the portion examined, so as to enable me clearly to trace the order of branching. This imperfect examination, and the absence of fructification, compel me to place the species, at present, among the doubtful ones, but I trust more perfect specimens may eventually be obtained. Meantime, the specific name is bestowed in honour of Mrs. Dietz, of New York; a lady whose diligent researches in marine botany entitle her to this token of respect from fellow-labourers.

Acrogenous.	Growing from the top.
Approximal	(branches) Two branches lie together and partly unite, so as to appear like a compound branch.
Appressed	In branching, when the smaller branches lie close to the larger, standing very erect.
Asci.	membranous cases in which the spores of lichens and Fungi are contained.
Byssoid	Excedingly slender like cobwebs.
Calli	hard parts.
Carnose	Fleshy.
Cephalodium	A conceptacle of ~~an ovate~~ form, pierced by a terminal pore and containing a tuft of spores rising from the base of the cavity.
Cilia	applied to slender ramuli fringing the margin of larger branches.
Cirrhous	Resembling tendrils of a vine
Coccidium.	a hemispherical or spherical conceptacle without pore, containing a tuft of spores on a central placenta.
Conaplacle	a hollow case containing a tuft or cluster of spores
Confervoid.	a thread formed of a single row of cells or articulations.
Conocystae.	The fruit or Sporangium of Vaucheria, Codium &c.
Coriaceous,	having the substance of leather
Corneous	" of horn
Dichotomous	branched by repeated forkings each division continually dividing at its apex.
Dissepiment	the membrane or partition separating one cell from another.
Distichous	In two opposing ranks.
Endochrome	Colored contents of the cells.
Epiphytic	growing on an other vegitable but attached to the surface only
Erumpant.	(Tetraspores) prominent as if bursting through the Epiderm
Falcate	shaped like a sickle,

Fastigiate. Level-topped	when the branches are parallel and all point upwards like the lombardy poplar.
Favella.	A form of the Conceptacle in which there is no proper conceptacle, but the spores are collected in spherical masses and either attached to the wall of the frond or imbedded in its substance. The Favella is a metamorphosis of a secondary branch; when immersed in the frond it is called a Favellidium
Fibro-cellular	when the cells are form elongated and strung together in threads or filaments.
Foliferous	bearing leaves
Fusiform	Spindle shaped. thick in the middle &
Gonidia	Reproductive cells, or germs formed in the substance of the plant and afterwards becoming free and seperated from the parent.
Hyaline	Transparent & colorless.
Involucre Involucrate	Ramuli surrounding a conceptacle forming a more or less perfect whorl around it.
Laciniæ	a narrow lobe or segment
Laminia	Surface of a frond
Lichenoid	Irregularly lobed and decumbent like one of the leafy lichens.
Moniliform	Like a string of beads.
Nematheciun	a wart like protuberance compound of vertical filaments closely packed together.
Papillated	Covered with little nipple or wart-like prominences called papillae.
Paraenemata	Filaments which accompany spores in the fructification of many algae.
Parasporules	distinct paraenemata or abortive spores.
Pelagia	~~Floating~~ Widely dispersed.
Penninerved	(Frond) Veined like the plumes of a feather.
Periphery.	outer stratum of cells in a cylindrical frond
Peripheric	belonging to the periphery
Perispore	Case or skin which surrounds the spore.
Phyllodium	a flattened leaflike portion of the frond.
Plumula	pinnated branchlet
Proliferous	when a new leaf or frond cut springs out of another.
Propagulum	a reproductive portion of a frond, not a regular spore.
Pulvinate	Cushion shaped.
Quadriferous	spreading on all sides of the stem
Reticulate	like a net work
Secund Secuniform	arranged along one side only.
	shaped like a knotte.

Sorus	a cluster of spores.
Sporaceous	Convertable into spores.
Sporidium	a reproductive spore like body but not a true spore.
Sporophyllade	Small leafy leaves containing tetraspores.
Stichidia	pod like receptacle containing tetraspores.
Stupose	covered with woolly hairs
Subulate	awl shaped.
Sessile	sound,
Tetraspore	a spore divided at maturity into four parts.
Trichotomous.	dividing continually in threes
Tuberc[illegible]le	see Coccidium
Urceolate	Egg shaped with a narrow protruding mouth,
Virgate	long and straight like a wand.
Zoospores	Spores which have a proper locomotive power

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[The systematic names in capitals are those which are adopted. The names in italic indicate synonyms, whilst the vulgar names are in roman. The asterisks refer to the page of description.]

