BOTANY

OF

THE FÆRÖES

BASED UPON

DANISH INVESTIGATIONS

PART III

ILLUSTRATED WITH 12 PLATES, AND 51 FIGURES IN THE TEXT

(PUBLISHED BY THE AID OF THE CARLSBERG FUND)

COPENHAGEN AND CHRISTIANIA
GYLDENDALSKE BOGHANDEL • NORDISK FORLAG

LONDON
JOHN WHELDON & CO.

1908

PRINTED BY H. H. THIELE

CONTENTS

APPENDIX.

CORRIGENDA.

Page 711, line 12 from bottom, for *two feet* read *100 feet*
- 711, - 6 - — , for *eight feet* read *eighty feet*

BOTANY

OF

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BASED UPON

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ILLUSTRATED WITH 24 PLATES, AND 202 FIGURES IN THE TEXT

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PREFACE.

With the third volume, the present work on the Botany of the Færöes is brought to an end. I had originally hoped that the work would have been completed three years ago; but more time than was expected had to be expended upon the last volume.

There is, of course, in the vegetation of the Færöes, much which still requires investigation and deeper consideration; and this is more particularly the case in connection with the lower plants and the plant-biology. But these matters must be left for future research, because other more pressing tasks, notably the botanical investigation of Iceland, are now claiming the attention of Danish botanists. It is well known that Danish investigations have been carried on in Greenland for a number of consecutive years, and they will be continued; reference can be made to the standard work, the series Meddelelser om Grønland, published by the Commission appointed for the Geographical and Geological Investigation of Greenland, in which will be found all the Danish investigations made since 1876. The Danish West Indies, also, are being botanically investigated with great energy (see especially Botanisk Tidsskrift, published by the Danish Botanical Society). But among the dependencies and colonies of Denmark, Iceland is the one with regard to which botanical investigation is least advanced; and it is the one which, owing also to its situation between Greenland and the Færöes, will now present the most

interesting field for research. It is my hope that a more thorough investigation will be commenced there as early as the summer of 1909.

My heartiest thanks are due to the many contributors to this work, for the warm interest they have shown, and for the devoted labour and unwearying trouble they have given to the subject.

EUG. WARMING.

Botanical Garden,
Copenhagen,
November 3rd, 1908.

CONTENTS.

Vol. I (1901).

Vol. II (1903).

Vol. III (1905—1908).

APPENDIX.

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THE ALGÆ-VEGETATION OF THE FÆRÖESE COASTS

WITH REMARKS ON THE PHYTO-GEOGRAPHY

BY

F. BØRGESEN.

PREFACE.

This paper contains the final report on my six journeys to the Færöes in the period 1895—1902. During my first three visits (1895, 1896 and 1898) I travelled about, partly by boat, partly by the local steamer »Smiril«, but the last three times I visited the islands, (1899, 1900 and 1902), I stayed on board the vessels stationed at the Færöes for the protection of the fisheries and for surveying purposes, the first two years on the gunboat »Guldborgsund«, in 1902 on the torpedoboat »Beskytteren«.

In this way I have been able to obtain a far more thorough knowledge of the algæ-vegetation than would otherwise have been possible. I have for instance visited all the islands, except Fuglø, and have been on a great many islets and cliffs, and on many remote coasts, where access might otherwise have been difficult. Further, the vessels of the Navy have not only helped me to make wide excursions, but their assistance has also been of advantage to my work as I then had the opportunity of working with larger apparatus than I could have used from a small boat. Thus in 1899 I had the use of a small trawl which helped me to obtain a rich material, and in 1902 a very large iron scraper was used, also with good results.

INTRODUCTION.

As is well known, J. G. Agardh was the first to try to give a description of the different regions of the algal vegetation on the Scandinavian coasts in his well-known work, »Novitiæ Floræ Sveciæ« (2)[1]. In this work he distinguishes between three regions: 1. *Regnum Algarum Zoospermarum.* 2. *Regnum Algarum Olivacearum* and 3. *Regnum Algarum Floridearum,* which are further divided into subregions.

[1] This and the following figures refer to the Index to literature.

At the same period (1836) Lyngbye was dealing with the algæ-vegetation in a paper entitled »Rariora Codana«, which was only published much later (1879) by Professor Warming. Lyngbye makes a division into three Zones: firstly that of the *Ulvaceæ*, reaching from the surface of the sea to a depth of 30 feet, secondly that of the *Florideæ*, as far down as from 30 to 60 feet, and finally that of the *Laminariaceæ*, from 50 to 90 feet. For each zone he mentions a number of specifically characteristic species, partly from Denmark, partly from the Færöes and from Norway. Lyngbye's division does not however seem quite satisfactory to me. It would have been most natural to determine the zone of the *Florideæ* as the lowest one, as in J. Agardh's division. Besides, several species (I refer only to the Færöese specimens mentioned by Lyngbye) do not occur in the depths mentioned. Thus *Fucus loreus, Scytosiphon filum lomentarius* and *Callithamnion arbuscula* are mentioned as belonging to the zone of the *Florideæ*; they are, however, all littoral. *Laminaria agarum* is given as in the zone of the *Laminariaceæ*, but it has never been found in the Færöes; to this zone he also refers *Callithamnion arbuscula*. It seems as if his memory had been failing him, and most likely his strength had already grown less as it was but a short time before his death (compare Warming's introduction [60, page 3]). It must be remembered also, that he wrote his paper many years after his visit to the Færöes.

In 1844 Ørsted published his well-known work, »De Regionibus Marinis«, in which, relying on the above-mentioned work of J. Agardh, he gives a detailed description of the algal vegetation of the Sound. He subdivides this into firstly, »*Regio Algarum viridium s. Chlorospermearum*«, reaching from the surface of the sea to a depth of 2 to 5 fathoms and embracing: »*Subregio Oscillatorinearum*« above, »*Subregio Ulvacearum*« below; secondly, »*Regio Algarum olivacearum s. Melanospermearum*«, consisting of »*Subregio Fucoidearum et Zosteræ marinæ*« and »*Subregio Laminariearum*« below it, and whose upper limit lies in depths of 3 to 5 fathoms and lower in 7 to 8 fathoms; finally, *Regio Algarum purpurearum s. Rhodospermearum,* in depths of 8 to 20 fathoms. Ørsted seeks the chief explanation for this distribution of the Algæ in the varying degrees of penetration of the light through the water, and, in connection with this, in the different colour of the light at different depths.

In addition to these authors, Areschoug, Kleen, Ekman and others have also contributed to our knowledge of the algæ of

the Scandinavian coasts, but it is only in different works by Kjellman, especially in his fundamental work: »Ueber Algenregionen und Algenformationen im östlichen Skager Rack« (45) that a more precise limitation and terminology of the particular algal regions and communities are first introduced. Several papers on the algæ-vegetation have been published later; amongst the more important of these, which are at the same time interesting as a means of comparison with the Færöese algæ-vegetation, I need only mention those dealing with the Norwegian algæ by Boye (6), Gran (36, 37) and Hansteen (38), and the detailed description of the Greenland algal vegetation by Rosenvinge (71).

With regard especially to the Færöes, Landt (57) is, so far as I know, the first to give some particulars of the occurrence and growth of some few algæ, in his list of Færöese algæ. Some short notes are also given by P. A. Holm (40, p. 203, 204). Rostrup, who states (72, p. 16—17) that many algæ are so abundant as to form regular forests of seaweeds, gives some information as to the habits of the algæ; thus he states, that *Porphyra laciniata* occurs abundantly on rocks washed at high tide. The paper by Simmons: Zur Kenntniss der Meeresalgen-Flora der Færöer«, published in 1897, is the first important contribution to our knowledge of the Færöese algæ-vegetation.

In accordance with Kjellman, Simmons makes a division between the littoral, the sublittoral and the elittoral regions, and gives a description of different formations belonging to these regions. Moreover he tries to compare the algal vegetation of the Færöes with that of the coasts of the adjacent countries, and his main results are briefly as follows: the Færöese algal vegetation is characterized by its strong concentration in the littoral and sublittoral regions and by its disappearance at no very great depth; secondly, an algal vegetation closely connected with that of the Færöese seems to occur in Nordland on the western coast of Norway, which lies far more towards the north than the Færöes. As to the first statement, however, I do not consider it quite correct; as a vigorous growth of *Laminaria hyperborea* is found even at a depth of about 15 fathoms (as to this I shall give further information later), and on the whole the algal vegetation is found down to a depth of 25 fathoms, wherever circumstances are favourable to its occurrence. This agrees with the observations made in adjacent countries.

Further investigations of the algal vegetation of Nordland

will probably prove, that there is no little resemblance between the algal vegetation of Nordland and that of the Færöes. Kleen has expressed the same view (51, p. 6—7, Note); but on the other hand, Kleen's descriptions are too brief and too few to allow any final conclusion to be drawn from them. Moreover his statement (page 9) that »on steep, overhanging cliffs, in immediate vicinity of the sea, no sort of luxuriant vegetation is found above the lowest water mark, where mostly nothing but small tufts of *Ceramium acanthonotum* and *Callithamnion arbuscula* occur«[1], is quite incompatible with the luxuriant littoral vegetation of the Færöes.

My investigations on the algal vegetation of the Færöes were published in Danish in the spring of 1904, and the present issue in English is based essentially on the Danish edition. My work has been sharply attacked by Porsild and Simmons, to whose criticisms I have already replied in the »Botaniska Notiser«. Referring to these notices for particulars, I may briefly mention here, that the main criticisms of these authors are directed against my view, that it is quite possible, that the Færöese algal flora may be transported over the sea to these islands. Thus, Porsild maintains that it is a »physical impossibility« for algæ, for example, to be carried from Ireland or the west coast of Scotland across the Gulf Stream to the Færöes. In his opinion algæ from the west coast of Norway, from the Shetlands, Orkneys and Scotland, must be carried far into the Arctic Ocean before they could reach the Færöes; a journey taking at least 3 years, probably more! Porsild further maintains, that but few of the Færöese algæ can float; also, that 26,7 % of all the Færöese species of algæ is what he calls »strictly sublittoral«, meaning thereby those algæ which are never found, in his opinion, so high up as low water mark, and which therefore can never have the chance to fix themselves on floating timber or the like and thus be carried about in the sea. Finally, 12,4 % according to Porsild are calcareous algæ, either living in calcareous shells, or incrusting stones, etc. »These algæ can certainly not float, and by far the majority of them are sublittoral forms, which can also not fix themselves to stones or shells borne by algæ which can float«. As to the biological conditions for the algæ during their drift to the Færöes, Porsild maintains in opposition to my

[1] »På branta, ytterst mot hafvet belägna klippor saknas all rikare vegetation ofvenför lägsta vattenmärket; och man träffar derstädes vanligen blott små tufvor af *Ceramium acanthonotum* och *Callithamnion arbuscula*«.

view: 1) that the biological conditions in the currents, which lead to the Færöes, are very variable and different from those at the Færöese coasts, 2) that marine algæ are very sensitive to changes of temperature and salinity, and also, 3) that the white light of the surface may have a destructive influence especially on the sublittoral algæ, 4) that the algæ could neither fix themselves again after the drift across the sea, nor develop new reproductive organs, these being lost presumably on the way. Consequently, even though cases are known of marine algæ having drifted a long way, yet the probability of any effective distribution occurring in this way is extremely small, and so far as known it has never been observed. Further Porsild opposes the possibility that algoid spores may be distributed widely by the oceanic currents, and considers navigation of no importance as a means of distribution. In fact, according to Porsild, the algal flora of the Færöes can only have arisenthrough some postglacial communication with land.

Simmons entirely agrees with Porsild's view. He also endeavours moreover, to criticise my description of the algal communities and my comparison of the Færöese flora with that of the neighbouring lands, and, for this purpose gives a list of the algal forms of the North Atlantic as well as of the Arctic Ocean. I shall not enter upon further details here, however, but merely mention that his list is not drawn up with sufficient accuracy to enable it o form the basis of a thorough comparison.

I.

ON THE EXTERNAL CONDITIONS AFFECTING THE ALGAL VEGETATION ON THE FÆRÖESE COASTS.

1. Climatic and hydrographic conditions.

a. Temperature and Salinity of the Sea.

The Færöes, lie in the Atlantic Ocean in 61° 23′—62° 24′ N. Lat. and 6° 14′—7° 41′ W. Long. The climate is markedly insular, the temperature very uniform, in summer low, but in winter relatively high. Rain and fogs are frequent, and the climate on the whole stormy and rough. Consequently the sea is most often in motion, and on exposed coasts there is much surf.

This very rough climate is mostly due to the fact that the boundary line between the warm Gulf Stream and the cold East Icelandic Polar Current is found at, or at any rate near by, the

Færöes. The boundary line between these two currents is influenced by the predominant direction of the wind, and thus goes sometimes nort hand east, sometimes west and south, of the Færöes (see Martin Knudsen 52). In a morere cent paper (»Havets Naturlære« 53, p. 29) Knudsen says: »It seems as if the Polar Current hardly ever reaches so far down as to surround the Færöes, but it may happen. On the other hand the Polar Current rarely recedes far northward from the Færöes«.

Whilst the Gulf Stream, as mentioned by Knudsen (52, p. 158), has a rather high temperature and a salinity above 35,25 ‰, the Arctic current is of a much lower temperature, which may even reach the freezing point of the sea in winter and spring, and its salinity is below 35,25 ‰. In summer and autumn a thin layer on the surface of the Polar Current will, however, attain a temperature almost equal to that of the adjacent water of the Atlantic Ocean. The Ingolf expedition passed the dividing line between the two currents several times, and it was then observed: »that in passing from the Atlantic Ocean to the East Icelandic Polar Current the salinity of the surface was reduced from more than 35,25 ‰, to less than this. A slight, but still perceptible, fall of temperature was likewise observed«.

In spite of the proximity of the colder Polar Current, the influence of the Gulf Stream predominates, causing the temperature of the sea to be very uniform all the year round, and in winter especially very high. When Simmons writes (78, p. 263), that it is rather low, his statement must only be applied to the temperature of summer, which is indeed much below that of the west coast of Norway in the same latitude, where an almost corresponding temperature is only met with much farther north, in Nordland. If we look at a map of the Northern Ocean, showing the temperature of the surface in summer (see for instance Hjort, Nordgaard and Gran: Report on Norwegian Marine Investigations 1895 to 1897, Bergen 1899), we observe that the isotherm of 12° C. is drawn midway across the Færöes. The isotherm first bends a little south east towards the Shetland Isles, and then north west to the centre of Nordland. The isotherm of 11° C., which passes close by the west and south coasts of Iceland, extends northward round the Færöes at no great distance from the Nordreöerne, and ends on the west coast of Norway as far up as the centre of Lofoten. The isotherm of 13° C. passes at a somewhat great

distance southward round the Færöes, goes between the Shetland Isles and the Orkneys, and ends on the west coast of Norway, a little north of Trondhjem Fjord. In winter and spring on the other hand the water is warmer round the Færöes than on the west coast of Norway. According to Mohn: »Den Norske Nordhavs Expedition«, 2 vol. Christiania 1883, the isotherm of 6°C. runs in March midway across the Færöes, then it bends northward, then southward, and stops almost in the centre of the east coast of Scotland.

According to observations made near Thorshavn (see Willaume-Jantzen 84, p. 29), the annual mean temperature of the surface of the sea is 7,8°C.; from January to March its temperature is 5,5°C., and from July to September 10—10,5°C., in exact accordance with the average observations of 20 years. The lowest mean temperature of the surface of the sea was in one month (March) 4,25°C., and the highest in an equally long period (August) 11,75°C. These figures clearly show the very small difference of temperature in the sea round the Færöes, where the greatest difference observed between the mean temperature of the warmest and the coldest months thus only amounts to 7,50°C. Ice is also unknown, and it is only in the inmost part of the larger fjords such as Skaalefjord, little affected by the tides, and where much fresh water streams into the sea, that the water may sometimes be covered by a thin crust of ice.

The above-mentioned figures only refer to the surface of the sea, but as the marine algæ are found down to a depth of about 25 fathoms, (for the Færöes I believe that this may be stated as the lowest limit), it would of course be of interest to our subject to know the temperature as far down as this depth. Such observations, however, do not exist, so far as I know, but on my application the officers of the »Guldborgsund« in 1899—1900 were kind enough to obtain some hydrographical data by aid of a reversing thermometer lent me by the Metereological Institute. The accompanying table shows the results of these observations and indicates that the difference of temperature between the surface of the sea and the lower layers of water is exceedingly small. During the warmer period of the year the temperature of the surface rises slightly, yet seldom more than $^1/_2$°, whereas in winter the water is somewhat warmer deep down than on the surface. In the fjords only, there may be a greater difference (see e. g. the observation $^{10}/_2$ Klaksvig); it is due

Deep-water temperatures in the sea around the Færöes 1899—1900.

(The temperature is given in degrees Celsius and is everywhere +).

Locality	Date	Time	Surface	5 fathoms	10 fathoms	15 fathoms	20 fathoms	25 fathoms
Fuglefjord	1900 16/1	p. m. 1½	6.5°	6.8°	6.8°	Bottom 7.0°		
Klaksvig[1]	1900 10/2	noon 12	1.8°	Bottom 5.5°				
Sjov (Strömö)	1900 12/2	p. m. 6	4.0°	4.3°	4.5°	4.9°	Bottom 5.1°	
Sörvaag	1900 28/2	a. m. 10	4.8°	4.3°	5.3°	Bottom 5.4°		
Kvannesund	1900 10/2	p. m. 3	5.5°	5.5°	Bottom 5.5°			
Lopra	1899 17/6		9.0°	8.8°	Bottom 8.7°			
Viderejde	1899 14/7		9.2°	8.8°	8.7°	8.8°	8.9°	Bottom 8.8°
Thorshavn	1899 21/7		9.4°	9.8°	Bottom 9.2°			
Trangisvaag	1899 26/7		9.4°	9.1°	9.0°	Bottom 9.0°		
Tværaa	1900 8/8	p. m. 4½	10.3	10.0	10.0	Bottom 9.8		
Porkere	1900 9/8	p. m. 3	10.3	10.0	Bottom 9.9			
Tværaa	1900 28/8	p. m. 3	10.8	10.2	10.0	Bottom 9.9		
Tværaa	1900 29/8	p. m. 7	10.4	10.0	10.0	Bottom 10.0		
Thorshavn	1900 1/9	a. m. 7½	10.2	10.0	Bottom 9.9			
Vestmanhavn	1899 18/9	p. m. 2½	10.1°	Bottom 10.0°				
Thorshavn	1899 21/9	a. m.	9.9°	9.9°	Bottom 9.8°			
Kongshavn	1899 22/9	p. m. 3	9.8°	9.8°	9.8°	9.8°	Bottom 9.8°	
Trangisvaag	1899 2/10	a. m. 7	9.0°	8.5°	9.1°	Bottom 9.1°		
Fundingsbotten	1899 8/10	a. m. 1½	9.5°	9.3°	9.2°			
N. f. Ennebjærg (Viderejde)[2]	1899 1/11	a. m. 10½	9.6°	9.7°	9.8°			

[1] The surface of the sea covered with snow. Calm.
[2] Change of current; depth, 45 fathoms, the thermometer was broken at 15 fathoms.

here to the more stagnant water, the surface of which may be somewhat cooled at a low temperature of the air, whereas the water of the open sea and of the sounds is constantly renewed by the strong current and mixed with the lower water-layers, so that it does not have time to be cooled to any degree worth mentioning. The algæ growing in deep water live consequently at more uniform temperatures than those growing in shallow water.

Near the shore among the seaweeds and in tide pools, the sun of course may warm the water to a considerable extent, so as to make it almost lukewarm; thus in a somewhat large water-basin at Skuö, 25° C. was observed on June 11th, 1900, and in smaller pools the temperature may certainly rise still higher.

As to the salinity, it varies, as already remarked, according to whether the salter water of the Atlantic Ocean (above 35,25 ‰) or the less salt water of the Polar Current reaches the coasts; the difference however is never very great.

Fresh water streams into the sea from almost all parts of the Færöese coasts, but on account of the strong oceanic currents it has hardly any effect in comparison with the large volume of circulating seawater, and as a rule it is only of local importance to the growth of algæ at the outlets of brooks and waterfalls. But at the bottom of larger fjords, where the water is more seldom renewed, the fresh water from the land is perceptible to a greater extent, and here the water often becomes more or less brackish. This has no small influence on the algal vegetation, which in these places is extremely poor in species.

b. Tides. Oceanic Currents.

Tides occur almost everywhere on the coasts of the Færöes. The difference between high and low tide is not great, as the tide does not rise to anything like the heights reached on the coasts of Norway and Scotland.

On the western side of the islands, where the tidal wave is strongest, the difference between ebb and flood will at most amount to 8—10 feet during the spring-tides, on the eastern side to hardly more than 4—5 feet.

The accompanying observations on the tides, made in the summer of 1900 and kindly placed at my disposal by the officers of the »Guldborgsund« further illustrate this. The observations extend

over quite a month, during which period the weather was calm, so that storms had no disturbing effects.

Vaagfjord (open to the east). Almost at the end of the fjord, the difference between high and low water is a little more than 3 feet when the current is strongest (spring-tide); with »fair« current (neap-tide) only $^3/_4$ feet. High and low water occur very regularly in this fjord.

Trangisvaagfjord (open to the east). High and low water do not occur so regularly in this fjord as in Vaagfjord. When the current is strongest the difference is generally about 3 feet, but one day during the period of observation it reached 6 feet; with »fair« current the difference is only 1 foot.

Sörvaagfjord (open to the west). Regular tides occur. At spring-tide there is a difference of ca. 6 feet, at neap-tide of ca. 3 feet.

Midvaagfjord. The fjord is open to the south-east, but on account of the western situation of the island the difference is considerable. Regular tides occur. At spring-tide there is a difference of ca. $5^1/_2$ feet, at neap-tide of $2^1/_3$—3 feet.

Vestmanhavn. The fjord is open to the west, and at Vestmanhavnsund to the north-west and south-west. Regular tides occur. At spring-tide there is a difference of ca. 6 feet, at neap-tide of ca. 2 feet

Sandsbugt (open to the south-west). Regular tides occur. At spring-tide there is a difference of about $5^1/_2$, but it may reach to about 7 feet; when the current is »fair« the difference is hardly 2 feet.

As appears from these observations, the greatest difference noted with certainty is about 7 feet; but there is no reason to doubt that there are places where a somewhat greater difference may occur. This is probably the case on the western side of Syderö and on the north-western side of Strömö. At Famien on Syderö, the inhabitants have told me that the difference may amount to from 8—10 feet. These figures are however small in themselves and would only mean a littoral algal vegetation of relatively limited extent compared with that of the western coasts of Norway and of the British Isles, were it not that other circumstances aid the algæ of exposed coasts to grow even far above the highest water mark.

The tidal wave, or, as they say in the Færöes, the »Westfall« and the »Eastfall«, produces a very rapid current, changing regularly every 6th hour[1] in open fjords and especially in the sounds.

At spring-tide, when the current is most rapid, it may in certain places, such as Vestmanhavnsund, flow as fast as 8—10 miles an hour, and in such places the larger algæ are of course exposed to a very great strain.

Whilst on all exposed coasts and in most fjords and sounds

[1] Nolsöfjord however excepted; on account of peculiar circumstances the current there runs 8 hours one way and 4 hours the other.

there are tides and consequently currents, there is a large tract of water without either tides or currents, or with at any rate almost imperceptible ones. This is found between Strömö and Österö, bounded on the south by a line drawn from Höjvig to Næs on Österö, reaching on the north as far as Kvalvig in Sundelaget, thus including the three large fjords Skaalefjord in Österö, Kalbak- and Kollefjord in Strömö, besides »the Sounds« between both islands. This almost stagnant area of water naturally shelters an algal vegetation of a peculiar kind. It is e. g. the true habitat of *Laminaria fœroensis*, and this characteristic alga reaches here its highest development.

c. Action of the Waves. Exposed Coasts; sheltered Coasts.

As already mentioned, the surf breaks more or less vigorously on all the coasts of the Færöes during the greater part of the year. The heavy, unbroken waves of the Atlantic roll in on the mostly steep and rocky coasts, and during the storms of winter the waves may be strong enough to move rocks, as was the case at Bosdalafos on the western coast of Vaagö, about 80 feet above the level of the sea. It may even happen, that the sea rushes into Sörvaags Lake itself, to which Bosdalafos is the outlet. It is not unusual for the surf to reach 100 feet up the cliffs, and it has even been said to reach several hundred feet up. Even in summer, when the weather is fine, there is almost always some surf produced by the swell, when it meets the land. Still periods may occur, especially in summer, when the weather is so fine and the sea so calm that the surf almost disappears.

When the algal vegetation of a country is investigated, it will soon be observed, that the more or less exposed condition of the localities is of great importance. The open coasts, constantly exposed to the surf, are covered by an algal vegetation differing greatly from that on sheltered coasts. The difference is so great, that with some few exceptions the species growing on exposed coasts are of quite another kind than those growing on sheltered coasts. This is quite easy to explain, as the mechanical influence of the waves is not the only influence affecting the algæ of open coasts in contrast to those on sheltered coasts; it is also probable, that the water is more rich in oxygen, more nutritive and often salter than in sheltered places, and further the water coming in contact with the algæ is more frequently renewed by the dashing of the

waves on exposed coasts than is the case on sheltered coasts, where the change of substance is likely to occur more slowly.

From the composition of the algæ-vegetation one may tell at once whether the coast on which they grow is exposed or sheltered, and if we come from the open sea towards a sheltered place we may notice how the algal vegetation changes in character. The change often comes on gradually, but sometimes a sudden bend in the coast may as suddenly change the character of the vegetation.

This fact may often be observed, and by way of illustration I may mention an investigation I made from the mouth to the head of Kalbakfjord. I landed at short distances along the southern side of this fjord, starting from Hvidenæs and noting the most important species of algæ. Tides and current are here scarcely perceptible.

At Hvidenæs there is a perfect »open sea« algal vegetation. Some small creeks with calcareous gravel excepted, the coast is here mostly steep, almost vertical, and as is usual in such places is covered from low water mark downwards by a dense *Alaria*-vegetation, and above it by the *Balanus*-belt, which supports several of the smaller red and brown algæ, e. g. *Ceramium acanthonotum*, *Polysiphonia urceolata*, *Callithamnion arbuscula*, *Ectocarpus litoralis*, etc. The littoral vegetation is however rather scanty on these vertical cliffs, which is probably due to the fact, that the sea is often relatively calm at this place, especially in summer, Nolsö as well as Österö yielding it some shelter. A little west of Hvidenæs (the place is marked 1 on the accompanying sketch, Fig. 151) the following species were the most prominent, passing upwards from the sea level: *Alaria esculenta*, *Himanthalia lorea*, *Gigartina mamillosa*, *Ceramium acanthonotum*, *Callithamnion arbuscula*, *Scytosiphon lomentarius* in small numbers in shallow pools, *Fucus spiralis f. nana* and *Porphyra umbilicalis;* as may be seen, exactly the vegetation of exposed coasts. A little farther on, at 2, where the shore is likewise steep, but with scattered rocks fallen from the overhanging cliffs, almost the same algæ were found: *Alaria esculenta*, *Himanthalia lorea*, *Gigartina mamillosa*, *Fucus spiralis f. nana*, *Porphyra*, *Enteromorpha intestinalis* var. *genuina* and var. *micrococca*. We thus have still the algal vegetation of exposed coasts, which was also found at 3, although the somewhat larger forms of *Fucus* indicate a somewhat more sheltered spot, viz.: *Alaria esculenta* and *Laminaria digitata*, *Himanthalia*, *Polysiphonia urceolata*, *Gigartina mamillosa*, *Ceramium acanthonotum* and *C. rubrum*, *Callithamnion arbuscula*, rather large

specimens of *Fucus inflatus, Fucus spiralis f. nana, Porphyra umbilicalis* and *Enteromorpha.*

At 4, the algal vegetation has also the character of algæ belonging to somewhat exposed coasts. The shore was here rather steep with almost flat rocks in front close to the water's edge; here were found *Laminaria digitata, Alaria esculenta* with a subgrowth of *Corallina, Gigartina mamillosa, Chordaria flagelliformis, Scytosiphon lomentarius, Ceramium rubrum*, large specimens of *Fucus inflatus* with *Elachista fucicola, Porphyra umbilicalis, Enteromorpha intestinalis* var. *micrococca* and *Ectocarpus litoralis.* At 5, the flora has still almost the same character; here were found *Laminaria*

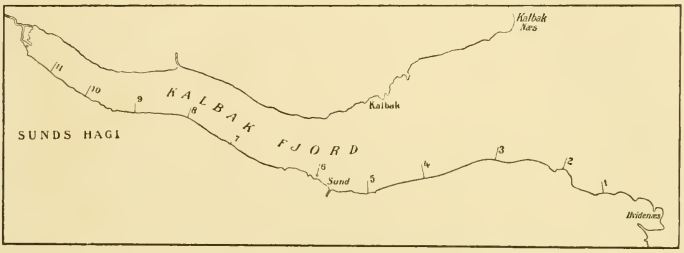


Fig. 151. Sketch of Kalbakfjord after the map of the generalstaff.

digitata, L. saccharina, Alaria esculenta, Himanthalia lorea, Rhodymenia palmata, Gigartina mamillosa, Ceramium rubrum, Dumontia filiformis, Acrosiphonia spec. *(albescens?), Fucus inflatus* (large) with *Elachista fucicola, Fucus spiralis* (large) and *Porphyra.* Close by the village of Sund there is a small and low mass of rocks (6). On its eastern side, towards the mouth of the fjord, the following species were found: *Laminaria digitata, Alaria esculenta, Himanthalia, Rhodymenia palmata, Gigartina mamillosa* and *Ceramium acanthonotum, Acrosiphonia, Fucus inflatus* (large), *Porphyra* and *Enteromorpha inestinalis*, the principal vegetation thus resembling that of exposed coasts; on the other hand, the western side of the rock, facing landwards, was covered by the typical flora of sheltered coasts, with *Fucus vesiculosus* at the top and next to that large luxuriant masses of *Ascophyllum nodosum* covering the almost horizontal surfaces from high water mark downwards. On the rock were found several pools of different sizes filled with water, the bottoms covered by *Corallina officinalis*, and *Leathesia difformis* was growing epiphytically on the latter in great profusion. *Monostroma fuscum, M. Gre-*

villei, *Chordaria flagelliformis*, *Ceramium rubrum* and *Acrosiphonia* spec. were also found.

From Sund a little farther up, the fjord inclines slightly towards the north, with the result that the algal vegetation remains similar to that of somewhat exposed coasts; at 7, where the coast is fringed by steep rocks, were found: *Alaria esculenta*, *Laminaria digitata*, *Rhodymenia palmata*, *Fucus inflatus* (large), *Ceramium rubrum*, *Porphyra* together with *Bangia* and *Urospora penicilliformis*, and still farther, at 8, *Laminaria digitata*, *Alaria esculenta*, *Corallina officinalis*, *Gigartina*, *Cladophora rupestris*, *Fucus inflatus* (large), *Fucus spiralis* (large), *Porphyra umbilicalis*, *Enteromorpha*, and so on, that is, a vegetation typical on the whole of somewhat exposed coasts, but large and vigorous specimens of *Fucus spiralis* and *Fucus inflatus*, up to 2 feet long, now occur. That the waves may wash heavily at times even so far up the fjord as this, is clear from the fact that there was some surf even on the day of my visit, in spite of the great calmness of the sea.

The fjord now bends again more towards the west, and the vegetation is henceforward typically that of sheltered coasts. At 9, the beach slopes gently and is covered with stones of different sizes on which are found sublittorally *Laminaria saccharina* and *Chorda filum*, (*Alaria* is now no longer found), *Himanthalia lorea* and *Fucus inflatus* (on open shores, the two last are always littoral), the lastmentioned still continuing far enough upwards to become littoral, and to form large clumps on the stones; then come *Fucus spiralis* and some few *Porphyra umbilicalis*. A little farther, at 10, in water one foot deep, were found: *Chorda filum*, *Laminaria saccharina*, *Ceramium rubrum*, *Monostroma fuscum*, *Enteromorpha Linza*, *Ectocarpus litoralis* (in large, thick masses), *Dictyosiphon foeniculaceus*, *Stictyosiphon tortilis*, *Scytosiphon lomentarius*; in shallower water: large clumps of *Fucus inflatus;* and at the surface: *Fucus vesiculosus* and *Fucus spiralis*, the latter partly dried. Still farther, at 11, were noted: *Laminaria saccharina*, *Ceramium rubrum*, *Acrosiphonia*, *Enteromorpha Linza*, *Monostroma fuscum*, *Dumontia filiformis*, *Fucus inflatus*, all sublittoral; and at the water's edge and a little above: *Ascophyllum nodosum*, *Fucus vesiculosus* and *Fucus spiralis*.

At the head of the fjord, *Enteromorpha clathrata*, *E. intestinalis*, *Ectocarpus litoralis*, *Ceramium rubrum* and *Fucus inflatus* were found at low water; farther also, *Fucus vesiculosus* and *Fucus spiralis* littorally, and highest of all *Pelvetia canaliculata*. Much fresh water

flows into the sea here, which is therefore often very brackish, and at certain places almost fresh. Even at the mouths of the large effluents only *Enteromorpha intestinalis* and a few *Ectocarpus litoralis* are found, but at a short distance from the exit specimens of *Fucus*, *Enteromorpha clathrata*, *Ceramium rubrum* and others.

Thus it is evident, and examples can be met with everywhere in the Færoës, that in passing from exposed to sheltered coasts the flora of these two localities will be found to vary greatly. Further illustration of this will be given in the section concerning communities of algæ.

Flowing or stagnant water are likewise of great importance to the algal vegetation and give it a widely varying character. The current constantly carries fresh sea-water, and thus new nutritive substances, to the algæ, whereas the vital functions must naturally proceed more slowly in stagnant water, where the supply of fresh sea-water is much smaller. If we examine the same forms of algal vegetation, e. g. the *Laminaria hyperborea*-association, we likewise find it much more vigorously developed than in places where the water is stagnant. Most likely this is also due to the mechanical influence of the current; at any rate we find a very well developed algal vegetation in places where there are rapid currents.

Just as a current causes fresh-water plants to become elongated, many algæ growing in places much exposed to currents have long and rather narrow fronds. I have seen very fine examples of this at Götebue near Mjovenæs on Österö, on dredging in ca. 10 fathoms of water. Here a *Laminaria hyperborea*-association was found, in which the main plant was strong and robust, but the lamina had narrow laps; and growing epiphytically on this, were some *Delesseria alata* a foot in length, and some still longer *Delesseria sinuosa* and *Odonthalia dentata*, all with very narrow fronds. On the other hand, the thallus of other species e. g. *Euthora cristata* and *Rhodophyllis dichotoma* was broad and robust in this place as elsewhere in rapid currents and on exposed coasts.

The same species of algæ is often very different in its appearance according to its habitat. Thus it seems, that many algæ in sheltered places are inclined to form proliferations, that is, long, thin appendages from the otherwise broad thallus; fine examples of this are shown by *Delesseria sinuosa*, which in sheltered places has a peculiar form, f. *lingulata*, remarkable for its numerous narrow proliferations, and *Enteromorpha intestinalis*, a variety of

which, var. *prolifera*, has by many authors been designated a separate species, but which is most likely nothing but strongly proliferating individuals, often loose and floating, growing in sheltered places.

In other species, such as *Rhodophyllis dichotoma*, the thallus becomes almost filiform when it grows at the bottom of fjords, but may become a centimeter broad in the open sea, as mentioned above. Kjellman has given a description and sketch of this peculiar narrow form (48, table XII, fig. 3). Exactly the same may be said with reference to *Euthora cristata*, which, as mentioned above, is robust with rather broad fronds in the open sea, whilst these are almost filiform in fjords. According to Rosenvinge (71, p. 227), similar conditions have been observed in Greenland.

Other species are also more or less transformed in stagnant water, e. g. *Himanthalia lorea*, the receptacles of which may become irregularly swollen; *Laminaria digitata*, where the lamina, as is well known, is split into a great many lobes, and which on exposed coasts with rapid currents has a form known as f. *stenophylla*, considered a separate species by many algologists, is often found in places of stagnant water with its lamina undivided and more or less sinuous and often urceolate in shape (f. *cucullata*). The fronds of *Alaria esculenta* and *Laminaria saccharina* likewise change according to the habitat. A special form of the latter, f. *linearis*, is found on exposed coasts and is remarkable for a narrow, but thick and robust thallus (see fig. 85 of my flora), whereas its broad forms, f. *bullata* and f. *grandis*, are found in sheltered places or in deep water; *Alaria* too becomes broad in sheltered places without currents (the narrow form from exposed coasts is drawn in my flora p. 449, fig. 84). It is most peculiar, that similiar conditions may act quite differently on different species of algæ, as may be seen from the preceding. I am unable to explain this satisfactorily.

d. Temperature and Humidity of the Air.

So far as the littoral algæ are concerned, and especially in the Færöes where the littoral algal vegetation often reaches far above the highest water mark, the warmth and humidity of the air are naturally of great importance and may therefore be briefly mentioned here.

With regard firstly to the amount of heat, the average temperature is 6,5 ° C. according to Willaume-Jantzen. January, the coldest month, has a temperature of 3,2°, July, the hottest, 10,8° C.,

and according to observations during 25 years the lowest temperature is — 11,6 °, the highest 21,2 °, but these extremes are very rare and on the whole of very short duration when they occur. Thus it is evident, that the temperature of the Færöes is relatively high in winter, low in summer, and very uniform all the year round. It is of course the direct influence of the sun that is of special importance to the algæ, and on hot, sunshiny days the amount of heat and consequently the evaporation and drying increase considerably. But days of really hot sunshine are as a rule few, (the Færöes have no so-called summer days, according to Willaume-Jantzen); moreover, the sun's warmth acts directly, as a rule, for but a short period and is soon replaced by rain, fogs or clouds, so that the danger of the algæ on the Færöese coasts being exposed to high temperature and consequently to évaporation is greatly diminished.

The amount of humidity in the air is rather high in the Færöes; for the whole year it is 82, in summer a little more, about 85, in spring a little less, about 80. Deviations naturally may occur, but are generally of short duration.

The very uniform and low mean temperature of the air together with the high degree of humidity, both varying but a little from the normal, are certainly of great importance to the littoral algal vegetation, the very luxuriant growth of which is certainly due for the most part to these conditions. This view has partly also been put forward by Simmons (75). On page 263, he writes: »Das Auftreten vieler Arten in weit höherem Niveau als sonst, kann deshalb, was die färöische (und wohl auch Nordlands) Algenvegetation betrifft, nur oder wenigstens am besten durch die Temperaturverhältnisse erklärt werden.« In addition to the temperature, the little direct sunshine, the weaker light on the whole, the humid air with much rain and fog, and especially the rough sea are naturally likewise important factors.

e. Light.

The climate of the Færöes is, as already mentioned, rich in fogs, rain, and cloudy weather, and on the other hand rather wanting in sunshine. According to Willaume-Jantzen, the amount of clouds at Thorshavn is 7,4 (0 = clear sky; 10 = overcast); and the Færöes have in all 178 »cloudy days«, that is,

days when the amount of clouds stands at 8. We must add that the amount of clouds is the greatest and fogs the most frequent at the brightest time of the year. The direct influence of the sun on the algæ-vegetation is thereby still more diminished just at the time of the year, when it might be most effective; at the darker time of the year the sun is so low in the sky, that its influence is but very slight.

Thus the fact, that the algæ-vegetation on the coasts of the Færöes does not grow at any greater depth, may most likely be accounted for by the small amount of sun and light. By dredging in a depth of 25 fathoms, I have sometimes found some tolerably well developed specimens of some *Florideæ*, but no vegetation whatever will by any means be found below 25—30 fathoms.

This is in agreement with Rosenvinge (71, p. 233), when he says: »As to the Arctic and the northern part of the Atlantic Ocean, all investigators seem to agree in this, that below 20 fathoms nothing but a scanty algæ-vegetation is in any case to be found, whereas it is very usual for the vegetation to reach as far down as this.« In more southern countries the algæ-vegetation will, however, be found at much greater depths. At Capri in the Bay of Naples, in clear water, Berthold (5, p. 414) found a luxuriant algæ-vegetation of deep-water forms at a depth of 120—130 metres, that is, almost three times as far down as at the Færöes[1]. It is true that algæ have been said to be found in very deep water, even in arctic districts, but these statements are surely in so far incorrect, as the algæ fished up in deep water were certainly floating and not fixed to any substratum, which has been pointed out by Kjellman and Rosenvinge.

On the whole, the fact, that the intensity of light diminishes and its colour changes as depth increases, is one of the most important factors as to the distribution of the algæ. As to the Bay of Naples, Berthold points out (5, p. 415), that among algæ growing in greater depths the *Florideæ* are certainly predominant, whereas only a small number of *Florideæ* and *Chlorophyceæ* but especially the bulk of brown algæ seek direct sunshine in shallow water. This is, however, almost in agreement with what has been observed at the Færöes. I have found that the *Laminariæ* and other larger,

[1] According to Sauvageau (77, p. 234—5, note), Rodriguez observed that the extreme limit to which the algæ-flora reached was 160 metres in the middle of the Mediterranean Sea, near Minorca.

brown algæ generally disappear at a depth of about 15—20 fathoms, leaving an almost pure vegetation of *Florideæ*, with the exception of some green, and bluish-green algæ, living in testa, and, however, often turning reddish here. On the beach, especially in its lower part, as well as in the upper part of the sublittoral region, where light is still intense, a vigorous vegetation of brown algæ is found. To these must be added several algæ, especially some green and bluish-green at the upper part of the beach, and at the lower part several red algæ.

That this distribution is principally, perhaps solely due to light, its quantity as well as its quality, may easily be proved by an investigation of the algæ-vegetation of one of the numerous caves on the coasts of the Færöes. When rowing into such a cave, it will be observed, that the species of algæ, common at the entrance, gradually disappear and are replaced by a great many different sublittoral *Florideæ*, directly under the surface of the water[1]. This will be more thoroughly explained later on, when the cave vegetation is dealt with. This fact has also been mentioned by several investigators, e. g. Berthold and Falkenberg (18, p. 220). But whilst Berthold only seeks the cause of the distribution of algæ in the intensity of light, Gaidukow maintains that it is entirely due to its quality. Founding his opinion on Engelmann's well known investigations as well as on his own, Gaidukow has recently in an interesting and instructive paper (35) clearly shown, that the distribution of the algæ is not so much due to the intensity as to the colour of the light. The fact is, that the green and bluish-green algæ grow uppermost, as the red

[1] In this connection it should however not be forgotten, that it seems as if some sublittoral species on the shores of the Færöes are only to be found at a certain depth. never directly under the surface of the sea, not even in dark places, e. g. several species of *Lithothamnion, Callophyllis laciniata, Rhodophyllis dichotoma, Antithamnion Plumula, Desmarestia aculeata* and *D. viridis*, etc. As to Greenland, some species are likewise mentioned by Rosenvinge (71, p. 228) as never occurring near the surface of the sea. He thinks that this is due to the fact, that temperature and salinity both become less variable as the depth increases. Several of these algæ may however be found littorally in other districts. Kjellman for instance states, that *Desmarestia aculeata* and *D. viridis* can occur in the littoral region, on the west coast of Norway, and *Antithamnion boreale* is sometimes met with littorally in the Norwegian Polar sea. Le Jolis (58) writes that *Callophyllis lacinata* is to be found at the lowest part of the beach. As these algæ do not appear on the shores of the Færöes at such a high level, even in the caves, it is most probably due to the fact that they cannot bear the strong surf here.

rays which they especially need, already become fainter at a small depth. The red algæ grow deepest, as they need the green rays, occurring at greater depths, the most; finally the brown algæ are specifically fitted for growing at a depth between that of the green and the bluish-green algæ on one side, and that of the red algæ on the other side. He calls our attention to the fact, that the algæ are very well able to accommodate themselves to the colour of the light of their habitats. He refers to the interesting observation made by Nadson, that certain *Cyanophyceæ* and *Chlorophyceæ* are represented by green specimens, near the surface of the sea, and by red, in deep water. This may also happen on the coasts of the Færöes, as I have already mentioned. Nadson thinks for instance, that *Conchocelis rosea* is a deep water form of *Ostreobium Quekettii*.

Berthold and Oltmanns determine the *Florideæ* as shade plants, but this is criticised by Gaidukow, who asserts that Oltmann's experiment only confirms Engelmann's theory, that the *Florideæ* of deep water have the typical colour of the *Florideæ*, because they grow in green and blue light, whereas they turn brown and yellow near the surface in the white light[1].

The Engelmann-Gaidukow theory on the whole coincides with my observations; still it seems to me that the quantity of the white light must practically be of no small importance not only to the colour of the algæ, but also to their distribution. On the coasts of the Færöes, on the beach, and even above it, a great many *Florideæ* of a deep red colour are found, perhaps sometimes of a more reddish-brown, but I have hardly ever seen them turning almost light yellow as the same species do, for instance, on the west coasts of Norway or on our own coasts[2]. No doubt this is due to the weaker light at the Færöes, where fogs are frequent, and the sky much overcast; and as a vegetation of *Florideæ*, typically red and including some of the forms usually belonging to great depths, is often found in small inlets between Thorshavn and Arge, in water not even 2 fathoms deep and overshadowed by *Laminariæ*, this is certainly also due to the

[1] In the West Indies *Florideæ* growing in shallow water, exposed to direct sunlight, are often perfectly green, or bluish-green, e. g. *Grateloupa filicina*. Svedelius has observed the same fact on the shore of Ceylon (compare: Bot. Notiser. 1905, p. 181).

[2] On one occasion I found *Porphyra umbilicalis* turning yellow, in the sounds north of Kvalvig.

weaker, but yet rather white light, which reaches it. The *Florideæ* growing near the surface of the sea, in the often very lofty caves on the Færöes, must likewise be supposed to get a some perhaps rather weak, but still white light, besides the still weaker, reflected, blue or green light, that comes up from the sea.

As the epiphytes on stipes of *Laminaria hyperborea* have always been found to be growing in a precise order, from the top downward (more will be said of this in connection with the *Laminaria hyperborea*-association), it is certainly solely due to a regard for light. The fact is, that those at the top are algæ wanting much light, and those further down, overshadowed by the latter, are algæ generally found in greater depths. Similar observations have been made by Berthold in the Mediterranean (5, p. 421—422), showing that the epiphytic algæ on a stem of *Cystosira* are likewise arranged according to their requirements of light.

Light is likewise, as before mentioned, of no small importance to the colour of the algæ, especially to the *Florideæ*. *Florideæ* growing in deep water or in the shade are of pure, bright red colour; most *Florideæ* growing littorally are of a dark reddish-brown often of an almost blackish shade, e. g. *Callithamnion arbuscula, Ceramium acanthonotum, Gigartina mamillosa, Polysiphonia urceolata, Porphyra umbilicalis, Chondrus crispus* and others, whereas the same species, when they find themselves in the shade, will recover their bright *Florideæ*-colour. According to Berthold (5, p. 416—417) the same thing has been observed in the Bay of Naples. This author likewise points out, that many more *Florideæ* are found on exposed than on sheltered coasts. This is in perfect agreement with my observations made on the coasts of the Færöes. That the *Florideæ* are thus found growing littorally in great numbers on exposed coasts, must naturally in the first instance be attributed to the fact that, in conformity with the Gaidukow-Engelmann's theory, they are of a reddish-brown colour. There may surely, however, also be some truth in the explanation given by Berthold, who supposes that, as the algæ are constantly stirred by the surge, and thus incessantly turning other sides to the light which reaches them, the influence of the light can only be of short duration on each part of their thallus; moreover the foam of the surf also lends some shade. Possibly many of these algæ are in different degrees adapted to stand the intense light; several species, e. g. *Chondrus crispus, Rhodymenia palmata, Odonthalia dentata* become

beautifully iridescent, as they are able to reflect certain rays of the light that reaches them, and it has been proved by an experiment made by Berthold (l. c. p. 419), that a vigorously iridizing specimen of *Chylocladia kaliformis* lost its iridizing power by being placed in the shade, and recovered it by being once more exposed to the light. A rich profusion of hairs is likewise probably of some importance to the algæ, as a means of protection from the intensity of the light. Several of the algæ growing in shallow water, especially in sheltered places, e. g. most of the species belonging to the *Stictyosiphon*-association, are rich in hairs. It is however most probable, that the hairs are in the first instance meant to serve as organs of absorption and respiration, as pointed out by Rosenvinge[1]. Whether they are likewise capable of defending the algæ against the dashing of the waves, as suggested by Henckel (Scripta botanica XX, p. 105), I cannot tell.

From what precedes it will be seen that I do not fully agree with Simmons when he writes (p. 262): »Was den Einfluss der Lichtintensität betrifft, so bin ich geneigt anzunehmen, dass man besonders, vas die Florideen angeht, derselben zu grosse Bedeutung hat zutheilen wollen. Wie will man nämlich erklären, dass im nordwestlichen Norwegen, wo doch im Sommer nicht von geringer Lichtintensität die Rede sein kann, die noch dazu während der Ebbe trocken liegende Litoralregion so viele Florideen beherbergt?«

There are always some *Florideæ* which require a great deal of light, and in the Færöes, where the light is far from strong, and the direct insolation particularly slight, a great many *Florideæ* may therefore easily thrive on the beach, even above the highest water mark, without fading, whilst they fade in districts with more light, are less numerous, and do not grow so far above the level of the sea, except where local circumstances are especially favourable.

During a journey in Norway in 1904, I stayed a few days at Christianssund, thus getting an opportunity of observing the algæ-flora there. It was interesting to observe, how much less developed the littoral algæ-vegetation was here than on the Færöes, the floral composition of the two vegetations, however, being much the same. The *Florideæ* were faded, light yellow to yellowish-

[1] Rosenvinge, L. Kolderup: Sur les organes piliformes des Rhodomelacées (Oversigt over det kgl. danske Videnskabernes Selskabs Forhandlinger, 1903, Nr. 4, p. 447—449).

brown, the vegetation was scattered, and with the exception of some faded fragments of the *Bangia*, it did not reach beyond high water mark. It was moreover most instructive to notice the difference between the littoral algæ-vegetation of coasts facing the North or facing the South. On exposed shores of the former places a rather luxuriant algæ-vegetation grew, not only littorally, but even above the highest water mark, whereas the latter places were almost destitute of algæ. I have not met with a similar difference on the coasts of the Færöes.

2. Nature of the Coast.

The Færöese coast is particularly favourable to algal vegetation. We meet with more or less broken cliffs everywhere on the open shore, especially on the northern and western sides of the islands. The rocks are of basalt and similar readily crumbling materials, which the wearing of the sea and weather make very uneven, thereby offering a very good hold for the algæ.

Sometimes the walls of the cliff descend almost vertically to considerable depths, sometimes they slope down gently and evenly, allowing the surf to wash up the slope constantly. Or long stretches of the coast, as at Myggenæs, on the western side of Syderö and the northern sides of Strömö and Vaagö, are wild and rugged, with numerous large and small rocks shelving into the sea and with masses of fallen rocks piled on one another; in this way the most varying habitats are produced, from the much exposed to those relatively sheltered behind the sea cliffs; the beach too offers many different degrees of light to the algæ, daylight sometimes coming straight down on the algæ, at other times obscured by overhanging or fallen rocks. Finally there are many ravines and caves along the coasts, where even sublittoral algæ, occurring elsewhere only in deep water, find suitable light at the very surface of the water.

At the foot of these almost vertical rocks there is often an almost horizontal or but slightly sloping foreshore, which is sometimes very broad, and more or less covered at high tide, but perfectly dry at ebb-tide. In such places a very luxuriant algal vegetation is often found, and on account of the sometimes very slight slope, the different algæ can spread widely in a horizontal direction, whilst those on vertical rocks are often reduced to a minimum, as many species only occur within a very limited regi-

onal level out of which they never thrive or only exceptionally. We therefore find the same belt-like mode of growth in the water-pools on the beach and practically all round the coast, one algal community gradually replacing another, exactly as an inland flora grows in belts round lakes and pools.

Lastly, numbers of large and small pools and basins filled with water are found on the beach at every possible level above the sea, sometimes so high up, that they are only filled with salt water by the storms of winter and consequently get more or less brackish and polluted in the course of summer, sometimes so low that they are cut off from the sea only for a short time at low ebb; the great variety of the algal vegetation in these shore-pools is naturally due to these varying habitats. In fjords and sounds the bottom frequently consists of stones or gravel forming a developing ground for many algæ, but most often the bottom is soft, covered with sand or mud which, apart from various free-floating algæ, is perfectly barren, as *Characeæ* are wanting, and *Zostera*, which at other places generally covers such regions of somewhat shallow water and often shelters a rich epiphytical algal vegetation, is but rarely found in the Færöes; it has only been met with in the innermost parts of Vaagfjord on Syderö, covering the bottom of a small locality where the water was from 1 to 2 fathoms deep.

On the whole, however, the rocky coasts of the Færöes must be considered especially favourable to algal vegetation; wherever one approaches the coast, it is found covered by a luxuriant vegetation, and such barren rocks as on the coasts of Greenland, mentioned by Rosenvinge (71, p. 152), are nowhere found on the coasts of the Færöes.

As to the conditions at the bottom, these are not everywhere favourable to the algæ. In the fjords, the bottom in shallow water often consists of sand, and in deep water, as in the sounds, of mud. Yet, large regions are covered with stones or rocks offering a favourable habitat for the growth of the algæ. On account of the great depth sometimes met with in the immediate vicinity of the land, the algal vegetation naturally disappears at such places close to land, the depth-limit of the sublittoral region being soon reached here. According to the most recent survey, the curve of 25 fathoms is found at a mean distance of about 6000 feet from the coast in southern islands, but only 2000 feet in the northern, especially in the Sounds. Occasionally it lies several miles from the coast.

II.

ALGÆ-REGIONS AND ALGÆ-FORMATIONS ON THE COASTS OF THE FÆRÖES.

In his well-known paper on the algæ-flora of the Murmann Sea (44, p. 57) Kjellman divides the flora: »in drei Gebiete und zwar in das litorale, sublitorale und elitorale«. By littoral »Gebiet« he means the part of the bottom of the sea which is left dry by the ebb of the spring tide, that is, from the highest tide mark to the lowest ebb mark. The sublittoral »Gebiet« extends from directly below the littoral »Gebiet« down to a depth of 20 fathoms, and finally the elittoral »Gebiet« consists of the bottom lying below yet overgrown by algæ. In a later paper (45) on the algæ-flora of the Skagerak, Kjellman introduces the name »region« instead of »Gebiet«. He asserts that the limit between the two first named regions is distinct and natural. The vegetation of the littoral region is essentially different from that of the sublittoral region, evidently a natural consequence of the very different local circumstances prevailing in each of these two regions. The limit between the sublittoral and the elittoral regions is, however, less distinct.

With more or less variation of the limits of these regions, later authors have used this division by Kjellman as a basis for their division of the algæ-vegetation of other tracts of the sea. I shall do the same, with some alterations.

Smaller types of vegetation belonging to the algæ-regions are named »Algenformationen« by Kjellman (45, p. 10); his definition is as follows: »Unter einer Algenformation sollte folglich ein Abschitt der ganzen Algenvegetation verstanden werden, der durch ein eigenthümliches Vegetations-Gepräge ausgezeichnet ist. Im Allgemeinen erhalten diese Abschnitte dadurch dieses Gepräge, dass eine oder einige Algenarten die Hauptmasse ihrer Bestandtheile ausmachen.«

I propose the name of association for these types of vegetation. These associations are often united in a natural way in larger communities, where they live together under the same or very similar biological and ecological conditions. I propose the name of formation for these more comprehensive groups. If any further subdivision is particularly wanted, we may use the word facies,

applied by Lorenz in his interesting and instructive paper[1]. Accepted in the sense applied by him to this word, it, however, mainly coincides with the term »formation«.

The species which form these formations and associations, often differ widely from each other in outer habit, their growth-form may vary much; but ecologically they must of course as a rule demand the same physical conditions (light, the temperature of the air, the temperature and salinity of the sea, the dashing of the waves, etc.). The large characteristic algæ of the formations do not grow under the same conditions as the smaller epiphytes which find their home on them. Epiphytes growing under the thallus of larger algæ are exposed to a weaker light, and on the beach larger algæ not only shade smaller epiphytes by their thallus, but also protect them from being dried or heated by the sun, from the dashing of the waves etc. Protected by the larger algæ, the smaller, often more delicate species thus obtain suitable surroundings; they are of course only found in localities answering to their requirements.

I. The Littoral Region.

It has been pointed out by Rosenvinge in his report on the algæ-flora of the coast of Greenland (71, p. 189), that Kjellman's determination of the limits of the littoral region as being respectively the highest tide mark and the lowest ebb mark, is not quite satisfactory, and in so far as the Færöes are concerned, Kjellman's determination is certainly not quite suitable. As to the uppermost limit, the algæ-vegetation on the exposed coasts of the Færöe Isles really extends far beyond, in more exposed places most likely even more than 100 feet beyond, the highest water mark. In sheltered places, subject to the influence of the tide, the uppermost tide-mark will be almost identical with the uppermost limit of the algæ-vegetation. According to Rosenvinge, the sea at springtide rises beyond the uppermost limit of the algæ-vegetation in Greenland; this will hardly ever happen even in the most sheltered places in the Færöes. It is true, that sheltered places with ebb and flood are but small in numbers here, so that my

[1] Lorenz, I. R., Physicalische Verhältnisse und Vertheilung der Organismen im Quarnerischen Golfe. Wien 1863. Page 188 he defines the facies as follows: »Die Facies sind also Vegetations- (oder Thier-) Formationen. oder Unterabtheilungen (Typen) derselben, betrachtet vom Standpunkte der Location und der bedingenden physicalischen Agentien.«

observations are relatively few; but according to my observations in Vestmanhavn, Klaksvig, and Trangisvaagfjord, *Pelvetia* is found a little below as well as a little above the highest water-mark, and the *Enteromorpha*-association, growing above that and indeed preferring places where fresh water oozes from the rocks, is met with far above the highest water-mark.

I therefore fully agree with Rosenvinge in thinking that the upper limit of the littoral region should be stated at the level where the algal vegetation begins[1]; but when Rosenvinge declares this limit to be identical with neap-tide mark at high water in Greenland, it is evident from what has already been said, that this greatly differs from the observations made on the Færöes, at any rate on their exposed coasts.

On account of the very luxuriant algal vegetation which extends, as before mentioned, far beyond the highest water-mark, it might perhaps be justifiable to introduce a special supralittoral region, as Lorenz has done (l. c. p. 193) and Warming suggested; (compare Simmons, 66, p. 173). I shall briefly state the reasons why I do not side with this view.

I take for granted that the highest water-mark is the lowest limit of such a region; but on investigating an exposed rocky coast, the algal vegetation will be found to offer not the slightest traces whatever of any limit. The specifically littoral region, which might thus be stated to be below the highest water-mark, merges imperceptibly into that of the algal vegetation above it; a line drawn at the highest water-mark on the rocks would certainly cut through several formations, causing the same formation to belong to both regions. As to the littoral and the sublittoral regions circumstances are quite different, the limit being often for miles sharp and distinct, though irregularities may indeed occur in the algal vegetation. Moreover, the more or less exposed situation of the coast might cause the same formation to belong, now to the supralittoral, now to the littoral region. It therefore seems most natural to me to say, that the littoral region includes also the algal vegetation growing beyond the highest water-mark, just as in what follows I say that the sublittoral includes the elittoral region, no dividing line being found between them.

As to the determination of the lowest limit of the littoral region,

[1] »at den övre Grænse for denne Region bör sættes der, hvor Algevegetationen begynder«.

I likewise agree with Rosenvinge in stating, that it ought to be drawn somewhat above the lowest ebb-mark. On the coasts of the Færöes, the *Himanthalia*-association of this region distinctly marks the limit. At very low tide a rather large portion, up to one or two feet of the *Alaria*-vegetation growing under *Himanthalia*, may sometimes be dried, but this undoubtedly belongs to the sublittoral region; Rosenvinge moreover reports, that portions of the *Laminaria*-vegetation, which naturally belong to the *Laminaria*-formation growing below that, are likewise uncovered at low tide in Greenland. The lower limit of the littoral region must therefore be fixed at about the ebb mark at neap-tide.

On tidal coasts it is therefore not very difficult to make a natural division of the algæ-vegetation into a littoral and a sublittoral region, but on non-tidal coasts the determination of these regions is much more difficult. Attempts have been made to define the limits in other ways; for Tönsbergfjord Gran, for the western part of the Baltic Sea Reinke, for Bohuslän Kjellman have made use of certain characteristic species growing within well-defined limits in the localities in question. In his valuable work on »Östersjön's Hafsalger«, Svedelius (79) is however certainly right in objecting that this division is anything but satisfactory, as one and the same species may grow at very different depths in different parts of the sea.

It is for instance a well-known fact, pointed out by Kjellman, that many algæ which are littoral on the west coast of Norway are sublittoral on those of Bohuslän, where the fresher surface current does not reach them. Svedelius therefore is certainly right, when he warns us against drawing a parallel between the regions belonging to heterogeneous flora domains, as the factors which in one place justify a very distinct division into regions and make a limit for the occurrence of a species, may be totally wanting in another.

As I have already explained in the introduction, there is in the Færöes a small tract of the sea between Österö and Strömö where the tides are almost imperceptible. Here the question is where to fix the limit between the two regions.

If the limit be fixed at the beginning of the *Laminariæ* as Kjellman has done on the coasts of Bohuslän, it would be very easy to point out a very distinct line between the two regions within the area mentioned, as the *Laminaria færoensis*-association

begins at a depth of about 3 to 4 feet; the *Stictyosiphon*-association growing above that would then be reckoned littoral.

I have not, however, done this. A comparison between this algal vegetation and that of a sheltered tidal locality e. g. Vestmanhavn, proves that under the *Fucaceæ*-formation just below the lowest water mark, a perfectly similar vegetation, the *Stictyosiphon*-association, is found, which is here sublittoral.

In this area of the sea the littoral region is therefore but slightly developed, only consisting of some scattered *Pelvetia, Porphyra umbilicalis, Fucus vesiculosus* and a few others, besides some crusts of bluish-green algæ, *Hildenbrandia* and *Rhodochorton*.

The algæ-vegetation found on exposed coasts differs as a rule considerably from that found on sheltered coasts; as in the former a great many species occur that are not always found in the latter places, and as the species common to both places are often represented by varying forms in each place I have divided the algæ-vegetation into that of exposed and that of sheltered coasts. The Norwegian investigators Hansteen and Boye have dealt in the same way with the algal vegetation of the west coast of Norway. We will first consider the vegetation of exposed coasts.

a. Exposed Coasts.

The Hildenbrandia-Formation,

or the formation of the crustlike algæ as well as of lichens is widely spread along the exposed coasts of the Færöes. It covers the rocks with a dense mat of various colours to a considerably height, i. e. up to more than two feet above the level of the sea and down to the *Corallina*-formation. The uppermost part of it mostly consists of lichens, which, according to the Rev. Deichmann Branth, belong to different species of *Verrucaria*, but crusts of bluish-green algæ soon appear, especially *Calothrix scopulorum, Rivularia atra* etc. and the crimson *Hildenbrandia rosea;* the last mentioned algæ I have found on the west coast of Vaagö, about eight feet above the level of the sea. At a shorter distance from the sea, *Hildenbrandia* becomes more and more predominant, still crusts of lichens and bluish-green algæ are intermingled with it, and another crust-alga, *Ralfsia verrucosa,* can now be found; this however prefers littoral pools where the water is constantly renewed by the surf. The walls of such basins

are almost always covered by brown, red, and black crusts, respectively consisting of *Ralfsia, Hildenbrandia* and *Lichens.*

These algæ, with the exception of *Ralfsia*, must necessarily be able not only to live for a long time without sea water and consequently to be dried up, but also to be washed by fresh water. They are moreover excellently fitted for resisting the surf, as they are very firmly attached to the rocks, of which they may almost be said to form a part. Lastly, they must be well fitted to stand intense light and great changes of temperature, as the southern side of rocks is often much heated by the sun.

On the west coast of Syderö at Vaag's Ejde I have seen extensive growths of *Ralfsia,* which are here found in large flat littoral pools with only a few inches of water. Whilst *Ralfsia* thrives best in littoral pools with shallow water, *Hildenbrandia* will thrive excellently in the latter, as well as on steep rocks which are dry in calm weather.

Among other algæ contributing to form this formation, *Pilinia maritima, Pleurococcus* spec., *Codiolum gregarium,* etc., which I have found intermingled with crusts of bluish-green algæ, ought likewise to be mentioned.

This formation is exposed to clear daylight and to the varying influence of the weather in its elevated habitats; in more low-lying regions it will often be found as a subvegetation covered by different larger algæ of the place.

Almost in the middle of the beach or somewhat farther down, this formation is replaced partly by *Corallina officinalis,* partly by *Phymatolithon polymorphum*, both spreading widely downwards into the sublittoral region.

Simmons briefly describes a »*Hildenbrandtia*-formation«, but he says that it is only to be found »An ruhigeren Oertlichkeiten«, and that »die Steine und Felsen in der Wasserfläche von dieser Formation bedeckt sind.« Later on he gives (66, p. 173) a further explanation of this formation, defining it as purely littoral.

The Chlorophyceæ-Formation.

The characteristic algæ of this formation are: *Prasiola crispa* subspec. *marina,* different forms of *Enteromorpha intestinalis, Rhizoclonium riparium, Prasiola stipitata, Prasiola furfuracea* and a few other species.

This formation stretches like a green belt along the exposed

coasts of the Færöes. Certain bluish-green algæ and perhaps *Hildenbrandia* excepted, this is the algæ-vegetation which extends the farthest upwards on bare rocks, on which, with the exception of lichens, an inland vegetation may only be found at a considerable height, in very exposed places, never less than several feet above the level of the sea. On exposed coast this formation therefore may be found many feet above the level of the sea; on the west coast of Vaagö, at Bosdalafos, the outlet of Sörvaagsvandet, at the time of year when the sea is calmest, that is, in June and July, above the cataract, consequently about 80 feet above the level of the sea, in moist cracks in the rocks shaded from the sun, I have gathered forms of *Enteromorpha intestinalis* and *Rhizoclonium riparium*, which are characteristic of the formation under discussion.

As a matter of course the algæ belonging to this formation must be able to do without water, and to be washed by fresh water. Some, but not quite all these species, may also be found under certain forms growing in more or less brackish water. They generally grow so far above the level of the sea, that they are only reached by the surf and the spray, and if the sea be calm for some length of time, which may sometimes happen, especially in summer in the very changeable climate even of the Færöes, they are totally prevented from being moistened by salt water. On the contrary they are at times soaked by fogs and rain to such a degree, that they are most probably completely deprived of salt. Some few of the algæ belonging to this formation moreover grow in localities where fresh water oozes from the rocks. On the other hand several of these algæ may in dry weather and sunshine appear to dry up, some of them, e. g. *Prasiola crispa* subsp. *marina, Prasiola stipitata* and *Enteromorpha intestinalis* even so as to be easily pulverised. As to *Rhizoclonium riparium*, I have not found it dry; it generally occurs on wet rocks and thus always keeps rather moist.

The algæ belonging to this formation must moreover be able to stand the full day and sunlight, as they grow on rocks facing south as well as north. On the other hand they are less in danger of being injured by the surf, as they most often grow so far up that only the spray can reach them. When they grow farther down, it may be supposed that the low, dense, often very gregarious growth of, for instance, *Prasiola stipitata* and *P. furfuracea* and *Enteromorpha*, serves as a means of protection from the dashing

of the waves. *Prasiola crispa* **marina* and *Rhizoclonium* may likewise be protected by the great flexibility and elasticity of their thallus. The upper limit of this algæ-vegetation changes as the locality becomes more or less exposed, the lower limit likewise gradually moving downward as the locality becomes more sheltered. Several of these algæ, for instance, *Prasiola stipitata* and *Enteromorpha*, may be found rather far down in the littoral region, in more sheltered places.

This green algæ-formation may be divided into several associations according to the predominant characteristic algæ. Naming them from the top downward: a *Prasiola crispa*-association, a *Rhizoclonium*-association, an *Enteromorpha intestinalis*-association and a *Prasiola stipitata*-association.

The *Prasiola crispa*-association is found at least 40 feet above the level of the sea[1]. It prefers steep, precipitous rocks, on which it is found as a dense cover, turning light yellowish-green when it dries up. This light colour makes it stand out against the dark rocks to which the thallus is fixed. When moist it turns dark green, each thread becomes free and sways with the waves. As subvegetation we find blackish lichen crusts, which have been defined by the Rev. Deichmann Branth as *Verrucaria mergacea, V. maura, V. mucosa* and *V. striatula.*

The *Rhizoclonium*-association may be found at the same level above the sea, but it prefers moist localities, for instance, such where fresh water is constantly dripping down, or pools and caves, where the air is very damp. I never found this alga perfectly dry; it is evident that it cannot stand to be dried up. It often forms large, unmixed growths and is easily discernible on account of its light-green colour and its often crisp, almost curly, appearance. In some places, at Glivernæs for instance, I have found *Vaucheria coronata* at about the same level in moist, but more sheltered little depressions in the rock.

The *Enteromorpha*-association is generally found farther down, but on an exposed coast it may reach to about the same height, that is ca. 40 feet. It consists for the most part of *Enteromorpha intestinalis* var. *micrococca*, and smaller forms of var. *genuina*, especially f. *cornucopiæ*. *Enteromorpha* prefers places where fresh water oozes from the rocks, but also grows in dry places and

[1] As before mentioned, several of these algæ, however, may be found growing scattered at least twice as high up on the rocks.

is sometimes found perfectly dry. This association may be found covering large stretches of rocks as a dense, moss-like mat, sometimes only consisting of *Enteromorphæ*, sometimes of *Enteromorphæ* mingled with *Prasiola stipitata* etc.

In some places the latter algæ, however, grow quite unmixed with any other species, and often carpet the rock with a short, dark

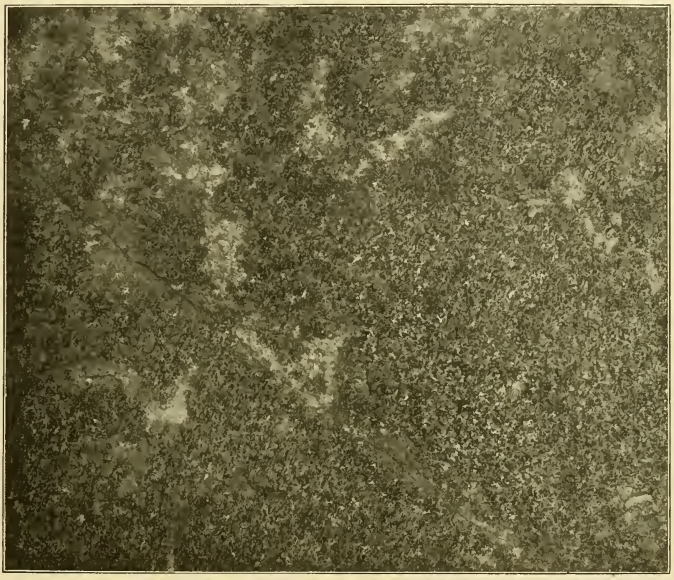


Fig. 152. *Prasiola stipitata*--association. From rocky coast near Höjvig. (F. B. phot.).

green covering, as shown in fig. 152. *Prasiola stipitata* grows as a rule on horizontal or slightly sloping sides of rocks, and prefers places where birds live, especially the summits of rocks under fowling cliffs. This alga may also be found quite dry.

Simmons mentions (78, p. 251) an *Enteromorpha*-formation which, judging from the species mentioned by him, must at any rate partly belong to the *Enteromorpha*-association. But on the other hand he also mentions some *Cladophora*-species as belonging to this association; these species, according to my observations, belong to algæ-associations which grow farther down.

The Porphyra-Association.

This association is found under the *Chlorophyceæ*-formation, but still on exposed coasts far above the level of the sea, 40—50 feet, perhaps even more. It is widely spread along the coasts of the Færöes, on which it extends as a belt often many feet broad.

In much exposed places it extends to far above the level of the sea; at Bosdalafos on the west coast of Vaagö to at least 40 feet. On the north western side of Viderö, I visited a rock (see plate XIII) about 30 feet high which was quite covered by *Porphyra umbilicalis*. On the islet of Myggenæs, where the southern side of the rocky coast slopes gently upwards, *Porphyra* certainly extends up to at least 50 feet above the level of the sea. These observations were moreover all made in summer time; in winter, when the surf reaches much farther up the coast, it is most probable, that *Porphyra* also grows at a greater height.

With the exception of the *Hildenbrandia*-formation, which here often forms a subvegetation, and of some species belonging to the *Chlorophyceæ*-formation, *Porphyra umbilicalis* is almost predominant in this association. *Porphyra umbilicalis* covers the rocks, sometimes densely, sometimes more sparsely. It grows in small tufts, 2 to 3 inches high, whose convolutions gives them the appearance of crumpled paper (see Wille 85, p. 38). The colour of this vegetation is a dark reddish-brown; sometimes, however, more purple, sometimes more tawny. On account of its crumpled nature *Porphyra umbilicalis* can retain sea-water for some length of time among the many folds of its thallus. If the exterior of the plant looks dry, there is, however, often some moisture left between the interior parts of the thallus and those parts which turn downwards. Nevertheless it can stand to become so dry, that it will creak when trodden upon. It is not only liable to be dried up, but also to being soaked in fresh water, i. e. by rain, for a long time. It is probably protected from the surf by the elasticity and toughness of its thallus, and by the lubricity of its surface. In more sheltered places *Porphyra umbilicalis* becomes higher, often to one foot or more, and its large, curling membranes then cover the rocks or hang down vertical rock-sides like long tufts swaying in the wind (see plate XVII). In sheltered places of this kind it likewise grows far down into the littoral region.

As before mentioned, this association generally only consists of

this alga together with *Hildenbrandia* and some species of *Verrucaria* as subvegetation, but different forms of *Enteromorpha intestinalis, Ectocarpus littoralis* and others are, however, often intermingled; the *Fucaceæ*-formation mentioned below (page 720) likewise sometimes extends into the *Porphyra*-association.

The *Porphyra*-vegetation was well developed in the months, April to August, when I visited the Færöes; Mag. H. Jónsson likewise tells me, that he has found it vigorously developed when he visited the islands from October to December, 1897. Thus it seems to be well developed all the year round, and is not, as Simmons says (l. c. p. 250), mostly a »Winterformation« on exposed coasts, even if it may be supposed to be still more vigorously developed in the winter, judging by its growth in other places. On coasts especially exposed to the surf it may also be supposed to extend still further up above the level of the sea. In more southern districts the *Porphyra*-association is really a characteristic winter vegetation. Thus when Kjellman (45) visited the »Skærgaard« of Bohuslän from Dec. 1874 to Jan. 1875, he found a luxuriant *Porphyra*-vegetation on the outer rocks facing the sea, whilst this vegetation is totally wanting in summer, which I have also observed during a visit to Lysekil in 1899. Neither was this alga found on the rocks in the Firth of Forth at North Berwick, where I had an opportunity of observing the local algal vegetation one day in July 1900. In winter it is most likely vigorously developed here also. On the west coast of Norway, Boyę points out (6, p. 20—21), that Sognefjorden seems to be the southern limit of its occurrence; he founds this opinion on his own as well as on Hansteen's observations. This is, however, scarcely correct. Mr. E. Norum, teacher at Haugesund, has for a long time investigated the marine algæ growing on this part of the west coast of Norway, and kindly reports, that *Porphyra umbilicalis* is met with as an unmixed vegetation in much exposed places at Haugesund and Utsire, an island about 3 miles west of Haugesund. At Utsire, where Mr. Norum made his observations in July, the *Porphyra*-vegetation reaches to a height of 2 to 3 metres above the »*Balanus*-belt« on the southern and eastern sides of the island, and it may be supposed that it reaches still further on its northern side. At Christianssund, I have myself seen *Porphyra* at the beginning of August, growing some few feet above the highest water mark on an exposed coast; but the association was indeed only slightly developed here, compared with that of the coasts of the Færöes.

A summer vegetation of *Porphyra* as luxuriant as that of the Færöes will most likely only be found in more northern parts of Norway. As to Nordland, Kleen for instance writes, that *Porphyra umbilicalis* is found at the highest level, often far above the highest water mark. That it may be found luxuriant even in summer, in the Færöes, is certainly due to the fact that the sea is almost always stormy. Even in calm weather there is most often a swell and therefore surf along the coast. And even when it happens that the sea is quite calm for some time, the littoral algæ-vegetation is not in great danger of being dried up, because the air is very moist, the weather often cloudy, and fogs and rain frequent. That it, however, may happen, that the littoral algæ-vegetation, to which the *Porphyra*-association belongs, may be found dried on sunshiny days has already been mentioned.

The lowest limit of the *Porphyra*-association is determined by Boye to lie at the highest usual water mark, which is almost identical with the sharply-marked, white line formed by the *Balanus*, as he likewise points out. As may be seen in my illustration from Midvaag (see plate XVII), his view agrees with observations from the Færöes, although only in somewhat more sheltered places. In more exposed places, the *Porphyra*-association is replaced here by other algæ, and is not found until far above the highest water mark. In these exposed places it may extend far in a vertical direction, sometimes even to many metres, thus Simmons' remark, that the *Porphyra*-association has »nur eine recht geringe vertikale Verbreitung«, holds good only in the case of somewhat sheltered places.

The Rhodochorton-Association.

The *Rhodochorton*-association commonly forms a kind of close felt, reddish-brown to crimson, on stones and rocks, but in places where it is apparently more exposed to be dried up and to the surf, it may be found on the rocks in small firm lumps resembling peas (f. *globosa*). It often grows on the underside of rocks and stones, in clefts in the rocks, and in the caves (about which more will be said presently); but it may also be found growing in full daylight.

It is found partly in the littoral region, especially in its higher part, and partly far above the highest water mark, especially in the caves.

The association almost exclusively consists of *Rhodochorton Rothii*, yet *Sphacelaria britannica*, *Ectocarpus littoralis*, *Callithamnion*, etc. may be found intermingled with it, and, epiphytically on *Rhodochorton*, *Pleurocapsa amethystea* var. is often found in great numbers.

Rhodochorton Rothii can stand to be dried up to a considerable degree, and may even be found apparently quite dry. It also very well stands fresh water, not only rain, but also that of small cataracts, growing sometimes at the very spot where the water falls on the rock.

The *Rhodochorton*-association has been briefly described by Simmons (p. 250), and Hansteen (p. 348) and Boye (p. 30) have mentioned its occurrence on the west coast of Norway.

The Bangia-Urospora-Association.

On exposed coasts, prominent points and steep rocks are often covered by a dense and matted reddish-brown vegetation, which in dry condition shines almost like silk, unless it is curled up like wool, as is often the case. It is *Bangia fuscopurpurea*, an alga very common on the coasts of the Færöes. It is found like a dense covering on the rocks, often at a very great height, 5—6 metres or more, above the highest water mark. Consequently it can stand being dried up for a long time, as well as being soaked with fresh-water.

Intermingled with *Bangia*, a luxuriant vegetation of *Urospora mirabilis* is likewise often found; its growth is quite similar to that of *Bangia*; it also bears to be dried up, though perhaps to a lesser extent. It forms a similar covering, on the rocks, only dark green. They are both algæ growing typically where the waves dash on the coast (cf. Gran, 37, p. 9). Of these two algæ, *Bangia* certainly grows highest above the sea level, often forming here a pure *Bangia*-facies; in much exposed places it extends far into the *Porphyra*-association; *Urospora* however may also be found far above the highest water mark. On Myggenæs Holm, for instance, this alga was found at a height of at least 20 feet above the sea level, partly as a subvegetation under and among larger algæ, such as *Fucus inflatus* f. *disticha*, *Rhodymenia palmata*, etc.

Hansteen, who, strange to say, has not observed the *Bangia*-association on the west coast of Norway, writes that it has been found by Wille at Mandal. According to Wille, it formed an

almost continuous, light yellow belt of dried up threads of *Bangia*, on rocks and stones above the average high water mark.

