ANNOTATIONS of the seaweed geographical distribution in the Atlantic Ocean North of Equator, in the Mediterranean and in the Baltic

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[PROLOGUE

Aulin defended his thesis at the age of 31, only a week before the 5 years younger Kjellman did. Although Kjellman's thesis, on the brown algal family Ectocarpaceae, was rather narrow-minded, it gained better support as it can be concluded by Kjellman's subsequent promotion as professor in Botany. We do not know what the situation would have been if Aulin was also granted a place, but he was ostracized and never made another contribution on algae. On the other hand, Kjellman's advancement led to his significant studies of the arctic algae, and a strong taxonomic school from where phycologists such as Kylin, Skottsberg and Svedelius graduated.

As sources to his thesis, Aulin cites mainly Harvey, Agardh and Areschoug, and indeed the largest part of the work is a compilation of the most recent floristic observations made by the above and other authorities. The major thrust of Aulin's thesis lies, however, in the 2nd part where he presents geographical data for distinct taxa (as briefly done by Lamouroux too). Orders, families, genera, and sometimes even species appear systematically (after Areschoug's latest unpublished classification) and information is given with regard to commonness, habitat, diversity and distribution. In this way, the various algae are separately examined within 'monophyletic' groups and the 'biogeography' of each group, is assessed in a way that is unique for that time. This analysis remains, however, sterile. No hypotheses are discussed as to possible centers of origin, dispersal routes, or closely related taxa, although some of these concepts are touched in the 1st part of the thesis. Aulin's account could be greatly improved if he had considered Darwin's recent theories, but this never happened.

Göteborg, 4th December 2000

Algologia]

[Introduction]

It was reserved to the scientists of the past century, to start the significant and large task of classifying the numerous living things of the botanical kingdom. They gave all their love to the study of higher plants, whose flowers could be distinguished by the naked eye; to the plant's structure, different tissues, and other peculiarities of the plant kingdom paid less attention. Obvious was that under such circumstances the lower plants would not be studied with care. The botanists were busy with describing and classifying the higher plants. The undeveloped optical instrument was a good reason for the botanists of that time to avoid the study of the lower plants. Because it is rather certain that not a Linné, in case he had access to the microscope of today, and his scientific time was enough for numerous investigations, would have placed the lichens within a few or the algae within 3-4 genera. The incomplete study of the reproductive structures, their function and purposes made also the reasons of separating the plants in two groups: phanerogams and cryptogams; hopefully the terms seed plants and spore plants should be instead used today.

It is true that the compound microscope had long ago been invented, but it was imperfect; in our century they have become much improved, and thereby the possibility to investigate many things in nature, that are obscure to the naked eye, has increased. Without these closer observations on the development and reproduction of the spore plants, no real knowledge of them could have been achieved. Now, the obstacle [PAGE 2] to gain this knowledge for the lower plants was removed. One could say that the footsteps of botanists went parallel to the improvement of the microscope, and soon the great discoveries on the reproduction and internal structure of the seed and spore plants were made. The study of ferns, most of the mosses and some other families of spore plants necessitate no high resolution; the plants in these families allow to be readily classified. But this is not the case with the three large groups Lichens, Algae, and Fungi, although the first named were relatively well-known prior to the advent of the microscope. Yet, only after its usage we have been able to name different species in a natural way within these groups.

As it is known, the algae exhibit forms that apart from reproduction are also highly different from each other. With regard to, e.g. *Wormskioldia [Delesseria]* and the species of the large genus Sargassum, which both have a kind of blade and a midrib, or the small unicellular algae that like *Caulerpa* are composed of a single cell, but only the latter become large and highly branched (and are undoubtly the most interesting ones). We also mark the Laminarians's and the Fucaceans's olive, green or brown coloured species, that have very solid structure and some of which can reach considerable length, Florideans's variations of red, purpure, violet and even green colour, the green algae, the incrusting corallines, those in the Mediterranean and in the West Indies occurring Siphonaceae, and the microscopic, motile, silicon-armed Diatomaceae. With regard to reproduction, they show no less variation; Florideans's reproduction, as far as we know, is highly strange and complicated, while in the Zoosporeae, Conjugatae, and in the lowest developed algae we deal we simple cell divisions. Of what [PAGE 3] has been indicated so far, and much more that could be added, it becomes clear that algae should have been studied carefully, and this has now been achieved. Many highly educated botanists have thoroughly studied these plants, and consequently the algae are now relatively well-known. To this event it has contributed to great extent the continuous expeditions to all oceans of the world. By this way, enormous amounts of seaweeds have been taken home. The algae, which almost entirely live in the water from where they take up the necessary nutrients that support their development and distribution, in such a different manner than earth plants which take up nutrients from a matrix. Since the rhizoids by which algae are attached do not play a role in the supply of nutrients, that are directly taken up from the surrounding medium that varies so greatly - different nutrients exist in fresh-, marine-, running-, or stagnant water- the algal vegetation must show differences in all these kinds of water. The present author has considered that it would not be without interest to attempt showing in some way, which differences exist in the algal vegetation within different parts of the Atlantic Ocean North of Equator, in the Mediterranean and in the Baltic, and even to tray clarify what the reasons for these differences could be. In the preparation of this paper, I have taken into consideration the works of [J.] Agardh and Harvey, as well as Prof. Areschoug's lectures during the semesters of Spring 1865 and 1866. In addition, several minor communications and papers from natural history journals have been used.

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[Chapter 1]

One is justified in saying that the geographical distribution of algae is mainly dependent on laws that correspond to those applying to other plants, although considering the freshwater algae our imperfect [PAGE 4] knowledge about their distribution within different regions and the diffuse limitation of the species makes harder the fixation of such laws. Of course, one should take into account the great variety of conditions that causes differences in algal distribution against those causing differences in the distribution of other plants. As regards the seaweeds, the phytogeographic laws appear rather clearly, although the large number of species and the many different parameters that contribute, makes it more difficult to separate the borders between the vegetation regions than it is for terrestrial plants. One should also remember that the more primitively a plant is organized all the better it

can overcome a greater variety of climatic variations under otherwise favorable conditions.- It has been observed that some algae in different waters of the same latitude show a very different distribution.
Because, so far the sea temperature exercises a decisive influence, the seaweed floras in similar climatic conditions are characterized by similar or analogous forms, in case other parameters permit that. Sea currents cause not insignificant changes in this respect, thereby bringing several southern species higher up to the nordic countries; thus the Gulf Stream brings the tropical Sargassum up to the 44 north latitude; and similarly because of that current bend the isotherms considerably and the arctic algae reach more southerly on the North American coast than in Europe, which NW coast receives a much milder climate than otherwise would have had. As it was said, many other parameters exist, apart from the temperature, that control the distribution of seaweeds, for example the salinity of the water, the depth, ebb and flow, the character of the bottom, etc. Otherwise, since the temperature of the water does not vary in the same grade as in the air, one could suppose that the seaweed flora should be homogenous; yet, seas with rather similar temperatures display usually different and widely related species, particularly if they occur in a far remote [PAGE 5] distance from each other. Thus, although the Atlantic seaweed flora on the American coast is similar to that of the [Atlantic] Europe, it is certainly composed of a great part of different species; the seaweed flora of Florida reminds us by its general physiognomy, and none the less by some identical species, of the Mediterranean flora. Certain groups of algae exist entirely or with few exceptions in the warmer seas, for example Sargasseae, Corallineae, Cystoseireae, other are found in the colder ones for example, Fuceae, Laminarieae etc.

Within the different regions of the world, we have for terrestrial plants considered certain places from where the plants gradually dispersed to adjoining territories and thereby formed certain phytogeographical provinces, characterized by a uniform vegetation; in the same way we have observed in the sea several different floristic regions, within each the same kind of alga dominates. The seaweed flora of the Baltic appears to have been formed by this way, viz. that a part of the North Sea algae penetrated in and then dispersed to the various parts of the Baltic. The invaded flora by this way has changed much; species have become dwarf-sized and modified in other ways as the salinity decreases. In similar way, become the brackish water forms gradually dominant as regards species diversity and quantity of individuals, until they are also replaced by fresh-water forms in the innermost parts of the Finish Bay and the Bothnia Gulf. In the Baltic diminish the Florideae, etc, which require for their growth partly higher salinity than that in the Baltic and partly other conditions not found there; therefore they become often sterile, dwarf-sized, and in many ways changed; Confervaceae [Cladophoraceae], Ulvaceae, etc., that thrive in lower salinity become instead the dominant species. Even in the North Sea, one can observe something similar; some algae become larger and more luxurious towards the north, other develop better in more southern sites, other still when the approach the open sea, thereby it appears that from their original centre have wander to foreign regions; also the North Sea display an analogous mixture of algae from different places. [PAGE 6] The Mediterranean represents another highly remarkable region; already by the large number of genera and species we can observe a significant difference from the Atlantic vegetation in general; observing closer the Mediterranean's many peculiar forms and the dominating families, one can confirm this truth still more. The coasts of SW Europe and NW Africa, and the islands between have an algal vegetation that forms a transition between that of the Atlantic and the Mediterranean in general. As it is known, the Mediterranean terrestrial coast has a rather peculiar plant vegetation, well distinct from those occurring in other coasts; and similarly its seaweed flora shows a different character than in other seas, such as the Atlantic in general or the North Sea. The algae growing at the surface of the water [splash zone], those forming the upper layer to say, belong more or less to the same genus and species and show no obvious differences in both seas; the algae growing around the upper tide level in general look like each other in different seas, in a similar way as it is the case with certain terrestrial plants, in the maritime zone or nitrogen-requiring plants, that apparently lack specific variation in different places. Those occupying the zone below exhibit however not minor differences: in the North Sea and the Atlantic this is demonstrated by the various brown algal species, such as *Fucus, Fucodium [Ascophyllum], Halidrys, etc.* which almost entirely are absent in the Mediterranean, where they are replaced by some Sporochnaceae, some species of *Sargassum* as well *Cystoseira,* that in the North Sea have only one corresponding form *Halidrys siliquosa* (L.). Similarly, in the Mediterranean occur only sporadic plants of some species of the characteristic Laminarieae that occupy the zone just below low tide; these are replaced by Dictyotaceae and several green algae such as *Bryopsis, Valonia, etc.* Certain North Sea forms are represented in the Mediterranean by similar but nevertheless really different species. Numerous of the beautiful Florideans of the North Sea, [PAGE 7] that grow in the Laminarian zone and also below are lacking entirely or occur rarely in the Mediterranean, such as *Delesseria, Plocamium, Ptilota, etc.* In their place one finds other superficially less distinctive forms such as *Aglaophyllum [Nitophyllum], Rytiphlaea, etc.* Of *Callithamnion, Ceramium* and *Polysiphonia* we find many species, some of which are more luxurious that those in the North Sea; some species are the same in both seas, but not seldom these forms are dwarf-sized or changed in one of the places. Another region, whose algal vegetation also deserves attention is the Atlantic coast of North America; nevertheless, this floristic region does not have so many peculiar or different elements like the previous one; it has some similarity deals with the North