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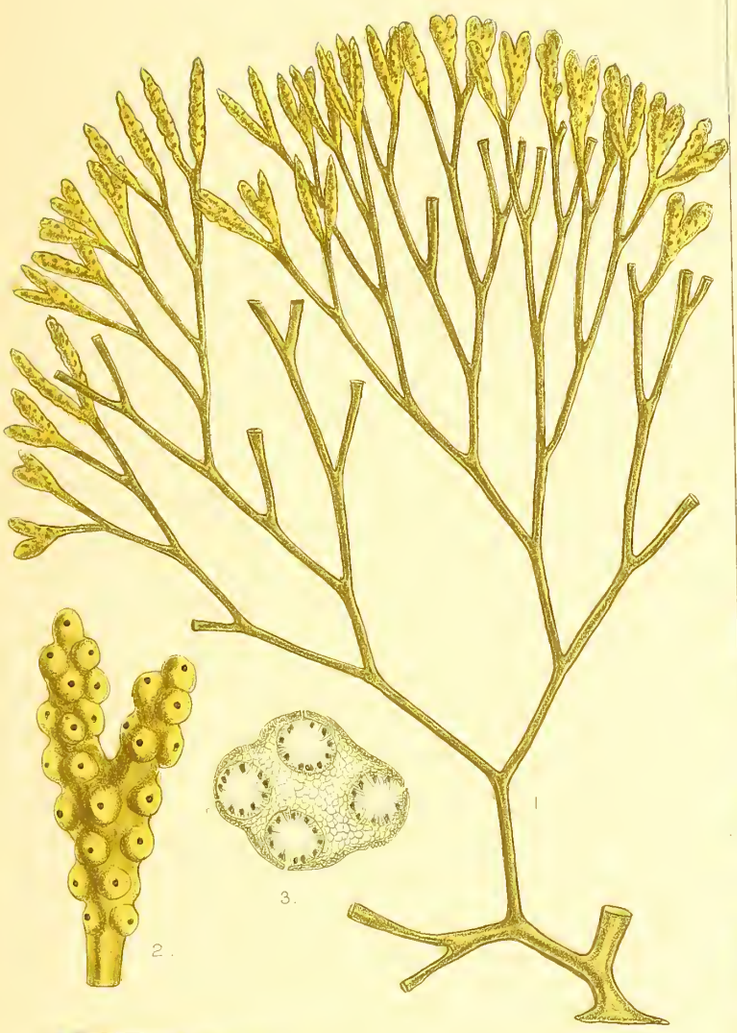