According to what Mr. E. Norum kindly informs me, *Bangia* is found in the neighbourhood of Haugesund on exposed coasts, to a height of 6 feet above the *Balanus*-region, often covering sloping rocks abundantly. Mr. Norum supposes, that its total absence in some years from long stretches of coast, may be the reason why Hansteen, as mentioned above, has not observed this species on the west coast of Norway. At Christianssund I saw *Bangia* myself; it grew on an exposed coast up to a few feet above the highest water mark, and was easily distinguishable because of its light yellow colour.

Similar light yellow growths of *Bangia* may fairly often be found in Denmark and on »Kullen« at the entrance to the Sound. In the Færöes *Bangia* however always keeps its dark, reddish-brown colour.

According to Gran, *Bangia* is the alga growing at the greatest height above the sea-level in Christiania Fjord; it is not so in the Færöes, where several algæ are found at a much greater height.

However much the two algæ treated in this section may differ, they agree very well biologically and form a very characteristic association, whether growing in the same locality, or, what is also frequent, each in its place forming a *Bangia*-, and an *Urospora*-facies. Intermingled with *Urospora* a great many *Ulothrix flacca* and other species of *Ulothrix* are found.

According to H. Jónsson, *Urospora* is in autumn and winter partly replaced by species of *Ulothrix* and *Codiolum*, which may each of them form extensive associations.

On the coasts of Greenland, Rosenvinge (71, p. 201) has observed a very similar association, composed of *Monostroma groenlundicum, Ulothrix flacca, Urospora mirabilis* and *Bangia fuscopurpurea*. Thus it is also here formed by thread-like, branchless algæ, as pointed out by Rosenvinge. He calls it the *Monostroma groenlandicum*-formation.

The Fucaceæ-Formation on exposed coasts.

This formation is found spread, but very commonly on all the exposed coasts of the Færöes, even in the most exposed places, as for instance Store and Lille Dimon, Myggenæsholm, the west coast of Suderö, Viderejde, Sumbö Holm, etc. It prefers

sloping rocks and especially recesses in these rocks that may be reached by the sea. In much exposed places this formation may extend far above the highest water mark, and the algæ growing here are consequently in danger of being dried up for rather a long time; this they, however, greatly avoid by means of their low, tuftlike growth, and especially by their great amount of mucus, in which *Fucus inflatus* f. *disticha* is particularly rich.

Fig. 153. *Fucus spiralis* f. *nana* and, below, *Fucus inflatus* f. *disticha* on steep rocky coast near Viderejde. (F. B. phot.).

The formation is typically formed by two species of *Fucus*, that is, *Fucus spiralis* f. *nana* and *Fucus inflatus* f. *disticha*. *Fucus spiralis* grows uppermost, often a couple of feet higher up than *Fucus inflatus*. They almost always grow together, but as *Fucus spiralis* seems to be able to stand being dried up better than *Fucus inflatus*, the former is found in somewhat more sheltered places, where the sea may happen to be calm for some length of time. On the other hand, it is most often only *Fucus inflatus* f. *disticha* which is found in particularly exposed places, and which seems thus to be the best fitted for resisting the surf. I have found vigorous specimens of it, 2—4 inches long, on Myggenæs Holm and Muletangen at

Vaag's Ejde, whilst *Fucus spiralis* only was found less exposed in the latter place. I must nevertheless point out, that I have found both species growing together on the west coast of Lille Dimon, which must also be considered a particularly exposed place.

The *Fucus*-plants hang in small, dense tufts, a few inches long, down the sloping rocks, often covering them so closely, that it is only by removing them that we discover the red subvegetation of *Hildenbrandia* which is common here, together with the intermingled lichens.

Forms of *Ectocarpus littoralis*, species of *Ulothrix*, besides *Elachista fucicola*, and a few others frequently grow epiphytically on the *Fucus*-plants. Among the latter, *Porphyra umbilicalis*, *Enteromorpha intestinalis* and other littoral algæ are often met with.

Whilst these small specimens, only a few inches high, are characteristic of the most exposed places (see fig. 153), the *Fucus*-plants gradually become larger as the locality becomes more sheltered (see plate XIV), and the most regular gradations may then be found, from the typical large form, f. *edentata* (fig. 158), to the dwarf form, f. *disticha*. Sometimes they may even be found growing in the same locality, the smaller form still growing uppermost, at or above the highest water mark, whilst large, well-developed specimens belonging to the main form grow at the lowest part of the beach.

This may easily be observed along the coast, between Arge and Gliversnæs, on the east of Strömö (see plate XIV), a locality where Nolsö really affords some shelter, but which must be considered rather exposed. A very easy transition may be found here from the *Fucus*-vegetation of exposed coasts to that characteristic of a sheltered coast, as not only the two species of *Fucus* growing on exposed coasts gradually become larger, but they are joined by *Pelvetia canaliculata*, *Ascophyllum nodosum* and *Fucus vesiculosus*. I have observed that these three algæ appear in the order I have named them. *Pelvetia* may be found in rather exposed places, growing abundantly for instance on rocks on the west coast of Syderö, at Vaag's Ejde, at a height of about 5 metres above the sea-level (see fig. 154). The place where it grows is, however, always somewhat sheltered. It is, for instance, never found on rocks facing the open sea, but on rocks facing the land, or at least in places sufficiently sheltered from the strongest surf. At Vaag's Ejde, a very exposed place, *Ascophyllum nodosum* is also found on the most sheltered, inmost rocks, but I have not seen *Fucus vesiculosus* there.

Even the most sheltered places here are not calm enough for this alga. When the wind blows on the shore, the sea washes over the rocks, in hard weather, flowing over the »Ejde« itself.

I have not met with any description of such a *Fucus*-vegetation growing on an exposed coast. Simmons, who found *Fucus distichus* in its well-known habitat, the west coast of Syderö, writes (l. c. p. 254): »Wo an der Westküste von Suderö *Fucus distichus* auftritt,

Fig. 154. *Pelvetia canaliculata*, and below that, *Fucus spiralis*. Illustration of a rock from Vaag's Ejde at Sydero. (F. B. phot.).

könnte man vielleicht am richtigsten eine besondere Formation unterscheiden, die dann die *Fucus distichus-Porphyra*-formation zu nennen wäre. *Fucus distichus* bewohnt nämlich mit Vorliebe abschüssige Felsen in der Nähe der Ebbengrenze und wächst da mit *Porphyra laciniata* vermischt.« Judging by these words, Simmons seems hardly to have got any distinct idea of this characteristic formation. Nor have I met with any description of it from Norway, where it may, however, be supposed to grow. It has therefore been very interesting to me, to receive the following report from Mr. Norum in Haugesund. »A *Fucus*-formation corresponding exactly with those

from the Færöes is likewise found here in the most exposed places. It consists of *Fucus spiralis* (most probably f. *nana*) and *Fucus inflatus* f. *disticha*[1]. They are most often attached to the *Balanus*. They grow partly intermingled, partly with *Fucus spiralis* extending a little higher up than *Fucus inflatus*. *Fucus spiralis* disappears where the surf is the most vigorous. Thus *Fucus inflatus* is also here the *Fucus* which is the best fitted for resisting the dashing of the waves.« According to this description, this Norwegian vegetation seems to correspond perfectly with that of the Færöes.

It is true that Boye (l.c. p. 25) speaks of a *Fucus*-formation growing on the outer side of the rocks; he says, that »even in the most exposed localities a very luxuriant *Fucus*-vegetation is usually found.« As members of this vegetation, he mentions, however, *Fucus serratus* f. *elongata*, and two forms of *Fucus vesiculosus*, which makes it quite clear, that his *Fucus*-vegetation is widely different from the Færöese. *Fucus serratus* is nowhere found in the Færöes, and *Fucus vesiculosus* grows here essentially on the inner side of rocks; it is the species of *Fucus* which I have mentioned before as disappearing first in passing from sheltered to exposed coasts. I am on the whole rather dubious as to the correctness of Boye's report. During a journey in Norway in 1904 I stayed for a few days at Christianssund, in order to observe the algæ-vegetation, and I found *Fucus vesiculosus* only in sheltered places. Mr. Norum also kindly informs me, that *Fucus vesiculosus* is never found in very exposed places in the neighbourhood of Haugesund, whilst *Fucus serratus* can grow on a very exposed coast immediately below the *Balanus*-belt.

Nor does Kleen (51) mention any such *Fucus*-vegetation; yet it must be supposed that a formation similar to that of the Færöes is found in Nordland.

Mag. Jónsson reports, that a *Fucus*-formation, very much like this, is found in Iceland on exposed coasts, and Strömfelt writes (80, p. 10): »On the cliffs of Seley which are constantly washed over by the surf, a particular *Fucacé*-formation is found. It consists of *Fucus spiralis*, *Fucus evanescens* **dendroides*, which are through many intermediate forms connected with f. *nana* of **arcticus* and f. *contracta* of **norvegicus* that are likewise found here[2]«. This vege-

[1] Mr. Norum has kindly presented me with specimens of both species, fully agreeing with those from the Færöes.

[2] På de af ständiga bränningar öfverspolade strandklipporna på Seley uppträdde en egendomlig *Fucacé*-formation, bildad af *Fucus spiralis*, *Fucus evanescens*

tation must certainly greatly resemble that of the Færöes, as all the forms named by Strömfelt are, according to my definition of species, similar to or at least closely connected with *Fucus inflatus* f. *disticha* (compare Jónsson 41, p. 184).

As to Greenland, Rosenvinge writes (71, p. 199) as follows: Where the coast is exposed to the dashing of the waves, the vegetation bears a totally different stamp. The *Fucaceæ* are either entirely absent or limited to deeper clefts in the rocks or to pools *(Fucus inflatus)*«.

It has since been said by Simmons (66, p. 178), that this circumstance may be due to the ice. This may possibly be true in some cases, but probably not in all.

In describing the algæ vegetation of the Murman Sea, Kjellman writes (44, p. 59), after pointing out that all littoral algæ are low: »*Fucus evanescens*, welche am häufigsten innerhalb des litoralen Gebietes angetroffen wird, scheint mir mit Recht den Namen (f. *nana*) zu verdienen, den ich ihr gegeben, denn sie ist selten über 6 ctmr. hoch und immer sehr schmal«. There must likewise be some resemblance between this and the Færöese vegetation.

It may be supposed, that *Fucus spiralis* is found on the Orkneys in localities resembling those in the Færöes (see Traill, 81, p. 316, who calls it *Fucus platycarpus*). If *Fucus anceps*, as I think[1], ought to be regarded as a form of *Fucus inflatus* f. *disticha*, the two characteristic forms of the Færöese formation are found on the west coast of Ireland. At Biarritz Sauvageau[2] has found some quite small specimens of *Fucus spiralis*, which certainly grew on an exposed coast there. On the northern side of Kullen, on steep rocks a little above the sea level, I have met with a dwarfish form of *Fucus spiralis*, that is, a very similar vegetation, only that *Fucus inflatus* f. *disticha* is also wanting here.

The Callithamnion-Association.

The above-mentioned types of vegetation have their habitats above the easily distinguishable white line formed by *Balanus* and bivalves. We shall deal next with an association growing in and about this »animal association«, which is found at about the highest water

**dendroides* genom en mängd former förbunden med de äfvenledes derstädes uppträdande f. *nana* af **arcticus* och f. *contracta* af **norvegicus*.

[1] Judging by a few small specimens kindly sent me by Mr. Batters.

[2] Sauvageau, C. Note préliminaire sur les algues marines du golfe de Gascogne, p 6—7 and p. 22—23. (Extrait du Journal de Botanique, XI, 1897).

mark in the Færöes, and, according to Boye, at the same height on the west coast of Norway.

This association is typically represented by *Callithamnion arbuscula* and *Ceramium acanthonotum*, which are almost always found together on exposed coasts and which are about equally common. On more sheltered coasts, *Callithamnion arbuscula* is often wanting, as it clearly prefers an exposed coast; and Simmons, who declares himself (78, p. 250 and 273), that he has not had much opportunity of investigating exposed coasts, and who has therefore not met with *Callithamnion arbuscula*, consequently calls this association the *Ceramium*-formation.

These algæ form small, dense, reddish-brown tufts, 2 to 4 inches long, and are attached either to the *Balanus* or to the rock itself, now forming a scattered growth, now a dense covering. On account of their ample ramification and their dense, compact growth, they look almost spongeous, and at high tide they really absorb water which is retained by their capillary action during low tide. After having been laid bare for several hours, they are still so full of water that it can be wrung from them as from a sponge. Kjellman has already (46, p. 479) briefly mentioned this fact. Berthold speaks in a similar way about *Callithamnion granulatum*, which has been found a few times on the coasts of the Færöes, together with *C. arbuscula* and much resembling the latter in its habits. He writes in the following way about it (5, p. 406): »Bemerkenswerth sind in dieser Hinsicht die dichten Thallome von *Callithamnion granulatum* mit sparrig gespreizten Ästen, welche sich wie ein Schwamm mit grösseren Wassermengen vollsaugen, wodurch ein Austrocknen auch nur der peripherischen zarten Spitzen vollständig verhindert wird.«

In less exposed places, this association hardly reaches above the highest tide mark, but in much exposed places it may extend far above it. At Viderejde on a rock lying off the landing place, I found a well-developed *Callithamnion*-association reaching to several feet above the extreme tide mark (see plate XV). Here it grew on steep, sloping rocks; besides the two characteristic algæ, a few *Porphyra umbilicalis* and several *Himanthalia lorea* grew here, the latter however being fructiferous only at the lower part of the association. There were, moreover, *Acrosiphonia albescens* and *Polysiphonia urceolata*, both fitted for retaining water by their dense, felt-like growth, together with *Ceramium rubrum*, *Dumontia filiformis*, *Scytosiphon lomentarius*, *Phyllitis zosterifolia*, a few small *Alaria esculenta* and,

as subvegetation, *Corallina officinalis* at the lowest part of the association. All these species and a few others are rather frequently found intermingled in this association.

A *Callithamnion*-association probably similar to this Færöese association has been found by Boye on the part of the west coast of Norway which has been especially investigated by him. Judging by his brief description it is probably quite similar to the Færöese one. According to Hansteen (38, p. 346), the *Callithamnion*-association in the neighbourhood of Bergen is formed of *Callithamnion arbuscula*, whilst nothing is said of *Ceramium acanthonotum;* there is however no reason to think that this species should be wanting there. At Christianssund, I have found a vegetation corresponding exactly with that of the Færöes, formed by the two characteristic algæ, and growing on steep rocks facing the open sea. It grew almost at the highest water mark. It has already been described by Ekman (17, p. 4) as being found in this place. Finally it may be supposed that a vegetation well agreeing with that of the Færöes may be found in Nordland (see Kleen 51, p. 9).

I have also met with this association on exposed coasts in Shetland, at Muckle Holm in Yell Sound.

As before mentioned, Simmons (p. 250) calls this association the *Ceramium*-formation, or, with regard to Nordland, the *Ceramium-Callithamnion*-formation. As that of the Færöes however corresponds with that of Norway, I have not considered it justifiable to change the name.

The Rhodymenia-Association.

A low, dense, dark, brownish-red vegetation, made up almost exclusively of *Rhodymenia palmata*, is found on sloping rocks on exposed coasts from a little below, or even a little above, high tide mark, down to a little above lowest tide mark. It grows very densely on the rocks, forming low tufts only a few inches high (see plate XVI and XVII). It is mostly a narrow-lobed form, related to f. *sarniensis*, which is found here, yet the typical form also occurs. Generally this association is not intermingled with other larger algæ, but a few *Fucus inflatus* f. *disticha, Acrosiphonia albescens*, etc. may be met with. On the other hand, there are many smaller epiphytes on the thallus of *Rhodymenia*, among which *Ectocarpus litoralis, E. tomentosus* and *E. fasciculatus, Myrionemaceæ, Chantransia virgatula, C. secundata* and others should be pointed out.

The *Rhodymenia*-association is widely spread on the Færöes. It seems to prefer places where fresh water oozes from the rocks, which is very common on the coasts. Even in places where small waterfalls fall from vertical or beetling rocks down on the littoral rocks, *Rhodymenia* grows abundantly. In such places it is of course soaked in fresh water at low tide, and this alga must be well adapted to resist great differences of salinity, for at high tide it is more or less flooded by the sea. The specimens are well developed even in such places; they are only of a paler colour, which perhaps indicates that circumstances are less favourable to them there. I imagine that *Rhodymenia* scarcely stands complete drying up and Rosenvinge is of the same opinion (71, p. 202). When *Rhodymenia*, however, is found on the coasts of the Færöes, rather far up on the beach, sometimes even above the highest water mark, the reason is, that it grows gregariously, and that it is always kept moist at ebb tide by the fresh water oozing from the rocks.

I have not found any description of a *Rhodymenia*-association quite agreeing with this vegetation which is so widely spread on the coasts of the Færöes. Still I feel inclined to believe that it will be found to be rather common on the coasts of the North Atlantic. According to Kleen (l. c. p. 9 and 17), it is probably also found in Nordland. It is true that Boye (l. c. p. 28) speaks of a *Rhodymenia*-formation on sheltered coasts growing in the *Ascophyllum*-*Fucus*-association, and on the the sheltered coasts of the Færöes *Rhodymenia* really often grows abundantly among and under the *Fucus* bushes. Lastly Kjellman mentions a sublittoral »*Rhodymenia*-region« (44, p. 67) on the coasts of Novaya Semlya and Spitzbergen. This agrees well with the fact that many littoral algæ elsewhere become sublittoral in Arctic countries. According to Rosenvinge (71, p. 202), it may however be found in the lowest part of the beach in Greenland, but usually only in small numbers. Simmons does not mention this association.

Besides forming this littoral association growing on rocks, *Rhodymenia* makes a characteristic littoral association close to, yet above the lowest water mark. On the parts of the *Laminaria hyperborea*-association which grows in such shallow water that the tops of the stipes rise above the surface of the sea at low tide, *Rhodymenia palmata* is found attached to the uppermost part of the *Laminaria* stalk, and often in such numbers, that the brown leaves of the *Laminariæ* are almost covered by the large, dark red *Rhody-*

menia-thallus. In the illustration (fig. 160, p. 756), a great part of the vegetation which is seen above the surface of the sea, is *Rhodymenia*. So this is really a littoral, but epiphytical association. *Rhodymenia* is often 2 feet long here and not short as when it grows on the rocks. Its thallus, especially the older parts of it, shelter a luxuriant vegetation of epiphytes, mostly species of *Ectocarpus* and *Myrionema, Chantransia*, etc. Simmons also mentions this littoral association (l. c. p. 256). In Trangisvaagfjord, he has found *Punctaria latifolia*[1] in numbers on the Laminæ of *Laminaria hyperborea* and *saccharina*; to this epiphytical association he moreover refers a great many other algæ, e. g. *Dictyosiphon foeniculaceus, D. hippuriodes,* species of *Ectocarpus*, and *Scytosiphon lomentarius*. They may certainly be found here exceptionally in more sheltered localities, but facing the open sea they are not common in this association, according to my observations.

The littoral Corallina-Formation

or the *Lomentaria-Corallina*-formation, will in much exposed places reach upwards into the *Callithamnion*-association, thus even passing the highest water mark. It however belongs mostly to the lower part of the littoral region, and *Corallina* is found together with sublittoral species far down in this region. In more sheltered places, *Corallina* hardly passes the lowest water mark, and is here limited to the more low-lying, littoral pools which it covers with a dense, pale-pink covering. As before mentioned, *Corallina* grows on the most exposed coasts, e. g. Lille Dimon and Store Dimon, Muletangen at Vaag's Ejde, Viderejde, Sumbö Holm, etc. In this respect, the occurrence of *Corallina* (48, p. 116) does not bear out Kjellman's words, that this alga »prefers sheltered places«[2].

In the more or less dense *Corallina*-vegetation, a great many small and scattered growing algæ are often sheltered. Larger algæ also find a favourable habitat here, occuring sometimes in such great numbers that they form their own associations, which will be described

[1] Called *P. plantaginea* by Simmons (compare my Algæ-Flora, 7, p. 436).

[2] It has been said by Wille (85, p. 14), that the chalky incrustation which he is undoubtedly right in considering as a means of protection from herbivorous animals, can hardly be supposed to afford any protection from the dashing of the waves. He founds this opinion on the observations of Kjellman and others. I cannot fully adopt this view. It seems to me that the firm construction of the thallus, together with the low, gregarious growth of the plant, must necessarily protect it from the dashing of the waves (cf. Wille p. 37).

later on (see table XXI). Of the many algæ-species which are found in the *Corallina*-formation, only some of the most important will be named here. One of the commonest and most characteristic is *Lomentaria articulata*, which grows in dense, dark reddish tufts, intermingled with *Corallina;* moreover, several forms of *Ceramium rubrum; Porphyra leucosticta, Polysiphonia urceolata*, and, especially in small littoral pools, also *P. Brodiæi*; moreover *Chondrus crispus, Scytosiphon lomentarius, Phyllitis fascia, Dumontia filiformis, Laurencia pinnatifida, Acrosiphonia, Himanthalia, Gigartina, Monostroma,* and many more. *Dermatolithon macrocarpum* f. *Corallinæ* is found epiphytically on *Corallina*; in more sheltered places *Leathesia difformis* is found; the latter is not common, but it is abundant in the few places where it grows, for instance at »Sundskær« in Kalbakfjorden. In this more sheltered place, *Chordaria flagelliformis, Dictyosiphon foeniculaceus* and *D. hippuroides* were also found.

It seems as if *Corallina* does not stand to be dried for a long time. This is clearly shown by the fact that in more sheltered places it grows luxuriantly in low-lying pools, but never outside of these. I have already mentioned that on a much exposed coast, e. g., Muletangen at Viderejde, it can stretch far up into the *Callithamnion*-association on sloping rocks, and even sometimes pass the highest water mark. But if the weather and the sea are calm in summer, it is also here discoloured, and it assuredly dies, if it is dried up for a long time. In such places *Corallina* is, however, protected from being dried, because it often forms a subvegetation under larger algæ. It is likewise not well fitted to stand fresh water; hence it is not found in places where fresh water oozes from the rocks; here the *Rhodymenia*-association occurs. As before mentioned, the *Corallina*-formation grows rather far down in the sublittoral region; this will be farther explained later on.

Boye (6, p. 26) seems to have found a very similar *Corallina*-vegetation on the part of the coast of Norway investigated by him.

It is to be supposed that a littoral *Corallina*-formation, very similar to this, is common along large stretches of the west coast of Norway; compare Hansteen's: »Broget-pelagiske-formation« (p. 348), which, as pointed out by Simmons (p. 260), includes about the same species as the formation from the Færöes. According to Kleen (51), it may also be supposed that a very similar *Corallina*-formation is found in Nordland, *Lomentaria articulata* however being rare and but badly developed there.

As to the Færöes, this formation has already been described by Simmons (78, p. 252), who points out that it is widely distributed here.

To the *Corallina*-formation I refer the following four characteristic and universally destributed associations.

The Monostroma Grevillei-Association.

On horizontal rocks or in very shallow, littoral pools where only very little water is left at low tide, *Corallina* will frequently be found at a height of a few feet above the lowest water mark, covered by a very dense, low spinach-green matting of the *Monostroma Grevillei.* Where *Corallina* sometimes is wanting, *Monostroma Grevillei* covers the rock itself. Its growth is so dense, that it is only exceptionally intermingled with other species, such as *Phyllitis fascia, Scytosiphon lomentarius, Dumontia filiformis,* etc.

On account of its dense and gregarious growth, the *Monostroma* is always kept moist by the great quantity of sea-water which it can retain, even when it grows on a slightly sloping substratum.

As *Monostroma Grevillei* is a spring and summer alga, this association disappears later in summer and the underlying *Corallina*-vegetation is now clearly seen or is covered by other algæ. The *Monostroma*-association is very common along the coasts of the Færöes and is found even in very exposed places, in spite of its apparently slight power of resistance against the surf.

The Acrosiphonia-Polysiphonia-Association.

This association which is formed of species of *Acrosiphonia,* especially *A. albescens,* and of *Polysiphonia urceolata* reaches from almost the lowest water mark to a few feet above it (part of this association is seen at the bottom of plate XVII). It grows on sloping rocks, which it covers with a very dense matting, generally green at the top and reddish-brown at the bottom, these two algæ frequently making unmixed facies, an *Acrosiphonia-facies* uppermost and a *Polysiphonia-facies* below it. They may however also be found intermingled. On account of their very ample ramification[1] they are both able to retain a great amount of sea-water at low tide, which protects them from becoming dried up.

[1] The littoral form of *Polysiphonia urceolata* is far more ramified than the plants that grow sublittorally (cf. Gran 37, p. 10).

Mingled with the characteristic algæ, we find e. g. *Ceramium rubrum, Cladophora rupestris,* and very rarely *Cladostephus spongiosus. Corallina* is usually absent in this association, as the dense growth of both species leaves no room for a subvegetation.

This association, which is very common in the Færöes, has not been described by Simmons, nor by any Norwegian investigator. It is however undoubtedly closely connected with Hansteen's »Broget-pelagiske-formation« (38, p. 348) and partly related to Boye's »Gigartinaformation« (6, p. 22—23).

The Gigartina-Association.

Somewhat above the lowest water mark, the height varying according to the exposure of the locality, a vegetation of *Gigartina mamillosa* (see plate XVIII and XXI), often dense and up to 6 inches high, is found in the *Corallina*-formation. This association often extends far horizontally, and on almost horizontal rocks, found within the level of this association, it is often widely distributed (see plate XVIII). Vertically it usually reaches only to a height of one or two feet; the height being the greatest on specially exposed coasts.

Epiphytes common on *Gigartina* are: *Chantransia virgatula*, very often forming a dense, velvety covering on the stalky part of the thallus, and *Dermatolithon macrocarpum* f. *fœroensis* which grows on it in smaller or larger pale pink incrustations. *Ceramium rubrum, Chondrus crispus, Polysiphonia urceolata, Acrosiphonia albescens,* and frequently some younger or older plants of *Himanthalia lorea*, besides *Corallina officinalis,* are found mingled with *Gigartina.* But generally these algæ are only few in numbers, or they may be totally wanting, so that the dark reddish-brown colour of the *Gigartina* predominates. *Gigartina mamillosa* grows luxuriantly in the most exposed places. Its tough, cartilaginous character probably makes it well fitted for resisting the surf. It is hardly exposed to any drying process, as it generally grows at the lower part of the littoral region.

According to Hansteen (38, p. 348), and Boye (6, p. 22), a similar *Gigartina*-association is found along the west coast of Norway. It seems to differ from the Færöese association only in its colour. Boye writes: »It (the formation) is easily distinguishable at a long distance as a light yellowish green belt, immediately above the lowest water mark, because the algæ inviduals are faded by the

sun«[1]. But on the coasts of the Færöes, *Gigartina* always keeps its dark reddish-brown colour.

Simmons does not set apart any special *Gigartina*-association. In reference to Boye's *Gigartina*-formation, he writes (p. 260): »Die letztere könnte wohl auch auf den Färöern unterschieden werden, ich bin aber geneigt, sie nur als eine lokale und zufällige Ausbildung der Corallinaformation zu betrachten, wo Gigartina überwiegend ist.« Opinions may of course differ on this matter, but as *Gigartina* can be found as an unmixed growth and often of considerable extent, I agree with Boye in maintaining a special *Gigartina*-association.

I have found the *Gigartina*-association beautifully developed on the northern side of the entrance of Trangisvaagfjord, where *Gigartina* (see plate XVIII) forms extensive growths on horizontal rocks.

On Sumbö Holm, the *Gigartina*-association was found on a very exposed coast, at a height of 2—4 feet, and on Myggenæs Holm I have seen it at a height of at least 10 feet above the lowest water mark. It is, on the whole, one of the commonest associations on the coasts of the Færöes.

Directly below this association,

The Himanthalia-Association

is found. The peculiar and characteristic *Himanthalia lorea*-association (see plate XIX) is very common on the exposed coasts of the Færöes. It grows from immediately above the lowest water mark down to the sublittoral *Alaria*-association. On flat rocks, the *Himanthalia*-association will stretch very far horizontally, but vertically, only to one foot as a rule. On sloping rocks which are constantly washed over by the sea, it may reach somewhat higher, sometimes even to the *Callithamnion*-association. For instance, on rocks at Viderejde I have observed well-developed specimens with receptacles (see plate XV), at a height of at least 6—7 feet above low water mark. On the other hand, the characteristic buttonlike or often globular, inflated, yellowish-brown, young plants are frequently found rather far above its special level, sometimes even above high water mark. But they

[1] »Den (formationen) er meget ioinefaldende paa lang afstand som et lyst gulgront belte straks over nederste vandstandsmærke; de enkelte algeindivider er nemlig aldeles afblegede i sollyset.

cannot produce receptacles in this unfavourable habitat. The *Himanthalia*-association is so characteristic on exposed coasts, that a luxuriant growth of this alga is a sure sign of the presence of surf. It is an association particularly fitted for resisting the dashing of the waves; the surf constantly washes over the association at low tide, and the metre-long, pliable, elastic receptacles of the *Himanthalia* follow resistlessly the movement of the sea. *Himanthalia* cannot stand to be dry for any length of time; when found

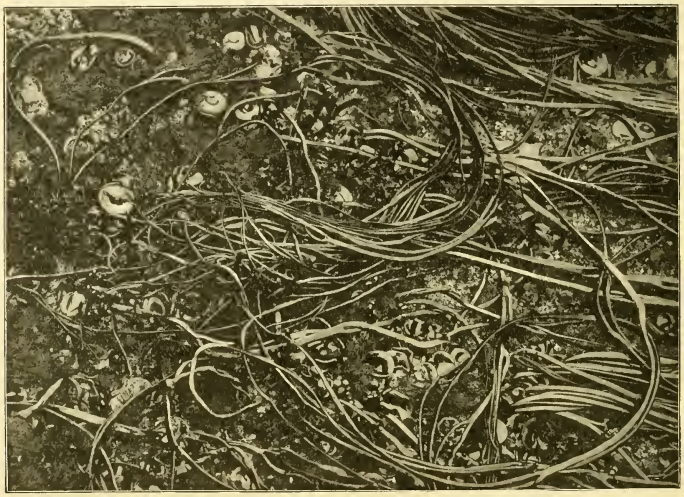


Fig. 155. The *Himanthalia*-association. Besides plants with receptacles, young plants are seen. The subvegetation consists of *Gigartina mamillosa, Polysiphonia urceolata, Acrosiphonia, Corallina*, etc. The illustration is taken from Midvaag. (F. B. phot.)

on a sheltered coast, where however it is rare, it always grows sublittorally in low water and often has another appearance. The receptacles are uneven, sometimes inflated, and the colour of the plant becomes a lighter yellowish-brown.

As a subvegetation to the *Himanthalia*-association, *Gigartina mamillosa, Acrosiphonia, Polysiphonia urceolata*, and others often occur besides *Corallina* (see fig. 155). *Elachista scutulata* has occasionally been found growing on the receptacles, and on the old plants a great many epiphytes are sheltered, especially species of *Ectocarpus* e. g. *E. fasciculatus, E. Hincksiæ, E. tomentosus* and *E. litoralis*, species

of *Myrionema*, etc. Simmons reports that he has found *Ectocarpus velutinus*, the parasite peculiar to *Himanthalia*.

The association seems to correspond with Hansteen's and Boye's description of their »*Himanthalia*-formation« on the west coast of Norway. They both refer it to the littoral region. Hansteen characterizes it as follows (38, p. 350): »This formation forms a sort of transition between the purely littoral and the purely sublittoral formations, as it is most often found both above, and especially below, the low tide mark.« This, however, seems to imply that it grows at a somewhat lower level on the west coast of Norway than on the Færöes.

Boye's remark (6, p. 24) that the formation »seems to avoid localities that are directly exposed to the surf«, does not agree with what I have observed, as I have found it in places as exposed as e. g. Store Dimon, Lille Dimon, Viderejde, Sumbö Holm, the western and northern coasts of Strömö, etc. At Christianssund in Norway I saw the *Himanthalia*-association growing on a very exposed coast and agreeing in all particulars with that from the Færöes. As pointed out by Hansteen, Kjellman has already (45, p. 34) mentioned the *Himanthalia*-association on the west coast of Norway. With regard to the Færöes this association has been briefly described by Simmons (l. c. p. 254).

THE ALGÆ-VEGETATION OF THE POOLS AND CAVES.

The algæ-vegetation of the littoral pools, and that of the caves, which are so abundant along the exposed coasts of the Færöes, must be described separately. In both places the algæ grow under very different conditions from those enjoyed by the other algæ-vegetation found at the same level.

The Algæ-Vegetation of the littoral Pools.

These pools must first be divided into two groups. 1) The pools found at a height to which the sea cannot reach at high tide, and which therefore cannot have their water renewed constantly. 2) The pools within the limits of high and low tide, and which are therefore connected with the sea at high tide for a shorter or longer time. Consequently these two groups of water-pools offer very different biological conditions to the algæ. In the low-lying littoral pools, the water will be continually renewed,

and the temperature and salinity will be constant or vary only slightly. It is quite different in the littoral pools where the water is but rarely renewed, perhaps even only in very stormy weather in winter. Through the heat of the sun, the temperature of the water may rise considerably and become lukewarm. The salt water will gradually be replaced by fresh water and become brackish or almost fresh. The water is usually anything but clean, as fragments of dead algæ are very often found in great quantities in the high-lying pools. These fragments have been washed up by the surf, and soon putrefy.

But even if the algæ of the littoral pools come in many respects under different biological conditions, in one respect, however, and that, of great importance, the conditions are similar, namely the algæ are always covered by water. In this respect they are under similar conditions to those of the sublittoral algæ and differ from the other littoral algæ-vegetation, which is laid dry for a shorter or longer time at low tide. Several otherwise sublittoral algæ are also found in the lower lying littoral pools. The light is certainly somewhat stronger here than in the sublittoral region, but to the sublittoral algæ which grow near the low water mark the difference will not be of great consequence. In the littoral pools, where the light is darkened by fallen rocks, one may even find some sublittoral algæ which are otherwise generally found at a great depth. In the low lying pools we find e. g. species of *Delesseria, Porphyra miniata, Rhodomela lycopodioides, Lomentaria clavellosa, Chætomorpha Melagonium, Ulva Lactuca*, etc. Rosenvinge has also reported these facts (71, p. 204) and in this connection he discusses the question, whether the littoral algæ which are regularly laid bare at low tide can also grow in littoral pools that are always filled with water.

To this he answers as follows: »Observations now tell us that a great many, perhaps most of the species that live in the littoral region outside the pools, can also grow in the pools.« This agrees with what has been observed on the coasts of the Færöes. But as pointed out by Rosenvinge, there are some littoral algæ which are never found in the pools. He mentions 8 species of this kind, 7 of which are also found on the Færöes. These 7, viz.: *Pilinia maritima, Calothrix scopulorum, Urospora mirabilis, Rhizoclonium riparium, Bangia fuscopurpurea, Porphyra umbilicalis* and *Ulothrix flacca*, I never found in pools on the Færöes, nor the following littoral algæ: *Callithamnion arbuscula, Plumaria ele-*

*gans, Rhodochorton Rothii, Pelvetia canaliculata, Ceramium acanthonotum, Prasiola crispa *marina, Prasiola furfuracea* and *Prasiola stipitata.* There are moreover several littoral algæ which grow but rarely in littoral pools, and when found there, are only imperfectly developed. In littoral pools between Thorshavn and Höjvig I have often found e. g. *Gigartina mamillosa*, which was hardly more than one inch long. Species of *Fucus*, e. g. *Fucus spiralis* and *Fucus inflatus* become paler in the littoral pools, the thallus likewise becoming thinner, and the plants are relatively small. This is the case with several littoral algæ. Evidently, some of them do not thrive when they are constantly in water; it seems as if they require to be laid bare for a shorter or longer space of time. Rosenvinge is also very probably right, when he supposes (71, p. 191) that certain littoral algæ perform part of their work of assimilation at low tide.

In the highest pools with their more or less fresh, luke-warm, and often half polluted water, where circumstances are very unfavourable to the algæ, only an *Enteromorpha*-vegetation is found, mainly consisting of forms of *E. intestinalis.* It is the only alga which can live under such unfavourable circumstances. It may be found far above the level of the sea, e. g. at Bosdalafos on Vaagö where it grows luxuriantly in small pools which are more or less inundated by small fresh water streams. In this connection it may also be mentioned, that I have found forms of *Enteromorpha intestinalis* at a height of about 600 feet (cf. 7, p. 242—245 and 8, p. 492).

A little lower, where the water is cleaner, other forms of *Enteromorpha* occur, e. g. var. *compressa*, var. *prolifera* and species of *Cladophora* e. g. *C. gracilis* and *C. sericea. Hildenbrandia* gradually gives a reddish hue to the sides of the pools, and several brown algæ appear, e. g. forms of *Fucus spiralis* and *Fucus inflatus* f. *linearis;* the latter has hitherto only been found at Famien on Syderö. Forms of *Ectocarpus litoralis, Scytosiphon lomentarius, Phyllitis fascia* and others moreover occur. Still farther down, where the water is regularly renewed at high tide, large, uneven brown crusts of *Ralfsia verrucosa* are found intermingled with the red *Hildenbrandia.* The bottom may also be covered by a dense matting of *Corallina officinalis*, sometimes mingled with *Phymatolithon polymorphum.* On *Corallina* one may also find crusts of *Dermatolithon macrocarpum* f. *Corallinæ.* Mingled with *Corallina*, several different algæ may be found e. g. *Dumontia filiformis, Rhodomela lycopodioides, Polysiphonia urceolata* and *P. Brodiæi, Lomentaria clavellosa,*

Furcellaria fastigiata, Chondrus crispus, Laurencia pinnatifida, Halosaccion ramentaceum, Ceramium rubrum, Chætomorpha Melagonium, Porphyra miniata and *P. leucosticta, Alaria esculenta, Laminaria digitata* and *L. saccharina*, especially f. *Phyllitis*, species of *Delesseria*, etc. and in general several algæ which otherwise grow only in the sublittoral region.

Thus it is evident, that a great many different species may be found in the pools; especially in the low lying basins. To show how rich in species such pools may be, we may mention that, according to Rattray (67, p. 428) Traill has found 67 different species in a relatively small littoral pool in the Firth of Forth.

It may be pointed out that it is peculiar to the algæ-vegetation growing in the pools that the different species often grow irregularly mingled with each other. This is surely due to the absence of tides. In larger littoral pools one may however see the algæ forming very distinct belts; various green algæ uppermost: *Enteromorpha, Cladophora* etc., and farther down *Polysiphonia, Rhodomela, Chondrus, Delesseria* etc. In a littoral pool above the highest water mark, but with clean water, *Enteromorpha intestinalis* for instance was found along the edge, next to that a belt of *Cladophora rupestris* and *Cladophora sericea*, below that a dense matting of *Corallina* with small *Monostroma fuscum*, and lastly *Laurencia pinnatifida* in great quantities.

This distribution is most clearly seen in large, deep pools found so far up in the littoral region that the waves can reach them only in stormy weather. In the summer in calm weather, the uppermost layer of water will turn brackish by the supply of rain and the different layers of water will be distinctly indicated by the vegetation.

In his report of the littoral rock pools on the west coast of Norway, Boye (6, p. 26) also calls our attention to the great differences in the vegetation which correspond with the different heights at which the basins are found. He moreover emphasizes that only *Enteromorpha intestinalis* is found at the greatest height. He also says that Hansteen's »*Ulvaceen*-formation« (38, p. 346) probably belongs in part to this vegetation.

Simmons, who does not give any special report of the vegetation of littoral pools, says (78, p. 253), when speaking of the »*Corallina*-formation«, that the *Corallina* may abundantly cover the bottom of such pools.

The Algæ-Vegetation of the Caves.

On almost all the coasts of the Færöes, facing the open sea, large or small concealed caves are found, where the sea often makes its way far into the rock. In stormy weather, when the sea is rough, these caves are more or less filled by the surf rushing in

Fig. 156. Cave in the rocks facing the sea. Illustration from Bordö: Arnefjord. (F. B. phot.)

with a noise like thunder. Now one might expect to find a luxuriant littoral algæ vegetation in these caves, which are always fresh and cool, and where there is less danger of the drying process than in the open air. But the dim light is a factor which very soon prevents the greater part of the littoral algæ from thriving here. These algæ are mostly such as seek the light and are accustomed to grow in full daylight. They are therefore only found at the entrance of these caves, and most of them soon disappear.

The algæ which cover the walls farther in the cave are either such littoral algæ as would be found in the open air on the beach in cracks and clefts or otherwise sheltered from strong light, or sublittoral algæ which here approach the surface of the water as the light grows fainter. Some of the latter may even be found at such a height, that they are dry at low tide. Among these there are several *Florideæ* which are usually only found at a great depth in the open sea. When rowing into such a cave, a condensed but exact picture is obtained of the algæ-vegetation that grows on a vertical rock in the open air, moving from the top downwards. Immediately at the entrance there are of course littoral algæ, but they soon disappear, as before mentioned, and so does the *Alaria*-association. The *Laminaria hyperborea* is found a little farther in, but it also soon disappears, and only *Florideæ* are left.

By closer observation of the algæ-vegetation, we find that, as mentioned above only a few specifically littoral algæ grow here. The alga which is most widely distributed and found at the greatest height is *Rhodochorton Rothii*. Far stretching vegetations of it like a dense, low, brownish-red felt cover the walls and ceilings of the caves (cf. the *Rhodochorton*-association, page 718). Even in the mighty caves on Troldhoved it is certainly this alga which gives the more than 50 feet high rocky vaults their redish hue. At the entrance of the caves and close to the level of the sea it grows on the rock in small, firm lumps of the size of a pea.

From about the highest water mark downward, a dense, almost blackish covering of *Plumaria elegans* is often found in the caves. In the Færöes I have only met with this alga in these places. Together with *Plumaria*, a dense covering of *Delesseria alata, Ceramium rubrum, Polysiphonia urceolata*, and others, are also found. They form a dark red, tangled vegetation which is often joined by *Cladophora rupestris* closer to the entrance of the cave. In a cave on the northern side of Kvalböfjord on Syderö, a low, red covering of a small *Phyllophora* (8, p. 359) was found, some way into the cave. A little above the lowest water mark, the elegant little *Callithamnion scopulorum* is abundant, and *Callithamnion arbuscula* may also sometimes be found in the caves. It partly changes its appearance here, becoming less ramified and of a lighter reddish colour. Whilst the *Corallina* is most often the subvegetation at the entrance of the caves, it is replaced by the *Phymatolithon polymorphum* farther into the cave. At the entrance of the caves, for

instance at Troldhoved, the *Phymatolithon*-formation (see page 750) is found at about low water mark or a little above; but on rowing into the cave, it will be found to extend further and further up, till far above the highest water mark. This alga is of a fine pink colour in the cave, and, as far as I have seen, reaches further into the cave than any other alga; darkness of course gets the better of it at last. Together with *Phymatolithon*, we often find *Cruoria pellita* forming large, shining, dark reddish incrustations, even far above the lowest water mark. Other sublittoral algæ found here are *Delesseria sinuosa* and even *Delesseria sanguinea* the thallus of which is torn by the surge into narrow lobes. One may moreover find *Odonthalia dentata, Plocamium coccineum, Lomentaria clavellosa, Ptilota plumosa*, *Enthora cristata*, and, just below the lowest water mark, the beautiful *Pterosiphonia parasitica* and many more sublittoral algæ.

As mentioned above (page 701, footnote), some sublittoral algæ may hardly ever be found at the level of the sea, not even in the caves, and as likewise pointed out at the same place, this must be ascribed most probably due to the surge, as several of these algæ are found in other places at the lowest part of the littoral region.

This peculiar circumstance, that a deep water-flora can be found at the level of the sea in caves, has however already been pointed out by several algologists. In the introduction to his algæ-flora (18, p. 220—221) Falkenberg speaks of a »Grotta del Tuono« in the neighbourhood of Naples, with only very shallow water, which was constantly renewed by its connection with the sea. He says: »Trotz des niedrigen Wasserstandes in diesem Bassin finden sich hier an den dunkelsten Stellen Algen, die sonst als charakteristische Pflanzen einer Tiefe von etwa 50—60 Meter im Golfe sich finden.« And after having named a certain number of the algæ found in this place, he continues: »So zeigt diese kleine Grotte mit flachstem Wasserstande in ihrer Algenvegetation je nach dem grösseren oder geringeren Grade von Dunkelheit einen ähnlichen Wechsel, wie er im freiem Meere bei dem Uebergang aus grösserer in geringere Tiefe stattfindet«. In the section on the influence of the different degrees of the intensity of light on the distribution of the marine algæ, Berthold points out that the algæ without exception must, as independent assimilating plants, require a certain intensity of light, yet different

for each species. He further writes: (5, p. 414) »In den beschatteten Grotten, in welchen *Lithophyllum Lenormandi, Callithamnion elegans, Derbesia Lamourouxii* die äussersten Grenzen der Vegetation bezeichnen, verschwinden diese Formen schon vollständig in geringen Entfernungen vom Eingange. Ist es erlaubt aus den Befunden an der Oberfläche auf das Verhalten in grösseren Tiefe zu schliessen — die Berechtigung dazu dürfte kaum bestritten werden können, denn die Algenformen sind an den entsprechenden Örtlichkeiten theils ganz dieselben, theils nahe verwandt —, so muss die Lichtintensität auch hier bei vorhandenem Pflanzenwuchs noch eine ziemlich beträchtliche sein«. If it were possible to measure in some way the amount of light that reaches the algæ growing in the innermost parts of the caves, this might certainly, as suggested by Berthold, serve as a measure of the intensity of the light at the depth where the algæ-vegetation disappears[1].

b. Sheltered Coasts.

The Chlorophyceæ-Formation.

Here this formation is chiefly represented by an *Enteromorpha*-association, but sometimes we also find others of the different associations belonging to this formation on exposed coasts e. g. the *Prasiola stipitata*-association.

The *Enteromorpha*-association grows highest, often somewhat far above the highest water mark and stretches down to a little below it. It is often found on moist rocks and in clefts and cracks, where fresh water oozes from the rock, and consequently it does not form any continuous belt, but larger or smaller patches in these places. It may moreover be found at the inner end of bays and inlets, where the bottom is covered with gravel or stones, and here it may often partly replace the *Fucaceæ*-formation. It is, for instance, richly developed in the innermost part of Kalbak- and Kollefjord, in Skaalefjord etc. Different forms of *Enteromorpha intestinalis*

[1] In order to try if any result might possibly be obtained, I used in 1900 Wynne's actinometer, which serves for photographic purposes to indicate the exact term of exposure in a certain place (cf. Johs. Schmidt: Bidrag til Kendskabet om Skuddene hos den gamle Verdens Mangrovetræer, København 1903, p. 11). But in these caves, where the light is faint and the term of exposure consequently long, the instrument proved less useful. With an instrument constructed by Dr. Steenstrup (cf. Meddelelser om Gronland. 25, page 1) to measure the intensity of the light, a satisfactory result might possibly be obtained.

are met with here: var. *micrococca* uppermost, next to that var. *genuina*, especially the forma *cornucopiæ*. Together with *Enteromorpha, Ectocarpus litoralis* is also often found, especially the form *rupincola*.

This association is closely related to the *Enteromorpha*-association, which has been mentioned as characteristic on exposed coast (p. 714), and to the *Enteromorpha*-vegetation which is found in the highest littoral pools. It seems to correspond exactly with the »*Enteromorpha*-formation« found by Hansteen (38, p. 358) at the head of the Vindefjord.

The Fucaceæ-Formation.

On sheltered coasts, especially in the littoral region, a very characteristic and luxuriant vegetation is found both on rocks and stones and consists almost entirely of the *Fucaceæ: Pelvetia canaliculata* uppermost, next to that *Fucus spiralis, F. vesiculosus, Ascophyllum nodosum*, and lastly *Fucus inflatus*, which grows a little above and sometimes a little below the lowest water mark. As these five *Fucaceæ* are differently adapted to resist the dashing of the waves or the supply of fresh water, they are not always found together. In the most sheltered places *Pelvetia, Fucus vesiculosus* and *Ascophyllum* will generally predominate, whilst *Fucus spiralis* and *F. inflatus* are absent entirely or only represented by a few scattered individuals. Where the coast begins to be more exposed, the two last-mentioned algæ appear. At the same time, *Fucus vesiculosus*, and later *Ascophyllum* totally disappear. *Pelvetia* may still be found in rather exposed places, but in the most exposed it likewise disappears, so that only *Fucus spiralis* and *Fucus inflatus* are left. These two algæ may be typically developed on a somewhat exposed coast, but the more exposed it is, the smaller the *Fucus*-species. Thus they pass easily into the above-mentioned *Fucacé*-formation found even on the most exposed coasts.

With regard to the species found on the coasts of Greenland, *Fucus vesiculosus, Ascophyllum nodosum* and *Fucus inflatus*, these observations agree well with Rosenvinge's report (71, p. 197). I also entirely agree with Rosenvinge, when he declares, that *Fucus vesiculosus* grows the farthest into the fjords, where the water may be almost fresh because of the inflow of rivers. Yet *Ascophyllum* may sometimes be found growing at the outlet of rivulets, where the alga at low-tide is irrigated by fresh water, but

this takes place generally nearer the mouths of the fjords, where the sea-water inundates its habitat at high tide.

As mentioned already *Pelvetia* grows uppermost. On a sheltered coast and at or a little above the highest water mark, it constitutes an association which may spread far horizontally, but which is vertically most often only one foot broad (see plate XXII). When moist, it is of a light yellowish, olive-brown hue, but in calm weather it is often liable to be dried; *Pelvetia* may be found quite dry and stiff, and is then of a blackish hue. In tideless bays, it is of course very liable to be drained, and circumstances are on the whole less favourable to it here than in places which are subject to a regular tide. This is quite clear from its slighter development; specimens from the Kalbakfjord for instance, especially those growing highest, were often but one inch long and consisted almost entirely of receptacles, a form which has been called f. *minima* by Simmons. Yet this dwarfish growth here in the fjords, may perhaps be partly due to the great amount of fresh water which flows constantly from the rivers, and which makes the surface-water with which *Pelvetia* comes in contact, very fresh. On coasts subject to the tide, a much more vigorous and better developed *Pelvetia*-association is found. Other algæ are but rarely found in the *Pelvetia*-association as Simmons (p. 251) has pointed out, probably because only a few algæ are able to grow so far above the level of the sea in sheltered places. *Ulothrix flacca* and *Ectocarpus litoralis* are however sometimes found epiphytically on *Pelvetia*, on the rock we find a sub-vegetation of *Verrucaria* and *Hildenbrandia rosea*, and in cracks in the rock, *Rhodochorton Rothii* and *Ectocarpus litoralis*.

Below this association, a *Fucus vesiculosus-Ascophyllum nodosum*-association grows on a sheltered coast. It is very common and on slightly sloping rocks it is widely distributed horizontally; a specially luxuriant growth of these algæ seems to be found on coasts with boulders and fragments of rocks of different sizes. On these stones, *Fucus vesiculosus* generally grows uppermost, in large dense clumps and facing landward; below, *Ascophyllum* hangs down the sides of the stones (see plate XXIV). Yet *Ascophyllum* may also be found growing above *Fucus vesiculosus*. This I have seen in the Vestmanhavnbugt, for instance. Strömfelt likewise writes (80, p. 10), that *Ascophyllum* grows uppermost, and *Fucus vesiculosus* farther down[1], whilst Rosenvinge reports that *Fucus vesiculosus* grows uppermost

[1] According to Jónsson's observations (41, p. 192—193), it is usually the reverse.

in Greenland. It seems to me most likely that the somewhat different occurrence of these two species, also in the Færöes, may be explained thus, that *Fucus vesiculosus*, as mentioned before, requires to be more sheltered than the other; therefore, this alga in a somewhat exposed place grows facing landward and uppermost, whilst it may grow nearer to the sea and farther down in a locality as sheltered as Vestmanhavn.

Fig. 157. *Fucus inflatus*-association at a small, low-lying pool on the beach. Illustrations from rocky coast at Thorshavn. (F. B. phot.).

Elachista fucicola is a very common epiphyte on *Fucus vesiculosus*, and *Polysiphonia fastigiata* is hardly ever sought in vain on *Ascophyllum nodosum*. Besides these, other epiphytes are sometimes found e. g. *Ectocarpus litoralis*, *Ectocarpus tomentosus*, *Ceramium rubrum*, *Rhodymenia palmata* etc. on both algæ. Below the dense tufts of seaweeds several red algæ are often found, e. g. *Gigartina mamillosa*, *Chondrus crispus*, *Hildenbrandia rosea*, *Rhodochorton Rothii*, etc.

On a somewhat more exposed coast, *Fucus vesiculosus*, as before mentioned, soon disappears and is replaced by *Fucus spiralis* which forms an association at about the same height as *Fucus vesiculosus*, or a little higher. Below *Ascophyllum nodosum*, *Fucus*

inflatus occurs. On a more exposed coast, the latter forms an extensive association (figs. 157 and 158). Both in the *Fucus spiralis*- and the *Fucus inflatus*-associations, *Elachista fucicola* is a very common epiphyte. On *Fucus inflatus*, several species of *Ectocarpus* e. g. *Ectocarpus tomentosus*, *Ectocarpus fasciculatus*, etc. are often found. On the rocks and stones, below and among these algæ, especially in the lowest *Fucus inflatus*-association, one may find a great many different algæ, e. g. *Porphyra umbilicalis*, *Urospora mirabilis*, *Cladophora rupestris*, *Acrosiphonia albescens*, *Polysiphonia urceolata*, *Ceramium rubrum*, *Gigartina mamillosa*, *Chondrus crispus*, etc.

In order to characterize the *Fucaceæ*-formation more closely, I shall give a description of some of the localities in which I have met it at its greatest development. In Vestmanhavn, and a little north and south of this gulf, in the Vestmannasund, between Vaagö and Strömö, a specifically well-developed *Fucaceæ*-formation is found, on sheltered coasts. The tide rises rather high here, about 6—8 feet, and at low tide the formation is laid perfectly bare. We find *Pelvetia* uppermost as a light yellow belt, almost a foot broad, showing up the high water mark with an almost perfectly straight line. Below this, we have some *Fucus spiralis*; this alga is abundant only on somewhat more exposed coasts. The *Fucus-Ascophyllum*-association, which comes next, is however very luxuriant. As shown in plate XXIII, the coast in certain places consists of large stones which are completely covered by these algæ. This vegetation is found as far down as the lowest water mark, where some few *Fucus inflatus* may occur.

On the east coast of Strömö, between Thorshavn and Höjvig, the *Fucaceæ*-formation is of a somewhat different appearance. The coast is here rather exposed and rugged, with several larger or smaller islands girding the coast. In one of the inlets, called Volgaravik, which forms a little natural harbour, having but a small opening towards the sea, a well-developed *Fucaceæ*-vegetation was found (see plate XXIV). Near the land, the coast was composed of boulders of different size which were covered by a dense *Fucus*-vegetation; a little farther out, in a more exposed position, *Fucus vesiculosus* disappeared making way for a luxuriant *Ascophyllum*-vegetation, which was replaced by a well-developed *Fucus inflatus*-vegetation at the greatest distance from the shore and at a lower level. Here, on the stones lying farthest from the shore, the position is rather exposed, and in a strong sea making towards the land the surf

dashes heavily into the inlet. This *Fucaceæ*-vegetation was widely distributed horizontally, but not vertically, as was easily observed on the perpendicular walls of the inlet, where all three species grew together, forming a belt hardly more than a few feet broad. It should not be forgotten, however, that ebb and flow are scarcely perceptible on this part of the coast.

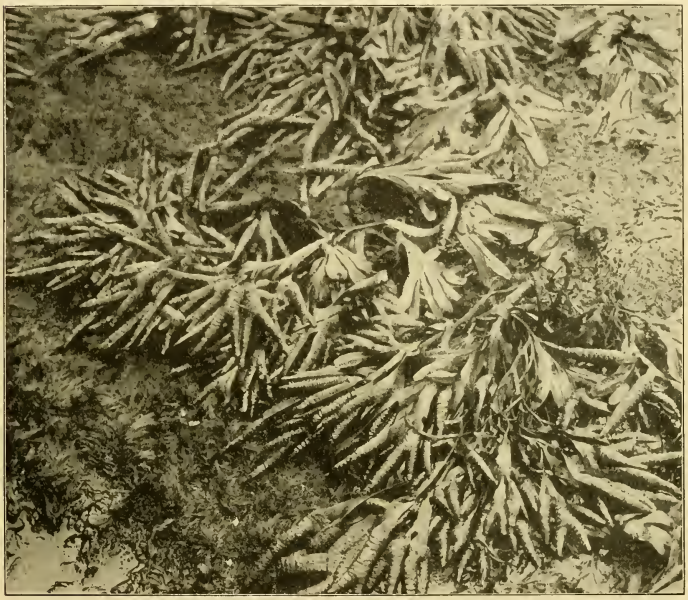


Fig. 158. *Fucus inflatus.* A small part of the *Fucus inflatus*-association illustrated in fig. 157. (F. B. phot.).

From Thorshavn, which has rather an exposed situation, southward to Arge, a *Fucaceæ*-vegetation is moreover found, with *Fucus spiralis* uppermost, *Fucus inflatus* lowest (see figs. 157 and 158). To these must be added *Ascophyllum nodosum* in somewhat sheltered places, and *Fucus vesiculosus* in the most sheltered. At Glivernæs, still more toward the South, and further on in the same direction, the coast becomes more exposed and only the dwarfish forms of *Fucus spiralis* and *F. inflatus* are found.

Examples of the above-mentioned *Fucaceæ*-formation will be

found almost anywhere on the coasts of the Færöes. The formation constantly adapts itself to the more or less exposed situation of the locality and by aid of the *Fucaceæ*-vegetation, it may as a rule be easily determined whether a certain locality is sheltered or exposed.

The *Fucaceæ*-formation of the Færöes seems to agree well with Rosenvinge's of the coasts of Greenland. According to Strömfelt's somewhat scanty description (80, p. 10), a very similar vegetation must be found on the coasts of Iceland. If we compare the *Fucaceæ*-formation of the coast of Norway, described among others by Hansteen (38, p. 351—52) and Boye (6, p. 27), we at once observe that they are essentially different from a floristical point of view, as *Fucus serratus*, which is very common on the west coast of Norway, is absent on the Færöes; œcologically there likewise seems to be a great difference between them. Boye writes (l. c. p. 25): »Even in the most exposed localities, a very luxuriant *Fucus*-vegetation is usually found«; he mentions moreover two forms of *Fucus vesiculosus,* besides a f. *elongata* of *Fucus serratus* as being found there. This is quite contrary to what we observe on the Færöes, where *Fucus vesiculosus* is absent on exposed coasts. The only *Fucus*-species that will thrive here are *Fucus spiralis* and *F. inflatus.* As before-mentioned (p. 724) I doubt, however, whether Boye's observations are perfectly correct.

In the northern part of Norway, where *Fucus inflatus* is common, the *Fucus*-vegetation hardly differs from that of the Færöes in anything but this, that *Fucus serratus* is frequent. The Færöese *Fucus*-vegetation also much resembles that of the Shetland Isles, except that a luxuriant growth of *Fucus serratus* occurs on the shores of the latter. What makes the resemblance still greater is, that *Fucus inflatus* has been found here (cfr. 9, p. 5). Simmons mentions (78, p. 251 and 253) a *Pelvetia*-formation and a *Fucus-Ascophyllum*-formation found on the Færöes.

2. The Sublittoral Region.

As mentioned before, I agree with Rosenvinge in determining the upper boundary line of this region at about low water mark, at neap-tide. In the Færöes the boundary line is almost identical with the distinct upper line of the *Alaria*-association. Kjellman determines the lower limit of this region at the curve of 20 fathoms, and he calls the area covered by algæ below this, the elittoral re-

gion. The reason why he chooses this curve for the lower limit is, that the algæ-vegetation at and below 20 fathoms becomes uniform and poor in species, as the greater part of the sublittoral algæ will not thrive at so great a depth. He himself points out, that this limit is »weniger scharf oder wenigstens nicht so auffallend« between these regions as between the littoral and the sublittoral. In agreement with Rosenvinge (45, p. 237), I therefore think, that it is unadvisable to determine the boundary line between two regions so arbitrarily, as the number of species and the luxuriancy of the vegetation are in reality reduced regularly and gradually from a certain depth downward. Moreover the sublittoral species growing at the lowest depth are likewise often found in the upper part of the sublittoral region. No other species are introduced here that might change the appearance of the vegetation. When moving downwards from the surface of the sea, the brown algæ first disappear, and at last hardly anything but *Florideæ* are left[1].

Finally, the curve of 20 fathoms may serve as a boundary line only in the northern seas, where the light does not reach far down. In the Mediterranean Sea, a vigorous vegetation is still found at a depth of more than 40 fathoms, and in the Tropics we may be sure to find a rich algæ-vegetation still farther down. It does not seem to me natural therefore to maintain this boundary line, as the algæ-vegetation is luxuriant down to a certain depth, (in the Færöes to about 15 fathoms, as far as my observations go) and then leaves off slowly and gradually, as the depth increases. When Kjellman objects (45, p. 8—9) to Ørsted's division of the algæ-vegetation in the Sound, that the boundary line between the brown and the red algæ is indistinct, it seems to me that the same objection might be applied to Kjellman's division into a sublittoral and elittoral region. If the sublittoral region must be divided, it is probably Ørsted's division that ought to be maintained, as it would seem

[1] In connection with this I shall refer to Rosenvinge's summary of the species (71, p. 231) found at a depth of at least 10 fathoms; algæ found at a still greater depth, at 15 fathoms and more, are printed in thick type. As pointed out by Rosenvinge (l. c. p. 232), it is evident from the list that the red algæ increase in number with the depth. There is hardly any doubt, that here also an almost pure *Florideæ*-formation will be found, shortly before the vegetation ceases. It is true that Rosenvinge in the same connection (p. 236) speaks of a *Desmarestia aculeata*, found at a depth of about 30 fathoms, near Upernivik. But I doubt whether this alga was adhering to any substratum.

most natural to determine the boundary line where the brown algæ leave off, and where only a pure or almost pure *Florideæ*-vegetation is left. But while we still know so little of the algæ-vegetation at greater depths, it seems to me most natural, as mentioned before to determine the sublittoral region as one, and, in agreement with Rosenvinge (l. c. p. 237), »to move the lower boundary line of the sublittoral region from the curve of 20 fathoms to the limit where the algæ-vegetation disappears. Thus the elittoral region will include that part of the bottom of the sea which is destitute of algæ«[1].

a. Exposed Coasts.

The Phymatolithon-Association.

This association begins at about the lowest water mark, or a little above, and probably extends down to a depth of several fathoms. My observations are, however, not exact, as *Phymatolithon polymorphum* which forms this association is almost always covered by the *Alaria,* etc. and is therefore not easily observed. Still I have seen that it may be found in caves several fathoms below low water mark as well as at and even over the highest water mark. It covers the rock with a whitish or slightly pink, glabrous crust, but as mentioned before it is mostly covered by various larger algæ, especially the *Alaria.*

This association grows on the most exposed coasts. Its stone-like consistency, and its firm hold on the rocks, serve to protect it from the surf. Simmons mentions a *Lithothamnion*-formation (p. 251) which probably agrees with this association. It is true that, according to his report, it is found almost only in the littoral region (»ausnahmsweise bis an die Fluthgrenze hinaufreichend und sich bis an oder zuweilen etwas unter die Ebbengrenze streckend,«) but later he has corrected this.

The sublittoral Corallina-Formation.

The littoral *Corallina*-formation stretches sublittorally, as mentioned before, down to a depth of several fathoms[2]. Here the *Co-*

[1] »at flytte den lavere Grænse for den sublitorale Region fra 20-Favne Kurven til den nedre Grænse for Forekomst af Algevegetation overhovedet, saa at den elitorale Region kommer til at omfatte den Del af Havbunden, der er blottet for Vegetation«.

[2] In my flora (8, p. 402), I have stated this depth as 1—2 fathoms. According to my later observations, it may however reach to at least 4 fathoms.

rallina is however often replaced by the above-mentioned *Phymatolithon polymorphum*-association.

Like the littoral *Corallina*-formation, the sublittoral shelters a great many different algæ, either epiphytically on the *Corallina*, or on the rock among the latter. Some of these are e. g. *Chondrus crispus*, *Delesseria alata*, *D. sinuosa*, *Chætomorpha Melagonium*, *Lomentaria clavellosa*, *Ptilota plumosa*, *Porphyra leucosticta*, *P. miniata*, etc. In smaller group of rocks, where the habitat is somewhat sheltered but the coast still exposed, e. g. on the east coast of Strömö, from the redoubt near Thorshavn northward, to Hvidenæs, or at Ejde on Naalsö, large associations of the gregarious *Furcellaria fastigiata* are often found in the *Corallina*-formation, besides large or small associations of *Ahnfeltia plicata*. A common epiphyte on the *Corallina* in these places is *Ceramium rubrum* subf. *secundata*. *Ulva Lactuca* and *Monostroma fuscum* are likewise found here. The *Corallina*-formation is moreover partly the subvegetation of the *Alaria*-association.

The Laminariaceæ-Formation.

This, the most widely distributed formation on the coasts of the Færöes is naturally divided into several well-defined associations. On an exposed coast, the *Alaria*-association is uppermost, which is sometimes replaced by a *Laminaria digitata*-association; a *Laminaria saccharina*-association is more seldom found, and lowest of all a *L. hyperborea*-association. On a sheltered coast we moreover find a *Laminaria fœroensis*-association, but of this and the *Laminariaceæ*-formation as a whole we will give further details later on.

This *Laminariaceæ*-formation corresponds with Kjellman's Laminariaceen-formation (45, p. 34).

The Laminaria digitata-Association.

This association, which gradually merges into the *Laminaria hyperborea*-association, growing below it, is found on open coasts on slightly sloping rocks. In localities where the sea is particularly turbulent and therefore constantly washing the rocks, this association may reach to several feet above the lowest water mark. On the southern and eastern coasts of Syderö, from Sumbö Holm to Vaagfjord, and on Vaagö and Troldhoved on Sandö, I have seen this association beautifully developed (see plate XX).

The *Laminaria digitata* is well adapted to resist the violence of the waves. Both leaf and stalk are of a tough, yet pliable character

and the stalk is, as pointed out by Wille (85, p. 9—10), very extensible, in contrast to *Laminaria hyperborea* which has a very stiff stalk. The stalk being often much compressed at the top, adds to its flexibility, which is also mentioned by Wille (p. 6). The plant is moreover firmly fastened to the rock by vigorous haptera, and if one tries to pull it up, generally only the stalk is broken, whilst the haptera are left. On coasts where the rocks project vertically into the sea, this association, however, is usually entirely absent, or a single *Laminaria digitata* at most may now and then be found. It is the form *stenopylla* which is represented here, but where the association is well developed, all transitional forms besides the main form are found. As a subvegetation, we find *Corallina, Gigartina, Polysiphonia urceolata, Cladophora rupestris, Phymatolithon polymorphum,* etc. and on the *Laminariæ* themselves, some smaller epiphytes which grow on the stipes or sometimes also on the margin of the lobes of the thallus. Among the latter *Ectocarpus fasciculatus, E. tomentosus* and *E. Hincksiæ* are the most important. Early in spring a dense covering of the parasitical *Ectocarpus tomentosoides* is invariably found (compare 8, p. 415).

The *Laminaria digitata*-association grows at about the same height as the *Himanthalia*-association which is usually absent where the former is well developed.

In connection with this I may say that I have also, though but rarely, found a *Laminaria saccharina*-association growing a little above and a little below the lowest water mark. On Sumbö Holm, a little above the lowest water mark, I have found a vegetation of *L. saccharina* represented by a form which I think might be referred to f. *linearis* (see the illustration of this alga in my flora, 8, p. 453). This form was smaller, the thallus narrow, thick, leathery and very wrinkled, probably an adaption to its very exposed habitat. On the lamina a great many epiphytes were often found, especially *Pogotrichum filiforme,* which made the alga resemble an ostrich feather when floating.

The Alaria-Association.

This association generally grows uppermost in the sublittoral region directly below the *Himanthalia*-formation, as pointed out by Hansteen. Thus it begins at about the lowest water mark at neap-tide; at spring-tide, part of it, one foot or more, is laid bare. In very exposed places, in clefts, or on sloping rocks that are constantly

Fig. 159. *Alaria*-association on the beach at Myggenæs Holm.
(F. B. phot.).

washed by the sea, *Alaria esculenta* may exceptionally be found up to several feet above the lowest water mark, as at Myggenæs Holm, where it grows up to at least 10 feet above the lowest water mark, that is to say, it passes above the highest water mark (see fig. 159). Other places where it grows under the same conditions, are e. g. Lille Dimon, Mölen at Ejde, etc. (see also plate XXI).

The *Alaria*-association prefers steep or perfectly vertical rocks in the most exposed places, and covers these rocks with a dense covering, often many feet thick, at varying but hardly ever very great depths. Yet the *Alaria* may be found at a depth of several fathoms, as in sounds where there is a rapid current. Here the *Alaria* is often richly represented in the *Laminaria hyperborea*-association.

The *Alaria* is excellently adapted to the violence of the waves; its elastic leaves constantly follow the motion of the water, as their great flexibility makes them utterly unresisting. In spite of this, the uppermost part of its lamina clearly shows traces of the force of the sea on exposed coasts, as it is torn and rent into small lobes, and lastly nothing but the bare, thin, much-worn midrib is left (see the illustration of this alga in my flora, p. 449).

Generally the association consists solely of the *Alaria esculenta*; the *Alaria Pylaii* seems to prefer somewhat more sheltered coasts, and it may be supposed that this species is rare, as only a few specimens of it have been found. It is therefore of no importance in reference to the composition of the *Alaria*-association. On the other hand, the *Litosiphon Laminariæ*, which is almost always found abundantly on the leaves of the *Alaria*, and the *Chantransia Alariæ*, which covers the lamina with a very dense, purple, velvet mat, are very characteristic in the association. I have however only seen the latter a few times on the coasts of the Færöes. On old stems of *Alaria* a number of different epiphytes are found; some of these are *Ectocarpus fasciculatus*, *E. Hincksiæ* and *E. tomentosus*, *Rhodymenia palmata*, *Porphyra umbilicalis*, *Ulothrix flacca*, etc.

Larger algæ but rarely belong to the association; however, *Laminaria saccharina* f. *linearis* may be found more or less abundantly, as well as *Laminaria digitata* f. *stenophylla*, which may in some places be found on slightly sloping rocks even far up in the littoral region, as will be mentioned below. In narrow inlets of shallow water lying between rocks and small islands, »Skærgaarde«, e. g. those mentioned before on the east coast of Strömö, north of the redoubt, large numbers of *Laminaria saccharina* f. *bullata*

are often found intermingled with the *Alaria*. Circumstances are, however, always somewhat altered where other species are intermingled. In places favourable to the *Alaria*-association, that is, on steep or vertical rocks on exposed coast, this association may be found almost unmixed for miles.

The *Alaria*-association in the Færöes which has already been shortly described by Simmons (78, p. 254) seems to agree well with Hansteen's (l. c.) and Boye's (6, p. 4—5) *Alaria*-formation. Yet we may suppose according to Boye that »*Laminaria stenophylla*« Harv. must be somewhat more common in the association on the coast of Norway than at the Færöes.

The Laminaria hyperborea-Association.

This characteristic algæ-association is widely distributed on the coasts of the Færöes. It grows abundantly from a depth of about 1 fathom down to 10—15 fathoms, and it is most luxuriant at 5—10 fathoms, forming large submarine forests. It prefers horizontal or slightly sloping rocks, on stony ground. In such localities, the very dense vegetation of *Laminaria hyperborea*, with its brown, pendulous, fan-like laminæ swaying with the waves, may be seen when the water is clear. Close to the land, in gulfs and inlets, it often grows in such shallow water that the uppermost part of the lamina are seen above the surface of the sea at low tide (see fig. 160).

It is here that the above-mentioned epiphytical *Rhodymenia*-vegetation has its habitat.

On account of its vigorous haptera, the *Laminaria hyperborea* is able to cling to even the most exposed places. This algæ is however not much exposed to the surf; it generally grows at too great a depth, and when it grows in shallow water it is most often in rather sheltered inlets and gulfs, as mentioned before. Its solid and comparatively not very flexible stalk would certainly make it unfit for resisting a strong surge. On the other hand, it is much exposed to and also excellently fitted for resisting the strong pull of the rolling waves. When the sea is rough, the effect of this pull is felt far down, as is seen from the fact that a stormy sea can break at more than 10 fathoms of water.

On a small rock outside of the »redoubt« near Thorshavn there is a dense vegetation of *Laminaria hyperborea* at a depth of 3—4 fathoms. During a tempest from the south and a rough sea, I have

seen how the lamina of the *Laminaria hyperborea* was sucked into the waves and kept swaying to and fro when they rushed over the rock; it is certainly exposed to a very strong pull here. But *Laminaria hyperborea* is excellently constructed for resisting this attack of the sea, its stalk being both thick and stiff at the bottom but becoming thinner and more elastic towards the apex, so that the flexible lamina can easily follow the motion of the water. It is firmly attached to the bottom by aid of the strong haptera. It is

Fig. 160. *Laminaria hyperborea* with numerous epiphytical *Rhodymenia palmata* rising above the surface of the sea at low tide. Illustration from the neighbourhood of Thorshavn. (F. B. phot.)

a well-known fact to anyone who has dredged among the *Laminaria hyperborea*, that only by a very strong pull, or by the teeth of the dredge cutting through the haptera more often through the stalk itself, can the plant be torn from the bottom. I have often tried from a boat to pull up the plants that grew in shallow water, but I have hardly ever succeeded in loosening them without cutting through the haptera. Thus the plant may resist a very strong pull without being detached from the bottom. Its gregarious growth also helps to protect it from the attack of the sea.

This association covers large areas with an almost unmixed growth of its characteristic alga. It would therefore look very uniform but for the very luxuriant subvegetation of epiphytes, mainly the

Florideæ. It is the haptera and especially the stalk which are almost densely covered by large or small algæ (see fig. 161). The lamina however is mostly destitute of epiphytes, most likely because it is changed every year. Various species, however, e. g. *Rhodymenia palmata, Ectocarpus tomentosoides,* which would probably be very common in spring, *E. tomentosus*, *E. fasciculatus*, and some others, may be found growing on the lamina, especially in shallow water.

Among the many epiphytes that grow on the stalk and the roots, the following species may be pointed out: *Polysiphonia urceolata, Chantransia Daviesii, Callophyllis laciniata, Euthora cristata, Rhodophyllis dichotoma, Lomentaria clavellosa, L. rosea, Plocamium coccineum, Delesseria alata, D. sinuosa, D. sanguinea, Polysiphonia elongata, Odonthalia dentata, Ptilota plumosa, Pt. pectinata, Antithamnion floccosum, Ceramium rubrum, Rhodochorton Rothii, Cruoria pellita, Lithophyllum Crouani, Dermatolithon macrocarpum* f. *Laminariæ, Peyssonelia Dubyi, Sphacelaria furcigera, Desmarestia aculeata, D. viridis;* that is to say, scarcely any but *Florideæ*. Most of these epiphytes may be found even in rather shallow water in the semidarkness under the *Laminariæ* which also afford some protection from the violence of the waves.

In describing the algæ-vegetation of the Mediterranean Sea, Berthold points out (5, p. 422) that the epiphytes on a *Cystosira granulata* grow in a certain fixed order. Those that require more light grow on the top of the *Cystosira*, those that want less grow under the latter. The epiphytes on the stalks of the *Laminaria hyperborea* likewise grow in a certain fixed order from the top downward, according to the degree of light required by each alga; those that want much light grow uppermost, the others lower down. The colour of the water can hardly be of any consequence where the distance from the top to the bottom only means the length of the stipes. At the top of the stipes we find *Ceramium rubrum, Polysiphonia urceolata, Delesseria alata, Polysiphonia elongata,* and from these algæ downward, we find *Odonthalia dentata, Delesseria sinuosa, Plocamium coccineum, Ptilota plumosa, Lomentaria clavellosa, Sphacelaria furcigera, Rhodochorton Rothii, Cruoria pellita, Dermatolithon macrocarpum* f. *Laminariæ* etc. On the lowest part of the stipes, and especially on the haptera, *Callophyllis laciniata, Rhodophyllis dichotoma* and *Euthora cristata* are found.

The *Laminaria hyperborea*-association reaches its finest development in the course of the summer. The lamina is changed in winter,

and the old fronds are thrown off in spring, at which time of the year they are washed up on the beach in great numbers by the heavy storms. Even in May and June, however, specimens may be found which still have the old lamina attached.

Fig. 161. Stipes and haptera of *Laminaria hyperborea* with a dense covering of epiphytes. On the stipes, *Ptocamium coccineum* is prominent; on the haptera, *Callophyllis laciniata* and *Euthora cristata*. Uppermost on the stipes we find *Ceramium rubrum*, *Polysiphonia arceolata*, *Delesseria alata*, *Polysiphonia elongata*. (F. B. phot.

The *Laminaria hyperborea* association grows more or less densely in all suitable localities down to a depth of 10—15 fathoms[1] (Simmons gave 25 meters). Besides the above mentioned epiphytes,

[1] It is hardly probable that the *Laminaria hyperborea* should be found forming an association below this depth; but a single specimen may well be dredged now and then from a still greater depth.

which are common and peculiar to the *Laminaria hyperborea* itself, a number of large and some small algæ are found in the *Laminaria hyperborea*-association, where the latter is less abundant. Thus a rich growth of the *Alaria esculenta* is often found in places with a rapid current, down to a depth of about 5—6 fathoms. At about the same depth, I have found enormous specimens, a fathom long, of *Chorda tomentosa* in the rapid current where Haraldssund is narrowest.

On stones and rocks below and among the *Laminaria hyperborea*, we often meet with different red algæ e. g. *Porphyra miniata, Phyllophora Brodiæi, Odonthalia dentata*, and several of the algæ that grow epiphytically on *Laminaria hyperborea*. Lastly *Desmarestia aculeata* and *D. viridis* may be found abundantly down to a depth of about 10—15 fathoms. So far as may be judged from the dredgings, these algæ form often an almost pure *Desmarestia*-association.

The *Laminaria hyperborea*-association has already been mentioned in connection with the Færöes by Simmons, who likewise writes that the »*Laminaria hyperborea*-formation« is the most common on the coast of these Isles. It is indeed only absent where the bottom is sandy right up to the beach. With the exception that the epiphytic vegetation presents slight differences, the *Laminaria*-vegetation of the Færöes corresponds exactly with the *Laminaria*-formation on the west coast of Norway described by Boye (6, p. 5) and Hansteen (38, p. 351); compare also Ekman (17, p. 4—5 and p. 10). On the Shetland Isles I have had an opportunity of seeing a *Laminaria*-vegetation which corresponds with this association. Strömfelt does not give any special account of the Icelandic *Laminaria hyperborea*-association; but most likely a similar vegetation must be found on the southern and western coasts of Iceland.

The Lithoderma-Association.

On the coasts of the Færöes, I have not seen this association so typically developed as has been described by Kjellman (23, p. 66) and Rosenvinge (45, p. 223).

The reason is, probably, that the bottom in deeper water is often of sand or mud and therefore destitute of plants. In the places where I found this association, the bottom was covered by pebbles. *Lithoderma fatiscens* grew here together with some other algæ, especially *Florideæ*, which made the vegetation look somewhat variegated.