Sea and Atlantic Europe, as also with the Mediterranean vegetation; on the coasts of Mexico, the West Indien Islands and Florida becomes easier to recognize the similarity with the Mediterranean vegetation. If we compare the algal vegetation on the Atlantic east coast with the west coast, we can observe numerous differences but also a significant similarity in many cases; a striking difference is that the same species on the american coast do not extent so far in the north as they do on the European coast.
The reason for that is easy to find. Looking on a physical map, where the isotherms are marked, we observe that these bend to the benefit of Europe, in particular for Europe's NW part, so that for example the same line that touches New York on the 41 latitude meats Europe in Ireland on the 54 latitude; thereby a temperature difference between the countries lying on the same latitude on the west and east side of the Atlantic must exist, large enough to result in the above mentioned difference of algal vegetation.
Among the peculiarities of the vegetation in this region that is formed by the American and European Atlantic coasts, it can be postulated that the algal vegetation is much more lively on the European coast than on North Americas corresponding parts, i.e. north of Florida; because south of this cape is [PAGE 8] the vegetation extraordinarily rich and varying. On the European north and northwestern coasts occur, apart from several rare, 6 common Fucaceae, of which at least 4 is easy to find on every coast; on the American coast only *Fucus vesiculosus* L. and *Halicoccus [Ascophyllum] nodosus* (L.) are widely occurring; *Fucus serratus* L. and *Fucodium [Pelvetia] canaliculatum* (L.) have not been recorded so far; whether *Halidrys* and *Himanthalia* exist is uncertain. This apparent lack of Fucaceae is more obvious on the NE coast and is partly replaced by numerous Laminarians; a few amongst them that are specific for this coast deserve a closer examination, in particular the highly characteristic genus *Agarum.* Florideans occur in large amount on the coast of both continents; amongst them the blade-like species seem to be more common on the American than on the European coast. it is certainly, as we will see in the following, that different families are differently represented on both coasts of the Atlantic, but on both coasts the red algae are generally the same. Along the northernmost parts of both continents occur about the same kinds of green algae; nevertheless, a few for the different localities characteristic forms are found; on the other hand, in Central America occur the green algae with numerous genera and species, of which nothing is found along the European Atlantic coast; in the Mediterranean is however encountered, as mentioned before, analogous species. The European coast between the Channel and Gibraltar is not different in its algal vegetation from the other [nearby] regions; numerous of those algae that have penetrated in the North Sea and where are usually met with as undeveloped, obtain here their natural forms as they grow on more open coasts and warmer waters; other disappear leaving space for northernmore and southernmore forms; a few Mediterranean algae are

scattered here and by this way the vegetation appears mixed. We thought we ought to point out these differences as regards [PAGE 9] the algal vegetation in general within these regions, that we particularly have to pay attention to.

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[Chapter 2]

Regarding the distribution of higher plants, as it is known, several different reasons exist that control more or less the species distributions; among other things, the nature of the ground and the related factors are of high significance, since these plants take up the nutrients through their roots from the matrix, which is not the case with the algae where the nutritive media that are dissolved in the water that surrounds the algae, are absorbed through the surface of the cell and by this way are acquired by the cell parts that deal with development and growth. The chemical compounds that are in the water are decomposed by the algae which take up what they need och separate the material that is useless; as an example that was demonstrated: a Confervaceous [Cladophora] was submerged in a solution of sulfur acid with copper oxid; the sulfur acid was then taken up by the alga while the copper was separated being useless. The algae lack such roots, that being penetrated into a surrounding substrate can take up nutrients for the plant; instead they have bulb-like, disc-like or filamentous so called rhizoids, by which they adhere, often very strongly to the substrate. They grow on rocks and stones of different types, on other algae, on wood, on shells of mussels, etc, in brief on every substrate, that being submerged in the water offers them appropriate attachment. The so called rhizoid of algae has not in any way the same function as in seed plants or in the higher spore plants; the algal rhizoid is exclusively a structure for attachment. In one or another [alga], it reaches a significant size, namely in some tropical species, that grow on loose bottom, on sand and among pieces of coral [rhodoliths ?]; under such conditions it develops towards each direction rhizoid filaments that go rather deep; by this way, these rhizoids bind together the loose parts, amongst which they grow, to a concrete lump [PAGE 10], and thereby they can remain attached despite a strong surge. When the algae grow on solid substrates, the rhizoids become of small size. Since the rhizoids of algae do not at all have with the nutrient uptake to do, one could think that the character of the bottom and the growth place have little or no influence on their distribution [of algae]. However, this is not the case; the character of the bottom along with many of the other conditions occurring at the growth place have a strong influence on the distribution of algae. Solid rocks are more advantageous for the algae than loose pebbles, since the latter are easily removed by the waves and thereby the algae are get loose; but if the surface of the rock is smooth, without any depressions, the strong waves can get loose the algae from their growing places and thereby prevent the development of a rich vegetation. At very sheltered shores and in the innermost part of bays, a rich vegetation is formed, but this is homogenous with a large number of individuals of few species, most often Fucaceans and the associated algae, which outcompete numerous younger species. In the same way as the large sand banks on earth are sterile and lack vegetation, the same applies to the sand bottoms below the sea surface and the long coast lines that have clay; we can say that bottoms of the this kind represent the sea deserts. When now off a coast similar substrates occur, of the one or the other kind, it is natural that this would make a large barrier for the dispersal of different species from the one place to the other; obvious is however, that on earth this is a more efficient barrier for the dispersal of terrestrial plants, because algal spores can benefit from the waves and with greater easiness reach more remote areas, than what seeds of terrestrial plants can achieve by the help of winds. The most suitable algal substrates are therefore rocks, not very exposed or very sheltered, provided with deeper depressions, where the algae can find the shelter they need. [PAGE 11] During ebb remain the depressions [rock pools] full of water and thereby a large number of younger and delicate species, that could not stand the effect of direct sunlight, are protected; in this way, however, the temperature rise in such rock-pools benefits the beginning and development of a lively algal vegetation. North America's east coast, north of Florida, is rather poor in algae; this is rather certain because similar localities are here rare; the few in number Fucaceans is apparently an event directly related to the above named conditions. Since it is known that certain algae thrive to be exposed sometimes to the air and sometimes protected by the water, it is natural that the regular low-leveling and high-leveling of the sea, that we name flood and ebb, must have a strong influence on the algal vegetation in the coasts where the phenomenon exists; this is confirmed by the rich and diversified vegetation that occurs between high and low water level. - Wherever water is missing for a time and becomes exposed to air, there develops shortly algae of one or another group. They occur in warm and cold climates, in fresh and marine waters, on moist earth and so far I know, yes, even in snow, and thereby show an extreme tolerance that surpasses that of any other plant. A striking difference between the marine algal vegetation and the fresh water algal vegetation in general is that the algae in lakes are and other fresh water systems are usually smaller in size and quantity in comparison to the higher plants that exist in the same waters and are both more numerous and larger; in the sea the situation is totally different; there, the algae take the first place as regards the amount of individuals and their size, and at times there are no seed plants at all in the sea; when they are found, are always of lower significance; they prefer the brackish and fresh waters than the salty sea water. Along the sea shores everywhere exists an algal vegetation, that usually is not vertically distributed to a great depth.

From the Polar seas, as far as the shores are free from ice, to the Equator, the shores are [PAGE 12] covered with algae, which of course differ a lot after temperature and other conditions [parameters] like growth place, water salinity, etc.