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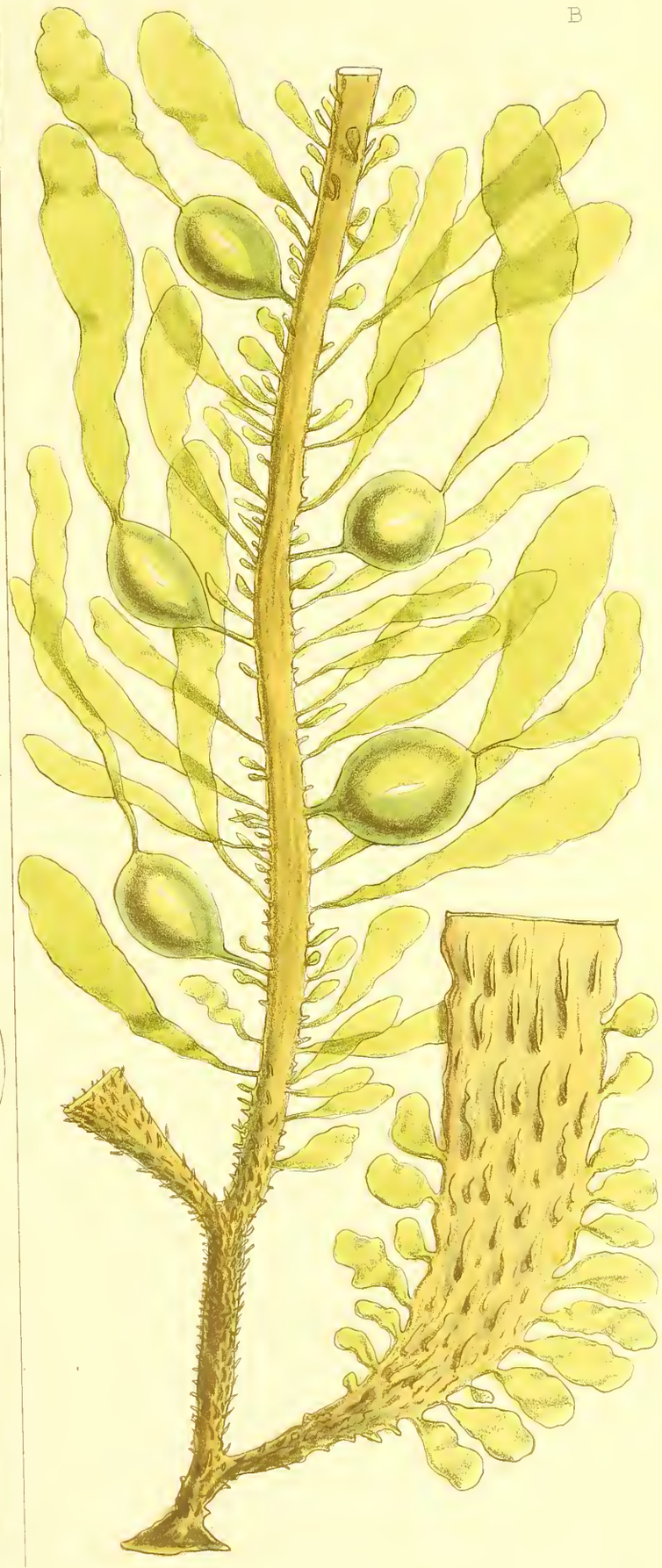