Near Gliversnæs, at a depth of about 10—15 fathoms, on a bottom of pebbles and shells, a vegetation was found consisting of the following algæ: *Antithamnion Plumula, Polyides rotundus, Porphyra miniata, Phyllophora Brodiæi, Callophyllis laciniata, Ulva Lactuca, Ectocarpus Hincksiæ, Desmarestia viridis, Laminaria saccharina,* and the following crust-like algæ: *Lithoderma fatiscens, Peyssonnelia Dubyi,* and less abundantly, *Lithothamnion læve* and *Phymatolithon lævigatum.* The calcareous shells found among the pebbles had here, as everywhere in the sublittoral region, a green or reddish hue from the *Conchocelis rosea, Gomontia polyrhiza, Ostreobium Queketti* and *Hyella.* At Hvidenæs, at a depth of about 10 fathoms, a similar vegetation was found; yet the following algæ: *Odonthalia dentata, Delesseria sinuosa, Derbesia marina, Polysiphonia Brodiæi* and *P. elongata* occurred in addition to the majority of the above-mentioned algæ from Gliversnæs. This vegetation seems to correspond with Kjellman's and Rosenvinge's descriptions except for some floristical differences. The characteristic alga is however not so common on the coasts of the Færöes as in Greenland and in the »Murman Sea«.

In connection with this, we must also point out that the Færöes seem to be perfectly destitute of the *Lithothamnion*-formation elsewhere very common in the northern seas. With the exception of *Phymatolithon polymorphum*, which is very common on rocks from the lowest water mark downward into the sublittoral region, the *Lithothamnion*-species are relatively few on the Færöes. The specimens found there are, according to what Mr. Foslie kindly tells me, often stunted and badly developed. Most likely the reason is, that the bottom is in deep water most often of sand or mud, and therefore not suitable to the requirements of these algæ.

Simmons, who once dredged with me at Gliversnæs, gives a description of some of the algæ from that place (p. 257) yet without drawing any final conclusion as to the character of this vegetation.

The sublittoral Florideæ-Formation.

The brown algæ which grow deepest e. g. *Laminaria hyperborea* and *Desmarestia aculeata*, already become scarce at 15 fathoms, and most likely disappear at 20 fathoms. At this depth hardly anything but *Florideæ* are found. At the curve of 20 fathoms

the bottom on the coasts of the Færöes is most often of soft material, either sand or mud, and therefore destitute of plants. I have however happened to meet with some small stretches covered with plant-life. In Nolsöfjord, for instance, outside Gliversnæs, at a depth of 20—25 fathoms, I found a somewhat luxuriant vegetation on larger or smaller stones, quantities of which came up in the dredge together with the algæ.

The following species were found here: *Delesseria sinuosa, D. sanguinea, Callophyllis laciniata, Rhodophyllis dichotoma, Euthora cristata* and *Ptilota plumosa.* Among the algæ were several *Bryozoa* which had a more or less reddish hue from the *Rhodochorton membranaceum* and the *Rh. penicilliforme.* Small crusts of species of *Lithothamnion* also grew on the stones, but only imperfectly developed. The calcareous shells scattered among the stones had likewise a reddish hue from the *Conchocelis rosea* and the *Hyella cæspitosa* var. *nitida*, and some had become green from the *Ostreobium Queketti.* As may be seen from this enumeration, this vegetation was rather rich in species.

It must be pointed out further, that all the algæ, with the exception of the *Ostreobium*, were red, which agrees with the theory of Engelmann, (cp. Gaidukow, 35). If Nadson is right, as seems likely, in declaring that *Conchocelis rosea* = *Ostreobium Queketti,* all the algæ found here may justly be called red algæ, as it seems quite natural, that an alga which takes on, now a red, now a green hue, according to the surrounding conditions, may also be found in both forms at one time.

Below 25 fathoms the individuals became very weak and were overgrown by *Bryozoa*, and at a depth of 30 fathoms no algæ were found. In Klaksvig, I have found *Phyllophora Brodiæi* on pebbles, at a depth of about 20 fathoms.

Moreover it must not be forgotten that all these algæ are common North Atlantic sublittoral species, growing especially in the deeper parts of this region. No species characteristic for these depths have been found either here or anywhere else.

This association agrees with the sublittoral *Florideæ*-formation found by Rosenvinge in Greenland (p. 222); floristically however it differs somewhat.

b. Sheltered Coast.

The Stictyosiphon-Association.

At the low water mark and below, and on non-tidal coasts directly below the surface of the sea to a depth of from 4 to 6 feet, in some places even still farther down, we meet with an association which consists of a great many different species of algæ. It corresponds to the *Corallina*-formation on exposed coasts; the *Corallina officinalis* is moreover often found scattered in the vegetation. On account of the great difference between the algæ belonging to this association, the colour of the vegetation varies greatly according to which algæ predominate at each place. It may be sometimes the *Ulvaceæ*, sometimes the brown, sometimes the red algæ. Their ample ramifications and bushy form are characteristic of the algæ which grow here. Where these marks are absent, they at least grow gregariously, in dense tufts. This tuft-like growth is also due perhaps to the fact, that this association grows on a stony bottom, especially on pebbles. Most often one stone carries one alga, its neighbour another.

Green algæ typical of this association are: *Enteromorpha Linza, Acrosiphonia albescens, Urospora Wormskioldii, Enteromorpha intestinalis, Monostroma fuscum* etc.; brown algæ: *Chordaria flagelliformis, Dictyosiphon foeniculaceus, Stictyosiphon tortilis, Scytosiphon lomentarius, Phyllitis fascia, Punctaria plantaginea,* different forms of *Ectocarpus litoralis*; *Ectocarpus siliculosus, Castagnea virescens, Chorda filum, Fucus inflatus*, and sometimes *Laminaria saccharina* and *Leathesia difformis* epiphytically on *Corallina officinalis.* Amongst the red algæ are: *Ceramium rubrum, Cystoclonium purpurascens, Rhodomela subfusca* and *R. lycopodioides, Polysiphonia Brodiæi* and *P. urceolata, Dumontia filiformis, Chondrus crispus, Rhodymenia palmata*, and, more rarely, *Halosaccion ramentaceum, Antithamnion floccosum* and *Laurencia pinnatifida.*

At Strender in Skaalefjord, which is not subject to high and low tides, this association is beautifully developed. There is a large flat area covered with shallow water, from 2 to 6 feet deep. In the immediate vicinity of the land, I found a rather broad belt of *Acrosiphonia albescens*, which was partly laid bare on the day when I visited the place, the water being extremely low and the weather fine and calm. Next to that, there came a variety of algæ of different colours, with the *Corallina officinalis* as a fairly frequent subvegetation. There were large, red tufts of *Ceramium rubrum, Rhodomela lycopodioides, Dumontia filiformis, Cystoclonium purpurascens* etc., together with some

brown tufts of *Dictyosiphon foeniculaceus*, *Chordaria flagelliformis*, *Stictyosiphon tortilis*, *Ectocarpus siliculosus* and *E. litoralis* together with gregarious growths of *Phyllitis fascia* and *Scytosiphon*. Among these darkish algæ the fresh green *Enteromorpha Linza* lightened up the vegetation, in which *Urospora Wormskioldii*, *Monostroma fuscum* and other green algæ were still intermingled. A little farther out in a few feet of water large specimens of *Laminaria saccharina* were found mixed with the association.

On the banks of the »Sundene« between Thorsvig and Kvalvig, a very similar vegetation is found. The bottom here is of sand with large stones and pebbles. From the lowest water mark down to a depth of from 3 to 6 feet we find an assemblage of algæ of many colours e. g. *Cystoclonium purpurascens*. *Castagnea virescens*, *Punctaria plantaginea*, *Ectocarpus siliculosus* and *E. litoralis*, *Dumontia filiformis*, *Chorda filum*, *Enteromorpha Linza* and several of the above mentioned species. At a short distance from the land, where the water is from 4 to 6 feet deep, the *Laminaria færoensis*-association covers the bottom.

Neither of the two above mentioned tracts are tidal, but a tidal locality with a similar vegetation from the lowest water-mark downwards to a depth of from 4 to 5 feet is found on the coast of the Vestmanhavn. This vegetation includes: *Monostroma fuscum*, *Ceramium rubrum*, *Porphyra miniata*, *Rhodymenia palmata*, large »clouds« of *Ectocarpus litoralis*, *Enteromorpha clathrata*, *Dumontia filiformis*, *Chorda filum*, the upper part of whose thallus floats on the surface of the water, and many more.

In Vestmanhavn and likewise in Klaksvig, where the vegetations much resemble each other, *Halosaccion ramentaceum*, otherwise very rare in the Færöes, is found. In Klaksvig it grows abundantly on stones to a depth of a few feet at low water, and it is most often much overgrown by green algæ e. g. *Enteromorpha*, *Acrosiphonia*, etc.

In the Danish edition I have called this association »The variegated Association«, because of its very motley appearance, due to the many different species which belong to it. But as this name has already, as pointed out by me (10, p. 70), been used by Kjellman (45, p. 24) I have found it more convenient to change the name, since the association of the Færöes is quite different from that of Bohuslän.

According to my definition of this association, it may perhaps partly agree with the Ulvaceenformation described by Simmons (p. 251). He at least says so himself (66, p. 174); but it seems to me, that his formation agrees mostly with the *Monostroma-Enteromorpha*-association mentioned below. Simmons declares, however, that his formation belongs to the littoral region, though he remarks that it may be found as far down as about 2 meters below ebb mark. Referring here to my statement on p. 710 I need only mention, that it seems very unnatural to call a vegetation littoral, when it is found below the lowest water mark in a locality subject to ebb and tide, and on the whole below the littoral algæ-vegetation, even though most of these algæ may also be found in the littoral region.

According to the descriptions of the algæ-associations on the coasts of Norway, I think, that this association shows no small similarity to the *Dictyosiphon-*, *Spermatochnus-* and *Corallina*-formations, described by Boye.

The Monostroma-Enteromorpha-Association.

This association reaches from the surface of the sea down to a depth of a few fathoms. The transition from the previously mentioned association is often smooth, as the *Chlorophyceæ* under certain conditions gradually become predominant. The association is especially luxuriant in the bottom of the fjords, where the outflow of the rivers turns the water more or less brackish. It mostly grows on a bottom of stones or gravel in shallow water, but it may also be found drifting on the surface of the sea.

Among the species characteristic of this association *Monostroma fuscum* ought to be mentioned, as it is often predominant and may be found as a pure facies covering large spaces of the bottom. Usually, various species of *Enteromorpha*, especially *E. clathrata* and forms of *E. intestinalis*, are, however, intermingled. The latter species may grow in the freshest water, especially var. *genuina* and var. *prolifera* which often form large entangled masses at the mouths of rivers, for instance in Kalbakbotn.

Further, varieties of *Monostroma undulatum* are found in the association. In Klaksvig, in the direct vicinity of the land, great numbers of *Chætomorpha tortuosa* and an *Acrosiphonia* spec. are found, besides the above-mentioned algæ.

Together with *Ectocarpus litoralis* these algæ form tough, entangled, loose-lying masses in shallow water. Besides these algæ we find *Chorda filum, Scytosiphon lomentarius, Ceramium rubrum, Halosaccion ramentaceum* and sometimes also other species belonging to the above mentioned *Stictyosiphon*-association. As already mentioned this association together with the *Stictyosiphon*-association perhaps answers to Simmons's Ulvaceenformation.

The Halidrys-Association.

As this association is but rarely found at the Færöes, it is of minor importance there. It has only been found attached to the bottom within a very limited region at Glibre in Skaalefjord on Østerö, but as this alga is rather abundant in this locality and agrees quite well with Hansteen's (38, p. 353), Boye's (6, p. 8) and Gran's (36, p. 19) descriptions of their *Halidrys*-formation, I think that it ought to be mentioned here. It grows here on a stony bottom at a depth of from 1/2 to 1 fathom, forming a narrow belt at no great distance from the coast. The specimens are enormous, almost one fathom long. It grows together with scattered specimens of *Laminaria digitata, L. hyperborea* and *L. færoensis* and *Chorda filum*.

When I visited the tract in May 1898, I found several small specimens of *Punctaria latifolia, Chordaria flagelliformis, Ectocarpus litoralis, Stictyosiphon foeniculaceus, Dictyosiphon* and a great many Diatoms growing epiphytically on the *Halidrys*.

In August (?) Simmons found it densely overgrown by *Dictyosiphon hippuroides;* he therefore calls it »the *Halidrys-Dictyosiphon*-formation«.

The Laminariaceæ-Formation on sheltered coasts.

The *Laminariaceæ*-formation varies much on sheltered coasts. Where there is no current, *Laminaria færoensis* grows abundantly, forming widely spread associations. But where there is a rapid current, as in most sounds between the islands, *L. færoensis* is wanting and is replaced chiefly by *L. hyperborea*.

Let us first consider the *Laminaria færoensis*-association which grows on sheltered coasts. This alga necessarily requires a habitat where the sea is never disturbed. The large lamina which is often several fathoms long and easily broken would soon be torn by the surf. The slender haptera and the brittle stalk would not long be able to resist the strain caused by the current.

I have found this association at its finest development in the Sounds between Strömö and Österö, and especially between Thorsvig and Kvalvig. The tides are wanting here, consequently there is no current, and even during a storm the water is only slightly troubled in this narrow sound. Huge specimens of *L. fœroensis* grow abundantly here in shallow water near the coast forming dense »forests«.

The stalk which is often nearly two fathoms long and thin below, is fastened by several haptera to stones on the bottom. Its uppermost part is thick, hollow and full of air; it often measures some inches in diameter and serves as an air-bladder. These may be seen side by side on the surface of the water, the huge lamina hanging down from them. This agrees perfectly with Rosenvinge's description (71, p. 211) of *L. longicruris* on the coasts of Greenland, which species in the whole mode of its life seems to be closely related to *L. fœroensis*.

L. fœroensis fructifies in summer, and probably then reaches its highest development. The changing of the lamina is hardly restricted to any special season. According to my observations it may be supposed, that the lamina grows more or less evenly for the greater part of the year, and gradually decays at the apex.

As mentioned before, *Laminaria fœroensis* grows down to a depth of about 10 fathoms; in deep water it is, however, most often somewhat smaller. Far out in the fjords, where there is some current and more troubled water, the lamina becomes narrower, almost lanceolate and the stalk less swelled. I call this form f. *saccharini-formis*, as it is very much like *L. saccharina*, from which it may, however, be easily distinguished by its hollow stalk.

The stalks of *L. fœroensis* are generally without epiphytes. According to Rosenvinge (l. c. p. 212), this is also most often the case with *L. longicruris* in Greenland. In »Sundene«, in shallow water, I have however sometimes met with plants with the stalks densely overgrown with some green and brown algæ, e. g. *Monostroma fuscum*, *Ectocarpus litoralis*, *Ectocarpus* spec., etc. The stones on which it grows are likewise often covered by large, dark red crusts of *Cruoria pellita*. In deep water various red epiphytes, e. g. *Polysiphonia urceolata*, *Lomentaria clavellosa*, *Ptilota plumosa*, *Delesseria sinuosa*, etc. are also found on the stalk. It very commonly occurs also, that young specimens of *Laminaria fœroensis* are attached to the stalks of old specimens. In deeper water the *Laminaria*

hyperborea is often found in the association. The lamina of *L. hyperborea* in this sheltered place is often only slightly divided, sometimes even perfectly whole as with f. *cucullata* of *L. digitata*, which species may also be found belonging to the association especially in shallower water.

The *Laminaria fœroensis*-association has also been found at the bottom of Trangisvaag and Vaagfjord on Syderö, and in Kalbakfjord and Kollefjord on Strömö, and in Skaalefjord on Österö, that is, in the most sheltered localities, but nowhere so luxuriantly developed as in the »Sundene«.

This vegetation is however quite wanting in places where there is a current or surf from the sea. Here we find a *Laminaria hyperborea*-association which essentially resembles that of exposed coasts. The rapid current makes up for the troubled sea and constantly carries clean water to the algæ. In these conditions we therefore find an epiphytical vegetation on the stalk of *L. hyperborea*, as luxuriant and well developed as on exposed coasts. *Laminaria digitata* is often found intermingled in the upper part of the association, and both here and lower down *Laminaria saccharina* and *Alaria esculenta* may be found.

Simmons mentions a *Laminaria longicruris*-formation (78, p. 256) which he calls this association, following my former determination of *Laminaria fœroensis*.

The Desmarestia-Association.

Here and there, where the bottom is stony, at a depth of about 10 fathoms, we find an association which mainly consists of *Desmarestia aculeata* with *Desmarestia viridis* intermingled. To judge from the dredgings, this association was well developed at the entrance of the gulf at Klaksvig, where it has also been observed by Simmons. *Phyllophora Brodiæi, Polyides rotundus, Porphyra miniata, Antithamnion Plumula*, and some few *Laminaria saccharina* and *L. hyperborea* were also found here on stones. Simmons mentions *Ph. rubens* and *Ph. membranifolia* in this locality, but my observations (8, p. 358) indicate that this must certainly be a mistake. In the »Sundene« I have met with a similar *Desmarestia*-association; and *Porphyra coccinea* was found growing on *Desmarestia aculeata* which may be perfectly hidden by this beautiful, little rosy alga.

On the coasts of the Færöes this *Desmarestia*-association is attached to the bottom, even in sheltered places. Some loose speci-

mens may of course be sometimes found, but not in great numbers, what is, however, the case on the coasts of Greenland, according to Rosenvinge (71, p. 218). The name »formation of loose-lying Algæ« may in the Færöes only be used of the above mentioned loose masses of algæ, which mainly consist of species of *Enteromorpha, Chætomorpha tortuosa, Acrosiphonia, Monostroma,* etc.

The Vegetation on soft bottom. The Zostera-Association.

With the exception of the *Characeæ*, which may be found in brackish water, algæ from the northern seas will not usually thrive on a bottom of sand or mud[1], which is therefore destitute of vegetation. Only here and there, where stones are found, may algæ be met with, but as a soft, loose bottom is rather common in the sounds between the islands and in the fjords, at any rate in deep water, somewhat large, naked regions occur with only a few loose drifting algæ. What makes the tracts still more naked is, that the *Zostera marina,* which has its habitat in shallow water (down to a depth of from 6 to 7 fathoms in our seas) in this kind of ground with loose bottom, is almost totally wanting at the Færöes. It has only been found at the bottom of Vaag Fjord. In a small limited territory it makes an association here at a depth of about 1 fathom, and at low tide, its leaves may be seen floating on the surface of the sea. The *Zostera* here as elsewhere shelters a number of different epiphytes, e. g. species of *Enteromorpha, Ectocarpus litoralis, Chantransia virgatula* and *C. secundata, Microsyphar Zosteræ, Scytosiphon lomentarius,* and so forth.

3. The lower limit of the Algæ-vegetation. The elittoral Region.

As mentioned before, I agree with Rosenvinge in determining the elittoral region as that part of the bottom of the sea where no vegetation grows on the bottom; I shall therefore leave this region out of consideration. At far greater depths than those at which the fixed algæ grow, we may of course find loose-lying algæ which have been carried by the current away from their habitats. Such portions of algæ may perhaps live for some time by consuming their reserve stores, but when these are used up they must

[1] In the tropics however we find an algæ-vegetation which is often quite dense and fastened on a bottom of sand or mud.

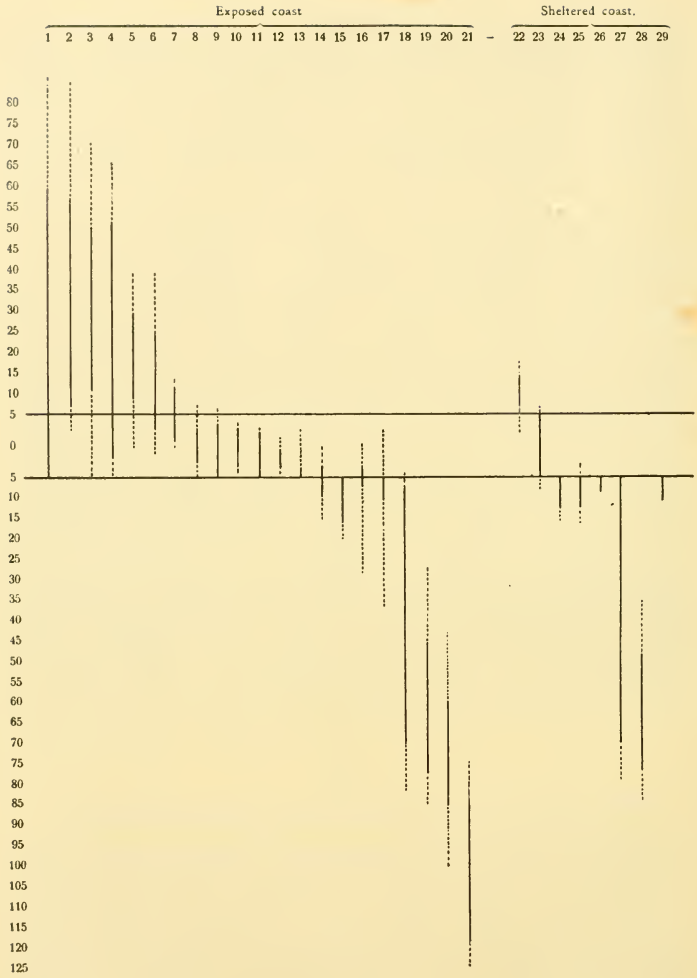
of course perish. They are, however, of no importance for the determination of the lowest depth at which the algæ-vegetation may be found; in this connection we are only interested with the fixed algæ-vegetation. It is, however, difficult to determine how deep this limit is. It varies much in the different seas and depends on how far down a sufficient amount of light may reach. The light reaches farthest down in the tropics, where the rays of the sun strike the surface of the sea almost vertically. In higher latitudes the rays strike the surface more and more slantingly, and therefore do not reach so far down. According to Berthold, a rich vegetation of deep water algæ was still found at a depth of about from 120 to 130 metres in the gulf at Naples, and according to Rodriguez, the very lowest limit of the vegetation is 160 meters at Minorca (compare Sauvageau: Remarques sur les Sphacélariacées, p. 235). In the tropics the algæ-vegetation probably grows at a still greater depth.

According to Rosenvinge, the lower limit of the algæ-vegetation in Greenland is about the curve of from 20 to 30 fathoms. As I have before indicated, this almost agrees with what has been observed at the coasts of the Færöes. Naturally, local conditions often cause the vegetation to disappear above this depth; there may for instance be plenty of Plankton, or the bottom may at a certain depth turn into mud or sand, which makes it unfit for the algæ. This is perhaps the case on the coasts of Bohuslän, where the algæ-vegetation, according to Kjellman, hardly grows any farther down than a depth of 20 fathoms.

III.

GENERAL CHARACTER OF THE ALGÆ-VEGETATION.

Upon the whole the algal vegetation on the Færöese coasts must be considered specially vigorous and luxuriant. That stunted forms may be found in unfavourable localities, such as the upper part of the beach or the heads of inlets, where the water becomes brackish or almost fresh, is of no consequence in comparison with the luxuriance which otherwise characterizes the vegetation. We could not easily imagine any locality better fitted for developing a vigorous algæ-vegetation than the Færöes, where the nature of the coast, the situation in the midst of a large ocean, and the climate, all serve to facilitate the growth of the algæ.



Explanation of the diagram:

The accompanying diagram will serve to display the occurrence of the different algæ-formations and algæ-associations on the coasts of the Færöes. The numbers to the left indicate the number of feet respectively above

or below the sea level at middle height of the water (0). The beach, which is represented by the distance between the two horizontal lines, is somewhat enlarged, in order to make it more distinct. The vertical lines indicate the level at which each algæ-formation and association mostly occurs, the dotted parts of the lines that they may be found beyond this level, though more scattered.

The numbers above the vertical lines indicate as follows:

1. *Hildenbrandia*-Formation with lichens.
2. *Chlorophyceæ*-Formation on exposed coast.
   Prasiola crispa-Association. *Rhizoclonium*-Association. *Enteromorpha*-Association. *Prasiola stipitata*-Association.
3. *Porphyra*-Association.
4. *Rhodochorton*-Association.
5. *Bangia-Urospora*-Association.
6. *Fucaceæ*-Formation on exposed coast.
   Fucus spiralis-Association. *Fucus inflatus*-Association.
7. *Callithamnion*-Association.
8. *Rhodymenia*-Association.
9. The littoral *Corallina*-Formation.
10. *Monostroma-Grevillei*-Association. } These four associations belong to the littoral *Corallina*-Formation.
11. *Acrosiphonia-Polysiphonia*-Association.
12. *Gigartina*-Association
13. *Himanthalia*-Association.
14. *Phymatolithon*-Association.
15. The sublittoral *Corallina*-Formation.
16. *Laminaria digitata*-Association } *Laminariaceæ*-Formation on exposed coast.
17. *Alaria*-Association.
18. *Laminaria hyperborea*-Association
19. *Desmarestia*-Association on exposed coast.
20. *Lithoderma*-Association.
21. The sublittoral *Florideæ*-Formation.
22. *Chlorophyceæ*-Formation on sheltered coast.
    Enteromorpha-Association.
23. *Fucaceæ*-Formation on sheltered coast.
    Pelvetia-Association. *Fucus vesiculosus-Ascophyllum*-Association. *Fucus inflatus*-Association.
24. *Stictyosiphon*-Association.
25. *Monostroma-Enteromorpha*-Association.
26. *Halidrys*-Association.
27. *Laminariaceæ*-Formation on sheltered coast.
    Laminaria fœroensis-Association. *Laminaria hyperborea*-Association.
28. *Desmarestia*-Association on sheltered coast.

(29. *Zostera*-Association.)

Lastly, it should be pointed out, that the heights refer to the coast as a whole, not to any special locality; thus the space within which an association may be found is represented larger than would be the case if we examined any single locality.

From even far above the highest water mark down to a depth of about 15 fathoms, we may often find a dense, well developed algal vegetation, which is divided naturally by the tides into two regions: the littoral and the sublittoral. At few places is there, I think, a littoral vegetation so luxuriant as that of the Færöes. This is certainly due in the first place to the very favourable climate, secondly to the situation in the open sea, where the surf constantly washes on the coast and thus enables the algæ to grow far above the highest water mark. Nevertheless the vegetation of exposed coasts hardly ever becomes as luxuriant as the *Fucaceæ*-vegetation in more sheltered places. But even this abundant, littoral vegetation is far surpassed by the sublittoral vegetation of the *Laminariaceæ* which covers a large area of the bottom of the sea with »forests« of almost a man's height, and a vigorous undergrowth of epiphytes.

As almost everywhere in the cold temperate seas, the brown algæ predominate in size as well as in number on the coasts of the Færöes, both in the sublittoral region with its *Laminariaceæ* and other algæ sheltered by these, and also in the littoral. As to the latter, this is only the case, however, so far as the *Fucaceæ*-vegetation of sheltered coasts is concerned, on exposed coasts the vegetation becomes more varied, both red, brown and green algæ crowd together, and sometimes green algæ, e. g. *Enteromorpha* and *Acrosiphonia*, sometimes red, e. g. *Porphyra* and *Rhodymenia* predominate over large tracts. Even in the size of the plants, the red algæ may rival the brown algæ. With the exception of some *Laminariæ* and *Alariæ* which in favourable places sometimes extend into the littoral region, only *Himanthalia* attains any considerable height.

In connection with this brief description of the general character of the algal vegetation I endeavour to give in the diagram above a general view of the different algæ-formations and algæ-associations, the different levels at which they occur, and the manner in which they replace each other; thus, it will be clearly seen that the number of algæ-associations reaches its height in the littoral region and then gradually decreases on each side.

IV.

THE PHYTO-GEOGRAPHICAL POSITION OF THE ALGÆ-FLORA OF THE FÆRÖES.

I. The constituent parts of the Færöese Algæ-flora.

Before entering on a comparison between the marine algæ-flora of the Færöes and that of neighbouring countries, we may first of all review the species occurring at the Færöes.

In my paper on the Færöese marine algæ 212 species are mentioned, with 4 whose genus only was determined. On renewed investigation, however, I have come to the conclusion that one of the latter, *Chilionema* spec. may be referred to *Ch. reptans.* Thus we have 213 + 3 species. From this number, again, *Dermatolithon Corallinæ* (see my »Flora« p. 402) must be withdrawn as, according to Mr. Foslie's latest investigations, kindly placed at my disposal, it should be referred to *Dermatolithon macrocarpum,* or, as he now calls it, *Litophyllum macrocarpum.* Moreover *Acrosiphonia Binderi* must be omitted, renewed examination of the present material having proved that some imperfectly developed curved branches occur, though but rarely, and this convinces me that it should be referred to *A. albescens.*

Thus the number is reduced to 211 + 3, but to these must be added *Choreolax Polysiphoniæ,* which I have discovered later[1].

In order to give a general view of the 212 + 3 species, and in order to discuss more closely the elements of which the Færöese algæ-flora consists, I have divided them, in accordance with the division made by Jónsson and myself (12, page XV—XXI), into the 4 groups: the subarctic, the boreal-arctic, the cold-boreal and the warm-boreal group (the arctic group is entirely wanting in the Færöes). As to the limitation of these groups, I may refer the reader to the above-mentioned paper. It should not be forgotten, however, that any such division must inevitably suffer from a certain

[1] Besides these alterations, the name of the species, or of the genus, or of both have been altered in the following list of Færöese algæ in the case of the following species: *Clathromorphum circumscriptum* which, according to Mr. Foslie, should be referred to *Phymatolithon compactum, Acrosiphonia flaccida,* which I refer to *A. hystrix* (Strömf.) Börgs., as already pointed out by me (8, p. 512). The form which I gave provisionally as *Spongomorpha lanosa,* and which I supposed to be related to *Sp. bombycina* (Kjellm.), I have found on renewed examination to be *Spongomorpha vernalis.*

arbitrariness, partly because we know so very little as yet about the distribution of many algæ, partly because several algæ are distributed so as to make it almost equally justifiable to refer them to different groups. Whilst Reinke and Kuckuck leave the *Chlorophyceæ* and the *Cyanophyceæ* out of consideration, as our knowledge of these plants is especially defective, I side with Rosenvinge's opinion, however, that it is more correct to mention them here, as the species belonging to these orders are as important from a phytogeographical point of view as those of the *Rhodophyceæ* and *Phæophyceæ*. The species hitherto found only on the Færöes are all referred to the cold-boreal group.

SUMMARY OF THE FÆRÖESE MARINE ALGÆ.

I. Rhodophyceæ.

83 species.

A. The arctic group.

0 species.

B. The subarctic group.

Subdivision 1. 6 species.

Rhodophyllis dichotoma.
Halosaccion ramentaceum.
Ptilota pectinata.
Rhodochorton penicilliforme.
Phymatolithon compactum.
Lithothamnion læve.

Subdivision 2. 14 species.

Porphyra miniata.
Conchocelis rosea.
Chantransia efflorescens.
— virgatula.
Harveyella mirabilis.
Phyllophora Brodiæi.
Actinococcus subcutaneus.
Euthora cristata.
Rhodymenia palmata.
Delesseria sinuosa.
Rhodomela lycopodioides.
Odonthalia dentata.
Ptilota plumosa.
Lithothamnion glaciale.

C. The boreal-arctic group.

10 species.

Bangia fuscopurpurea.
Porphyra umbilicalis.
Chantransia secundata.
Ahnfeltia plicata.
Polysiphonia elongata.
Antithamnion Plumula.
Ceramium rubrum.
Rhodochorton membranaceum.
— Rothii.
Hildenbrandia rosea.

D. The cold-boreal group.

38 species.

Erythrotrichia ceramicola.
Porphyra coccinea.
Chantransia Alariæ.
— Daviesii.
Choreocolax Polysiphoniæ.
Gigartina mamillosa.
Phyllophora membranifolia.

Callocolax neglectus.
Sterrocolax decipiens.
Cystoclonium purpurascens.
Lomentaria rosea.
Delesseria alata.
— sanguinea.
Polysiphonia urceolata.
— violacea.
— fastigiata.
— atrorubescens.
— nigrescens.
Rhodomela subfusca.
Callithamnion polyspermum.
— arbuscula.
Plumaria elegans.
Antithamnion floccosum.
Ceramium acanthonotum.
Rhodochorton seiriolanum.
Dumontia filiformis.
Furcellaria fastigiata.
Polyides rotundus.
Cruoriella Dubyi.
Rhododermis elegans.
Phymatolithon lævigatum.
— polymorphum.
Lithothamnion Lenormandi.
Lithophyllum Crouani.
— incrustans.
— macrocarpum.
— hapalidioides.
Corallina officinalis.

E. The warm-boreal group.
15 species.

Porphyra leucosticta.
Chondrus crispus.
Callophyllis laciniata.
Lomentaria clavellosa.
— articulata.
Plocamium coccineum.
Nitophyllum laceratum.
Laurencia pinnatifida.
Polysiphonia Brodiæi.
Pterosiphonia parasitica.
Griffithsia setacea.
Callithamnion scopulorum.
— corymbosum.
— granulatum.
Cruoria pellita.

II. Phæophyceæ.
72 species.

A. The arctic group.
0 species.

B. The subarctic group.

Subdivision 1. 8 species.

Lithoderma fatiscens.
Sorapion Kjellmani.
Myrionema globosum.
Ectocarpus æcidioides.
Spacelaria britannica.
Chætopteris plumosa.
Laminaria færoensis.
Alaria Pylaii.

Subdivision 2. 17 Arter.

Ralfsia clavata.
Ectocarpus tomentosoides.
Leptonema fasciculatum.
Elachista fucicola.
Punctaria plantaginea.
Isthmoplea sphærophora.
Litosiphon filiforme.
Stictyosiphon tortilis.

Dictyosiphon hippuroides.
— foeniculaceus.
Desmaresta viridis.
— aculeata.
Chordaria flagelliformis.
Chorda filum.
— tomentosa.
Laminaria digitata.
Fucus inflatus.

C. The boreal-arctic group.
7 species.

Ectocarpus littoralis.
— confervoides.
— siliculosus.
Scytosiphon lomentarius.
Phyllitis fascia.
Fucus vesiculosus.
Ascophyllum nodosum.

D. The cold-boreal group.
35 species.

Petroderma maculiforme.
Ralfsia verrucosa.
Myrionema vulgare.
— Corunnæ.
— foecundum.
— færoense.
— speciosum.
Chilionema reptans.
Microsyphar Polysiphoniæ.
— Zosteræ.
Ectocarpus Stilophoræ.
Ectocarpus velutinus.
— lucifugus.
— tomentosus.
— dasycarpus.
— fasciculatus.
— granulosus.
— Hincksiæ.
Elachista scutulata.
Sphacelaria cæspitula.
— furcigera.
— cirrhosa.
Cladostephus spongiosus.
Desmotrichum undulatum.
Litosiphon Laminariæ.
Phæostroma parasiticum.
Phyllitis zosterifolius.
Dictyosiphon Ekmani.
Castagnea virescens.
Laminaria saccharina.
— hyperborea.
Alaria esculenta.
Fucus spiralis.
Pelvetia canaliculata.
Himanthalia lorea.

E. The warm-boreal group.
5 species.

Punctaria latifolia.
Asperococcus echinatus.
Desmarestia ligulata.
Leathesia difformis.
Halidrys siliquosa.

III. Chlorophyceæ.

44 species.

A. The arctic group.
0 species.

B. The subarctic group.
Subdivision 1. 6 species.

Chlorochytrium inclusum.
Monostroma undulatum.
— fuscum.
Ulothrix consociata.
— pseudoflacca.
Acrosiphonia hystrix.

Subdivision 2. 18 species.

Codiolum gregarium.
Percursaria percursa.
Monostroma Grevillei.
Ulothrix flacca.
Bolbocoleon piliferum.
Pilinia maritima.
Ulvella fucicola.
— confluens.
Pringsheimia scutata.
Urospora mirabilis.
— Wormskioldii.
Chætomorpha Melagonium.
Spongomorpha vernalis.
Acrosiphonia incurva.
Cladophora rupestris.
— sericea.
Ostrobium Queketti.
Vaucheria coronata.

C. The boreal-arctic group.
7 species.

Enteromorpha intestinalis.
— clathrata.
Ulva Lactuca.
Chætomorpha tortuosa.
Rhizoclonium riparium.
Cladophora gracilis.
Gomontia polyrhiza.

D. The cold-boreal group.
11 species.

Codiolum pusillum.
Prasiola crispa *marina.
— furfuracea.
— stipitata.
Endoderma Wittrockii.
Acrochæte repens.
Acrosiphonia albescens.
— flagellata.
— grandis.
Derbesia marina.
Valonia ovalis.

E. The warm-boreal group.
2 species.

Enteromorpha Linza.
Bryopsis plumosa.

IV. Cyanophyceæ.
13 species.

A. The arctic group.
0 species.

B. The subarctic group.

Subdivision 1. 0 species.

Subdivision 2. 1 species.

Pleurocapsa amethystea.

C. The boreal-arctic group.
3 species.

Spirulina subsalsa.
Calothrix scopulorum.
Rivularia atra.

D. The cold-boreal group.
2 species.

Dermocarpa Farlowii.
Hyella endophytica.

E. The warm-boreal group.
7 species.

Chlorogloea tuberculosa.
Dermocarpa violacea.
Hyella cæspitosa.
Phormidium autumnale.
Lyngbya lutea.
Microcoleus tenerrimus.
Calothrix æruginea.

It is clear from this summary that the *Rhodophyceæ* are most numerous, contributing almost $^2/_5$ of all the species collected. The *Phæophyceæ* are a little less numerous, about $^1/_3$ of all the marine algæ-species of the Færöes; next come the *Chlorophyceæ*, which only amount to a little above $^1/_5$, and lastly the *Cyanophyceæ*, of which only a few species have been collected.

Rosenvinge (71, p. 173) has given a summary in per centages of the number of species belonging to each of the four classes of algæ, as they occur in the algæ-floræ of Greenland, the British Isles and in the Spanish-Canary region. If the numbers that represent these groups in the Færöese algæ-flora are placed in this summary, and if, at the same time, the numbers representing the Greenland algæ are altered to agree with the latest contributions concerning the latter, and the numbers from the British Isles are calculated from Batters's latest list (4), the result will be as follows:

	Greenland	The Færöes	The British Isles	The Spanish-Canary Reg.
Rhodophyceæ	26.0 %	38.6 %	42.3 %	60.4 %
Phæophyceæ	40.0 %	34.0 %	27.8 %	18.7 %
Chlorophyceæ	30.0 %	20.9 %	17.9 %	14.8 %
Cyanophyceæ	6.0 %	6.5 %	12.0 %	6.1 %
Total number of species	169	215	744	492

As clearly shown by the figures, the Færöes hold an intermediate position between Greenland and the British Isles; the *Rhodophyceæ*, which are in the majority in England, to say nothing of the Spanish-Canary region, are still predominant on the Færöese coasts; whereas the *Phæophyceæ*, which are vastly in the majority in Greenland almost reach to the same number.

The *Chlorophyceæ* likewise hold an intermediate position as regards number of species between the British Isles and Greenland, where they are relatively more numerous; the same may be said of the *Cyanophyceæ*, only inversely, as these are more numerous in the British Isles and less numerous in Greenland. That only a relatively small number of the latter have been found in the Spanish-Canary region, is certainly due to the fact that this region (as regards the *Cyanophyceæ*) has hitherto been but very little investigated.

It is, on the whole, a well-known fact that the *Phæophyceæ*

predominate in the northern countries both in growth[1] and in number of species (see Rosenvinge's table 71, p. 174); whether the same may be said of the *Chlorophyceæ*, as the table above seems to indicate, appears to me, however, rather doubtful. At any rate they are very numerous in the littoral and the upper sublittoral regions of the West-Indies and seemingly predominate there[2].

After these remarks we may consider how the Færöese species are grouped in the above-mentioned five groups. We have the following result:

0	arctic species or	0 %
70	subarctic species or	32.55 %
27	boreal-arctic - -	12.55 %
89	cold-boreal - -	41.4 %
29	warm-boreal - -	13.5 %

It is clear from this table that the cold-boreal species are in the majority in the Færöes, as not far from one half of the Færöese algæ belongs to this group. Next to that come the subarctic species, including nearly one third of all the Færöese algæ. Of species occurring in more southern regions, the warm-boreal species, the Færöes have a little more than 13 %; almost the same number of species must be referred to the boreal-arctic group, which is, however, of less interest from this point of view, as all these species are widely spread and often ubiquitous, and at any rate common in all five groups.

If we leave the *Chlorophyceæ* and *Cyanophyceæ* out of consideration, as they possibly make the result less reliable, the result is nevertheless much the same. 156 red and brown algæ in all are found at the Færöes; that is:

45	subarctic species or	28.9 %
17	boreal-arctic - -	10.9 %
74	cold-boreal - -	47.4 %
20	warm-boreal - -	12.8 %

In order to show more plainly in which of the surrounding countries we meet with an algæ-flora having a composition very closely connected to that of the Færöes, and to demonstrate the

[1] Cf. Kjellman, F. R., Ur polarväxternes lif (Nordenskiöld, Studier och Forskningar, p. 544).

[2] Cf. Kjellman, F. R., l. c. p. 540 where he says: »Ett utmärkande drag för algvegetationen i Ishafvet är fattigdomen på gröna alger«.

phyto-geographical position of this flora on the whole, I give a summary of the *Rhodophyceæ* and *Phæophyceæ* of these countries in the following table; the numbers are taken from the table prepared by Jónsson and myself (12, p. XXII)[1].

Rhodophyceæ and *Phæophyceæ*	Scotland	West Norway	The Shetl. Isles	The Færöes	Nordland	South West Iceland	Finmark	North East. Iceland	The Murman Sea	West Greenland
Number of Species	184+128 = 312	101+89 = 190	49+38 = 87	83+72 = 155	70+53 = 123	65+60 = 125	65+60 = 125	45+55 = 100	37+35 = 72	41+63 = 104
arctic	»	0.5	»	»	0.8	1.6	5.5	8.9	15.3	17.3
subarctic 1	3.8	3.16	«	8.9	9.7	15.2	16.6	18.8	18.0	26.0
— 2	9.9	14.2	17.2	20.0	16.2	24.0	23.8	*29.7*	*30.0*	*27.8*
boreal-arctic ...	5.7	8.4	16.0	11.0	13.0	13.6	14.3	15.8	18.0	16.3
cold-boreal.....	25.8	*38.0*	*40.0*	*47.1*	*49.6*	*38.4*	*36.5*	25.7	18.0	12.5
warm-boreal 1 .	6.7	9.47	18.4	13.0	10.6	6.4	4.0	0.9	»	»
— 2 .	*28.4*	26.3	8.0	»	»	0.8	»	»	»	»
— 3 .	19.0	»	»	»	»	»	»	»	»	»

It is evident from this table, that the Færöes come next to the Shetland Isles and Nordland. Scotland has a considerable percentage of warm-boreal species, no arctic and only very few subarctic species. West Norway has a much smaller number of warm-boreal, ½ % of arctic (*Turnerella Pennyi* found in Trondhjemsfjord by Foslie), and a little higher percentage of subarctic species. The Shetland Isles likewise have a smaller number of warm-boreal species, but apparently an equally large number of subarctic species as West Norway; this is, however, certainly due to the fact, that these Isles have not been sufficiently investigated, for it is clear, that if the subarctic group 1 is represented by 3.8 % in Scotland, it must reach to the same amount at least in the Shetland Isles, where none of these species have been found hitherto. Of the Færöese algæ, only 13 % are warm-boreal, almost one half are cold boreal and 29 % subarctic. Nordland has not quite so many warm-boreal species, that is, only a little more than 10 %; one half of the species are cold-boreal; the subarctic group is a little smaller than at the Færöes, but on the other hand a small arctic element is found here. In

[1] The numbers belonging to the Færöes differ a little from those above, as *Ectocarpus* spec. is left out of consideration here.

South West Iceland, the warm-boreal group is again reduced (to a little more than 7 %) and the cold-boreal group is likewise diminished; on the other hand the subarctic group is much increased amounting to more than 39 %, and here we meet with almost 2 % of arctic species. If only South Iceland is taken into consideration, however, the agreement with the Færöes becomes still more evident, as arctic species are totally wanting and the subarctic group is much reduced in numbers. As Jónsson, however, is preparing a paper on the Icelandic algæ-vegetation in which he intends to give a further account of the different smaller groups into which the algæ-flora of Iceland is naturally divided, I shall not enter on this matter here, the more so, as this examination requires a very thorough knowledge of the algal vegetation of Iceland. In Finmark the warm-boreal group is further reduced (to 4 %) and the cold-boreal is likewise a little reduced; the subarctic group is only a little richer in species than that of South West Iceland, but here we meet with 5½ % of arctic species. In North East Iceland, we see that the warm-boreal species do not even reach to 1 %: the cold-boreal species are considerably reduced; the subarctic group amounts to almost one half (48.5 %) of the algæ of this area, and lastly, almost 9 % of arctic species are found here. On the coasts of the Murman Sea, no warm-boreal species are found, and only 18 % of cold-boreal species; almost one half (48 %) are subarctic, and there are more than 15 % of arctic species. Lastly, as to West Greenland, warm-boreal species are likewise totally wanting; there are only 12.5 % of cold-boreal species, more than one half of all the species are subarctic (53.8 %), and more than 17 % arctic.

As will be clearly seen from the table, the Færöes and Nordland must be called the habitat of the cold-boreal algæ, as in both places almost one half of the algæ belong to this group; next to these countries must be named, on one side the Shetland Isles, on the other South West Iceland.

2. Comparison with the adjacent Countries.

A more thorough comparison shows us a good many difficulties of various kinds, especially caused by the fact, that the algal vegetations of the different countries have not all been equally thoroughly investigated. It is no wonder, therefore, that the results obtained may suffer from small and large errors.

In order to show some of the most important causes of errors, I shall point out, that several of the species, which have been found on the coasts of Greenland, the Færöes and Iceland, according to papers published during the latest years, e. g. Rosenvinge's on the marine algæ of Greenland, my own paper on the Færöese marine algæ, and lastly Jónsson's on the marine algæ of Iceland, also will be found in the surrounding countries on renewed investigations. In Batter's recently published list of the marine algæ of Great Britain we thus find many of Rosenvinge's new Greenlandic species mentioned. Another source of error is naturally the different authors' varying opinions of species; and even if we try ever so conscientiously to make out the different synonyms, there are still, according to our present knowledge, a great many genera — I need only mention promiscuously *Lithothamnion, Sphacelaria, Myrionema, Acrosiphonia, Spongomorpha, Cladophora, Enteromorpha, Ulothrix* — of which it is almost impossible to make any statement with certainty. On the whole, it is especially the classification of the *Chlorophyceæ* which causes the greatest difficulties; and as the plants of this group thrive in very extreme conditions, which quality they have in common with the *Cyanophyceæ*, for instance they are well fitted for standing a mixture with fresh water, it would perhaps be most correct to side with Kuckuck who says (56, p. 10): »Bei pflanzengeographischstatistischen Zusammenstellungen scheinen mir daher die Chlorophyceen und Cyanophyceen eher geeignet, das Resultat zu trüben als zu klären, und aus diesem Grunde will ich auch hier von einer Berücksichtigung jener Pflanzengruppe absehen.« But as it cannot be denied, however, that there are several species, even among the *Chlorophyceæ* and *Cyanophyceæ*, which are of no small importance from a phyto-geographical point of view, I have used them here as far as possible for the sake of comparison.

Further, it is naturally of great importance in a comparison of this nature, to exclude the species which by mistake have been included previously in the flora of a country, when closer investigations have shown that it is only by erroneous determination or for some other reason, that they have been included, and thus do not belong to the flora at all. As to Greenland, so many species had been incorrectly admitted, according to Rosenvinge (71, p. 154) that the phyto-geographical character of the algæ-flora has been essentially altered by their omission; also, with regard to the Færöes we have been obliged to exclude several of the species

previously admitted in botanical works. But in spite of all this, there are still some few species of which it is doubtful, whether they have any right to belong to the Færöese algæ-flora[1].

Of the 215 species (compare p. 773) found at the Færöes, 6 species besides a few new varieties and forms have been described as new; there are moreover an *Ectocarpus* spec. and a *Hypheothrix* spec., of which no statement could be given with certainty because of defective material, and which therefore by closer examination may possibly be referred to species already known, and lastly, Lyngbye's *Palmella adnata* which I think may be referred to the genus *Pleurococcus*, as I have examined Lyngbye's old material, but cannot determine any closer. In the comparison I leave these 3 species out of consideration[2].

As to the 6 new species, it is hardly probable, however, that they should be endemic at the Færöes; the 5 species: *Dermocarpa Farlowii, Hyella endophytica, Myrionema færoense*, and *M. speciosum* together with *Phæostroma parasiticum* are small forms, that are easily overlooked; one of them, *Myrionema færoense* has besides already been found at Iceland, and according to what Dr. Bornet reports (cf. my flora, 8, page 523) *Dermocarpa Farlowii* is found in Japan and must therefore be supposed to be widely spread. *Laminaria færoensis*, on the other hand, is a tall plant, quite the tallest found on the Færöese coast. On one side it is connected with the Greenland—North-American *Laminaria longicruris,* and on the other side closely with *Laminaria saccharina;* it has already been found at Iceland, but it is rather doubtful if it is to be found on other European coasts, as it has not already been found there; still it is of course not impossible. The bottoms of the fjords in northern Norway would most naturally be the places to look

[1] Of such species I need only mention: *Phyllophora membranifolia.* of which I have only seen a small fragment which had been found by Ostenfeld in a plaice-net on board the cruiser »Ingolf« in Trangisvaagfjord; as the ship had, however, just come from the Sound, and as there had most likely been some fishing there, it is very probable, that this fragment had been left in the net and thus carried on. Another species which only doubtfully belongs to the Færöes is *Chætopteris plumosa*; in Rostrup's herbarium we find good specimens sent to him by Mr. Randropp of Thorshavn, but as this alga was never found by other investigators, we have a right to doubt whether these specimens really belong to the Færöes.

[2] The *Chilionema* spec., mentioned in my flora (8, page 427), must, I think, as mentioned above, be referred to *Chilionema replans.*

for it. During my short visit at the Shetland Isles I sought it in vain, still it might possibly grow there.

From these introductory remarks I now pass to the proper comparison of the marine algæ-flora of the Færöes with that of the adjacent countries. In order to make such a comparison, a list of the algæ-flora of the particular countries, as correct as possible and critically revised, is of course indispensable. Helgi Jónsson I and have prepared a list (12), which we hope to be serviceable, and I have used it as a basis for the following comparison, which therefore appears somewhat altered from that of the Danish issue.

We may first consider the countries which are nearest to the Færöes, that is Scotland with the Orkneys and the Shetland Isles. In Batters's recently published lists (4) of the British marine algæ, where these countries are treated as a whole, about 430 species are stated as belonging to Great Britain. Of these, 163 species are also found at the Færöes. The total number will certainly be considerably increased by renewed investigations, a few species which I found during my short visit at the Shetland Isles, have already been added, namely: *Fucus inflatus, Sphacelaria furcigera, Prasiola crispa* subsp. *marina, Ulvella fucicola* and *Derbesia marina*[1]; to these must be added *Sphacelaria britannica* which is stated by Sauvageau as found in Scotland; the total number is thus increased to 169 or 79 % of the marine algæ of the Færöes. Of the remaining species we may certainly suppose, that the following species also occur in Scotland with the Orkneys and the Shetland Isles: *Chantransia efflorescens,* found in South England; *Chantransia Alariæ* found, besides at the Færöes, also at North-America, at Iceland, on the coast of Norway at Haugesund and in 1904 by myself at Christianssund, and in the same year by J. Adams at Portrush in North Ireland (Journal of Botany 1904, p. 351), and which probably has the same distribution as *Alaria esculenta; Rhodochorton seiriolanum* which has been found in West-England; *Callithamnion scopulorum* which according to Batters' list has not hitherto been found at the British Isles, but which must be supposed to be there, if Agardh's determination of its occurrence in the Mediterranean is correct; *Rhododermis elegans,* a variety of

[1] Batters mentions *D. tenuissima* as occurring in Scotland; judging from a specimen kindly sent me by Mr. Batters, I think that it most likely is *Derbesia marina.*

which, v. *polystromatica*, has been found in North England, and the closely related species *Rh. parasitica* also in Scotland; *Phymatolithon compactum* f. *circumscripta* (Strömf.) Fosl. is according to Batters (4, p. 97) found in West Ireland, and must therefore also be supposed to be found for instance at Shetland; *Ectocarpus dasycarpus*, found in South England; *Ectocarpus lucifugus*, a few years ago mentioned from Heligoland, but which must be supposed to be more widely destributed as it has now been found at the Færöes; *Ectocarpus Stilophoræ* found in South England; *Myrionema foecunda* which is perhaps closely related to *M. Corunnæ; Microsyphar Polysiphoniæ* found in North England; *Microsyphar Zosteræ*, originally mentioned from Heligoland; *Sorapion Kjellmani*, most likely the same as *Sorapion simulans* (see Rosenvinge, 71, p. 161, note) which has been found in South England; *Petroderma maculiforme* stated from Heligoland; *Sphacelaria cæspitula* which according to Batters has been found in North England, but is, however, possibly doubtful, as it has not been given by Sauvageau; *Prasiola furfuracea*, found for instance in Germany and on the north coast of Norway; *Ulothrix pseudoflacca* and *U. consociata* which have but recently been described by Wille as found in Kristianiafjord and of which we therefore know but little as to how far they are distributed; *Pilinia maritima* which is known from Greenland and the Færöes and has lately been found by Sauvegeau in the gulf of Gascony; *Ulvella confluens* found in South England but which Batters supposes to be common; *Codiolum gregarium*, in Batters' list only stated from South England, but which is mentioned as »not uncommon« in the same author's »List of the marine Algæ of Berwick-on-Tweed«; *Codiolum pusillum* which is possibly found in Scotland (see Batters p. 9), but which is, however, not stated from Scotland in Jónsson's and my own list, as we have felt doubtful as to the correctness of the determination because of the synonyms mentioned by Batters; *Chlorogloea tuberculosa*, lately described by Wille and probably widely distributed; *Pleurocapsa amethystea* found at South England; *Phormidium autumnale* found in North England; *Microcoleus tenerrimus* found in South England.

All these 26 species which are mostly small and therefore only to be discovered by thorough investigation, can with some certainty be supposed to occur on the coasts of Scotland and the surrounding isles, and can therefore for comparison be included in the total number. The total number of species thus becomes 195.

Of the remainding 20 species, 6 are the above mentioned new species and 3 are forms only determined as to the genus, and of which we know nothing concerning their eventual occurrence on the coasts of Scotland. It is, however, most probable, that at any rate some of them will be found to grow there. Of the remainding 11 species, 5 belong to *Acrosiphonia* and *Spongomorpha* which should be left out of consideration because of the uncertain classification of these genera; most likely they will all be found, however, on the coasts of the British Isles, with the exception perhaps of *A. hystrix*, a northern species uncommon even in the Færöes and not found there either in its typical form. We thus have a remainder of 6 species: *Rhodophyllis dichotoma, Halosaccion ramentaceum, Ptilota pectinata, Rhodochorton penicilliforme, Lithothamnion læve* and *Alaria Pylaii.*

These 6 species are essentially typical to northern regions; they all belong to the coldest portion of the subarctic group and thus are species having their greatest distribution in the Polar Sea proper. Whether any of these species may be found at the British Isles is certainly very doubtful, but even if they do not grow there and some few of the above mentioned Færöese algæ, which have not yet been found in Scotland, should really be wanting there, it is, however, but a very small number of species found at the Færöes which are not found in Scotland or at any rate may not be supposed to grow there.

Any further examination dealing with the great number of species found in Scotland and the surrounding isles, but not at the Færöes, has but little interest here. It is a matter of course, that a much greater number of species must be found in a territory of such an extent, than at the Færöes, and it is likewise evident that a great number of more southern forms will appear there on account of the more southern situation of Scotland. Of the species (about 250) found there, but not at the Færöes, more than one half have hitherto only been found in the southern part of Scotland, comprising the east coast about the Firth of Forth (Fife, Haddington, Berwick) and the west coast reckoned from Argyle to the English boundary; of red and brown algæ there are no less than 68 species (see Börgesen and Jónsson 12, p. XXI, group E 3). Of the remainding species (as to the red and brown algæ compare the group E 2, in the above-mentioned paper (12) p. XIX and XX) we may be sure that a great many do not grow so far north as the Shetland Isles.

As the Shetland Isles are of about the same size as the Færöes and lie nearest to the latter (the distance is almost 300 kilometers), a comparison between the marine algæ-flora of these two groups of islands would be particularly interesting. It is therefore to be regretted, that the marine algæ-vegetation of the Shetland Isles has been but little investigated. The most important contribution to our knowledge of these algæ is to be found in Edmonston's Flora of the Shetland Isles (16) with a list of the marine algæ known at that period. Since then no other contribution had been published, so far as I know, until 1902 when I paid a short visit to the islands. In a small paper (9) I have published my discoveries and added the species mentioned by Edmonston. The number of species known from the Shetland Isles is about 108, as I include *Enteromorpha clathrata* and *Callithamnion tetragonum* var. *brachiatum*, whilst *Gelidium cartilagineum* must be left out, as it does not belong to the flora of the islands. Of these 108 species, about 88 are also found at the Færöes; of *Rhodophyceæ* and *Phæophyceæ* 87 have hitherto been known, of which 72 are common to both countries. But as already emphasized by me in dealing with the flora of Scotland and adjacent islands, there is hardly any doubt, that by far the greater part of the algæ-species of the Færöes will be found there, especially on the islands that are the nearest. The only species which have less likelihood of being found there are the above mentioned 6 subarctic species, to which perhaps may be added a few more, e. g. *Laminaria fœroensis, Phæostroma parasiticum* etc. Of the 20 species found at the Shetland Isles but not at the Færöes we must first mention *Fucus serratus* which is very common at the Shetland Isles but is, strangely enough, wanting at the Færöes; the other 19 are: *Helminthora divaricata, Chylocladia kaliformis, Nitophyllum Bonnemaisonii, Spermothamnion Turneri, Callithamnion tetragonum, Ceramium diaphanum, C. ciliatum, Dilsea edulis, Asperococcus bullosus, Myriotrichia clavæformis, Mesogloia vermiculata, Saccorhiza bulbosa, Cutleria multifida, Fucus ceranoides, Acinetospora pusilla, Chætomorpha ærea, Cladophora Hutchinsiæ, Dermocarpa prasina* and *Calothrix confervicola.* It is not impossible, that some of these species may grow on the Færöese coasts, but most of them are forms from more southern countries, most likely having their northern limit at the Shetland Isles.

It appears from this, that the Færöese algæ-flora must be regarded as a rather poor selection of the algæ of Scotland and adjacent is-

lands, as almost all the Færöese algæ are found on the coasts of Scotland, whereas Scotland has on the other hand a very great number of species, which are wanting at the Færöes. The greatest resemblance is between the Færöese algæ-flora and that of the Shetland Isles; the Færöes have a few, perhaps no more than 6, specially northern species which will most probably not be found on the Shetland Isles; on the other hand the Shetland Isles have a number (how many can only be stated when a more thorough investigation of the algal vegetation of these islands has been undertaken) of forms from more southern countries which do not grow any farther north than the Shetland Isles.

From the British Isles the comparison most naturally passes to the west coast of Norway. Boye (6) has given a list of the algæ found by him at a part of the coast, round Sulen north of Bergen. This part of the coast is at about the same degree of latitude as the Færöes, and consequently of special interest; but unfortunately Boye's list is rather defective, as is clearly proved by the fact that such species as *Fucus spiralis, Desmarestia viridis, Odonthalia dentata, Enteromorpha Linza* and others, are not mentioned. I have therefore made an attempt to supplement Boye's list, partly by including the species mentioned by Areschoug in his well-known work: »Phyceæ scandinavicæ marinæ« (3), even if these algæ are not specifically stated as belonging to Bergen and its neighbourhood but only from some locality on the Norwegian west coast south of Trondhjem, partly by adding the species which Hansteen mentions in his paper (38). Further, several species from the west coast of Norway are mentioned in different papers by Foslie (e. g. 25, 27); and Mr. E. Norum of Haugesund, who has been investigating the algæ-vegetation in this neighbourhood, has kindly placed his still unpublished list of brown algæ from this part of the west coast at my disposal. Lastly, *Chantransia Alariæ* has been found by Rosenvinge at Haugesund and by me at Christianssund. Of the species mentioned in Boye's list (according to my calculation about 165, which number will certainly be much increased on further investigation), 97 are found at the Færöes, but if we include the species, which are stated by the various authors mentioned as found on the west coast of Norway, the total number of common species is increased by at least 40, which makes in all about 137 species or about 64 % of the Færöese algæ. If we exclude the green and bluish-green algæ, 190 *Rhodophyceæ* and *Phæo-*

phyceæ have been found in West Norway, according to our list; of these species 114 or more than 73 % are found at the Færöes. There is, however, hardly any doubt, that the greater part of the many Færöese algæ which have hitherto not been found on this part of the coast, that is about 80 species, will certainly be found there. It seems unnecessary to name all these species, but I may mention some Færöese species which may be supposed not to occur on this part of the west coast of Norway: *Halosaccion ramentaceum*, *Ptilota pectinata*, *Rhodochorton penicilliforme*, *Alaria Pylaii*, *Laminaria fœroensis*, and possibly some few more. These species all belong to colder regions. Of the great number of species found at Norway and not at the Færöes (of red and brown algæ 76 species[1]) the greater part are of a more southerly distribution, but some few are more northern algæ, for instance: *Turnerella Pennyi*, which is arctic, and *Lithothamnion tophiforme* and *Haplospora globosa* which are subarctic.

From West Norway we pass on to Nordland. On account of the Gulf Stream the algæ-flora here has a much more southern character than might be expected so far north; a great many Færöese species are also found here.

For our knowledge of Nordland's algæ-flora we are especially

[1] According to our list they are divided in the following way into different groups:

The arctic group: *Turnerella Pennyi.*

The subarctic group: *Lithothamnion tophiforme, Haplospora globosa.*

The cold-boreal group: *Spermothamnion Turneri, Callithamnion Hookeri, C. roseum, Ceramium Deslongchampsii, C. circinnatum, C. diaphanum, Dilsea edulis, Lithothamnion intermedium, L. fornicatum, L. norvegicum, Ectocarpus Turnerellæ, E. Pringsheimii, E. terminalis, E. penicillatus, E. draparnaldioides, Myriotrichia filiformis, Dictyosiphon Chordaria, Mesogloia vermiculata, Spermatochnus paradoxus, Fucus ceranoides* and *Fucus serratus.*

The warm-boreal group: *Nemalion multifidum, Gelidium crinale, G. latifolium, Phyllophora rubens, Catenella opuntia, Rhodophyllis bifida, Chylocladia kaliformis, Nitophyllum punctatum, Bonnemaisonia asparagoides, Polysiphonia spinulosa, P. simulans, Brongniartella byssoides, Monospora pedicellata, Pleonosporium Borreri, Callithamnion tetragonum, Compsothamnion thuyoides, Ceramium flabelliferum, Gloiosiphonia capillaris, Halarachnion ligulatum, Lithothamnion membranaceum, L. Sonderi, L. calcareum, Lithophyllum orbiculatum, L. pustulatum, Melobesia farinosa, M. Lejolisii, M. minutula, Corallina rubens, Ralfsia pusilla, Myrionema intermedium, Chilionema ocellatum, Ascocyclus orbicularis, Microspongium gelatinosum, Ectocarpus sphæricus, E. globifer, Myriotrichia repens, M. clavæformis, Myriactis Haydeni, Elachista stellaris, Giraudia sphacelarioides, Sphacelaria bipinnata, Asperococcus bullosus, A. compressus, Litosiphon pusillus, Striaria attenuata, Myriocladia Zosteræ, Chordaria divaricata, Stilophora rhizodes, Saccorhiza bulbosa, Cutleria multifida, Tilopteris Mertensii, Dictyota dichotoma.*

indebted to Kleen (51); but Kjellman (48) has furnished us with important information. We know 123 species of *Rhodophyceæ* and *Phæophyceæ* together with about 20 *Chlorophyceæ* from Nordland, that is very nearly 150 species. 113 of these species are also found at the Færöes, that is, 75 % of the species of Nordland and 52. 8 % of the Færöese species. Nordland has 123 red and brown algæ, 95 of these are also found at the Færöes, that is, 61 % of the Færöese algæ of these groups. The 28 species which are found at Nordland but not at the Færöes are the following: *Turnerella Pennyi* (A)[1], *Brongniartella byssoides* (E 1), *Spermothamnion Turneri* (D), *Callithamnion Hookeri* (D), *Callithamnion roseum* (D), *Ceramium Deslongchampsii* (D), *C. circinnatum* (D), *C. diaphanum* (D), *Dilsea edulis* (D), *Petrocelis cruenta* (D), *Lithothamnion intermedium* (D), *L. fornicatum* (D), *L. tophiforme* (B 1), *L. norvegicum* (D), *Ralfsia deusta* (B 1), *Ectocarpus Turnerellæ* (D), *E. terminalis* (D), *E. borealis* (D), *E. ovatus* (B 1), *E. penicillatus* (D), *E. draparnaldioides* (D), *Myriotrichia filiformis* (D), *Sphacelaria racemosa* (B 1), *Mesogloia vermicularis* (D), *Spermatochnus paradoxus* (D), *Cutleria multifida* (E 1), *Fucus ceranoides* (D), *F. serratus* (D). With the exception of some few warm-boreal species (E 1), the greater part of these algæ belong to the cold-boreal group (D); we are therefore justified in expecting that some of them may perhaps be found at the Færöes; the other species are arctic or subarctic, and can scarcely be expected there.

On the other hand, the following 60 species are found at the Færöes: *Porphyra leucosticta, P. coccinea, Conchocelis rosea, Chantransia Alariæ, Ch. efflorescens, Ch. virgatula, Choreocolax Polysiphoniæ, Harveyella mirabilis, Phyllophora Brodiæi, Actinococcus subcutaneus, Callophyllis laciniata, Callocolax neglecta, Sterrocolax decipiens, Lomentaria rosea, Nitophyllum laceratum, Laurencia pinnatifida, Polysiphonia atrorubescens, Rhodomela subfusca, Griffithsia setacea, Callithamnion scopulorum, C. granulatum, Rhodochorton seiriolanum, Rh. membranaceum, Rhododermis elegans, Phymatolithon lævigatum, Lithophyllum incrustans, L. hapalidioides, Lithoderma fatiscens, Petroderma maculiforme, Sorapion Kjellmani, Ralfsia clavata, Myrionema Corunnæ, M. foecundum, M. globosum, M. færoense, M. speciosum, Microsyphar Polysiphoniæ, M. Zosteræ, Ectocarpus æcidioides, E. Stilophoræ, E. velutinus, E. lucifugus, E. tomentosoides, E. dasycarpus, E. granulosus, E. Hincksiæ, Leptonema fasciculatum, Elachista scutulata, Sphacelaria britannica, Sph. cæspitula, Sph. furcigera, Sph. cirrosa,*

[1] For explanation of the letters see: Börgesen and Jónsson (12, p. XV—XXI).

Desmotrichum undulatum, *Punctaria latifolia*, *Litosiphon filiforme*, *Phæostroma parasiticum*, *Phyllitis zosterifolia*, *Desmarestia ligulata*, *Chorda tomentosa*, *Laminaria færoensis*. It is most probable, that a great many of these species will be found in Nordland on further investigation, the remainding species are partly some that grow in more southern regions and most probably do not occur in Nordland, partly the species hitherto found at the Færöes only, of whose occurrence outside the Færöes we know nothing as yet. Of green and bluish-green species 40 have been found at the Færöes but not hitherto at Nordland, namely: *Chlorochytrium inclusum*, *Codiolum gregarium*, *C. pusillum*, *Enteromorpha Linza*, *Prasiola crispa* **marina*, *P. furfuracea*, *Ulothrix consociata*, *U. pseudoflacca*, *U. flacca*, *Endoderma Wittrockii*, *Acrochaete repens*, *Pilinia maritima*, *Ulvella fucicola*, *U. confluens*, *Pringsheimia scutata*, *Urospora Wormskioldii*, *Spongomorpha vernalis*, *Acrosiphonia flagellata*, *A. incurva*, *A. grandis*, *A. hystrix*[1], *Cladophora sericea*, *Gomontia polyrhiza*, *Ostreobium Queketti*, *Derbesia marina*, *Vaucheria coronata*, *Valonia ovalis*, *Chlorogloea tuberculosa*, *Dermocarpa violacea*, *D. Farlowii*, *Pleurocapsa amethystea*, *Hyella cæspitosa*, *H. endophytica*, *Spirulina subsalsa*, *Phormidium autumnale*, *Lyngbya lutea*, *Microcoleus tenerrimus*, *Calothrix æruginea*, *C. scopulorum*, *Rivularia atra*. Most probably a great number of these species will likewise be found in Nordland.

What we know of the algæ-flora of Finmark is mostly due to papers by Foslie; Kjellman, however, has also contributed important information. According to our list, 125 red and brown algæ have been found there. Of these algæ 50 red and 41 brown algæ are common to the Færöes and Finmark, that is 91 in all or 58 % of the Færöese algæ and 72 % of those of Finmark. The 34 species which are found at Finmark but not at the Færöes are as follows: *Chantransia microscopica*, *Turnerella Pennyi*, *Polysiphonia arctica*, *Spermothamnion Turneri*, *Ceramium Deslongchampsii*, *C. cincinnatum*, *Petrocelis Middendorffi*, *Peyssonnelia Rosenvingii*, *Phymatolithon investiens*, *Lithothamnion flavescens*, *L. foecundum*, *L. intermedium*, *L. fornicatum*, *L. tophiforme*, *L. norvegicum*, *Lithoderma lignicola*, *Ralfsia deusta*, *Ectocarpus terminalis*, *E. nanus*, *E. ovatus*, *E. penicillatus*, *Myriotrichia filiformis*, *Sphacelaria racemosa*, *Phæo-*

[1] Kleen, however, mentions both a *Cladophora arcta* and a *Cl. uncialis*, which are most probably identical with some of the species of *Acrosiphonia* and *Spongomorpha* mentioned here.

saccion Collinsii, Delamarea attenuata, Coiledesme bulligera, Dictyosiphon Chordaria, D. corymbosus, D. hispidus, Saccorhiza dermatodea, Laminaria Agardhii, L. nigripes, Haplospora globosa, Fucus serratus. Almost half of these species are arctic and subarctic, and may not be expected to grow so far south as the Færöes; the others, however, are of a more southern distribution, and some of them may therefore also be found possibly at the Færöes. The majority of the 65 Færöese species absent at Finmark are the same as were wanting at Nordland; some Færöese species not found at Nordland are, however, found here, but on the other hand Finmark lacks the following 19 species: *Erythrotrichia ceramicola, Phyllophora membranifolia, Pterosiphonia parasitica, Callithamnion arbuscula, C. polyspermum, C. corymbosum, Ceramium acanthonotum, Lomentaria articulata, Plocamium coccineum, Polysiphonia violacea, P. Brodiæi, Cruoria pellita, Cruoriella Dubyi, Rhododermis elegans, Ralfsia verrucosa, Ectocarpus tomentosus, Cladostephus spongiosus, Litosiphon Laminariæ, Himanthalia lorea.* As already pointed out with reference to Nordland, there is hardly any doubt, that some of the wanting Færöese species may also be found at Finmark though probably in lesser number.

As to the green and bluish-green algæ, 37 Færöese species (I take it for granted, that *Acrosiphonia hamulosa* belongs to *A. albescens*) are also found at Finmark; some more species have been found here, but as the determinations in many cases greatly need to be revised, I shall not deal with them any more in this connection.

From this comparison it is seen, that Finmark has a somewhat smaller number of species in common with the Færöes than Nordland has, and that it has a much greater number of arctic species than the latter country.

From Norway we pass on to Iceland, and here our comparison has the advantage of the up to date list worked out with much care by Jónsson, in his paper on the marine algæ-flora of this country. As already pointed out by Strömfelt, the algæ-flora of the coasts of Iceland varies greatly. He divides it into two territories: North-East Iceland with an algæ-flora of an essentially arctic character, and South-West Iceland with a north-atlantic flora. This great difference has been confirmed by Jónsson, who, however, has kindly communicated to me, that the flora ought to be further subdivided, as the flora of the southern part of the country is purely

cold-boreal, that of the eastern part arctic, whilst that of the western and northern parts is a mixed flora. As Jónsson intends to enter more fully into a comparison with the adjacent countries, in his paper on the algæ-vegetation of Iceland using this division as basis I may avoid too much detail here and simply keep to the two principal divisions: North-East and South-West Iceland.

The total number of species mentioned by Jónsson from Iceland is 195[1], Of these 195 species, 121 *Rhodophyceæ* and *Phæophyceæ* and 44 *Chlorophyceæ* and *Cyanophyceæ*, in all 165, are found on the southern and south-western part of the country, that is, from Lónsheiði on the south-east coast to Látrabjarg on the north-west coast. From Látrabjarg to Hornbjarg on the adjacent coast of North-West Iceland with mixed flora, we further find the following 7 species: *Ceratocolax Hartzii, Phyllophora Brodiæi, Actinococcus subcutaneus, Punctaria plantaginea, Monostroma groenlandicum, Acrochæte repens* and *Bolbocoleon piliferum,* which have hitherto not been found in more southerly places in Iceland. With the latter species the total number becomes 172. 134 of these species and 5 from the adjacent coast, 139 in all[2], are also found at the Færöes.

The 76 Færöese species which are not found at South-West Iceland can be divided into the following groups:

I. Species found at North-East Iceland:
Laminaria færoensis, Petroderma maculiforme, Codiolum gregarium, C. pusillum, Phormidium autumnale.

II. Species found at Greenland:
Chantransia efflorescens, Harveyella mirabilis, Polysiphonia elongata, Rhododermis elegans, Sorapion Kjellmani, Ulothrix consociata, Pilinia maritima, Ulvella confluens, Vaucheria coronata, Calothrix scopulorum.

III. Species found on the coast of North Norway:
Erythrotrichia ceramicola, Chantransia Daviesii, Polysiphonia violacea, Polysiphonia Brodiæi, Rhodomela subfusca, Callitham-

[1] According to Mr. Foslie's latest determination, *Lithothamnion circumscriptum* must be excluded from the number of species, whilst on the other hand *Chantransia microscopica* and *Vaucheria sphærospora* must be included (compare Börgesen and Jónsson, 12).

[2] Of *Phyllophora Brodiæi* only the subspecies *interrupta* has been found at Iceland, but the Færöese specimen is very much like it; as to *Acrosiphonia,* I consider *A. flaccida* as belonging to *A. hystrix* (8, p. 512), and *Spongomorpha lanosa* to be the same as *Sp. vernalis* (12, p. XXV).

nion corymbosum, C. polyspermum, Furcellaria fastigiata, Polyides rotundus, Cruoriella Dubyi, Chilionema reptans, Sphacelaria cirrosa, Cladostephus spongiosus, Asperococcus echinatus, Halidrys siliquosa, Himanthalia lorea, Acrosiphonia flagellata, A. grandis, Bryopsis plumosa, Derbesia marina; to this group we may most probably also refer *Sterrocolax decipiens,* which has certainly not been found farther north than the Færöes, so far as I know, but which may be supposed to grow in the same regions as *Ahnfeltia.*

VI. Southern forms, not found hitherto north of the Færöes and West Norway:
Porphyra leucosticta, Callophyllis laciniata, Callocolax neglecta, Lomentaria articulata, Nitophyllum laceratum, Laurencia pinnatifida, Polysiphonia atrorubescens, Griffithsia setacea, Callithamnion granulatum, Rhodochorton seiriolanum, Phymatolithon lævigatum, Lithophyllum incrustans, L, hapalidioides, Ectocarpus dasycarpus, E. granulosus, E. lucifugus, E. velutinus, Myrionema foecundum, Microsyphar Zosteræ, Sphacelaria cæspitula, S. furcigera, Elachista scutulata, Punctaria latifolia, Desmotrichum undulatum, Litosiphon Laminariæ, Valonia ovalis, Chlorogloea tuberculosa, Dermocarpa violacea, Hyella cæspitosa, Lyngbya lutea, Microcoleus tenerrimus, Calothrix æruginea and *Choreocolax Polysiphoniæ.*

Lastly, we have the 6 new Færöese species, and the 3 which are only determined as to the genus. Of these, *Myrionema færoense* has been found at South-West Iceland and is thus already included in the total number, and *Laminaria færoensis* has been taken at North-East Iceland and is included in the first group; thus there are only 7 species left, of which nothing[1] is known as to their occurrence outside the Færöes, but of which some at least may probably also be found at Iceland.

As to group I, it seems to me, that the 5 species it includes must also be supposed to occur at South-West Iceland. I likewise think it most likely, that the 10 species belonging to group II, may be met with at Iceland. As to the 21 species of group III I think there is some probability at any rate, that some of them may be found at South-West Iceland, as they have been able to grow so far north as the coast of Norway.

[1] *Dermocarpa Farlowii* excepted.

Lastly there are the more southern forms belonging to group IV. With the exception of some few species, especially those of which we know very little as to their distribution, we can in general take it for granted, that they are most likely not found at Iceland; thus their north western boundary is at the Færöes: in Norway, however, several of them grow much farther north.

As to the 33 species found at South-West Iceland, but not at the Færöes, they can be divided into the following groups; I retain the designations used in the preceding section.

I. Arctic species: *Ceratocolax Hartzii, Polysiphonia arctica, Cruoria arctica, Monostroma groenlandicum;* 4 species in all.

II. Subarctic species:
Subdivision 1: *Peyssonnelia Rosenvingii, Lithothamnion tophiphorme, Coilodesme bulligera, Ralfsia ovata, R. deusta, Myrionema Laminariæ, Saccorhiza dermatodea, Acrochæte parasitica, Urospora Hartzii* and *Chlorochytrium Schmitzii;* 10 species in all.
Subdivision 2: *Phaeostroma pustulosum, Chlorochytrium dermatocolax, C. Cohnii* and *Cladophora hirta;* 4 species in all.

III. Cold-boreal species: *Dilsea edulis, Rhodochorton minutum, Petrocelis Hennedyi, Rhododermis parasitica, Ectocarpus penicillatus, Dictyosiphon Chordaria, Fucus serratus, Sphacelaria radicans, S. olivacea, Codiolum Petrocelidis, Cladophora glaucescens* and *Vaucheria sphærospora;* 12 species in all.

IV. Warm-boreal species: *Bonnemaisonia asparagoides;* 1 species.

Lastly we have the 2 new species: *Rhodochorton repens* and *Acrosiphonia flabelliformis,* the distribution of which is unknown outside of Iceland.

Firstly as to *Bonnemaisonia asparagoides,* it must be pointed out, that it is not perfectly certain that this species really grows on the coasts of Iceland (compare Jónsson, 41 p. 141).

Of the species mentioned in group III it is probable, that some of them at any rate, especially the smaller species, will also be found to grow at the Færöese coasts. With the exception of some few species, there is, however, only a slight possibility that some of the species belonging to group II should be found on the Færöese coasts, and as to the 4 arctic species there is certainly no doubt that they are absent at the Færöes.

Thus we see that even if there is an important, though not very great, difference between the flora of South-West Iceland and

that of the Færöes, in so far that 4 species belonging to the arctic group, which is quite wanting at the Færöes, have been found at Iceland, as also that many more subarctic species occur there than at the Færöes, the difference is much reduced, if we make the comparison between the algæ-flora of South Iceland proper and that of the Færöes. At South Iceland 82 red and brown species and 26 green and bluish-green have been found, 108 species in all. The following 12 of these species are wanting at the Færöes:

Subarctic species: *Lithothamnion tophiphorme, Ralfsia deusta, Urospora Hartzii, Cladophora hirta;*

Cold-boreal species: *Rhodochorton repens* (endem.), *Petrocelis Hennedyi, Rhododermis parasitica, Sphacelaria radicans, S. olivacea, Fucus serratus, Acrosiphonia flabelliformis* (endem.);

Warm-boreal species: *Bonnemaisonia asparagoides,* which does not belong perhaps to the flora.