A parameter that has a great influence on the lower, no much less than the higher, plants's geographical distribution and perhaps to a greater degree than growth place is the water temperature. With regard of the wide temperature variations in the air, and the small changes in the water, particularly of the oceans, one could conclude that by no means the influence of temperature can have the same large impact on the water vegetation, and particularly on the marine one, as it does on the terrestrial plants. The influence of temperature is however easily observed. Comparing the algal vegetation at different latitudes, one founds that it changes in a similar way as the water temperature, approaching or moving away from the Equator, increases or decreases; this difference depending on temperature change is shown thereby in the presence of certain genera and groups exclusively in warm waters, and others exclusively in cold ones. Sea shores laying on the same latitude can, however, have a quite different algal vegetation, when because of one or another reason the temperature at one or the other place is higher or lower, as for example is the case between the [North] European and [North] American coasts. This difference of temperature and the corresponding difference in algal vegetation depend significantly on the currents, that passing through the seas bring warm water to colder or cold water to warmer zones; thus, the above mentioned differences between Europe's and North America's algal vegetations are caused; and therefore southern forms on the European coast reach much higher in the north than on the North American coast, and northern forms reach much lower in the south on the North American coast than on the European one; this Gulf Stream influence on the climate of various European coasts is marked when numerous algae that have been recorded in large amounts and well-developed sizes on the Irish coast, [PAGE 13] are absent on the English coast except in the southernmost bays and then [are found again] on the south coast of the European continent. In the North Atlantic, the Gulf Stream brings *Sargassum bacciferum* (Turn.) far up on the 44 latitude, although this alga belongs to the tropics[1]. Of similar examples, it is easily understood, what great influence the temperature exercises on the geographical distribution of the marine algal vegetation. Even the seasonal

[1] On the South American west coast, in Peru and Chile between the 10 and 20 southern latitude, we encounter numerous algae, e.g. *Lessonia, Macrocystis, etc.* that otherwise are characteristic of the Antarctic Ocean; the reason that they reach higher up towards the Equator, than in any other place, is that the cold Polar Stream cools down much of the otherwise warm water of S. America.

temperature variations have an effect on the fertility of algae and in their rich or limited occurrence. This is particularly obvious for those species occurring between ebb and flood; they develop richer fructification and form well-developed structures during the warmer than the colder seasons, which is easiest observed for species that have exceeded their natural vegetation limit. Harvey takes as an example Padina pavoni[c]a (L.) that during summer on the English coast reaches a size slightly smaller than that, which the plant obtain in the subtropical seas; during the cold seasons it becomes again dwarfish and stunted. The marine vegetation, like the terrestrial one, is considerably richer after a favorable winter and spring, than when these seasons of the year have been disadvantageous. To judge from the information that the present author had available, it appears that the algae in the Northern Hemisphere's warmer seas are more numerous that in the hot waters; towards both Poles diminish their number gradually. A striking difference between the algal vegetation between the Northern and Southern Hemispheres is that within the former the species are usually smaller than in the latter, that is characterized by the [larger] size of algae, while the Northern Hemisphere again has again a greater variety of forms.

Another noteworthy reason of the differences of algal geographical distribution can man search in the difference of depth, [PAGE 14] where they grow in seas, in the water's different pressure and in the light's stronger or lower intensity, conditions that are closely related to each other. Known is, what strong influence the light has on the higher plants; although submerged in the water are the algae sensitive to it in high degree. It is strange to see, what significant differences exists between the same kind of algae, because they grew in deeper or shallow waters, on places exposed or not to the light; exceeding their natural territory, they become often dwarfish or distorted. A similar ability of change is observed, not only for the individual, but also for the terrestrial vegetation in general after the different height of the growing places over the sea; in the terrestrial plants should this ability of change be mainly controlled by temperature conditions; for the algae, this cannot be the only case, but several other reasons must exist; and some other [factors] than changes in light intensity and pressure being mutually connected, should be difficult to find. Sometimes the algae are getting loose from deeper places and drift to the surface, or the opposite; but they do not thrive and develop abnormally, on the same way as terrestrial plants, that having passed their niche (moving upper or lower) change in one way or the other. Harvey tells us that in many such algae, which usually occur in shallow waters, a large number of branches and branchlets is present when specimens drift to deeper water; they show a clear tendency to develop a kind of rhizoids from various parts of the frond and the branches. In some cases, the habit changes considerably by the development of these outgrowths that it is difficult to identify such forms with the typical ones. The algae on the sea shores are usually restricted to a

narrow zone, outside of which they do not thrive particularly well. Most algae grow in relatively shallow water; an exception appears to be the Diatomaceae, which occur everywhere between the splash zone and so deep in the sea as human [PAGE 15] research has gone; the lowest algae reach thereby to the greatest depths, in the same way as the lower [terrestrial] plants on earth reach the highest tops of mountains. Apart from diatoms, it appears that the deep sea lacks vegetation; however, the diatoms exist there in large number. As an example of in what amount they occur, it can be enough to cite that d'Orbigny counted no less than 3.849.000 such small plants in a pound sand from the Antilles. When one follows the bottom in a sea shore, he observes easily, as said, that the main vegetation soon diminishes and disappears long
before the limit of the animal life is reached. To tell more exactly, where the algal vegetation ceases, is not so easy to say, particularly with the limited material of that type that we can refer to. Lamouroux maintains, according to Harvey, that algae exist down to a depth of 100 to 200 fathoms [180-360 m], which Harvey finds as being of a great difference; he names of course that *Macrocystis,* that as far as we know is the longer alga, was once found by Hooker at about 40 fathoms depth (the length of the plant was of course greater); however, he considers this as an exception and cites 8 to 10 fathoms as the usual limit of the algal vegetation in southern temperate and Antarctic regions; this limit is probably deeper in the tropics and in the Northern Hemisphere after the observations we have on hand; and so has Humboldt collected an alga from a depth over 30 fathoms, and he marks that despite the low light and great pressure it was very alike as if it grew at a usual depth. In the Aegean Sea, Forbes collected an alga[2] from a depth of 50 fathoms [c. 90 m] - the greatest depth from where an alga other than Diatomaceae has been demonstrably collected. The green, olive-coloured [brown] and red algae usually occur at different depths in the sea; the green generally thrive best in the splash zone or in shallow waters, sometimes floating on the water surface; they love sun light and exist most in such places, where they are not totally [PAGE 16] exposed to the sun; certain genera however, such as *Anadyomene, Caulerpa, Bryopsis* are exceptions to that; they are by no means less green that the other, even if they occur on such depths where light is partly reduced. Within the zone that lies between ebb and flood or just below water level, we encounter the brown algae. The prefer sites where the water surf reaches them, and also localities where they can be exposed to the air during ebb and washed by the water during flood; they form a relatively broad zone along the shores just below water level; these are the condition in the Northern Hemisphere; in the Southern

[2] Apparently, this is the alga from Paros that Harvey described as *Cryptonemia forbesii.* The species was later considered to be a synonym of *Neurocaulon foliosum* (Meneghini) Kuetzing.

Hemisphere, those belonging to this group are gigantic species of the genera *Macrocystis, Nereocystis, Lessonia,* and by them many brown algae are deep water plants. The following extensive zone is occupied by the red algae that occur in the relatively deeper and darker parts of the oceans[3]; they are rarely found in tide pools, when they are not protected from the direct sun light. Their red colour is most clear and intensive, when the plants come from deeper water, which can be easily observed if they are collected from both the shallowest and deepest places they are found. The strange encrusting or erect Corallineae are amongst the red algae, which one could not count with; while other algae decrease in number, increasing depth, these grow until they are the dominating in places where they soon become the only vegetation. As to the question of place, between the surface and the bottom, that the differently coloured algae intake, the ability of the sea water to absorb the different colors of the white light that it can break up to must be remembered, since this appears to play a significant role, and apparently because of this capacity of the sea water the different shades of colour are dependent on. [PAGE 17]

The distribution of higher plants is to a great extent controlled by the type of substrate in which they grow, especially its composition and whose nutrients the plants take up. Since the algae, as said above, do not take up any part of their nutrition from the sea bottom, but exclusively are depending on the nutrients existing in the surrounding sea water, one could conclude that the sea water is for the algae what for the higher plants represents the type of susbstrate itself. Obviously, the components that are essential for the growth of algae must exist in the water; analyses of the sea water indicate that the same substances occur as those found in seaweeds, although one and another element is rare in the seawater in contrast to what is found in algae; analyses of ashes of burned algae present just the most particular salts existing in the sea water. With knowledge of that, without difficulty, we can realize that the geographical distribution of seaweeds to a significant part, perhaps more than any other, is depending on the sea water different salt content. Iodine and bromine is obtained, as known, through the burning of Fucaceans, and after further processing of the ashes; when we now realize how small- just 0.000001%- the iodine percentage is in the sea water, and thereby consider, how much iodine is produced from the Fucacean ash, we can only wonder over the large amount that the Fucaceans yearly take up from the sea water. Since all the iodine compounds with alkali-metals are highly water soluble, we can only presume that in the Fucacean's organization there exists a control that permits the uptake of iodine, in some

[3] Aulin follows Örsted (1844) who first observed these three algal zones (green, brown, and red algae) in Öresund (see Athanasiadis 1996, p. 239) and also suggested a link between the light spectrum and the vertical distribution of green-brown-red algae.

kind of soluble salt compound, and its assimilation so that the iodine cannot return to the surrounding water; these plants are for the iodine similar storerooms like terrestrial plants are for alkalines. Amongst the reasons of salinity difference in the seawater, one can name the great or small depths, the differences of desiccation from the surface, as also the large rivers that within considerable regions can decrease the water salinity with their outflow. In general, salinity becomes greater [PAGE 18] and greater from the Poles towards the Equator and from the surface to the bottom; in bays, where large rivers discharge their waters, the salinity considerably varies even during different seasons, as the rivers do not bring always the same water amount. The salinity in the oceans could be generally estimated between 33 and 38 p.m. (Forchhammer cites a median value of 34.304 for the world oceans); that significant fluctuations in this case can take place, is natural. The great salinity of the Mediterranean is apparent; in this, its extension on the North African coast exercises a significant influence, as because of the hot winds the Mediterranean waters evaporate to a great part; because of the greater temperature in the Equatorial areas, the seawater becomes in these regions more saline than in the Poles. Following the work of Forchhammer, which as known, deals much with research about the sea water composition, the table below has been prepared, to show the salinity variation within diverse parts of the Atlantic north of Equator, in the Mediterranean and the Baltic (here, like elsewhere, is salinity always cited in p. m.):

		SALINITY		
	No Analyses	Median	Maximum	Minimum
1. Atlantic from Equator - 30^{o} N	19	36,253	37,908	34,283
2. Atlantic from 30^{o} N - to a line between Scotland and Newfoundland	25	35,932	36,927	33,854
3. Atlantic from the above line-Iceland and Labrador	12	35,391	36,480	34,831
4. Greenland's current	13	35,278	35,563	34,694
5. Davis Straits and Baffin's Bay	8	32,281	34,414	32,304
6. North Sea	6	32,823	35,041	30,530
7. Kattegat and Ö resund (The Sound)	7	15,228	19,940	10,869
8. Baltic and Bothnia Bay	9	4,931	7,481	0,610
9. Mediterranean Sea	11	37,936	38,654	36,931