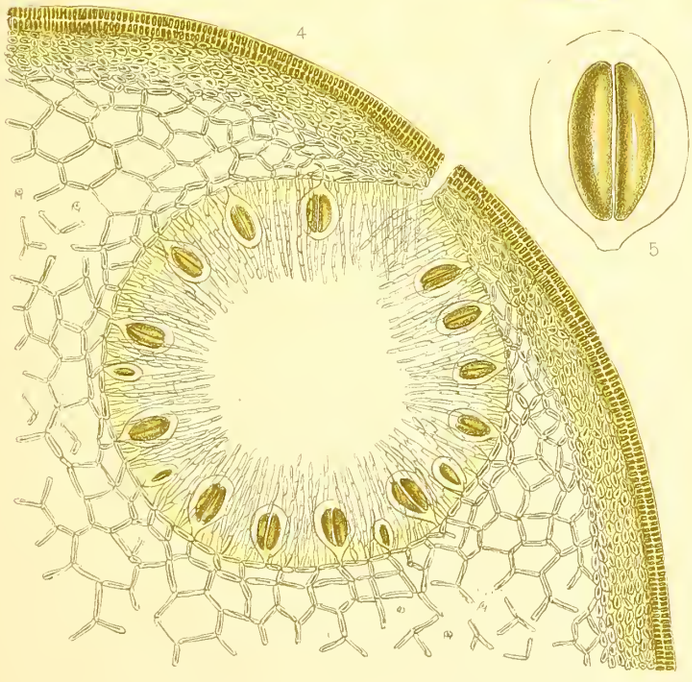

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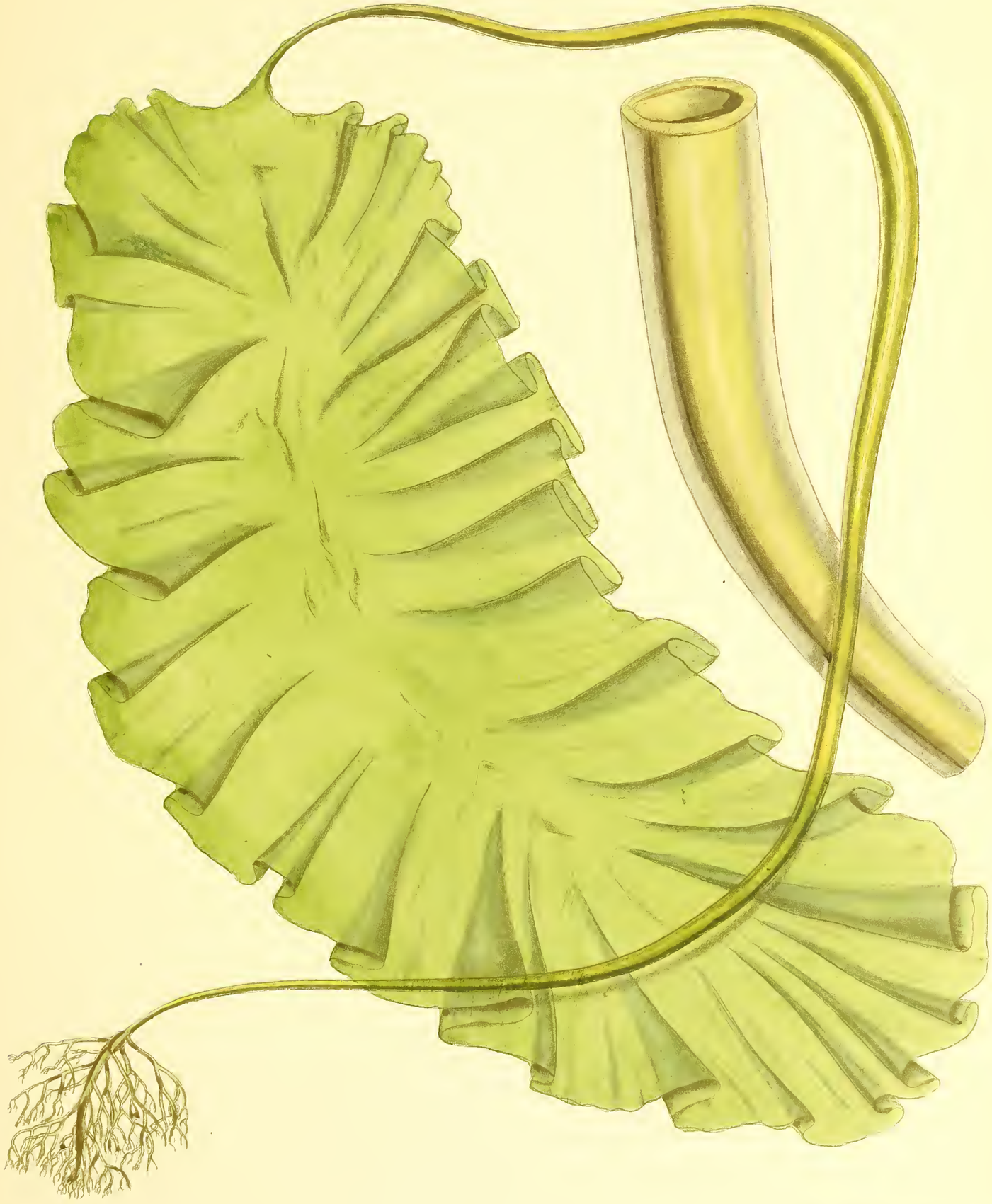