As mentioned above, there is hardly any doubt, that at any rate some of these species will also be found at the Færöes, just as, on the other hand, several of the species wanting at the Færöes may most likely be found at this part of Iceland, especially perhaps at the Vestmanöer. Some of the latter however can hardly be considered to occur there, as for instance some of the most important: *Porphyra leucosticta, Callophyllis laciniata* with *Callocolax neglectus, Lomentaria articulata, Nitophyllum laceratum, Polysiphonia violacea* and *P. Brodiæi, Griffithsia setacea, Cladostephus spongiosus, Punctaria latifolia, Himanthalia lorea, Halidrys siliquosa, Bryopsis plumosa, Valonia ovalis* etc. The algæ-flora of South-Iceland must be regarded as a poorer selection of the Færöese algæ-flora, particularly as some of the warm-boreal species, found at the Færöes, are wanting there.

When we turn to North-East Iceland, we see that the difference between the algæ-flora there and that at the Færöes is much greater, as might well be expected. From North- and East-Iceland proper, that is, if we count from the head of Huna-Floi to Lónsheiði on the south-east coast of Iceland, we have 92 red and brown species and 34 green and bluish-green; east of Hornbjarg along the adjacent north-western coast, we have moreover 8 brown and red algæ, and 9 green and bluish-green species, namely: *Chantransia microscopica, Cystoclonium purpurascens, Polysiphonia nigrescens, *Ralfsia ovata, Ascocyclus islandicus, *Leptonema fasciculatum, *Sphacelaria britannica, Leathesia difformis, *Chlorochytrium dermatocolax, Codiolum pusillum, Enteromorpha aureola, *Ulva Lactuca, *Ochlo-*

*chæte ferox, Cladophora rupestris, *C. sericea, Plectonema norvegicum* and **Spirulina subsalsa.* If we add these to the above-mentioned number[1], we have 143 species. Of these, 111 are also found at the Færöes. Thus North-East Iceland has 23 species less in common with the Færöes than South-West Iceland.

Firstly, as to the 32 species found at North-East Iceland and not at the Færöes, they may be divided into the following groups:

I. The Arctic group: *Turnerella Pennyi, Delesseria Baerii, Polysiphonia arctica, Lithothamnion flavescens, L. foecundum, Omphalophyllum ulvaceum, Dictyosiphon corymbosum, Laminaria nigripes* and *Monostroma groenlandicum;* 9 species in all.

II. The Subarctic group:
Subdivision 1: *Peyssonnelia Rosenvingii, Lithothamnion tophiforme, Ralfsia densta, R. ovata, Coiledesme bulligera, Saccorhiza dermatodea, Ulothrix subflaccida, Pseudendoclonium marinum, Urospora Hartzii, Acrosiphonia penicilliformis;* 10 species in all.
Subdivision 2: *Phæostroma pustulosum, Chlorochytrium dermatocolax;* 2 species in all.

III. The Boreal-arctic group: *Chantransia microscopica.*

IV. The Cold-boreal group: *Petrocelis Hennedyi, Lithothamnion norvegicum, Ascocyclus islandicus, Ectocarpus penicillatus, Sphacelaria radicans, Dictyosiphon Mesogloia, D. Chordaria, Enteromorpha aureola, Ochlochæte ferox, Plectonema norvegicum;* 10 species in all.

If we compare these species with those that are not common to South-West Iceland and the Færöes, we at once perceive a very distinct difference in that the arctic group is much increased[2]. It is not likely that any of these 9 species will be found at the Færöes; and as to the subarctic species of the subdivision 1, it is likewise improbable that they will be found there, a few species perhaps excepted. On the other hand the species of subdivision 2 may probably also be found on the Færöese coasts, and this is certainly also the case with the greater part of the cold-boreal species.

[1] It is, however, doubtful, whether they may all be found at North and East Iceland proper; the 8 species marked with asterics and which have all been found much farther north, for instance at Greenland, must, however, be supposed to occur at North Iceland, and especially at East Iceland.

[2] This group will most probably be still more increased on renewed investigations, as we may certainly suppose, that the two arctic species at any rate, *Cruoria arctica* and *Ceratocolax Hartzii,* found at the other side of Hornbjarg, also grow there.

The 104 Færöese species which have not been found at North-East Iceland are divided into the following groups:

The subarctic group: *Chantransia efflorescens, Ch. virgatula, Harveyella mirabilis, Sorapion Kjellmani, Percursaria percursa, Pilinia maritima, Ulvella confluens, Pringsheimia scutata, Spongomorpha vernalis.* All these 9 species will most likely be found at North-East Iceland.

The boreal-arctic group: *Polysiphonia elongata* and *Rivularia atra,* both of which will certainly also be found at North-East Iceland.

The cold-boreal group includes the great majority, namely, 66 species, but I need not mention themhere; some of them may perhaps be found at North-East Iceland, but most of them probably not.

Lastly, the warm-boreal group includes 27 species, none of which probably are to be found on the coasts of North-East Iceland.

If we now pass on to Greenland, we find, according to Rosenvinge (71, p. 166—172), that the total number of species is 167, when the algæ-flora of both West and East Greenland is included. To this number must be added *Actinococcus subcutaneus* which Rosenvinge did not accept as a species, according to Darbishire's view at that time. According to Jónsson (42), we must further add 7 species, firstly *Microsyphar Polysiphoniæ*; then Rosenvinge's *Spongomorpha arcta* includes *Acrosiphonia incurva, A. hystrix* and *A. penicilliformis*; also 3 species of *Ulothrix* must be added: *U. pseudoflacca, U. scutata* and *U. subflaccida,* whilst *U. consociata* is partly the same as Rosenvinge's *U. implexa.* Lastly, Rosenvinge's *Sphacelaria olivacea* includes *Sphacelaria radicans* and *Sph. britannica.* Thus the number of species we know from Greenland becomes 176. According to my judgment of the species, *Enteromorpha prolifera* must, however, be withdrawn, and according to Foslie's latest views the 12 species of *Lithothamnion* mentioned by Rosenvinge must be reduced to 6[1]; the total number of species thus becomes 169. At the Færöes we meet with 104 of these species. The Færöes have 108 species (+ 3 only determined as to the genus) that are not found at Greenland, but on the other hand, we find 65 species there that do not grow at the Færöes; thus 49% of the 212 Færöese algæ are common to both countries.

[1] *Lithothamnion botryoides, L. flabellatum, L. colliculosum* and *L. varians* being referred to *L. glaciale,* and *L. circumscriptum* to *L. compactum. L. investiens* is doubtful at Greenland and *L. fruticulosum* is the same as *L. intermedium.*

As to the 111 Færöese species wanting at Greenland, they are mostly species also wanting at Iceland (namely the 54 species mentioned as belonging to group III and group IV p. 793—94), and in addition the following 57 species: *Porphyra coccinea, Chantransia Alariæ, Chondrus crispus, Gigartina mamillosa, Phyllophora membranifolia, Ahnfeltia plicata, Cystoclonium purpurascens, Lomentaria rosea, L. clavellosa, Plocamium coccineum, Delesseria alata, D. sanguinea, Polysiphonia fastigiata, P. nigrescens, Pterosiphonia parasitica, Odonthalia dentata, Callithamnion arbuscula, C. scopulorum, Plumaria elegans, Ptilota plumosa, Ceramium acanthonotum, Dumontia filiformis, Cruoria pellita, Phymatolithon polymorphum, Lithothamnion Lenormandi, Lithophyllum Crouani, L. macrocarpum, Corallina officinalis, Petroderma maculiforme, Myrionema vulgare, M. Corunnæ, M. færoense, M. speciosum, Ectocarpus tomentosus, E. fasciculatus, E. Hincksiæ, Phæostroma parasiticum, Dictyosiphon Ekmani, Desmarestia ligulata, Leathesia difformis, Laminaria færoensis, L. hyperborea, Fucus spiralis, Pelvetia canaliculata, Codiolum pusillum, Enteromorpha Linza, E. clathrata, Prasiola furfuracea, P. stipitata, Acrochæte repens, A. albescens, Dermocarpa Farlowii, Hyella endophytica, Phormidium autumnale,* besides the 3 referred only to the genus. These 111 species are almost all of a more southern distribution and belong to the warm-boreal and cold-boreal groups.

As to the 65 species found at Greenland and not at the Færöes, they can be referred to the following groups:

The arctic group: *Ceratocolax Hartzii, Callymenia sanguinea, Turnerella Pennyi, Delesseria Baerii, D. Montagnei, Polysiphonia arctica, Dilsea integra, Petrocelis polygyna, Cruoria arctica, Lithothamnion foecundum, Ectocarpus pycnocarpus, Omphalophyllum ulvaceum, Kjellmania subcontinua, Coelocladia arctica, Dictyosiphon corymbosum, Myriocladia callitricha, Laminaria solidungula, L. cuneifolia, L. groenlandica, L. nigripes, Monostroma groenlandicum, M. leptodermum, Ulothrix scutata, Arthrochæte penetrans, Chætobolus gibbus, Urospora crassa;* 26 species in all.

The subarctic group:

Subdivision 1: *Peyssonnelia Rosenvingii, Lithothamnion tophiforme, Ralfsia ovata, R. deusta, Myrionema Laminariæ, Ectocarpus helophorus, E. ovatus, Sphacelaria racemosa, Phæosaccion Collinsii, Symphyocarpus strangulans, Delamarea attenuata, Coilodesme bulligera, Dictyosiphon hispidus, Saccorhiza dermatodea, Laminaria longicruris,*

Agarum Turneri, Chlorochytrium Schmitzii, Ulothrix subflaccida, Acrochæte parasitica, Urospora Hartzii, Rhizoclonium pachydermum[1], *Acrosiphonia penicilliforme;* 22 species in all.

Subdivision 2: *Phæostroma pustulosum, Haplospora globosa, Chlorochytrium Cohnii, Ch. dermatocolax, Cladophora hirta;* 5 species in all.

The boreal-arctic group: *Chantransia microscopica, Oscillatoria amphibia, O. tenuis*[1]; 3 species in all.

The cold-boreal group: *Lithothamnion intermedium, Ectocarpus Pringsheimii, E. penicillatus, Sphacelaria radicans, Dictyosiphon Chordaria, Epicladia Flustræ, Ochlochæte ferox, Vaucheria intermedia, V. sphærospora;* 9 species in all.

Thus we see, that by far the greater part of these species belongs to the arctic and the coldest subdivision of the subarctic group; it is not probable that any of these species will be found at the Færöes. On the other hand, some of the few species referred to the other groups will no doubt be found to grow there.

This comparison thus leads to the conclusion that the Færöese algæ-flora includes a great number of southern forms wanting at Greenland, whilst Greenland has a great number of arctic species not found at the Færöes.

Lastly we may make a comparison with the algæ-flora of North-America. It is a well-known fact that in spite of the great distance separating the algæ-flora of North-Europe from that of the North-American coast of the North-Atlantic Ocean, they still have a great many species in common. Our knowledge of the North-American algæ-flora we owe firstly to Farlow's well-known paper (20) which is now somewhat antiquated, however, as it is 25 years since it was published, secondly to later works of Farlow, Collins and others. The latter author published in 1900 a list (13) of the North-American algæ, which has been used together with Farlow's above-mentioned paper as a basis for this comparison. Of the species mentioned in this list about 130 are also found at the Færöes, that is, more than one half (60 %) of all the Færöese species. Farlow has already called our attention to the great resemblance between the algæ-flora of both sides of the North-Atlantic Ocean; he likewise mentions (20, p. 4) some of the commonest species that grow both east and west of the Ocean.

[1] Found in freshwater at the Færöes.

However, many widely distributed North-European species are, as is well-known, wanting at North-America, e. g. *Callophyllis laciniata*, *Lomentaria clavellosa* and *L. articulata*, *Delesseria sanguinea*, *Laurencia pinnatifida*, *Polysiphonia Brodiæi*, *Griffithsia setacea*, *Callithamnion scopulorum* and *C. arbuscula*, *Dumontia filiformis*, *Ptilota plumosa*, etc. On the other hand, the coast of North-America has some species that are wanting at the European coast; of these I may mention: *Grinellia americana*, *Polysiphonia vestita*, *P. Olnei* and *P. Harveyi*, *Callithamnion Baileyi*, *Ceramium Hooperi*, *Ectocarpus Chordariæ*, *E. lutosus*, *Stictyosiphon subsimplex*, *Dictyosiphon Macouni*, *Scaphospora Kingii;* to these must also be added *Agarum Turneri* and *Laminaria longicruris* which are both very common on the coasts of North-America and Greenland, but have not been found further to the east. It is true, that *Laminaria longicruris* is stated to have been washed ashore at certain places of the European coasts, but it has never been found growing on any substratum, and it is indeed very probable that these hollow stalks of *Laminaria* are fragments of the very similar *Laminaria fœroensis*, and have come from the Færöes or Iceland.

To what result does this comparison lead? As our knowledge of the floræ of several of the countries we have dealt with is deficient, the result can only be somewhat hypothetical. First of all it must be emphasized that the algæ-flora of the Færöes is to be regarded as a scanty selection of that of North-Scotland, with the addition of some few, more northern species not found at the British Isles. If we had a more thorough knowledge of the algæ-flora of the Shetland Isles, the flora of these islands and that of the Færöes would certainly be found to agree well, just as the algæ-vegetation of the Shetland Isles, at any rate the littoral vegetation, agrees well, with that of the Færöese coasts (compare 9). The Færöese algæ-flora moreover much resembles that of South-West Iceland; the algæ of this part of Iceland must be regarded as a somewhat poorer selection of the algæ of the Færöes, still with a few more northern forms than at the Færöes; lastly there seems to be considerable resemblance between the algæ-flora of the Færöes and that of Nordland.

When the Danish issue of this paper was published, I did not have the revised list of algæ which I have prepared later together with Mr. Jónsson, and without which a thorough examination of

the relation between the different algæ-flora is impossible; on account of this, my comparison of that time led to the result, that »the Færöese algæ-flora mostly resembles that of the nearest parts of the British Isles, less that of West Norway, South Iceland and Arctic Norway, still less that of North-East Iceland, least of all that of Greenland, and a little more that of the North-American coast of the North-Atlantic Ocean«.

This result has been criticized by Simmons. Founding his opinion on his list of algæ published in »Botaniska Notitser«, 1904 (compare Porsild and Simmons, 66, p. 203) he comes to the conclusion that the countries, judged by the degree of resemblance between their algæ-floræ and that of the Færöes should be named as follows: South-West Iceland, North Norway, West Norway, Scotland, North Iceland, America, Greenland.

The difference however is not very great, when we consider that Simmons takes all Scotland as a whole, which tends to reduce the resemblance with the Færöes considerably, and that I expressly deal with the British Islands closest to the Færöes, that is, the Shetland Isles. Moreover, whilst Simmons only deals with the numbers (that his list is wanting in accuracy, and his numbers therefore not to be relied upon, has already been mentioned above), I have proceeded more hypothetically, as we know very little of the algæ-flora of many of the particular countries, and have therefore tried to point out which species we may still expect to find in the flora of the different countries; thus my result necessarily becomes less precisely formulated.

I do not wish naturally to deny all importance to these numbers, on the contrary, I think that Simmons's method might be rather instructive, for instance his table l. c. p. 219, and I therefore add one of the same kind (see next page), calculated from the list prepared by Jónsson and myself. Simmons's method is this: he adds up the number of the species of two floræ, calculates the percentage of those species common to both and of those peculiar to each flora. Like Simmons I have in the following table only dealt with *Rhodophyceæ* and *Phæophyceæ*, and likewise only with the species that we know with certainty to be found in the particular countries. The relative order is, as will be seen from the table, therefore as follows: South-West Iceland, Nordland, West Norway, Finmark, North-East Iceland, the Shetland Isles, Scotland, North-America, Greenland.

The Færöes	Common species	South-West Iceland
52	103	22
30 %	58 %	12 %
The Færöes	Common species	Nordland
60	95	28
33 %	52 %	15 %
The Færöes	Common species	West Norway
14	114	76
18 %	49 %	32 %
The Færöes	Common species	Finmark
64	91	34
34 %	48 %	18 %
The Færöes	Common species	North-East Iceland
78	77	22
44.5 %	43 %	13 %
The Færöes	Common species	The Shetland Isles
83	72	15
50 %	42 %	8 %
The Færöes	Common species	Scotland
25	130	182
7.5 %	38.5 %	54 %
The Færöes	Common species	North-America
57	98	104
22 %	38 %	40 %
The Færöes	Common species	Greenland
87	68	43
44 %	34 %	22 %

As mentioned before, I do not think it justifiable to attach any great validity to this table, until the flora of the particular countries have been thoroughly investigated; it may serve as a hint, perhaps a correct one, but no more.

In agreement with my first thesis (cp. 10, p. 123), the algæ-flora of the Færöes may thus for the present be regarded as most closely related to that of the northern coasts of the British Isles (the Shetland Isles), also to that of West Norway (especially Nordland), and to that of South-West Iceland. This likewise agrees well with the result attained in the preceding chapter, namely, that the Færöes, Nordland, South-West Iceland, and the Shetland Isles are especially the habitats

of the cold-boreal algæ. It is certainly very probable that the greatest resemblance will be found to exist between the Færöese algæ-flora and that of South-West Iceland, more specially with that of South Iceland, as the numbers of the table above tend to show, but until the Shetland Isles have been more thoroughly investigated nothing can be said with certainty.

3. Floristic Differences in the Marine Algæ-Flora of the Færöes.

It is evident that no great floristic differences can be met with within a territory so small as the Færöes, which in their greatest extent from north to south only extend over a little more than one latitude, and where the hydrographic conditions are so very uniform.

Thus the vegetation is in similar localities everywhere almost perfectly homogenous in its composition, and it is only on closer observation that a few disagreements between the northern and southern parts of the islands become discernible. These disagreements are probably caused by the East-Icelandic Polar current which is naturally of great influence on the north coast of the islands. Nevertheless, the Polar current has at the Færöes already, partly been heated by mixture with water from the Atlantic Ocean, partly become more saline, to such a degree, that, according to Ostenfeld (65, p. 610) no arctic plankton has been found at the Færöes; on account of this, the influence of the Icelandic Polar current must likewise be supposed to be relatively small on the fixed algæ-vegetation.

According to the division made by Jónsson and myself, no arctic species are to be found at the Færöes, as already mentioned. Among the subarctic species there is one, however, belonging to the coldest division of this group, which is somewhat more interesting; it is *Halosaccion ramentaceum* a circumpolar species very common in the Polar Sea. It is usually found on the south and west coasts of Iceland, is frequent at the northern coasts of Norway, but does not grow south of Nordland where it has only been found at a few places. At the Færöes, where the southern limit of this alga is most likely found, a supposition already mentioned by Rostrup (72, p. 16), it has been found at 3 places; namely, in addition to the well-known habitat in Klaksvig, also at »Havnen« on the west coast of Svinö, and in Vestmanhavn. Thus the two habitats are found on the Nordreöer, which likewise shelter most of the arctic inland plants, the third on Nordströmö.

In Klaksvig and Vestmanhavn it grows under exactly similar outer conditions; in both places, especially in Vestmanhavn, much fresh and cold water streams down the rocks into the sea, and the temperature of the sea can be fairly low in winter, especially in the upper water layers. At Svinö it grows on an exposed coast but at a high level in a large water basin which is only inundated by the sea at high-tide and by rough seas; here also the temperature of the water can of course be somewhat reduced in the winter.

Whilst this species has thus only been found in the northern territories of the islands, there are also some few others which have only been found at the southern and western coast. *Griffithsia setacea*, for instance, has only been found in Trangisvaagfjord on Syderö, likewise *Polysiphonia violacea; Laurencia pinnatifida* has only been gathered in Trangisvaagfjord and at Höjvig on Strömö; very stunted specimens of *Nitophyllum laceratum* on the west coast of Strömö, south of Kvivig and, according to Simmons, *Ectocarpus velutinus* in Kvalböfjord on Syderö, but it is certainly not excluded, that these and a few other forms, hitherto only found at the southern and western half of the islands, may also be found farther north.

In this connection it should be pointed out, that the Færöes form the southern limit[1] of several species of northern distribution, as well as the northern limit of several species of southern distribution.

Among the former should be mentioned, besides the above mentioned *Halosaccion ramentaceum*, also *Ptilota pectinata, Rhodochorton penicilliforme, Rhodophyllis dichotoma*, which is, however, reported as found at Bergen in Norway, that is, almost as far southward, and a few more. Of species having their north-western limit here (the real northern limit of several of these species is on the west coast of Norway) the following should be mentioned: *Porphyra leucosticta, Callophyllis laciniata, Callocolax neglecta, Nitophyllum laceratum, Griffithsia setacea, Callithamnion granulatum, Rhodochorton seiriolanum, Lithothamnion lævigatum, Lithophyllum incrustans, Ectocarpus lucifugus, E. velutinus, Himanthalia lorea, Valonia ovalis,* and several others.

4. The Origin of the Marine Algæ-flora of the Færöes.

Kjellman (48, p. 58—77) and Reinke (68, p. 96—99) are certainly right in supposing that both the European and American

[1] Several of these species are, however, found still farther south on the east coast of America on the Atlantic Ocean.

algal flora of the North Atlantic have originated from a mixture of Atlantic and Arctic species. I shall briefly explain the main reasons for this conclusion.

There is hardly any doubt, that in tertiary times there has been a land-connection, reaching from Europe by means of the Færöes and Iceland to America. This explains the great resemblance that exists nowadays between the algal floræ on both sides of the ocean. The flora north of the land-connection differed much from that which grew south of it. The Arctic flora has gradually developed from that north of the land-connection, and as pointed out by Kjellman, it is an old flora, which has developed in the seas about the Pole and has been very rich in endemic species. But when the land-connection was broken, which probably happened in the later Tertiary period, a comingling of the species from the two formerly separated territories began and continued into the Glacial Period. During the latter, when the Polar Sea and the northern part of the Atlantic Ocean were covered by great masses of ice the algal flora was forced to go southwards, so that a flora of Arctic character probably occurred as far down as the coasts of South England and North France. On its way south, however, this Arctic flora met and became intermingled with the species of the Atlantic flora, which had been able to resist the climatic changes.

When the ice again receded after the Glacial Period, this algal flora, now composed of species from two different territories, again wandered towards the North, yet a few Arctic forms, which were able to adapt themselves to the higher temperature, remained on the coasts of England and France, whilst others withdrew to the Polar Sea proper. On the other hand, several more southerly Atlantic forms likewise followed northwards, and in such quantities, that they still occur so numerously as to stamp the character of the algal flora in places where circumstances were favourable to their growth, for instance, on the northern coast of Norway. In some such manner as this we may suppose, that the algal flora of the northern part of the Atlantic Ocean has originated. At the end of the Glacial Period its general appearance must have been much the same as it is to-day: a comingling of old Atlantic and Arctic elements.

The flora of the Færöes and with it the oceanic algal flora were probably completely destroyed during the Glacial Period. How have the Islands again recovered their flora, and in what manner especially has the immigration of the marine algæ taken place?

In reference to these questions opinion is divided into two sharply opposing camps; the one finds the explanation in a postglacial land-bridge, which makes the immigration of the flora apparently easy to understand. The other maintains, that this land-bridge is very problematic and not necessary to explain the immigration of the flora of the islands.

I shall not further discuss what has already been said concerning this question, but merely call attention to Warming's treatise on this matter[1] and to his paper (83) published (p. 660) in this work. In the latter paper Warming again takes up the discussion of this question, and on the one hand emphasizes the improbability of the existence of a postglacial land-bridge, on the other declares that the plant-immigration may have taken place by aid of the following factors: (1) birds; (2) the wind; (3) ocean currents; (4) floating ice, floating timber, etc. and finally (5) man's agency. In reference to great distances, thus also to the Færöes, Warming thinks that the birds, the ocean currents, and the floating timber, etc. are of small importance or none at all. On the other hand he assigns great importance to the influence of the wind and the agency of man.

Shortly after this, in the spring of 1904, I published in Danish my treatise on the marine alga-vegetation of the Færöes (10), in which I likewise tried to explain the occurrence of the marine algæ on the coasts of the Færöes by means of factors at work to this day, without having recourse to the theory of the postglacial land-bridge. This hypothesis was, as already mentioned in the introduction, attacked by Porsild and Simmons, who both adopt Ostenfeld's view (64) and assume, that there has been a postglacial land-bridge by means of which the flora immigrated to the islands. They maintain moreover, that as natural conditions are now, the algal flora could not possibly traverse the sea; Porsild for example thinks it a »physical impossibility«, that the algæ should be able to cross the Gulf Stream.

I have already replied (11) to this attack, quoting amongst other arguments, several hydrographers e. g. Komm. Holm, Doc. M. Knudsen, Prof. Mohn, Prof. Fr. Nansen, Kapt. Ryder, and Admiral Wandel, well-acquainted with the course of the currents in the North Atlantic, to prove that there is nothing to prevent floating ar-

[1] Warming, Eug., Om Grønlands Vegetation (Meddelelser om Grønland, København, 1888).

ticles from being transported to the Færöes from all sides under favourable winds.

I have likewise quoted what has been published since Warming's paper against the theory of a postglacial land-bridge by A. C. Johansen[1], Helgi Pjetursson[2] and also a discussion by Fridtjof Nansen who refers especially to his own works[3]. But the most important article concerning this matter is of recent date and due to Prof. Th. Thoroddsen.

In a paper published in February 1905[4] he sets forth arguments against a postglacial land-bridge from a geological point of view. At my request, Prof. Thoroddsen has very kindly given me a short resumé of his paper, which I give here:

»A land-bridge of basalt existed across the Atlantic from Scotland to the Færöes, Iceland and Greenland at the beginning of the Miocene period, but the tectonic features of Iceland, the displacements of the basalt-sheets and the relation of the beds of »Surtarbrand« to the lines of faults show, that the country was not much larger at the end of the Miocene period than it is now. The land-bridge had sunk into the sea. During the Pliocene period Iceland's systems of valleys and rivers were formed in the basaltic regions. These systems conformed closely to the present form of the country. Thereafter doleritic, later striated lava-streams flowed down into the valleys, and at the time these doleritic lava-beds were laid down, the basaltic regions had pretty much the same essential contours as at present. The doleritic, striated lava-streams are either preglacial or glacial, that is, they date from an earlier period than that during which the land was last covered by ice. The pliocene valleys and fjords are continued by deep channels out to the edge of the submarine plateau, and at east Iceland even on to the submarine ridge. These channels are no doubt older than the last ice period in Iceland and younger than the submarine ridge. The Red-Crag-beds in North-Iceland show also, that there was no connection between Iceland and Greenland

[1] A. C. Johansen: »Om den fossile kvartære Molluskfauna i Danmark og dens Relationer til Forandringer i Klimaet«, Kobenhavn 1904, p. 42.

[2] Helgi Pjetursson: »Om nogle glaciale og interglaciale Vulkaner paa Island«, (Oversigt over d. kgl. danske Videnskabernes Selskabs Forhandlinger 1904, n:o 4), p. 266.

[3] Fr. Nansen: The Oceanography of the North Polar Basin (The Norwegian N. P. Expedition, vol. III, Nr. 9 pp. 419—420). Fr. Nansen: »The bathymetrical features of the North Polar Seas with discussions of the continental shelves and previous oscillations of the shore line (Ibid. Vol. IV. 1904).

[4] Th. Thoroddsen: Hypotesen om en postglacial Landbro over Island og Færoerne set fra et geologisk Synspunkt (»Ymer«, 1904, H. 4, Stockholm).

at the end of the Pliocene period, that the sea-level was 80—100 meters above the present high water-mark and that the contours of the coast were almost the same as now. At the close of the glacial period, when almost the whole country was covered by inland ice, the level of the sea was at the coast 80—130 meters above the present high water-mark and gradually sank down to 30—40 meters, when the animal life at the coast had become the same as it is now. Raised beaches are to be seen all round the coast in every inlet. It seems to me for these reasons, that Iceland cannot possibly have been connected with other countries during a postglacial period.«

With regard to the immigration of the flora on the whole, reference may be made to Warming's above-mentioned, detailed work, and I shall now pass on to discuss the possibilities of immigration as regards the algæ, especially the marine algæ. The latter, which live in the sea, are of course widely different from the land flora, so far as the present question is concerned. In my paper on the fresh-water algæ of the Færöes (7) I have pointed out, as already mentioned, that the supposition is at least tenable, that the fresh-water algæ have been transported to the islands by birds or the wind. As to several marine algæ, especially littoral algæ, it also seems to me most probable, that birds have contributed to their distribution. It is now said, however, that migratory birds not only journey with stomachs empty but are on the whole clean (comp. Ostenfeld p. 116); yet small crusts of mud and similar substances have frequently been found on the beaks and feet of the birds. Spores and resting cells can very well be hidden in these crusts (comp. Winge's observations in Warming's paper (83, p. 676)).

The birds which might be supposed to carry the algæ, for instance, from Shetland to the Færöes need not, however, be migratory birds only. The distance between these two groups of islands is only about 300 kilometres, and numerous birds journey everywhere across the sea between them. When fogs and tempests suddenly arise, the birds may very easily be blown off from one coast to another, and it is even very probable, that some of the many sea birds, perhaps particularly the wading birds which live on the coasts of Shetland and the Færöes sometimes visit the one coast, sometimes the other. Even halfway between the islands large flocks of gulls, fulmars and gannets may be met with, and it cannot be supposed that these birds always return to the same coast.

In order to have an opinion from a competent authority on

this matter I applied to Mr. Winge, Vice-Inspector at the Zoological Museum, who has very kindly supplied me with the following report: »Small crusts of mud, clay, etc., may be found on the beaks and feet of the birds[1], that are killed at the Danish light-ships during migration and I consider such birds as *Charadrius pluvialis*, *Hæmatopus ostreologus*, *Numenius phæopus*, *N. arquatus* which are frequent both on the shore and inland, particularly fitted for carrying about spores of algæ etc. They fly excellently; they may be able to travel the distance from Shetland to the Færöes in about four hours when the weather is favourable[2]; and they wander

[1] Mr. Winge has afterwards sent me the feet of two larks which had fallen down on the light-ship of Gedser in the autumn of 1904. I scraped 120 milligrammes of mud from these. Further a wing covert of a female blackbird, fallen at the light-house of Skagen on the second of Nov. 1904, on which two things had stuck, one of them a *Betula*-fruit, which must probably have been carried from Norway.

On March 3rd, 1905, I at length received a sample of earth from Inspector Winge, with the following information: »Earth and fragments of plants from the feet of a lapwing, fallen on the light-ship of Horns Reef, March 5th, 1905. The earth most likely is from England or Holland.« When I received the sample its weight was 360 mgr. Shortly after, I placed it in a Petri-glass under a hand-glass on filter-paper moistened with well-boiled water. During the summer, some algæ were developed, and Professor Wille, to whom I sent the sample, has kindly stated them to be the following species:

Nostoc sp. (most likely *N. Linckiæ* (Roth) Born.).
Anabæna sp. (most likely *A. variabilis* Kütz).
Ulothrix sp. (belonging to the *flaccida*-group).
Cystococcus humicola Nægl.
Navicula sp.
Moss-protonema (large and well developed) and hyphae of fungi.

As it is of the greatest importance to know whether the birds had been soiled during the transport from the light-ship to the Zoological Museum of Copenhagen, I applied to Mr. Winge for information, and he kindly reported: »From the letters of conveyance I learn that all birds sent from the light-ship of Horns Reef during the spring arrived in »boxes in paper«, that is small, tight, square, nailed wooden boxes, made on board the ship and wrapped up in cap-paper. The boxes were packed on the light-ship, lying in the North Sea about 21 Eng. miles west of the coast of Jutland, and were not opened until they had arrived in my study at the Zoological Museum. With the end of a clean knife I here knocked off the earth that stuck to the lapwing's feet, and wrapped it up in a paper which was left unopened till you opened it yourself. Mould and the like might possibly occur in the Museum but certainly nothing else.«

I likewise think, that the species which developed in the earth cannot possibly have been conveyed to the sample in my study at the Botanical Museum. Mould and the like might also have been conveyed to the sample here, but such forms were not developed at all. The species found were all earth-plants, and we can certainly take it for granted therefore that they were present in the sample, when the bird fell on the light-ship.

[2] Compare Wille: »Færoernes Ferskvandsalger« p. 18.

about a great deal, the whimbrel perhaps most of all.« Mr. Winge further states that »a great many migratory birds really go to the Færöes, not only those that are breeding there but also many on their passage north- or southward.«

It seems to me very probable, that several, especially littoral algæ have been carried across the sea by the agency of these migratory birds. How easily may not the filament of a *Rhizoclonium* or a *Bangia* stick to a bird's feathers, feet or beak. These filaments are, as is well known, so elastic and roll up so easily, that they may readily become entangled in the feathers of a bird. A small portion of an alga, e. g. *Porphyra*, *Enteromorpha*, *Monostroma*, *Ulva*, *Ulothrix*, *Urospora* or *Prasiola* may also easily stick to the beak or the foot of a bird, and thus be carried off. It is of course only smaller algæ as a rule, or species of which a fragment is sufficient to develop new individuals, that we can suppose have been carried across the sea in this way.

As to the wind, it is certainly not incredible that small fragments of algæ may be swept up and carried across large distances, as has been shown for both organic and inorganic substances (see Warming, 83, p. 678—679[1]); but I think, that no great importance can be assigned to the wind as a means of transporting marine algæ. As to the freshwater algæ it is quite different. They often live in places that dry up, from which they may easily be carried a long way with the dust as resting cells or spores.

But the factor of greatest importance in the distribution of the marine algæ is naturally the sea currents, and in the following pages we must examine which of the currents are the most important in this connection. We should naturally suppose that the greatest supply of fragments of algæ, resting cells or spores is furnished by the countries which are nearest to the Færöes; namely 1) the coasts of Ireland and Scotland, 2) the west coast of Norway and 3) Iceland. Each of these countries may be examined from this point of view.

The coasts from which first of all the immigration would be expected, are those of Ireland and Scotland, as they are the nearest to the Færöes.

It cannot, however, be denied that the first view of a map of the currents of the Northern Atlantic is somewhat disappointing, if information is expected regarding the currents of these regions, as

[1]) Cp. also: Warming, Eug., Den danske Planteverdens Historie efter Istiden. Kjøbenhavn 1904.

they do not seem to flow in any direction favourable to the immigration. As pointed out by Ostenfeld (64, p. 115) a broad arm of the Gulf Stream flows south east round the islands and seems to prevent all immigration from Europe. As it comes from the open Atlantic and has not touched any country after the West Indies and tropical North America, it can, as Ostenfeld says, only carry tropical fruits and seeds[1]. These circumstances are seemingly unfavourable, and Ostenfeld also declares, that in his opinion the current can never carry species that will thrive in the Færöes.

This is however scarcely quite right; even if the circumstances are far from favourable, it seems to me it cannot be denied that marine algæ, which will thrive at the Færöes, can be carried there by currents. If we look at one of the latest of the current maps of the northern part of the Atlantic, as for instance Ryder's (73, table 11) which represents the seas between Norway, Scotland and Greenland, and of which fig. 162 represents a photographic reproduction, it must be acknowledged, that as to the parts of the British Isles which are nearest to the Færöes, the direction of the current is anything but favourable, as it flows from the Færöes in an almost straight line towards the Shetland Isles. Circumstances are however totally different as to the west coast of Ireland.

In order to understand this, an ordinary, theoretical map of the currents is not sufficient; one must study a detailed chart, for instance, the excellent »Monatskarte für den Nordatlantichen Ozean« prepared by the »Deutsche Seewarte«, on which are indicated all the directions of the currents observed during one month[2]. Also in a paper on Rockall (Notes on Rockall Island and Bank etc. Transactions of the Royal Irish Academy, vol. 31, Dublin 1896—1901) the observed directions of the currents (all possible directions!) and

[1] Such fruits and seeds are frequently washed ashore on the Færöes. Lyngbye even mentions this in »Tentamen Hydrophytologiæ« p. 60. I myself have also found and received from inhabitants of the Færöes fruits and seeds of *Cocos, Entada gigalobium* and *Guilandina*, all well known from the beach woods of the West Indies.

[2] In order to prevent any misunderstanding, I may give a report of what Commodore G. Holm, the director of the chart-archives, has kindly communicated to me, concerning the meaning of the arrows (compare figs. 163—4). »The arrows indicate the observed directions of the currents. They are most likely compiled from the journals of ships, and are the mean of the directions caused by a current. Most likely these directions are immediately due to the wind, but in this they do not differ from other currents, for most currents are originally produced by the agency of the wind. The arrows must indicate surface currents extending down more than several feet, several fathoms at least.

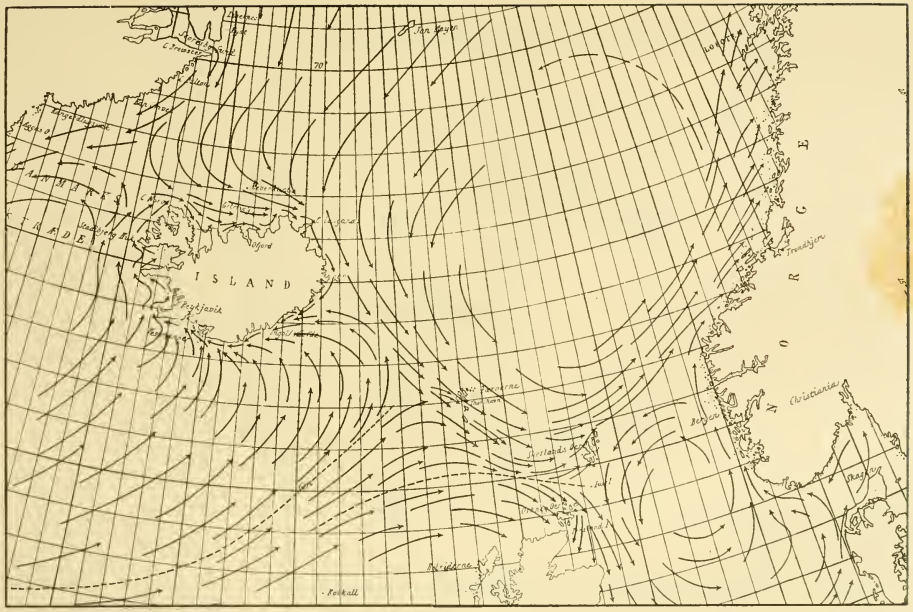


Fig. 162. Reduced, photographic reproduction of Ryder's chart of the North Atlantic Ocean.

their rapidity (sometimes almost nil, sometimes rapid) may be seen in the two charts (Pl. XIII and XIV) accompanying the paper.

Thus it is evident, that even far out in the Gulf Stream, where the current might be expected to flow to a certain degree regularly, it may go, so to speak, in all directions. This is of course due to the fact, that the Gulf Stream flows very smoothly here, so that strong winds may give rise to currents in all directions, even across

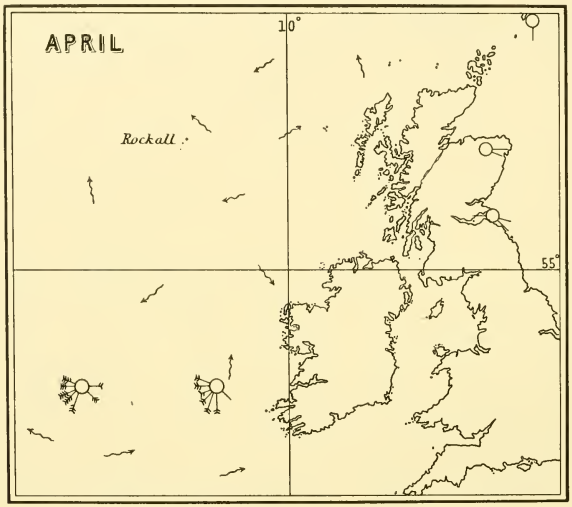


Fig. 163. Chart showing the observed directions of currents in April 1903. (From Deutsche Seewartes Monatskarte.)

it. In the accompanying figs. 163 and 164 I have given portions of two charts from the year 1903; the arrows indicating the observed directions of the currents.

Even if it is far from usual, it cannot, however, be denied, that algæ, floating timber, etc. may be carried as far as the Færöes by strong winds from the East or the South, which are very frequent, at any rate in the spring, and by the above-mentioned changes in the direction of the currents. They may even be carried as far as Iceland, which happened to the bottle No. 12 thrown overboard north-west of Rockall by the »Thorvaldsen« (see Ryder l. c. p. XLII). Another bottle, No. 11, which was thrown overboard by the »Skálholt« was washed ashore on the Færöes. The latter bottle (see also »Ceres« bottle No. 6) proves

the irregularity of the setting of the current. The same can be said, for instance, of the bottles No. 32, 33 and 26 of the »Tejo« 1899. These bottles were thrown overboard to the south of Iceland; under ordinary circumstances they would have been carried westwards, but on account of the heavy winds from the west they were hurried eastwards to the west coast of Norway. How very irregular the direction of otherwise constant currents can be on the whole

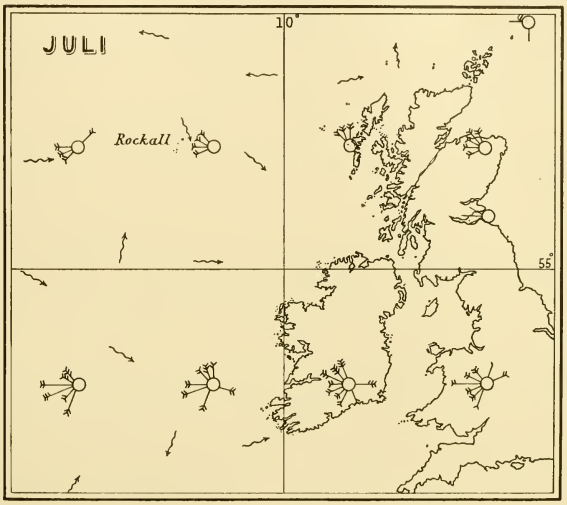


Fig. 164. Chart showing the observed directions of currents in July 1903.
(From Deutsche Seewartes Monatskarte.)

(comp. Boguslawski and Krümmel: Handbuch der Ozeanographie, vol. II, for instance p. 374—375) is also proved by the fact, that the current of the North Sea went in an opposite direction from the usual in December 1896 and January 1897[1].

I cannot but believe therefore that floating algæ, floating timber to which algæ are attached, etc. can be carried to the Færöes sometimes when the wind is favourable, probably not only from the coasts of Ireland, but also from the Hebrides and the west coasts of Scotland.

But it is not only from these parts of the British Islands that

[1] Fulton, T. W. The Currents of the North Sea, and their Relation to Fisheries. (Fifteenth Annual Report of the Fishery Board for Scotland for the year 1896, Edinburgh. 1897.)

things may be carried to the Færöes, but also from the west coast of Norway. According to Ryder we must suppose that there is a large circulation north of the Færöes between Iceland and Norway. This circulation is formed by the East Icelandic Polar Current to the west and the current along the coast of Norway to the east. Ryder thinks, that the northern part of the circulation is formed by a current which goes from the northern part of Norway at about Lofoten in a north-westerly and westerly direction towards Jan Mayen, and then southward along the east coast of Iceland (the East-Icelandic Polar Current), and finally south westwards to the Færöes. From here the current again runs in a north-easterly direction to the west coast of Norway, after having touched the Shetland Isles. It is also very probable, that the great distance which the algæ have to float, if they are carried round the whole circle, can be much shortened, when the winds are favourable. If we look at Ryder's map of bottles thrown overboard from the »Antarctic«, we find, that a bottle (No. 15) thrown out at about 250 miles N. E. of Langanes is believed by Ryder to have been carried first in a south-westerly, then in a south-easterly direction, in a large curve close past the Færöes, and to have been washed ashore on the north coast of Norway.

If algæ can now be carried from the west coast of Norway out into the North Sea, some of them may have a chance of being carried to the Færöes. Fortunately Prof. H. H. Gran has kindly communicated to me an observation made by him during his expedition in the North Sea (from May to June 1904). He writes that he found floating seaweed with epiphytes all over the North Sea. He has sent me extracts from his journal regarding some of the places between 67° 44′—62° 57′ N. Lat. and 11° 10′ W. L.—6° 22′ E. L., that is to say, midway between Iceland and Norway, and on both sides of the route which Ryder supposes the above mentioned bottle to have taken. There can hardly be any doubt, that such algæ floating far out in the North Sea can be carried to the Færöes, if the wind is favourable.

As to the third possibility for the immigration of algæ, namely from Iceland, the currents are even highly favourable. As will be seen on Ryder's map, the current from East Iceland goes straight down to the Færöes, and algæ can thus easily be carried from East Iceland to the Færöes. But as the hydrographic conditions differ greatly on this part of the coast of Iceland from those at the Fær-

öes, the immigration of algæ from there is probably of but small importance. It is probable, however, that the Færöese species of a more northern distribution e. g. *Halosaccion ramentaceum* and *Ptilota pectinata*, which are distributed more specially in the northernmost part of the islands have been carried this way to the Færöes.

It is my opinion therefore that 1) circumstances are somewhat favourable to marine algæ being carried across and over the sea to the Færöes from the west and north coasts of Ireland, from the west coast of Scotland, from the Hebrides, etc., 2) that algæ can possibly be carried from the west coast of Norway, and 3) that algæ can very well be introduced from East Iceland (probably also from other parts of this island).

Having thus discussed the possibility, that objects floating in the sea can be carried to the Færöes from the coasts of the adjacent countries, when circumstances are favourable, we may enquire into what enables the algæ to float for a long time in the sea. One reason is, that they are in themselves able to float for a long while; another, that they are attached to floating timber, etc.

As to the first reason, there are not a few algæ, especially littoral algæ, with air-bladders or with a thallus partly inflated with air[1], which keep them on the surface of the water for some length of time. Almost everywhere in the sea one can meet with floating seaweed (comp. the above-mentioned observation made by Gran) often far from their habitats. Kjellman says (48, p. 73), that he has found *Ascophyllum nodosum* and *Fucus vesiculosus* floating in the sea at different latitudes between Norway and Spitzbergen; and on the south coast of Spitzbergen he has collected *Ascophyllum* with numerous *Polysiphonia fastigiata*. He has not found these algæ fixed to any substratum, but others have stated that they grow there; at any rate they must have been carried there by the Gulf Stream. It

[1] Of the algæ from the Færöes there are in the first place nine brown algæ which are either always or at any rate more or less frequently supplied with air-bladders: *Ascophyllum nodosum, Fucus vesiculosus, F. inflatus, F. spiralis, Himanthalia lorea, Halidrys siliquosa, Laminaria færoensis, Scytosiphon lomentarius* and *Chorda filum*. Moreover, there are the species of *Enteromorpha* and perhaps a few more brown and red algæ. Here the *Zostera* must also be mentioned; it is well known that its thallus floats excellently. These species, which are almost all rich as to numbers, float easily, and on these different algæ and *Zostera* there often, indeed almost always, grow a great many different epiphytes and endophytes, which are likewise carried about in the sea.

is such a well-known fact, and it has so often been proved, that sea-algæ are capable of floating far out to sea, that further discussion of the matter is scarcely needed[1]; nevertheless I may illustrate this by some examples.

A great many algæ are washed ashore on the sandy and therefore in many places barren west coast of Jutland. Dr. L. Kolderup Rosenvinge has recently stated at the »Botaniske Forening«, that about 40 species have hitherto been washed ashore there; several of these species do not grow on the west coast of Jutland, some of them not in all Denmark. Among these algæ some perfectly well-preserved, fruit-bearing specimens are found, e. g. of *Himanthalia lorea*, which must be supposed to have been carried probably from the English coast.

I do not know for certain, whether there are algæ which are not air-inflated and yet able to drift or perhaps only hang suspended in the water for some length of time; but I am inclined to believe that such algæ do exist, some however sink down quickly, some even very quickly e. g. *Fucus serratus*. It seems, however, very probable, that several filiform and much ramified algæ must be able to float for a long time in the sea. Dr. Johs. Schmidt for instance informs me, that he has met with species of *Ectocarpus* and other higher forms of algæ floating near the surface of the sea east of Iceland. In this connection I may also mention, that Hesselman (Bot. Notiser, 1897) found, in addition to some larger algæ *(Chorda filum, Fucus vesiculosus* and *Enteromorpha intestinalis)* also some smaller forms, which unfortunately are not named, in Nortälge skärgård amongst drift. And in »Botanische Untersuchungen der Pommerania-Expedition« vom 3. bis 24. August 1871, p. 77, Magnus declares that at a distance of 4 miles from the east coast of Gotland

[1] I may further mention a few examples: *Gelidium cartilagineum* from the southern part of the Atlantic has been washed ashore on the coast of Scotland), it is therefore also mentioned in early botanical works e. g. Edmonston: Flora of Shetland), and on the coast of Norway, where it was found for instance by *Gunnerus* (comp. Sernander: Den skandinaviske vegetationens spridningsbiologi, Upsala 1901, p. 120). The American *Laminaria longicruris* has an inflated stalk, by aid of which it can be carried a long distance; it has been found for instance on the west coast of Jutland, at Bohuslän and Finmark (comp. Sernander l. c.). Still it is not excluded, that some of these inflated stipes of *Laminaria*, if not all, which have been found, came from the Færöes or Iceland, as *Laminaria færoensis* which grows there has similar inflated stipes, though without mucous canals. Possibly it might, however, be the American species which has been carried across the Atlantic. If that is so, the immigration of algæ from America to the Færöes is certainly not excluded.

he has met with *Rhodomela subfusca*, *Ceramium diaphanum*, *Sphacelaria cirrhosa* and other algæ floating about in the sea.

But even if the algæ cannot of themselves float about in the sea for a long time, they can nevertheless be carried about by adhering to floating timber or other objects floating on the surface of the sea.

Between Shetland and the Færöes I have several times seen floating timber completely covered by a dense vegetation of algæ. In Nolsöfjord near Thorshavn, I once saw a large beam quite overgrown by algæ. Amongst these were a great many well-developed *Alaria esculenta*, carrying numerous *Litosiphon Laminariæ* on their lamina, several species of *Ectocarpus*, small forms of *Enteromorpha*, Diatoms, etc. Another time I found a piece of cork with a dense, velvet-like vegetation, consisting of *Callithamnion scopulorum*. Finally, algæ destitute of air-bladders can be carried a long distance by the sea-currents, either by growing on species provided with bladders or only entangled among such algæ.

To the factors contributing to the distribution of the algæ one must be added which is certainly of no small importance nowadays, that is: man's agency. There can hardly be any doubt, that a great many species of algæ are carried far by the aid of navigation. It is a well-known fact that ships which lie near to land very quickly become green below the water-line. The reason is, that the part of the ship which is under the surface of the sea is covered after a short time by a great many animals and plants, which thrive excellently on account of the movement of the ship, and the ensuing constant renewal of water. On a ship one can meet with a vigorous algæ-vegetation, rich in different species[1].

[1] The following species were for instance collected by me on the 13th of June 1900 from the »Guldborgsund«, which had been scraped and scrubbed on the 15th of May of the same year, according to the journal of the ship. The species were: large, vigorous *Alaria esculenta*, several specimens more than one foot long; they preferred the most »exposed» parts of the ship, some specimens for instance grow on the screw, where however the lamina were somewhat torn and split. Of *Laminaria*, there were *Laminaria saccharina* and *L. digitata*, ca. half a foot long. Further fairly large specimens of *Porphyra miniata*, smaller specimens of *Chordaria flagelliformis*. Of green algæ there were *Monostroma fuscum*, small *Enteromorpha* and a great many quite small specimens of different species, Diatoms, etc. which I did not get an opportunity of examining. This comparatively luxuriant vegetation had thus been produced during about one month. It must of course not be left out of consideration, that if the bottom of a ship is ever so thoroughly cleaned, it will never become perfectly clean, unless it is taken into dock. In the above mentioned case, however, one may take it for granted, that only small specimens or fragments of algæ had been left. As to the transport of algæ by ships see also Kjellman (48, pag. 59).

When we see, that a ship can become overgrown to such a degree during so short a time, as is shown by the case mentioned in the foot-note, the algæ must often have a chance of being transported by ship and thus of being carried to other countries, where they can fix themselves, but of course only where there are suitable conditions of life[1].

If we may now assume that the algæ can float far across the seas, another question presents itself, viz. if they can also stand the changes of temperature and salinity which a long passage involves.

As to the first, it may at once be said, that the changes of temperature and salinity in the seas we speak of are relatively small, and we may therefore also suppose that as a rule they have hardly any injurious influence on the algæ. It must not be forgotten, that the changing of temperature proceeds very slowly during the passage, and that the algæ are very well fitted to these changes within certain limits[2]. On the other hand, the algæ are usually very sensible to sudden changes of temperature and salinity, as previously mentioned by me, still by no means so very sensible as was formerly assumed. In a paper (Notizen über die Cultur und Lebensbedingungen der Meeresalgen, Flora 1895) Oltmanns has already pointed out that freshly gathered marine algæ were much better fitted to resist changes of salinity, than algæ which

[1] That this supposition is right is confirmed by the fact, that we frequently meet with algæ, belonging to very remote territories, on harbour moles, just as is the case with the inland flora found in harbours and on wharfs. In »Bulletin de la soc. bot. de France« vol. 35, 1888, p. 364, Bornet for instance mentions 3 *Laminariaceæ* which have been met with a few times in and near harbours of the Mediterranean, but which were otherwise never found there. The *Fucus inflatus* which I found on Lerwick mole (8) and the two isolated habitats of *Fucus serratus* found in Iceland (Jónsson, 41) can probably also serve as examples.

Finally, Dr. Bornet has kindly informed me by letter of some interesting discoveries. *Chorda filum* has been found at the entrance to the harbour of Nice; the species was never observed at other places in the Mediterranean. *Helminthocladia purpurea* was found at the harbour of La Nouvelle, likewise in no other place in the Mediterranean. *Bonnemaisonia hamifera* which is distributed on the coasts of Japan and California has been found on the coasts of England and later also of France (Cherbourg). The plant is dioecious, and only the female plant has been imported; it propagates by aid of buds which are found at the top of the branches like hooks. *Hypnea musciformis* has been found in the Channel; its true habitat is more towards the south.

[2] Cp. for instance: Porter, H. C., Abhängigkeit der Breitling- und Unterwarnow-Flora vom Wechsel des Salzgehaltes. (Arch. Ver. Nat. Meckl., 1894).

had been cultivated for a long time. And in a paper (Verhalten einiger mariner Algen bei Änderung des Salzgehaltes. Oesterr. bot. Zeitschrift, 1904) Karl Techet in his »Übersicht« comes to the following conclusion: »Die individuelle Anpassungsfähigkeit — um diese handelte es sich bei den angeführten Versuchen — an Änderungen des Salzgehaltes ist bei marinen Algen eine ziemlich weitgehende und zwar sowohl bei spontaner Erhöhung als spontaner Verminderung der Salzintensität.«

With regard to change of salinity, I may also call attention to the different observations mentioned in my description of the vegetation. I have met with algæ, even *Florideæ*, growing at the mouths of rivers, where they were completely covered by fresh water at low tide, and by salt water at high tide[1]. These are sudden changes.

With regard to the temperature, the algæ seem specifically unfit for resisting changes from cold to warm water. They can probably stand the reverse change much better, within certain limits of course[2].

Algæ carried about by a ship are naturally much more exposed to the danger of sudden changes in the temperature and salinity, and if such changes occur the algæ simply perish[3]. But for short distances, as for instance between the Shetland Isles and the Færöes, the difference is too small to hurt the algæ.

It is very probable, that the white light on the surface may hurt some of the algæ, which usually grow deepest down, when they happen to be carried near the surface of the sea, but we know nothing for certain. We may however suppose, that they are sometimes protected against the white light; for instance by growing on the under side of wrecks or by being entangled between larger algæ. The motion of the waves also perhaps serves to protect them in some way, as it constantly makes them turn another side to the light. We may also suppose that sublittoral algæ which have become attached as spores to floating timber, etc. are perhaps better

[1] See also Gomont, Sur la végétation de quelques sources d'eau douce sousmarines. (Bull. soc. bot. Fr., t. 51, 1904).

[2] Cf. Kjellman, Norra Ishafvets Algflora, p. 73.

[3] I may briefly illustrate this by an example. In the summer of 1899. the »Guldborgsund« was more than usually foul, and was therefore ordered to go in dock at Copenhagen. But when it arrived there, the bottom of the ship was perfectly clean, all the algæ had perished and dropped from the ship, as soon as it had entered the warm and less salt water of the »Sound«.

fitted to stand a strong light, than an alga which is suddenly torn from its habitat in deep water.

But even if the alga is destroyed by unfavourable biological conditions, the reproductive cells (tetraspores, carpospores etc.) which it possibly carries may be able to survive the transport.

If an alga has finally surmounted these various difficulties and been washed ashore, it is still far from being settled among the flora of the island. In order to become so, it must be able to fix itself. A great many algæ are certainly able to do so; I may just mention such species as *Ceramium, Polysiphonia, Callithamnion, Ectocarpus, Sphacelaria, Cladophora, Acrosiphonia* etc.

There is hardly any doubt, that all species belonging to these very rich genera are normally supplied with rhizoids, or at any rate are very apt to form them. If therefore one of these algæ when it is washed ashore, sticks to something or other, for instance to an alga growing there, it will perhaps only be a short time before it forms rhizoids, which can fasten the plant to its subtratum. Even very small fragments of several algæ seem to be able to produce new individuals. Thus Oltmanns mentions (l. c.), that he has cut shoots of *Polysiphonia* and *Ceramium* into very small pieces which quickly formed rhizoids and gradually developed into small plants. In different papers Tobler[1] also tells us that even one cell of some *Rhodomelaceæ* can develop into new individuals. By cultivating a *Dasya elegans* he observed, that the alga divided after a short time into many small pieces, which gradually developed into small plants in the culture-glass. He therefore supposes that the algæ must sometimes have a similar reproductive power in the sea.

On the other hand there certainly are many algæ which cannot take root again, when they have once been torn from their subtratum. That it may be possible for such algæ to immigrate into another region, they must necessarily carry reproductive cells within them. When an alga with more or less ripe tetraspores, carpospores, etc. is torn from its habitat, nothing prevents us from supposing, that after having floated for a shorter or longer time it can succeed in carrying the spores to another habitat. In the new region the spores can thrive, if the external conditions are suitable to the species.

[1] Tobler, F., Zerfall und Reproduktionsvermögen des Thallus einer Rhodomelacee. (Berichte d. deut. bot. Ges. Bd. 20, 1902.)

— — Ueber Eigenwachsthum der Zelle und Pflanzenform. Versuche und Studien an Meeresalgen. (Pringsh. Jahrb. Bd. 39, 1904.)

After having thus taken into consideration what serves to support the theory of the transport of algæ across the sea, we must, however, admit that on the whole we know very little with certainty about the matter — and so far, our conclusions must necessarily be hypothetical. Taking everything into consideration, however, it seems probable to me, and at least not incompatible with the real conditions, that perhaps all the algæ of the Færöes have been transported across the sea by the agency of the currents. They can either have floated by themselves or have been fixed to various objects floating in the sea. The agency of birds must perhaps also be taken into account. Floating ice has also perhaps contributed to the distribution of the algæ towards the end of the glacial period and shortly after. Nowadays the floating ice is of no importance to the Færöes.

There is one further evidence, which indirectly but strongly confirms the hypothesis concerning the immigration by sea — viz. the fact, that hardly any island has not got its algæ-vegetation, even those at the greatest distance from the coast and of volcanic origin or built by corals. Jan Mayen serves to prove this by its algal vegetation, which is certainly very poor, so far as we yet know, but still has species not only from shallow, but also from deep water.

It is naturally more difficult for algæ to pass across the sea than to travel along a coast. This serves to explain the fact, that several species common on the coasts of the adjacent countries, are wanting on the coasts of the Færöes, it likewise seems to me to very clearly refute the hypothesis of a postglacial land-bridge. *Fucus serratus* for instance is totally wanting on the coasts of the Færöes, and this is the more worth mentioning, because this alga is very common along all the coasts of North Europe. On the Shetland Isles for example, which are nearest to the Færöes, it grows abundantly. That this species has not spread so far as to the Færöes is certainly solely due to its want of air-bladders, which prevents it from floating by itself on the surface of the sea. The species of *Fucus* found in the Færöes are on the other hand always or at least sometimes provided with air-bladders and are thus able to float. It cannot surely be denied, that the Færöes offer an excellent locality for *Fucus serratus*, if it should succeed in reaching so far. It is therefore probable, that it would have grown

there abundantly, if a postglacial land-bridge had existed, by aid of which it might easily have made the passage.

Several sublittoral algæ e. g. *Chætopteris plumosa*, *Phyllophora rubens*, *Dilsea edulis*, *Brongniartella byssoides*, etc. are also wanting at the Færöes, though they are more or less frequent in the surrounding seas.

When everything is taken into account, the algæ-flora from the deeper sea has perhaps had the greatest difficulty in reaching the islands. This perhaps explains, why some sublittoral algæ which might reasonably be expected to grow at the Færöes are not found there. The sublittoral algæ which grow deep down are probably the least fitted for floating a long time, and as to their adhering to algæ from the littoral region or to floating timber as a means of transport, this likewise seems to occur only rarely. On the other hand we know but little about the first stages of development of many of these algæ. We especially want to know whether the different reproductive organs are able to float for a long time in the sea apart from the mother-plant. They may possibly be carried far about as plankton[1]. Finally if the algæ spores cannot float far either by themselves or by the agency of the sea currents, it is however probable, that they can stick to the mucilage of larger algæ, or to the mucus of fishes, and thus be carried off.

It is hardly probable, that any of the sublittoral algæ have been able to survive the glacial period, according to Geikie[2]. He

[1] In connection with this it may be pointed out, that the late Prof. Cleve, the well-known Swedish plankton-investigator, thinks it probable that algæ-spores can be carried about by the agency of marine currents. He has even expressed the opinion, that the stunted forms of algæ from the Polar Sea met with in the Baltic can have been carried there together with Arctic plankton (see Botaniska Notiser, 1898, p. 269). If it is so, the short distance from the English coast to the Færöes is nothing by comparison. It should however be observed that these forms of algæ in the Baltic must rather be considered as »relicts« as pointed out by Svedelius (Studier öfver Östersjöns Hafsalgflora, p. 68—69).

A remark by Oltmanns should also be mentioned here. In a paper »Notizen über die Cultur- und Lebensbedingungen der Meeresalgen« (Flora 1895), after having emphasized the necessity or at least the desirability of having sterilised sea water for culture-experiments, he writes: »Die Steriliserung ist aber auch besonders dann unerlässig, wenn man kleine Ectocarpeen einigermassen rein cultiviren will, weil das Seewasser fast zu jeder Jahreszeit und an jedem Ort eine recht erhebliche Anzahl von Schwärmsporen der verschiedensten Species enthält, welche alle neben den ausgesäten Formen keimen würden.« (The emphasis is mine.)

[2] Geikie, James, Prehistoric Europe. A Geological Sketch. London 1881, p. 663.

writes: »but the ice was so thick that it filled up all the fjords and sounds between the various islands of the archipelago, thus forming one compact *mer de glace* which flowed outwards in all directions from the dominant points, and discharged its icebergs into the surrounding ocean«. But as the Færöes lie so far out in the Atlantic Ocean, they cannot have been far from the open sea, and possibly there may then as nowadays have been strong currents at the coasts, and for this reason the ice may not have reached everywhere to the bottom of the sea in the sublittoral region, some of the sublittoral algæ thus being spared.

In accordance with what I have previously said about the possibilities of immigration of the fresh-water algæ (7), it seems to me that there cannot be any doubt, that the marine algæ-flora has likewise been able to immigrate to the islands across the sea from the coasts of North Europe, and by the agency of factors which are at work to this day. Thus, the possibility of immigration always exists, and a postglacial land-bridge is not at all necessary to explain the occurrence of the algæ-flora.

In perfect agreement with Warming's view regarding the land-flora, I may therefore conclude by saying that the marine algæ of the islands have also been able to immigrate after the glacial period across the sea from the nearest countries, especially from the British Islands, but also from Norway and from Iceland.

V.

SOME BIOLOGICAL OBSERVATIONS.

It is a well-known fact, that at different seasons of the year, no small difference is discernible in the appearance and luxuriance of the algal vegetation in the northern seas. This has been mentioned by Kjellman (49) with reference to Bohuslän, and other authors e. g. Gran (37, p. 15) and Rosenvinge (71) have expressed the same view for other regions of the sea. On the Færöese coasts the development and luxuriance of the algal vegetation likewise vary according to the seasons. Unfortunately, I myself have only spent some months of the spring and summer on the Færöes and have therefore only been able to make an incomplete study of the development of the vegetation throughout the year; but this want has been greatly helped out by the collection of algæ from

the autumn months of 1897, brought home by Mr. Helgi Jónsson, as well as by the information he has also given me. With these as basis we may safely conclude, that the algal vegetation of the Færöes is much richer and more luxuriant in summer than in winter; the greater development probably begins early in spring and continues into July or August, when the greatest luxuriance is reached, then it decreases again. But on account of the great uniformity of the Færöese climate, the variability of which, particularly as to temperature, is regulated in the sea itself, this varying development according to the seasons is hardly so great here as in many other places with a cold temperate climate.

The algal vegetation of the Færöes agrees well, as regards the richer development in summer, with what is known even in Arctic seas, where the period for the growth of the algæ is at the brightest time of the year, for instance, on the coasts of Greenland, whilst their resting period begins at the beginning of winter (see Rosenvinge 71, p. 239). On the other hand the algal vegetation of more southern countries is much less developed in summer. This may be remarked even on our own coasts, where the vegetation in shallow water is more luxuriant during the months of spring and autumn, but less so during the warmest summer days; and in the Mediterranean Sea the littoral algæ-vegetation is, according to Berthold (5, p. 426), very poor in summer, but rich and well developed during the months of winter and spring.

DURATION OF LIFE. PERENNIAL, ANNUAL AND SHORT-LIVED SPECIES.

As on the coasts of Greenland, the algæ growing on the Færöese coasts are for the most part certainly perennial. It is impossible for the time being, however, to make any reliable comparison between the perennial and the annual species, as our knowledge of the developmental history of a great many species is still very imperfect.

On the other hand, several species are certainly or most probably annual. To these belong: *Porphyra umbilicalis* and probably other species of *Porphyra, Chantransia (?), Erythrotrichia (?);* of brown algæ may be mentioned: *Chorda filum* and *C. tomentosa, Castagnea virescens, Scytosiphon lomentarius, Dictyosiphon Ekmani, Punctaria plantaginea, Leathesia difformis, Phyllitis fascia* and *Ph.*

zosterifolia, *Isthmoplea sphærophora*, *Himanthalia lorea*, which is, however, most likely hapaxanthic (see 8, p. 480), several species of *Ectocarpus* and others; of green algæ may be mentioned several species of *Enteromorpha*, *Monostroma Grevillei* and *M. undulatum*, (whereas *M. fuscum*, as pointed out by Rosenvinge (p. 238) can most likely live for more than one year), the species of *Ulothrix*, *Acrochæte repens*, *Bolbocoleon piliferum*, *Pringsheimia scutata*, *Urospora mirabilis* and *U. Wormskioldii*, *Codiolum*, *Cladophora sericea* and *Cl. gracilis*, *Acrosiphonia (?)* and others.

Several of these species are certainly capable of producing more than one generation in a year; as pointed out by Gran (37, p. 9), those short-lived species (e. g. *Porphyra umbilicalis*, forms of *Enteromorpha intestinalis*, species of *Ulothrix*, possibly *Monostroma Grevillei* etc.) only belong to the littoral region, the reason probably being that only algæ growing in full daylight are able to go through all stages of development in so short a time; we may likewise suppose with some reason that the rapid development of the short-lived algæ, as pointed out by Gran, is an adaptation to the often very unfavourable biological conditions under which the littoral algæ live, especially those growing at the highest level, just where the short-lived algæ are met with.

With regard to Greenland, Rosenvinge has remarked that the low temperature of the sea prolongs the lifetime of many annual algæ, and just in the same way the low summer temperature of the Færöes, together probably with the small amount of direct sunshine, has a preserving and prolonging influence on the annual algæ of spring and summer. For example, a great many species, which are only found towards the end of winter and during the months of spring in the Danish and adjacent seas, grow luxuriantly during the whole summer in the Færöes.

Thus *Porphyra umbilicalis* forms well developed associations during the whole summer, whilst, according to Kjellman, it only forms associations in winter on the coasts of Bohuslän. Vigorous specimens of *Dumontia filiformis*, which in the Danish seas grows in spring and beginning of summer, are found during the whole summer on the Færöese coasts. *Fucus inflatus* f. *disticha* is found in the summer at Haugesund according to a report from Mr. Norum; but the specimens are only badly developed at that season, though vigorous when found during the months of December to March. At the Færöes, however, it

is well developed in the summer. According to Reinke (68, p. 61)[1], *Phyllitis fascia* in Kiel Bay is an alga of the winter and spring, and only rare in summer, whilst it is luxuriant and very common during the whole summer on the coasts of the Færöes[2]. *Monostroma Grevillei* is likewise well developed at the Færöes during the greater part of the summer, whereas, according to Rosenvinge (71, p. 238), it only lives from the end of the winter to April or May in the Danish seas. According to Batters (4, p. 57) *Porphyra miniata* grows in spring and early summer on the coasts of England; at the Færöes it is found during the whole summer and far into the autumn.

Gran calls our attention to the fact (37, p. 15), that the annual, littoral algæ usually have a shorter or longer resting period, but whilst this period is at the warmest time of the year (July-August) in Kristianiafjord, it most likely occurs at the Færöese coasts only in the autumn, and probably lasts for the greater part of the winter, as these algæ do not come to life again until early in spring.

THE PERIOD AND CONDITIONS OF GROWTH AND TIME OF FRUCTIFICATION.

A great many of the perennial algæ of the Færöes are certainly capable of growth all the year round even if their vital functions are somewhat reduced during the darkest time of the year. This is most probably the case, for instance, in the *Fucaceæ* and the *Laminariaceæ*, but, on the other hand, we must suppose, that the last months of the year, as also January and perhaps February, form a resting period for several Færöese algæ, and that their proper vegetative period is the months of spring and summer. Judging from the material I have at hand, I believe that many algæ begin to develop new shoots even towards the end of winter. The material collected by Jónsson during the months of autumn mainly consists of badly developed specimens, whose apices are often dead or dropped; only a few species, e. g. *Phyllophora Brodiæi* and some specimens of *Fucus* had begun to form some few new shoots. In April, however, I found a great many species which already had large, vigorous shoots, e. g. *Odonthalia dentata, Delesseria sanguinea*

[1] See also Simmons: Algologiske Notiser II. Einige Algenfunde bei Dröbak (Bot. Notiser, 1898, p. 118).

[2] In the Danish seas it is, however, also common in the autumn; it may be found well developed even in August.

and *D. sinuosa*, *Callithamnion arbuscula*, *Furcellaria fastigiata* and many others. In the course of winter, especially towards its end, and during the first months of spring, the new lamina appears in the periodically lamina-changing species of *Laminariaceæ*, e. g. *Laminaria digitata*, *L. hyperborea* and *L. saccharina*, and the old laminæ are thrown off during the months of spring, at which time huge masses of the latter are washed ashore on the beach.

As the vegetative period for several species is much prolonged in Greenland, the same may be said though to a less extent of several species on the Færöese coasts, compared with what is the case on our Danish coasts. Besides the above-mentioned annual algæ, which live somewhat longer, as just stated, we may find, e. g. *Desmarestia aculeata* with new shoots and densely covered with assimilating hairs as late as June and July, whilst in Denmark it is often hairless already at this time of the year. *Rhodomela lycopodioides* likewise grows for the greater part of summer on the Færöese coasts, whilst *Rhodomela subfusca*, which is closely related to the latter, stops developing at the beginning of the summer on the Danish coasts. On the whole, several algæ which at a certain moment stop developing in our seas, seem to be able to throw out shoots much later in the year on the Færöese coasts; but whether their vegetative period is really prolonged or whether it is due to the fact, that this period begins later and thus likewise ends later than on the Danish coasts, I cannot say as yet. The latter seems at any rate rather probable.

As to the time of fructification, it sets in at very different periods of the year for the different species; in my paper on the Marine Algæ of the Færöes I have stated the time of fructification of each species, so far as it is known. As a general rule it may be stated, that the greater part of the Færöese algæ seem to fructify during the summer season.

Some species, however, have only been found with reproductive organs at other times of the year; e. g. *Delesseria sanguinea*, found with cystocarps and tetraspores during the last months of the year; *Halidrys siliquosa* which is sterile in summer, but which had young receptacles in October: *Furcellaria fastigiata* of which I have seen specimens with tetraspores in great quantities in November-December, whilst specimens with antheridia or cystocarps did not occur in the material, as they are most probably developed during the winter months, as on our own coasts.

Some species begin to develop their organs of fructification in

winter, and fructify the next summer. *Ascophyllum nodosum*, for instance, has young receptacles in December: it has been found with ripe receptables in April, and fructifies constantly during the summer; just the same seems to be the case with *Fucus inflatus* and *Fucus vesiculosus; Himanthalia lorea* has been found with young receptacles in April, and they become perfectly ripe in July-September.

Other species e. g. *Ectocarpus lucifugus*, *Sphacelaria cirrhosa, Elachista scutulata*, *Desmarestia aculeata* etc. have only been found with ripe sporangia during the months of autumn, others, e. g. *Ectocarpus tomentosoides* in the end of the winter and more rarely in spring; species of *Urospora, Monostroma Grevillei* etc. during the months of spring and early in summer.

Lastly, it seems as if a great many algæ are able to fructify all the year round; several of the above mentioned short-lived species, e. g. *Porphyra umbilicalis*, also *Chantransia secundata*, *Callophyllis laciniata, Euthora cristata, Delesseria sinuosa, Ectocarpus litoralis*, *Elachista fucicola*, and probably many more may serve as examples.

Just as the period of life and growth of several algæ is prolonged under the influence of the Færöese climate, the fruit-bearing period is often likewise of longer duration here than in more southern countries; this is similar to what Rosenvinge has observed in Greenland. As illustrations of this may be mentioned: *Rhodochorton Rothii* which in Denmark only fructifies during the winter months, but which has been found with tetraspores even in June and July on the Færöes; *Ascophyllum nodosum* which here in Denmark only fructifies during the winter, but which has ripe reproductive organs all the summer on the Færöes as in Greenland, and *Delesseria sinuosa* of which the same may be said.

On the whole, the fruit-bearing period seems, as regards several species, to occur at other seasons than in more southern countries, and the Færöes seem also in this to occupy an intermediate position between Greenland, where still greater differences are observed according to Rosenvinge, and more southern countries.

Before closing this treatise I would here express my grateful thanks to Professor Warming and Dr. L. Kolderup Rosenvinge, my »Opponenter« *ex officio*, who by their thorough criticism of the Danish issue of my work have greatly contributed to improve the present edition.

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ADDITIONS AND CORRECTIONS TO THE LIST OF THE PHANEROGAMAE AND PTERIDOPHYTA OF THE FÆRÖES

BY

C. H. OSTENFELD.

SINCE the publication in 1901 of my list of the flowering plants and ferns found in the Færöes[1] several investigators have contributed to the flora. The result is not a few additions to the list together with new localities of already known species. Further, a reexamination of the material of several critical species has caused alterations in my views of their value, and besides that some specialists have examined Færoese specimens of several genera, e. g. Mr. H. Dahlstedt the genus *Taraxacum* and Mr. W. Becker (of Hedersleben) the genus *Viola*. For all these reasons I feel it necessary to publish a corrected list of the vascular plants, containing the additions and corrections to the former list. For convenience I follow the same arrangement of the plants as in the main list, i. e. the alphabetical arrangement of the species within a genus, of the genera within a family (order), and of the families within the large groups: *Sympetalae*, *Choripetalae*, *Monocotyledones*. *Gymnospermae* and *Pteridophyta*. With regard to the nomenclature I have used the same names as in the main list, with very few exceptions. I do not find it convenient to have different names to the same plant in the different parts of one work, so the changes are extremely few. I have in the following list repeated all the species names, consequently also the names of plants to which I have nothing to add or correct. The list will therefore contain the names of all the flowering plants and ferns hitherto found in the Færöes.

I have to mention the main contributors to this list. An American lady Miss Elisabeth Taylor has for several years lived

[1] See Vol. I pp. 41—99.

in the Færöes; she has collected many plants in the different islands, especially in the Nordreöer. A member of the teaching staff of the Highschool at Fagralid on Bordö, Mr. R. Rasmussen is an eager and successful botanical explorer; he has investigated some parts of Bordö, Kunö and Kalsö very thoroughly. Further I may mention one inhabitant more, Mr. Gazet Patursson, who has found many interesting plants especially in the southern part of Strömö.

In 1903 I visited the islands again and studied the vegetation in the neighbourhood of Thorshavn (Strömö), but the floristic result was very poor, because this place is most often visited.

In the literature after 1900 I have found only one book, in which there are remarks on the Faeroese flora, viz. W. Bisiker: Across Iceland, With illustrations and maps and an appendix by A. W. Hill on the plants collected. London (E. Arnold), 1902. The Appendix II (pp. 226—231) to this book is »a list of plants collected in the Faroes and Iceland in June and July 1900«. The places in the Færöes visited by the authors are Trangisvaag (Syderö), Thorshavn (Strömö) and Klaksvig (Bordö), just the ordinary stopping-places on the way to Iceland, and all visited and investigated by many botanists before. The list gives most of the plant-names without indication of which of the three places is the locality, only »Faroes« is added to the name, and it contains both Icelandic and Færoese species together. All this makes it probable, that the records of *Draba verna, Viola ericetorum (= V. canina), Dryas octopetala, Geum rivale* and *Galium uliginosum* are incorrect, as none of these species have been found before in any of the three visited places, and *Draba verna* and *Viola canina* are not elsewhere recorded from the Færöes. All these species are not rare in Iceland. I therefore consider the records as incorrect and do not take them up in my list.

It remains only to refer to the paper by Mr. H. Dahlstedt on the Færoese *Hieracia*[1]. He describes herein all the species found in the Færöes as new. A good many of them I refound in 1903 and was able to determine correctly, as shown by a later revision of my material by Mr. Dahlstedt.

I take here the opportunity of thanking Miss Elisabeth Taylor, Mr. G. Patursson and Mr. R. Rasmussen for their valuable contributions to the flora, and Mr. H. Dahlstedt and Mr. W. Becker for assistance with regard to the *Taraxaca, Hieracia* and *Violæ*. I also wish to give my best thanks to Mr. W. H. Beeby for his kind

[1] See Vol. II, pp. 625—659, pl. XI—XII.

help in correcting the English in this paper and for his friendly leaving at my disposal his large collection of Shetland plants.

The abbreviations used are explained in the following manner:
Str. = Strömö. Öst. = Österö.
Syd. = Syderö. Vid. = Viderö.
G. P. = Gazet Patursson. R. R. = R. Rasmussen.
E. T. = Miss Elisabeth Taylor.

! found by myself.

I have examined all the specimens recorded in the list, unless there is added »according to«.

The species of the following list to which a number is prefixed are truly wild-growing or quite naturalized, while a † means that the species is introduced lately and at present not completely naturalized.

I. Dicotyledones.

A. Sympetalae.

Fam. I. BORRAGINACEAE.

† **Anchusa arvensis** (L.) M. Bieb.

1. **Mertensia maritima** (L.) D. C.
2. **Myosotis arvensis** (L.) Roth.
3. **M. palustris** (L.) Roth., var. *strigulosa* Rehb.

The specimens collected by H. G. Simmons at Ejde (Öst.) in 1895 ($^{19}/_{8}$) bear ripe fruits.

4. **M. repens** Don.
5. **M. versicolor** (Pers.) Sm.

Fam. II. CAMPANULACEAE.

6. **Campanula rotundifolia** L.

Str.: Vestmanhavn (according to G. P.).

Fam. III. COMPOSITAE.

7. **Achillea millefolium** L.
8. **A. ptarmica** L.
9. **Bellis perennis** L.

† **Chrysanthemum leucanthemum** L.

Str.: sparsely in a cultivated grass-field at Kirkebö (G. P., 1904).

† **Cirsium arvense** (L.) Scop.

10. **C. palustre** (L.) Scop.

Also found in the Nordreöer: Kalsö: Husum and other places (according to R. R.), Viderö: Viderejde, in enclosed fields (E. T.).