As it shown above, the salinity changes much among the various parts of each region; one observes a rising from the Pole to the Equator. Of interest, can also be to see how the salinity increases in the Mediterranean, as we penetrate it, but it decreases in the same direction in the Baltic and the Bothnia Bay. We also have to deal with the following information of salinity:

[PAGE 19]

Mediterranean Sea[4]		Baltic Sea[5]	
In the Gibraltar Straits	36,391	In Karlskrona sev. decades of km off shore	7,688
Between the Balearic Isles & Spain	38,321	In Landsort at Sö dertö rn	6,984
Between Sardinia & Naples	38,654	Sev. decades of km north of Å land Isles	5,668
In Malta	37,177	Qvarken at Holmön	1,916
Between Malta & Greece	38,013	Haparanda skerries, Malören	1,505

To even show how the concentration of nutrients varies within different places, often to a large extent, the following is stated[6]:

	Atlantic below Equator	Atlantic 20^{o} 54' N & 40^{o} 44' W	Mediterranean bet. Sardinia & Naples	Baltic Sea
Natriumchlorid	27,892	26,424	30,292	25,513
Magnesiumchlorid	3,332	4,022	3,240	4,641
Natriumbromine	0,520	0,400 (Caliumchlorid)	0,779	0,373
Potashium (in H_2SO_4)	1,810	1,625	-	1,529
Calcium (in H_2SO_4)	1,557	1,597	1,605	1,622
Talc (in H_2SO_4)	0,584	0,678	2,638	0,706

Morover, different amounts and concentrations of substrates in the asches of burned algae are produced:

	Ash %	KO	N_2O	C_2O	MgO	Fe_2O_3	NaCl	NaI	SO_2	PO_5	SiO_3
1.	20,40	22,40	8,29	11,86	7,44	0,62	28,39	3,62	13,26	2,56	1,56
2.	16,39	15,23	11,16	9,78	7,16	0.33	25,10	0,37	28,16	1,36	1,35
3.	15,63	4,51	21,15	16,36	12,66	0,34	18,76	1,33	21,06	4,40	0,43
4.	16,19	10,07	15,80	12,80	10,93	0,29	20,16	0,54	26,69	1,52	1,20

1. *Laminaria digitata.* 2. *Fucus vesiculosus.* 3. *Fucus serratus.* 4. *Halicoccus [Ascophyllum] nodosus.*

Of the above, where much more could be added, it is easily understood the great impact of the various amounts of nutrient in the seawater on the geographical distribution of algae. Moreover, even the rolling of sea has an influence on the composition of the seawater; in high sea its concentration of chlorine and sulphuric acid increases, to decrease again in calm weather.

[PAGE 20] That the sea currents play an important role in the geographical distribution of seaweeds, since through their impact the temperature of the sea changes significantly, has been already said; but they also contribute purely physically in the dispersal of algae, often to widely remote areas. They bring with

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[4] The data of this and the previous table are taken from Forchhammer's work about the seawater in "Oversigt over det Kongl. Danske Vidensk. Selsk. Forhandl. Dec. 1862".

[5] The data of this table are taken from Krok's thesis on the algal flora in the inner Baltic Sea and Bothnia Bay in "Ofversigt af Kongl. Vetensk. Akad. Fö rhandl. 1869"; all the analyses refer to surface water.

[6] The data are taken from different journals of Chemistry.

them not just spores but also sometimes entire individuals drifting them to places far away from where they had grown; even storms and strong waves tear loose and bring them from one coast to the other; (so is *Himanthalia* found drift on the coast of Bohus [Swedish west coast] with the help of west winds); usually then it is not possible for them to propagate, but for a short time it is possible like for example *Sargassum bacciferum* (Turn.) out in the Atlantic. As an example of how far an alga can reach by the help of the winds and the waves, it could be noted, that this *Sargassum* species often is found driven on the coast of England and sometimes even on the coast of Flanders. - As it is known, the algae are variously coloured in the most strange ways; we have rather generally assumed, that this difference in colour is caused by light, that in this respect must have a strong influence; the stronger or lighter light, the stronger or lighter pressure, as well as the larger or smaller amount air in the water should be the most important factors on the issue of algae's color; algae of different colors are however found together from the surface and down to several fathoms depth. Examples occur [however], that red algae which have their tips over the water surface become green-coloured, while the frond that is submerged in the water remains red-coloured. We have also tried to find an explanation of the various algal colors, in the latitudinal differences; but this appears to hold even less, since algae of different colors occur even more mixed on the same latitude than at the same depth.

After these general observations, a brief description of the geographical distribution of the most important genera within the different groups must be given; here of course the notorious question of species number within families and orders can be raised, especially as the authors have rather different opinions about the species limits, [PAGE 21] as it is for the present the case; one extreme is for example to mention Kuetzing's rather soon to say countless species. - Professor J. E. Areschoug has kindly allowed me to use in my work his systematic classification that he applied in his lectures.

Order 1. Corallinales [as Corallineae].

The plants that belong here represent a rather rich group of highly specialised algae both as regards structure and reproduction. Members of Corallinales occur in almost all oceans, although they are more common in tropical and warm [temperate] waters. Some species reach very long up both in the north and the south; they generally thrive well on both sides of the Equator, but it seems they occur in larger amounts on the Pacific rather than the Atlantic coasts; apparently many and well-developed species of this group are found in Australia. The Corallinales thrive on very different depths; one founds them from very near to the splash zone and down to, as previously noted, relatively significant depth. The individuals that grow in shallow water, usually bear fruit, while those that are brought from the depths are generally sterile, although their vegetative structures are apparently well-developed. The species of an order that occur in so far remote areas and in so different depths, as the Corallinales, must of course show a great diversity; moreover, one often encounters individuals of the same species, which because of those different conditions have changed form; the species that belong here are found partly on wood, stones, and similar substrata, and partly on other algae. About 150 species are described; close to 1/3 of them is found within within the [here examined] regions (i.e. Atlantic north of Equator, Mediterranean and the Baltic). Most of them occur in the warmer parts of the Atlantic, in the Mediterranean and the Adriatic, thereby become less and less towards the north, so that on the Scandinavian west coast only a few species are known. Among the genera that belong here, one can name *Corallina* that has a few species in the different parts of the [here examined] regions, and also in Scandinavia; *C. officinalis* (L.) occurs throughout the entire [examined] area and as far north as the Arctic Ocean; most species of the genus occur in the Southern Hemisphere; *Amphiroa* that occurs up to the 40^{o} latitude on both sides of the [PAGE 22] Equator, has in the Mediterranean a couple of species, of which one even occurs in North America[7]; therefore, it is strange that not even a single species of the genus is found on the European Atlantic coast; besides the genus has many species in the Indian and Pacific Oceans. *Jania* has a single species in our [Swedish] coast and a couple in North America and in the Mediterranean, and as far south as South Africa as also several other species from more remote areas. *Hapalidium [Pneophyllum ?]* is a strange genus with just a couple of species in the Mediterranean and the Adriatic. The genus *Melobesia,* mainly distributed in the temperate seas, has apparently many species, whose number decreases towards the Poles; our knowledge of the North American species is limited; in the Mediterranean and the Adriatic, the genus is well represented; *M. membranacea* (Esp.) - common in nearly all waters- exists on our coast together with some other here belonging species. *Lithothamnion* has several species within the [here examined] regions, mainly in the temperate parts; even on our coasts exist a couple relevant species. (Some [restricted to] Southern Hemisphere genera exist too.)

Order 2. Floridales [as Florideae]

Family 1. Rhodomelaceae. This family is the largest and most important amongst the red algae, not only in the Atlantic but also in other oceans. The various members of this family are encountered partly in the warm and temperate seas, and partly in the cold ones; some of the species are cosmopolitan. Within the [here examined] regions, the relevant members occur not only in the Mediterranean and the Adriatic but also in the cold and warm parts of the Atlantic, not just in Europe but also on the North American coast; in the North Sea and its bays, several species are found, and even in the Baltic occur a few. More than 300 species are described, of which about the half are found with the [here examined] different regions. As an example of the here belonging genera, that exist in the warmer seas, we can name *Chondriopsis, Acanthophora, Bostrychia, Vidalia, etc.* which occur in large number both north and south of the Equator; these genera have species in the

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[7] It probably refers to the norterhmost record of *A. fragilissima* from North Carolina (see Hoyt, Marine algae of Beaufort: 526. 1920).

Mediterranean and Adriatic Seas and in the West Indies; one or another extents its distribution [PAGE 23] to the U.S., to France and England. These like similar species of this group, are rather restricted to bays than to the open coasts; something peculiar for *Bostrychia,* is that some of its species are found in brackish water, and even in freshwater. Here also belong some poor in species genera as *Alsidium, Digenea, etc.* which have about the same distribution as mentioned above. Amongst the genera whose most species are found in the Southern Hemisphere, but one and another occurs in our regions, we can name *Martensia, Amansia, Dictyurus, etc.* that are encountered in the Mediterranean, Mexican Gulf or in West Indies. Within this family is found the previously mentioned relationship between the algal vegetations of the Mediterranean and the West Indies, [visually] that some algae are restricted to just these two regions. *Rhodomela* and *Odonthalia* are arctic genera; the former has its natural habitat in the Southern Hemisphere; on the other hand, almost all species of the latter occur in the north, most of them in the Okhotsk and Kamchatka Seas. *Rhodomela* has a few species- *R. subfusca* (Woodw.) is found right up to the Baltic- and *Odonthalia* one, that from the northernmost Atlantic extends to England and the Ö resund. The largest and most significant genera are *Polysiphonia* and *Dasya,* whose species represent more than half of the entire family. *Polysiphonia,* which is the most rich in species genus, occur in all coasts, even in the northernmost ones- on the coast of Finnmark still occurs *P. urceolata* (Dillw.) etc.; in the Mediterranean and Adriatic Seas, they are rather common, and many species are characteristic for these seas; at Cadiz, the Canaries and even the West Indies, they occur in large amounts; moreover they are common along the European coast right up to the North Sea and the Baltic, as well as in the U.S. The species differ considerably as regards size; they also occur in very different depths. The genus *Dasya* has many species both in the Northern and Southern Hemispheres, from the Equator and towards the Poles. Amongst those occurring within the [examined] regions, several species are characteristic for the Adriatic and Mediterranean Seas. Along the American coast numerous [PAGE 24] species are found; on the European Atlantic coast, many are encountered, amongst which *D. coccinea* (Huds.) [*Heterosiphonia plumosa*] is one of the most beautiful algae on the coast of Bohus [Swedish west coast] (the Family has numerous genera that are restricted to the Southern Hemisphere).