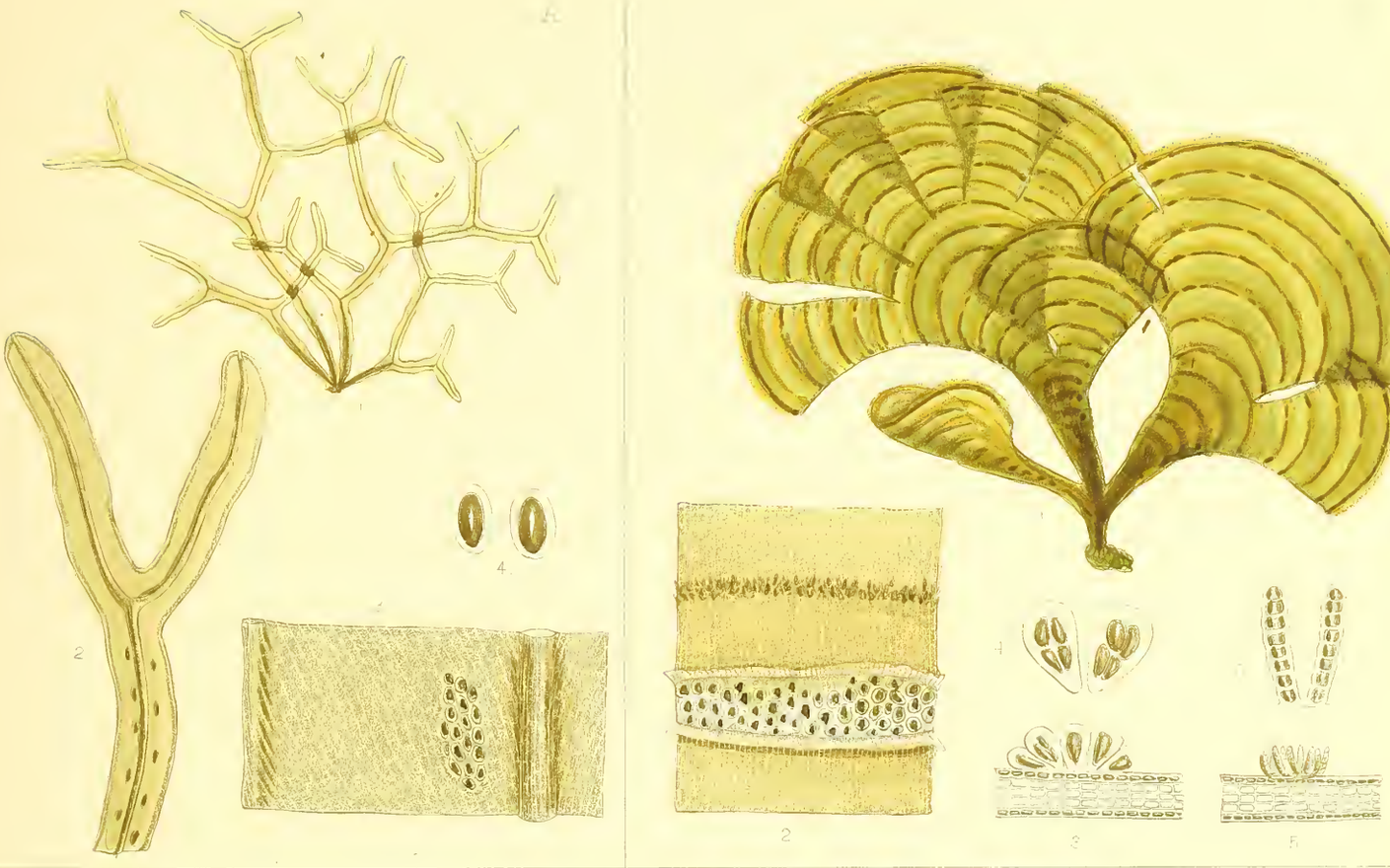

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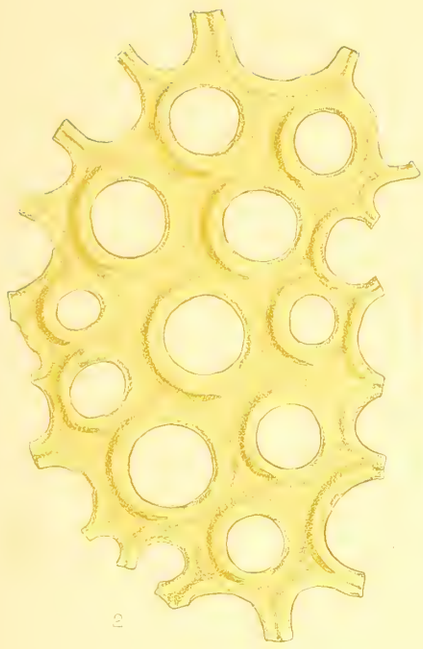