11. **Gnaphalium supinum** L.

12. **Hieracium ardisodon** Dahlst.

Str.: Sandegærde near Thorshavn (!).

13. **H. ciliolatum** Dahlst.

14. **H. constrictiforme** Dahlst.

15. **H. cordifrons** Dahlst.

Str.: Thorshavn, at the rivulet; Havnedal, at the rivulet; Syderdal (!).

† **H. danicum** Dahlst., K. Svenska Vetensk. Akad. Handl., Bd. 25, No. 3, 1893, pp. 118 & 120. *H. vulgatum* **integrifolium* Joh. Lange, Haandbog i den danske Flora, ed. 1, 1851, p. 456; *H. integrifolium* Lange, ibidem, ed. 2, 1856—59, p. 520; Flora Danica, tab. 2661; non *H. integrifolium* Fries, Herb. Normale, fasc. XII, No. 23, 1846, nec Symbolæ Hierac., 1848, p. 117.

In a little plantation in the enclosed fields around Thorshavn I found in 1903 a *Hieracium*, which I could not identify with any of the Færoese species described by Mr. Dahlstedt. I therefore sent some specimens of it to Mr. Dahlstedt, who determined them as *H. danicum*, adding, that the species probably had been accidentally introduced to the Færöes. His supposition is without doubt right, as will appear from the following: In 1898 the direction of the Botanical Garden of Copenhagen sent different young shrubs to Torshavn for planting and some of them were forwarded to Mr. Jone Isaksen, to whom the small plantation in question belongs. As *H. danicum* occurs in the shrubberies and carpets in the Botanical Garden of Copenhagen, it is but natural to suppose, that some fruits have been carried with the sending of shrubs to Thorshavn and have grown here. — It will be interesting to follow this introduction, of which we know the date so exactely.

16. **H. epileucoides** Dahlst.

17. **H. epileucum** Dahlst.

18. **H. faeröense** Dahlst.

Str.: On grassy slopes at Thorshavn and Sandegærde (!); specimens from this locality have been issued in I. Dörfler, Herbarium normale, No. 4550.

19. **H. Hartzianum** Dahlst.

20. **H. heterophyllum** Dahlst., and var. *pinnatifrons* Dahlst.

21. **H. kalsöense** Dahlst.

22. **H. leucograptum** Dahlst.

Str.: On grassy slopes at Höjvig near Thorshavn (!).

23. **H. melanochrotum** Dahlst.

24. **H. Ostenfeldii** Dahlst.

25. **H. perampliforme** Dahlst.

26. **H. peramplum** Dahlst.

Str.: Thorshavn, at the rivulet (!).

27. **H. perintegrum** Dahlst.

Str.: Thorshavn, at the rivulet (!).

28. **H. sarcophylloides** Dahlst.

29. **H. scoticiforme** Dahlst.

Str.: On grassy slope at Höjvig near Thorshavn (!); specimens determined by Mr. H. Dahlstedt.

30. **H. Simmonsianum** Dahlst.

31. **H. subrubicundum** Dahlst.

Str.: Thorshavn, at the rivulet (!).

32. **H. veterascens** Dahlst.

Str.: Thorshavn (Th. Mikkelsen); Höjvig (!); Syderdal (!).

var. *eidense* Dahlst.

33. **Leontodon autumnale** L., and var. *Taraxaci* (L.).

34. **Matricaria inodora** L., var. *phaeocephala* Rupr.

35. **Senecio vulgaris** L.

† **Sonchus arvensis** L.

36. **Tanacetum vulgare** L.

37. **Taraxacum spectabile** Dahlst. in Botaniska Notiser 1905, p. 159.

var. *faeröense* Dahlst., nov. var.; Syn. *T. palustre* Rostrup, Færöernes Flora, 1870, p. 51, non D. C.; *T. laevigatum* Ostenfeld, Botan. Tids., Bd. 22, 1898, p. 139, non D. C.; *T. croceum* Ostenfeld, Bot. Færöes, vol. I, 1901, p. 45, non Dahlstedt.

A forma primaria diversum foliis vulgo (semper in specim. cultis) solo arcte adpressis, pedicellis vulgo foliis brevioribus ± decumbentibus, involucris angustioribus basi ovato-descendente, squamis exterioribus angustioribus nec non ligulis angustioribus calathioque flosculis paucioribus magis radiante.

Mr. H. Dahlstedt of Stockholm has lately examined all the Færoese specimens of *Taraxacum* preserved in the Botanical Museum of Copenhagen and has given me the results of his studies. The species, which I in my list had taken as *H. croceum* Dahlst., is according to Mr. Dahlstedt a special Færoese variety of his species *H. spectabile.* He has sent me the description just quoted and also all the following remarks concerning the Taraxaca.

The *T. spectabile,* var. *faeröense* Dahlst. has been collected in the following places:

Bordö: Klaksvig (A. Poulsen, 1886); Str.: Kirkebö. Thorshavn and Sandegærde (C. A Feilberg & E. Rostrup, 1867); Syd.: Tværaa and Trangisvaag, rock-ledges at Kvanhaugen (J. Hartz, C. H. Ostenfeld & E. Warming, 1897); Viderö: Malinsfjæld, 300 M. (J. Hartz & C. H. Ostenfeld, 1897).

Mr. Dahlstedt remarks: »The characters given above are only relative, and they are such as might possibly be induced by the place of growth, but that is not the case. I have had specimens raised from fruits from Syderö under cultivation through several generations, and they keep themselves distinct from cultivated specimens of the main form (from Sverige, Jemtland)«.

var. *maculiferum* Dahlst., nov. var.

A forma primaria et a var. præcedente satis diversum foliis in pagina superiore ± purpureo-maculatis squamisque paullo laxius adpressis.

Syd.: Tværaa and rock-ledges at Kvanhauge (J. Hartz & C. H. Ostenfeld, 1897); Str.: Havnedal near Thorshavn (C. H. Ostenfeld, 1903). Collected in the Færöes as early as 1821 (by Trevelyan?), as there are specimens in the Riksmuseum of Stockholm, labelled: »Færöe, 1821, about 2000 feet above the Sea.« [Also collected on St. Kilda, Outer Hebrides by O. Paulsen, 1905].

»This variety differs only from the foregoing form by the characters given in the diagnosis, but as it seems that both characters always are combined, it is probable, that they are persistent. — The variety in question is of special interest, as it in many respects reminds us of the nearly related species *T. naevosum* Dahlst.«

38. **T. naevosum** Dahlst., nov. spec.

Folia dense et late lobata — pinnatifido-lobata, lobis latis — angustis deltoideis, utrinque v. præcipue in margine superiore ± dentata inferne angustius lobata, inter lobos inferne ± irregulariter dentata, lobo terminali satis brevi, lato ovato-triangulari — hastato, supra purpureo- v. atropurpureo-maculata (v. in umbrosis fere emaculata) et in pagina superiore vulgo pilis crassis articulatis sparsis — densiusculis obtecta, petiolis ± intense purpureis nervoque mediano inferne v. pro max. parte purpureo.

Involucrum ± obscure oleraceum, magnum satis longum, squamis exterioribus longis lanceolatis breve acuminatis, supra medium inv. attingentibus, anguste v. inconspicue marginatis, apice ± purpureis v. fuscopurpureis et in pag. interiore superne ± fuscoviolaceis, laxe adpressis v. erecto-patentibus, apicibus vulgo ± recurvato-patentibus, interioribus sub apice ± purpureo leviter callosis.

Calathium obscure luteum, multiflorum, radians.

Ligulæ longæ, marginales latiusculæ, extus stria lata rubro-purpurea vittatæ, dentibus in lig. omnibus ± rubris.

Antheræ polline ± repletæ.

Stylus et stigmata livescentes.

Achenium fusco-stramineum apice muricato-spinulosum, cæterum fere læve v. minute tuberculatum, c. 4 mm. longum, 1 mm. latum, pyramide c. 0,9 mm. longo, rostro 8—9 mm. longo et pappo albo.

Syd.: Ravine near Kvanhauge (J. Hartz & C. H. Ostenfeld, 1897).

Geogr. area: Regio alpina and subalpina of the Scandinavian mountains.

Mr. Dahlstedt writes: »The form found in a ravine near Kvanhauge seems to me to be the same as *T. naevosum* Dahlst., a hitherto undescribed species, which is rather common in the alpine and subalpine parts of the Scandinavian mountains. The involucres and the fruits of the Færoese form are quite like those of the Scandinavian one, but the leaves differ in lacking the purple-spots and the coarse hairiness on the upper side. In Scandinavia similar forms have been found here and there and always growing in shadow; they want the spots, but very seldom the coarse hairs, although sometimes very sparsely occurring.

T. naevosum differs from *T. spectabile*, var. *maculiferum* by longer, more patent outer phyllaries, shorter achenes, shorter beak (pyramid), but longer rostrum and developed, more or less abundant pollen.

var. (?) *bipinnatifidum* (Rostr.) Dahlst.; *T. obliquum* Fr., var. *bipinnatifidum* Rostrup, Færöernes Flora, 1870, p. 51.

A forma primaria foliis valde et profunde laciniatis laciniis deltoideis valde laciniato-dentatis omnibus in apicem elongatum attenuatis.

Sandö: At the dune at Sandsbugt (C. A. Feilberg & E. Rostrup, 1867).

»Of this very peculiar form only three fruiting individuals have been collected, and it is therefore difficult to examine the characters of the involucre and the phyllaries. It seems to agree with the main species as regards the phyllaries. The achenes also are similar to those of the main species, but they are somewhat longer and more coarsely denticulate towards the top. The leaves bear the same characteristic hairiness of the upper side as the Scandinavian species of the main form. Of this last specimens from open and sunny places have deeply and narrowly laciniate leaves, which come rather near to the leaves of the Faeroese form, but are easily distinguable by their wanting the laciniation of the second order (»*bipinnatifidus*«), highly characterizing the Færoese form. This diffe-

rence is too great to justify us in regarding the form as a merely growing-place-form. I suppose that it is a race adapted to living in the sandy soils of the dune. Nevertheless closer examination of new material and also cultivation is highly desirable. Flowering specimens are necessary to settle the question of the true (correct) systematic place of it.«

39. **Tussilago farfarus** L.

Fam. CONVOLVULACEAE.

† **Convolvulus sepium** L.

Fam. IV. DIPSACACEAE.

40. **Succisa pratensis** Moench.

† **Trichera arvensis** (L.) Schrad.

Fam. V. ERICACEAE.

41. **Calluna vulgaris** Salisb.

42. **Erica cinerea** L.

43. **Loiseleuria procumbens** (L.) Desv.

Str.: Kirkebö Rejn from c. 250—300 M. (Lyngbye, Rostrup, G. P., !).

Fam. VI. GENTIANACEAE.

44. **Gentiana campestris** L., subsp. *islandica* Murb., mostly »ad subsp. *germanicam* Murb. accedens«.

45. **Menyanthes trifoliata** L.

Fam. VII. LABIATAE.

46. **Brunella vulgaris** L.

47. **Galeopsis tetrahit** L.

None of the collected specimens seems to belong to *G. bifida* Boenn.

† **Lamium dissectum** With.

† **L. intermedium** Fr.

† **L. purpureum** L.

48. **Mentha aquatica** L.

Sandö: Sandslid (accord. to G. P.). The few specimens existing in our herbarium (from Vaagö and Strömö) are quite sterile, without any flowers at all.

49. **Thymus serpyllum** L.

Besides the main form with purple corollas a form with rose-coloured (pink) flowers has been found on Fuglö, at about 550 M. (J. Hartz & C. H. Ostenfeld, 1897).

Fam. VIII. LENTIBULARIACEAE.

50. **Pinguicula vulgaris** L.

51. **Utricularia vulgaris** L.

Miss E. Taylor has discovered this interesting addition to the Færoese flora. She found it in 1904 and reinspected the locality in 1906, and in both summers she only saw specimens without any flowerstalks at all.

Vaagö: plenty in pools and ditches about half way from Midvaag to Sörvaagsvatn, in the outfields.

Fam. IX. LOBELIACEAE.

52. **Lobelia dortmanna** L.

Fam. X. PLANTAGINACEAE.

53. **Litorella lacustris** L.

54. **Plantago coronopus** L.

Syd.: Cliffs on the west coast opposite Lopra (Ove Paulsen).

55. **P. lanceolata** L., and f. *depressa* Rostr.

† **P. major** L.

56. **P. maritima** L.

Fam. XI. PLUMBAGINACEAE.

57. **Armeria elongata** (Hoffm.) Koch., mostly var. *maritima* (Mill.) Willd.

Fam. XII. PRIMULACEAE.

58. **Anagallis tenella** L.

59. **Lysimachia nemorum** L.

60. **Primula acaulis** (L.) Jacq.

Fam. XIII. PYROLACEAE.

61. **Pyrola minor** L.

Kunö: Skard, both at the top of the mountain and in its lower parts, flowering and fruiting sparingly (R. R.); Vid.: Malinsfjæld, c. 400—500 M.; Mornefjæld, c. 300 M.; and eastern ridge of Villingedalsfjæld; in all places with flowers (E. T.).

Fam. XIV. RUBIACEAE.

† **Galium aparine** L.

62. **G. palustre** L.

63. **G. saxatile** L.

Fam. XV. SCROPHULARIACEAE.

64. **Alectorolophus groenlandicus** (Chab.) Ostf. emend.

65. **A. minor** (Ehrh.) Wimm. & Grab. I hope to be able in another place to treat the northern species of *Alectorolophus minor, sens. lat.*

66. **Bartschia alpina** L.

J. Landt in his book on the Færöes (1801) mentions, that *Bartschia* occurs in the North-Strömö, but as no later investigator had found it, and as the statements of the Rev. Landt are not always correct, I had omitted it in my list. Now I have got evidence of the correctness of its occurring in the Færöes, as both Miss Taylor and Mr. R. Rasmussen have sent me specimens.

Vaagö: near Sörvaag (sent to R. R. from a relative, Mr. Niclas Rasmussen, but without more exact indication of the locality); Vid.: rockledge on Mornefjæld, ab. 300—400 M. (E. T.).

In my list (l. c. pp. 55—56) I have put down the result of my examination of the Færoese *Euphrasias*, but I expressed some doubt with regard to the correctness of my determinations, as I must admit, that the limits between the small-flowered forms were arbitrary. I have taken up again the study of these interesting plants and have had a large material at my disposal, consisting of the collections made by Mr. J. Hartz and myself in the Færöes in 1895, 1896, 1897 and 1903 together with smaller collections from other investigators. As some of the species in question have been described upon specimens from Shetland or Scotland, it was necessary to have material from these countries for comparison. We have in the Botanical Museum of Copenhagen a good many Euphrasias from Shetland and Scotland sent me from my friend Mr. W. H. Beeby and from the English monographer of the genus the late F. Townsend, and furthermore Mr. Beeby had sent me all his Shetland-Euphrasias on loan. I have therefore been able to decide several points of interest, having in my hands specimens from the original locality and original collecting-date (»co-types« of the American botanists) of *E. foulaënsis* Towns., *E. paludosa* Towns. (= *E. scotica* Wettst.) and *E. borealis* (Towns.) Wettst.; besides the type specimens of *E. arctica* Lange and *E. gracilis* Fr., f. *atropurpurea* Rostr. are in our herbarium.

The following treatment will show, that the result of my examination is a reduction of the number of species. I think, that it is because the authors have had too scanty material at their di-

sposal, that they have described so many species — this is a common fault by monographers working in a country far away, a fault which now-a-days often is committed with regard to northern species belonging to genera, monographed by Central-European botanists.

67. **Euphrasia borealis** (Towns.) Wettst.

This is the only Færöese species with larger corollas, and it is therefore easily distinguished from the other species. On the other hand it is very near *E. brevipila* Burnat et Gremli, and is perhaps, as suggested by Mr. Townsend, only an eglandular from of it.

68. **E. curta** Fr., Wettst.

Small specimens of this species are not rare beyond the enclosed fields in the lowlands; they are rather broadleaved and tend to approach *E. latifolia* Pursh, without giving place for any doubt with regard to their naming.

69. **E. minima** Jacquin apud Schleich.; R. Wettstein, Monogr. der Gatt. Euphrasia, 1896, p. 151; *E. scotica* Wettst., l. c. p. 170; Townsend, Journ. Botany, 1897, p. 425; Ostenfeld, Bot. Fær., I, p. 56; *E. paludosa* Townsend, Journ. Botany, 1891, p. 161, non R. Br.; *E. gracilis* Ostenfeld, Bot. Færöes I, p. 56, non Fr.; *E. latifolia* Ostenfeld, ibid. p. 56, non Pursh; *E. arctica* Lange apud Rostrup, Færöernes Flora, Bot. Tids. IV, 1870, p. 47, ex parte (quoad plantæ færoenses).

In 1891 Mr. F. Townsend published a note in the Journal of Botany on a new form of *Euphrasia*, which he named *E. paludosa*. He had found it in boggy ground around Braemar in Scotland. In some respects it was like *E. gracilis*, but differed, among other characters, in its small, whitish flowers, its short and rather broad capsule and its wet habitat. As R. Brown had applied the name *paludosa* to another species (from Australia), R. Wettstein in his monograph (1896, p. 151) altered the name of Townsend's plant to *E. scottica* Wettst. (more correctly spelt *scotica*), and under this name the plant has gone since (e. g. by Townsend, Monograph of the British species of Euphrasia, Journ. of Botany, 1897, p. 425, and Euphrasia scotica, Journ. of Botany, 1903, p. 57).

Wettstein considers *E. scotica* to be very near *E. minima* and says (l. c. p. 171), that the only difference of importance lies in the length of the capsule in proportion to the calyx, but adds that he does not know if this difference is constant. Shortly after Townsend (Monograph, p. 426) declares, that it is not constant, as he has found specimens of *E. scotica* with capsules exceeding the calyx; he says that »a marked distinction seems to lie in the form of the

upper leaves and bracts of *E. scotica* which are narrower than those of *E. minima* and have a cuneate base.« I have examined many hundred specimens of *E. scotica* from Scotland, Shetland and the Færöes and have compared them with many specimens of *E. minima* both from the Alps and from Scandinavia, and I can not find any distinction which holds good. I feel pretty sure, that the Scottish etc. plant is identical with true *E. minima*. Townsend who has seen a good deal of my Færoese material, has determined many specimens with capsules exceeding the calyx as *E. scotica*, specimens which are quite like the typical *E. minima* from the Alps.

As pointed out by R. Wettstein (l. c. p. 159) *E. minima* varies much with regard to the colour of the corolla; the true *E. scotica* represents a form with pale or whitish flowers (f. *pallida* Gremli), but from this we find all possible variations of colour until a form with dark purple corolla (f. *purpurascens* Wettst. l. c. p. 159). The main form is very common in the Færöes, and also the purple-flowered form occurs frequently in the Færoese heaths; it is the same form which has been described as *E. foulaënsis* Towns. apud Wettstein (l. c. p. 139). I have examined Mr. W. H. Beeby's specimens from Hamnafeld on Foula, Shetland, upon which F. Townsend has made his description, and they are, after my opinion, only rather coarse, unbranched *E. minima* with dark purple corollas and long capsules; the specimens were found among heather and this explains their somewhat flexuose stem. Both Wettstein (l. c. p. 140) and Townsend (Monograph, p. 423) compare it with *E. latifolia* Pursh; but it is easily distinguised from it by its nearly glabrous leaves; common to both forms are the obtuse teeth of the leaves and bracts.

The same form has been described in 1870 by E. Rostrup (Færöernes Flora, p. 48) as *E. gracilis*, f. *atropurpurea* Rostr., which consequently is the name to be used. I have seen Rostrup's specimens (from Hestö) and found them almost identical with Beeby's specimens of *E. foulaënsis*.

The synonymy of the form is then as follows:

E. minima Jacq., f. *atropurpurea* (Rostr. sub *E. gracili*); *E. minima*, f. *purpurascens* Wettst., Monographie, p. 159; *E. Foulaënsis* Towns. ap. Wettstein, l. c. p. 139; Townsend, Journ. of Botany, 1897, p. 422; *E. atropurpurea* (Rostr.) Ostenfeld, Bot. Færöes, I, p. 55; *E. gracilis* Fr., f. *atropurpurea* Rostrup, Færöernes Flora, Bot. Tids., IV, 1870, p. 48.

E. gracilis Fr. is distinguished from it by its slender, erect, often

branched stem, longer internodes, small and quite glabrous leaves, rather short and small capsule and dark-coloured stem and leaves.

70. **Pedicularis palustris** L.

71. **Veronica alpina** L.

Kunö: not rare at high levels, f. i. Nakken (R. R.).

72. **V. beccabunga** L.

† **V. hederifolia** L.

73. **V. fruticans** Crantz; *V. saxatilis* Scop. A very interesting discovery for the flora.

Kalsö: Mountain north of Husum, ab. 500 M. (E. T.).

74. **V. officinalis** L., and f. *glabrata* Fristedt.

75. **V. serpyllifolia** L.

As mentioned in my list (l. c. p. 57) there occurs in the hills a variety: var. *borealis* Læstad., which is easily distinguised from the main species by its denser clothing of the short raceme, lower growth and bright-blue corollas. The clothing consists of a pubescense of short crisped hairs, among which longer patent hairs, partly glandular, especially in the flower-stalks, occur. L. M. Neuman (Sveriges Flora, 1901, p. 132) considers this form as a separate species, viz. *V. borealis* (Læstad.) Neuman, and I should think he is right in so doing. It is probably identical with *V. humifusa* Dickson.

Besides from the Færöes, where this form is rather common in the hills, I have seen specimens from Lapland (collected by Læstadius), from the Alps, the Apennines and the higher mountains of North America (especially in British Columbia). It seems therefore to have a wide range of distribution.

Fam. XVI. VACCINIACEAE.

76. **Vaccinium myrtillus** L., and f. *pygmaea* Ostf.

77. **V. uliginosum** L., and f. *microphylla* (Lge.).

78. **V. vitis idaea** L.

Str.: Between Leinum and Kvalvig, fruiting in Aug. 1900 (accord. to E. T.).

B. Choripetalae.

Fam. XVII. CALLITRICHACEAE.

79. **Callitriche autumnalis** L.

80. **C. hamulata** Kütz.

In my preliminary list (Botan. Tids., vol. 22, 1898, p. 140) I have reported *C. pedunculata* D. C. from the Færöes, while in my list in Bot. Færöes, vol. I (p. 59) I have altered it to *C. hamulata*. I now

think that both opinions are correct, as I take *C. pedunculata* as merely a variety of *C. hamulata*, distinguished by its stalked fruits. Such a form: *C. hamulata* Kutz., f. *pedunculata* (D. C. pro sp.) has been found in Strömö (Miavevatn).

81. **C. stagnalis** Scop.

Fam. XVIII. CARYOPHYLLACEAE.

† **Agrostemma githago** L.

82. **Alsine verna** Bart., var. *hirta* (Wormskj.) Lge.

83. **Cerastium Edmondstonii** (Watson) Murb. & Ostf.

Cerastium alpinum has been recorded from Fuglö in my list (l. c. p. 60), but on closer examination I find it to be only a male form of *C. Edmondstonii*, which elsewhere always occurs as a hermaphrodite. The male specimens from Fuglö differ from the type in the more branched inflorescence and the whole shape of the tufts, but the broad sepals and the narrowness of the white membranous margins of the bracts point decidely to *C. Edmondstonii*.

With regard to the name of this species S. Murbeck (Botaniska Notiser, 1898, p. 246) and I myself (l. c. p. 60) have pointed out that the oldest name must be *C. latifolium, β, Edmondstonii* Watson, London Botan. Soc. Catalogue of British Plants, 1844. The species name *C. arcticum* given by Joh. Lange, Flora Danica, fasc. 50, p. 7, 1880, to forms of this neighbourhood, can not be retained for two reasons: 1⁰ it is much later than Watson's name. 2⁰ Lange himself has mixed two distinct species together, as his description and the drawings in the plate are based upon partly *C. Edmondstonii* from East-Iceland, partly *C. alpinum* from Greenland (a condensed dwarf form). From this it will be evident, that the name *C. arcticum* in all cases should be omitted.

84. **C. glomeratum** Thuill.

85. **C. tetrandrum** Curtis, and var. *zetlandicum* Murb.

86. **C. trigynum** Vill.

87. **C. vulgare** Hartm., mostly var. *alpestre* (Lindbl.).

88. **Honckenya peploides** (L.) Ehrh., and var. *major* Rostr.

89. **Lychnis flos cuculi** L.

90. **Melandrium rubrum** (Weig.) Garcke.

Myggenæs (accord. to G. P.); Vaagö: Midvaag, rock-ledge on the fowling cliffs (accord. to G. P.).

91. **Sagina nivalis** (Lindbl.) Fr.

92. **S. procumbens** L.

S. procumbens L. × **subulata** (Sw.) Prsl.

Str.: bare, gravelly, damp places between Thorshavn and Höjvig (!, 1903); Syd.: Frodeby (E. Rostrup & C. A. Feilberg, 1867). Probably not rare.

93. **S. subulata** (Sw.) Prsl.

94. **Silene acaulis** L.

95. **Spergula arvensis** L.

An examination of the Færoese specimens with mature fruits showed, that they all belong to *S. sativa* Boenn.

The localities of the examined individuals are: Str.: Thorsvig (J. Hartz & C. H. Ostenfeld, 1897), Thorshavn (E. Rostrup & Feilberg, 1867, C. H. Ostenfeld, 1903); Öst.: Ejde (E. T.).

96. **Stellaria media** (L.) Cyril.

As an unusual locality the following is worthy of notice: Vid.: Villingedalsfjæld, in a hole under a hammer, ab. 400 M. (E. T.).

97. **S. uliginosa** Murr.

Fam. XIX. CHENOPODIACEAE.

98. **Atriplex Babingtonii** Woods.

Mr. O. Paulsen has examined all the specimens of *Atriplex* collected in the Færöes, and he supposes, that all belong to *A. Babingtonii.* As his determinations are deciding with regard to all fruiting individuals, I think it better to omit the two other species from the flora, viz. *A. hastata* and *A. patula*, at least until further researches alter the question.

The species is common on the coasts; specimens with fruits have been collected as follows:

Bordö: Bordövig (J. Hartz & C. H. Ostenfeld, 1897); Str.: Sandegærde (E. Rostrup & C. A. Feilberg, 1867), Thorshavn (J. Hartz & C. H. Ostenfeld, 1897; O. Paulsen, 1903), Thorsvig (J. Hartz & C. H. Ostenfeld, 1897); Syd.: Trangisvaag (E. Rostrup & C. A. Feilberg, 1867), between Trangisvaag and Tværaa (C. H. Ostenfeld, 1895); Vaagö: Sörvaag (E. Rostrup & C. A. Feilberg), Midvaag (J. Hartz & C. H. Ostenfeld, 1897).

† **Chenopodium album** L.

Fam. XX. CORNACEAE.

99. **Cornus suecica** L.

Fam. XXI. CRASSULACEAE.

100. **Sedum rhodiola** D. C.

101. **S. villosum** L.

Fam. XXII. CRUCIFERAE.

Arabis alpina L.

As stated in my list (l. c. p. 66) Trevelyan records it from the hills of Kunö, but as this island lately has been much investigated by Miss E. Taylor and Mr. R. Rasmussen without refinding the *Arabis*, I doubt the statement of Trevelyan.

102. **Arabis petraea** (L.) Lam.

† **Brassica campestris** L.

† **B. napus** L.

† **B. nigra** (L.) Koch.

103. **Cakile maritima** Scop., var. *latifolia* (Poir.)

104. **Capsella bursa pastoris** (L.) Moench.

105. **Cardamine hirsuta** L., both var. *campestris* Fr. and var. *silvatica* (Lk.).

106. **C. pratensis** L.

107. **Cochlearia officinalis** L., coll.

As pointed out in my list (l. c. p. 67) the *Cochlearias* of the Færöes are very varying, but I had not succeeded in discovering discernible limits. During 2—3 years I have had several *Cochlearias* under cultivation in the Botanical Garden of Copenhagen and among them some raised from seeds collected in the Færöes. The results were, that many distinct forms occur, which keep their special characters from generation to generation, but it seems very difficult, if possible, to express these distinctions verbally. Consequently my opinion is, that at present we are not able to distinguish the elementary species of *Cochlearia*, but must retain the old collective name *C. officinalis*. I do not doubt, that many forms will be segregated in future, and I think the English and Scottish botanists are on the right way, when separating *C. alpina* H. C. Watson, *C. micacea* Marshall and *C. groenlandica* »L.« from the common *C. officinalis* »L.«

I have compared authentic specimens of *C. micacea* Marshall (see Journ. of Botany, vol. XXXII, 1894, p. 289, pl. 345, 346; cfr. Journ. of Botany, XXX, 1892, p. 225, pl. 326 A) with Færöese specimens grown in bare gravelly places in the hills, and I have found them quite like; but on the other hand there are specimens which do not match any of the above mentioned »species« in their typical shape, but are intermediate-looking.

108. **Draba hirta** L., f. *rupestris* (R. Br.).

109. **D. incana** L.

† **Raphanus raphanistrum** L.

† **Sinapis alba** L.

† **S. arvensis** L.

110. **Subularia aquatica** L.

As the localities in my list (l. c. p. 67) through a fault in the printing are incomplete, I give them all here again:

Sandö: lake between Skopen and Sand; Str.: Leinumvatn and Miavevatn, lake on Vardebakken, at ab. 300 M.; Havnedal, a little pool at ab. 200 M.; Öst.: Kornvatn near Næs, at ab. 100 M.; Toftevatn.

Fam. XXIII. DROSERACEAE.

111. **Drosera rotundifolia** L.

Fam. XXIV. EMPETRACEAE.

112. **Empetrum nigrum** L.

Fam. XXV. GERANIACEAE.

† **Geranium molle** L.

113. **G. silvaticum** L.

Fam. XXVI. HALORAGIDACEAE.

114. **Myriophyllum alterniflorum** D. C.

Fam. XXVII. HYPERICACEAE.

115. **Hypericum pulchrum** L., f. *procumbens* Rostr.

116. **H. quadrangulum** L.

Str.: near Höjvig (Th. Mikkelsen); Vaagö: refound on the old locality at Sörvaag (E. T., 1906).

Fam. XXVIII. LINACEAE.

117. **Linum catharticum** L.

Fam. XXIX. OENOTHERACEAE.

118. **Chamaenerium angustifolium** (L.) Scop.

Bordö: Fagralid, rock-ledge, sparingly and not producing any flower during the last five years (accord. to R. R., 1901—05); Kalsö: Husum, ravine, flowering (accord. to R. R.).

119. **Epilobium alsinifolium** Vill.

120. **E. anagallidifolium** Lam.

E. anagallidifolium Lam. × **palustre** L.

121. **E. lactiflorum** Hausskn.

122. **E. montanum** L.

123. **E. palustre** L.

Fam. XXX. OXALIDACEAE.

124. **Oxalis acetosella** L.

Recorded from the Færöes by Trevelyan, but not refound until Mr. R. Rasmussen in 1904 discovered it on Kunö. He has later found it in several places with flowers and fruits; he writes to me: »Oxalis occurs everywhere in the ravines and talus of débris from Nakken (the northern cape) to Skardsgjov, but only in the eastern half of the island«.

Fam. XXXI. PAPAVERACEAE.

125. **Papaver radicatum** Rottb.

Kunö: on the hill-plateau at the southern end of the island (J. Hartz & C. H. Ostenfeld); everywhere in the hills of the eastern half of the island (accord. to R. R.).

Fam. XXXII. PAPILIONACEAE.

126. **Lathyrus pratensis** L.

Myggenæs, and Vaagö: Midvaag (accord. to G. P.).

127. **Lotus corniculatus** L., f. *carnosa* (Pers.).

Kunö: Skard, and Kalsö: Husum (accord. to R. R.).

† **Pisum sativum** L.

† **Trifolium hybridum** L.

† **T. pratense** L.

† **T. procumbens** L.

128. **T. repens** L.

129. **Vicia cracca** L.

Bordö: Fagralid, in a ravine (accord. to R. R.); Str.: Kirkebö, on two spots in the outfields (accord. to G. P.); Vid.: Viderejde, in the enclosed field (E. T.).

Fam. XXXIII. POLYGALACEAE.

130. **Polygala serpyllacea** Weihe.

131. **P. vulgaris** L., var. *Ballii* (Nyman) Ostf.

Fam. XXXIV. POLYGONACEAE.

132. **Koenigia islandica** L.

133. **Oxyria digyna** (L.) Campd.

134. **Polygonum amphibium** L.

135. **P. aviculare** L.

† **P. convolvulus** L.

136. **P. viviparum** L.

137. **Rumex acetosa** L.

† **R. acetosella** L.
† **R. crispus** L.
138. **R. domesticus** Hartm.
R. domesticus Hartm. × **obtusifolius** L.
139. **R. obtusifolius** L., f. *agrestis* Fr.

Fam. XXXV. PORTULACACEAE.

140. **Montia lamprosperma** Cham.; Syn. *M. rivularis* auctt., non Gmel.

In my list (l. c. p. 73) I have mentioned, that all the *Montias* from the Færöes belong to the form with finely netted and shiny seeds, and that this form is more northern than *M. minor* Gmel. I have followed most of the botanists in naming this form »Montia rivularis Gmel.«, but this name is not correct according to the opinion of H. Lindberg. He has pointed out (Medd. af Soc. pro Fauna et Flora Fenn., vol. 27, 1901, pp. 18—21), that the differences between the two species described by G. C. Gmelin in his *Flora Badensis* (1806) are based only upon the vegetative parts of the plants, and the characters taken from the testa of the seeds are not at all mentioned. Upon this last character Ad. de Chamisso has first laid emphasis, when he in *Linnæa* (1831, p. 565) described his new species *M. lamprosperma;* this author says, that the seeds of *M. minor* and *M. rivularis* have just the like structure, and places his new species as a contrast to them. This view is after H. Lindberg — with the opinion of whom I agree — the correct one, and consequently the *Montia* which occurs in Greenland, Iceland, the Færöes, Scandinavia etc. must bear the name *M. lamprosperma* Cham. It consists of a smaller (annual?) form — the typical — and a larger perennial water-form: var. *boreo-rivularis* Lindb. fil., both found in the Færöes[1].

Fam. XXXVI. RANUNCULACEAE.

141. **Caltha palustris** L., and var. *radicans* (Forst.).
142. **Ranunculus acer** L., and f. *pumila* (Whbg.).

This species varies very much after its much varying habitats. In luxuriant rock-ledges a tall and robust form with the stem patently stiff-hairy beneath (f. *velutina* Lindbl.) is met with. In bare gravelly places in the hills the f. *pumila* Whbg. is the substitute. This last form is — after the description — probably the same as

[1] The more southern species, *M. minor* Gmel., with smaller, tuberculate-netted, somewhat opaque seed-testa has a parallel development, the water form of which must be named *M. minor* Gmel., var. *rivularis* (Gmel.) Lindb. fil.

R. icelandicus (should be *R. islandicus*) published by Davis (Minnesota Botan. Studies, IV, 1900 p. 472, Native and cultivated Ranunculi of North America and segregated genera) upon specimens collected by Miss E. Taylor in Seydisfjord in East-Iceland (which does not belong to North America!).

143. **R. auricomus** L.

Recorded from the Færöes by Trevelyan and rediscovered by Mr. G. Patursson in 1904.

Str.: Kirkebö, the lowest ledge of the hill above Kirkebö.

† **R. ficaria** L.

The Rev. J. Landt mentions this species from Kirkebö (Str.), and Mr. G. Patursson has seent me pretty and large specimens taken April 10., 1904 in full flower. It occurs on the churchyard and around the ruins of the cathedral; without doubt it has been introduced in former times.

144. **R. flammula** L.

My form *speciosa* (l. c. p. 74) resembles in many respects the Scottish species *R. scoticus* Marshall (= *R. petiolaris* (Lange) Marshall, Journ. Botany, XXX, 1892, p. 289, pl. 328), but differs in the more numerous, larger and broader petals a. o.

145. **R. glacialis** L.

146. **R. repens** L.

147. **R. reptans** L.

I should prefer to take this as a distinct species and not as a form of *R. flammula*, as I have done in my list (l. c. p. 74).

148. **Thalictrum alpinum** L.

Fam. XXXVII. ROSACEAE.

149. **Alchimilla acutidens** Buser; Syn. *A. Wichurae* Buser.

150. **A. alpina** L.

151. **A. faeroënsis** (Lange) Buser.

In J. Dörfler's Herbarium normale, Cent. XLVII, Nr. 4654, Icelandic specimens of this interesting species have just (Dec. 1906) been distributed, and the well-known authority in *Alchimilla* Mr. R. Buser of Geneva has thereof taken the opportunity of giving a rather exhaustive list of citations concerning the form in question. He is of the opinion, that it is a subspecies of *A. splendens* Christ, to which it is very near-allied, but its quite peculiar geographical distribution removes it so much from the alpine *A. splendens* and its different races, that it deserves — after my opinion — specific rank.

152. **A. filicaulis** Buser, with var. *denudata* Buser and var. *vestita* Buser.

The var. *denudata* has been found on Vid.: Villingedalsfjæld, ab. 500 M. (E. T.).

153. **Dryas octopetala** L.

Kunö: Gjovadal near Skard (R. R.); Vid.: Mornefjæld (accord. to E. T.).

154. **Geum rivale** L.

Str.: Ravnabjörgini south of Kirkebö and rock-ledge near Kirkebö (G. P.).

155. **Potentilla anserina** L.

156. **P. erecta** (L.) Dalla Torre.

157. **P. palustris** (L.) Scop.

Rediscovered in its old locality given by Mohr on Vaagö: Gaasedal (E. T.).

158. **P. verna** L.; *P. maculata* Pourr.

159. **Rosa mollis** Sm.

160. **Rubus saxatilis** L.

161. **Sibbaldia procumbens** L.

162. **Spiraea ulmaria** L.

Fam. XXXVIII. SALICACEAE.

163. **Salix glauca** L.

Kunö: Skard (accord. to R. R.; the locality is perhaps the same as »Hills on the south side from about 250 m.«); Vid.: Ormedalen (E. T.).

164. **S. herbacea** L.

165. **S. phylicifolia** L.

Fam. XXXIX. SAXIFRAGACEAE.

166. **Saxifraga caespitosa** L.; *S. decipiens* Ehrh.

167. **S. hypnoides** L.

168. **S. nivalis** L., and var. *tenuis* Whbg.

169. **S. oppositifolia** L.

170. **S. rivularis** L.

171. **S. stellaris** L.

Fam. XL. UMBELLIFERAE.

† **Aegopodium podagraria** L.

Str.: The churchyard and gardens in Kirkebö (G. P.); gardens in Velbestad (accord. to G. P.); a plantation in Thorshavn (!).

172. **Angelica silvestris** L.

173. **Archangelica officinalis** Hoffm.

174. **Haloscias scoticum** (L.) Fr.

Sandö: Troldhoved (accord. to G. P.).

Fam. XLI. URTICACEAE.

175. **Urtica dioica** L.

† **U. urens** L.

Fam. XLII. VIOLACEAE.

Mr. W. Becker of Hedersleben (Germany) has examined the material of Violæ from the Færöes and has kindly sent me the following notes.

176. **Viola palustris** L.

177. **V. silvestris** (Lam.) Rchb., var. nov. *rotundato-crenata* Becker; Syn. *V. Riviniana* Ostenfeld, Bot. Færöes, I, p. 80, non Rchb.

Folia plerumque rotundato-cordata, subacuminata, rotundato-crenata.

Mr. Becker means that the Færoese form of the Silvatica-group does not exactely match *V. silvestris*, var. *Riviniana*, but represents an intermediate stage between *V. silvestris, typica* and var. *Riviniana*. From his letter I quote: »it is especially noteworth with regard to the inferior systematical rank of the *V. Riviniana*, that there occur in islands forms which come more or less near to *V. Riviniana* or may be identical with it and at the same time show the characters of the true *V. silvestris*.«

178. **V. tricolor** L., subsp. nov. *faeroënsis* Becker.

Folia ovato-rotundata, plane crenata, ad apicem obtusissima, partim subemarginata, ad basim in petiolum breviorem abrupte vel subabrupte angustata. Stipulae lyrato-incisae, lacinia terminalis lata obtusa, laciniae laterales breves oblongae, obtusiusculae, introrsum 1—2, extrorsum 3—4. Sepala late lanceolata.

To this description Mr. Becker add the following note: »The form in question is characterized by the broad-ovate leaves and by the stipules pinnatifid to a smaller degree than the main form (coming near to the stipules of *Viola cornuta*)«.

In my list (l. c. p. 80) I had named the form »*V. tricolor* L. subsp. *genuina* Wittr., forma« and had mentioned, that it is perennial. I should now like to name it: *V. tricolor* L., subsp. *genuina* Wittr., var. *faeroënsis* (Becker), as it without doubt belongs to the subspecies *genuina* in Wittrock's sense.

All the specimens from the Færöes are of this form. It is found in the southern part of Str. (Kirkebö and Velbestad) and on Sandö (Sand, and other places according to Dr. Knud Poulsen), and it occurs always around the houses and in the enclosed fields.

II. Monocotyledones.

Fam. XLIII. COLCHICACEAE.

179. **Narthecium ossifragum** (L.) Huds.

180. **Tofieldia palustris** Huds.

New to the færoese flora.

Bordö: Mountain between Kvannesund and Klaksvig (E. T., 1903).

Fam. XLIV. CYPERACEAE.

181. **Carex atrata** L.

182. **C. binervis** L.

C. caespitosa L. × *Goodenoughii* Gay should be omitted, see under *C. Goodenoughii.*

183. **C. dioica** L.

184. **C. echinata** Murr.; *C. stellulata* Good.

185. **C. flacca** Schreb.; *C. glauca* Scop.

C. flacca Schreb. × *Goodenoughii* Gay.

The Rev. G. Kükenthal has examined the specimens, which Mr. C. Raunkiær determined as the just mentioned new hybrid, and he does not believe in the hybrid nature of them. He writes: Nil nisi forma spiculis abbreviatis Caricis Goodenoughii Gay.

186. **C. flava** L.

C. flava L. × **fulva** Good.

187. **C. fulva** Good.; *C. Hornschuchiana* Hoppe.

188. **C. Goodenoughii** Gay.

The specimens which in my list (l. c. p. 81) are named *C. caespitosa* × *Goodenoughii* do not belong to this hybrid. It would *a priori* also have been curious, if a hybrid should occur in a country where one of the parent species, at least at present, has not been found.

The form in question must be referred to var. *juncella* Fries, characterized by its densely tufted growth and the very narrow long leaves.

I have in 1903 reexamined its only known locality in the Færöes, viz.: Syd.: near Tværaa, boggy place in the enclosed field (!).

C. Goodenoughii Gay × **rigida** Good.

189. **C. incurva** Lightf.

190. **C. leporina** L.

191. **C. Lyngbyei** Hornem.; Syn. *C. cryptocarpa* C. A. Mey.

The name *C. Lyngbyei* is older than *C. cryptocarpa*, and as it has been published by Hornemann just on specimens from the Færöes (collected by H. C. Lyngbye), I feel it necessary in a list of Færoese plants to prefer it. The type-specimens, which have been pictured in Flora Danica, tab. 1888, are in the herbarium of the Botanical Museum of Copenhagen.

C. Lyngbyei Hornem. × **rigida** Good., f. *sub-Lyngbyei* G. Kükenthal.

In a salt-marsh at the head of Trangisvaagfjord on Syd. I found in 1897 a curious robust *Carex*-form growing among *C. Lyngbyei, C. Goodenoughii* and *C. salina*, subsp. *kattegatensis*. I took it at first as a hybrid between the two first named species, but could later not find a satisfying determination of it. Now the Rev. G. Kükenthal has examined it and given it the name placed above, remarking at follows: »multo magis ad C. Lyngbyei accedens quam C. haematolepis Drej.[1], sed praeter spiculis erectis squamae latae basi involventes uninervae culmusque rigidus C. rigidam indicant.« The specimens are tall and robust, of about the same shape as *C. Lyngbyei;* the leafy shoots bear long and broad leaves, higher than the flowering shoots. 1—2 male spikes with brown, obtuse scales, 2—3 short-cylindrical or ovoid, erect female spikes; the lower one short-stalked, with a leafy bract, as long as or longer than the short upper ones, which often are male at the top. The female scales are dark-brown or blackish with pale midvein ovate, subacute, about as long and broad as the perigynium.

192. **C. panicea** L.

193. **C. pilulifera** L.

194. **C. pulicaris** L.

195. **C. pulla** Good.; *C. saxatilis* auctt.

Kunö: above Kunö village, c. 400 M. (R. R.).

196. **C. rigida** Good.

197. **C. salina** Whbg., subsp. *kattegatensis* Fr.

Str.: Saltmarsh at Selletræ (J. Hartz & C. H. Ostenfeld), a somewhat divergent form, which nevertheless also by the Rev. G. Kükenthal is referred to the form here given.

198. **Eriophorum polystachyum** L.

199. **E. vaginatum** L.

200. **Heleocharis multicaulis** Sm.

[1] In my Flora Arctica, I, 1902 (p. 76) I have showed, that *C. haematolopis* Drej. according to the authentic specimens is a hybrid between *C. Lyngbyei* and *C. rigida*.

201. **H. palustris** (L.) R. Br.

Mr. H. Lindberg of Helsingfors has examined the specimens from the Færöes and has testified, that all are: *Scirpus palustris* L., subsp. *eupalustris* Lindb. fil.

202. **H. uniglumis** Lk.

203. **Scirpus caespitosus** L.

All the specimens from the Færöes belong to var. *germanica* (Palla), but are somewhat merging into var. *austriaca* (Palla). Mr. E. Broddesson of Lund (Sweden), who has examined our specimens has labelled most of them »Scirpus germanicus Palla, ad austriacum Palla vergens.«

204. **S. pauciflorus** Lightf.

Fam. XLV. GRAMINEAE.

205. **Agropyrum junceum** (L.) P. B.

A. junceum (L.) P. B. × **repens** (L.) P. B.

206. **A. repens** (L.) P. B.

207. **Agrostis canina** L.

A. canina L. × **vulgaris** With.

208. **A. stolonifera** L.; *A. alba* L.

209. **A. vulgaris** With.

210. **Aira alpina** L., *vivipara*.

I think it is better to keep this form distinct from *A. caespitosa* and not take it as merely a viviparous form of it.

211. **A. caespitosa** L., var. *brevifolia* Hartm.

212. **A. flexuosa** L.

213. **Airopsis praecox** (L.) Fr.

Myggenæs (accord. to G. P.); Nolsö (E. Rostrup & C. A. Feilberg); Str.: Kirkebö (G. P.); Syderdal (!).

214. **Alopecurus geniculatus** L.

† **A. pratensis** L.

215. **Anthoxanthum odoratum** L.

† **Apera spica venti** (L.) P. B.

† **Avena sativa** L.

† **A. strigosa** Schreb.

† **Briza media** L.

† **Bromus mollis** L.

216. **Catabrosa aquatica** (L.) P. B.

† **Dactylis glomerata** L.

217. **Digraphis arundinacea** (L.) Trin.

218. **Elymus arenarius** L.

219. **Festuca ovina** L., *vivipara.*

† **F. pratensis** Huds.

220. **F. rubra** L., and f. *arenaria* Osbeck.

The large, broad-leaved form which I in my list have named var. *planifolia* Trautv., is according to Mr. R. Rasmussen common in the cliffs inhabited by sea-fowls. I do not know whether the variety name is correct or not, but the form is a very remarkable one.

221. **Glyceria distans** (L.) Whbg.

222. **G. fluitans** (L.) R. Br.

223. **G. maritima** (Huds.) Whbg.

Syd.: On the west-coast opposite Lopra, ab. 125 M. supra mare (Ove Paulsen).

224. **Holcus lanatus** L.

225. **H. mollis** L.

† **Hordeum vulgare** L.

† **Lolium multiflorum** Lam.

† **L. perenne** L.

Öst.: Ejde (»sown with seeds from England, but nearly superseded by other grasses«, 22. Aug., 1817, H. C. Lyngbye).

226. **Molinia coerulea** (L.) Moench.

227. **Nardus stricta** L.

† **Phleum pratense** L.

228. **Phragmites communis** Trin.

229. **Poa alpina** L., *vivipara.*

230. **P. annua** L.

231. **P. glauca** M. Vahl.

232. **P. nemoralis** L., f. *glaucantha* Gaud.

233. **P. pratensis** L., f. *humilis* Ehrh.

234. **P. trivialis** L.

In my list (l. c. p. 90) I have described a f. *pallida*, but this name must fall, as f. *pallescens* Stebler & Volkart, 1895 is earlier.

235. **Psamma arenaria** (L.) R. & S.

236. **Sieglingia decumbens** (L.) Bernh.

† **Triticum vulgare** Vill.

Fam. XLVI. IRIDACEAE.

237. **Iris pseudacorus** L.

Fam. XLVII. JUNCACEAE.

238. **Juncus balticus** Willd.

239. **J. biglumis** L.

Str.: Kirkebörejn, ab. 350 M. (!).

240. **J. bufonius** L.

241. **J. conglomeratus** L.

242. **J. effusus** L.

243. **J. lampocarpus** Ehrh.

244. **J. obtusiflorus** Ehrh.

245. **J. squarrosus** L.

246. **J. supinus** Moench.

247. **J. trifidus** L.

248. **J. triglumis** L.

249. **Luzula arcuata** (Whbg.) Sw.

250. **L. campestris** (L.) D. C.

251. **L. multiflora** (Ehrh.) Lej.

252. **L. silvatica** (Huds.) Gaud.

253. **L. spicata** (L.) D. C.

Fam. XLVIII. JUNCAGINACEAE.

254. **Triglochin palustre** L.

Fam. XLIX. LILIACEAE.

255. **Scilla verna** Huds.

Mr. G. Patursson writes, that according to a communication from Mr. Skaalum of Thorshavn this pretty little plant grows in several places on Nolsö and Sandö.

Fam. L. ORCHIDACEAE.

256. **Habenaria albida** (L.) R. Br.

Str.: Ravnabjörgini near Kirkebö (G. P.); Vid.: rock-ledge on Mornefjæld, ab. 400 M. (E. T.).

257. **H. viridis** (L.) R. Br.; *Coeloglossum* Hartm.

Kalsö: Mountain near Husum (E.T.); Vid: Malinsfjæld, ab. 400 M. (E.T.).

258. **Listera cordata** (L.) R. Br.

Bordö: Fagralid (R. R.), flowering in May—June, fruiting in August; Vid.: Malinsfjæld, slope ab. 2—300 M., flowering (E. T.).

259. **Malaxis paludosa** (L.) Sw.

260. **Orchis latifolius** L.

Myggenæs: »Lundelandet« (accord. to E. T.); Str.: Velbestad (accord. to G. P.).

261. **O. maculatus** L.

262. **O. masculus** L.

Str.: Between Velbestad and Kirkebö, and Ravnabjörgini near Kirkebö (G. P.).

Fam. LI. POTAMOGETONACEAE.

263. **Potamogeton alpinus** Balb.
264. **P. filiformis** Pers.
265. **P. gramineus** L.
P. gramineus L. × **perfoliatus** L.
266. **P. natans** L.
267. **P. perfoliatus** L.
268. **P. polygonifolius** Pourr.
269. **P. praelongus** Wulf.
270. **P. pusillus** L.
271. **Ruppia maritima** L., f. *rostellata* (Koch).
272. **Zostera marina** L.

Fam. LII. SPARGANIACEAE.

273. **Sparganium affine** Schnizl.

III. Gymnospermae.

Fam. LIII. PINACEAE.

274. **Juniperus communis** L., f. *nana* (Willd.).

IV. Pteridophyta.

Fam. LIV. EQUISETACEAE.

275. **Equisetum arvense** L.

Specimens referable to f. *pseudosilvatica* Milde have been found on Str.: Slope at Sandegærde near Thorshavn (!).

276. **E. heleocharis** Ehrh., f. *limosa* (L.).

Str.: Kirkebö (G. P.); Öst.: Lervig, in ditches (R. R.).

277. **E. palustre** L.
278. **E. pratense** Ehrh.

Kunö: near the village (accord. to R. R.); Str.: Kirkebö (G. P.).

279. **E. silvaticum** L.

Fam. LV. HYMENOPHYLLACEAE.

280. **Hymenophyllum peltatum** (Poir.) Desv.

Fam. LVI. ISOËTACEAE.

281. **Isoëtes echinosporum** Dur.
282. **I. lacustre** L.

Fam. LVII. LYCOPODIACEAE.

283. **Lycopodium alpinum** L.
284. **L. annotinum** L.
285. **L. selago** L.

Fam. LVIII. OPHIOGLOSSACEAE.

286. **Botrychium lunaria** (L.) Sw.

Fam. LIX. POLYPODIACEAE.

287. **Aspidium dryopteris** (L.) Baumg.

Str.: Kirkebörejn, rock-ledge sloping towards Arge (!).

288. **A. filix mas** (L.) Sw.
289. **A. lonchitis** (L.) Sw.

Vid.: Rock-ledge on Mornefjæld, ab. 300 M. (accord. to E. T.).

290. **A. phegopteris** (L.) Baumg.
291. **A. spinulosum** (Müll.) Sw., subsp. *dilatatum* (Hoffm.) Sw.
292. **Asplenum adiantum nigrum** L.
293. **A. trichomanes** L.
294. **Athyrium filix foemina** (L.) Roth.
295. **Blechnum spicant** (L.) With.
296. **Cystopteris fragilis** (L.) Bernh.
297. **Polypodium vulgare** L.

Fam. LX. SELAGINELLACEAE.

298. **Selaginella selaginoides** (L.) Link.

LIST OF POPULAR PLANT NAMES FROM THE FÆRÖES

COMPILATED BY

GAZET PATURSSON.

At the request of Mr. C. H. Ostenfeld the author of the present list has tried to put together the popular names of the færoese plants. The names originate partly from papers published by other authors, partly from my own knowledge supplemented by that of fellow-countrymen. During several years I have been interested in collecting the plant names used on my native islands, and I have always noted the names I heard, when travelling from village to village, from island to island.

I am fully aware that the list is not at all complete, but I hope it may be of some value as an attempt to refer the popular names of the færoese plants to the species fixed by their Latin names.

Áarmosi: Astrophyllum sp.
Adam og Eva[1]*:* Orchis maculatus.
Akeleia: Lychnis flos cuculi, Orchis maculatus (Sv.).
Akurull: Eriophorum polystachyum.
Apaldur: Pyrus malus.
Arvi: Stellaria media, Montia lamprosperma.
Bála see Korki.
Baldursbrá: Matricaria inodora, var. phaeocephala (Baldursblað, Sv.).
Baraldin: Juniperus communis.
Bátsmans hattur: Brunella vulgaris.
Bergsýra: Oxyria digyna.
Ber(ja)lyngur: Empetrum nigrum.
Bervísa: The flower of Berlyngur.
Biðiskinn see Mjölkasölja.
Birki: Betula sp.
Bjöllika: the rhizome of Equisetum arvense.
Bjöllikustrá: the sterile stems of Equisetum arvense.
Bjargahvonn see Hvonn.
Bláber: Vaccinium myrtillus (the fruit).
Bláberlyngur: Vaccinium myrtillus.
Bjölgagras: Equisetum silvaticum.
Blaðtari: Laminaria saccharina.
Bláhattur[2]*:* Viola silvestris (Sv.).
Blákolla[2]*:* Succisa pratensis; Viola silvestris.
Blóðgras: Blechnum spicant.
Bjargablomstur: Melandrium rubrum.
Blik see Korki.
Blöðrutari: Fucus vesiculosus, Ascophyllum nodosum.
Bók: Fagus europæa.
Bólatari: Ascophyllum nodosum.
Borð(a)gras: Juncus squarrosus, Carex salina Whbg.
Borður see Borðgras.
Börkubóndi[3]*:* Orchis maculatus.
Breiðsköra: Tussilago farfarus.
Brobber[4]*:* Thymus serpyllum.
Bukkablað: Menyanthes trifoliata.
Börkuvísa: Potentilla erecta; the rhizome: *Börka.*
Bygg: Hordeum vulgare.
Bökkur: Silene acaulis.
Dái: Galeopsis tetrahit.
Dunnuber[5]*:* Vaccinium uliginosum.

[1] The inhabitants of Thorshavn call the white-flowered form Eva, the red-flowered form Adam. [2] According to E: Bláhattur = Blákolla = Succisa prat.; Blákolla = Viola silvestris. [3] Sv. says: it is the root, which is called Börkubóndi. [4] After E: Bróðber, Bróðberg. [5] After Sv.: Dunnuber = Bláber.

Dyngjumosi: Grimmia hypnoides.
Eik: Quercus robur.
Einir: Juniperus communis.
Eyrisgras: Cochlearia officinalis.
Eyrissýra: Oxyria digyna.
Eldurt: Geranium silvaticum.
Eyingras: Euphrasia sp.
Flindur see Korki.
Fransagras: Lathyrus pratensis, Primula acaulis.
Físibjölgur: Lycoperdon sp.
Fura: Pinus.
Glanssölja: Ranunculus acer and R. repens.
Gulbeita: Equisetum silvaticum.
Götubrá: Plantago major, Brunella vulgaris, Gentiana campestris, Polygala serpyllacea, Epilobium (?).
Hagasölja: Taraxacum, Leontodon autumnale, and Hieracium.
Hártari: Desmarestia aculeata.
Havri: Avena sativa.
Heimahvonn see Hvonn.
Hjálpirót: Sedum rhodiola.
Hógvgras: Tussilago farfarus.
Hostagras: Lycopodium selago.
Hoyloppa: Anthoxanthum odoratum.
Hoylús: Myosotis arvensis.
Hoytari: Desmarestia aculeata.
Húsagras: Poa trivialis and P. pratensis.
Hundaland: Agaricaceæ.
Hveiti: Triticum sp.
Hvonn: Archangelica officinalis; cultivated: *Heimahvonn;* wild: *Bjargahvonn;* the stem of the fruiting specimens: *Hvonnjólur.*
Hömilia: Rumex sp.
Iglagras: Potamogeton polygonifolius.
Jarðarsipa: Peltigera canina.
Javni: Lycopodium alpinum.
Jóansökugras: Plantago lanceolata; the leaves: *Langsköra.*
Jomfrú Mariu gras: Orchis maculatus.
Jörðepli: Solanum tuberosum.
Kaggaber: Vaccinium uliginosum.
Kannubjölla see Kannubjölluvísa.
Kannubjöllustrá: Equisetum arvense.
Kannubjölluvísa: Equisetum arvense; the tubers of the rhizome: *kannubjölla.*
Karsi: Cardamine hirsuta.
Kattaklógv: Narthesium ossifragum.
Korki: Lecanora tartarea; the apothecia: *Bála,* the thallus: *Blik, Flindur* and *Tel.*
Koyril (Sv.), *Koyring* (F.): Laminaria saccharina.
Kráka: the sporophylls of Tangur.
Krákuber: Empetrum nigrum (especially the immature fruit).
Krökja, Krökjugras: Vicia cracca.
Krusemynta: Mentha sp.
Langsköra see Jóansökugras.
Línbinda: Brassica campestris (also Sinapis and Raphanus).
Líragras: Succisa pratensis.
Lodnasköra: Tussilago farfarus.
Loppugras: Gentiana campestris.
Lúsagras: Lycopodium selago.
Lyngur: Calluna vulgaris.
Lundasina see Sina.
Marleggur: Isoetes lacustre; marine alga in Sundalag.
Mekja: Iris pseudacorus.
Mekjugestur: flower of Mekja.
Meistarurt: Haloscias scoticum.
Miðkjalsköra: Alchimilla alpina.
Mirkjallur: the midrib of Tangur.
Mjaðarurt: Spiræa ulmaria.
Mjölber: Galium saxatile (F.).
Mjölkasölja: Taraxacum; *Ullakona,* when the flower has fadened; *Biðiskinn,* when the fruits are dropt.
Mógras: Eriophorum and Juncus sp.
Múra, Múrgras: Potentilla anserina, the root: *Murild.*
Mýrimosi: Sphagnum sp.
Mýrisnípugras: Orchis maculatus (and latifolius).
Mýrifípa: Eriophorum polystachyum.
Mýrisölja: Caltha palustris; the leaves: *Sötjuruður, Söljukappar.*
Nátil: Galeopsis tetrahit (F.).
Notur: Urtica dioica.
Óvrökjá: Pedicularis palustris.
Pálmi: Salix phylicifolia.

Perikum: Hypericum quadrangulum.
Pína: Chorda filum.
Prunella: Brunella vulgaris.
Pungagras: Alectorolophus minor.
Puntalastrá: Aira caespitosa.
Ravnaleikur: Orchis maculatus.
Reyðblomstur: Melandrium rubrum.
Reinfann: Tanacetum vulgare.
Riski: Luzula silvatica.
Rívugras: Vicia cracca.
Roygras: Anthoxanthum odoratum.
Royggj: Digraphis arundinacea.
Reipatari: Himanthalia lorea.
Royuber: Cornus suecica.
Rossaber: Rubus saxatilis.
Röllik: Achillea millefolium.
Rugur: Secale cereale.
Sand(s)arvi: Elymus arenarius (Sv.).
Sev: Scirpus pauciflorus.
Seyðasmæra see Smæra.
Sina, Sinugras: Festuca rubra; in the fowling cliffs: *Lundasina.*
Siftusökugras (Svitunsvökugras): Alopecurus pratensis, Phleum pratense (L.).
Sif: Juncus conglomeratus.
Sjeysköra: Alchimilla vulgaris.
Sjógvgras: Armeria elongata.
Skrikkjugras: Vicia cracca; Potentilla anserina (Sv.).
Skúagras: Scirpus cæspitosus.
Skrøpurót: Silene acaulis.
Slíggj: Porphyra umbilicalis.
Slökja: Angelica silvestris.
Smæra: Trifolium repens (the flower oftenest: *Smæra,* the leaves *Seyðasmæra).*
Snjallibjalli: Alectorolophus minor.
Sóleya, Sölja: Ranunculus; Caltha palustris (Sv.).
Söljuruður, Söljukappar see Mýrisölja.
Sortugras: Geranium silvaticum, Spiræa ulmaria.
Spógvagras: Callitriche.
Spóngras: the leaves of Orchis maculatus.
Svartber: Empetrum nigrum.
Stargras: Carex.
Steinamosi: Parmelia saxatilis.
Steinbrá: Galium saxatile.
Störur: Carex, Elymus arenarius.
Summardái: Bellis perennis.
Svínahvánnur: Ranunculus acer.
Svínasölja: Ranunculus repens.
Svövngras: Hypericum pulchrum.
Svövnurt: Haloscias scoticum.
Sýra: Rumex acetosa.
Sötagras: Vicia cracca.
Súir: Parmelia saxatilis.
Söl: Rhodymenia palmata.
Tálgagras: Galium saxatile.
Tarablöðra: the basal part of Reipatari.
Tari: Marine Algae.
Tangur: Alaria esculenta; the stem: *Tangbjölla.*
Tel see Korki.
Tirilshattur: Taraxacum and Leontodon.
Tirilstunga: Lotus corniculatus.
Tirilsgras: Equisetum.
Tistil: Cirsium palustre.
Tröllakambur: Aspidium filix mas.
Tröllablomstur: Brunella vulgaris.
Tröllkonufingur: Cystopteris fragilis.
Trælamosi: Polytrichum commune.
Tágvugras: Silene acaulis.
Tussatongul: Chorda filum.
Tussingur: Laminaria hyperborea; the fringed and torn leaf of Tangur.
Tongul: the stem of Laminaria.
Ullakona se Mjölkasölja.
Undirlögugras: Pinguicula vulgaris.
Vatnlilja: Cardamine pratensis.
Veikur: Juncus conglomeratus.
Víriksgras: Hypericum pulchrum.
Vælaks: Hordeum hexastichum.

Note: The letters *E., F., L.* and *Sv.* are abbreviations for A. C. Evensen, C. A. Feilberg, J. Landt and Svabo, who all have collected popular names of the Færöese plants.

THE LAND-VEGETATION OF THE FÆRÖES,

WITH SPECIAL REFERENCE TO THE HIGHER PLANTS,

BY

C. H. OSTENFELD.

INTRODUCTION.

An attempt is made in these pages to give an account of the vegetation of the Færöes, including its dependence on, and adaptation to external conditions; the whole together forms a contribution to the plant ecology of the Færöes. It is not my intention to discuss questions relating to the Færöese flora and the history of its immigration, because the floristic and phyto-geographical aspects of the land-vegetation have already formed the subject of contributions in »The Botany of the Færöes«, Vol. I (Ostenfeld 1901 b, 1901 c). In a later supplementary list (Ostenfeld 1907), I also revised the vascular plants found on the islands, adding those species found since the issue of the earlier memoirs, and in other ways bringing the floristic list up to date.

My observations on the vegetation of the islands were made chiefly during the summer of 1897, the period referred to in »Bot. of the Færöes«, Vol. I. Previously I had made short visits in 1895—1896 with the Ingolf-Expedition, and in 1903, in addition, I spent three weeks on Strömö (Thorshavn) and on Syderö. The experience thus gained led to the publication of the memoirs referred to and also provided material for the present contribution, which was first published in Danish in December 1906 (Ostenfeld 1906).

That this paper has its shortcomings and defects I know too well. The principal reason for this is, that all my observations were made during summer (between May 7th and Sept. 10th), hence I have no personal acquaintance with conditions during the stormy, sleety Færöese winter, and am obliged to supply this lack in my information by purely meteorological statistics relating to the Færöese climate (Willaume-Jantzen, 1899 and 1905). Fortunately however, I have obtained a certain amount of supplementary information of great value from a botanical point of view. This consists

of a number of notes from Dr. Knud Poulsen on the nature and duration of the snow-covering during the winters 1901—02 and 1902—03, and also relating to the time when certain plants began to flower in the spring of 1902 and 1903. I take here the opportunity of tendering my sincere thanks to Dr. Poulsen, a friend of many years duration, for the great care and regularity with which he prepared these notes, especially so since the vocation of physician allowed him only a scanty leisure. In more ways than one, these notes have been of great benefit in enabling me to grasp the peculiarities of the Færöese vegetation.

I have also been permitted to use some notes made by Mr. R. Rasmussen, Fagralid on Bordö; these include records of the commencement of flowering periods, and also lists of plants in different habitats on the Nordreöer (Northern Islands).

Acknowledgements are also due to Mr. C. Jensen and Mr. J. Hartz for valuable assistance with regard to the mosses and lichens mentioned in this paper; Mr. Jensen especially has aided me greatly in identifying the numerous examples of mosses which I collected.

For most of the photographs reproduced here I am indebted to Professor E. Warming and Dr. F. Börgesen. The former has also placed at my disposal a number of notes, some taken on the Færöes in 1897, others being annotations on the Danish edition of this memoir.

The material for this memoir was put together in 1897, but its completion has been delayed for many reasons which need not be detailed. To delay was easy, when one had a certain reluctance in attempting a task which seemed unsatisfactory on account of the insufficient preliminary study possible, in what was really a sojourn of a single summer.

As the work progressed this reluctance disappeared almost entirely, and in recalling my stay on the islands I could not forget the hearty hospitality and helpfulness extended to me everywhere on these charming crag-girt isles.

If in the smallest degree this paper will aid any efforts towards the welfare and success of the islands, then I feel that in this way it may in some measure repay my debt to their inhabitants.

The plan of this paper is to give in the first part a brief historical survey of our knowledge of the Færöese vegetation, especially as regards its ecology. The influence of external conditions on the vegetation is next considered along with different biological features of importance with regard to the physiognomy of the vegetation and its composition. The main part of the paper then follows as a description of the plant-formations, with a review of the adaptations of the various plants to the conditions under which they live.

The English edition differs in several respects from the Danish one, as I have altered the treatment of some parts (especially Chap. III.) and have put in many corrections and amendments. The translation, made by a Danish translator, has been corrected and revised by Dr. W. G. Smith of the University of Leeds, and I wish here to thank him sincerely for his assistance in the necessary, but not always easy task of finding English equivalents for Danish ecological terms. The full text of this paper has thus been rendered available for English readers.

I. HISTORICAL REVIEW OF LITERATURE RELATING TO THE VEGETATION OF THE FÆRÖES.

Prior to the detailed investigations carried out during the last 10 years, the principal source of our knowledge of the vegetation of these islands was E. Rostrup's treatise: »Færöernes Flora« (1870). Some of the still earlier works refer to vegetation in more or less casual manner. Nowhere, however, is there any special consideration of that aspect which is our particular objective, namely: a description of the plant associations of the Færöes, and their conditions of life.

It is only regarding the associations of cultivation (the Farmland with its cornfields and grass-meadows) that the earlier authors give any information.

Jörgen Landt in 1800 published a description of the Færöes with a long list of plants, but says nothing about the vegetation in the uncultivated part of the country. There is a detailed chapter on the condition of agriculture (l. c., p. p. 292—320) and on haymaking (p. p. 320—328), and we are told how the inhabitants treat the soil brought under cultivation. The methods then in use, more than a hundred years ago, were much the same in their principal features as those now employed and described later in this paper. The

same cultivated plants were in use, chiefly barley (Bigg)[1] and turnips; the cultivation of potatoes, which is now rather extensive, was then only beginning, while oats and other crop-plants were then as now of no great importance. Nature was left, as it is today, to clothe the cultivated fields with grass after the barley-harvest, and so in the course of a few years to form a meadow. It is noteworthy to what degree conservatism has ruled in agricultural affairs during the past century, and how only in recent years there has been any progress.

Pastor H. C. Lyngbye, the author of the well-known, important work on Algae: »Tentamen Hydrophytologiae danicae«, visited the Færöes in 1817. From his pen we have (Lyngbye 1822) some: »Anmærkninger til kort Efterretning om Færöerne efter Sir Mackenzie«. This paper includes a somewhat abbreviated translation of Mackenzie's paper, which however contains little of much interest to us, merely the usual description of methods of cultivation. Lyngbye's comments, on the other hand, contain some valuable botanical information. His description of the ascent of Skællingfjæld on Strömö (l. c., p. p. 125—126) is specially worthy of notice on account of the detailed observations on the vegetation of the summit-plateau of the mountain. — He states that the summit is »in places covered with moss, especially *Trichostemum [Grimmia hypnoides* and *G. ericoides]*[2], and in other places it is bare sand and gravel with *Koenigia islandica* appearing sparsely here and there.« Lyngbye has in these words defined the two highland plant-formations, distinguished in this paper as Grimmia-heath and Rocky-flats. He gives a list for the latter which, in addition to a number of lichens and mosses, includes the following species of flowering plants: *Festuca vivipara [F. ovina vivipara], Aira montana [A. flexuosa montana], Koenigia islandica, Polygonum viviparum, Rumex digynus [Oxyria digyna], Saxifraga palmata [S. caespitosa], S. stellaris, Cerastium alpinum [C. Edmondstonii], Arabis hispida [A. petraea], Statice Armeria* and *Salix herbacea.* This collection of species coincides exactly with my own conception of a rocky plateau as seen in the Færöes. Lyngbye also describes (l. c., p. p. 130) how a cornfield, left uncultivated, be-

[1] Byg, Bigg or Bere are names applied to several hardy varieties of *Hordeum vulgare* with short six-rowed ears; the crop is grown only in the upper part of the Oat-zone (e. g. in Scotland) or on inferior soils, and is much less valuable than the finer qualities of brewing Barleys grown in the Wheat-zone. (Note by W. G. Smith).

[2] The names enclosed in square brackets are those now used.

comes covered with weeds (my Metamorphic Vegetation), and gradually arrives at the condition of a grassy meadow with *Holcus lanatus* and *mollis*, *Anthoxanthum*, *Festuca pratensis*[1] and *Agrostis vulgaris;* in other words the usual »Bö«-formation.

A record is also made of the peculiarity that the houses are all thatched with green turf, on which the grass thrives so well, that »one can mow hay on the housetop« (l. c., p. 149), and a list of the plants growing on the roof of Sörvaag church on Vaagö is given.

A few years after Lyngbye, the danish geologist Forchhammer visited the Færöes accompanied by a Scotsman, W. C. Trevelyan, who published a short paper on the vegetation and climate of the Færöes (Trevelyan 1835—37). What he has to say regarding the vegetation is mainly quoted from the memoirs of Landt and Lyngbye, but some original observations are given in his note on an ascent of Malinsfjæld on Viderö, which Trevelyan and Forchhammer made on July 18th 1821. The list of species growing on the summit-plateaux corresponds exactly with Lyngbye's list from Skællingfjæld, and Trevelyan adds the altitudes at which the different alpine species were first observed during the ascent.

The next contribution to our knowledge of the vegetation of the Færöes is that of Ch. Martins, who came to Thorshavn with the French corvette »La Recherche«, and during his stay there made excursions to Strömö and Nolsö. His observations formed the basis of a comparative study of the flora of the Færöes, Shetland and Iceland with regard to the routes and agents concerned in the immigration of these floras (Martins 1848). It is beyond the province of this paper either to review or to criticise this part of Martins' contribution. There is the oft-repeated description of agricultural conditions and the methods of cultivating the soil. Short sketches are given, however, of the vegetation in the immediate neighbourhood of Thorshavn, and on Nolsö from the coast to the summit of the mountain on that island.

The characteristic rounded rocks north of Thorshavn with their varying vegetation are accurately described, and he distinguishes between the barren and exposed tops, where *Armeria* is so prominent, and the boggy hollows with *Eriophorum*, etc. On Nolsö he mentions the vegetation of the sandy strand with *Honckenya*, *Cochlearia* and *Potentilla anserina*, and attention is drawn to *Nardus stricta* as

[1] The identification is not correct; *Festuca rubra* is probably what is meant.

the dominant plant of the mountain slopes; »it had, so to speak, excluded all other vegetation« (l. c., p. 369). Martins' lists are very faulty, and a number of species reported from the vicinity of Thorshavn have not been confirmed by more recent observers, although undoubtedly this district has been more thoroughly examined than any other part of the Færöes.

A picturesque description of the Færöes was written by P. A. Holm (1855) in a somewhat general and popular style.

The vegetation of the thatched roofs, the grassy »Bö's«, and the cultivation of corn, potatoes and turnips all come under notice. Regarding the vegetation outside of the area of cultivation, we are told that »Tue-Kogleaks« *(Scirpus caespitosus)* and »Tue-Star« (presumably *Juncus squarrosus* is meant) form pretty green tussocks on the moors, with the intervening spaces occupied by many kinds of »Siv« (*Juncus lampocarpus* and *Carex*-species) and »Kæruld« *(Eriophorum)*, the prevailing sombre tone being relieved by the coloured flowers of »Benbræk« *(Narthecium)* and »Fjæld-Vibefedt« (must be *Pinguicula vulgaris*, not *P. alpina*). What he refers to here is the Grass-moor and the Sedge-moor as they are found on the »Hauge« i. e. the uncultivated parts of the lower zone. Holm also mentions the Calluna Heath (Lynghede) with its »Rævlinger« *(Empetrum)* and *Vaccinia*, also the rock-vegetation, and he adds a few notes on the mountain vegetation.

Our review of the literature now brings us to the memoir of Rostrup, which is based on a voyage made in 1867 along with Mr. C. Feilberg round most of the islands. An effort was made to complete the list of plants as far as possible and to extend it over all groups of plants. Earlier, often incorrect, statements were revised and verified, and many new discoveries by the authors themselves were added. Thus for the first time a complete and reliable floristic list was obtained for the Færöes. Rostrup also gives a general account of the vegetation, and this up till now has been the main source of information on this subject. At the time Rostrup wrote this paper (1870), systematised studies on vegetation in relation to its environment were hardly known. Hult's »Forsök til analytisk behandling af växtformationerna« (1881) did not appear till 10 years later, and still later Warming published his »Plantesamfund« (1895), the first systematised work on the vegetation of the earth from an ecological point of view. Rostrup therefore does not attempt a consecutive account of the plant-associations, but

merely describes the vegetation of different localities: e. g. »Bö«, moor, shore, lake etc. For each locality the common and dominant plants are recorded with remarks on features of biological interest. A few examples will illustrate his method. Describing a »Bö«, Rostrup enumerates the principal characteristic grasses, and he points out that the grasses of the Færöes are particularly liable to appear as »viviparous« forms, a condition which »may probably be attributed to the moistness of the atmosphere«. The grasses of the thatched roofs are included in this list. Then follows a list of those »flowering« herbs which occur most frequently among the grasses. The »Bö« at Sand on Sandö, a well-known Færöese locality for flowering plants is described at some length. He concludes with a list of species, which although most at home in »the higher regions«, may appear occasionally in the »Bö«. Other plant-associations and their habitats are dealt with in like manner (l. c., p. 12—20).

The introduction also contains some interesting notes on the duration of species. Rostrup points out the peculiar absence of trees and shrubs, and that most of the plants are perennial herbs, while the comparatively few annual and biennial plants which are found, occur with few exceptions as weeds in the arable land, in enclosed fields, or near the sea. He estimates that »about half a score of true mountain plants« are annuals or biennials, and gives the names of six species. Only one of these however, is an annual, another is a parasitic plant, and the remainder are perennials. The annual referred to is still the one annual species on the Færöese mountains, viz. *Koenigia*.

During the next 20 years no papers were published on the vegetation of the Færöes, but early in the nineties a fresh start was made.

The first to be mentioned is a short contribution by two English ladies, Miss Copland and Miss Birley (1891), who visited the Færöes in 1889: this contains few observations which had not been made already. In describing an ascent of Odnedalstind on Strömö a few common mountain plants are recorded: *Ranunculus glacialis, R. acer pumila* etc.

In 1895 the Swedish botanist, Dr. H. G. Simmons made a voyage to the Færöes, principally to study marine algae, but he also made collections on land, and gives brief floristic notes on these. (Simmons 1896).

Dr. F. Börgesen paid his first visit to the islands in the same year. My first observations were also made about this time when I landed at Trangisvaag on Syderö on the outward and homeward voyages of the Danish Ingolf-Expedition. A short note on our combined observations on the vegetation with some lists of plants was published later (Börgesen and Ostenfeld-Hansen 1896).

The systematised investigation of the vegetation of the islands, projected by Prof E. Warming, was begun during the following year (1896), when Mr. C. Jensen investigated the moss-flora of most of the islands, and Dr. Börgesen studied the algal flora of several of them. C. Jensen's excellent account of his voyage (Jensen 1897) contains many extracts from his diary which are of ecological interest. There are numerous observations on the vegetation and on the habitats of particular species, as well as reflections on the influence of environment. This memoir has been of much service to me, and will be referred to again and again in my chapter on plant-associations. Mr. Jensen has not limited his observations to mosses only, but has recorded many noteworthy facts regarding the vegetation as a whole, his extensive knowledge of the flowering plants enabling him to give descriptions of plant-associations superior to those resulting from a one-sided study of either flowering plants or mosses alone.

The plant-associations of the Færöes are also dealt with in P. Feilberg's »Fra Lier og Fjælde« (From slopes and mountains) which was printed privately as a manuscript (1900). The author spent the summer of 1899 on the Færöes and Shetland, principally to study vegetation from an economic point of view, and he gives a delightful account of his travels.

The paper deals mainly with the grassland of the cultivated area, the cultivation of corn and potatoes, and the lower zone of uncultivated land (»Haugen«). Although the purely botanical side is only of minor importance from the author's point of view, yet he gives some excellent descriptions of certain plant-associations.

The grass-vegetation of the »Bö« and the cultivated fields is first dealt with at considerable length; in a less degree the grass-slopes and grass-moors, boggymoors, heather-moors and Calluna-heaths.

Special attention is directed to the constitution of the soil and its influence on the composition of the vegetation, and the exception-

ally wide distribution of humous and peaty soils in the Færöes is referred to again and again.

The result of my own travels in 1897 were published in 1901, C. Jensen's method of treatment being followed. This may be regarded as a preliminary study to the present paper, hence need not be formally summarised, nor is it necessary to consider further the short account of the vegetation which I wrote for the article »Færöerne« in the Danish periodical »Atlanten« (1905—06, p. 216—221). With regard to the present and most recent contribution it may be stated that a Danish edition appeared in 1906.