Family 2. Laurenciaceae. Species of this family occur in one or another form in almost all seas except the Arctic; they are not so many and belong mainly to the warmer seas of both hemispheres, but have also a few species on our coasts. Of the genus *Laurencia,* we encounter species from the Mediterranean and Tangier up to the Faeroes and the Bohus, as well as outside the examined regions; just a couple of species occur in North America. *Laurencia* is the most rich in species genus within the family; its species thrive in the warm seas, [such as] the Mediterranean and the Mexican Gulf and also on many sites in the Southern Hemisphere; in Central America, we find a few species; more in the north, the species number diminishes; a similar condition exists on the European coast; in west Scandinavia we encounter a couple of species. Finally, the genus *Bonnemaisonia* must be cited, whose single particularly beautiful species exists also on our west coasts; it seems to be restricted to Europe. Not a single species belonging to the Laurenciaceae occurs in the Baltic. (here belong also a few genera from the Southern Hemisphere.)

Family 3. Sphaerococcaceae [as Sphaerococcoideae] comprise numerous species, that belong to the warmer seas; a few exist in the temperate and cold waters. They have their main distribution in the Southern Hemisphere, where the numerous genera have developed many endemic species at the Cape of Good Hope and in New Holland. The largest part of this group, within the [here examined] regions, is encountered on the south coast of Europe and the south part of North America, in North Africa, in the Mediterranean and the Adriatic Seas; yet, some species still exist in the North Scandinavia and Greenland; in the same way, we find one or another species in the Southern Hemisphere far in the south. We know about 150 species, one third of which are encountered in the here examined regions. On the west coast of Scandinavia, we find some and in the southernmost Baltic another few species. A rich in species genus in this group is *Gracilaria,* that has representatives from the [PAGE 25] tropics to the North Sea; most species of the genus in the Northern Hemisphere are found in the West Indian Islands, in the Gulf of Mexico, in the Mediterranean and the Adriatic Seas. *G. confervoides* (L.) is distributed from the Equator to high latitudes both in the south and in the north, *G. multipartita* (Clem.) has also wide distribution but not as much as the previous species. Another genus, *Nitophyllum* has many recently found species in the Southern Hemisphere; some species have been long known and to exist in abundance from the Atlantic coast of Europe to England and Norway, from Africa and the Mediterranean. On the North American coast, a very different situation exists, just a few specimens belonging to 2 species have been found; although species are found in Tangier, Cadiz and the Mediterranean, we have not encountered any in the West Indian Islands, as it would be anticipated. *Delesseria* is one in many respects significant genus, that particularly belongs to the colder waters of both the Northern and Southern Hemispheres; one or more species are found in both; certain species in the north correspond to some in the south; some have a very restricted geographical distribution, other are widespread; the southernmost locality in the Northern Hemisphere is Tangier. Most species of the genus exist in the Pacific and the Arctic Oceans. *Sphaerococcus* has a few species in the Atlantic. Two genera with just few species occur in the Mediterranean and the Adriatic Seas.
The genus *Euchema* [that occurs] in East Indies, the Cape of Good Hope and in New Holland, has a couple of species in West Indies; moreover a few poor in species genera exist in the warmer part of the Atlantic. (It is natural to find many genera of this family outside the examined regions.).

Family 4. Gelidiaceae have most of their species in the warmer seas, within which some have a very widespread distribution. The family does not include many species, but these occur in all parts of the world; most of the species exist in the Southern Hemisphere, while just a few in the Northern Hemisphere. On the European coast just two are known with certainty, both in the Atlantic; one of them is also found in the Mediterranean (whether any other species of the family occurs there it is not known for sure); from the Central America, several species are [PAGE 26] known; on our coasts until now only one species is found, and this only in the SW Norway. *Gelidium,* which is the main genus, has species in the Indian Ocean and in the warmer parts of the Atlantic and the Pacific Oceans; two [species] reach to England and Scotland, and *G. corneum* (Huds.) is also found on the Norwegian coast. (A few here belonging genera, of which one has a species in Brazil, exist in the Cape of Good Hope and one [species] in New Zealand.)

Family 5. Spongiocarpaceae [as Spongiocarpeae] is a small insignificant group, whose genus *Polyides* with one species occurring both on the European and North American Atlantic coasts.

Family 6. Squamariaceae is represented by a few small in size, easily overlooked plants, and therefore they are little known - Harvey describes, probably because of this reason, just two species from North America - and it is rather difficult to give an account for their distribution. All have, of what is known, an insignificant distribution, each of them within its region. Most of the species are known on the European coasts, that are the best investigated; they have representatives through Skagerrack and Kattegatt as far as in the Baltic; a few species exist in the Mediterranean and its bays. The most important genera are *Hildenbrandia* and *Peyssonnelia,* of which the former has its species mainly distributed in the Atlantic as well as in the Mediterranean and the Adriatic, and even one species in fresh water; the latter has apart from some species in the examined regions, even one and another little known species from South Africa. *Actinococcus* [the carpo-tetrasporophytic stage of *Coccotylus*] has two species in the Baltic; moreover, there are some other insignificant genera from different parts of the examined regions, such as *Petrocelis, Cruoria,* and others; of the last named genus there is a species even in our west coasts.

Family 7. Helminthocladiaceae [as Helminthocladieae]. This relatively poor in species group mainly belongs to the temperate and warmer waters; the northernmost sites we have found members are in England and the North Sea, and even in the SW Baltic. Most of the known species are encountered in the here examined regions. Numerous species are found in the Mediterranean and the West Indies, and a few on the Scandinavian coasts. *Helminthocladia* exclusively belongs the old world, where [PAGE 27] 2 species of the genus are found. *Nemalion* has also a couple of species on the European coast; *Nemalion multifidum* (Web. et Mohr) occurs both in Europe and America.

The richest in species genus is *Liagora,* whose most members occur in the warmer seas; in the examined regions, some species are encountered in the West Indies, a few in the Mediterranean coasts and some are cited by Harvey from North America. Moreover, a few minor genera such as *Helminthora* and *Scinaia* are also found in the examined regions. In this, like in the previous family we also encounter species that even grow in freshwater.

Family 8. Hypneaceae occur exclusively within warmer seas and do not have a single species that extends to the north further than to France. Only a few genera exist, and their species are largely met with in the Southern Hemisphere. Almost all species in the area here considered are found in the West Indies or in the Mediterranean. The main genus is *Hypnea,* whose most species are found in the Indian Ocean, at the Cape of Good Hope, and elsewhere; a few exist in the here examined regions. *H. musciformis* (Wulf.) is widespread in tropical and subtropical seas.

Family 9. Wrangeliaceae comprise just a few poor in species genera, whose members are found in the warmer seas; a few are met with in the Southern Hemisphere. *Wrangelia* has 3 species within the examined regions; one of them extends as far as to Ireland. *Naccaria* appears to be a European genus, whose species are spread; one grows even in England and Heligoland. Here also belongs *Spermothamnion,* whose species *S. turneri* Mert. reaches Öresund [in the Baltic].

Family 10. Rhodymeniaceae belong, with few exceptions, to the cold sometimes temperate seas, not only in the Northern but also in the Southern Hemisphere; however, one or another [species] occurs in the tropics. The relevant genera are not rich in species; about half of the number of species is encountered within the examined regions. Therefore, as one excepts of what was said, the family is poorly represented in the Mediterranean; in Central America, there is none. Along the North American and the North European coasts, occur many different species; None of them, however, extends in to the Baltic, although some reach the Scandinavian west coast. The genus *Rhodymenia* has 3 species in the North Atlantic, and other species are found in Peru, Indian Ocean and elsewhere. *Euthora* has 2 species, one in the [PAGE 28] northernmost Atlantic and the other from van Diemens land ! [Tasmania] The genus *Rhodopyllis,* with one species in Scandinavia, belongs also to the northern Atlantic, but has a single species as far south as Cadiz and the Mediterranean. Similarly, the beautiful genus *Wormskioldia [Delesseria]* has its centre of distribution in the northern Atlantic and extends until Skagerrack. The most rich in species is *Plocamium,* although within the examined regions is represented only by one species *P. coccineum* (Huds.) with very large distribution within both hemispheres, in the northern one from Faeroes and Scandinavia to the Canaries; the other species of the genus belong in the Southern Hemisphere, where they are spread in the Pacific, Atlantic and Indian Oceans.