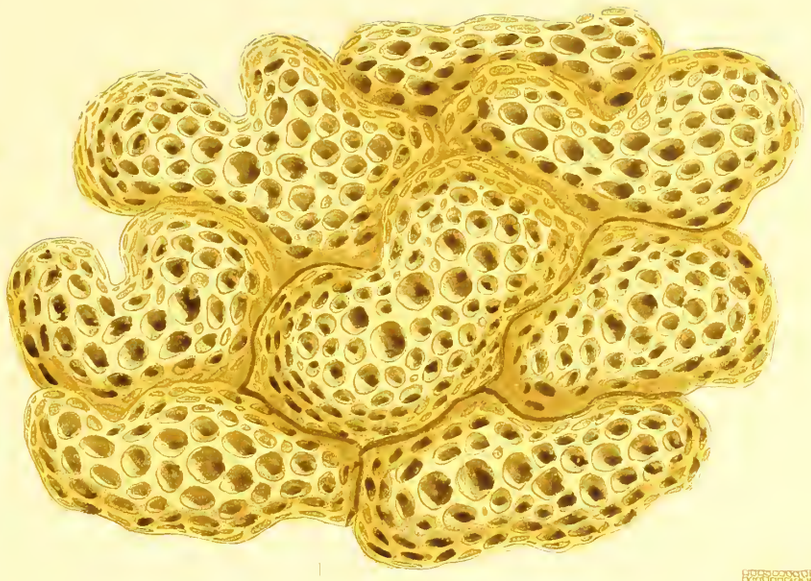

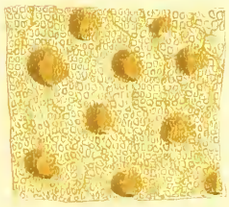

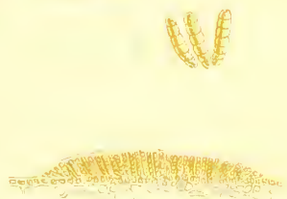

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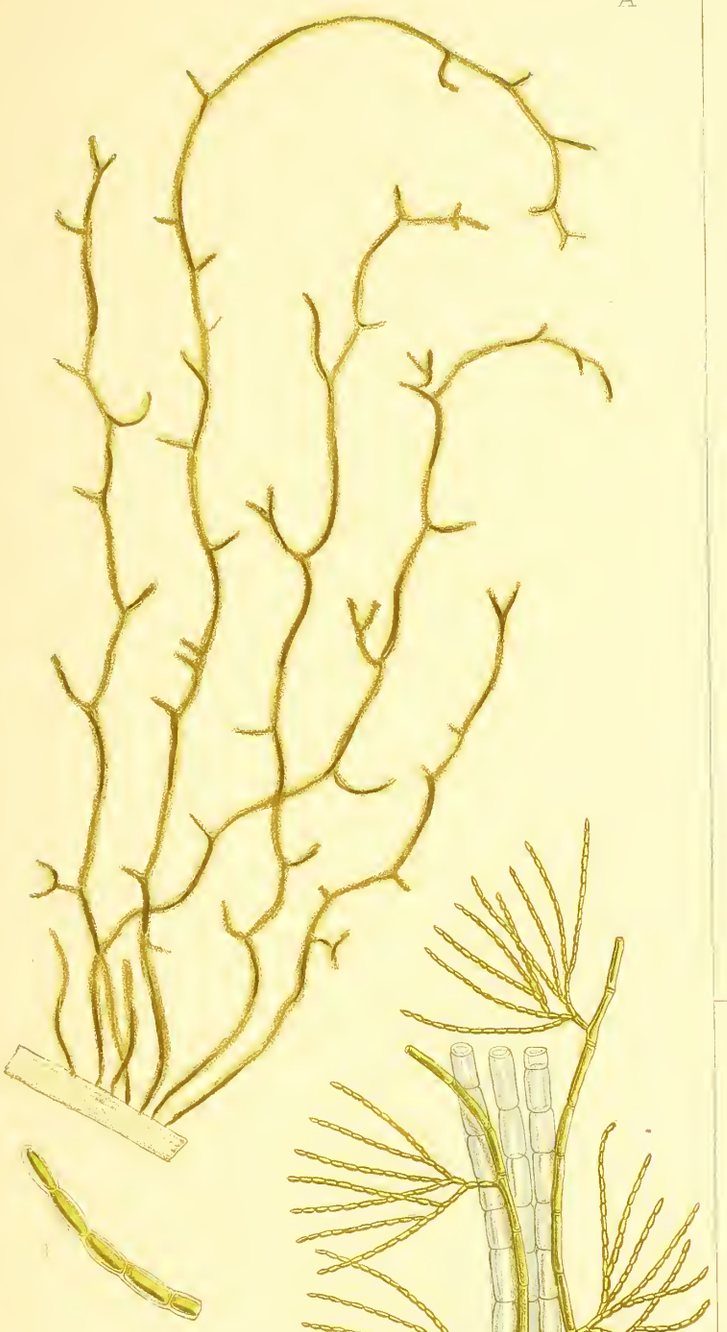