In addition to these more strictly botanical papers, one may find many references to the vegetation scattered throughout the pages of memoirs on the Færöes, many of which have appeared in recent years. The titles of some of these may be given without attempting a formal summary of observations generally of minor botanical importance: J. Lomholt's descriptive article on the Færöes in the periodical »Nord og Syd« (1898); Pastor I. F. Rönne's popular pamphlet on the Færöes (1900); James Currie's descriptions of the islands in »The Scottish Geographical Magazine (1906); and the article in »Atlanten«, already mentioned, which includes a description of the agriculture by L. Berg (1906). Bibliographical lists of works relating to geography and natural history are given in »Atlanten« (1905—06); under »Færöerne« (by J. J.) in Salmonsen's Lexicon; and in »Færö Amt« (The district of the Færöes) in Trap's large topographical and statistical work »Danmark« (3rd edition).

This summary I trust, has now dealt with all the more important contributions on the vegetation (plant-associations) of the Færöes.[1]

It may be stated, however, that only a brief reference has been made to agricultural literature, because it is regarded as lying somewhat beyond the scope of this paper which is purely scientific. For the same reason horticulture has been passed over. Both departments are worthy of special consideration by experts on the respective subjects.

[1] Professor Eug. Warming in his introduction to »The Botany of the Færöes«, vol. I (1901) has given a short description of botanical investigations in the islands; this agrees essentially with the summary given here.

II. THE INFLUENCE OF EXTERNAL FACTORS ON THE VEGETATION.

The vegetation of the Færöes bears the impress of the peculiar climatic conditions which result from the geographical position of the islands.

The decidedly insular climate with cool summers and absence of extreme cold in winter, with an all-prevailing humidity and abundant rainfall, all these together produce moist conditions in the soil almost everywhere and favour the rapid production of humus.

Excellent accounts of the Færöese climate are given by Willaume-Jantzen in »Geografisk Tidsskrift« (1899) and »Atlanten« (1905). In »Bot. of Fær.«, Vol. I. (Ostenfeld 1901 a) I have given a short abstract of the first of these papers.

These accounts show at once a climate with characteristics so marked that they must of necessity have a determining influence on the vegetation. It will therefore be advantageous to consider in some detail these climatic conditions in so far as they influence plant life.

Vegetation is affected not by climate alone, but also by edaphic factors, nor can the influence of man and animals be left out of account. There are thus three main groups of factors to be investigated when considering the relation between external conditions and the vegetation.

1. Climatic factors.

a. *Temperature.* Willaume-Jantzen's sketch of the climate makes it quite evident that there is an unusually slight variation in the temperature of the air in the different seasons of the year. The climate is decidedly insular. The coldest season extends into the middle of March, and the highest temperatures begin to be registered in July and August.

Observations made at Thorshavn over a period of 30 years[1] give the following averages (in Centigrade) for the months of the year:

[1] In my abstract (Ostenfeld 1901 a) I have only been able to use Willaume-Jantzen's first paper which is based upon observations during 25 years; therefore the figures given there do not exactly correspond with those published here.

January	February	March	April	May	June	July	August
3° 2	3° 2	3° 1	5° 5	7° 2	9° 7	10° 8	10° 8

September	October	November	December.
9° 4	6° 7	5° 0	3° 5

The mean annual temperature is 6° 5 C.

These show, that winter and early spring (December-March) have nearly the same temperature, about 3° 3—3° 2 C. Consequently there is no winter to speak of with prolonged periods of temperatures below zero. So far as vegetation is concerned, however, the mean readings for any period are of less value than the real reading, because it is more especially the extreme ranges of temperature, which are of importance in this connection. The lowest temperature in Thorshavn during 30 years is — 11° 6 C. It is furthermore of interest to note, that the annual number of »ice-days« (i. e. 24-hour periods during which the temperature does not exceed zero) is only 8, and there are 70 »frost-days« (i. e. 24 hours during which the temperature falls for some time below zero). These are comparatively small numbers. Even on »frost-days« the temperature is seldom much below zero, as is proved by the fact that in Thorshavn during a period of 30 years only 9 days have yielded a temperature below — 10° C.

It must also be considered whether the changes of temperature occur often and suddenly, or whether the periods are long, and the transitions slow and uniform. It is not easy to obtain good data to answer this question, but all things considered the changes seem to be rapid. An abrupt change from frost to thaw, especially in spring, will invariably have an injurious effect upon the vegetation, and on the Færöes one frequently hears of damage from this cause. These sudden changes are confirmed by the observations on the snow-covering in the winters 1901—02 and 1902—03, made by my friend Dr. Knud Poulsen. These I have given in full on a later page, but one part of his notes is particularly applicable here: December 30th and 31st, 1902, heavy fall of snow, and a fairly deep snow-covering; January 1st, 1903, rain; Jan. 2nd, snow disappeared in the lowlands; Jan. 4th, black-frost; Jan. 5th and 6th, continuous fall of snow; Jan. 7th, snow with wind; Jan. 8th, rain, the snow melting; Jan. 9th, black-frost; etc. Thus within ten days the district has been twice covered with snow, twice cleared of snow by rain, and twice in the grip of black-frost. One can easily conceive that changes of this kind must have some influence on the growth

of plants. Even with the relatively high winter temperature, plants must be very hardy to endure changes so rapid and frequent as these.

On the other hand, compare the summer temperatures and their influence. The two hottest months are July and August with a mean temperature of 10° 8 C. In other words, there is no real summer, as understood in Europe. If however the actual temperatures are taken into account, the conditions are not so unfavourable. The highest actual temperature recorded in thirty years is 21° 2 C. But even in summer considerable variations in temperature from day to day are frequent, mainly as a result of the extremely changeable winds.

Our knowledge of atmospheric temperature may be summed up in a general statement:

The temperature of the air in winter is comparatively high, as a rule above 0° C., occasionally a rapid fall below zero may occur for a brief period, yet extreme low readings never occur. The coldest period extends into the middle of the spring, and it is April before the temperature begins to increase. July and August are the hottest months, but even then the temperature is rather low, seldom rising above 20° C.; rapid changes also occur during this season.

Plants capable of thriving under these conditions, must therefore be adapted to comparatively low temperatures, but there is no need for any special adaptability to extreme and continuous cold.

b. *Rainfall and atmospheric moisture.* The rainfall is considerable, the annual amount being 1570 mm. At all times of the year there is an abundant downpour; it is least during the spring and summer months, viz. April (93 mm.), May (88), June (77), July (87), whereas December and January have 185 and 184 mm. respectively.

The rain generally falls as a fine drizzle, the total amount for any given period being small. This is indicated by the fact that in spring and summer there are no less than 20 rain-days per month, or two thirds of the entire month; yet the actual amount recorded in this period is only 86 mm. or an average of 4.3 mm. for each day with rain. In winter the number of rain-days is 28 per month. The mean annual number of rainy days is about 280, which leaves only 85 days without rain in the year (23 p. cent).

Fogs are also frequent, and take the place of rain, especially during the summer months. The annual number of fog-days is 54, of which 30 occur during the months of June, July and August, whereas the months from December to March have only one foggy day each on the average. It must be noted, however, that all these meteorological observations have been taken in Thorshavn, consequently in the lowlands. The number of foggy days amongst the mountains is certainly much greater, but unfortunately no record of these is available.

The relative humidity of the atmosphere is great, namely 82 p. cent., p. annum. On comparing the figures for each month it is found, that there is no great variation during the different seasons. The lowest mean humidity, 78—80 p. cent., is during the spring months, February to May; the greatest is in the summer, July to September (85 p. cent.).

The variation in the relative humidity is not, unfortunately, indicated by these figures, but, through the courtesy of the »Danish Meteorological Institute«, I have been able to consult a table showing the lowest records of relative humidity observed. This table states, that periods may occur, during which the humidity falls to 30—50 p. cent., but this is exceptional (e. g. 30 p. cent. has been observed only once in 25 years, and 31 to 39 only seven times). The lower readings occur without relation to season, but on the whole are more frequent in early summer. According to M. Knudsen (1900), the humidity and the temperature are both dependent upon the direction of the winds, or rather, whether the wind comes from the »East-Icelandic polar stream«, or from the »Gulf stream». When the wind blows from the polar stream, the average relative humidity is 72—81 p. cent.; if from the Gulf stream, then 81—90 p. cent. is attained. Winds from the polar stream also lower the temperature over the islands to a considerable extent.

Thus though the atmospheric humidity may become very low on rare occasions, it is open to us to regard it as almost always comparatively high.

Under these conditions, and with the prevailing moistness of the soil, there is no necessity for the development of structures, such as dense hair-coverings, etc., which protect plants from the effects of excessive evaporation. It is actually the case, as we shall see later, that woolly or tomentose species are the exceptions amongst Færöese plants; in fact, xerophilous characters are exhibited by com-

paratively few species, and these are almost all plants of the mountain or swamp.

c. *The snow-covering.* In arctic regions, where the winter is severe and enduring, the presence or absence of snow is of the upmost importance for vegetation. The mild winters of the Færöes render a snow-covering less essential, but even here the plant covered by snow possesses advantages over the unprotected one. The snow not only serves to mitigate the alternations of frost and thaw,

Fig. 165. Snow-clad landscape, Trangisvaagfjord on Syderö.
(From photo. by O. Effersöe.)

but it also protects the plants from direct insolation during frost, and from the dessicating effect of severe storms.

As no information respecting the duration of the snow-covering is to be found amongst the meteorological statistics, I prevailed on Dr. Knud Poulsen to make as many observations on snow-covering as possible, during his sojourn of two winters in Thorshavn. His notes are extensive, but I have no hesitation in quoting them at full length, because they are valuable both from the purely meteorological and from the botanical point of view.

The winter 1901—1902.

November 12th: the first snow fell, covering the mountains and lowlands with a thin coating. 16th: lowlands free from snow, the south-sides of the mountains practically in the same condition. 17th: snow again, covering every place with a thin and equal coating. 20th: snow gone everywhere. December 9th: a thin coat of snow everywhere. 10th: a thaw setting in. 11th and 12th: thaw; the lowlands snowless. 13th and 14th: a heavy fall of snow, the lowlands covered. 16th: the lowlands almost free from snow. 17th: snow and wind. 18th: fall of

snow. 19th: snow commencing to disappear in the lowlands. 21st: rain. 22nd: the snow has disappeared in the lowlands, and practically on the mountains. 26th: snowless nearly everywhere. 27th Dec. to 9th January: essentially unchanged; no precipitation of any consequence; apparently very little evaporation, because the few patches of snow in sheltered places on the mountain-slopes and on the summit-plateaux do not seem to decrease in size to any considerable extent. 10th: snow-storm. 11th: snow everywhere, calm, frosty. 12th: snow-storm. 14th: rain. 15th: snow has almost disappeared. 25th: snow-storm, snow everywhere. 30th: thaw. 31st: snow has disappeared almost everywhere. February 4th: snow everywhere. 4th—13th: frequent falls of snow. 13th: the snow lies in great drifts, especially on the gentle northern and western slopes; on the other hand, on the summit-plateaux and in the lowlands, the snow-covering varies from a few ctm. to 30—60 ctm. 14th: thaw has commenced. 15th: the snow has already partially disappeared in the lowlands. 16th: the snow has disappeared almost everywhere; rain. March 10th: fall of snow, the mountains covered with a thin coat of snow; thaw in the lowlands. 19th and 20th: once more a little snow. 21st: snow-storm during the night, a thin coat of snow everywhere. 23th: the snow lies, as usual, mostly on the northern and western sides; snow also in the lowlands. 27th: much has evaporated and melted; the patches of snow become fewer and more scattered, as one approaches the sea. We were told, there is still much snow on the northern islands, extending down to the sea. 29th: fall of snow. 31st: thaw, storm from the east. April 1st: almost free from snow. 3rd: fall of snow. 4th: thin coat of snow on the mountains. 6th: coating of snow on the summit-plateaux, scattered patches on the mountain-sides. 6th—9th: thaw. 10th—12th: rain. 12th: only a few patches of snow remain on the summit-plateaux. May 2nd: the patches have nearly disappeared. 3rd—4th: slight fall of snow. 4th: thin cover of snow on the mountains. According to report, much snow on the northern islands all the way down to the sea. 10th: much snow on the mountains of the northern islands (personally observed); southwards completely free from snow.

The following remarks by Dr. Poulsen may be added to these notes:

»The parts of the islands which I have been able to observe to some extent, include the southern parts of Strömö and Österö, as well as Sandö and Nolsö. These are all comparatively low, and they are, presumably mainly on this account, snow-covered to a much less extent than the great northern part.

Nevertheless there is a marked difference between Nolsö, for example, and the immediate neighbourhood of Thorshavn on the one hand, and, on the other, the district about 25 km. further north on Österö. Nolsö frequently becomes snowless in a few hours, presumably because it is small, low and dome-shaped, sloping on almost every side steeply towards the sea. Snow is never present on it in large quantity, nor does it form drifts.

When the expression »snow-covered« is used in these notes it is only an approximation, because extensive bare places may always be

found, while outstanding boulders, rocky ledges (»Hamre«) etc. are never, strictly speaking, buried in snow. A real snow-field suitable for snow-skating is thus a rare occurrence.

In the early part of February, when we had the largest fall of snow, much more snow than usual, we were told, I was obliged to walk on several occasions from Thorshavn to Velbestad on the west-side of Strömö. The snow was distributed as follows: A number of large and deep snow-drifts occurred on the gradually ascending slopes from Thorshavn to the summit-plateaux (c. 200 M.); alternating with these were areas entirely free from snow, and other stretches covered with a smooth uniform coating of snow from 30 to 60 ctm. deep; the plateau itself was covered by a layer of snow with a depth from 15 to 30 ctm., so that the larger stones and boulders were not covered. The steeper slope from the plateau downwards to Velbestad was practically without a single snowless spot, even the »Hamre« (rock-ledges) being buried. The snow everywhere reached almost to my waist, and had gathered in many places into enormous snow-drifts.

From what I saw myself at this and other places, and from what I have been told, I believe that this example will convey a tolerably good idea of the conditions at this period.

The snow disappears very rapidly as a rule, as shown by the notes. Indeed, it is often surprising how a heavy rain may cause, in the course of a couple of hours, the rapid disappearance of a comparatively large amount of snow, and this quite as much on the mountains as in the lowlands. I find, after everything is taken into consideration, that there is much less difference between the snow on the mountains and in the lowlands than I had expected.«

The winter 1902—03.

November 15th: a thin layer of snow on the summits of the northern islands. December 25th: snow, 2—3 ctm., forming a uniform covering in the lowlands and on the mountains. 26th: heavy and general fall of snow. 27th: heavy rain, the snow melts. 28th: the snow entirely gone in the lowlands, but still isolated wreaths and patches on the mountains. 30th and 31st: heavy fall of snow, forming everywhere a uniform coat, 2—8 ctm. January 1st 1903: rain. 2nd: snow gone in the lowlands. 4th: black-frost. 5th and 6th: general fall of snow. 7th: drifting snow. 8th: rain, the snow melts. 9th: black-frost. 10th: snow-storm. 11th: black-frost. 12th: snow, 15—60 ctm., lying on the mountain-plateaux, the larger stones and boulders exposed; much snow with snow-wreaths, 1—1.25 metres deep, lying on the western side of Strömö (the mountain slope towards Hestö-fjord); only a little snow on the eastern side of Strömö and on Sandö. 13th and 14th: thaw and rain. 15th: snow gone. 18th: a little snow yesterday and during the night, now thaw and snow gone. February 1st: snow. 2nd: snow, 2—2.5 ctm., everywhere in the lowlands and on the mountains. 3rd: rain. 8th: heavy fall of snow, almost 15 ctm., lowlands and mountains uniformly covered. 10th: the snow completely gone in the lowlands and partially so on the mountains. 20th: hardly any change, snow in patches on the mountains. 22nd: slight fall of snow, chiefly on the

mountains. 23rd: uniform layer of snow on the mountains, about 5 ctm.; no snow in the lowlands. 24th: the snow on the mountains partly gone. 26th: a thin layer of snow still lying on the higher mountains. March 6th: patches of snow here and there only. 10th: almost entirely gone. April 5th: snow. 7th: snow gone again. 10th: fall of snow. 12th: fall of snow with some wind. The layer of snow about 5 ctm. deep, except in occasional deeper drifts. 14th: fall of snow, lying about 15 ctm. deep. 15th: slight fall of snow. 17th and 18th: the snow evaporating rapidly. 19th: rain. 20th: lowlands and mountains almost snowless; scattered wreaths on the tops of the mountains. 21st: slight fall of snow in the evening. 22nd: fall of snow, with thaw. 23rd: snow gone in the lowlands, scattered spots and wreaths on the mountains. 26th: almost all the snow gone. May 8th and 9th: fall of snow; the mountains snow-covered, but not south of Thorshavn, the lowlands snowless.

Dr. Poulsen further states: »These observations as a rule hold good only for the southern part of Strömö, with Nolsö, Hestö and Sandö. These islands present somewhat similar conditions as regards snow-covering. Nolsö, however, always loses its snow first of all, and it is under snow to a less extent than the others, particularly Strömö; this is probably due to its situation and form. The same is true to some extent with regard to Hestö. Much more snow falls on the northern part of Strömö and on the northern islands, and the mountains there have been more or less snow-covered through the entire winter; this has certainly been the case on the higher mountains. This is due probably to the much greater altitude of the mountains, though the difference in latitude and situation must also be of some importance. So far as my information goes, snow and the snow-covering on Syderö have been rather less than in Thorshavn district, although part of that island has a high elevation.

On the whole, less snow has fallen during this winter than in the one before, there being very little previous to Christmastide.«

These notes on the two winters present an original and in all essentials a perfect picture of the snowfall and the snow-covering on the Færöes. The prominent feature is the frequent and rapid changes between snow, thaw and black-frost.

The speedy disappearance of snow and frost is due doubtless to the proximity of a relatively warm ocean; the mean temperature of the ocean at Thorshavn from January to March being 5° 5 C.

The snow is never allowed to stay long, and a constant snow-covering throughout the entire winter never occurs. Hence on the Færöes the snow-covering plays quite a subordinate part in protecting the vegetation against the cold of winter; on the other hand the cold itself is not severe enough to be of prime importance. The snow probably exerts its greatest influence as a form of precipitation,

since it is soon converted into water. Only on rare occasions does the snow-covering become a protection against the united forces of frost and wind; this was the case in the period February 4th to

Fig. 166. Malinsfjæld (750 m. altitude) on Viderö. Upper part snow-clad, the lower slopes being entirely clear. (From photo. by K. Rimestad.)

13th of 1902, the greatest and most lasting snow-covering of these two winters.

The observations apply, as emphasized by Dr. Poulsen, only to the lower districts. A more continuous snow-covering seems to occur, however, on the mountains of the northern islands. The climate there is presumably colder, since sub-arctic plants are known to be located there in greater numbers, e. g. *Dryas, Veronica alpina, Saxifraga rivularis, Papaver radicatum, Salix glauca*, etc. Unfortunately we have no exact information on the climatic conditions in the mountains, and must be content with what may be gathered from the scanty records available. Observations of this kind carried on for several years on the summit-plateau of one of the

higher mountains would form an extremely valuable contribution to meteorology and to plant-ecology.

d. *Movements of the air (wind).* The Færöes have earned a well-deserved reputation for their stormy climate.

The mean records show that at Thorshavn only 12 p. cent p. ann. of the days are calm, the remaining 88 p. cent have some wind, frequently a stiff breeze. During the winter-season one in four or five of the southwesterly winds becomes a gale or storm, but in summer-time only one in thirty does so. If the strength of the wind be expressed by a scale of 0—6, then the average figures are 2,0—2,2 in winter, and 1,3—1,5 in summer. The winds blow in nearly equal proportions from all points of the compass; though there is some difference in the frequency, in that they are oftenest S. W. and W., N. and N. E. coming next. There is, however, this great difference between the two groups: the former bring heat and moisture, whereas the northerly winds bring cold and little moisture (cfr. M. Knudsen 1900).

The great influence of the wind on vegetation (mainly as a desiccating agent, but also as a mechanical one), is a well known fact emphasized in the case of northern countries by many botanists, particularly E. Warming, N. Hartz (1895), O. Kihlman and more recently by Adolf Hansen. The effects of the wind are very marked in many places on the Færöes. One characteristic type of vegetation, primarily determined by the wind, occurs in its most typical form on the so-called »Eider« (see Fig. 167). These valley-like depressions extending across the islands are swept by winds of such strength, that at times it is impossible to maintain an upright position. All plants there are dwarfed to such a degree, that they form a closely shorn green sward in which the flowers open amongst the leaves instead of rising some distance above, as under ordinary conditions. As an instance there is in a sward of this kind at Vaag on Syderö an abundance of *Lychnis flos cuculi* with flowering stems not exceeding 2—5 ctm., instead of the usual height of 20—50 ctm. The force of the wind is also indicated by the vegetation of the summit-plateaux of the mountains. Here the sward of dwarfed plants may be found with portions torn up and carried away (Fig. 170). It is even possible by examination to determine for any given place the direction of the strongest wind, from the fact that the vegetation forms strips or elongated patches, the long axis of which is at right angles to the wind. In the case of sum-

mits with only a meagre rocky-flat vegetation, the majority of the plants shelter around and on the lee-side of stones. Another example of the power of the wind in the mountains may be given: One frequently comes across small patches of powdery soil quite devoid of any vegetation whatever; they are generally situated in a shallow depression liable to be flooded with water, but when this evaporates, the soil dries up and forms cracks arranged in a kind

Fig. 167. An »Eide« at Kvalbö on Syderö. The soil over large patches has been carried off by the wind; the portions where the plant-covering still remains form slightly elevated tables or pedestals with scarped or overhanging hollowed out margins. (From photo. by E. Warming.)

of polygonal honeycomb (»Rudemark«). In summer the gaping cracks are seen to be filled with stones varying in size from a nut to a closed fist (see Fig. 168); on the surface, however, there are hardly any stones. This we regard as evidence that the wind tumbles these stones about, and causes them to lodge in the cracks.

The few trees to be found, chiefly in and about Thorshavn, are all planted in places sheltered from the wind, and cannot grow any higher than their shelter allows; they have the same stunted growth as the trees on the western coast of Jutland.

e. *Light.* There are no forests on the Færöes, and the plants receive the full benefit of any light which may reach the surface

of any given place, according to the geographical position of the islands and the local topographical conditions. The frequency of fog has already been referred to, and the amount of light available on foggy days is of course comparatively limited. In addition, the atmosphere is almost constantly more or less overcast. The mean amount of cloud is about 7,4 (scale 0 – 10; 0 = clear; 10 = completely overclouded). In other words three-fourths of the sky on an average are covered with clouds. There are annually only 18 clear days (0—2 of the scale), but 184 »dark« days with the sky entirely cloudy are recorded. The full effect of the sun is lost from

Fig. 1 8. Mountain plateau on Kirkebörejn on Strömö. Bare »Rudemark« showing large and small stones blown together into the cracks. (From photo. by Author).

this cause, and an additional loss results from the high northerly latitude of the islands. The angle of incidence of the sun's rays to the earth's surface at noon in winter is only 5°, and this only holds good if the surface is flat, a rare circumstance on the Færöes where almost the whole surface is more or less sloping. According to the exposure of the slope the vegetation receives light, together with heat, to a greater or less extent than on a flat surface. A slope facing south is thus more favourably situated in this respect than one facing northwards, and a marked difference in the composition of the vegetation is the result. The southern exposures carry a great wealth of flowering plants, while the northerly exposures have a larger proportion of mosses. The Calluna or heather moors of the islands, for instance, are always met with on slopes facing southwards; similarly the rock-terraces (»Hamre«) towards the south always have the greatest variety of flowers. It follows naturally that places of this kind offer the best climatic

conditions for vegetation, and that here it will reach its fullest development when the edaphic conditions are also favourable.

This distinction between the north and south slopes is a result of the sun's influence, or, in other words, the combined effects of the varying degrees of light, heat, and the amount of soil-moisture resulting from the exposure. It is a fundamental difference which we shall have occasion to refer to frequently in the chapter on plant-formations.

2. Edaphic factors.

a. *Nature of the soil.* The geological structure of the Færöes is very uniform (see geological account Vol. I, pp. 24—31). The islands consist entirely of basalt laid down in almost horizontal beds separated by thin strata of tuff and clay; on Syderö and Myggenæs the clay includes thin layers of coal. Both tuff and clay have originated from the basalt, hence this rock alone need be considered when dealing with the chemical composition of the Færöese soil.

Mr. O. B. Böggild has drawn my attention to an analysis of Færöese basalt[1], which states that it should contain 10,16 p. cent CaO. Although this is the only definite statement available, Mr. Böggild still regards it as a fair estimate of the probable percentage all over the Færöes, since it is the amount found in most basalts, and they are fairly uniform. This is a high percentage of lime compared with the 1—2 p. cent in common granite, and plants need have no lack on this account. On the whole, basalt must be regarded as producing a fair soil for plants, partly because of its chemical composition, and partly because of its comparatively rapid decay.

The basalt on weathering forms a reddish-brown soil, of fine texture. The process of disintegration is most noticeable on the mountains, where the soil is more or less free from vegetation, and, if one may judge by personal observations, the weathering proceeds always very rapidly there. The numerous mountain-plateaux are covered as a rule with loose shattered flakes of basalt, with here and there a block falling into fragments, and one rarely sees large exposures of solid rock. The finer disintegrated particles soon settle down, among the coarser material, or they are transported by wind and water, to collect again in sheltered nooks, in cracks and crevices, etc. The frequent and abrupt changes between thaw

[1] Durocher in Annales des Mines, 19, 1841, p. 559.

and frost in winter, together with the plenteous rain, which lodges in every depression, will considerably hasten the work of destruction. A part will also be taken by the lichens and mosses, which thrive on the solid rock (e. g. *Lecidea*-species, *Placodium* and *Andreaea*-species).

Thus it is that the products of weathered basalt form the primary soils, in which plants settle and by their growth carry the transformation to further stages.

The calcareous nature of the soil is still further increased on many parts of the coast by broken shells of Molluscs, fragments

Fig. 169. Sandsbugt on Sandö. Flat expanse of sand traversed by the stream in the foreground which bends and is seen again to the right; the open sea in the distance, with a steamship at anchor. (From photo. by O. Effersöe).

of Corallinaceæ, etc., which have drifted ashore. These fragments may be present in such quantity, that they give the soil a whitish tint; thus Hvidenæs (White Naze) a short distance north of Thorshavn derives its name from the abundance of shells there. The soil in places of this sort is naturally much more calcareous than elsewhere.

On the coast where the finer particles of the soil are washed out, there remains a rather dark coarse-grained coast sand, which is presumably less fitted for the nutrition of plants than the unwashed soil; it never has, however, that white barren colour such as one finds, say on the washed out quartz-sand on the west coast of Denmark.

Sand-strands are not common on the Færöes, yet may be found over small areas in almost any fjord. The greatest accumulation

of sand on the Færöes is found, as indicated by the place-names, on Sandö at the head of Sandsbugt. Here (Fig. 169) a wide flat stretch of sand has formed around the outlet of the river, and on the landward side the drifted sand forms a veritable dune. A dune-formation in its earlier stages occurs also at Midvaag on Vaagö. Deposits of coarse sand or gravel are also formed along the margins of numerous small lakes and streams which have washed away

Fig. 170. Mountain plateau on Nolsö. The wind has torn up most of the plant-carpet and carried it off along with the fine-soil, leaving a bare gravelly plain with isolated plant-covered patches. (From photo. by E. Warming).

the finer particles of soil. The vegetation on these places is generally sparse, but its meagre development ought not to be put down to any quality of the materials themselves, it is rather due to the unstable condition and the recent formation of the substratum. Similar conditions exist on the rocky floors of the upland plateaux, except that here wind more than water has carried away the finer soil (Fig. 170).

The fine-soil appears to be an excellent medium for the growth of plants. Wherever it is allowed to lie at rest, it becomes covered by a close carpet of plants, and these through their death and decay bring about great changes in different ways according to the condition of moistness.

b. *The moistness of the soil.* The abundant rainfall gives rise to innumerable watercourses of small size and often active for a short time only. One may safely say of the Færöes that they are irrigated by fresh-water. The water bears with it dissolved materials and the fine-soil, which accumulate when the course of the water is blocked. If the impediment is such as to prevent the water from going further, then it gathers to form a pool or a lake, according to circumstances. If the lake is fairly large, it never becomes completely overgrown by vegetation, because growth proceeds much too slowly for this. If, however, the accumulation of water is small, then gradually a swamp of *Eriophorum* is formed, followed by *Carices*, etc., and finally there remains a firm bed of peaty matter.

Peaty soil plays an important part on the Færöes. The excessive moisture in the soil and air, along with the low temperature, result in that incomplete decomposition of vegetable matter, which is characteristic of peat. The condition may be still further assisted by a close covering of plants with roots interwoven so as to hindering the access of air. In this way most soils with a fairly large supply of organic matter become humous[1]. Every kind of humous soil may be found from the fairly dry conditions in the smaller lowland tracts of Calluna-heath and the expanses of Grimmia-heath on the mountain-plateaux, onwards to the moist spongy swamp-peat. Much the greater part of the area under vegetation has peaty soil. Hence the Færöeses in bringing soil under cultivation encourage the outflow of water by draining and other aerating operations. They strive to change a hydrophilous sedge-moor into a mesophilous grass-meadow, and the soil from peat to mould or loam.

Mould. The mould-earth is confined as a rule to the cultivated areas, although beyond these it also occurs to a limited extent. When the drainage conditions are good and the situation favourable, as on slopes and mountain-terraces (Hamre), one finds an abundant vegetation of grasses and herbaceous plants (Græsli) with a substratum of mould. As might be expected, every gradation occurs from mould to peat, and on quite small areas these changes may be so frequent as to give the vegetation a varied and motley appearance. In the lower zone of the hill pasture one may fre-

[1] For the formation of humus in arctic countries see H. Hesselman: Om mykorrhiza-bildningar hos arktiska växter; Bih. Sv. Vet. Akad. Handl., vol. 26, III, 2, 1900.

quently find mould and grass on the more elevated parts, with a sedge-vegetation on the peaty soil of the depressions; the former as it were on the crest of a wave, the latter in the trough[1].

The soil of the Færöes in relation to the vegetation may be classified as follows:

Mineral soils	Soils with much organic matter
1. solid rock	4. peaty soil
2. gravel and sand (sea-sand, calcareous sand)	5. mould.
3. fine soil.	

3. The influence of man and animals on the vegetation.

a. *Man.* The Færöes have been inhabited for about ten centuries by a race engaged mainly in the rearing of domestic animals and to a less extent in cultivating the soil. It is therefore only natural, that this occupation by man has influenced the vegetation by altering or modifying its composition. It has already been stated by E. Warming (1903, p. 680) and myself (Ostenfeld 1901 c, p. 118), that a number of the plants of the Færöese flora have immigrated through the aid of man[2]. This has certainly played, and still plays an important part in the vegetation of northern countries, where in former times the Norsemen settled as colonists, for example in Iceland and the southern part of Greenland. It is also probable that the presence of several European species (e. g. *Calluna*) in Newfoundland and adjoining lands, is due to the roving propensities of these ancient Norsemen. It is not my intention to enter further into this matter here, but to confine myself to the influence of man upon the vegetation as it exists at the present time.

On the Færöes the only vegetation entirely produced and maintained by human action is that limited to the small areas on which barley and potatoes are cultivated and to numerous small gardens

[1] Earthworms, so characteristic of mould-formation, also occur on the Færöes. Several of the lesser species of the genus *Lumbricus* appear to be common. According to the identification of the Zoological Museum of Copenhagen, my collections include no less than 4 species *(L. turgidus, purpureus, Boeckii* and *subrubicundus)*.

[2] Professor W. says (l. c., p. 680): Ostenfeld mentions it, but very briefly (p. 117), as follows: »Further . . . man has doubtless introduced and keeps on introducing new species«; but he appears to have overlooked my further reference to the question on the page which follows.

laid out especially in recent years and principally at Thorshavn. The vegetation here consists partly of the few species under cultivation, and partly of weeds, most of which are plants native to the Færöes. A similar vegetation of weeds or ruderal species may be found round the houses and along paths and roads in the rural districts (e. g. *Montia lamprosperma* and *Cardamine hirsuta*).

One must also include as products of cultivation the »Bö«, fenced and drained enclosures, with a vegetation which will be dealt with in detail later.

Outside the enclosed area, traces of human influence are not evident to any noteworthy extent, except the change brought about by the removal of peat and turf, which produces other conditions in the amount of moisture and thereby affects the original vegetation.

b. *Domestic animals.* Sheep play far and away the greatest part among the domesticated animals. There are on the Færöes rather more than 15,000 inhabitants and about 100,000 sheep, in other words about 7 sheep per head of population. These sheep are allowed to roam at large all the year round, and their influence upon the vegetation is undoubtedly enormous. Outside the enclosed land, the vegetation is almost everywhere closely clipped by the grazing of the sheep, and the taller plants have little chance of flowering and fruiting. Full development is only possible in places inaccessible to sheep, such as mountain-terraces and small islands in lakes[1].

A typical example of this was found on a little isle (Holm) in Vatnsdals-lake on Syderö between Trangisvaag and Kvalbö. When I visited the valley in the summer of 1897, I was impressed with the uncommon appearance of this isle when seen from a distance. The green vegetation looked as if flecked with white, and on closer inspection this was seen to be due to numerous inflorescenses of *Eriophorum polystachyum*. This plant was also quite common in the swampy vegetation on the shores of the lake, but one might search long and not find a single inflorescence here, where the sheep had free access. Numerous stalks could be found which ought to have borne inflorescences, but these were all bitten

[1] Mr. W. H. Beeby informs me that this is also the case in Shetland; he says, one must search for the less common species on the small islands (Holms) in the lakes, and there also the best developed specimens of the commoner species are found; several rare species have hitherto only been recorded from the »holms« (cfr. W. H. Beeby, Ann. Scott. Nat. Hist., 1907, p. 236).

off. On wading to the isle, I could see that it was covered by a vegetation, consisting mainly of the same *Eriophorum, Luzula silvatica* and *Carex binervis*, all the plants with an average height of 75 ctm. Indeed, one wonders how the Færöese vegetation would look if there were no sheep!

The influence of the sheep is more perceptible on the vegetation of lower levels, less so in the mountains, where only a sparse vegetation occurs (the rock-flat formation and the Grimmia-heath).

Cows, horses and geese, the other domesticated animals on the Færöes, are of much less importance, as they are fewer in number, and, so far as the cattle are concerned, they obtain their food partly from the enclosures.

I believe one may say without exaggeration, that the character and features of the vegetation outside the enclosures in the lower zones of the Færöes are in a high degree due to the grazing of sheep.

c. *Birds.* The cliffs of the Færöes are well known as the nesting places of thousands of sea-birds, — Guillemots *(Uria grylle* and *U. troile)*, Puffins *(Fratercula arctica)*, Gulls *(Larus tridactylus*, etc.*)*, Fulmar-Petrels *(Fulmarus glacialis)* and Cormorants *(Phalacrocorax)*. As a natural result, the vegetation on these cliffs has a character of its own. The bird-manure containing a large proportion of nitrogenous matter (uric acid, etc.) furnishes, more or less directly, good nutriment for the plants. The sea-fowl cliffs can almost always be distinguished, even from a distance, by the vegetation, which consists of tall, vigorous plants.

Some plants, such as »Kvan« *(Archangelica officinalis)*, are nearly only to be found growing wild on the sea-fowl cliffs, and others occur there in specially luxuriant forms.

On the other hand a number of plants, especially mosses, are entirely cleared out by the activity and the excrements of the birds. During an excursion to Nolsö in August 1897 I had occasion to observe the vegetation on a large talus of débris (Ur) situated on the east side. Here the puffins (»Lunder«) nested at some places, but not at others, and there was a very noticeable difference in the appearance and composition of the vegetation. Places frequented by the puffins were dominated by a luxuriant blue-green form of *Festuca rubra* (»Lundasina»); and on one of the smaller patches only 8 phanerogams and 7 mosses were noted. Much richer however was the vegetation on the parts of the »Ur« not

disturbed by puffins; we noted here 27 phanerogams and 33 mosses; the latter being predominant and giving the vegetation its character, while the phanerogams taken altogether could not be compared in quantity and luxuriance with the mass of *Festuca* of the puffin-Ur.

This example will illustrate how birds may exert considerable influence in selecting the places where they breed, and in altering the vegetation on them.

Something of the same kind happens on Myggenæsholm, the nesting place of a large colony of Gannets *(Sula bassana)*, and on Kirkeböholm, where the Eiderducks *(Somateria mollissima)* nest.

The other wild animals are of secondary importance so far as vegetation is concerned. The rabbit *(Lepus timidus)* is not numerous enough to play an important part. Invertebrates may also be left out of account[1].

III. SOME BIOLOGICAL FEATURES.

Before proceeding to the description of the plant-formations, it may be well to notice some biological features of the species appearing therein, confining ourselves, however, to the higher plants. The features dealt with in this chapter are:

1° Duration of life.
2° Biological types, in Raunkiær's acceptation.
3° Vegetative propagation and structure of the shoots.
4° Time of flowering.
5° Maturation of fruit.
6° Distribution in altitude.

It seems advisable that I should give an alphabetical list of the vascular plants which, in my opinion, are to be regarded as native or as quite naturalized in the Færöes. The species listed are those indicated by numbers in my supplementary floristic list (Ostenfeld 1907), but I have omitted the species which are not completely naturalized.

[1] As already stated, earthworms and other animals, including bacteria, take part in the formation of mould, and hence may be regarded as indirectly important for vegetation.

Alphabetical list of the vascular plants

(phanerogams and pteridophytes), growing wild or quite naturalized in the Færöes.

The species with names printed in italics are of common occurrence.

KEY TO THE ABBREVIATIONS AFTER THE PLANT-NAMES.

Biological type (Raunkiær).

Ch. = Chamæphyte.
G. = Geophyte.
HH. = Helo- or Hydrophyte.
Hcr. = Hemicryptophyte.
Nph. = Nanophanerophyte.
Th. = Therophyte.

Duration of life.

I = annual (summer-annual).
II = hapaxanthic (i e. flowering only once), but not annual.
sed. = perennial without power of migration (sedentary or spot-bound).
sub. = perennial with subterrean wandering shoots.
epi. = perennial with epiterrean wandering shoots.

Distribution in Altitude.

subalp. str. = Species found only in the lowland and the lower parts of the mountain slopes.
subalp. lat. = species found in the lower regions, and also exceptionally on the mountain-plateaux.
subalp.-alp. = species found both in the lower regions and on the mountain-plateaux.
alp. lat. = species found on the mountain-plateaux, and also exceptionally in the lower regions.
alp. str. = species found only on the mountain-plateaux.

1	*Achillea millefolium*	Hcr.	sub.	subalp. str.
2	— ptarmica	Hcr.	sub.	subalp. str.
3	Agropyrum junceum	G.	sub.	subalp. str.
4	— *repens*	G.	sub.	subalp. str.
5	*Agrostis canina*	Hcr.	epi.	subalp.-alp.
6	— *stolonifera*	Hcr.	epi.	subalp. lat.
7	— *vulgaris*	Hcr.	sub.	subalp. lat.
8	*Aira alpina*	Hcr.	sed.	subalp.-alp.
9	— *caespitosa*	Hcr.	sed.	subalp.-alp.
10	— *flexuosa*	Hcr.	sub.	subalp.-alp.
11	Airopsis praecox	Th.	I.	subalp. str.
12	*Alchimilla acutidens*	Hcr.	sed.	alp. lat.
13	— *alpina*	Hcr.	sed.	alp. lat.
14	— *faeroensis*	Hcr.	sed.	alp. lat.
15	— *filicaulis*	Hcr.	sed.	subalp.-alp.
16	Alectorolophus groenlandicus	Th.	I.	subalp. lat.
17	— *minor*	Th.	I.	subalp. str.
18	*Alopecurus geniculatus*	Hcr.	epi.	subalp. str.
19	Alsine verna, hirta	Hcr.	sed.	alp. str.
20	Anagallis tenella	Ch.	epi.	subalp. str.
21	*Angelica silvestris*	Hcr.	sed.	subalp. lat.
22	*Anthoxanthum odoratum*	Hcr.	sed.	subalp. lat.
23	*Arabis petraea*	Ch.	sed.	alp. lat.
24	*Archangelica officinalis*	Hcr.	sed.	subalp.-alp.

25	*Armeria elongata*	Her.	sed.	subalp.-alp.
26	Aspidium *dryopteris*	G.	sub.	subalp. str.
27	— *filix mas*	Her.	sed.	subalp. str.
28	— lonchitis	Her.	sed.	alp. str.
29	— phegopteris	G.	sub.	subalp. lat.
30	— *spinulosum, dilatatum*	Her.	sed.	subalp. str.
31	Asplenum adiantum nigrum	Her.	sed.	subalp. str.
32	— trichomanes	Her.	sed.	subalp. str.
33	*Athyrium filix foemina*	Her.	sed.	subalp. str.
34	*Atriplex Babingtonii*	Th.	I.	subalp. str.
35	Bartschia alpina	Her.	sed.	alp. str.
36	*Bellis perennis*	Her.	epi.	subalp. str.
37	*Blechnum spicant*	Her.	sed.	subalp.-alp.
38	*Botrychium lunaria*	G.	sed.	subalp.-alp.
39	*Brunella vulgaris*	Her.	epi.	subalp. str.
40	*Cakile maritima*	Th.	I.	subalp. str.
41	Callitriche autumnalis	HH.	epi.	subalp. str.
42	— *hamulata*	HH.	epi.	subalp. str.
43	— *stagnalis*	HH.	epi.	subalp. str.
44	*Calluna vulgaris*	Ch.	sed.	subalp. lat.
45	*Caltha palustris*	Her.	sed.	subalp. lat.
46	Campanula rotundifolia	Her.	sed.	subalp.-alp.
47	*Capsella bursa pastoris*	Th.	I.	subalp. str.
48	*Cardamine hirsuta*	Th.andHer.	II.	subalp. lat.
49	— *pratensis*	Her.	sed.	subalp.-alp.
50	Carex atrata	Her.	sed.	alp. str.
51	— *binervis*	Her.	sed.	subalp. str.
52	— *dioica*	G.	sub.	subalp. str.
53	— *echinata*	Her.	sed.	subalp. lat.
54	— *flacca*	G.	sub.	subalp. str.
55	— *flava*	Her.	sed.	subalp. lat.
56	— fulva	Her.	sed.	subalp. str.
57	— *Goodenoughii*	G.	sub.	subalp.-alp.
58	— incurva	G.	sub.	subalp. str.
59	— leporina	Her.	sed.	subalp. str.
60	— Lyngbyei	G.	sub.	subalp. str.
61	— *panicea*	G.	sub.	subalp. lat.
62	— *pilulifera*	Her.	sed.	subalp. str.
63	— *pulicaris*	Her.	sed.	subalp. str.
64	— pulla	G.	sub.	alp. str.
65	— *rigida*	G.	sub.	alp. str.
66	— salina, kattegatensis	G.	sub.	subalp. str.
67	Catabrosa aquatica	Her.	epi.	subalp. str.
68	*Cerastium Edmondstonii*	Ch.	sed. (and epi.)	alp. lat.
69	— glomeratum	Th.	I.	subalp. str.
70	— tetrandum	Th.	I.	subalp. str.
71	— trigynum	Ch.	epi.	alp. str.
72	— *vulgare*	Ch	sed.	subalp.-alp.
73	Chamaenerium angustifolium	Her.	sub.	subalp. str.
74	Cirsium palustre	Her.	II.	subalp. str.

75	*Cochlearia officinalis*	Her.	H.	subalp.-alp.
76	*Cornus suecica*	Her.	sub.	subalp. lat.
77	*Cystopteris fragilis*	Her.	sed.	subalp.-alp.
78	*Digraphis arundinacea*	HH.	sub.	subalp. str.
79	Draba hirta	Ch.	sed.	alp. lat.
80	— *incana*	Her.	sed.	subalp.-alp.
81	Drosera rotundifolia	Her.	sed.	subalp. str.
82	Dryas octopetala	Ch.	epi.	alp. str.
83	*Elymus arenarius*	G.	sub.	subalp. str.
84	*Empetrum nigrum*	Ch.	epi. (and sed.)	subalp.-alp.
85	*Epilobium alsinifolium*	Her.	sub.	subalp.-alp.
86	— anagallidifolium	Her.	epi.	alp. lat.
87	— *lactiflorum*	Her.	sub.	subalp.-alp.
88	— montanum	Her.	sed.	subalp. str.
89	— *palustre*	Her.	sub.	subalp. str.
90	*Equisetum arvense*	Her.	sub.	subalp. str.
91	— heleocharis	HH.	sub.	subalp. str.
92	— *palustre*	Her.	sub.	subalp. str.
93	— pratense	Her.	sub.	subalp. str.
94	— *silvaticum*	Her.	sub.	subalp. str.
95	*Erica cinerea*	Ch.	sed.	subalp. lat.
96	*Eriophorum polystachyum*	G.	sub.	subalp.-alp.
97	— vaginatum	Her.	sed.	subalp.-alp.
98	*Euphrasia borealis*	Th.	I.	subalp. str.
99	— curta	Th.	I.	subalp. lat.
100	— *minima*	Th.	I.	subalp.-alp.
101	*Festuca ovina*	Her.	sed.	subalp.-alp.
102	— *rubra*	G.	sub.	subalp.-alp.
103	*Galeopsis tetrahit*	Th.	I.	subalp. str.
104	Galium palustre	Her.	sub.	subalp. str.
105	— *saxatile*	Ch.	epi.	subalp. str.
106	Gentiana campestris	Th.	H.	subalp. lat.
107	*Geranium silvaticum*	Her.	sed.	subalp. str.
108	Geum rivale	Her.	sed.	subalp. str.
109	*Glyceria distans*	Her.	sed.	subalp. str.
110	— fluitans	HH.	epi.	subalp. str.
111	— maritima	Her.	epi.	subalp. str.
111	Gnaphalium supinum	Her.	epi.	alp. str.
113	Habenaria albida	G.	sed.	subalp. lat.
114	— viridis	G.	sed.	subalp. lat.
115	Haloscias scoticum	Her.	sed.	subalp. str.
116	Heleocharis multicaulis	Her.	sed.	subalp. str.
117	— palustris	G.	sub.	subalp. str.
118	— uniglumis	G.	sub.	subalp. str.
119	Hieracium ardisodon	Her.	sed.	subalp. str.
120	— ciliolatum	Her.	sed.	subalp. str.
121	— constrictiforme	Her.	sed.	subalp. str.
122	— *cordifrons*	Her.	sed.	subalp. str.
123	— epileucoides	Her.	sed.	subalp. str.
124	— epileucum	Her.	sed.	subalp. str.

125	Hieracium *faeroense*	Hcr.	sed.	subalp. str.
126	— Hartzianum	Hcr.	sed.	subalp. str.
127	— heterophyllum	Hcr.	sed.	subalp. str.
128	— kalsoense	Hcr.	sed.	subalp. str.
129	— leucograptum	Hcr.	sed.	subalp. str.
130	— melanochrotum	Hcr.	sed.	(?) subalp. lat.
131	— Ostenfeldii	Hcr.	sed.	subalp. str.
132	— perampliforme	Hcr.	sed.	subalp. str.
133	— *peramplum*	Hcr.	sed.	subalp. str.
134	— perintegrum	Hcr.	sed.	subalp. lat.
135	— sarcophylloides	Hcr.	sed.	(?) subalp. lat.
136	— scoticiforme	Hcr.	sed.	subalp. str.
137	— Simmonsianum	Hcr.	sed.	subalp. str.
138	— *subrubicundum*	Hcr.	sed.	subalp. str.
139	— *veterascens*	Hcr.	sed.	subalp. str.
140	*Holcus lanatus*	Hcr.	sed.	subalp. str.
141	— *mollis*	G.	sub.	subalp. str.
142	*Honckenya peploides*	Hcr.	sub.	subalp. str.
143	*Hymenophyllum peltatum*	Ch.	epi.	subalp. str.
144	*Hypericum pulchrum*	Hcr.	sed.	subalp. lat.
145	— quadrangulum	Hcr.	sed.	subalp. str.
146	Iris pseudacorus	HH.	sed.	subalp. str.
147	*Isoëtes echinosporum*	HH.	sed.	subalp. lat.
148	— *lacustre*	HH.	sed.	subalp. lat.
149	Juncus balticus	G.	sub.	subalp. str.
150	— biglumis	Hcr.	sed.	alp. str.
151	— *bufonius*	Th.	I.	subalp. str.
152	— *conglomeratus*	Hcr.	sed.	subalp. str.
153	— *effusus*	Hcr.	sed.	subalp. str.
154	— *lampocarpus*	Hcr.	sed. (and sub.)	subalp. str.
155	— obtusiflorus	G.	sub.	subalp. str.
156	— *squarrosus*	Hcr.	sed.	subalp.-alp.
157	— *supinus*	Hcr.	epi. (and sed.)	subalp. str.
158	— *trifidus*	Hcr.	sed.	subalp.-alp.
159	— triglumis	Hcr.	sed.	alp. lat.
160	Juniperus communis, nana	Nph. (and Ch.)	sed.	subalp. lat.
161	*Koenigia islandica*	Th.	I.	subalp.-alp.
162	Lathyrus pratensis	Hcr.	sub.	subalp. str.
163	*Leontodon autumnale*	Hcr.	sed.	subalp. lat.
164	*Linum catharticum*	Th.	II.	subalp. str.
165	Listera cordata	G.	sub.	subalp. str.
166	*Litorella lacustris*	HH.	epi.	subalp. lat.
167	Lobelia dortmanna	HH.	sed.	subalp. str.
168	Loiseleuria procumbens	Ch.	sed. (and epi)	alp. str.
169	Lotus corniculatus, carnosus	Hcr.	sed.	subalp. str.
170	Luzula arcuata	Hcr.	sub.	alp. str.
171	— *campestris*	Hcr.	sub.	subalp. str.
172	— *multiflora*	Hcr.	sed.	subalp. lat.
173	— *silvatica*	Hcr.	sed.	subalp. lat.
174	— *spicata*	Hcr.	sed.	subalp.-alp.

175	*Lychnis flos cuculi*	Hcr.	sed.	subalp. str.
176	*Lycopodium alpinum*	Ch.	epi.	subalp.-alp.
177	— annotinum	Ch.	epi.	subalp. str.
178	— *selago*	Ch.	sed.	subalp.-alp.
179	Lysimachia nemorum	Ch.	epi.	subalp. str.
180	Malaxis paludosa	Hcr.	sed.	subalp. str.
181	*Matricaria inodora, phaeocephala*	Hcr.(and Th.)	sed.	subalp. str.
182	Melandrium rubrum	Hcr.	sed.	subalp. lat.
183	Mentha aquatica	Hcr.	sub.(and epi)	subalp. str.
184	Menyanthes trifoliata	HH.	sub.	subalp. str.
185	Mertensia maritima	Hcr.	sed.	subalp. str.
186	*Molinia coerulea*	Hcr.	sed.	subalp. lat.
187	*Montia lamprosperma*	Th.andHH.	sed.(and epi)	subalp. lat.
188	*Myosotis arvensis*	Hcr.	II.	subalp. str.
189	— palustris, strigulosa	Hcr.	epi.	subalp. str.
190	— repens	HH.	epi.	subalp. str.
191	— *versicolor*	Th.	I.	subalp. str.
192	*Myriophyllum alterniflorum*	HH.	sub.	subalp. lat.
193	*Nardus stricta*	Hcr.	sed.	subalp.-alp.
194	*Narthecium ossifragum*	Hcr.	sub.	subalp. lat.
195	Orchis latifolius	G.	sed.	subalp. str.
196	— *maculatus*	G.	sed.	subalp. lat.
197	— masculus	G.	sed.	subalp. str.
198	Oxalis acetosella	Hcr.	sub.	subalp. str.
199	*Oxyria digyna*	Hcr.	sed.	subalp.-alp.
200	Papaver radicatum	Hcr.	sed.	alp. str.
201	Pedicularis palustris	Hcr.	II.	subalp. str.
202	Phragmites communis	G.	sub.	subalp. str.
203	*Pinguicula vulgaris*	Hcr.	sed.	subalp.-alp.
204	Plantago coronopus	Th.	II.	subalp. str.
205	— *lanceolata*	Hcr.	sed.	subalp. str.
206	— *maritima*	Hcr.	sed.	subalp.-alp.
207	*Poa alpina*	Hcr.	sed.	alp. lat.
208	— *annua*	Th.	I.	subalp. str.
209	— *glauca*	Hcr.	sed.	subalp.-alp.
210	— nemoralis	Hcr.	sed.	subalp. lat.
211	— *pratensis*	Hcr.	sub.	subalp. str.
212	— *trivialis*	Hcr.	sed.	subalp. str.
213	*Polygala serpyllacea*	Ch.	sed.	subalp. lat.
214	— *vulgaris, Ballii*	Hcr.	sed.	subalp. str.
215	Polygonum amphibium	Hcr.(and HH.)	sub.	subalp. str.
216	— *aviculare*	Th.	I.	subalp. str.
217	— *viviparum*	G.	sed.	subalp.-alp.
218	Polypodium vulgare	Hcr.	epi.	subalp. str.
219	Potamogeton alpinus	HH.	sub.	subalp. str.
220	— filiformis	HH.	sub.	subalp. str.
221	— gramineus	HH.	sub.	subalp. str.
222	— natans	HH.	sub.	subalp. str.
223	— perfoliatus	HH.	sub.	subalp. str.
224	— *polygonifolius*	HH.	sub.	subalp. lat.

225	Potamogeton praelongus	HH.	sub.	subalp. str
226	— pusillus	HH.	sed.	subalp. str.
227	*Potentilla anserina*	Hcr.	epi.	subalp. str.
228	— *erecta*	Hcr.	sed.	subalp.-alp.
226	— palustris	HH.	sub.	subalp. str.
230	— verna	Hcr.	sed.	alp. str.
231	Primula acaulis	Hcr.	sed.	subalp. str.
232	Psamma arenaria	G.	sub.	subalp. str.
233	Pyrola minor	Hcr.	sub.	alp. lat.
234	*Ranunculus acer*	Hcr.	sed.	subalp.-alp.
235	— auricomus	Hcr.	sed.	subalp. str.
236	— *flammula*	Hcr.	epi.	subalp. lat.
237	— glacialis	Hcr.	sed.	alp. str.
238	— *repens*	Hcr.	epi.	subalp. str.
239	— reptans	HH.	epi.	subalp. str.
240	Rosa mollis	Nph.	sed.	subalp. str.
241	*Rubus saxatilis*	Hcr.	epi.	subalp. lat.
242	*Rumex acetosa*	Hcr.	sed.	subalp.-alp.
243	— *domesticus*	Hcr.	sed.	subalp. str.
244	— *obtusifolius*	Hcr.	sed.	subalp. str.
245	Ruppia maritima	HH.	sub.	subalp. str.
246	Sagina nivalis	Hcr.	sed.	alp. str.
247	— *procumbens*	Ch.	epi.(and sed.)	subalp.-alp.
248	— *subulata*	Hcr.	sed.	subalp. lat.
249	Salix glauca	Ch.(and Nph.)	sed.	alp. str.
250	— *herbacea*	Ch.	sub.	subalp.-alp.
251	— phylicifolia	Nph.	sed.	subalp. str.
252	*Saxifraga caespitosa*	Ch.	sed.	subalp.-alp.
253	— *hypnoides*	Ch.	epi.	subalp.-alp.
254	— nivalis	Hcr.	sed.	alp. lat.
255	— *oppositifolia*	Ch.	sed.(and epi.)	alp. lat.
256	— rivularis	Hcr.	sub.	alp. str.
257	— *stellaris*	Hcr:	sed.(and sub.)	subalp.-alp.
258	Scilla verna	G.	sed.	subalp. str.
259	*Scirpus caespitosus*	Hcr.	sed.	subalp.-alp.
260	— pauciflorus	Hcr.	sub.	subalp. str.
261	*Sedum rhodiola*	Hcr.	sed.	subalp.-alp.
262	— *villosum*	Hcr.	sed.	subalp.-alp.
263	*Selaginella selaginoides*	Ch.	sed.	subalp.-alp.
264	*Senecio vulgaris*	Th.	I.	subalp. str.
265	*Sibbaldia procumbens*	Ch.	epi.	alp. str.
266	*Sieglingia decumbens*	Hcr.	sed.	subalp. str.
267	*Silene acaulis*	Ch.	sed.	subalp.-alp.
268	*Sparganium affine*	HH.	sub.	subalp. lat.
269	*Spergula arvensis*	Th.	I.	subalp. str.
270	*Spiraea ulmaria*	Hcr.	sed.	subalp. str.
271	*Stellaria media*	Th.	I.	subalp. str.
272	— *uliginosa*	Hcr.	epi.	subalp. str.
273	Subularia aquatica	Th.	I.	subalp. lat.
274	*Succisa pratensis*	Hcr.	sed.	subalp. str.

275	*Tanacetum vulgare*	Hcr.	sub.	subalp. str.
276	Taraxacum naevosum	Hcr.	sed.	subalp.-alp.
277	— *spectabile*, var.	Hcr.	sed.	subalp.-alp.
278	*Thalictrum alpinum*	Hcr.	sub.	subalp.-alp.
279	*Thymus serpyllum*	Ch.	epi.	subalp.-alp.
280	Tofieldia palustris	Hcr.	sed.	alp. str.
281	*Trifolium repens*	Hcr.	epi.	subalp. str.
282	Triglochin palustre	Hcr.	sub.	subalp. str.
283	Tussilago farfarus	G.	sub.	subalp. str.
284	*Urtica dioica*	Hcr.	sub.	subalp. str.
285	Utricularia vulgaris	HH.	sed.	subalp. str.
286	*Vaccinium myrtillus*	Ch.(and Nph.)	sub.	subalp.-alp.
287	— uliginosum	Ch.(and Nph.)	sub.	subalp.-alp.
288	— vitis idaea	Ch.	sub.	subalp. lat.
289	Veronica alpina	Hcr.	epi.	alp. str.
290	— beccabunga	Hcr.	epi.	subalp. str.
291	— fruticans	Ch.	sed.	alp. str.
292	— *officinalis*	Ch.	epi.	subalp.-alp.
293	— *serpyllifolia*	Hcr.	epi.	subalp.-alp.
294	Vicia cracca	Hcr.	sub.	subalp. str.
295	*Viola palustris*	Hcr.	sub.	subalp. lat.
296	— *silvestris, rotundato-crenata*	Hcr.	sed.	subalp.-alp.
297	— tricolor, faeroensis	Hcr.	sed.	subalp. str.
298	Zostera marina	HH.	sub.	subalp. str.

1. Duration of life.

Annuals and other hapaxanthic species which only flower once, although not necessarily in the first year of growth, are not strongly represented in the natural plant-formations of the Færöes. Even in the culture-formations, perennial species are dominant except in cornfields. It is natural to expect that the insular climate with mild winters, cold summers and high rainfall throughout the year, must influence in a favourable way the dominance of perennial species.

The list of plants shows that there are 298 wild species of vascular plants in the Færöes. The preponderance of perennial species will be seen at a glance from the following tabulated summary; I gives the number of summer-annuals, II the other hapaxanth-species, and III the perennial species.

	Actual numbers.				Percentages.			
	I	II	III	Total	I	II	III	Total
Vascular Cryptogams	.....	.....	24	24	.....	.....	100	100
Gymnosperms	.....	.....	1	1	.....	.....	100	100
Monocotyledons	3	.....	92	95	3,2	.....	96,8	100
Dicotyledons	18	8	152	178	10,1	4,5	85,4	100
Vascular plants	21	8	269	298	7,0	2,7	90,3	100

Certain species merit special attention, which in other countries may be hapaxanthic, but in the Færöes, in my opinion, they must be reckoned among the perennials: *Montia lamprosperma* occurs both as an annual and as a perennial, because it is so in the natural formations, while it is only in cornfields and gardens that its annual form is found. The case is much the same with *Matricaria inodora,* var. *phaeocephala,* which is perennial in the sand-strand formation, but perhaps becomes annual, when it occurs as a rare plant in potato-fields near the coast. The condition is less clearly defined with regard to *Cardamine hirsuta*; in shady places among cliffs, it is certainly not annual, but still, as a rule hapaxanthic, hence I have placed it in the second column; as a weed in gardens it may sometimes be an annual. In an earlier paper (Börgesen and Ostenfeld Hansen 1896, p. 146), I pointed out that *Cochlearia officinalis* in the Færöes sometimes behaves as a perennial plant, since the same individual is able to produce flowers more than once (see Fig. 171); this, however, is exceptional.

This tendency to pass from hapaxanthic to perennial has gone farther in *Viola tricolor* and in *Alopecurus geniculatus*, both of which are true perennials in the Færöes.

The table shows that of the 298 vascular plants not less than 269 (c. 90 p.ct.) are perennial, and only 29 (c. 10 p.ct.) are hapaxanthic.

(I). Of the latter 21 (c. 7 p.ct.) are summer-annuals viz:

Airopsis praecox (c)	Galeopsis tetrahit (c)
Alectorolophus groenlandicus (p)	Juncus bufonius (c)
— minor (p)	Koenigia islandica (n)
Atriplex Babingtonii (h)	Myosotis versicolor (c)
Cakile maritima (h)	Poa annua (c)
Capsella bursa pastoris (c)	Polygonum aviculare (h)
Cerastium glomeratum (c)	Senecio vulgaris (c)
— tetrandrum (h)	Spergula arvensis (c)
Euphrasia borealis (p)	Stellaria media (c)
— curta (p)	Subularia aquatica (w)
— minima (p)	

The habitats of these annual plants are indicated after the names: *c*, meaning that the species occurs in the culture-formations, *h*, in the halophile formations, *n*, in the natural inland-formations, *w*, that it is a water-plant, and *p*, that is a parasite. We find that

as many as 10 of the 21 annual species have their home in the culture-formations, 4 in the halophile formations (sand-strand formation), and 5 are parasites (all belonging to the Rhinantheæ). Of the remaining 2 species, one is a water-plant, so that there remains only one single annual species — *Koenigia*

Fig. 171. Perennial specimens of *Cochlearia officinalis* from a wet rock-ledge at Trangisvaag on Syderö, 9th May 1895.
I. Stem-rudiments from the first period of flowering, *II* from the second period, *III.* stem with flowering scapes of the third period. *i.* long internodes. *a.* specimen at least 4 years old, probably 5 years. *b.* specimen at least 3 years old, probably 4 years.

islandica — as an inhabitant of the natural land-vegetation of the Færöese interior (the parasite Rhinantheæ of course excepted).

The annual species confined to the cultivated soil are weeds in the fields and gardens, along roadsides and round houses, and it is open to suppose that they owe their existence on the Færöes to mankind, but as they are so common I have included them as quite naturalized species.

We are therefore justified in describing the Færöese vegetation as relatively deficient in annual herbs. The reason for this may be traced, as suggested above, to the insular climate and the occurrence

of rain throughout the whole year. Perennial species are thus enabled to continue their growth nearly all the year, the winter rarely causing a complete cessation; yet growth as a whole is a slow process because of the constant low temperature, and the frequent interruptions.

(II). The other hapaxanthic species (column II in the table) include: *(a)* wintering-annual herbs — i. e. plants which germinate in autumn, but do not flower until next summer; *(b)* true biennial or pleiocyclic plants.

The list comprises 8 species (all dicotyledons):

Cardamine hirsuta (n)	Linum catharticum (n)
Cirsium palustre (n)	Myosotis arvensis (c)
Cochlearia officinalis (n, h)	Pedicularis palustris (p)
Gentiana campestris (n)	Plantago coronopus (h)

The letters in brackets indicate the habitat as in the case of annuals. The difference between the habitat of the two categories of hapaxanthic herbs is a striking one. Whereas the majority of the summer-annuals (I) inhabit cultivated land and the sea-shore, 5 of the species (II) given above have their home in natural inland formations of the lowlands, such as mountain-crags with a good exposure, rock-ledges and slopes; only one species, *Myosotis arvensis,* occurs in the »Bö« (the cultivated meadow); one is a parasite, and one a true shore-plant; *Cochlearia officinalis* is both a shore-plant and a mountain-plant, being most frequent on bare gravelly places on the hill-plateaux. Thus, most of the small number of Færöese hapaxanthic species which are not summer-annuals, live in the more luxuriant habitats of the lowland. It looks as if they were not quite happy in their surroundings, and must resort to these places which receive most sunshine and where the soil is a well-drained mould.

(III). The perennial plants of the Færöes are herbaceous. Trees and larger shrubs do not occur growing wild, but there is a certain number of decumbent or dwarfy shrubs: *Juniperus communis* (rare and mostly decumbent), *Salix phylicifolia* (rare), *S. glauca* (rare and always decumbent), *S. herbacea, Rosa mollis* (very rare), *Vaccinium myrtillus, V. uliginosum, V. vitis idaea, Loiseleuria procumbens, Erica cinerea, Calluna vulgaris, Dryas octopetala* (rare), *Empetrum* and *Thymus serpyllum.* In all 14 species, half of which have evergreen and more or less ericoïd leaves.

Only 6 species *(Salix herbacea, Vacc. myrtillus, Erica, Calluna, Empetrum* and *Thymus)* are common and important for the physiognomy of the vegetation.

The remaining 255 perennial species of the Færöes are herbs.

2. Biological types in Raunkiær's acceptation.

At a meeting of the Danish Botanical Society in December 1903, Mr. C. Raunkiær gave a lecture on a new phyto-geographical classification of the vascular plants. A short Danish summary of this classification appeared in 1904 (Raunkiær 1904), and an exhaustive account of the subject was published in 1905 under the title »*Types biologiques pour la géographie botanique*« (Raunkiær 1905); more recently an enlarged Danish edition has been issued (Raunkiær 1907). The basis for M. Raunkiær's classification is as follows: the structure and form of plants are influenced by and dependent on the climate, more especially the unfavourable season of the year, — winter, period of drought, etc. This relation to the climate becomes an expression in the manner and the degree in which the buds surviving the unfavourable season are protected. If therefore we study the adaptions of the species for surviving the unfavourable season, we will find a scale of adaptations ranging from species the buds of which are not protected at all, because these plants live in countries where there is no unfavourable season, to species the buds of which are highly protected. Raunkiær has now arranged these different stages of protection into categories — his biological types — and infers that these furnish a biological characteristic for the climates of the different countries of the earth. In the warmer parts of the earth, it will be found that the less protected »types« are more in evidence than in the colder. There is, however, a further great difference if the country has or has not a distinct dry season. In the tropical rainforest the buds of most of the plants are not protected against any unfavourable season, because there is none; the dominant species there are large trees with evergreen leaves and often with no scales hiding the embryonal leaves: Raunkiær's Mega- and Mesophanerophytes. But plants of other »types« also occur in the tropical rainforest. Hence it is not the case that all the species occurring in a given country belong to one and the same »type«, but only that in a certain climate one or a few of the types are relatively dominant.

Consequently it is necessary in characterising a country with the aid of its biological plant-types — i. e. the plant-climate of a country — to make a »statistic« of the species with reference to their biological types.

In the later Danish edition of his paper Mr. Raunkiær has made the first attempt towards such a characterisation. This is not an easy task, because it is assumed that one knows all the species of a country so well, that they can be referred to their biological type. To make the matter easier, Raunkiær has reduced the number of his types by grouping them, and has set the limit at 10 types. The value of such statistics will be evident at once on comparing the figures obtained by counting the species of two countries with different climates, and Mr. Raunkiær has prepared (Raunkiær 1907, p. 129) a tabular comparison between the plants of Denmark and those of two West-Indian islands, St. Thomas and St. John, with regard to their biological types.

As it is of interest to obtain statistics of the biological types from as many countries as possible, I have attempted to do so with the Færöese flora. In the list on pp. 896—902 I have added to the plant-names an abbreviation which indicates the biological type of each species. Mr. Raunkiær has kindly looked through my list and states that my references are comparable with those used in his papers (Raunkiær 1907, and Raunkiær, Dansk Ekskursionsflora, 2. ed., 1906). I give here the figures, together with those for Denmark and for St. Thomas and St. John taken from Raunkiær's paper: —

	Færöes	Denmark	D. W. Ind. St. Thomas and St. John
Number of species	298	1084	904
Biological types			
1. Mega- and Mesophanerophytes	.	1	5
2. Microphanerophytes	.	3	**23**
3. Nanophanerophytes	1 (3)	3	**30**
4. Epiphytes	.	.	1
5. Phanerophytes with succulent stems	.	.	2
6. Chamæphytes	**11** (33)	3	12
7. Hemicryptophytes	**58** (176)	**50**	9
8. Geophytes	11 (33)	11	3
9. Helo- and Hydrophytes	10 (29)	11	1
10. Therophytes	9 (26)	18	14
	100	100	100

A few explanatory notes will assist in the study of the three columns given. The figures are expressed as percentages, but I have added the actual figures for the Færöese flora in brackets within the Færöese column. The number of species from the Færöes is 298, but I have taken it as 300, *Montia lamprosperma* being reckoned both as Therophyte and as Helophyte, and *Cardamine hirsuta* both as Therophyte and as Hemicryptophyte. A divergence from Raunkiær's figures is introduced, because I have included the vascular cryptogams, while his figures only refer to phanerogams[1]. In a few cases I have transferred species to another type than Raunkiær has given in his paper, e. g. *Polygala serpyllacea* to the Chamæphytes. This is quite natural, and Raunkiær himself has emphasised the fact that in many cases it is difficult to decide under which of two types a plant should be placed, also that the same species may belong to one type in one country and to another elsewhere.

On comparing the figures for the three countries, it is at once evident, that the West-Indian islands are quite different from Denmark and the Færöes. They are tropical countries with predominance of Phanerophytes, while in our own countries the Hemicryptophytes prevail. Between Denmark and the Færöes there are some small, but perceptible differences. Whereas Denmark has 7 per cent Phanerophytes, the Færöes has only 1; a reduction in the figures for Therophytes is also evident. On the other hand the figures for Chamæphytes and Hemicryptophytes are higher in the Færöes than in Denmark, the increase being slight for the Hemicryptophytes, but very striking with regard to the Chamæphytes. This fact is explained by the insular climate of the Færöes, the same factor which also explains the few Therophytes. The lack of Phanerophytes is due to this circumstance and to the low temperature jointly. We are now in a position to summarise the facts in the way: The plant-climate of the Færöes is characterised by the absence of Phanerophytes, the predominance of Hemicryptophytes, the relative abundance of the Chamæphytes and the scarcity of the Therophytes.

[1] If we exclude the vascular cryptogams, the figures are as follows: Nanophanerophytes 1 p. cent (3), Chamæphytes 10 p. cent (28), Hemicryptophytes 59 p. cent (163), Geophytes 11 p. cent (30), Helo- and Hydrophytes 9,5 p. cent (26) and Therophytes 9.5 p. cent (26); from this it becomes evident that it makes no important difference whether we include the vascular cryptogams or not.

3. Vegetative propagation and structure of the shoots.

The hapaxanthic species propagate by seeds alone, whereas many of the perennials propagate both by seeds and vegetatively. It will be of interest to examine which species and how many of them possess both modes of propagation. In the list pp. 896—902, abbreviations are given relative to the vegetative propagation of the perennial species in the Færöese flora. I have dealt with them under three categories:

1. Spot-bound (sedentary) species, i. e. species, which have no stolons, creeping rhizomes nor bud-producing roots, or the rhizomes are so short that the plants have little, if any, power of wandering vegetatively.

2. Wandering species with epiterrean (above-ground) runners.

3. Wandering species with subterrean shoots: stolons, creeping rhizomes or bud-producing roots.

In preparing this part I have used the excellent paper by E. Warming (1884) on the structure of the shoots, hibernation and rejuvenescence. The reference of the species to one of the three categories is based on this same paper, on Raunkiær's book on the Danish Monocotyledons (Raunkiær 1895—99) and on my own researches. In many cases it has been difficult to decide whether a species with only a slight power of wandering should be taken as spot-bound or as wandering; my decision will be seen as regards all the species in the list. Some of the spot-bound species have another kind of vegetative propagation, viz. the power of producing bulbils or hibernacles, but as this phenomenon falls from a biological point of view nearer to that of propagation by seeds, I have kept the species in question among the spot-bound. They are the following: *Aira alpina, Festuca ovina, Lycopodium selago, Poa alpina, Polygonum viviparum, Potamogeton pusillus, Sedum villosum* and *Utricularia vulgaris.* The following also fall naturally among the spot-bound since they produce bulbils exceptionally: *Cardamine pratensis, Drosera rotundifolia, Malaxis paludosa* and *Saxifraga stellaris.*

Of the 269 perennial species not less than 151 (56 p. cent) are spot-bound, while 118 (44 p. cent) have wandering power; of the latter 42 (16 p. cent) have epiterrean runners and 76 (28 p. cent) subterrean wandering shoots. The percentage-figures are much the same, if we consider only the species of commoner occurrence in

the Færöese flora, that is those species printed in italics in the list (pp. 896—902). Of the 145 perennial plants 86 (59 p. cent) are spot-bound, 25 (17 p. cent) have epiterrean runners and 34 (24 p. cent) subterrean shoots.

The large number of spot-bound herbs indicates a close vegetation and a soil closely woven through with rhizomes and roots, amongst which stolons make their way with difficulty. The majority of the wandering species have their habitat not in the generally prevailing close grassy vegetation, but in the opener formations in water, in bogs, on the shores or on the rock-flats; thus most of the limited number of aquatic plants are species with wandering shoots (Potamogetonaceæ, etc.).

It is also noteworthy that only 7 species — 6 being orchids — have bulbs or tubers, viz. *Scilla verna*, 3 species of *Orchis*, *Malaxis paludosa* and 2 species of *Habenaria*.

When the plant-associations come to be treated in detail later on, we shall have occasion to return to this aspect, and it will then be seen how far the different associations are characterised by species with one and the same mode of vegetative propagation.

4. **Time of flowering** (Phenology).

As far back as Landt's book on the Færöes (1800), there was a little information of a general kind on the flowering period of some of the species.

In the list of plants given in »Botany of the Færöes« (Ostenfeld 1901 b) I have stated as far as possible the flowering and fruiting periods for each species. These are based on my own observations and on herbarium material, but all the statements are only approximately correct, especially as regards the early flowering species, since my principal sojourn on the Færöes was in the middle of the summer (15 July—4 Sept. 1897). The knowledge requisite for a complete phenological account can only be acquired in early spring; in fact one would require to spend several years in collecting the necessary information.

Some notes on the period of flowering are given in a short paper on the Færöese flora (Börgesen and Ostenfeld Hansen 1896). Börgesen states there, that on 15th June 1895, on the summit-plateau of Nolsö, he observed in flower: *Arabis petraea*, *Silene acaulis*, *Thalictrum alpinum*, *Cerastium Edmondstonii* and *Carex*

rigida. My own notes on 9th May 1895 give the following in bloom on Syderö at the Trangisvaag fjord: *Bellis perennis, Viola palustris, V. silvestris, Saxifraga oppositifolia, Caltha palustris, Polygala serpyllacea, Empetrum nigrum, Cochlearia officinalis, Luzula campestris, Scirpus caespitosus, Eriophorum vaginatum, E. polystachyum, Carex pulicaris,* and 3 species of *Equisetum* with fertile shoots *(E. arvense, E. palustre, E. pratense).* A year after (1896) I made a short excursion to the Trangisvaag fjord, and noted there on 7th May flowers of the following: *Bellis perennis, Cardamine hirsuta, Viola palustris, Eriophorum vaginatum, E. polystachyum, Luzula campestris, Scirpus caespitosus, Carex pulicaris, Saxifraga oppositifolia, Cochlearia officinalis,* also some *Polygala serpyllacea, Ranunculus acer, Silene acaulis, Saxifraga nivalis,* and a few flowers of *Alchimilla faeröensis* and *A. filicaulis.* It will be seen that the species are almost the same as in the previous year, with some additions, and they also agree fairly well with the notes of Dr. K. Poulsen and Mr. R. Rasmussen quoted below. My own notes are to some extent supplementary to these, because they originate from the south-most island, and because I have included several of the grass-like species.

C. Jensen (1897) also refers to some species he observed in flower at Trangisvaag about the same time as my visit. I also quote some other notes of his, because they refer to mountain plants, concerning the flowering period of which on the Færöes, nothing else is known. On the summit of the »Klakken« on Bordö on 15th May he noted *Loiseleuria procumbens* flowering and *Silene acaulis* in bud. *Caltha palustris* was in full bloom at Klaksvig on 17th May. *Vaccinium myrtillus* covered with flowers was seen on the 20th May, at a height of about 200 m. on Slattaratindur on Österö, and at Eide, *Caltha palustris* and *Silene acaulis* were also in flower. *Saxifraga oppositifolia* was nearly over, and *S. caespitosa* was covered with buds. On Slattaratindur at a height of 500—700 m. *Ranunculus glacialis* was in full bloom on May 23rd. *Carex Lyngbyei* on Myggenæs was hardly in bloom on June 1st. *Scilla verna* was in full flower on June 14th at Lopra on Syderö.

These notes convey a fairly good idea of the constitution of the spring flora, of its poverty in species, and of the time when the vegetation, as a whole, begins to flower, yet they give little information on the commencement of flowering of each species. Towards supplying this deficiency, I have received much help from

the notes of Dr. Knud Poulsen and Mr. R. Rasmussen, but these not being expert botanists, do not wish their notes to be taken as exhaustive, especially, with regard to grass-like plants.

Dr. Poulsen during his stay of two years (1902—1903) noted as carefully as possible the first flowers observed on species known to him; all his observations were made in the neighbourhood of Thorshavn on Strömö.

The observations made by Mr. R. Rasmussen are from Bordö, chiefly from the neighbourhood of Fagralid situated in the southern part of the island; they were made in the years 1904 to 1906. Although this island is somewhat more northerly than Thorshavn on Strömö, there seems to be little, if any, difference in the time of flowering for the species observed in both places. On the other hand my own few notes from Syderö seem to indicate a slightly earlier commencement of flowering on this island.

I give here a list of the species with the time of flowering observed by Dr. Poulsen and Mr. Rasmussen; in the brackets after the plant-names I have added the dates of my own observations at Trangisvaag in 1895 and 1896.