Family 11. Cryptonemiaceae comprise two groups well-separated from each other on the basis of their reproductive structure; because they even have different geographical distribution, are here considered separately:

1. Gigartineae. These have their centre of distribution in the Pacific Ocean; they do not belong to the warmer seas in the same extent as the Cryptonemeae. Numerous extent along the NW coast of America, other are re-encountered in the Indian Ocean, in Chile, Peru, the Cape of Good Hope and in Australia. In the Atlantic are found just a smaller amount of the known species; some extent north to the Arctic Ocean; other occur in the Mediterranean, a few on the Scandinavian west coast and a couple of them enter the Baltic Sea through Ö resund. *Gymnogongrus* and *Phyllophora* that have about the same number of species in the regions here examined, are the most diverse in the whole group; a few species of the last mentioned genus extend far in the north, up to our coasts, and a few as far as Iceland; even in the Baltic we have Phyllophoreae and one, *P. brodiei* (Turn.) is found up to Qvarken [Bothnia Bay]; both genera occur in the Mediterranean and in the warmer pats of the Atlantic; they also occur outside the regions here examined and *Gymnogongrus* has most of its species in the Indian Ocean and the Pacific. *Kallymenia* has several species, partly within or outside the here examined regions. *Gigartina* has a few species in the relevant regions, but numerous in the Southern Hemisphere. *Rissoella* and *Constantinea,* that belong to the Pacific Ocean, have one species each in the Mediterranean. Numerous other genera, which like those just mentioned have their centre of distribution in other [PAGE 29] seas, have one or another species in the regions here examined, such as *Chondrus, Ahnfeltia, Callophyllis,* which have one species each in Scandinavia. Certain species apparently have a widespread distribution within the examined regions as well as outside; thus, for example *Cystoclonium purpurascens* (Huds.], *Gigartina mamillosa* (Good. et Woodw.), *Chondrus crispus* (L.) och *Ahnfeltia plicata* (Huds.) extent from the Arctic Sea to Gibraltar and even south to Brazil on the American coast. (The genus *Iridaea* has more than 20 species, 6 of which occur on the NW coast of America; not one occurs in the examined regions. Moreover, several other genera exist not having a representative in the relevant areas.)

2. Cryptonemeae. The plants belonging to this group prefer the warm and the tropical seas; yet, cold and temperate species also occur here. In the Mediterranean and Adriatic Seas, as also in the adjoining regions of the Atlantic as well as in Central America, occur rather many species, while they are poorly represented in the northern Atlantic and on our coasts where some species are found. They often grow in depressions, on the shore or on submerged rocks or in mud, etc., in deeper or shallow waters. A couple of species, *Dumontia filiformis* (Fl. Dan.) and *Furcellaria fastigiata* (Huds.), enter the Baltic; the latter even the Bothnia Bay. Amongst the here belonging genera, we can note *Halymenia,* whose most species are found in the Mediterranean, Adriatic and nearby regions in the Atlantic, from where the extend to other places - ones species is even found on the coast of Bohus [Swedish west coast] ; about half of these genera are characteristic [endemic] for the first named

Sea. *Nemastoma,* whose all species with one exception are found in the regions examined, thrive also well in the Mediterranean, where most species are exclusively found; a few come out in the Atlantic and one even reaches France. Even *Chrysymenia* has several species characteristic for the Mediterranean and the Adriatic Seas; Harvey describes no less than 5 species from America, where they occur in deep rock depressions.
Cryptonemia has several species with the regions here studied. *Grateloupia* and *Schizymenia* have each several species; the largest number of them occurs outside the examined regions, but one or another is also found within; *Schizymenia edulis* (Stackh.) reaches up to Ö resund. Here also belongs [PAGE 30] *Rhizophyllis* with one species *R. bangii* (Hornem.), originally reported from Fyen [Denmark]. Species of the genus *Chylocladia* are found in the Mediterranean and the Adriatic Seas as well as in America; one species is distributed along the European and even Scandinavian coasts. *Rhabdonia,* that in fact belongs to the Southern Hemisphere, has one species in the West Indies. *Halosaccion* belongs exclusively to the Arctic Sea and northern parts of the Pacific and Atlantic Oceans and one species extends to the North Sea along the Norwegian coast. (Moreover, there are several genera with species in widely apart areas within the Atlantic as well as in other seas.)

Family 12. Spyridiaceae comprise just a single genus, *Spyridia,* with a few species, that all belong to the warmer seas; within the investigated area, there are species of this genus in the West Indies and Cadiz as also in the Mediterranean. *S. filamentosa* (Wulf.) has widespread distribution throughout the warm seas, both in the Atlantic and Pacific Oceans, in the Mediterranean, along the European coast to England and along the North American one to Massachusetts.

Family 13. Ceramiaceae. The species of this family that are generally rather small and delicate, are encountered in very different regions where they occur in very different depths and in waters with considerable variations in salinity. The species which belong here are generally parasites [epiphytes], occasionally also occur on lifeless substrates; [they may grow] either near the splash zone or in great depths; some thrive in the marine waters, other extent in bays whose water contains just a small amount salts. As a result of this, is also their distribution rather widespread; the here belonging species are met with both in the Atlantic and the Baltic as far as the Bothnia Bay, as well as in the Mediterranean and other warmer seas. In the tropics, they do not seem to be so numerous, as in the northern seas; some for the tropics characteristic [endemic] genera do not exist; on the European coast there are more Ceramiaceae than on the American coast, probably because the N. American coast neither shows the same length and variety of habitats as the European one, nor is suitable as this, for those small algae's distribution, and moreover the former coast is not so well investigated as the latter one. Something else that also contributes to the difficulties of knowing many [PAGE 31] red algae, and apparently this family's geographical distribution, is that, in contrast to the brown algae, they have a loose and easily damaged structure. The fact that the relevant species are usually found to be sterile makes their study even more difficult. Finally, many species are small and are easily overlooked. Naturally, many species belong to this family, and because the opinions of the authorities differ greatly, it is difficult to estimate the number of known species; however, we could postulate that at least 200 are known; about half of them are known in the regions investigated. The most rich in species genus is *Callithamnion sensu lato*; it comprises about half of the species described; here we encounter several [species] with widely diverging geographical distribution; while some are restricted to England, France, Greenland, in Skagerrack, a.s.o., other apparently have a widespread distribution, occurring not only in the Atlantic but also in other seas. From the Mediterranean and the Adriatic seas, a large number has been described. What was said about the geographical distribution of *Callithamnion,* applies also for *Ceramium,* another large genus, that has numerous species on the Scandinavian west coast as well as in the Baltic and Bothnia Bay. *Griffithsia,* that apparently prefers the warmer seas and the open coasts, has most of its species in the Mediterranean and adjoining regions in the Atlantic; some occur as far as England and even longer up to the north; one species occurs in North America and also in Scandinavia. *Ptilota* is again met with in the cold seas; of its species, three are found within in the regions examined and several in the North Pacific. *P. plumosa* (Lin.) is even found along the Arctic coasts. Apart of *Corynospora, Halurus* and *Crouania,* that have most of their species within the examined regions, we must name *Centroceras* and *Dudresnaya* (with one species occurring even in Bohus [Swedish west coast]) that belong to the Mediterranean, and the temperate and warmer Atlantic. (Moreover, [to the Ceramiaceae] belong several small genera, whose species occur entirely outside the examined regions.).

Family 14. Porphyraceae comprise only a few genera that are [PAGE 32] widespread throughout the examined regions. In a few areas we have encountered local species, otherwise they generally exhibit a widespread distribution. On our coasts, a few species occur partly in deep water, and partly in the splash zone in bays, one even in nearly fresh water. *Porphyra* and *Bangia,* that both have species on our west coasts, belong to this group; *Bangia* stretches into the Baltic and the Bothnia Bay.

Order 3. Dictyotales [as Dictyotaceae]

The algae which belong to this order show up numerous particularities, both as regards habitus and characteristics as also phytogeographical features. These plants love exceptionally the warm seas, and in these we should seek to find most of the species belonging to the family; from the warmer seas they extent both in the north and in the south, but the number of species and individuals apparently diminishes so that from the rather rich family only just few [species] reach so far as England. On the American coast a similar situation takes place; they occur very sporadically north of Florida; south of this cape they occur in such great amounts, that, like the Fucaceans's on our shores, leave their characteristic stamp on that coastal vegetation. They thrive in the marine water, and do not exist in bays with brackish one. They even occur in rock pools in temperate seas, where the sea water is warmed up by the sunlight, demonstrating their preference of a higher temperature. Apart from that they occur in larger numbers in the tropics, they also show a higher organization there than in temperate waters. They do not go deep but remain between ebb and flood or just below the water level. About half of the known species are encountered in the here examined areas. Species of them occur mainly in the Mediterranean, the Central America and the Canaries; likewise, a couple of species are found on our coasts but not one of them goes in the Baltic. The main genus *Dictyota* has many species in Cadiz, in the Mediterranean and on the coast of the Gulf of Mexico; outside the examined regions, several species occur in the Indian Ocean and in the Pacific; [PAGE 33] *D. dichotoma* (Huds.), the only one occurring on the Swedish west coast, has a very widespread distribution; apart from the Atlantic and the Mediterranean, it is also found at the Cape of Good Hope, New Zealand, South America, and elsewhere. Most of the species of the genus *Zonaria* are found within the examined regions, the other species occur in the Indian and Pacific Oceans; *Taonia* has all of its species within the Mediterranean and the warmer parts of the Atlantic. The genus *Padina* has one species, *P. pavonica* (L.), that like *Dictyota dichotoma* has an apparently widespread geographical distribution; it probably also occurs on our west coasts. In the Mediterranean and Central America, *Haliseris [Dictyopteris]* has a few species; the rest are found in the Indian and Pacific Oceans. (Outside the examined regions, several other genera exist.)