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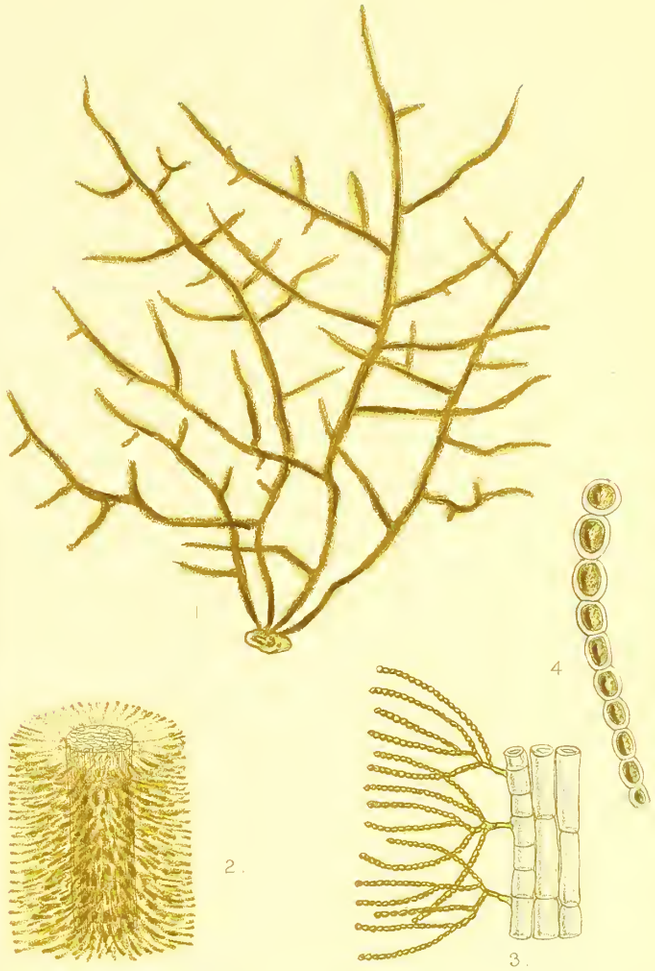