FIRST FLOWER OBSERVED	Thorshavn 1902	Thorshavn 1903	Bordö (Fagralid) 1904	Bordö (Fagralid) 1905	Bordö (Fagralid) 1906
Achillea millefolium	—	30/7	—	—	—
Alchimilla alpina	3/6	—	—	—	—
— sp. (filicaulis?) (7/5)	2/6	—	—	—	—
Angelica silvestris	—	20/7	—	—	—
Arabis petraea	4/7	15/6	—	—	—
Archangelica officinalis	17/7	8/7	—	—	—
Armeria elongata	17/5	7/6	—	—	13/6
Bellis perennis (9/5, 7/5)	15/4	25/4	—	—	4/6
Brassica campestris	5/7	13/7	—	—	—
Brunella vulgaris	16/7	13/7	—	15/7	—
Calluna vulgaris	—	—	22/7	—	—
Caltha palustris (9/5)	1/5	19/5	25/5	—	4/6
Capsella bursa pastoris	4/6	8/7	—	—	—
Cardamine hirsuta (7/5)	—	27/5	1/6	—	6/6
— pratensis	16/6	8/6	—	—	20/6
Cerastium vulgare	—	8/6	—	—	19/6
Cochlearia officinalis (9/5, 7/5)	20/5	12/6	8/5	—	8/5
Draba incana	14/6	—	—	—	—
Empetrum nigrum (9/5)	22/4	—	20/4	—	—
Erica cinerea	15/6	—	—	22/7	—
Euphrasia minima	1/7	—	—	—	—
Galeopsis tetrahit	10/7	12/7	—	—	—
Galium saxatile	22/6	30/6	—	—	19/6

	Thorshavn		Bordö (Fagralid)		
	1902	1903	1904	1905	1906
Gentiana campestris	2/8	—	—	—	—
Geranium silvaticum	22/6	22/6	—	—	—
Hypericum pulchrum	17/7	20/7	—	—	2/7
Juncus squarrosus	—	—	22/7	—	—
Leontodon autumnale	—	—	15/7	—	—
Listera cordata	—	—	25/5	—	—
Lotus corniculatus, carnosus	5/7	—	—	—	—
Lychnis flos cuculi	—	30/6	—	—	12/7
Matricaria inodora, phaeocephala	5/7	—	—	—	—
Montia lamprosperma	—	15/6	—	—	27/6
Myosotis arvensis	16/7	16/7	—	—	—
Orchis maculatus	17/6	16/6	—	—	20/6
Pinguicula vulgaris	18/6	10/6	8/6	—	19/6
Plantago lanceolata	3/6	28/5	3/6	—	—
Polygala serpyllacea (9/5, 7/5)	29/5	1/6	1/6	—	7/6
Potentilla anserina	4/7	12/7	—	—	—
— erecta	30/5	11/6	—	—	19/6
Ranunculus acer (7/5)	7/6	27/5	—	—	12/6
— flammula	—	—	20/6	—	—
— repens	—	7/6	—	—	19/6
Rumex acetosa	—	—	8/6	—	—
Saxifraga caespitosa	—	10/6	—	—	—
— oppositifolia (9/5, 7/5)	—	7/6	—	—	—
— stellaris	22/6	—	29/5	—	11/6
Sedum rhodiola	4/6	8/6	29/5	—	6/6
Senecio vulgaris	20/6	3/7	—	—	—
Silene acaulis (7/5)	23/5	3/6	31/5	—	12/6
Stellaria media	3/6	—	—	—	—
— uliginosa	—	—	23/6	—	—
Succisa pratensis	—	23/7	—	—	—
Taraxacum spectabile, var.	26/5	6/6	—	—	20/5
Thalictrum alpinum	—	—	29/5	—	11/6
Thymus serpyllum	22/6	1/7	—	15/7	—
Trifolium repens	—	10/7	—	15/7	—
Tussilago farfarus	19/4	3/5	—	—	—
Vaccinium myrtillus	27/6	—	25/5	—	20/6
Veronica officinalis	28/5	—	—	—	—
— serpyllifolia	—	15/6	—	—	12/6
Viola palustris (9/5, 7/5)	—	30/5	—	—	7/6
— silvestris, rotundato-crenata (9/5)	13/5	30/5	—	—	—
— tricolor, faeroensis	5/7	15/7	—	—	—

There are thus 64 species, 21 of which have been observed in only one of the five years; most of the others have been observed twice or three times, some even four times, but none five. The dates for the first two years agree on the whole rather well. It will be seen, that 1902 had a somewhat earlier spring than 1903,

the difference in flowering being greatest in the case of the earlier spring-plants.

Accompanying a cold spring, as already stated (p. 876) the flowering begins late. Only a few pioneers open into flower before the end of May, the majority of the species do not bloom till June or July, and some, like *Angelica, Achillea,* and *Succisa* are surprisingly late.

Taking all the records together, inclusive of my own from Syderö, it is fairly safe to assume that the spring flora of the Færöes is made up of: *Bellis perennis, Tussilago, Caltha, Cardamine hirsuta, Cochlearia, Empetrum, Polygala serpyllacea, Saxifraga oppositifolia, Silene acaulis, Viola palustris, V. silvestris, Equiseta, Luzula campestris, Eriophora* and other *Cyperaceæ.*

5. Maturation of fruit.

In a former publication (Ostenfeld 1901 c, p. 106) I have stated briefly that a number of species on the Færöes were never found with mature fruits, and I gave some examples. Reference was also made to the fact pointed out by A. G. Nathorst (1883), Gunnar Andersson (1900) and Ekstam (1897, 1898) that similar conditions exist on Spitzbergen and Novaya Semlya. It seems then, as if some species, belonging to a temperate climate, are able to exist north of the area within which they normally produce mature fruit. This failure to fruit may be due partly to climatic conditions, partly to lack of the insects necessary for the pollination.

So far as the Færöes are concerned, both factors must be taken into account. The low temperature in summer no doubt hinders the setting and ripening of the fruit of several species, and the very scanty insect-life will operate in a similar way.

Bees, humble-bees and diurnal Lepidoptera are entirely absent from the Færöes[1]. The plants must therefore be self-pollinated, or they are pollinated by small night-flying Lepidoptera and by flies, the latter of which are frequently seen in large numbers on different flowers (e. g. *Angelica*). The majority of the entomophilous flowers are therefore open »fly-flowers«, which when the insects are lacking, effect self-fertilisation. A great proportion of the flora is wind-pollinated, and among the Monocotyledons in particular it

[1] *Vanessa atalanta, V. cardui* and *V. urticae,* casually carried to the islands, have been taken a couple of times.

is surprising how few entomophilous species occur; Liliiflorae and Orchids are very sparsely represented.

My notes on the flowering and fruiting of each separate species, as I have observed these and recorded them in my lists (Ostenfeld 1901 b and 1907), show that altogether 36 species do not ripen their fruits, or cannot do so with certainty year after year.

Landt mentions, for instance, (1800, p. 184) that during a stay of 7 years on the Færöes he nowhere found *Menyanthes* in bloom, whereas Rostrup (1870, p. 50) says he found it blooming everywhere; according to my own observations it was in bloom in a few places, and I found a few fully developed fruits. A similar irregularity has been observed with *Myosotis palustris* which Simmons found with ripe fruits in 1895, while in 1897 at the same time of the year I could find no developed fruit at all. This same happens with other species.

The list given below is based on my own observations, on information from Mr. R. Rasmussen, and from examination of herbarium material.

Agropyrum junceum, ears produced as usual, but I did not succeed in finding any developed fruit.
A. repens, like the previous species.
Chamaenerium (Epilobium) angustifolium, flowers late and rarely, no fruit observed (cfr. Ostenfeld 1907, p. 851).
Cirsium arvense, flowers very late, no fruit observed.
Cornus suecica, flowering and fruiting sparse and variable in different years.
Digraphis arundinacea, like *Agropyrum junceum.*
Iris pseudacorus, flowers sparingly, but no fruit observed.
Juncus obtusiflorus, seems to flower very late and sets hardly any fruit.
Lathyrus pratensis, flowers, but does not set fruits.
Lotus corniculatus, var. *carnosus,* flowers, but does it set fruits?
Malaxis paludosa, found with flowers, but no fruit developed.
Mentha aquatica, always found without inflorescences.
Menyanthes trifoliata and
Myosotis palustris, var. *strigulosa,* already referred to in text.
Phragmites communis, always found without inflorescences (occurs only in one place).
Polygonum amphibium, very rarely flowering, but no fruit set.

Potamogeton alpinus, found with flowering spikes, but no fruits developed.

P. gramineus, flowers sparingly and not in all places; fruit-setting very meagre.

P. natans, like the foregoing species.

P. perfoliatus, like the foregoing species.

P. praelongus, always found without spikes (occurs only in one place).

P. pusillus, always found without spikes.

Psamma arenaria, as *Agropyrum junceum.*

Pyrola minor, flowers sparingly and not in all places (cfr. Ostenfeld 1901 b, p. 51, and 1907, p. 843).

Rosa mollis, rare with flowers and hardly any fruit set; Landt mentions (1800, p. 198), that he transplanted this species into his garden, but that in the course of 4 years it did not flower.

Rubus saxatilis, flowers, but gives fruit very sparingly. Landt states (1800, p. 198) that »the fruits ripe very seldom, because of the storms which almost always occur at the time of fructification«.

Ruppia maritima, as *Potamogeton alpinus.*

Sparganium affine, flowers in many places, but ripe fruits are very rarely met with.

Tanacetum vulgare, flowers late, hardly any fruit set.

Utricularia vulgaris, always found without inflorescenses (one place only).

Vaccinium myrtillus. Landt (1800, p. 192) mentions, that in certain years it does not ripen its fruits. We found only very few berries of this and the following species.

V. uliginosum, as the foregoing, but not so common.

V. vitis idaea, rarely flowering, and very seldom with ripe fruits.

Veronica officinalis, flowers abundantly, but fruits badly.

Vicia cracca, flowers abundantly, but only once found with a few ripe pods with seeds.

Zostera marina, seems not to develop fruits, although it has been found with inflorescences.

Most of the 36 species are rare in the Færöes, and that also agrees with the supposition, that they are outside their true area, and only with difficulty thrive on a few specially favourable places on the islands. The majority of the Dicotyledons are probably insect-pollinated (if not self-fertile), and as regards the Papilionaceae

and some of the others, one may presume, that their defective fruiting is due in some degree to the lack of the necessary insects. Such an explanation will not suffice, however, for most of the Monocotyledons, because they are wind-pollinated (Orchids and Zostera excepted), and it seems more probable that the defective fruit-formation is due to the low summer temperature, and to the injurious effect of the incessant rain on the pollen.

Another effect of these climatic conditions is the tendency of certain species to appear as viviparous forms, a fact, already referred to by Rostrup (1870, p. 13). On the Færöes *Aira alpina, Festuca ovina* and *Poa alpina* occur in viviparous forms only, and with these we may put *Polygonum viviparum, Sedum villosum* and *Lycopodium selago,* which nearly always bear bulbils (compare the bulbiferous species, p. 909). This tendency towards Pseudovivipary may also be observed in the case of species not generally given to the habit; thus we found viviparous specimens of *Aira flexuosa* particularly in the mountains, and at one place some of *Agrostis canina.*

It is my opinion, that this tendency towards pseudovivipary, together with the lack of fruiting, are due to the action of the insular climate in discouraging sexual reproduction and encouraging vegetative propagation.

6. Distribution in altitude.

Species in mountainous countries are not equally distributed in the lower regions and up in the mountains. The external conditions in the mountains are more rigorous and hinder the growth of many lowland species. On the other hand certain species find their natural home on the heights, probably because they cannot compete with the lowland species, and are unable to endure the higher summer temperature of the lower zones. It is not, however, the height of any locality above sea-level that determines, which species may thrive there, and which may not. The condition of the soil and the exposure are of great importance. A slope facing south affords, as already stated, conditions (sunshine, etc.) differing from and generally better than a northern exposure or a flat place, hence plants can thrive at a higher altitude.

The altitude above sea-level need not be an indication of the limits of any species, and the mere record of how high up any

plant may occur, must always be an approximation. In regions with a continental climate it is possible to state altitudinal limits with some precision, and one can distinguish sharply between lowland and mountain plants. This is the case f. inst. in Sweden and in Eastern Norway[1] and to a still greater degree in mountainous regions like the Pamir and the Himalaya, which lie in the interior of a great continent. In regions with a temperate insular climate the distinction between lowland and mountain plants is much less apparent, because the majority of the species can also thrive in the lowlands, as a relatively low summer temperature does not affect them injuriously. This is well known, and has been frequently referred to. A. Blytt (1869, pp. 36—39) has dealt with it in considerable detail for Western Norway. E. Rostrup in his Færöese flora (1870, p. 18) also refers to it, and enumerates some of the mountain plants, which are found all the way down to the coast.

In my own list of plants (Ostenfeld 1901 b), I have stated the vertical range of each species, as far as my information allowed. These data are here summarised as concisely as various difficulties will permit. It is however hardly possible to prevent one's own personal opinions from entering in. Thus in selecting a boundary between mountain and lowland, I have chosen to limit the term »mountain« to such species as grow on the mountain-plateaux at least 300 m. above the sea, and oftener ranging up to 500—800 m. On the contrary, I do not include as mountain the slopes from the plateaux towards the sea.

The species are arranged in 5 groups[2] as shown in the following table:

I.	Species found only in the lowland and the lower parts of the mountain-slopes	161	206
II.	Species found in the lower regions and also exceptionally on the mountain-plateaux	45	
III.	Species found both in the lower regions and on the mountain-plateaux		58

[1] Many mountain plants are carried down to the lowlands by the rivers and are able to maintain themselves there; this is especially the case with bog and swamp plants.

[2] In the alphabetical list on pp. 896—902 I have added a reference to those groups to the name of each species.

IV.	Species found on the mountain plateaux and also exceptionally in lower regions	12	34
V.	Species only found on the mountain-plateaux	22	

If we take the sum of groups I and II as comprising the lowland flora, then this amounts to something like two-thirds (206:298) of the entire flora. The true mountain plants (groups IV and V) only amount to about one-ninth (34:298), a very small proportion, which loses still further in importance, in that most of the species occur only in a few localities and in scanty numbers. Only 9 mountain species can be regarded as common, viz: *Alchimilla acutidens, A. alpina, A. faeröensis, Arabis petraea, Carex rigida, Cerastium Edmondstonii, Poa alpina, Saxifraga oppositifolia* and *Sibbaldia*; 7 of these belong to group IV, which means that they approach group III (the species found on the mountain-plateaux and in the lowland). Group III includes about one-fifth (58:298) of the flora, but on closer examination it will be found that a large proportion of the species are characteristic Færöese plants with a general distribution. Certain of these are regarded as mountain plants, the commoner being 16 in number: *Aira alpina, Epilobium alsinifolium, E. lactiflorum, Juncus trifidus, Koenigia, Lycopodium alpinum, Oxyria, Polygonum viviparum, Salix herbacea, Saxifraga caespitosa, S. hypnoides, S. stellaris, Sedum rhodiola, S. villosum, Selaginella, Thalictrum alpinum.* The majority of group III are lowland (temperate) species, of which the following merit particular mention: *Agrostis canina, Aira caespitosa, A. flexuosa, Alchimilla filicaulis, Armeria, Blechnum, Cardamine pratensis, Carex Goodenoughii, Cochlearia officinalis, Empetrum, Eriophorum polystachyum, Juncus squarrosus, Nardus, Plantago maritima, Potentilla erecta, Ranunculus acer, Rumex acetosa, Scirpus caespitosus, Vaccinium myrtillus, Veronica officinalis* and *V. serpyllifolia.* Most of these are species with a wide distribution in all temperate and to some extent in subarctic regions of the Northern Hemisphere. They might be added to groups I and II, the lowland plants, and would still further increase the predominance of these. On the other hand, the addition of these species of group III, which we have named as mountain plants, would somewhat increase groups IV and V. Even with this addition it would still be the case, as already indicated, that nearly all the more common mountain plants on the Færöes are also found in the lowland; in other words, that the Færöese

mountain plants generally have no limit of extension downwards short of the sea-level, and that the subalpine region extends to the coast.

IV. THE PLANT-FORMATIONS.

An attempt has been made in the preceding pages to describe external factors which influence vegetation, to consider the biological circumstances of most importance in enabling the plants to thrive under these external conditions, and to survey the vertical distribution of the species. Keeping these in view we now propose to describe the plant-associations with regard to their development and their dependance on each other.

It may be stated as a general rule, that the more insular a climate, and the more irregular the configuration of the surface, then the more difficult it is to form in one's mind a definite picture of the plant-associations, which under these conditions merge gradually into each other, and are liable to frequent change. This holds true in a marked degree for the Færöes. The great humidity of the atmosphere, the frequent and abundant rainfall, and the resulting moistness of the soil nearly everywhere, together ensure almost constant and sufficient supplies of that most important factor, water.

Consequently most of the plant-associations are closely related, and the distinctions between them depend on small differences in the quantity and the quality of water. It will easily be understood, that distinctions so slightly defined are difficult to maintain.

The difficulty is further emphasised by the incessant changes, up and down, which characterize the Færöese landscape, and which within a single square meter may present to the plants widely varying conditions as regards access of water, protection against wind, light and shade, etc. The arrangement of the plant-associations which is attempted in the following pages is therefore somewhat more abstract than is the case in most other countries, and it will be necessary again and again to indicate the gradual transition from one association to another.

The following are the main groups used as a basis for our classification (for complete scheme see »Contents«):

1. Natural formations and cultivated formations.
2. Halophile and inland formations.
3. Subalpine formations (in the lower regions) and alpine formations of the mountains.

In dealing with the natural inland formations the groups are arranged according to their water-requirements, commencing with those which require most water.

A. NATURAL FORMATIONS.

J. Bernatsky in a little paper (1904) has given an interesting summary of his views on plant-formations as influenced by man and herbivorous animals. As it is of the greatest importance to estimate precisely the great change in the vegetation of a landscape brought about by man and animals, I have dealt with it in some detail in the preceeding pages (pp. 892—895) and would again direct attention to it. Classifying the plant-formations from this point of view, Bernatsky gives three main divisions: 1) Natural formations, 2) Culture-formations, 3) Derelict formations, i. e. formations on soils primarily cultivated, but afterwards abandoned to natural vegetation. This last division does not appear to be so good as the other two, because in my opinion the formations included under this head might be distributed with no great effort under one or other of the first two divisions. We shall adopt, therefore, only two groups: natural and culture formations. Bernatsky's analysis of the natural formations into smaller divisions according to the degree, in which they are influenced by animals and man, has much to recommend it, but I think it will be more in accord with natural conditions if I base my subdivision on other factors. We may however utilize Bernatsky's definition of a natural formation, viz: »One in which all the elements have taken their places naturally, and whose presence can in no way be attributed to human influence.«

Several examples of Bernatsky's groups occur in the pages which follow. Thus the rock-vegetation, the Grimmia-heath, the rocky-flat formation and others may be included in his »untouched primeval formations«; while the grass-moor and the grass-slopes are example of »formations, which have undergone a fundamental change through grazing.«

The first group of natural formations treated here includes those influenced by the close proximity of the ocean.

I. Halophile formations.[1]

By far the greater part of the coast-line of the islands consists of cliffs, which in many places descend vertically into the ocean, and thus give little opportunity for the development of the typical shore-vegetation. Within the bays and fjords, however, sloping beaches occur (note Fig. 172) and there one finds the typical strand-plants.

Most of these beaches are formed of sand, and the vegetation consists of sand-plants. In a few localities the salt-marsh with its

Fig. 172. Head of Kvalböfjord, Syderö. The flat sand-strand can be seen curving round the head of the fjord. (From photo. by K. Rimestad).

characteristic plants may be found on a moist soil formed of finely divided material with much organic matter.

Finally the coast-cliffs are occupied by a peculiar vegetation which distinguishes them from the commoner type of cliffs.

a. The sand-strand formation.

The species of the sandy seashore are few in number, and generally occur scattered in an open formation with bare soil appearing between the plants.

The sand is coarse and dark, being composed mainly of water-worn grains of basalt. In some places, and particularly near Hvidenæs on Strömö, it is considerably mixed with fragments of the shells of Mollusca and Barnacles *(Balanus)* and with *Corallina*

[1] The reader is referred to Börgesen (1905) for the submarine plant-associations, including the small formation of *Zostera marina* in Vaagfjord.

officinalis cast ashore and bleached. The most important species are: *Honckenya peploides, Cakile maritima, Matricaria inodora,* var. *phaeocephala, Atriplex Babingtonii, Elymus* and *Potentilla anserina*; the following are also met with: *Mertensia maritima, Cochlearia officinalis, Agropyrum repens, Carex incurva, Agrostis stolonifera, Glyceria distans* and *Cerastium tetrandrum,* as well as a few other casual visitors.

These plants do not all occur on the same beach-level. One

Fig. 173. Sand-strand vegetation with *Cakile* as character-plant; Kvalbö on Syderö. (From photo. by E. Warming).

may distinguish between the typical strand-vegetation *(Honckenya association)* characterized by *Honckenya, Cakile* and *Atriplex* (viz. Fig. 173), and the somewhat denser vegetation of the higher banks *(Elymus association)* with *Potentilla anserina, Carex incurva, Elymus*, etc., which in turn gradually passes over to the dune-formation.

These associations may occur on broad flat sandy beaches, or in narrower zones along the steeper coast-banks. On the latter the conditions for existence are somewhat better than on the flat beach, because the rising and the falling tides have more influence on a flat expanse than on the narrower beaches of a fjord-margin. This influence is further increased by the force of the waves during the frequent storms, so that large tracts of the beach may be completely devoid of vegetation (Fig. 169).

As regards duration of life, the sand-strand formation includes annuals *(Cakile, Atriplex)* and perennials. The latter may be »spot-bound« (sedentary) forms *(Mertensia, Glyceria distans, Matricaria)*, or such as wander by means of surface runners *(Agrostis stolonifera, Potentilla anserina)*, or by subterrean stolons *(Honckenya, Elymus, Agropyrum, Carex incurva)*. The anatomical structure of most of the species has been investigated by different botanists, especially by E. Warming (1897). The leaves of *Honckenya, Mertensia, Matricaria, Atriplex, Cakile* and *Cochlearia* are thick and succulent; those of the grasses are to some extent xerophytic; *Potentilla anserina* is provided with felted hairs on the lower surface, while the leaves of *Cerastium tetrandum*, besides being somewhat succulent, have glandular hairs.

Mosses and lichens do not appear in this formation.

Examples:

1. Sandy strand at the head of Trangisvaagfjord, Syderö. *(Honckenya association)*. Honckenya, Atriplex Babingtonii, Potentilla anserina, Matricaria inodora phaeocephala grow scattered about the beach south of the mouth of the stream. On the north side there is a large beach-mound with a luxuriant vegetation of Honckenya, Matricaria, Atriplex, Agropyrum repens, Potentilla anserina, Haloscias scoticum with Rumex obtusifolius and R. domesticus here and there. The beach itself is almost barren, but isolated plants of species of the mound may occur, with the exception of Haloscias and the Rumices.

2. The beach outside of the valley at Kvalbö, Syderö. *(Honckenya association)*. Here we have a large naked sand-flat, but towards the sea on a small beach-mound with stones, Honckenya and Cakile try to maintain existence.

3. Beach towards the head of Bordövig, Bordö[1]. *(Honckenya association, Atriplex facies)*. Atriplex Babingtonii grows in abundance, with some Agrostis stolonifera with runners and Glyceria distans.

4. The head of the inlet near Midvaag, Vaagö, is a smooth, flat sandy beach, the greater part of which is left dry at low-water. Above that part which may be flooded by the sea at high-water, there is a sand-bank formation *(Elymus association)* in that the wind has heaped up the sand in little mounds, which are covered by Poa pratensis, Agropyrum repens, Agrostis stolonifera and Potentilla anserina, mixed with Elymus, Honckenya and Trifolium repens; the Agrostis also extends seawards, and spreading with its long runners forms a luxuriant growth on the bare sand.

5. The mouth of the stream at Sandevaag, Vaagö. Here there is an expanse of sand and gravel with: Potentilla anserina, Honckenya, Poa pratensis and Agrostis stolonifera, together with a few representatives of a number of species which have no doubt been carried thither by the stream.

[1] On the northern islands (Nordreöer) there are very few sand-strands.

b. The sand-dune (Klit) formation.

At only one place on the Færöes has sand been washed ashore in sufficient quantity to form, with the assistance of the wind, a typical dune. The material deposited here is basalt-sand similar to that of the sandy strands, but somewhat finer in texture. This dune is therefore dark grey, not whitish like the quartz-sand dunes along the western coast of Europe. It is noteworthy however, that

Fig. 174. On the dune at Sandsbugt on Sandö. The vegetation consists chiefly of *Psamma* with low patches of *Honckenya*. (From photo. by E. Warming).

the dominant species of this one dune at the head of Sandsbugt on Sandö (Fig. 174) is the same as that on the dunes of the western Europe, namely *Psamma arenaria (Psamma association).* This very conspicuous plant has been found on the Færöes only in this station, and one may almost assume that it occurs in no other places. That *Psamma* is adapted in a special degree for life on the dunes is well known, and this has been confirmed by F. Buchenau (1889) and E. Warming (1891) with regard to the shores of the North-Sea. The form found on the Færöes does not seem to differ in any respect from the typical species, but, as already mentioned, it does not appear to bear any fruit. I examined many plants during the last days of August 1897, and although there were numerous inflo-

rescences, no mature fruits could be found; if this be the case, the plant must propagate vegetatively only.

The other plants occurring on the sand-dune are generally the same as those already recorded for the sand-strand formation, viz: *Elymus, Agropyrum repens, Cakile, Honckenya, Matricaria, Potentilla anserina, Agrostis stolonifera*; several other species are casual migrants from the neighbouring cultivated fields, e. g. *Taraxacum, Ranunculus repens* and *R. acer, Leontodon autumnale, Plantago lanceolata, P. maritima* and *Rumex domesticus.* Two other species almost as characteristic as *Psamma* also occur on the sand-dune and hardly anywhere else on the Færöes. These are *Agropyrum junceum* (which like *Psamma* has not been found in fruit) and *Juncus balticus,* which here occupies its usual habitat on the sandy stretch at the foot of the dune, rather than on the dune itself.

It is thus evident, that this small isolated dune corresponds in its vegetation with the dunes of western Europe except that its flora is much poorer. It occupies a limited area at the head of Sandsbugt while between it and the open ocean there is an extensive, flat stretch of sand, devoid of vegetation; landwards it passes gradually over into cultivated fields, more or less sandy like the dune.

c. The salt-marsh formation.

Small salt-marshes occur here and there within the fjords in places where stagnant water renders the soil moist and humous. This is the case where an embankment prevents the land-water from escaping, or where soil accumulated in hollows amongst the cliffs is kept moist by freshwater springs. That such places become salt-marshes depends, however, on one condition, namely that sea-water can gain access and contribute a certain amount of salt.

The flora of these salt-marshes is made up of: 1⁰ species only found near the ocean, i. e. halophile species; 2⁰ species pertaining to bogs or other hydrophile vegetation, but which are so accomodating in their requirements that they can grow in any soil, even one containing salt, if it is moist. The characteristic plants of the salt-marsh are those belonging to the first or halophile group.

The most typically developed salt-marsh I have seen in the Færöes is at the head of the Trangisvaagfjord. Here behind the embankment already referred to (p. 924, Ex. 1) on the north side of the stream, there is a tract agreeing precisely in appearance

with a salt-marsh[1] in the south-eastern corner of the North-Sea, or on the Kattegat and the Belts[2].

The dominant species for this *Atropis association*[3] are: *Glyceria maritima, Plantago maritima, Festuca rubra, Triglochin palustre, Agrostis stolonifera* and *Armeria*; scattered among these are also *Cochlearia, Glyceria distans* (on open spots), *Leontodon autumnale, var. Taraxaci,* and *Scirpus pauciflorus.* These together form a close,

Fig. 175. The salt-marsh in Trangisvaagfjord. In the middle may be seen two well-defined pools or »pans« filled with water. (From photo. by E. Warming.)

low carpet, interrupted in places by groups of taller, social, grass-like plants, namely *Heleocharis palustris, Carex Lyngbyei, C. salina* and a large hybrid *Carex (Carex-salina association).*

Heleocharis and others of the species named (e. g. *Scirpus pauci-*

[1] Compare f. inst. E. Warming 1890 and 1906, C. Raunkiær 1889, and A. Mentz 1900.

[2] A similar association is recorded by E. Warming (1888, p. 143—147) and N. Hartz (1894, p. 24) in West-Greenland, and by H. Jónsson (1900, p. 52) in West-Iceland. All three authors regard the presence of such a formation as unusual, exactly as is the case with regard to the Færöes.

[3] *Glyceria maritima, G. distans,* and allied species are frequently separated under the generic name *Atropis.* This name seems to me to be more characteristic for the association than »the zone of Andelgræs« used by E. Warming (1890, p. 218), or his later term »*Glycerietum, Glyc. maritima*« (1906, p. 206).

florus, Triglochin palustre) may be regarded as belonging to the second category given above, and they indicate that the soil is not very saline.

The taller *Carices*, on the contrary, are species indigenous to the salt-marshes of Scandinavia from Bohuslen to the Murman-Sea and always in close proximity to the ocean.

The salt-marsh has an appearance peculiar to itself (see Fig. 175), with its sharply defined »pans« devoid of vegetation save some drifted *Enteromorphae.* This characteristic feature is familiar in our salt-marshes at home, (compare for inst. Fig. 175 with the picture Fig. 113 of Warming 1906, p. 262).

Another salt-marsh (with *Carex-salina association*) was found on the north side of the Trangisvaagfjord at Skarvatange, on a narrow flat tongue lying out in the fjord. The substratum is solid rock covered by a shallow humous soil, closely permeated with roots and rhizomes. The dominant species were: *Carex Goodenoughii, C. salina, Agrostis stolonifera, Plantago maritima* and *Leontodon autumnale, var. Taraxaci,* with *Glyceria maritima* nearer the shore in hollows in the cliffs. The following species were subdominant: *Festuca rubra, Poa pratensis, Armeria, Triglochin palustre, Lychnis flos cuculi* and *Juncus lampocarpus.* A number of other less characteristic species were also observed scattered in the association.

A salt-marsh of the same kind was observed on Syderö at the head of Vaagfjord, with *Carex salina* also dominant.

Glyceria maritima occurs constantly amongst the coast-cliffs of Syderö, where there are hollows with some soil, often enriched with remains of drifted Algæ. This species was also found under similar circumstances, north of Thorshavn, but elsewhere its place was taken by the allied species *Glyceria distans.*

As Syderö is the island with the greatest extent of low coast-line, it follows that salt-marshes occur most frequently there. Small areas with *Carex-salina association* have been observed, however, on other islands, for example on Strömö near Torsvig, and at Ejde and Selletræ on Österö. Another example was found on the landward side of the dune on Sandö (see pag. 925) at the point of Sandsvatn nearest the ocean, and again at the mouth of the stream. On Bordö a fully developed *Carex-salina association* was observed at Klaksvig, but unfortunately there was no opportunity for a close examination of its constitution.

The dominant species of the small salt-marshes which occur

on the Færöes may be summarised thus: *Carex salina, C. Lyngbyei* (rather rare), *Glyceria maritima* and sometimes *G. distans, Plantago maritima, Agrostis stolonifera, Leontodon autumnale, var. Taraxaci* and a few others. The species included here are only those which have a more or less maritime distribution.

The two *Carices* belong to the group *Microrrhynchae* Drejer, which includes the majority of the northern *Heterostachyae distigmaticae.* Both are tall, vigorous plants with strong, horizontal rhizomes, which are well adapted to make their way through the compact soil. The leaves are broad and long, especially in *C. Lyngbyei,* which has papillæ and stomata on the lower surface only, whereas *C. salina* has them on both sides (C. Raunkiær 1895-99, p. 513). In contrast to these *Glyceria maritima* and *Agrostis stolonifera* have long aërial surface runners, while *Leontodon Taraxaci, Plantago maritima, Armeria* and *Glyceria distans* are »spot-bound« plants. The leaves are more or less succulent, except in the grasses.

Plantago-maritima association[1]. This is an association closely allied to the salt-marsh, yet distinct enough to merit special notice. On several islands, particularly Syderö, there are low narrow necks of land which are swept from one side to the other by winds from the sea. These low stretches form a connecting link between higher and broader parts of the islands, and are distinguished on the Færöes as »Ejder«. The configuration of Syderö lends itself to the development of Ejder; the western side is almost intact, but the coast-line of the eastern side is broken by several fjords and bays, frequently cut back almost to the western side. On these narrow necks the Ejder occur sloping gradually upwards from the head of the fjord, and descending abruptly to the sea on the western side by steep, almost perpendicular slopes varying from 25 to 100 metres in height.

The vegetation of these Ejder is very distinct in character. On the landward side of the sand-strand or salt-marsh at the head of

[1] R. Lloyd Praeger (1903, 1904) describes this association on Clare Island and Achill Island off the west coast of Ireland: »The best marked association of halophile tendencies was that which formed the exceedingly short springy turf along the top of the low cliffs, and of which *Plantago maritima* and *P. coronopus* were the dominating plants« (1903, p. 281); then follows a list of species constituting the association.

A description by P. Feilberg (1900, p. 42) indicates the presence of the same association on Shetland at Sumburg Head.

a fjord, the vegetation is of the ordinary inland type, frequently with a small lake present. On passing over this and approaching the cliff-edge (i. e. the western side of Syderö) another very characteristic vegetation is met with. All the plants are small and low, a feature probably due to the force of the wind which sweeps over. The soil is rich in humus and frequently peaty, but not particularly moist. Under these conditions the plants of the Ejder all tend to be dwarfed in stature, a feature already referred to (p. 885) and particularly marked in a plant like *Lychnis flos cuculi.*

This well marked association I propose to designate the *Plantago-maritima association* after the plant which predominates both in number and in constancy. *Plantago maritima*, always an extremely polymorphous species, occurs in this association with short fleshy leaves and short-stem med globular inflorescences which hardly rise above the crowded rosettes of leaves.

The following are representative examples of the association and its constituent plants.

1. Kvalbö-Ejde on Syderö. *Plantago maritima* dominant with Plantago coronopus and P. lanceolata, Brunella, Agrostis stolonifera, Festuca rubra and F. ovina, Armeria, Thymus and Bellis. A similar vegetation occurred also on the west side of an Ejde rather more to the north near Kvalbö, but in places the dense plant-carpet was torn up by the wind to such an extent that large sharply defined patches were entirely denuded, except some isolated tabular masses of soil still covered with a dense vegetation (see Fig. 167, p. 886).

2. The Ejde in the Kvalvig-valley, Syderö. The Plantago-association occurs on the western side on a steep slope towards the ocean (about 100 m.). *Plantago maritima* dominant; Thymus, Armeria, and Silene acaulis are subdominant species; Festuca rubra and Plantago lanceolata occur somewhat dispersed, while here and there one sees Agrostis vulgaris, Festuca ovina, Selaginella, Ranunculus acer, Sagina procumbens, Cerastium vulgare, Luzula multiflora, Nardus, Anthoxanthum and Bellis. On places which had been entirely denuded, we found that single plants of Montia, Koenigia and Juncus bufonius had made their appearance.

3. Vaags Ejde, Syderö. This Ejde lies on the western side about 25 m. above sea-level. *Plantago maritima* dominates. The following were also recorded, all in a dwarfed condition: Plantago coronopus, Juncus lampocarpus, Leontodon autumnale, var. Taraxaci, Lychnis, Bellis, Ranunc. flammula, Sagina procumbens, Agrostis stolonifera, Festuca rubra, Carex Goodenoughii, C. flava, Brunella, Euphrasia minima, etc. The soil here was more peaty than on the other Ejder, and this was also indicated by the occurrence of some bog-plants. These latter disappear a little way up the mountain-side, being replaced by Silene acaulis, etc., but Plantago remains the dominant species.

4. The *Plantago-maritima association* occurs on other islands besides

Syderö, wherever similar conditions exist. Thus on the Ejde on Nolsö just south of the village it was found on a steep slope with an eastern exposure towards the ocean.

5. On Vaagö, on the narrow neck near Bosdalafos, between Sörvaagsvatn and the ocean, I noted in addition to the dominant species, Silene acaulis, Sagina procumbens, Cerastium vulgare, Agrostis vulgaris, Armeria and Poa pratensis. The wind here blows with such force that the cliffs are quite bare with their sharp edges weathered away.

The plants common to this association are first and foremost *Plantago maritima*, accompanied on Syderö by *P. coronopus*: along with these we have *P. lanceolata, Silene acaulis, Armeria, Festuca rubra, Agrostis stolonifera, Leontodon autumnale var. Taraxaci, Sagina procumbens*, etc. They are all perennial species with dwarfed habit; most of them are »spot-bound«, the grasses alone being able to wander. Another feature of the association is wind-pollination, which takes place in the species of *Plantago* and the grasses; one can imagine that the locality is no pleasant place for insects. The vegetation in some respect resembles that of the salt-marsh, but it differs by the presence of the *Plantago*-species and the absence of *Glyceriae* and the larger *Carices*. Strictly speaking, none of the species are entirely confined to the coast; *Plantago maritima* and *Armeria* for example, occurring on the bare rock-plateaux in all parts of the islands. The plant-form assumed on the »Ejder« is quite different, however, from that of the rock-associations, *Plantago* especially being characterized by its smooth, almost cylindrical, fleshy, short leaves. The remaining species are also widely distributed on the Færöes. Some, like *Silene acaulis*, occur on the rock-plateaux and on grassy slopes, while others belong to the bog-vegetation, e. g. *Leontodon*. They all reappear in the vegetation of the coast-cliffs, but they do not as a rule play any conspicuous part there in comparison with other species.

Mosses are unimportant elements of the coast formations, but we may note in passing the frequency of *Pottia Heimii* and *Amblystegium polygamum*.

d. The coast-cliff formation.

The numerous steep cliffs are not altogether naked and devoid of vegetation, for plants can always be found in the fissures and crevices which scar the face of the cliffs. If the cavities are large enough to permit the accumulation of some fine-soil, then the plants are often surprisingly luxuriant in their growth. Nor is

the vegetation limited to fissures and small ledges, for the faces of the cliffs themselves become covered with cryptogamic plants, including lichens, mosses and algæ.

The cliff-vegetation as a whole will be dealt with more comprehensively later, but this is the place to consider that particular form of cliff-vegetation which belongs to the cliffs facing the sea. Here the sea-water often lashes up in spray over the plants, and this in conjunction with the salt-charged and vapour-laden atmosphere, produces special conditions which favour halophile species and drive others away.

In analysing the cliff-vegetation later, reasons will be given for dividing the plants growing on the cliffs into Lithophytes and Chomophytes. It will suffice for the present to define the two categories. Lithophytes are the plants which grow on the surface of the cliff proper; cryptogams alone are represented in our temperate countries. Chomophytes, on the other hand, inhabit fissures and small terraces among the cliffs where fine-soil has gathered.

A belt of coast-cliff plant-formation is found all round the coasts of the islands. Downwards it merges into the Verrucaria formation and the littoral algæ-formations, and upwards it is gradually transformed into the ordinary cliff-vegetation.

The lithophytes belonging to the coast-cliff formation are lichens and mosses; the algæ becoming of minor importance as soon as we pass above the zone liable to occasional inundation by sea-water.

The transition-formation between the submerged vegetation and the aërial vegetation is the Verrucaria formation (see F. Börgesen 1905, pp. 711—718, Hildenbrandia-Formation, Chlorophyceæ-Formation and Porphyra-Association), the species of which form a zone on the cliffs where sea-water occasionally lashes over. This formation has been named the »supralittoral« region by E. Warming (cfr. Porsild and Simmons 1904, p. 173), a name which has also been used by Lorenz (1863, p. 193), but not with quite the same meaning.

Above the Verrucaria formation we meet a number of other lichens, characteristic of the coast-cliff formation, the most important and typical species are: *Ramalina scopulorum* and *Lichina confinis* (fruticose lichens), *Physcia aquila* and the rare *Ph. ciliaris saxicola* (foliaceous lichens), and *Placodia, Verrucariae,* etc. (crustaceous lichens). Along with the lichens two species of mosses are very

common on the coast-cliffs, viz. *Grimmia maritima* and *Weissia maritima.* They do not approach the sea so much as some of the lichens, hence we must distinguish two zonal associations: *The Ramalina association* (see Fig. 176) and *the Grimmia-Weissia association.*

The phanerogams of the coast-cliffs are not quite so characteristic; but occasionally chomophytes of the coast-cliffs may be found.

Fig. 176. Coast-cliff plant-formation at the Skanse in the vicinity of Thorshavn; *Ramalina* and *Placodium* (the light coloured spots) are dominant. (From photo. by F. Börgesen).

The terraces and the crevices of the coast-cliffs frequently harbour *Armeria, Cerastium tetrandum, Cochlearia officinalis, Haloscias, Matricaria inodora phaeocephala* and a luxuriant form of *Plantago maritima; Lotus corniculatus carnosus* is also frequent, and where the soil in the crevices is wet, one can nearly always find *Glyceria distans,* and (on Syderö) *G. maritima.* The latter two species do not belong to the typical cliff-vegetation *(Haloscias association),* but they indicate a rudimentary salt-marsh and should be included in this formation (cfr. p. 927).

In addition to these species or forms of species typical of the coast, we naturally meet with several representatives of the ordinary cliff-vegetation, such as *Sedum rhodiola, Cerastium vulgare, Angelica silvestris, Festuca rubra* and other grasses.

It is worthy of notice that all the phanerogams named for the coast-cliffs (the Glyceria's not being included) are succulent plants with more or less fleshy leaves; most of them are quite glabrous, *Plantago maritima* being somewhat hairy at the base of the leaves. *Cerastium tetrandrum* differs most; it is an annual, rather closely covered all over with glandular hairs. All the species, with the exception of *Cerastium*, are spot-bound, perennial herbs, with a strong deep tap-root, well adapted to enable the plant to maintain a foot-hold in its exposed habitat.

Examples:

1. Kvalbö Ejde on Syderö. The steep coast-cliffs towards the west have a rich and luxuriant vegetation, the dominant species being: Haloscias, Weissia and Grimmia maritima, Ramalina scopulorum, Physcia aquila, Ph. ciliaris, together with Armeria, Plantago maritima, P. coronopus, Cerastium tetrandum and Cochlearia.

2. Rock-ledge near the sea at Bosdalafos on Vaagö. Phanerogams: Haloscias, Matricaria, Plantago maritima, Succisa, Leontodon autumnale, Cerastium vulgare, Plantago lanceolata, Angelica silvestris, Sedum rhodiola, Lotus corniculatus carnosus and other herbs, as well as several grasses. The ledge lies a short distance from the sea, and this is evident from the abundance of non-halophilous species. This example illustrates the transition from the coast-cliff formation to the ledge formation.

On reviewing what has been said regarding halophile formations, it is clearly evident that only a small and inconspicuous proportion of the land-vegetation bears a distinct impress of the presence of the sea.

The halophyte formations are limited to a narrow restricted belt along the coast; they are poor both as regards individuals and species, and are only halophytic to a limited degree. That the halophytes are thus poorly represented is presumably due to the temperate and extremely moist climate. The downpour on the Færöes is so plentiful and of such frequent occurrence, that the water in sinking downwards washes the soil almost free from the marine-salts and thus renders it habitable for non-halophile plants.

Plants with pronounced halophytic adaptations belong almost exclusively to the coasts of warmer and drier climates, where insolation has a greater effect and where the removal of salts from the soil is neither so frequent nor so rapid. In confirmation of this, we find that in the Færöese shore-vegetation it is the species of the sand-strand and the coast-cliffs which exhibit halophile characters most distinctly; these are just the places where the sun's

rays heat up the black sand and the dark surface of the rocks (particularly those with a southerly exposure) and bring about a more rapid evaporation of the fresh water from land-springs which might wash out the salts.

2. Subalpine formations.

The natural plant-formations of the Færöes which bear no direct impress of maritime influence, may be classified in a general way according to their vertical range. The mountain plateaux and the summits carry their own vegetation, the alpine formations; the lower zones, from sea-level up to 200—400 metres altitude, harbour the remainder, which we are justified in calling subalpine formations, if an attempt is made to compare the vegetation of the Færöes with that of Scotland[1], North-England[2], Ireland[3], and certain parts of Scandinavia and Switzerland[4].

It is almost self-evident that no hard and fast line can be drawn between the alpine and the subalpine formations. This is particularly the case on the Færöes, where transitions from one formation to another recur with almost tiresome frequency, and an accurately defined survey is almost impossible.

In considering the subalpine plant-formations, it will be most natural to arrange them according to the amount of water contained in the soil, commencing with the lakes and ending with the dry cliffs.

The Færöes contain numerous small lakes (tarns) and pools, a few somewhat larger lakes (Sörvaagsvatn, Toftevatn, Leinumvatn, Sandsvatn) and a great number of watercourses generally of no great size. The vegetation in the standing and running water is meagre; it may be divided into the following plant-formations:

a. The plankton formation,
b. The freshwater lithophyte formation,
c. The limnæ formation of the lakes,
d. The limnæ formation of running water.

[1] Hardy 1905 and 1906; Lewis 1905; Robert Smith 1898 and 1900; W. G. Smith 1902 a, 1902 b, 1904 and 1905.

[2] Moss 1904; W. G. Smith, Moss and Rankin 1903; Lewis 1904.

[3] Pethybridge and Praeger 1905; Praeger 1903, 1904.

[4] Stebler and Schroeter 1892.

a. The plankton formation.

The lacustrine phytoplankton of several of the lakes was found to be scanty when investigated by F. Börgesen and the author (Börgesen and Ostenfeld 1904). We found that Sörvaagsvatn alone (Toftevatn and Leinumvatn have yet not been investigated) contained a true lake-plankton which included *Asterionella formosa, Dinobryon divergens, Staurastra* a. o. The plankton of the smaller lakes, so far as examined, can only be called a poor pond-plankton, consisting of various forms of Desmids, green Algæ, Diatoms and Flagellates. Nothing further can be said until the plankton has been studied in the different seasons of the year, regularly and at not too distant intervals.

We are also able to state that the character of this plankton shows close agreement with that observed in lakes under similar climatic conditions elsewhere, such as those in Scotland (W. West and G. S. West 1903 and 1906 a), Ireland (W. West and G. S. West 1902 and 1906 b) and Iceland (Ostenfeld 1904; Ostenfeld and Wesenberg-Lund 1906).

b. The freshwater lithophyte formation.

A meagre vegetation, consisting mainly of mosses and algæ, occurs on stones and rocks in the lakes and streams. Owing to lack of the necessary notes, I cannot, unfortunately, deal with this particular formation so fully as desirable. C. Jensen (1897) and F. Börgesen (1899, p. 322 and 1901, p. 204) give some attention to the formation in their papers. The most conspicuous and presumably the commonest moss on the stones and boulders is *Fontinalis antipyretica* and in some places also *F. gracilis;* amongst others recorded are *Jungermannia cordifolia, Hypnum rusciforme* and *rivulare, Pohlia færoensis, Grimmia alpicola rivularis, Amblystegium ochraceum, A. Smithii* and *A. dilatatum.* The more important of the numerous mosses of the marginal vegetation along the streams will be mentioned later (p. 943).

As regards Algæ a large green species, *Cladophora glomerata,* grows abundantly on the crags and shelves of the lake on Kvalbö Ejde.

There is also a characteristic *Enteromorpha association* in the watercourses at a considerable distance from the sea. This has long been known from Lyngbye's record (1819, p. 64) and is referred to later by F. Börgesen (1901, pp. 243—45). I have also

observed it on Fuglö, in a little stream about 200 M. above sea-level. Börgesen refound it on Strömö, whence Lyngbye's record came. According to Börgesen (1902, p. 492) the plant should be named *Enteromorpha intestinalis, var. prolifera.*

In addition to these few larger Algæ, there is crowd of smaller forms, growing on stones and rocks in freshwater; these include numerous Desmids and green Algæ, conspicuous amongst which are the filamentous forms: *Ulothrix, Conferva, Microspora* and *Conjugatae.*

c. The limnæ formation of the lakes.

The rooted vegetation in the lakes is also very meagre. The margins of most of the lakes are bare and gravelly, but occasionally one meets a swamp-vegetation extending some distance into the water. True aquatic plants occur in patches which only occupy small parts of the surface or bottom. Lakes covered with vegetation are almost unknown; a little pond in Skopen and one near Sand were, however, almost entirely covered by *Potamogeton natans.*

The bare strand is continued as a gravelly bottom for some distance into the lake to a summer-depth[1] of about 50 Cms.; beyond this depth the bottom is generally soft and muddy. These conditions prevail in most of the lakes and for the greater part of the margin. At the lake outflow the appearance of the margin is altered, for here the gently sloping gravel beach disappears and the outlet is steep and rugged, through exposure of the solid rock, or from the presence of a barricade of large boulders (Fig. 177). The extent of these rocky margins varies in each lake, and several of the smaller lakes are completely rock-bound. As a rule the submerged base of the cliff shows no vegetation, but occasionally a growth of *Fontinalis antipyretica* or some green Algæ may be found (Compare the lithophyte formation described above).

The limnæ formation of the lakes is naturally grouped into two associations according to the condition of the bottom and the depth of water:

a. The *Litorella association* extending from the shore to a depth of about 50 Cms.

[1] The water covers the bare marginal zone during the higher surface-levels of autumn and winter, and it is to this circumstance that the barrenness of the beach is due; at its upper limit it is frequently sharply defined from the grass-vegetation by a distinct low bank (Compare the *amphibious association* on p. 945).

β. The *Sparganium-Potamogeton association* extending from about 50 Cms. to 100—150 Cms. depth[1].

The *Litorella association* includes in addition to *Litorella, Isoëtes lacustre* and *I. echinosporum, Subularia aquatica,* submerged specimens of *Juncus supinus, Callitriche hamulata,* and as rarer species: *Lobelia dortmanna, Ranunculus reptans* and *Potamogeton filiformis; Nitella opaca* is rather common, while *Chara delicatula* occurs occasionally.

The first four of the plants named, as well as *Lobelia* and *Ranunculus,* bear only radical leaves which are short, more or less fleshy, cylindrical and often pointed. *Potamogeton filiformis, Callitriche*, the *Characeae* and as a rule *Juncus supinus* have well-developed stems, but approach the first type in leaf-form, which is, however, somewhat more slender (linear or setaceous). All grow quite submerged, at any rate as regards vegetative organs, and they are adapted to a submerged habitat in shallow water, hence exposed to the influence of the waves. In this respect they are much better adapted than those species with longer shoots and leaves liable to be torn against the stones or gravel of the bottom.

The different species vary considerably as regards structure of the shoot and vegetative propagation. *Subularia* and *Nitella* (and occasionally *Callitriche*) are annuals, the others are perennials. *Lobelia* and the species of *Isoëtes* are sedentary (spot-bound), *Litorella* and *Ranunculus reptans* have surface runners while *Potamogeton filiformis* has subterrean rhizomes with special winter-buds (hibernacula). It is noteworthy that the phanerogams flower sparingly and rarely form perfect seed. I have seen *Litorella* in bloom only once in a lake on Syderö, and yet it grows in almost every lake. The other species are found in flower more frequently, but only *Callitriche* and *Subularia* bear fruit in abundance (compare p. 916). As regards pollination *Litorella, Callitriche* and *Potamogeton filiformis* are pollinated by wind, but *Callitriche,* and probably also *Subularia,* are capable of self-pollination, when the water is high and the flowers submerged, thus accounting for the regularity of fruiting. *Ranunculus reptans* and in particular *Lobelia* are possibly insect-pollinated, but may perhaps be capable of self-pollination.

[1] Most of the lakes at greater depths are probably destitute of vegetation, yet I collected near the shore of Sandsvatn on Sandö a large number of small balls of *Aegagropila Martensii,* which were strewn about on the bottom and doubtless had grown further out in the lake.

The *Isoëtes* and the *Characeae* are altogether distinct from the phanerogams; they form spores abundantly and regularly.

Beyond the Litorella association the lake-bottom, as already stated, is soft and loose, and here the spot-bound plants and those which wander superficially over the bottom are largely replaced by others with rhizomes embedded in the mud and with stems on which the inflorescences are carried up to the surface. Spot-bound species are still represented, however, since the *Isoëtes* and *Nitella* still survive

Fig. 177. Kvanhauge lake on Syderö, seen from a cleft above the valley. The inner side of the lake has a flat sandy shore, while the outer is bound in by cliffs. The sea in the background. (From photo. by E. Warming).

in this zone, while perhaps *Myriophyllum alterniflorum* and *Potamogeton pusillus* must also be regarded as spot-bound. The last-named species occurs rarely; it has no creeping rhizome, but propagates, on the Færöes, entirely by its winter-buds, which each year produce a new shoot, hence it is analogous with an annual plant. This plant-association I have named after the most characteristic and most frequent species the *Sparganium-Potamogeton association.* It includes, besides the species just mentioned: *Sparganium affine, Potamogeton gramineus, P. natans, P. perfoliatus, P. nitens* and less frequently *P. alpinus* and *P. praelongus.* Several of the *Potamogeton*-species have submerged leaves only (*P. perfoliatus, P. praelongus, P. nitens* and *P. alpinus* on the Færöes); others such as *Sparganium,* have floating-leaves, which are ribbon-shaped, whereas in the pond-weeds (*P.*

natans and *P. gramineus)* they are elliptical. Wind-pollination is characteristic for all the species, but frequently the fruit is not developed. Several of the rarer species have never been found in fruit on the Færöes (see further p. 916), but *Myriophyllum* appears to fruit with some degree of regularity[1].

It is thus evident that the Færöese lakes are inhabited by a very meagre vegetation. George West (1905) in a recent memoir on the Flora of the Scottish lakes has furnished material for a comparison between the lakes of Scotland and the Færöes respectively. From this it is quite evident that the lakes of the Scottish Highlands closely resemble those of the Færöes, both as regards vegetation and general appearance. The numerous photographs which accompany West's paper, show several lakes astonishingly like the Færöese ones, e. g. Figs. 49, 53, 55, 58, 63, 64 and 69 (l. c. pp. 1002—1003). From the text one sees that the vegetation is made up by the same species, with some additional not represented on the Færöes, and that the general character is obviously similar. The resemblance is, however, not so strongly appearent, since West does not discriminate between the limnæ and the swamp formation, but treats them as one.

Examples:

1. The Kvanhauge-lake on Syderö. *Litorella association:* Litorella and Nitella from the water-edge to a depth of about 50 Cms. — *Sparganium-Potamogeton association:* Potamogeton perfoliatus and Isoëtes lacustre from about 50 to 100 Cms.

2. The Kvalbö-Ejde lake on Syderö. *Litorella* grows and flowers on the west side quite out of the water, and extends out to a depth of about 75 Cms. Flowering and sometimes fruiting specimens of Myriophyllum and Potamogeton filiformis and sterile P. gramineus extend landwards almost to the water-edge on the sandy west side. Myriophyllum appeared in great numbers, some way further out, and also some Isoëtes lacustre. Where cliffs formed the margin, these were closely covered by Cladophora glomerata (see above p. 936).

3. Lake in Vatnsdal, Syderö. *Litorella association:* Litorella, Isoëtes lacustre, Juncus supinus (submerged). — *Sparganium-Potamogeton association:* Potamogeton gramineus and P. praelongus, Myriophyllum and Isoëtes lacustre. In the outlet from the lake: Litorella, Heleocharis palustris and Myriophyllum.

4. Vaag-Vatn, Syderö. Marginal swamp-vegetation *(Heleocharis association):* Heleocharis palustris, Equisetum fluviatile, E. palustre, Carex salina. — *Litorella association:* Litorella, Isoëtes lacustre, Nitella opaca, Callitriche hamulata and Myriophyllum. — Outward they pass into the *Sparganium-Potamogeton association* with Potamogeton perfoliatus and

[1] *Ruppia maritima* may be given as a lake plant, since it has been found in some small shallow ponds near the sea at Kvalbö.

Sparganium affine. Some fragments of Callitriche autumnalis were found driven ashore.

5. Miavevatn and Leinumvatn, Strömö. Margins nearly everywhere stony and gravelly. In places *Heleocharis association* consisting of Heleocharis palustris and Ranunculus flammula. — Outside of this the *Litorella association:* Litorella, Isoëtes echinosporum and I. lacustre, Subularia, Nitella opaca, Callitriche hamulata and Myriophyllum; the last on the transition-belt to the *Sparganium-Potamogeton association* of which only Sparganium affine was observed.

6. Small lakes above Næs parsonage on Österö, about 100 M. above the sea. *Litorella association:* Litorella, Isoëtes lacustre and I. echinosporum, Juncus supinus, Subularia, Ranunculus flammula. — *Sparganium-Potamogeton association:* Sparganium, Potamogeton gramineus (sparingly), and Myriophyllum from a depth of about 50 Cms.

7. Toftevatn on Österö; a large lake. No vegetation on the stony and gravelly margin. Some distance out in the water, *Litorella association* with Litorella, both Isoëtes-species and Subularia. — *Sparganium-Potamogeton association* very scanty, with Potam. gramineus, P. perfoliatus and Myriophyllum.

8. The larger lake at Ejde, Österö. Beyond the ordinary *Litorella association* there is in the inlets a dense growth of Sparganium and Potamogeton natans; further out, submerged Potamogetons (P. alpinus, P. perfoliatus and P. pusillus).

The smaller lake is entirely covered with P. natans and a little Myriophyllum.

9. Sörvaagsvatn on Vaagö, the largest Færöese lake. At the time of my visit, the surface-level was so high that the few small plants (Montia and Sagina procumbens) of the gravelly margin were entirely under water *(amphibious association).* Beyond were patches of Litorella with Isoëtes mixed between, but I saw no other vegetation.

10. Sandsvatn on Sandö. This is just as barren as the other larger lakes, Toftevatn and Sörvaagsvatn. The gravelly strand is overrun with Sagina procumbens, Montia, Juncus lampocarpus and Ranunculus reptans (partly submerged) and some casuals, such as Poa annua, Juncus bufonius and Koenigia *(amphibious association).* In the water Litorella was seen, and further out Potamogeton perfoliatus with a little P. gramineus.

11. Grothusvatn (»Saltvigsvatn«) on Sandö. The greater part of the margin is rocky, but towards the west is also gravelly. The lake is very shallow with a depth of 50—100 Cms., and is entirely covered by *Sparganium-Potamogeton association:* Potamogeton perfoliatus, P. nitens and P. gramineus dominating, with Sparganium, a little Litorella, Juncus supinus (submerged), Isoëtes, and in places Potamogeton pusillus forming low, dense tufts, which make no attempt to reach the surface.

Small pools near Grothusvatn have a luxuriant vegetation of Litorella, Lobelia, Juncus supinus, Sparganium, Potamogeton natans and P. polygonifolius, amongst which Menyanthes and Heleocharis make their appearance.

12. A small lake in Skopen Bygd, Sandö. Gravelly border, with muddy bottom. A rich algal vegetation occurs on Myriophyllum

and Potamogeton natans, which form the vegetation; Litorella and the two Isoëtes-species are rather unimportant elements.

d. The limnæ formation of running water.

The innumerable short watercourses of the Færöes are fringed as a rule with plants, most of which are mosses. If the watercourse is only a seasonal one, then the moss-vegetation may fill it entirely, but in the case of larger and less ephemeral streams, the water runs as a rule over a stony and gravelly bottom, which bears a very sparing lithophyte vegetation (see p. 936). It is only in the larger streams, that one occasionally finds a meagre vegetation of vascular plants in places where the fall is slight and the movement of the water sluggish, that is in the lower reaches of a stream, or in the inlets. The plants which make their appearance under these conditions include those recorded for the lakes, and also certain swamp-plants, but neither the *Isoëtes*-species, nor *Subularia* are found in watercourses. As the swamp-plants will be dealt with later, nothing further will be said regarding this formation, except to give some examples, taken from my notebooks:

1. Stream in the Hove-valley on Syderö. An inlet with slight current, and peaty bottom: Litorella and Myriophyllum in abundance, with Potamogeton polygonifolius, Chara delicatula, Callitriche hamulata and submerged Juncus supinus.
2. Stream at Höjvig in the vicinity of Thorshavn. Watercourse with rather rapid flow of water; in the quieter places Potamogeton natans with narrow floating-leaves, Myriophyllum, Litorella, Nitella opaca, Juncus supinus and lampocarpus (both submerged).
3. Stream in the bottom of Kollefjord, near outlet into the sea. Equisetum fluviatile, Callitriche hamulata, Juncus lampobarpus (submerged), Litorella and a little Glyceria fluitans.
4. A stream flowing into Grothusvatn, Sandö. Myriophyllum and Potamogeton polygonifolius in abundance, with P. nitens and submerged Juncus supinus here and there.

The plant-associations just described all occur in freshwater. The associations which now come under consideration occur close to the water, or are covered by water occasionally during the year; they are thus a degree less hydrophytic than the first group. There is a marked distinction between the formation existing alongside fresh and running water and that beside stagnant water, hence we recognise two formations:

e. The hydrophyte formation round the springs and along streamlets.

f. The swamp formation.

These two formations lead naturally over to the moor formation (g) and the heather-moor formation (h), both of which in common with the swamp formation inhabit a humous soil, but differ from it and from one another in the proportion of water present in the soil (see further under *g*, p. 947).

e. The hydrophyte formation round springs and streamlets.

This forms a characteristic plant-formation and takes a conspicuous place in the physiognomy of the landscape. Even from a distance the mountain slopes can be seen to be veined by bright green stripes, which break the monotony of the predominating darker green. On closer examination one soon finds that the stripes indicate the courses of small hill-streams issuing from springs. The light-green vegetation consists principally of mosses, and may be designated the *Philonotis association* from the commonest and most conspicuous species.

In addition to *Philonotis fontana,* the following mosses are dominant: *Martinellia undulata, M. purpurascens, Pellia Neesiana, Chiloscyphus pallescens, Anisothecium squarrosum, Astrophyllum punctatum, Bryum ventricosum,* and *Pohlia albicans, var. glacialis*; somewhat less abundant are: *Hypnum rivulare* and *Amblystegium spp.*, etc. The commoner phanerogams are: *Montia lamprosperma, Saxifraga stellaris, Epilobium alsinifolium* (and *E. palustre*); also frequent are: *Caltha, Cardamine pratensis, Stellaria uliginosa, Carex panicea, Eriophorum polystachyum* and other swamp-plants.

This formation — with which we may include the vegetation on cliffs over which water constantly trickles — has a characteristic habitat in that it is constantly saturated with water, which is flowing, fresh, cold and contains much air (oxygen). The swamp vegetation has this in common that it possesses a constant surplus of water, but it differs in all the other characteristics of the water-supply and so there arises that great difference which exists in the composition of the vegetation.

The fresh, flowing spring-water is doubtless favourable to the occurrence of the numerous mosses. The low temperature resulting from the constantly renewed supply of cold water, is unfavourable to phanerogams, or, more correctly, it decreases in an extreme

degree the number capable of thriving under these conditions. The most characteristic phanerogams *(Montia, Epilobium alsinifolium, Saxifraga stellaris,* and *Stellaria uliginosa)* grow in the moss-cushions, and their shoots ramifying in the mossy substratum, form more or less dense swards.

The Philonotis association has evidently a wide distribution in northern mountainous countries. From my own observations, it occurs in Greenland and especially in Iceland, and it is also recorded by authors who have described the vegetation of these regions. E. Warming in his memoir on the vegetation of Greenland (1888, p. 35) mentions a »Philonotis vegetation« which is identical with what we are now describing. H. Jónsson in describing it (1895, p. 73) from Iceland says: a moss-vegetation consisting of light green, larger or smaller moss-cushions, resting on a muddy substratum (»Di«). The same author in more recent papers (1900, p. 25 and 1905, p. 11) refers again to this formation which he calls moss-bog (»Moskær«), and characterises it by *Philonotis fontana* and to some extent by *Mniobryum (Pohlia) albicans,* var. *glacialis*; the phanerogams recorded by him are almost identical with those given here for the Færöes. Similar in character is also the vegetation surrounding the »warm« springs (»Unartut«) on Disco in Greenland, as mentioned by Porsild (1902, p. 227).

It is hardly correct, however, to group the Philonotis association as Jónsson has done, with the moss-bogs (Moskær) described by Warming (1888, p. 132). Warming's definition of a moss-bog really amounts to this, that they are grass-bogs (Græskær) so overgrown by mosses that the phanerogams have been displaced; it follows from this that one of the characteristics of a moss-bog is the stagnant water (opposed to the Philonotis association). It is of course the case that these two plant-associations are related, but they are not identical. Kolderup Rosenvinge in his paper on the vegetation of South-Greenland (1897, pp. 243—44) also included both forms of vegetation in his term »Moskær«. On the other hand Porsild (l. c., p. 226 and 227) has distinguished them, but removes them too far apart from one another. In my own opinion it seems most natural to separate the two formations; the fresh, running water which presumably contains abundance of oxygen and carbonic acid gas, with little humic acid, is extremely important for the Philonotis association, and brings about the presence of some species while suppressing others, which are common in a true bog-formation.

As related to the Philonotis association I take a plant-association which has its home on the bare gravelly margins of lakes, water-courses, etc. (see Fig. 9 in Vol. I, p. 15). Prof. Warming has verbally proposed to me the name »*Amphibious association*«. Its characteristic conditions are the great changes in the amount of water; in the winter and early spring the places where it occurs are submerged from the lake or watercourse or by some temporary

Fig. 178. Small pool with *Menyanthes* near Næs parsonage on Österö. (From photo. by E. Warming).

lodgment of water; in the summer the places are exposed to the air and the sun (see foot-note p. 937). The plants occurring under those conditions are naturally short-lived, the commoner species being *Montia lamprosperma* (in its small annual form), *Sagina procumbens, Sedum villosum, Koenigia, Juncus supinus,* while *Polygonum aviculare* and *Poa annua* are not uncommon; mosses and lichens do not occur. I have met this association in many places, but have only a few notes on its composition.

Examples 9 and 10 of the limnæ formation of the lakes include plants from the amphibious association (p. 941).

f. The swamp formation.

Swamp vegetation plays a minor part on the Færöes, because the configuration and the small extent of the islands do not favour

the existence of large swamps. Such swamps as there are occur on the margins of some of the lakes or in the numerous small pools present all over the lower country, some being natural, while others are the result of human agency, — turf-cutting, etc.

The vegetation on swampy lake-margins differs considerably from that of the pools, hence my division of the Færöese swamp formation into two associations:

α. Heleocharis association.

β. Menyanthes-Polygonifolius association.

Heleocharis association. This forms the transition from the water-vegetation to that of the moors near a few Færöese lakes. The association — very familiar to us round the smaller lakes of the heath-regions of Jutland and other parts of Denmark — is found in its typical form at Vaag-Vatn on Syderö, with *Heleocharis palustris, Equisetum fluviatile, E. palustre, Carex salina* and *Ranunculus flammula.* A similar vegetation made up of *Heleocharis palustris, Iris pseudacorus, Carex salina, Menyanthes, Myosotis palustris strigulosa* and *Galium palustre* was also observed round the lakes at Eide on Österö. At several places on the margin of Sandsvatn on Sandö we also observed patches of *Heleocharis palustris, Carex salina* and *Polygonum amphibium natans.* Traces were also found in other places (e. g. Example 5, p. 941); one or two of the species already named forming small patches.

The only characteristic species are *Heleocharis palustris, Equisetum fluviatile* and *Carex salina,* all three being species with vigorous, horizontal, subterrean rhizomes[1].

Menyanthes-Polygonifolius association. The association to which I give this name is of more frequent occurrence than the last, but not so easy to define. The principal plants are *Menyanthes* and *Potamogeton polygonifolius.* The latter species appears in all places where there is a bare substratum of muddy peat, which is permanently, or at least occasionally at certain periods, saturated with water. Here *Potamogeton polygonifolius* forms a more or less dense growth, which is a forerunner of the true bog and moor vegetation.

Menyanthes occurs with the *Potamogeton,* or it may entirely replace it in many pools, especially the larger ones. Several other plants may also appear, e. g. *Myosotis repens* (only on Syderö),

[1] The occurrence here of *Carex salina* out of its natural habitat in the salt-marsh, is due to the fact that the few localities for swamp are all near the ocean.

Ranunculus flammula, Juncus supinus and *J. lampocarpus, Sphagna, Amblystegium scorpioides* and many others. This plant-association forms a transition to the boggy moors to be considered next. Yet it merits independent recognition as one form of pioneer-vegetation leading to the moor, because its two dominant species cannot be regarded as ordinary moor-plants. Similarly the Heleocharis association is another form of pioneer-vegetation.

The difference in the composition of those two associations is caused by the difference in the soils of their habitats, but when the growth becomes denser, that is, as we approach the true moor-formation, the difference disappears; thus starting from two points we get one and the same result.

g. The moor formation.

The greater part of the Færöes under vegetation, is covered by plant-formations on humous soils. A series of associations may be drawn up according to the water-content, but as might naturally be expected, these merge into each other by gradual transitions. The wettest type is the swamp-formation already described, but its extent is very limited in comparison with what I call the moor-formation, and the heather-moor. The dry Calluna heath does not occur at all, the nearest representative being better described as the heather-moor.

The moor formation of the lower parts of the country consists, in my opinion, of two subdivisions, based on the degree of moisture in the soil and the resultant difference in the plants present:

α. *The boggy sedge-moor association* or *Cyperace-Sphagnum association* (Kær).

β. *The grass-moor association* or *Glumiflor-Hylocomium association* (Hedekær).

In each case the second designation is used to indicate the most characteristic phanerogams and mosses. The mosses play an important part in the Færöese plant-associations, particularly in those occurring on humous soils.

(α) *The boggy sedge-moor association (Cyperace-Sphagnum association)* occurs especially in the numerous valleys of the undulating landscape. Wherever one finds a distinct development of low dome-shaped »roches moutonnées« or »Rundheller«, there, in the depressions between, the boggy association is met with,

if water does not lie all the year round. On the slopes of the domes the heather moor occurs, and crowning the summits there is frequently a meagre rocky-floor vegetation with the bare rock or soil showing up. Besides occurring in these hollows, the boggy-moor association is met with throughout the lower parts of the valleys, if water is abundant and its movement is retarded or blocked. The removal of peat[1] for fuel and the formation of turbaries in almost every valley have resulted in a great increase of this formation. The floors of the valleys are very irregular, the rock being quite exposed or just below the surface at one place, while not far off there may be peat to the depth of a metre; peat-cutting is therefore only possible in pockets where there is sufficient depth.

The surface of a Færöese valley-bottom is thus very uneven, constantly changing between low knolls or hillocks and the intervening hollows. The boggy-moor association appears in natural depressions and turbaries when water is present in sufficient quantity to provide the necessary conditions. As time goes on the accumulation of vegetable matter raises the surface-level and reduces the water-content, so that the vegetation assumes a somewhat less boggy character. *Eriophorum* and the *Carex*-species become replaced by *Scirpus caespitosus*, *Juncus squarrosus*, and *Nardus*, while *Sphagnum* and *Campylopus atrovirens* give place to *Hylocomia*, *Isothecium tenuinerve* and *Grimmia hypnoides*. In this way the plant-association, which I have named grass-moor (Hedekær) comes into existence. This change affects the landscape, in that the surface of a valley-bottom becomes more uniformly level, and brings a greater homogeneity into the plant-covering. So long as the depressions remain distinctly lower than the heights, the vegetation on the latter remains rather dry, often heath-like. Later as depression and height become effaced, the difference in the vegetation also disappears, and ultimately there may result a gently undulating surface covered by a grass-moor vegetation.

The plant-covering has probably developed in this way in the

[1] Use of the terms »Turf« and »Peat« (Note by Dr. W. G. Smith): »Turf« is used in two common ways 1) Grass-turf or sod, 2) Turf for burning. The latter is in some parts the surface layer (about 5 cm.) from Calluna moor or heath; certain local names e. g. »flad« are distinctly Scandinavian, allied to German »plagg«. »Peat« is dug from below the surface in more or less brick-shaped pieces; it occurs chiefly in bog-formations. In Ireland and other places this is also called »turf«. »Turbary« = the place from which peat is taken.

course of time, and the influence of man during the ten centuries he has inhabited the islands, has most likely been to set back the vegetation here and there by his operations to an earlier stage of development through which it has already passed.

The aspect of the boggy-moor association is rather gloomy. Grass-like plants prevail and give it a dark-green colour, much darker than the meadows (Bö) and the grassy hill-slopes; »flowering« (i. e. not grassy) herbs are not numerous enough to make an impression

Fig. 179. Undulating landscape on Sandö between Sand and Skopen; a small lake lies in the distance, to the left. The depressions are occupied by moor-formations, the knolls by heather-moor or the intermediate association. (From photo. by F. Börgesen).

on the vegetation. The places where this association occurs have, as already stated, an undulating surface with many small depressions from peat-cutting, while channels and small watercourses of various forms furrow the vegetation.

The dominant phanerogams are: *Eriophorum polystachyum, Juncus lamprocarpus, Carex stellulata, C. flava. C. panicea* and *C. Goodenoughii;* also the following »flowering« herbs: *Ranunculus flammula, Narthecium, Caltha,* and partially to some extent *Pinguicula, Leontodon autumnale* var. *Taraxaci* and *Triglochin palustre*; in some places *Pedicularis palustris, Agrostis canina* and *Molinia* are of some consequence.

I cannot venture to say much about the mosses. Several species of *Sphagnum* are the most conspicuous, and the dark-green

Campylopus atrovirens is also very characteristic, with its dense cushions covering large areas of the turf, and allowing no opportunity for the growth of flowering plants. Other mosses make their appearance in the moist bogs, viz. *Amblystegia (A. stellatum* and *intermedium)*, also liverworts, e. g. *Pellia Neesiana*; some other mosses of the boggy-moor association are *Dicranum scoparium, Gymnocybe palustris, Astrophyllum hornum* and *Acrocladium cuspidatum.*

Generally speaking the moss-vegetation is extremely luxuriant and consists of many species. Amongst others we can always find in the real moist bogs, those species of *Hylocomia*, which appear to me to be the most characteristic for the somewhat drier grass-moors. The growth-habit of the *Sphagnum* species differs considerably from that found in less insular climates; the plants never form real *Sphagnum*-moors on the Færöes (nor on Iceland, as far as I know). In other words, there are no moor-areas covered with a carpet of *Sphagnum* in which a few flowering plants are scattered. Even in those places where I saw *Sphagnum* most dominant, there was a considerable proportion of other mosses and flowering plants. This peculiarity has already been pointed out by C. Jensen (1897, p. 202).

Turning now from the mosses to the vegetative features of dominant flowering plants, it will be found that the boggy-moor includes species with subterrean wandering shoots *(Eriophorum, Carex panicea, C. Goodenoughii, Triglochin palustre* and *Narthecium)*, other species which are spot-bound *(Carex flava, C. stellulata, Leontodon, Caltha, Pinguicula, Molinia* and the biennial *Pedicularis)*; and others more or less adapted for wandering by means of epiterrean shoots *(Ranunculus flammula* and *Agrostis canina)*. The species with subterrean shoots prevail over the others because of their mode of growth, and they will always dominate on a bog area.

There is not much to say regarding the flowering and fruiting of the chief plants mentioned. The »grass-like« species are all wind-pollinated. Some of the »flowering« herbs *(Narthecium, Caltha, Ranunculus)* have open flowers with yellow petals, and are presumably visited by flies or are self-pollinating; a few are more highly developed »insect-flowers«, e. g. *Pedicularis, Pinguicula* and *Leontodon.* Fruiting is very likely abundant and regular in every species, even in bad summers.

The species already mentioned are, in my opinion, the most

characteristic, because they attain their best development and appear in greatest abundance in this association. In addition to these there are of course many others, although the boggy-moor associations is by no means so rich in species as the grass-moor association. During excursions on the islands, I have made notes on many boggy moors; these notes will probably convey in the best way some idea of the appearance of these moors, and show how gradually they pass over into the condition of grass-moors:

1. A peaty landscape at Punthavn on the south-side of the Transgisvaag-fjord, Syderö. Carex panicea, C. stellulata, C. Goodenoughii, C. binervis, C. flava, Narthecium, Scirpus caespitosus, Juncus squarrosus, J. lampocarpus, J. supinus, Leontodon Taraxaci, Anthoxanthum, Ranunculus flammula, Potentilla erecta, Polygala serpyllacea, Eriophorum polystachyum etc.; on the substratum Sphagna, Campylopus atrovirens, Hylocomia and other mosses. There is a perceptible transition from boggy moor to grass-moor.

2. »Dalen« at Kvalbö, Syderö. A comparatively flat expanse furrowed by numerous small watercourses and ditches. *Carex Goodenoughii* and *Juncus lampocarpus* dominant; common are: Ranunculus flammula, Bellis, Nardus, Brunella, Lychnis flos cuculi, Scirpus pauciflorus; also noted Succisa, Alchimilla filicaulis, Taraxacum sp., Caltha, Plantago maritima, Festuca rubra, Anthoxanthum, Agrostis canina, Eriophorum, Juncus supinus, Potentilla erecta, Comarum, Pedicularis, Euphrasia sp., Sagina procumbens, Carex panicea, C. stellulata and C. flava. A sample of the bottom-moss, according to C. Jensen's identification, consisted mainly of Amblystegium stellatum and Pellia.

3. The hollows amongst »roches moutonnées« (Rundheller) north of Thorshavn. *Eriophorum polystachyum*, *Carex stellulata*, and *Sphagna* dominant; common or locally dominant in places were: Carex Goodenoughii and Juncus supinus. Other species recorded: Epilobium palustre, Potamogeton polygonifolius, Carex pulicaris, C. flava, Ranunculus flammula, Viola palustris, Scirpus caespitosus and the mosses Gymnocybe palustris, Astrophyllum hornum, Polytrichum commune, Breutelia and Diplophyllum albicans.

4. The north side of Kollefjord; flat area near the water held up by a gravel-mound. *Eriophorum*, *Juncus lampocarpus*, *Carex Goodenoughii*, *C. panicea* and *Ranunculus flammula* were dominant. Other species: Molinia, Anthoxanthum, Agrostis canina, Caltha, Trifolium repens, Epilobium palustre, Succisa, Leontodon Taraxaci, Carex stellulata, Montia, Euphrasia minima, Alectorolophus minor, Luzula multiflora, Heleocharis palustris, Scirpus pauciflorus, Lychnis and Juncus effusus.

5. A flat expanse at the upper end of Grothusvatn on Sandö. Boggy-moor vegetation with great cushions of *Sphagnum*, *Carex panicea*, *C. Goodenoughii* and *C. stellulata*, *Eriophorum*, *Ranunculus flammula*, *Nardus*, *Potentilla erecta*, etc.

Other examples might be added, but these will probably suffice to give some idea of the boggy-moor vegetation.

An intermediate association, whose composition shows it to be a transition between the boggy-moor and the grass-moor has an extremely wide distribution. All my lists, including those just given above, contain some, at least, of the dominant species of the grass-moor; this is particularly conspicuous in the first example.

The following lists will show still better the plants of this intermediate association.

1. Turbary on the west-side of Toftevatn, Österö. The surface very uneven through frequent excavation for peat. Eriophorum, Carex Goodenoughii, C. panicea, C. flava, Agrostis canina, Scirpus caespitosus, Juncus squarrosus, Potentilla erecta and Calluna are the more abundant phanerogams, and they become dominant in turn on different parts. In the same way there is alternate domination of mosses: Sphagna, Polytrichum commune, Hylocomia and Grimmia hypnoides.

2. Turbary in the valley from Midvaag to Sörvaagsvatn on Vaagö. The higher parts of this irregular undulating stretch are covered by a luxuriant growth of heather-moor; Eriophorum, Juncus lampocarpus, Carex flava, Scirpus caespitosus, Carex Goodenoughii, etc. are dominant in the hollows.

3. Stretch of moor beside the lakes between Sand and Skopen, Sandö; dominant species: *Eriophorum*, *Scirpus caespitosus* and *Sphagna;* common: Potentilla erecta, Calluna, Cladonia rangiferina; scattered are Empetrum, Pinguicula, etc.

4. Stream-delta at the upper end of Sandsvatn, Sandö formed by the different outlets of the river; surface level. Dominant species: *Juncus lampocarpus*, *Nardus* and *Agrostis sp.;* common: Succisa, Potentilla erecta, Ranunculus flammula; others noted: Anthoxanthum, Bellis, Festuca ovina, Leontodon, Brunella, Carex panicea, Euphrasia borealis, Plantago lanceolata, Ranunculus acer.

5. The flat area round Kvanhauge-lake on Syderö. Dominant: *Carex Goodenoughii, Nardus* and *Anthoxanthum;* other species noted: Eriophorum, Juncus conglomeratus, Luzula multiflora, Potentilla erecta, Galium saxatile, Festuca ovina, Rumex acetosa, Polygala serpyllacea, Selaginella, Euphrasia minima, Pinguicula, Bellis, Ranunculus flammula, Carex pilulifera. Very luxuriant moss-covering in the bottom. A sample of the moss-vegetation, brought away, contained according to C. Jensen's identification: Sphagna (S. subnitens, S. Gravetii, S. cymbifolium), Hylocomia (H. loreum, H. proliferum, H. parietinum, H. squarrosum), and other mosses (Isothecium tenuinerve, Thyidium tamariscifolium, Gymnocybe palustris, Astrophyllum hornum and Hypnum purum).

The latter two lists (No. 4 and 5), in particular, are distinct from the true boggy-moor vegetation as regards species, and show a marked approach towards the grass-moor.