Order 4. Fucales [as Fucaceae]

This order is apparently rich in species and significant, since it nearly comprises about half of the known olive-colored brown algae. With respect to seaweed distribution, the Fucales are also highly interesting, particularly as they form associations that cover long parts of the seashores from the tropics to the polar seas; one could reasonably say that they represent 3/4 of the entire vegetation within the particular zones they are restricted to. Species belonging to the family Fucaceae, are met with in all seas; even in the Baltic is the family represented as far north as Söderhamnskären [c. 60^{o} N]. In the Atlantic, north of Equator, the species number is not that large; but the number of individuals is so much larger. More than half of the known Fucaceae belong to the genus *Sargassum,* that in the tropics and subtropics is represented by some 130 species, of which just a few occur within our regions; they mainly occur in the Pacific Ocean, where they are distributed between the 45^{o} N and 45^{o} S latitudes. Among the species occurring in the Atlantic, *S. bacciferum* (Turn.) deserves to be mentioned, since it forms the so called Sargasso Sea. In the middle of the Atlantic between the 20^{o} and 40^{o} N latitudes, it covers a surface of about 4.000.000 square km, an area 5 times as big as the entire Sweden. This algal mass is floating on the surface with the help of the Gulf Stream. [PAGE 34] A few similar but smaller concentrations exist in some other places. We regard that this alga, that grows in large amounts on the North American coast, has originally drifted away out in the Atlantic; later it was affected by the influence of the Gulf Stream, and now continues to grow vegetatively and never reproducing sexually; it is true that this dispersal of *S. bacciferum* from the American coast goes on even today; but the largest parts of this colossal masses should must have been produced locally through vegetative reproduction of previously dispersed individuals that that place. Because, *S. bacciferum* that grows on the coast reproduces via spores. Except of this species, the genus has a few more within the examined regions, partly on the American coast, and partly in the Mediterranean; one species even occurs in the Atlantic just outside the Gibraltar Straits, on the coast of Spain, Portugal as well as in North Africa. Of course, any *Sargassum* is not found in the North Sea; we could regard that the genus is here represented by *Halidrys,* that extends down to the Canaries, and on our coast is distributed between the Sound and North Cape. The genus *Fucus* is very important, particularly to us; species of this genus, likewise of its closely related *Fucodium [Pelvetia]* and *Halicoccus [Ascophyllum],* are certainly found outside the Atlantic north of Equator, but it is in this region they really belong to. They occur much more abundantly on the European than the American coast, where they are found in a much smaller area, generally limited to the NE part. On the North American central and south coasts, they occur sporadically, as it has been described in the former part of this thesis; with a few exceptions, species of this group are also lacking in the Mediterranean and the Adriatic Seas. Instead of these genera, the genus *Cystoseira* is represented in these seas with many species, few of which extend through the Gibraltar up to England; on the American coast, this genus is absent; a few other species are found outside the regions here investigated; therefore the genus appears to be very characteristic for the Mediterranean Sea. On the Scandinavian coast, the Fucaceans have few species that exist in an overwhelming number of individuals; *Fucus vesiculosus* L. marks characteristically with its color the vegetation on the shore; this species and *F. serratus* L. extend into the Baltic; except of these and *Halidrys, Halicoccus* also occurs on the Swedish west coast; besides, on the Norwegian coast occurs *Himanthalia lorea* (L.) and *Fucodium canaliculatum* (L.), while on the coast of Finnmark a few arctic species are also found. In New Zealand and New Holland, numerous of the most particular species of this region are found; with regard to the Fucaceae, we have observed that in the Southern Hemisphere a number of characteristic species are distributed while in the Northern Hemisphere exists an overwhelming number of individuals of a few species. On the seashore they occupy a characteristic position, mainly between ebb and flood; on our coasts occur on the splash zone and somewhat below; a few species, apparently from the Southern Hemisphere, belong to the deeper waters. (To this order belong many genera not found in the here examined regions.)

Order 5. Tilopteridales [as Tilopterideae]

[This] comprise just one genus, *Tilopteris,* with one species *T. mertensii* (Eng. Bot.), that belongs to the European Atlantic coast, where it is found in England and France as well as on the Scandinavian west coast. Several species currently placed in *Ectocarpus* would probably be referred to this order after a revision.

Order 6. Vaucheriales [as Vaucherieae]

Order 7. Coleochaetales [as Coleochaetaceae]

Order 8. Oedogoniales [as Oedogoniaceae]

[These] occur largely in fresh water; a few exist also in seas but rather prefer the brackish waters than a clear marine habitat. Along the Atlantic coasts of Europe and America, several species are known; in the Baltic, algae belonging to these [orders] are found too.

Order 9. Phaeozoosporales [as Phaeozoosporeae]

Family 1. Laminariaceae [as Laminarieae]. As previously said, we encounter species of this group mainly in the cold seas, [PAGE 36] where they occur in high latitudes. They are found commonly in the Northern Hemisphere; even in the south a large number of species is found; some belong to the warmer seas where they occur sporadically. The plants of this group are generally larger than those mentioned so far, and within some genera from the Southern Hemisphere we found species that are enormously big, perhaps the largest within the plant kingdom[8]. These large species of course occur in deep water - occasionally down to a couple of hundred feet; even our species do not thrive in shallow waters, as for example the Fucaceae generally; a few times they are found between ebb and flood. On the Atlantic coasts of Europe and North America, they form a wide band between ebb and down to 25 - 30 feet. Of the known species, a small part occurs in our region; In the Pacific several characteristic [endemic] for that region species are met with. They are, as we would expect, very few in the Mediterranean and the warmer parts of the Atlantic; on the Scandinavian west and north western coasts, several species are found. The most rich in species and for us important genus is *Laminaria,* whose several species occur in the North Atlantic; a couple of species are found in the Mediterranean, the only representatives of the entire family; a few *Laminaria* species extend down to the Sound [Baltic]; one or another occurs in large numbers as far north as to the Arctic Sea, where a few particular [endemic] species exist; none of the Atlantic species extends much to the south; in the Baltic, they are apparently missing, although a few drifting specimens have been found, probably passing via Ö resund. *Laminaria saccharina* (L.) has such a widespread distribution, that it is found on the coasts of all northern seas; strange is that on the west coast of North America, none one species of *Laminaria* exists. Of the characteristic genus *Agarum,* two species are found in the Atlantic and exclusively belong to North America; moreover, here belong the genera [PAGE 37] *Alaria* and *Haligenia [Saccorhiza]* each with one species in Norway. The genus *Ecklonia,* that primarily belongs to New

[8] As an example of their large number and enormous size, Hooker describes that during an expedition to the Pacific the Captain, in spite of Hooker's directions, let the gathering of floating stems of such algae to use as fuel believing that the material was drifting.

Holland [Australia] and the Pacific Ocean, has also one member within the examined regions and this species occurs in the Canaries and the nearby coast of Africa. (Moreover, in the north and south parts of the Pacific Ocean, several remarkable genera exist, which only recently have been closely studied, mainly thanks to the magnificent English expeditions to these waters.)

Family 2. Sporochnaceae. The algae which belong to this family occur at places of the sea bottom where the Laminariaceae become rare and therefore are generally deep water plants; in the tide zone are not found, except occasionally in some deep depressions. They are relatively few; within the examined regions just a couple are found: The main genus is *Sporochnus,* whose several species occur on the Atlantic coast of Europe and in the Mediterranean; so far none is found in North America, where the genus probably also has some species; on the coast of Bohus [Swedish west coast], one species , *S. pedunculatus* (Huds.) is found. The genus *Carpomitra* with several species from New Holland and New Zealand, also has one species the regions here investigated.

Family 3. Cutleriaceae. A small group composed of a single genus, that has a few species, mainly found in the Mediterranean and Adriatic Seas. *Cutleria multifida* (Grev.) extends outside the Mediterranean to France and England, and also reaches the west coast of Sweden.

Family 4. Asperococcaceae include a few genera, that are spread throughout the regions examined here and even outside them; it appears that they thrive in the temperate seas, although they are not lacking from the warm ones. Usually, they grow a bit below the water surface. Some species extend from the Atlantic to the North Sea and then to Skagerrack and Kattegatt as far as in the Baltic. Their distribution on the North American coast is similar to that on the European one, with the only difference that fewer species are known in America; also in the Mediterranean exist a few species. *Asperococcus* has most of its species within the examined regions, partly in the North Sea and nearby waters and partly in the warmer parts of the Atlantic. Species of *Stilophora, Striaria* and *Ralfsia,* similarly exist even on the [PAGE 38] coast of Scandinavia; *Stilophora* has one species in the Southern Hemisphere, the other occur just within the regions examined. Two species of the genus *Ralfsia* are arctic and extend partly south in the Atlantic; a third one is found in the Gulf of Mexico.

Family 5. Chordariaceae are distributed within very different parts of the world but apparently confined mainly to the temperate regions and particularly to the Northern Hemisphere; yet, they are not entirely absent from the cold regions. Like in some other related families, we found here many parasites [epiphytes]. A few American species have a highly restricted distribution and are only encountered in the Gulf of Mexico; on the Mediterranean coast, several for this region characteristic species are found such as two species of *Leathesia,* two species of *Cladosiphon,* and other. Simultaneously, as some species are restricted to some areas, are other cosmpolitan like *Leathesia tuberiformis [L. difformis]* (Eng. Bot.), that occurs in both hemispheres; even *Chordaria flagelliformis* (Fl. Dan.) has an apparent widespread distribution. The members of this family do not generally grow in deep water; yet, they occur deeper than the rest of the family whose species, being parasites [epiphytes], are usually found near the water surface. Not few are found in Scandinavia; several extend into the Baltic, as far as Å land and Roslagen, one up to Qvarken. *Castagnea baltica* Aresch. appears to be a unique species for the Baltic. The genus *Chorda* has a few species within the North Atlantic and a couple in other seas; a few species occur in the Baltic. Of another well-known genus, *Elachista,* that comprises small easily overlooked species, only one species from North America is reported; on the Scandinavian coast several are found; *Elachista's* species seem to be mainly distributed in Europe. Except of those mentioned, several other genera exist like *Mesogloia* and other which all have representatives in the Atlantic and in other seas.

Family 6. Sphacelariaceae are similar to the previous family's species as regards distribution and occurrence; yet, within this family we know relatively more species from the Southern Hemisphere. The species generally occur, [PAGE 39] as said above, not in deep water but close to the splash zone. Most of the species occurring in the Atlantic are found in Europe; just a few are known from North America; they have their greatest part of distribution in the middle and northern regions. The Sphacelariaceae are represented on the Scandinavian west and east coasts; in the Mediterranean and the Adriatic Seas, several species exist, partly unique to these seas and partly in common with others. *Sphacelaria* has members in almost all coasts within the various parts of the regions examined here. *Chaetopteris* has two species, one on the Cape of Good Hope and the other in Greenland and North Europe. The genus *Cladostephus* is represented by a couple of species on the American and European coasts, as well as in Scandinavia; it also has a few species outside the examined regions.