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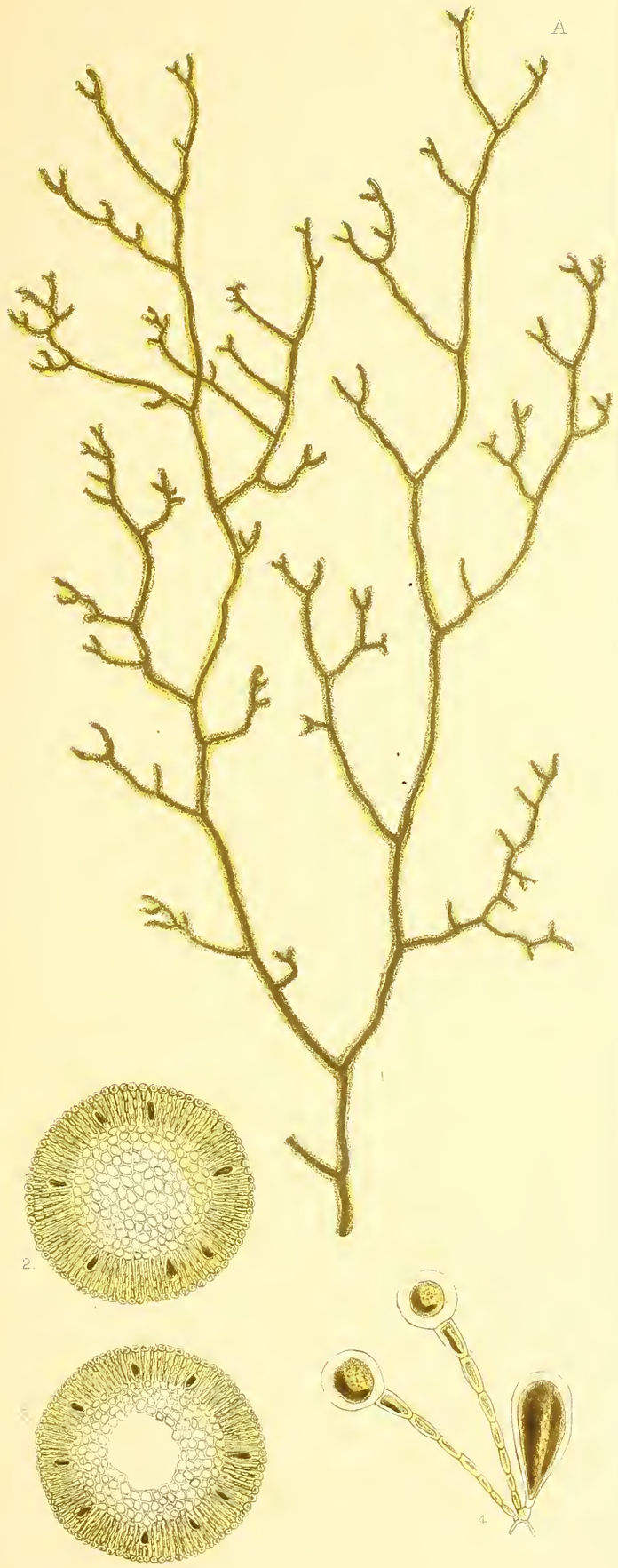

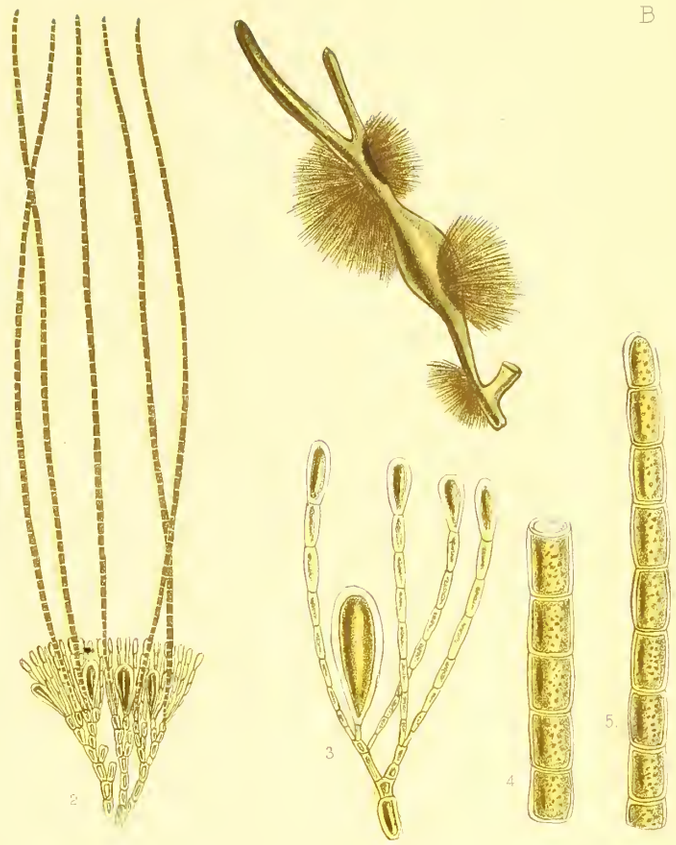

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