Family 7. Ectocarpaceae. Also the members of this group have their main distribution in temperate regions, but occur in colder seas too; they decrease in number towards the north and apparently the south; thus not a single species is, for example, reported from Central America or the corresponding part of Africa. As a result of being often sterile and morphologically similar to each other, members of this group are apparently not well-known, but usually misidentified, and therefore we do not have an accurate knowledge of their distribution. In Europe it appears that they are most common on the coast of France and England, and in North America along the middle and northern states. In the Mediterranean and the Adriatic Seas, we also found a few species of this group; on the Swedish and Norwegian west coasts are they rather common; in the Baltic, a few are found and one of them reaches up to the Bay of Bothnia. They thrive best in shallow warm bays; some are parasites [epiphytes]. The main genus is *Ectocarpus* whose species occur both on the

European and American coasts; certain species are widely distributed, other occur within a restricted area, for example several species in England; Harvey has separated several unique species for the North American east coast, but for their species status he is not very certain. Of this genus exist several species on our coasts, some extent even in the Baltic. [PAGE 40] *Myriotrichia* has a couple of species mainly in the British Isles; *Myrionema* has most of its species in the North Sea.

Family 8. Punctariaceae comprise just a few genera whose species occur within the examined regions, mainly in the temperate part of both Europe's and America's coasts; we encounter one or another in the Mediterranean and a few more species on the Scandinavian west coast, where some extend into the Baltic; *Punctaria plantaginea* (Roth) thrives on smooth rocks, exposed to strong waves; *P. latifolia* (Grev.) and *[P.] undulata (J. Ag.)* are again only parasites [epiphytes]. *Phyllitis [Petalonia]* has a few species, one of which is also found in the Baltic. *Padinella [Aglaozonia]* that has one species on the Swedish west coast, grows mostly on shell bottoms.

Family 9. Desmarestiaceae. Some species grow close to the water level and among them we find one or another parasite [epiphyte]; other occur in deep water, between 20 and 100 feet or more; they usually grow in associations that compete out other plants, and form meadows on the sea bottom. Harvey cites that in deep, enclosed bays on the coast of North America, *Desmarestia aculeata* (L.) dominates over all other vegetation at about 30 feet depth[9]. Ceratin [species] have a widespread distribution extending through the temperate and cold seas rather far to the north and the south; other are more locally occurring species. Within the warm seas are found just a few, most of them belong to the temperate and cold seas. From the coast of North America just a couple species are known, while in the Mediterranean none. In Scandinavia several; a few extending south to the Sound and one is also found in the Baltic. *Desmarestia,* which is the most rich in species genus belongs really to the Indian and the Pacific Oceans, but also has a few species in the Atlantic and Scandinavia. *Dichloria [Desmarestia viridis]* occurs even in other seas, apart from most Atlantic coasts. *Dictyosiphon* that belongs to the cold seas has a few for Scandinavia unique species. *Litosiphon* also has some species; a couple of these are found in Scandinavia.

[9] Hooker has described a similar situation in a few other species from the Southern Hemisphere.

[PAGE 41]

Order 10. Chlorozoosporales [as Chlorozoosporeae]

Family 1. Siphonaceae belong almost exclusively to the warm seas; therefore, within the examined regions they are met with in the Mediterranean and on the coasts of SW Europe and Central America; few extend up to England and Scandinavia; not a single one occurs in the Baltic. The remarkable genus *Caulerpa* belongs to the tropical and subtropical seas, extending to the north with a few species in the Mediterranean and a few other to New Zealand in the Southern Hemisphere. They occur mostly in sand between high and low water level, but a few [species] are encountered below low water level; some are characteristic for specific sea shores, where they grow within a restricted area; other are widespread throughout the tropics; some species occur in Florida. *Halimeda,* that has a similar distribution, is restricted to the warm seas of both hemispheres; its species apparently thrive well in coral reefs; a few occur on the American coast. A similar distribution even has *Udotea,* and other genera. Of the genus *Codium,* several species are found on the coast of Europe; *C. tomentosum* (Huds.) has a very widespread distribution throughout the Pacific and the Atlantic Oceans; strange is that on the east coast of North America, it has only been found on a few places, while it is common in Europe and in the Pacific. The genus *Bryopsis* is apparently abundant in the Mediterranean; a few species are also found in the Adriatic Sea; as also a few occur along the European and American Atlantic coasts; one of them *B. plumosa* (Huds.) extends north to the Faeroes, to the south until New Zealand, and it additionally occurs in many places both in the Atlantic and in the Pacific Oceans.

Family 2. Dasycladaceae [as Dasycladeae] comprise just a few tropical genera; within the examined regions, a few species occur in the warmer parts of North America and one species is found in the Mediterranean. Apart from *Cymopolia, Dasycladus* and *Acetabularia,* that occur within the regions investigated, a few more genera that belong to this group are exclusively found in the Southern Hemisphere and in the Pacific Ocean.

Family 3. Valoniaceae [as Valonieae] is a group restricted to the tropics and the subtropics, whose few genera and species that occur in the area examined are known from the Mediterranean and Central America. As regards their growing place, it is similar to the previous group; they thrive in coral reefs between the surface and several feet depth. Of the genus *Valonia,* 4 species are found in the regions examined, and they belong to the Mediterranean and Adriatic Seas. Moreover, here belong a few other genera that have one and another species in North America.

Family 4. Ulvaceae occur mainly in the temperate zones, partly in the sea in both marine and brackish water, partly sometimes in fresh water and on humid soil. Species of some here belonging genera occur nearly in all regions. Some are widely spread, other restricted to a small area; thus, several species of *Enteromorpha, Ulva* and *Monostroma* are widely occurring within the examined regions, while other grow just in Flandern, England or in the Gulf of Mexico, a.s.o. *Enteromorpha compressa* (L.) occurs abundantly from the cold regions in both hemispheres to the Equator. *Prasiola* also has several species within the regions examined.

Family 5. Confervaceae [Cladophoraceae] comprise a large number of species that are widely distributed over the entire globe; most of them belong to the fresh water, but a few are also found in marine waters. When they occur in the sea, they thrive best in brackish water or in rock pools between ebb and flood; they are usually met with near the water surface; yet, one or another grows in deep water. The species belonging here are distributed both in Europe and in America, in the Mediterranean and the Baltic. Some of the species, like in the previous group, are widespread, other are restricted in a small area. Both of the two large genera, *Cladophora* and *Conferva* are found within all regions examined here; both have several species in the Mediterranean and the Adriatic Seas. *Hormotrichum [Ulothrix]* and *Rhizoclonium* belong exclusively to the northern seas in Greenland and North Europe. *Hormiscia [Urospora ?]* has a couple of species on our coasts. Numerous of the here belonging fresh water species, are occasionally met with in bays where the water is slightly marine.
[PAGE 43]

Order 11. Algae conjugatae virides

The members of this group are almost exclusively found in fresh water; occasionally in brackish water. To give an account of their distribution in the seas is therefore rather difficult, apparently since they are usually sterile and therefore nearly impossible to identify at the level of species.

Order 12. Diatomales [as Diatomaceae]

This order consists of those unique algae that are silicon-armed, microscopic, and distributed to all seas. On the seashores, like in fresh water, we encounter numerous genera and species of this group; however, from the phytogeographical point of view, we pay less attention to them than to the macrophytic vegetation; but the Diatomaceae deserve our attention even in this respect; since they occur even in places where all other vegetation has disappeared. Through deep dredging and similar ways, we collect from the sea bottom a large number algae belonging to this group, together with small sea animals and mud. We still lack any proof of maximum depth where such Diatomaceae are not found, although we have dredged down to 14.000 feet. They occur in countless numbers in all seas.

Rivularieae and Oscillatorieae

The species that belong to these groups are widespread all over the world under almost all different conditions, on humid soil, in fresh water and even in the sea. Some are attached forms, other are planktonic on the water surface. Numerous of these algae occur often in fresh water and occasionally even in marine water, growing on the surface and producing a shining colour. Since the distribution of these groups is not closely known, it is not possible to give an account of the regions where the various species are found. From the Mediterranean, several unique species are described; similarly, we know of several [species] that are [PAGE 44] exclusively found in the British Isles or within a restricted area in North America, a.s.o. *Calothrix scopulorum* (Ag.) is common throughout the North Atlantic and its various bays; a few species of *Lyngbya* are found both in Europe and North America's coasts. Even in the Baltic occur some members of these groups.

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Since we know that in previous times, water occupied a much larger area on earth than it does now, we can conclude that algae occurred in larger amounts than in our days. Although easily destroyed, have them, as we could expect, left tracks after them in the oldest rich in fossil deposits, where we encounter forms that come close to the Fucaceans or other living algae. If not the first, the algae were surely among the first organisms that appeared on earth. In general, we have not taken into account the influence of the algae in the development of the present earth surface; only for the Diatoms, because of their large number and ability to persist, we have considered some influence in this matter; although microscopic they form unmistakable huge layers of considerable size. Recently, Mohr has advanced an opinion that should be here cited but not critically assessed. According to this hypothesis, the large deposits of mineral coal, that are spread over the world, would namely be the product of algae, which in this way would have considerably contributed to the formation of earth crust. Among other reasons that he takes as a support, he cites that we do not find entire layers of mineral coal with clear structure, but just spread clear rests of higher plants embedded in an amorphous mass; that in the dray distillation of mineral coal, like in the distillation of mixed seaweeds [Fucaceans], we obtain a similar product; [the latter] characterized by a strong percentage of ammonia that it colors the red litmus paper blue, while [on the other hand] using wood, grass or Fucaceans, that have been cleared from their animal epiphytes, we get an acid distillate; that mineral coal usually occurs over a widespread area in very thin layers, and that the algal vegetation in the sea is still capable for an ongoing mineralization.

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