(β) *The grass-moor association (Glumiflor-Hylocomium association).* This name is used to indicate a plant-association

on humous peaty soil, which contains only a moderate proportion of water; at times the water-content may be scanty, but at other times the soil may be saturated with water or even completely flooded.

This alternate drying and saturating of the soil has the effect of rendering it less acid than the boggy moor, consequently the *Eriophorum* and *Carices* which were dominant on the boggy moor are replaced by *Nardus, Juncus squarrosus* and *Scirpus caespitosus.* These three plants which in Denmark frequently occur on rather dry heaths, seem to prefer rather more moisture on the Færöes. There, on fairly moist peaty soils, they constitute the vegetation, and in my opinion, the plant-associations formed by them are to be regarded as somewhat equivalent to a moist heather-moor without heather. The grass-moor is found everywhere on the slopes, when heather-moor might have been expected if the exposure towards the sun had been more favourable. The aspect or lie with respect to the direction of the sun's rays is a factor of so much importance that one always finds a marked difference between the two sides of a valley running east and west. The south side, exposed to the north is moister, richer in mosses and without heather, whereas the opposite side lying towards the south is drier, poorer in mosses, but has heather.

The grass-moor is what in the account of my journey to the Færöes (1901) was called »Nardus-Eng« (Nardus-pasture) or »Nardus-formation«. It has a wide distribution on the Færöes extending from the sea upwards on the mountains to an altitude of 300—400 meters. In the higher zones of this area *Grimmia hypnoides* plays so important a part that we find there a transition association (The »Grimmia-Nardus formation« of my account of travels). On the summit-plateaux of the mountains we find the third link of the chain, the pure Grimmia heath. The grass-moor attains its best development on the lower zone of the mountains where the slope is distinct, yet so slight that movement of water is slow. The habitat lies, therefore, between the valley-bottom with its moors and the drier grass-slopes (Græsli), or in the case of a southern exposure, the heather-moor.

The three Glumifloræ, *Nardus, Scirpus caespitosus* and *Juncus squarrosus* are dominant, and occur in such a way, that frequently one may prevail and almost entirely exclude the other two; thus we get three facies of the grass-moor, viz:

αα. Nardus facies.
ββ. Juncus-squarrosus facies.
γγ. Scirpus-caespitosus facies.

It is just possible that there may be a slight difference between these three plants in relation to the water-content; if so, *Nardus* must be regarded as the least water-loving (or water-enduring). It is noteworthy that all three are tufted plants, — the short horizontal rhizome of *Nardus* seems to me to be unimportant as an adaptation for wandering.

The appearance of the grass-moor is generally rather variegated by the presence of many »flowering« herbs which break the monotous green of the grass-like plants. Some of the commoner species are: *Potentilla erecta, Polygala serpyllacea, Succisa, Pinguicula, Viola palustris, Ranunculus flammula, Galium saxatile, Euphrasia minima,* etc.

The following Glumiflorae are common in addition to the three »character-grasses«: *Anthoxanthum, Luzula multiflora, Carex pilulifera, C. binervis, Agrostis vulgaris, A. canina, Festuca ovina,* etc.

Mosses form a distinct feature of the ground-vegetation of a grass-moor; they occur in large numbers and many species are represented, the following being the more conspicuous: *Hylocomia (H. loreum, H. proliferum, H. squarrosum* and *H. parietinum), Stereodon ericetorum, Isothecium tenuinerve, Thyidium tamariscifolium, Breutelia chrysocoma,* etc., and amongst others the ever-recurring *Grimmia hypnoides* is sometimes abundant. In C. Jensen's account of his journey (1897) more detailed descriptions are given of the moss-vegetation from many localities representative of this widespread and multifarious plant-association.

The surface of the soil beneath the higher plants is sometimes bare except for a purple film of the alga *Zygogonium ericetorum*; these spots have probably been flooded in spring.

The grass-moor is, I should say, the Færöese plant-association which receives the greatest prominence in the account of my travels, being referred to again and again, sometimes in its typical form, at other times in one of its diverse transition-forms leading to the Grimmia heath. The reason why I have dwelt on it so strongly is that the association is so widely distributed and so important from the economic point of view. The plants of this association form the bulk of the food-supply of the sheep, the principal domestic animal of the Færöes.

It also occurs on every island I have visited and one may safely say it is found all over the Færöes.

1. Skaalefjæld, north of Kvalbö on Syderö; about 250 meters above the ocean and sloping towards the south; *Nardus* dominant, but replaced here and there by *Juncus squarrosus*. The most frequent secondary species are: Potentilla erecta, Polygala serpyllacea and Galium saxatile; other species recorded: Luzula multiflora, Anthoxanthum, Euphrasia sp., Selaginella, Hypericum pulchrum, Carex pilulifera, Thymus, Agrostis canina, Vaccinium myrtillus, Carex flava, C. binervis, Festuca ovina, Pinguicula, Carex stellulata, C. panicea, Lycopodium selago, Thalictrum alpinum, Ranunculus flammula, Aira caespitosa, Juncus supinus, Calluna, Plantago maritima, Festuca rubra. Mosses rather abundant, especially: *Grimmia hypnoides*, *Isothecium tenuinerve*, *Polytrichum alpinum* and *P. commune cubicum*, with less abundant Hylocomia, Thyidium, Dicranum scoparium, Polytrichum subrotundum, Nardia scalaris and Marsupella emarginata; a few tufts of Sphagnum subnitens and S. subsecundum (mosses identified by C. Jensen).

2. South-side of the Hove-valley, on the way from Porkere, Syderö. Terrain with undulating surface: *Juncus squarrosus* and *Nardus* dominant; common: Anthoxanthum, Potentilla erecta, Galium saxatile, Agrostis canina, Luzula multiflora, Euphrasia sp., Festuca ovina, Carex stellulata in small hollows; scattered Carex Goodenoughii, Polygala serpyllacea, Viola silvestris, Carex flava, C. panicea, Pinguicula, Lycopodium selago, Aira flexuosa; here and there Calluna and Empetrum. Mosses very conspicuous, especially Sphagna (S. subnitens, S. tenellum), Campylopus atrovirens, Amblystegium revolvens, Astrophyllum hornum, Martinellia gracilis, Gymnocybe palustris, Hylocomium loreum, H. proliferum, Grimmia hypnoides, etc. (mosses identified by C. Jensen).

3. Valley-bottom at Öreenge below Skællingfjæld, Strömö. Terrain undulating and slightly sloping. Dominant species: *Nardus*, *Juncus squarrosus* and *Narthecium*. Common: Calluna, Molinia, Agrostis canina, Scirpus caespitosus, Potentilla erecta, Grimmia hypnoides. Scattered Anthoxanthum, Luzula multiflora, Carex pilulifera, Lycopodium selago, Festuca ovina, Polygala serpyllacea, Galium saxatile, Succisa, Aira flexuosa, Vaccinium myrtillus, Orchis maculatus, Euphrasia sp.; with Campylopus atrovirens, Hylocomia and other mosses.

4. Sörvaagsvatns east-side, Vaagö. Gently sloping and undulating. *Nardus* dominant, replaced here and there by *Scirpus caespitosus* and *Carex panicea*, other species: Anthoxanthum, Festuca ovina, Leontodon, Potentilla erecta, Succisa, Agrostis canina, Sieglingia; and more scattered Narthecium, Calluna and Juncus lampocarpus.

5. Above Selletræ on Österö; slightly sloping terrain, 150—200 meters above the sea. *Juncus squarrosus*, *Nardus*, *Narthecium*, *Potentilla erecta* and *Polygata serpyllacea* dominant; replaced in places by *Scirpus caespitosus* and *Agrostis canina;* further noted Carex panicea, Calluna, Empetrum, Viola palustris, Erica cinerea (rare), Galium saxatile, Pinguicula, Festuca ovina, Leontodon, Lycopodium selago, L. alpinum, Juncus lampocarpus, Epilobium palustre, Vaccinium myrtillus, Sphagna, Gymnocybe palustris, Grimmia hypnoides and other mosses.

It may be of interest to review the occurrence of this plant-association, the grass-moor, in other countries. Several of the English and Scottish authors (see p. 935) deal with similar associations which occur in the subalpine region in Northern England and Scotland. Jónsson describes (1900, p. 67) in Iceland a »Nardus-Li« (Nardus-slope) which evidently in many respects bears a resemblance to the Færöese Nardus facies, and my own observations in Northwest-Iceland include a similar association with *Nardus* as dominant species (Ostenfeld 1905, p. 118). In the west of Jutland there is a similar association (Warming, 1897 b, p. 106; 1902, p. 72; Börgesen and Jensen 1904). I think, however, that in few other places is it so widely distributed as on the Færöes, and the reason is most probably to be found in the insular climate and the abundant moisture in the soil and the air at all seasons.

h. The heather-moor formation (moist Calluna heath).

A gradual transition may be traced from the grass-moor to the heather-moor. This occurs where the humous substratum becomes still less moist, as is generally the case on slopes exposed towards the south or west in the lower region, as already stated. Nowhere on the Færöes have we found large areas of the true heath, so familiar in regions nearer home, with *Calluna* and *Erica tetralix* almost supreme, with hardly any grass-like plants, and relieved only by a few other flowering species. Nor do we meet with the arctic and subarctic heath, so important in Iceland, Greenland, etc. and characterised by its variegated aspect due to the numerous species of dwarf-shrubs (chiefly *Ericineæ*). The appearance of the Færöese heath-formation is not so characteristic as that of a true Calluna heath. The ericaceous shrubs are not so dominant, and as a rule they flower sparingly, partly on account of grazing sheep. If we add that »flowering« and »grass-like« plants are numerous among the heathers, then it will be evident that the Færöese heath has not the sombre hue of a true heath.

The Færöese heath is no doubt most nearly related to the heath on the west coast of Norway, but unfortunately there are no ecological descriptions of this heath. Some idea of its character may be formed from descriptions given in the papers by O. Dahl, dealing with floristic investigations in Söndmöre, Romsdal, Nord-

and Söndfjord. Thus in one paper (1895, p. 40) he gives briefly the characteristics of »the heath-carpet (Lyngtæppet) on bare rocks« on the coast, and these fit in rather well with the Færöese conditions. He gives *Calluna* as dominant species, refers next to *Erica cinerea*, and regards as secondary species *Juniperus*, *Polygala serpyllacea*, *Hypericum pulchrum*, *Galium saxatile*, *Euphrasia (gracilis)*, *Bunium flexuosum* and the tall, grass-like *Carex binervis* and *Luzula silvatica*. All these, with the exception of *Bunium flexuosum*, find a place

Fig. 180. Undulating heather-moor at Sand on Sandö. Sandsvatn in the distance. Numerous lichen-covered rocks and stones emerge above the plant-carpet. (From photo. by author).

in the Færöese heath-formation. There is also a list of dominant species given by A. Blytt (1869, p. 49) from »Törvemyrene og Lyngen i de vestligste Egne« (turf-moors and heath in the most western tracts). Of the 19 species mentioned there, no less than 14 are common in the Færöese plant-association of a similar type; but the heath of the West-Norwegian coast, so far as I can make out, is a much purer type of Calluna heath than the Færöese. This is the case at all events with the heath-formation around Lerwick on Shetland, which I saw for a few hours during a passing visit in 1903. The following notes from my diary refer to this: »Undulating ridge on primitive (archaic) rock, north of the town. The vegetation is typical heath, with *Calluna* strongly dominant. *Aira flexuosa*, *Nardus*, *Juncus squarrosus*, *Festuca ovina vivipara*, *Scirpus caespitosus* and *Potentilla erecta* are rather common, but generally in hollows. The Calluna heath is remarkably uniform. On a somewhat moister soil *Eriophorum polystachyum* occurs, *Calluna*

still continuing; also abundance of *Sphagnum*. The dry heath has a little *Grimmia*, *Dicranum* and *Hylocomia*, a small amount of *Empetrum* is also present. *Cladonia rangiferina* also seen, and amongst other secondary species *Luzula multiflora*, *Carex binervis* and *Anthoxanthum*. *Euphrasia spp.* were not seen at all in this heath, neither *Erica cinerea* nor *Vaccinia*.«

It is hardly possible to account satisfactorily for the difference between the heath of Shetland, western Norway and Scotland on the one hand, and the heath (heather-moor) of the Færöes on the other. The Færöese climate is certainly of a more pronounced insular character than that of the other countries named, yet the difference is small. It is possible that the geological substratum is the more important factor. This is basalt in the Færöes, whereas it is made up of primitive rocks in western Norway, Shetland and, to some extent also in Scotland (cfr. the papers by R. Smith, W. G. Smith and Lewis, quoted on p. 935). This in itself, however, is not decisive, for we learn that in basaltic tracts in South-Iceland there is a well-developed Calluna heath (cfr. Ostenfeld 1899, pp. 247—249, and Jónsson 1905, p. 43); but here the climate is less insular, and the winter, at least, is much more rigorous than on the Færöes. It may also be pointed out, that the rainy climate and the character of soil give rise to a very large degree of moisture in the air and in the substratum respectively, and this no doubt helps in the production of the variegated and mixed character of the Færöese heather-moor.

The appearance and distribution of heather-moor on the Færöes convey the impression that it is a formation not quite at home there, hence it picks and chooses its stations. Its requirements are a rather dry substratum with sunshine, both of which are rare on the Færöes. It occurs principally in the southern, lower parts of the larger islands (Österö and Strömö) and again in the region between Sand and Skopen on Sandö. Smaller patches also appear on most of the islands, wherever the valleys are broad enough to allow free access of sunshine to fairly dry slopes with a southerly exposure. Very little heath is present on Syderö, the only moderately typical heath I saw was in the Trangisvaag-valley.

On Fuglö I did not see any heather-moor at all; only a few bushes of *Calluna* on some rocky ledges, and no trace of *Erica*. C. Jensen mentions (1897, p. 182 and p. 190), that he saw no

heather-moor on Myggenæs and Store Dimon, »but the conditions for heath were also entirely lacking.«

The form of heather-moor which appears on the Færöes ought to be called *Calluna-Erica-cinerea moor* to distinguish it from the moist heath which Warming and other Danish authors have named »Calluna-Erica heath«. This last bears much more of the true heath character, and differs (among other things) in that it is *Erica tetralix* which occurs, and not *E. cinerea*.

In the Færöese heather-moors, numerous herbs and grasses put in an appearance among the heath-shrubs; so predominant may they become at times, that one can no longer use the term heather-moor. In one direction we may have an approach to the grass-slopes described later. In other directions the heather-moor passes over gradually into the grass-moor (see p. 952), or it may present transitions from the heather-moor of the lower regions to the rocky-flat formation and to the Grimmia heath of the mountain-plateaux.

A few examples may aid towards forming a concept of the appearance and character of the Færöese heath (heather-moor).

1. Banks of the lower course of the Trangisvaag-river, Syderö. Nearly flat stretches of river alluvium (gravel, sand and clay), and not particularly turfy. These spots are partly covered with pure *Calluna*, but the bushes are low and badly developed. The following secondary plants were noted: Anthoxanthum, Succisa, Potentilla erecta, Luzula multiflora, Festuca ovina vivipara, Scirpus caespitosus, Nardus, Empetrum, Thymus and some Grimmia hypnoides. The vegetation here is relatively young and the habitat is unstable on account of the river.

2. Slopes of the »roches moutonnées« on terrain north of Thorshavn (compare example 3, p. 951). *Calluna* gives the tone, and after that *Empetrum*. Secondary species: Erica cinerea, Thymus, Galium saxatile, Potentilla erecta, Plantago maritima, Anthoxanthum, Festuca ovina, Leontodon autumnale, Polygala serpyllacea, Viola silvestris, Luzula multiflora, Hypericum pulchrum, Agrostis vulgaris, A. stolonifera, Brunella, Nardus, Juncus squarrosus, Viola palustris, Pinguicula; mosses: Grimmia hypnoides, Hypna and Thyidium.

3. Outfield at Videreide, Viderö. Lower part of the north side, south exposure; a slightly sloping undulating and tufted terrain, the peaty soil showing in hollows and drains, because it is imperfectly covered by plants: Campylopus atrovirens, Carex flava, Narthecium, Scirpus caespitosus, etc. The tufts consist of *Calluna*, *Empetrum* and *Erica cinerea*, among which we find: Nardus, Juncus squarrosus, Potentilla erecta, Anthoxanthum, Carex panicea, Brunella, Festuca ovina vivipara, Luzula multiflora, Selaginella, Cerastium vulgare, Polygala serpyllacea, Euphrasia sp., Agrostis vulgaris and Leontodon.

4. Slope along the northern side of Bordövig (»Skaarene«); the

slope up to a height of 100 m. covered with heather, especially with *Calluna*, but also *Erica*, and some *Empetrum*. On the terrace above (about 140 m.) the heather is mixed with much Scirpus caespitosus, Nardus and Juncus squarrosus, as well as Grimmia hypnoides; on the next terrace (about 240 m.) Calluna has become subordinate, and Erica has almost disappeared, while Nardus and Grimmia have gained ground, and on the 3rd terrace (about 300 m.) the usual transition formation between the Grimmia heath and the grass-moor appears, the heather having disappeared.

5. The terrain above Næs parsonage, Österö. The surface-conditions very similar to those north of Thorshavn (see example 2). *Calluna* and *Erica* dominant on the drier places, while the depressions are covered with moor-vegetation.

6. The lowland between Midvaag and Sörvaagsvatn, Vaagö. Conditions similar to example 5. The tufts are covered with *Calluna*, some *Erica*, *Scirpus caespitosus*, etc.

7. Slope at about 200 m. on the western side of the Skaalefjord-vallęy, Österö. According to C. Jensen (1897, p. 208) the main part of the phanerogam-vegetation is formed by Vaccinium myrtillus, V. uliginosum, Cornus suecica, Calluna, Empetrum, Eriophorum polystachyum, Potentilla erecta, Narthecium, Nardus, Rumex acetosa, Anthoxanthum, Juncus squarrosus and Scirpus caespitosus. The more important of the mosses were: Polytrichum commune, P. alpinum, Grimmia hypnoides, Hylocomium parietinum, H. proliferum, H. loreum, Plagiothecium undulatum, further Diplophyllum albicans, Frullania tamarisci and other species of liverwort.

This example has been quoted from Jensen's paper to show partly the mosses found in the heather-moor, and partly to indicate its arctic-alpine association with *Vaccinia* resembling the variegated heath of Iceland.

From these examples we learn that *Calluna* takes the foremost place amongst the dwarf-shrubs forming the Færöese heath (heather moor), then come *Empetrum* and *Erica cinerea*. More subordinate, but still characteristic we have *Vaccinium myrtillus*, *V. uliginosum* (not common), *Thymus serpyllum* and *Juniperus communis*, var. *nana* (very rare). Amongst the more dominant herbaceous plants we may mention: *Potentilla erecta*, *Cornus suecica*, *Hypericum pulchrum*, *Viola silvestris*, *Polygala serpyllacea* and *Galium saxatile*. The following grass-like species have their habitat here: *Carex binervis* (to some extent)[1], *Anthoxanthum*, *Festuca ovina vivipara*, *Luzula multiflora*, etc. The ground vegetation of the heath includes a large number of mosses, e. g. *Grimmia hypnoides*, *Hylocomia*, *Stereodon ericetorum*, *Thyidium tamariscifolium*, *Isothecium tenuinerve*, *Dicranum scoparium*, *Polytrichum alpinum*, and *P. commune*, also *Diplophyllum albicans*, *Ptilidium ciliare* and

[1] Really more characteristic for grass-slopes and sunny rock-ledges.

Frullania tamarisci. Lichens, on the other hand, are unimportant; *Cladonia rangiferina* occurs of course in most heaths, but nearly always as a very subordinate component. Still less conspicuous and in very small numbers we have found other *Cladonia*-species and *Cetraria islandica.*

The structure and biology of the true ericaceous shrubs is well known from the investigations of Warming and other botanists. We need only add that *Erica cinerea* stands closer to *Calluna* as regards shoot-structure than its relative *Erica tetralix,* The ripening of fruit is successfully carried out in *Calluna,* and probably also in *Erica*; it seems to be uncertain in the case of *Empetrum,* and is rarely successful in the *Vaccinia* and also *Cornus suecica* (see pp. 915—916).

The phanerogams of the heath are all perennials (with the exception of the *Rhinantheæ*), but they differ as regards structure of the shoots. It is noteworthy that the development of wandering shoots occurs in very few of the species. Thus *Potentilla erecta, Viola silvestris, Hypericum pulchrum, Juniperus, Carex binervis, Festuca ovina, Anthoxanthum* and *Luzula multiflora* are spot-bound. Subterranean wandering shoots occur in *Cornus suecica* and the two species of *Vaccinium.* The remaining species have decumbent shoots which occasionally become rooted, viz. *Polygala serpyllacea, Erica, Calluna, Galium saxatile, Thymus* and *Empetrum*; the order in which they are given indicates approximately an increase in the frequency with which adventitious roots are developed, *Empetrum* having the greatest tendency in this direction. I regard this mode of wandering as intermediate between spot-bound species and those with specialised aerial wandering shoots, but as a means of migration it is little or no benefit to the species.

As regards flowering we find in the heath that the species are generally adapted to insect-pollination. Those with wind-pollination and the simpler modes of insect-pollination (i. e. open and generally yellow flowers) are in a decided minority. Hence it is probable that the poor fructification of some of the species mentioned is correlated with the scarcity of insects on the islands, although doubtless many of those so-called insect-flowers are self-pollinating.

Reference has already been made to the occurrence of a vegetation in which the subordinate elements of the heath, the herbaceous plants and grasses, were predominant; it was also suggested

that this vegetation might be regarded as a transition to the grass-slopes. Its position may be taken as about mid-way between the heath and the grass-slope, and it might perhaps be regarded as a separate plant-association. In one respect it is more closely related to the heath, in that its soil is to some extent humous, whereas the grass-slope prefers a loamy soil. On the other hand, the dominant species are very much those of the grass-slope, hence it is easier and more correct to use these as distinguishing marks, rather than the soil-conditions, and consequently to consider this as an association of the grass-slope formation. The fact of our being thus uncertain where the limit should be drawn will indicate clearly how very gradual the transitions are.

i. The grass-slope formation.

The term »grass-slope« (Græsli) is used here to indicate a plant-formation where grasses are the dominant plants (i. e. a pasture), and which occurs on a moderately moist soil, generally with a sloping surface; the soil in most cases is loam or mould, but it may be more or less humous.

H. Jónsson in his studies on the Icelandic vegetation has given a rather detailed account of this formation and its nearest allies. His descriptions harmonise well with those of the grass-slope formation found on the Færöes; this is especially the case with the South-Icelandic grass-slope (Jónsson 1905, pp. 36—40) which has evidently much the same composition as the Færöese. He enumerates 10 dominant species, of which *Agrostis vulgaris, Anthoxanthum, Festuca ovina, Brunella vulgaris* and *Leontodon* are equally characteristic for the Færöese grass-slope; the remaining 5 also occur, although *Trifolium repens, Geranium silvaticum* and *Poa alpina* do not entirely belong to this formation on the Færöes.

The grass-slope is met with on the Færöes in similar places to those on Iceland, that is on the lower and middle parts of the mountain slopes, and more rarely in the upper zone, provided that the conditions are such as will permit water to flow away rather rapidly, hence a rather steep slope; the soil must also be stable, and not too often disturbed by falling earth and rocks.

In the lower region, this formation occurs most frequently on slopes exposed to the north, and as already explained, a southerly exposure promotes heath (heather-moor), if the slope is not too steep.

Higher up we meet the grass-slope formation on both north and south exposures. As a rule the grass-slopes are much destroyed by the sheep, which find there a choice fodder. The surface is consequently traversed by numerous sheep-tracks which run in parallel lines nearly at right angles to the slope, and at a distance give the hill-side a rippled appearance[1]. Few plant-formations on the Færöes have suffered so much from the numerous sheep as the grass-slope, and the investigation of the vegetation is extremely difficult in consequence of the close grazing. The natural environment of the slope (and also the luxuriant »Hammer«) offer especially good conditions for the growth of plants, and before the islands were inhabited, one would in all probability have found there the majority of the less hardy species of the Færöese flora; under present conditions the species, which have not been eradicated, have taken refuge on the more favourably situated ledges (Hamres) where the sheep cannot approach (see p. 974).

Besides the typical grass-slope with a sloping substratum, one finds here and there a grass-vegetation similar in character, but on a flat surface. The conditions for the occurrence of such a pasture (»Græseng«) are, that the soil is moderately moist and yet so well drained that in spite of its flatness, there is no excess of humus, and water does not stagnate. The rugged topography of the Færöes rather operates against the frequent occurrence of these conditions, hence the area of flat well-drained grass-pasture is generally limited to the margins of rivers and lakes; some examples of this pasture are included in those given below.

Grass-slopes may be found on all the islands, but not always to the same extent. Thus they are few and small in the northern parts of Vaagö, Strömö, Österö and on the northern islands (Nordreöer) which are very steep, the climate also being more rigorous. On Syderö, the grass-slope occurs to such an extent, that this island, when seen from the ocean, appears much greener than the other islands.

The following examples taken from my notes will illustrate the composition of the grass-slopes:

1. Punthavn on the southern side of the Trangisvaagfjord, Syderö. Slightly undulating expanse with the higher ridges occupied by the following grass-association: *Carex binervis*, *Anthoxanthum* and

[1] This appearance due to the sheep-tracks may be what Jónsson (l. c. p. 36) refers to as wrinkles (»Rynker«).

Potentilla erecta, dominant; other species noted: Luzula multiflora, Galium saxatile, Agrostis stolonifera, Festuca ovina vivipara, Carex Goodenoughii, Nardus, Orchis maculatus, Cornus succica, Vaccinium myrtillus, Carex pilulifera, Polygala serpyllacea, etc.

2. Islet (Holm) in the lake in Vatnsdal, Syderö. Tall luxuriant vegetation (see p. 893). Dominant species: *Carex binervis*, *Luzula silvatica* and *Eriophorum polystachyum*; other species: Potentilla erecta, Succisa, Nardus, Anthoxanthum, Euphrasia minima, Festuca ovina vivipara, Agrostis stolonifera, Polygala serpyllacea, etc. The ground-vegetation is a luxuriant moss-carpet of Polytrichum commune, Hylocomium loreum and other species.

3. Near Örerenge, Strömö. A large moor lies at the outlet of the river into the head of the Fjord; beyond this lies a belt of grass-vegetation with *Agrostis vulgaris*, *Trifolium repens* and *Bellis* as the dominant species; secondary species are: Sagina procumbens, Leontodon, Ranunculus acer, Plantago lanceolata, Euphrasia borealis, Cerastium vulgare, Anthoxanthum, Brunella, Succisa, Taraxacum sp., Rumex acetosa and Luzula multiflora.

4. The valley-bottom below Skjællingfjæld, between Leinumvatn and Örerenge, Strömö. The greater part of this valley-bottom is moor (see Ex. 3, p. 955); but near the watershed (ca. 100 m. above the ocean) there is a mossy grass-association with *Agrostis vulgaris* as dominant species. Other species noted were: Trifolium repens, Festuca ovina vivipara, Luzula silvatica (without flower), L. multiflora, Potentilla erecta, Galium saxatile, Euphrasia minima, Bellis, Leontodon, Brunella, Thymus, Ranunculus acer, Veronica officinalis, Anthoxanthum, Festuca rubra and Cerastium vulgare.

5. Slightly sloping part of Nolsö, about 260 m. above sea-level and with a northern exposure. Grass-slope with *Agrostis vulgaris* as dominant species; of general occurrence are Anthoxanthum, Galium saxatile and Thymus; scattered species: Rumex acetosa, Viola palustris, Luzula multiflora, Festuca rubra, F. ovina vivipara, Potentilla erecta, Ranunculus acer, Cerastium vulgare and Euphrasia minima. Thick bottom-vegetation of mosses, especially Hylocomium squarrosum and H. proliferum, also Polytrichum alpinum.

6. Slope on Höjefjæld, Viderö, about 400 m. above the sea, north-easterly exposure. Grass-slope consisting of *Agrostis vulgaris*, *Nardus* and *Anthoxanthum*, with a rich bottom-vegetation of Hylocomia and other mosses. Secondary species: Potentilla erecta, Viola palustris, Blechnum, Luzula silvatica, Alchimilla alpina, Sibbaldia, etc.

7. The slope of Ritebjærg, Vaagö. Above the moister parts with moor and grass-moor, there is grass-slope all the way up to the top, at any rate on the side towards Sörvaagsvatn. *Nardus* is the dominant species on some parts, in others, *Agrostis vulgaris*, *Anthoxanthum* or *Festuca ovina vivipara*[1].

[1] Grass-slopes are described in C. Jensen's accounts of his travels (1897) p. 183 (Gjoverbotn), p. 189 (Store Dimon), p. 190 (Sunnbö) and p. 209 (the slope of the Skaalefjord-valley).

The grasses and grass-like plants characteristic for the grass-slope are as follows: *Anthoxanthum*, *Agrostis vulgaris* (also to some extent *Agrostis stolonifera*), *Festuca ovina vivipara*, *Carex bi-*

Fig. 181. »Hamre« (rock-ledges) on Stigafjæld on Strömö; two rather steep grass-slopes can be seen, one in the foreground and the other (smaller one) between the two »Hamre«. (From photo. by K. Rimestad.)

nervis, *C. pilulifera*, *Luzula multiflora* and to some extent *L. silvatica*. Nearly all these are tufted species, this feature being correlated with the firmness of the soil, a condition unfavourable for wandering shoots[1].

[1] The *Agrostis* spp. are provided with wandering shoots; in the case of *A. stolonifera* these occur above as well as below the ground; in *A. vulgaris* (the more abundant species in this formation) the shoots are subterranean, but are of minor importance as wandering organs.

Herbaceous plants with showy flowers are strongly represented on the grass-slope, the following being most frequent: *Bellis, Trifolium repens, Brunella, Cerastium vulgare, Viola silvestris, Leontodon, Polygala serpyllacea, P. vulgaris Ballii, Potentilla erecta, Euphrasia minima, Thymus, Ranunculus acer* and *Sagina procumbens.* Here again spot-bound plants are in a strong majority, although there are a few species like *Trifolium repens* with wandering shoots above ground. All these plants lend to the grass-slope a wealth of colour, but in consequence of the close and searching grazing by sheep, this is not so great as might be expected.

The fructification of most of the species is generally satisfactory, provided the grazing does not interfere with development. Most of the flowers are of the open type, and either self-pollinated or visited by flies; several species require insects with a longer proboscis (e. g. *Thymus, Brunella* and *Trifolium repens*); whether these set their fruits so well is doubtful.

It may have been noted that many of the plants of the grass-slopes also occur both in the heather-moor and in the grass-moor. This is even more noticeable with the mosses. These play an important part in this formation, more especially the *Hylocomia* (the species are named above, p. 954), and the following are also very abundant: *Polytrichum alpinum, P. commune, Dicranum scoparium, Thyidium tamariscifolium, Grimmia hypnoides, Stereodon ericetorum, Ctenidium molluscum, Isothecium tenuinerve* and *Amblystegium aduncum,* also the liverworts, *Diplophyllum albicans, Frullania tamarisci* and *Nardia scalaris.* The lichens are very subordinate elements, except *Peltigera canina* which occurs frequently, but not in quantity.

The associations of the grass-slope formation differ considerably from each other, as can be seen from the examples given above.

Thus the *Carex-binervis-Luzula-silvatica association* (Examples 1 and 2) may be singled out as a distinct association with a close affinity in one direction to the Færöese heather-moor, and on the other hand to the »Hammer«-vegetation, described later. This association has generally a more or less humous substratum which has already been referred to (p. 962).

The association which I regard as the typical grass-slope is the *Anthoxanthum-Agrostis-vulgaris association* (Examples 3—7). It appears in two distinct facies — the *Agrostis-vulgaris facies* (Ex. 3—5) and the *Anthoxanthum facies* (included in

Ex. 6, 7), — according as one or other of the indicator-species becomes the dominant element.

j. The cliff vegetation.

The grass-slope completes the series of the subalpine formations which entirely cover their substratum, and we now pass on to consider those in which bare soil, solid rock, boulders, stones or gravel show up amongst the components of the vegetation. The formations belonging to this category are by no means similar, but fall into two main groups: the cliff vegetation and the rocky-flat vegetation. In the former the incomplete plant-covering is due to unfavourable edaphic conditions; the higher plants are unable to fix themselves on the bare surface of the rocks, and require loose soil, either that lodged in a crevice in the rocks or that lying on a ledge. The open vegetation of the rock-flat, on the other hand, is due to extreme climatic conditions, especially the strong wind, hence only a few particularly hardy and well-adapted species are able to thrive. A feature common to both these types of vegetation, and also to the grass-slope, is their occurrence in the lower zones as well as on the mountains. They do not therefore quite fit into the subalpine formations with which series we are at present concerned. I propose to describe the cliff vegetation here amongst the subalpine formations, as has already been done with the grass-slope, because these formations are more frequent and better developed in the lower regions; when they do occur at greater elevations, they are not essentially different, and may be regarded simply as an impoverished form of the lowland type. This conformity in the vegetation at different altitudes can only be explained by assuming that the external conditions especially as regards light and the solar radiation accompanying it, are much the same on any slope; the height above sea-level may vary considerably, but the exposure of the place is more important than its altitude.

The rocky-flat vegetation (»Fjældmarken«) is much more an alpine formation, and rarely makes its appearance in the lower regions on the Færöes. Where this formation is most at home is on the flat plateaux of the mountains, and there it always occurs, ranging from the lower plateaux (200—300 m. above sea-level) up to the summits of the loftiest mountains (700—800 m.). It seems therefore more natural to treat the whole of this formation as part

of the alpine division, and to defer any remarks on the less typical vegetation on rocky flats at lower altitudes.

The cliff vegetation is a concept meant to cover a number of different formations, which extend as a continuous series from the exposed vertical cliff-wall with its covering of lichens, to the sheltered »Gjov« (ravine), with its terraces so closely clothed with a luxuriant vegetation that the grassy sward overhangs the edge and reaches down to the next terrace. The coast-cliff formation, which is a special type of the cliff vegetation, has already been described (pp. 931—934).

The conditions of life of the cliff vegetation[1] are characteristic in that the plants must be capable of enduring wide ranges of temperature, and of resisting periodical drought. The variations of temperature are caused by the configuration of the cliffs, insolation being greatest, when the sun's rays strike at an angle approaching 90° on a cliff-wall with a southerly exposure; cliffs facing northwards can only receive diffuse light. As a result, the cliff vegetation varies, according to aspect, much more than the grass-slope. The important effects of exposure on vegetation have been pointed out by nearly every author who deals with the plant-associations of northern countries (Warming 1888, Hartz 1895, Rosenvinge 1897, Kjellman, Gunnar Andersson 1900, Kihlman, Vestergren 1902, Hesselman 1905, etc.). Special reference to the Færöese conditions has been made by C. Jensen (1897, p. 165, 192, etc.) and in my own papers (Ostenfeld 1901, p. 27, 33, 35, etc.).

Great variations in the water-supply are also closely connected with the insolation. The solar heat falling directly on south slopes will rapidly reduce the water-content of the soil, especially on projecting parts of the cliffs where a continuous fresh supply of telluric water is frequently impossible, and only rain and fog are available. The plants growing on such places must therefore be able to endure periodic drought. On slopes with a north exposure, there will always be, in a country like the Færöes, a rather considerable degree of moisture in the soil. Apart from exposure the amount of water available in each separate crevice or terrace will vary considerably according to the amount of loose soil, the nature of the water-supply, and other local circumstances.

Whereas phanerogams and mosses have formed the integral

[1] Cfr. E. Warming 1895, pp. 182—185, and Alb. Nilsson 1899, p. 93.

part of the plant-covering in the associations hitherto considered, it is necessary on the cliffs to include the lichens and to some extent the algæ.

My notes on the cryptogamic groups are unfortunately very fragmentary because of my insufficient knowledge of them, so that the following sketch is incomplete and defective in many respects.

When a survey of the constituents of the cliff vegetation is being made, it is necessary to recognise, that the vegetation seen on a cliff-face, a cliff-slope and a cliff-terrace, respectively, is made up of plants which live under widely differing conditions. Pri-

Fig. 182. On the Kirkebörejn on Strömö (300 m. above sea-level), the solid rock is exposed almost everywhere, and is covered by a typical lithophyte vegetation, mostly lichens. (From photo. by author).

marily they may be arranged under two main groups: I. Lichens, algæ, and mosses attached to the surface of the bare rock (Schimper's Lithophytes). II. Lichens, mosses and higher plants which grow in crevices, on terraces, or in other places where loose soil has accumulated through weathering of the cliffs and the decay of plant-remains (Oettli's Chomophytes).

I. The surface-vegetation of the bare rock (Lithophyte formation). This consists entirely of cryptogams, principally of a great number of lichens with some mosses clinging to them, and also some algæ in wet places. The »black stripes« so frequently seen on the Færöese cliffs, are formed by different algæ (*Stigonema* spp., etc.), which have become more or less incorporated into lichen-forms. The majority of the mosses also prefer

places where the water-supply is fairly abundant. As a rule, both mosses and lichens receive their main supply of water from atmospheric sources.

The lichens cover the cliffs almost entirely, and give rise to a series of colours ranging from nearly black to nearly white, with a predominance of greyish tints of almost every conceivable hue (see Fig. 182). Crustaceous lichens are most common, especially the following genera: *Lecanora* (*L. tartarea, L. atra,* etc.), *Lecidea, Placodium, Squamaria (S. gelida)* and *Buellia;* foliaceous lichens also occur among the dominant species, the commoner being, *Parmelia saxatilis, Xanthoria parietina* var. *aureola* and *Gyrophora (G. cylindrica).* The following lithophile mosses are the most frequent: *Andreaea petrophila* and *Grimmia* spp. (*G. fascicularis, G. acicularis, G. heterosticha, G. apocarpa,* etc.). To these might be added many other mosses which occur wherever shelter and other conditions are favourable, especially on isolated boulders and stones, and on talus-slips (Ur).

The lithophyte vegetation of isolated blocks constitutes a special association: *the lithophyte association of the isolated stones and boulders*, and is different from *the lithophyte association of the solid cliffs.* The characteristic species of isolated boulders are *Antitrichia curtipendula* and *Isothecium myosuroides,* also the rare *Hedwigia albicans*[1].

[1] C. Jensen has kindly given me the following complete list of lithophile mosses on the Færöes:

Frullania fragilifolia
— Jackii
Lejeunea calcarea
Radula commutata
Porella Thuja
— rivularis
Hygrobiella laxifolia
Metzgeria furcata
Pottia crinita
Blindia acuta
Weissia maritima (coast cliffs)
— americana
Orthotrichum rupestre
Zygodon viridissimus v. rupestris
Glyphomitrium polyphyllum
— Daviesii
Grimmia fascicularis
— heterosticha
— affinis
— acicularis
— trichophylla
Grimmia pulvinata
— funalis
— torquata
— maritima (coast cliffs)
— apocarpa
— gracilis
— alpicola v. rivularis
Andreaea petrophila
Hypnum rusciforme
— viride
Lesquereuxia patens
Isothecium myosuroides
— viviparum
Heterocladium heteropterum
Stereodon resupinatum
Porotrichum alopecurum
Fontinalis antipyretica } Water-
— gracilis } lithophytes
Antitrichia curtipendula
Hedwigia albicans.

In ravines and crevices where there is little light and much moisture, we find another special lithophyte association, characterized by mosses and algæ (*Trentepohlia aurea, Nostoc carneum,* etc.), but only a few lichens (*Ephebe pubescens, Collema flaccidum* and *Leptogium* spp.); this association I call *the wet lithophyte association.*

The lithophyte vegetation is extensively distributed on the Færöes because so much bare rock is exposed, either in the form of more or less steep walls, or as somewhat flat expanses on the mountain-plateaux, whence the wind has removed all the loose products of disintegration (see Fig. 182). This kind of vegetation may be said to be extremely well-developed in this country and is no doubt a result of the high degree of atmospheric moisture, the frequent and abundant rainfall, and the comparatively slight insolation.

II. The vegetation in crevices and on rock-ledges, the chomophyte vegetation. A. F. W. Schimper (1898, p. 191) has called those plants which grow in crevices of the cliffs, Chasmophytes as opposed to lithophytes. Max Oettli (1905), who studied the ecology of the rock-vegetation in Switzerland, originated the term Chomophytes to include the chasmophytes and the plants of rock-ledges (l. c., p. 15). Chomophytes and lithophytes he includes under the term cliff-plants or Petrophytes: »all those plants growing on rock-faces or blocks, which are in a condition, as the first of their kind, to make the cliffs their habitat, and which in distribution or structure show a more or less marked dependance on the rock as a substratum.«

Chomophytes he defines as those petrophytes »which are only able to settle amongst the cliffs where detritus has gathered, either in crevices or on the surface of the cliff.« Oettli's conclusions on the peculiarities of rocky substrata as a habitat are equally applicable to areas beyond the district investigated by him. Hence I propose to quote some of his more important inferences, arranging them, however, in a slightly different way:

1° Places devoid of a plant-covering will always exist on cliffs because of the hardness and steepness of the surface, and because the higher plants can only find a home on terraces and crevices with loose soil.

2° Each place has its own particular degree of soil-moistness;

thus one may find, for example, a very moist crevice side by side with one that is quite dry.

3° Destruction of the roots and other injuries will frequently result from the steepness of the cliffs, and altogether the habitat may be far from being a stable one.

4° In consequence of the steepness of the cliffs, climatic factors may have a very marked influence — wind, light, heat and exposure generally, also intense cold with absence of snow.

5° Cliff vegetation is protected from the grazing and trampling of animals by its inaccessibility, but on the other hand it is deprived of any manuring which might result (this of course does not apply to the vegetation of sea-fowl cliffs, referred to later).

These and other factors tend naturally to the evolution of certain features distinctive of the chomophytes. The more noteworthy among these are, that the roots as a rule strike deep and are very vigorous, that the majority of the plants are spot-bound, while many are succulent, also that the individuals are often tall and remarkably vigorous in growth. On the other hand the external conditions present such wide variations, that it is not possible to regard the chomophytes as a single natural unit in the same sense as moor-plants, heath-plants, etc.

The fact that the amount of water varies exceedingly in the cliff vegetation must be specially emphasised; this before all others is the factor which has the greatest influence, and is the first and most important condition in differentiating between plant-associations with the same geographical and topographical position. It would therefore be most natural to base the grouping of the different forms of cliff vegetation on the water-content of the substratum, and thus follow the method employed for the other associations. It must be granted, however, that this is a method full of difficulties in the case of the cliffs, since the amount of water varies so much from place to place. The difficulty in preparing a satisfactory survey of a landscape so rugged as the Færöes, where the formations displace one another with bewildering frequency, becomes a still greater difficulty as regards the cliff vegetation, which may be compared to a variegated mosaic set in a homogenous matrix, the solid rock.

Some divisions can, however, be recognised, and these lie ready to hand in certain descriptive names already in common use amongst the inhabitants. These designations generally have reference to

topographical conditions, and do not always coincide with the botanical; but they may be used to a certain extent.

The steep cliffs are generally weathered out in such a way that vertical scarps alternate with more or less horizontal shelves, the

Fig. 183. The »Gjov« at Vestmanhavn. The bottom is filled with loose rocks, which conceal a small stream; both sides are luxuriantly covered with plants; the foliage to the right is leaves of *Angelica*. (From photo. by E. Warming).

profile as seen from the side being a zig-zag line resembling a rude titanic stair. This surface-formation is due to the geological structure, layer upon layer of basalt. The projecting ledges are known as »Hamre« and on the shelf of such a ledge, a certain amount of soil and débris accumulates. If the amount of soil is small, the shelf forms a rather flat cliff-terrace. With increasing amounts of soil, etc., the surface of a shelf becomes more and more a short

slope or »Brække« (see Fig. 181). On the lower part of a mountain, this development has generally proceeded so far that the perpendicular scarps are entirely obliterated, the narrow »Brækker« run into each other, and a broad typical slope or »Li« results.

The vertical escarpment with its cracks and small ledges is the home of the cliff vegetation. . The »Brække« and its modifications have so much loose soil that other plant-associations take possession. It will now be evident, that a mountain-terrace with some loose soil and favourably situated as regards moisture and insolation may become a habitat which offers greater advantages to plants than the grass-slope (compare p. 963), and is, relatively speaking, a »forcing bed«.

Another type of cliff-formation is that popularly known as »Gjov« (gorge, ravine or cove). By »Gjov« (see Fig. 183) we understand a great mountain cleft or ravine, often of considerable length and so roomy that people may journey in it; the water which trickles from the rock-springs frequently forms a streamlet which flows along the bottom. The sides of the »Gjov« may be regarded as two »Hamre« parallel to each other and at no great distance apart. It is characteristic of a »Gjov« that the position of its walls checks excessive insolation and drought, hence particularly favourable conditions may be offered to vegetation, except that in places it may be too dark and too moist. It is well known in the Færöes that the »Hamre« and the »Gjove« are just the places where vegetation developes with the greatest luxuriance. Here again we may recall what has been already pointed out, and is confirmed by Oettli (see 5⁰ on p. 972), that these places are specially favoured because inaccessible to sheep and their grazing.

From a botanical point of view the »Hamre« (rock-ledges) and the sides of »Gjove« (ravines) may be considered together as one group which may be subdivided according to light, exposure and humidity. We have found the following subdivisions suitable:

(1) the sombre and humid »Gjov«-side of a narrow ravine.

If the ravine is sufficiently wide, so that the illumination is favourable, its sides may be regarded as »Hamre«, which may be grouped under one of the following:

(2) the humid, north-exposed »Hammer« or »Gjov«-side,

(3) the semi-humid, usually south-exposed »Hammer« or »Gjov«-side, and

(4) the dry, south-exposed »Hammer«[1].

The »Hammer« or »Gjov«-side which is moderately humid and favourably exposed will naturally favour the most luxuriant vegetation. Those which are moist and north-exposed will be characterised by an abundance of mosses. The dry south-exposed »Hammer« and the gloomy moist »Gjov«-side form a contrast, the former

Fig. 184. Luxuriant vegetation on a moist »Hammer« above Trangisvaag on Syderö. (From photo. by E. Warming.)

is inhabited by the more typical rock-plants with decided xerophytic features, while the latter is the hiding-place of some mosses, some terrestrial algæ, and a few higher plants.

(1). The sombre and humid »Gjov«-side may be taken first; the following notes from my diary refer to it:

»A small, very wet and rather gloomy ravine, with its entrance

[1] When the exposure of the two sides of a »Gjov« is more towards east and west, then local conditions determine the degree of moisture and thus also the character of the vegetation (cfr. C. Jensen 1897, p. 192, and Ostenfeld 1901, p. 33); generally there is a distinct difference between the two sides of a ravine according as they differ in exposure and moistness. Since a ravine is always distinctly humid, we never find a Gjov-side which corresponds exactly to our 4th category.

towards the north, on the southern side of Kvanhauge, Syderö. Abundance of water, oozing downwards. In the innermost recesses, the only growth is mosses and algæ, with gigantic rambling specimens of *Cochlearia officinalis,* also *Epilobium alsinifolium, Saxifraga stellaris, S. nivalis, S. hypnoides, S. caespitosa, Sedum rhodiola, Ranunculus acer, Oxyria, Poa alpina vivipara, Festuca ovina vivipara, Montia* and *Stellaria media* — all being tall elongated plants. Further out, where there is more light and less moisture, we have the usual plants of the »Gjov« and »Hammer«.«

Several of these plants belong to the same species as those present in the moss-carpet by springs and brooks (see p. 943), e. g. *Epilobium, Montia* and *Saxifraga stellaris.* Others are typical rock-plants *(Oxyria, Sedum rhodiola, Saxifraga nivalis, S. hypnoides, S. caespitosa)*; others again are general everywhere.

(2). The moist north-exposed »Hammer« or »Gjov«-side harbours many more species. Mosses also play an important part; unfortunately I did not collect specimens, hence cannot give lists of my own, but must refer to Jensen's paper.

As an example, let us take my notes on a north-exposed, fairly moist »Hammer« on the southern side of Hovedalen on Syderö. There is a very rich moss-vegetation, in which flowering plants and ferns grow most luxuriantly. *Hymenophyllum* was abundant, scattered among the mosses and also as large nearly pure cushions. The dominant flowering plants were: *Sedum rhodiola* and *Luzula silvatica.*

The following were also noted: Ranunculus acer, Aspidium filix mas, A. dilatatum, Athyrium filix foemina, Cystopteris, Oxyria, Polypodium vulgare, Anthoxanthum, Saxifraga stellaris, Festuca ovina vivipara, Juncus trifidus, Hieracia spp., Alchimilla alpina, Blechnum, Carex binervis, C. rigida, Taraxacum spectabile, Rumex acetosa, Angelica silvelstris, Festuca rubra, Succisa pratensis, Cerastium vulgare and Poa pratensis — altogether 19 flowering plants and 7 ferns.

As a supplement to this we may take a »Hammer« with north-eastern exposure in the bay of Bordövig, Bordö; it differs from the last in having a better exposure with less moisture, thus forming a transition to the next group.

The long list of species observed includes: Rumex acetosa, Cystopteris, Silene acaulis, Luzula silvatica, Angelica, Saxifraga stellaris, Cardamine silvatica, Sedum rhodiola, Festuca rubra, Alchimilla alpina, Thalictrum alpinum, Cerastium vulgare, Stellaria media, Montia, Ranunculus acer, Anthoxanthum, Festuca ovina vivipara, Hieracium Hartz-

ianum, Saxifraga caespitosa, Poa glauca, Luzula spicata, Euphrasia minima, Sagina procumbens, Epilobium palustre, Aira alpina, Poa trivialis, Aira flexuosa, Luzula multiflora, Juncus triglumis, Alectorolophus sp., Armeria, Plantago maritima, Epilobium alsinifolium, Thymus, Viola silvestris, Hymenophyllum, Empetrum, Calluna, Succisa, Agrostis stolonifera, Pinguicula, Epilobium lactiflorum, Polypodium vulgare, Agrostis vulgaris, Aspidium filix mas, Lychnis flos cuculi, Leontodon, Taraxacum sp. and Carex pulicaris — altogether 46 flowering plants and 3 ferns.

(3). The semi-humid and usually south-exposed »Hammer« and »Gjov«-side. This group includes the most luxuriant habitats for plants on the Færöes. Certain »Gjove« well-known to the islanders because of their unusual wealth of flowers must be included here, although the exposure of their sides is more frequently east and west than north and south. Such is the case with the large Vestmanhavn-Gjov on Strömö and the Gjogavara-Gjov near Vaag on Syderö. It is peculiar for both these ravines that the west side with an eastern exposure bears the richer vegetation; why this should be so, is not quite clear, but it must be ascribed to local conditions (water-content, inclination of the basalt-strata, etc.). The »Gjove« near Selletræ on Österö, and near Husum on Kalsö, may be mentioned as other examples of luxuriant ravines which extend in a north-to-south direction, with their sides facing east and west. The vegetation of all these ravines is rich, not only as regards luxuriant growth, but also in the number of species. The higher plants and mosses take the leading part, but lichens and algæ also occur. The following examples may illustrate how numerous are the higher plants; a list of the mosses will be found in C. Jensen's paper (1897, p. 191). In the ravine near Vaag, Jensen recorded 99 species, or about one-third of the entire moss-flora of the Færöes, and in the ravine at Vestmanhavn the number was 87.

Examples:

1. Moist rock-ledge above Trangisvaag, Syderö (Fig. 184). The dominant species are: *Epilobium alsinifolium*, *Lychnis*, *Cochlearia officinalis* (the perennial form) and *Luzula silvatica*. Others noted were: Cerastium vulgare, Polypodium vulgare, Rumex acetosa, Angelica, Festuca rubra, Pinguicula vulgaris, Cardamine pratensis, Sedum rhodiola, Saxifraga stellaris, S. hypnoides, S. nivalis, Rubus saxatilis, Epilobium palustre, Oxyria, Alchimilla alpina, Hieracia spp., etc.; the mosses, Philonotis fontana, Pellia Neesiana, etc., a lichen, Solorina crocea, and an alga, Nostoc carneum. (After notes by Prof. Warming and the author).

2. The ravine, Gjogvara-Gjov, near Vaag on Syderö; a very luxuriant vegetation; a brook running in the bottom. Spiraea ulmaria,

Ranunculus acer, Aspidium filix mas, Athyrium filix foemina, Cystopteris, Polypodium vulgare, Rumex acetosa, Festuca rubra, Luzula silvatica, Sedum rhodiola, Geranium silvaticum, Bellis, Poa pratensis, Angelica silvestris, Epilobium alsinifolium, E. palustre, E. montanum, Sagina procumbens, Cerastium vulgare, Saxifraga hypnoides, Hieracium færoense, H. peramplum, Anthoxanthum, Holcus lanatus, Caltha (in great masses in the bottom), Alchimilla filicaulis, Saxifraga stellaris, Cardamine pratensis, C. silvatica, Agrostis vulgaris, Luzula multiflora, Potentilla erecta, Succisa, Lychnis, Plantago lanceolata, Festuca ovina vivipara, Oxyria, Ranunculus repens, Equisetum silvaticum, Rumex domesticus, Chamaenerium angustifolium, Rubus saxatilis, Aspidium dilatatum, Blechnum, Botrychium, Vaccinium myrtillus, Hymenophyllum, Alchimilla alpina, Cochlearia officinalis, Linum a. o. species which really belong to the adjacent vegetation. Altogether 42 phanerogams and 8 ferns.

3. The ravine at Vestmanhavn (see Figs. 183 and 185) is still richer. The dominant species are: *Luzula silvatica*, *Ranunculus acer*, *Rumex acetosa*, *Saxifraga stellaris*, *Saxif. hypnoides*, *Festuca ovina vivipara*, *Spiraea ulmaria*, *Alchimilla alpina*, *Geranium silvaticum*, *Sedum rhodiola*, *Aspidium filix mas* and *Cystopteris*; others noted: Angelica silvestris, Geum rivale, Rubus saxatilis, Epilobium montanum, Hieracium Ostenfeldii, Cardamine silvatica, Poa trivialis, Carex flacca, Athyrium filix foemina, Aspidium dilatatum, Hymenophyllum, Anthoxanthum, Festuca rubra, Holcus lanatus, Poa nemoralis, Cerastium vulgare, Alchimilla filicaulis, Viola silvestris, Polypodium vulgare, Epilobium palustre, E. alsinifolium, Caltha (mostly in the bottom), Taraxacum spectabile, Aira flexuosa, Ranunculus repens (in the bottom), Rumex obtusifolius (in the bottom), Oxyria, Aira alpina, Lychnis, Succisa, Alectorolophus sp., Sagina procumbens, Plantago maritima, Agrostis vulgaris, Veronica officinalis, V. serpyllifolia, Plantago lanceolata, Hypericum pulchrum, Pinguicula, Leontodon, Draba incana, Cirsium palustre (in the bottom), Draba hirta, Blechnum, Equisetum silvaticum, Vaccinium myrtillus, Polygala serpyllacea and Brunella (the last five high up near the edge of the ravine); altogether 52 phanerogams and 8 ferns.

4. The ravine near Selletræ on Österö. This also has a brook in the bottom; the direction of the cleft is east-west, and the south-exposed side bears the following species: Luzula silvatica, Blechnum, Succisa, Hieracium cordifrons, Leontodon, Angelica, Alchimilla alpina, A. færöensis, Rumex acetosa, Chamaenerium angustifolium (in great number), Hypericum pulchrum, Thymus, Alectorolophus minor, Festuca ovina vivipara, Calluna, Geranium silvaticum, Polygala vulgaris Ballii, Festuca rubra, Anthoxanthum, Agrostis vulgaris, Carex pulicaris, Euphrasia minima, Silene acaulis, Epilobium palustre, Holcus lanatus, Ranunculus acer, Plantago lanceolata, Nardus, Pinguicula, Cerastium vulgare, Thalictrum, Epilobium alsinifolium, Sagina procumbens, Saxifraga stellaris, Luzula multiflora, Viola silvestris, Linum, Trifolium repens, Poa glauca, Veronica officinalis, Luzula spicata, Plantago maritima, Taraxacum spectabile, Luzula campestris, Sedum rhodiola, Polypodium vulgare, Potentilla erecta, Aspidium filix mas, Poa pratensis, Cystopteris, Alectorolophus groenlandicus, Spiraea ulmaria, Oxyria, Aira alpina, Draba incana, Brunella, Juncus triglumis; altogether 53 phanerogams and 4 ferns.

The vegetation which appears on the »Ur«, is very closely related to that of the luxuriant rock-ledges and ravines, and it is

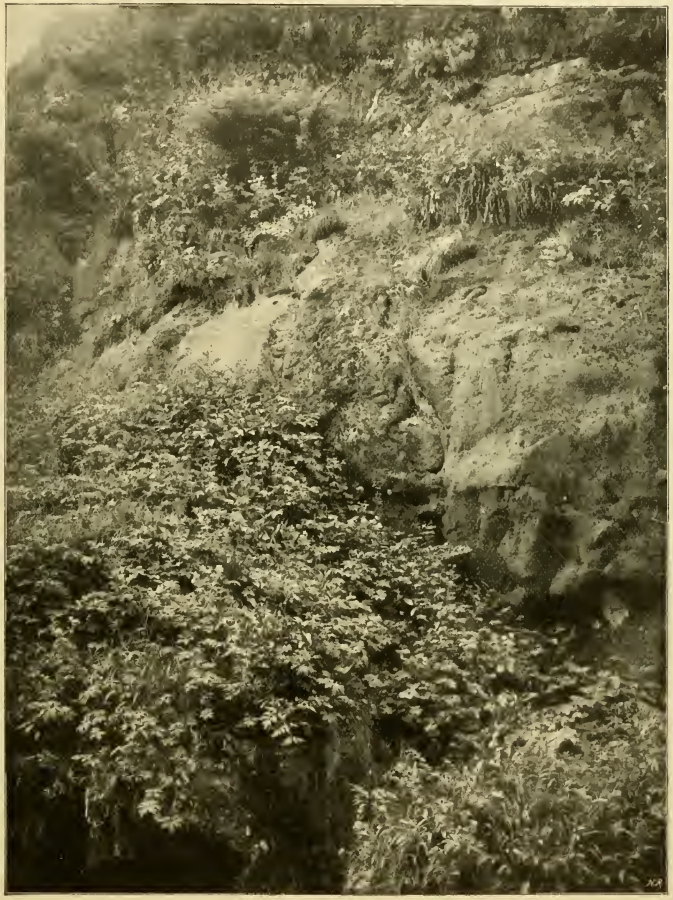

Fig. 185. Vegetation on one side of the ravine at Vestmanhavn; ferns on the higher ledge, the lower being covered principally by *Geranium silvaticum* and *Angelica*. (From photo. by F. Börgesen).

also remarkable for its enormous wealth of mosses, species as well as individuals.

»Ur« is the Scandinavian name used to indicate the slope,

scree or talus of fallen blocks and débris which is found at the base of steep mountain precipices (see Fig. 186). They offer extremely good conditions for the growth of mosses, as the plants are well sheltered among the blocks from excessive insolation. The »Ur«, like the cliff-face, has a scanty amount of loose soil lodged among the blocks; it is also not easily accessible for sheep. An »Ur« in its earlier stages is completely dominated by mosses, later, as it becomes older and more overgrown, soil accumulates chiefly by the decay of the large moss-cushions; the higher plants may then become dominant and lead to the formation of other plant-associations, for example the grass-slope. The unstable character of the »Ur« must not be forgotten as an important factor which operates against this development. Fresh fragments and blocks are constantly falling down to destroy the existing vegetation, and at the same time to form a fresh terrain. An example of the vegetation of the »Ur« will show, how much it resembles that of the »Gjov«.

On the east-side of Nolsö an extensive »Ur« (see Fig. 186) has formed at the base of the mountain-mass (200—300 m. in height) constituting the larger southern part of the island. Part of this »Ur« inhabited by sea-fowl has that type of plant-covering described in more detail in other parts of this paper as the vegetation peculiar to sea-fowl-cliffs (see p. 894 and p. 1004). The part of the »Ur« not used as a nesting-ground carries a very luxuriant moss-carpet from which the species recorded below were taken. Growing in the moss-sward there was also a rich flora of higher plants, *Oxyria*, *Rumex acetosa* and *Festuca rubra* being the more dominant.

The following species were also noted: Poa trivialis, Saxifraga caespitosa, Cerastium vulgare, Cystopteris, Draba incana, Polypodium vulgare, Sagina procumbens, Stellaria media, Taraxacum sp., Epilobium alsinifolium, E. lactiflorum, E. montanum, Cardamine silvatica, Poa glauca, Agrostis vulgaris, Sedum rhodiola, Poa alpina, Veronica serpyllifolia, Festuca ovina vivipara, Alchimilla filicaulis, Poa annua, Euphrasia sp., Veronica officinalis and Cerastium tetrandrum; altogether 25 phanerogams and 2 ferns.

Among the mosses collected, the following species were most common: *Frullania tamarisci*, *Metzgeria furcata*, *Sphagnum subnitens*, *Polytrichum urnigerum*, *Grimmia hypnoides*, *Isothecium tenuinerve*, *Hylocomium squarrosum*, *H. triquetrum*, *H. proliferum*, *Stereodon ericetorum*.

The less common species were Diplophyllum albicans, Jungermannia

quinquedentata, Lejeunea patens, Radula commutata, Plagiochia asplenioides, Fegatella conica, Astrophyllum hornum, A. Seligeri, Glyphomitrium polyphyllum, Weissia maritima, Polytrichum juniperinum, Grimmia gracilis, G. fascicularis, Hypnum sericeum, H. Stockesii, Plagiothecium undulatum, Isothecium myosuroides, I. viviparum, Stereodon resupinatum, Thyidium tamariscifolium.

The mosses as well as the higher plants convey the same impression, they are a very mixed and heterogeneous company, and

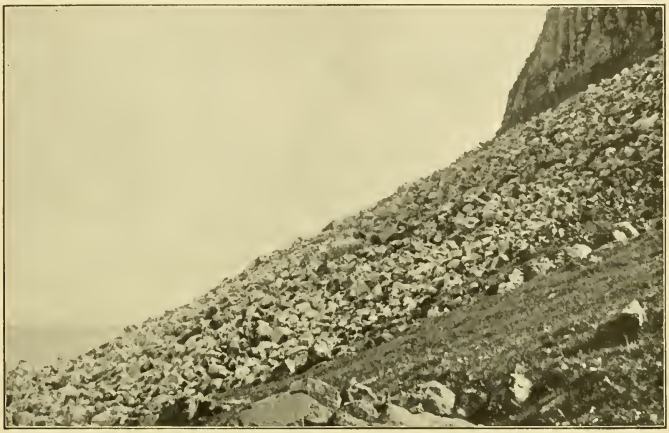

Fig. 186. »Ur« on the eastern side of Nolsö. (From photo. by E. Warming).

conform to the irregularities of their habitat, where some places are dry and warm while others are humid and cold.

(4.) The vegetation of the south-exposed »Hamre« (rock-ledges) is not so rich as that just described. The chief difference is, that on the dry »Hammer« the mosses occur neither in such masses nor as so many species, because the light is too strong and the water-content of the soil too scanty for them. The higher plants which prefer shade and moisture are also absent and their places are taken by other more xerophile species.

The dry, south-exposed »Hamre« occur in all the islands from the lower regions upwards to the highest mountains, but as might be expected, the constituents of the vegetation vary somewhat according to the altitude above sea-level.

It has already been stated that this type of vegetation does not appear in the typical »Gjove«, but the following example shows a transition from the moister south-exposed type to the dry.

The ravine near Husum on Kalsö (notes by Mr. R. Rasmussen, 1905). The direction of the cleft is east-to-west, the ravine being very open and consequently rather dry and well-situated with regard to light. The species noted were the following: Alchimilla færöensis, Angelica silvestris, Bellis perennis, Blechnum spicant, Caltha palustris, Cardamine hirsuta, Chamaenerium angustifolium, Cirsium palustre, Cochlearia officinalis, Draba incana, Empetrum, Epilobium sp., Geranium silvaticum, Hieracium spp., Luzula multiflora, Orchis maculatus, Oxyria, Pinguicula, Plantago lanceolata, P. maritima, Polygala sp., Potentilla erecta, Ranunculus acer (very tall specimens), Rubus saxatilis, Rumex acetosa, Saxifraga caespitosa, S. hypnoides, S. stellaris, Sedum rhodiola, Spiraea ulmaria, Taraxacum sp., Thalictrum, Thymus, Vaccinium myrtillus, Viola palustris, V. silvestris; altogether 36 species.

As an example of the dry Hammer of the alpine region I will take the vegetation on ledges with south-western exposure on Fuglö, about 600 m. above the sea. These were unshaded and rather dry, with a luxuriant vegetation of phanerogams, many arctic species being represented in this elevated habitat. Mosses were few, both as regards species and individuals; *Grimmia hypnoides* here, as nearly everywhere on the Færöes, was the most conspicuous. The dominant phanerogams were: *Alchimilla alpina*, *A. færöensis*, *Oxyria*, *Sedum rhodiola*, *Silene acaulis*, *Saxifraga caespitosa* and *S. hypnoides*.

Other species noted: Alchimilla filicaulis, A. acutidens, Cerastium Edmondstonii, Polygonum viviparum, Salix herbacea, S. glauca, Dryas octopetala, Thymus, Papaver radicatum, Aira flexuosa montana, Luzula spicata, Festuca ovina vivipara, Saxifraga oppositifolia, S. nivalis, S. rivularis (in crevices of the cliffs), Arabis petraea, Thalictrum, Euphrasia minima, Taraxacum spectabile, Saxifraga stellaris, Sagina procumbens, Empetrum, Ranunculus acer, Draba hirta, Cochlearia officinalis and Archangelica (a single individual); altogether 33 flowering plants.

These ledges were not particularly dry, and this, together with their alpine situation, has produced a vegetation somewhat different from that of the two following examples which, in my opinion, are more representative of the dry »Hamre«.

Hammer on Östnæs, the southern point of Österö; exposure to south and south-west. Among the more conspicuous phanerogams were: Luzula silvatica, Sedum rhodiola, Plantago maritima, Oxyria, Epilobium alsinifolium (in crevices), Alectorolophus groenlandicus, Hieracium veterascens, Polygala vulgaris Ballii, Chamaenerium angustifolium. The ferns noted were: Aspidium filix mas, Polypodium vulgare and Cystopteris; Asplenum adiantum nigrum and A. trichomanes both occur here sparsely and are only recorded from this one place on the Færöes.

Luxuriant Hammer directly opposite Tværaa, Syderö; southern exposure (see Fig. 187). Plantago maritima, Anthoxanthum,

Fig. 187. Part of a luxuriant, south-exposed »Hammer« above Tværaa on Syderö; a rich vegetation with large tufts of *Luzula silvatica*. (From photo. by O. Effersöe).

Hieracium cordifrons, H. subrubicundum, H. veterascens, Viola silvestris, Luzula silvatica, Vaccinium myrtillus, Calluna, Succisa, Galium saxatile,

Sedum rhodiola, Angelica silvestris, Hypericum pulchrum, Plantago lanceolata, Festuca rubra, F. ovina vivipara, Thymus, Empetrum, Taraxacum sp., Polypodium vulgare, Aspidium filix mas, Athyrium filix foemina, Ranunculus acer, Alchimilla alpina, Potentilla erecta, Geranium silvaticum, Cerastium vulgare, Blechnum, Polygala serpyllacea, Draba incana, Veronica officinalis, Rumex acetosa, Aira flexuosa and Rubus saxatilis were noted; altogether 29 phanerogams and 4 ferns. The mosses were comparatively of little consequence.

A closer examination of the species enumerated in these long lists from Gjov (ravine), Ur (talus) and Hammer (ledge) will reveal, that only a comparatively small proportion can be called chomophytes (see p. 971). The appearance of so many species which properly belong to other plant-associations, may be accounted for by conditions so varied and yet in many ways so favourable to plant-life. It is naturally anything but easy to decide what is and what is not to be reckoned as a chomophyte, but by utilising what one has learned regarding the distribution and habitat of the various species on the Færöes, it is possible to make a selection which on the whole will be in accord with the true natural conditions.

The chomophytes of the Færöes, that is those plants which have their home in crevices or on terraces as distinct from the cliff-face, may be grouped into three divisions or plant-formations. The plants may appear in other formations also, but as a rule their best development is attained on the cliffs. In the case of the first division, many of the species may equally well be regarded as characteristic of the rocky-flats. These three formations are:

(1°) the formation of the dry and light rock-crevices and terraces, — chomophytes in the stricter sense; (2°) the formation of the moist and shady crevices; (3°) the formation of the luxuriant warm and sunny ledges.

(1°) The formation of the dry and light rock-crevices and terraces, the typical chomophyte formation, is widely distributed on the Færöes, occurring in every place where the solid cliff-wall comes in sight. Its general appearance is shown very well in Fig. 188, the light lichen-crusted rock contrasting strongly with the deep green of the chomophytes which fill the crannies and nooks, and cover the narrow terraces.

Fig. 188. Cliff-exposure on Glyvernæs on Strömö. *Sedum rhodiola* and swards of *Festuca rubra* form the greater part of the vegetation; the rocks are encrusted with light-coloured lichens. (From photo. by F. Börgesen).

The characteristic higher plants[1] of this formation are: *Sedum rhodiola*, *Oxyria digyna*, *Armeria*, *Plantago maritima*, *Cochlearia officinalis (forma)*, *Saxifraga caespitosa*, *S. oppositifolia*; less important are: *Draba hirta*, *Silene acaulis*, *Alchimilla alpina*, *A. faeröensis*, *Juncus trifidus*, *Polypodium vulgare*, and the grasses, *Poa glauca* and *Festuca rubra*.[2]

All the dicotyledons of this group have certain features in common. They are all spot-bound and have a vigorous tap-root extending far down into the fissures, thus anchoring the plant and securing it against mechanical injury; the tap-root is also able to secure water from a great depth, and in some species probably serves also as a reservoir for storage of water and food. Another feature common to almost all, is that they are decidedly xerophytes; many are succulent, some have small leaves, and others are closely beset with hairs *(Saxifraga caespitosa, Draba hirta* and parts of the two species of *Alchimilla)*. The majority are »rosette-plants«, but as exceptions to this rule we have *Sedum rhodiola* and *Saxifraga oppositifolia*.

Among the characteristic monocotyledons, *Poa glauca* is distinctly a cæspitose grass; *Festuca rubra* has subterranean stolons and forms a close grass-sward (see Fig. 188), *Juncus trifidus* has a horizontal subterranean rhizome, with short jointed shoots closely set together, so that from a biological point of view the plant is spot-bound. *Polypodium vulgare* has also a horizontal rhizome. This fern and the grass *Festuca rubra* are species also found in other formations, the latter occurring almost everywhere in all kinds of habitat and in many varying forms; we may therefore be justified in omitting these from the more typical chomophytes. It may thus be said, that all chomophytes are rosette-forming or tufted plants, mostly with a long, vigorous tap-root.

As these plants have no organs for vegetative propagation, their multiplication is entirely dependent on seed, and accordingly they are found to flower and fruit abundantly. Most of the species mentioned, have a comparatively early flowering period and mature their fruits in good time. A large majority are entomophilous or

[1] The mosses have not been taken into consideration in this and the two following formations.

[2] The rarer species, — *Dryas octopetala*, *Salix glauca* and *Papaver radicatum* — may perhaps be included here; although they are not strictly chomophytes in countries, where common.

self-pollinated, few being wind-pollinated[1]. The habitat on the open cliff renders the flowers rather conspicuous and easily found by insects. Flies are the most frequent insect-visitors, but some species (e. g. *Silene acaulis*) are frequented by insects with a long proboscis.

(2°.) The formation of the moist and shady crevices, the ombrophile chomophyte formation. This consists of a number of species which require for their growth a certain amount of moisture in soil and atmosphere, and protection from excessive insolation. It is at once evident from their leaf-structure that, although not hydrophytes, the plants are unable to endure dessication. The general type of leaf has a thin cuticle, an open structure with rounded cells, and no great development of palisade-tissue. These features are best seen in the dicotyledonous character-species of the formation, viz: *Cardamine silvatica, Cochlearia officinalis (forma), Saxifraga rivularis, S. stellaris, S. nivalis, Epilobium lactiflorum* and *E. alsinifolium*. The same may he said of the characteristic ferns: *Athyrium filix foemina, Aspidium filix mas, Asp. dilatatum, Cystopteris fragilis* and *Hymenophyllum peltatum*. The grasses which I consider to belong to the formation are *Poa nemoralis, Aira alpina* and a giant form of *Festuca ovina vivipara*. The two last mentioned species appear in other formations in other forms; when they grow in moist crevices they have comparatively broad leaves and a tall loose habit, and both are distinctly pseudoviviparous. *Poa nemoralis* is a grass of the woods in Denmark and has a very delicate leaf-structure. Attention is here called to the general rule that when the ombrophile chomophytes named above occur in the Central-European region, it is as plants of the woods; for example several of the ferns and *Cardamine silvatica*. *Cochlearia officinalis* is noteworthy as a plastic species, or, to put it more correctly, the specific name conceals a whole series of elementary species[2]. The plant appears on the Færöes in nearly every formation with a loose

[1] The formation of seeds in *Alchimillae* is apogamic.

[2] For several years (see also Ostenfeld 1907, p. 850) I have cultivated in the botanical garden at Copenhagen *Cochleariae* grown from seed collected in different countries. Each form has there retained its peculiarities throughout several generations and is easily distinguished by its habits as a whole, although it seems extremely difficult to give a morphological description with distinguishable and fixed characters. The forms cultivated included one from the coast-cliff of the Færöes, a second from the rocky-flat, and a third from the formation considered here; they have remained quite distinct from each other.

substratum, and it differs greatly in its appearance in the different habitats.

The vegetative organs of plants of this formation are mainly cæspitose and spot-bound, but several of the species occurring in moss-carpets have some capacity for wandering, e. g. the two *Epilobia* and in a small degree *Saxifraga stellaris*. Fruiting and spore-production take place abundantly. The dicotyledons (*Epilobium* spp. excepted) have open and generally white »fly-flowers«, which appear early in the year.

The ombrophile chomophyte formation has its home in the moist and sombre parts of the ravines; here, in many places, water oozes over luxuriant moss-carpets, studded with flowering plants, while here and there patches of *Nostoc carneum* and filamentous green-algæ cover the mosses; at other places the ferns and some of the phanerogams form a tall dense growth with a dull or deep green colour, and no space is left for mosses.

(3°.) The formation of the luxuriant warm and sunny ledges, the thermophile chomophyte formation. This occurs in the open sunny higher parts of the ravines and on favourably exposed rock-ledges, and there the many handsome flowers give the rocks an attractive appearance. It includes a large number of species, but I only regard those as characteristic which do not attain their full development except on well-watered cliff-terraces with a good exposure, or those species which are more frequent and more conspicuous there, while of very secondary importance in all other habitats. The following species are included in the formation: all the *Hieracia* (21 species), *Hypericum pulchrum, Geranium silvaticum, Chamaenerium angustifolium, Epilobium montanum, Polygala vulgaris Ballii, Alectorolophus groenlandicus, Rubus saxatilis, Angelica silvestris, Draba incana, Spiraea ulmaria,* and the Monocotyledons, *Luzula silvatica, Carex flacca* and *Festuca rubra planifolia*. The most conspicuous and commonest species are the *Hieracia, Luzula, Geranium silvaticum*, and the large *Festuca*.

These character-plants include species with subterranean root-buds or wandering-shoots *(Chamaenerium angustifolium, Carex flacca* and *Festuca rubra)*, others with epiterranean runners *(Rubus saxatilis)*; but the majority are spot-bound — all the *Hieracia, Geranium silvaticum, Luzula silvatica*, etc. Completely detached from all the others we have the annual parasitic plant *Alectorolophus groenlandicus*. Most of these species have a southern distribution, and this

is in agreement with their preference for the warmest and most favourable places on the Færöes.

The plants of this formation fruit fairly well, with some exceptions, thus *Chamaenerium angustifolium* which frequently does not even come into bloom (cfr. Ostenfeld 1907, p. 851); this may also happen with *Rubus saxatilis* (see p. 916). The dicotyledons are all entomophilous, if not self-pollinated[1]; the flowers are conspicuously coloured, blue, reddish-purple, yellow and white being represented (e. g. *Polygala, Geranium, Alectorolophus, Spiraea,* etc.).

3. Alpine formations.

The geological structure of the mountains is such that in almost every case the summit is flattened and forms a plateau, from which the mountain flanks fall away towards the ocean or some valley in a succession of terraces, the home of the cliff-vegetation already described. The broader terraces may also be regarded as plateaux occurring on a lower plane than the actual summits, but the narrower terraces fall in with our conception of ledges and slopes.

In this higher region of the Færöes, or what may be called the alpine region, we find the following plant-formations:

1⁰. On the slopes and ledges, and in the ravines:

a) Grass-slope formation, b) Lithophyte formation, c) Chomophyte formations; the last generally being present as the typical chomophyte formation, less frequently as the ombrophile, and very rarely as the thermophile.

2⁰. On the plateaux or flats:

a) Lithophyte formation, b) Rocky-flat formation, c) Alpine-bog formation, d) Grimmia-heath.

The second group of formations, the vegetation on the flats of the mountain-plateaux, alone will be dealt with here. The other alpine formations (Group 1⁰) we have already included under our descriptions of the grass-slope and the cliff formations.

The plateaux are situated at different altitudes ranging from 200—300 m. above the sea-level, upwards to 700—800 m., the highest. The vegetation is essentially of the same character, although it decreases in luxuriance and in wealth of species as the highest levels are reached.

[1] All the *Hieracia* are apogamic.

Metereological statistics for the mountain-climate have, unfortunately, never been obtained, but it may be assumed that it is more rigorous than in the lower regions. The temperature being lower, the cold period is thus prolonged, and the summer is less warm. Fog is more frequent, so that among other things, light is considerably reduced. Finally the effect of storms will be much increased on the broad expanses of the plateaux. The conditions of plant-life are in every way harder, and it follows that the species which can thrive are fewer in number than in the lowlands; the species are also to some extent different.

The plant-formation with the greatest distribution on the tablelands of the Færöese mountains is that of the rocky-flats, the »Fjældmark«, in the form first characterised by Warming (1888, p. 68), and generally adopted by later authors dealing with the vegetation of northern countries. Proceeding from this formation, one can trace the development of two other formations relatively more luxuriant in character — the alpine-bog formation and the Grimmia-heath. It is therefore more natural to deal with the drier rocky-flat formation first, rather than to begin with the formations having a higher water-content, as was done with the sub-alpine formations.

a. The rocky-flat formation (Fjældmark).

The plateaux of the Færöese mountains are gravelly or stony and have a barren greyish-brown appearance. The rocks generally stand out like islets in a sea of gravel, the product of a rapid erosion of the easily weathered basalt. But in some places there is hardly any loose material of erosion, nothing but solid rock forming a rugged surface.

This wilderness is relieved here and there by a few plants, which contrive to grow in small depressions amongst the rocks or under shelter of boulders and stones, anywhere, in short, away from the violent winds.

That the winds are the chief cause of the barrenness of the mountain-plateaux is everywhere evident. Let the vegetation be sheltered from the blast, even to a slight degree, then it becomes richer and more continuous. Mosses in particular appear in increasing number. Amongst these *Grimmia hypnoides* and *G. ericoides* are always abundant species, and in this way the Grimmia-heath begins to be developed. One can trace in many places how the plant-covering advances step by step over the treacherous loose

gravel. On the other hand, it happens often enough, that the wind gets hold in some break in the moss-carpet, and using this as a point of attack, rolls up the carpet and carries it away, thus actually peeling the earth and laying it bare (see Figs. 170 and 189); the whole process of colonisation must then begin anew. Tufts of higher plants may also be observed which have been uprooted and carried away by the wind.

This continual struggle and the precarious conditions resulting from it, must greatly limit the number of plants capable of existing

Fig. 189. Mountain-plateau above Velbestad on Strömö. The surface has been much denuded leaving a gravelly expanse with stones scattered about. A moss-carpet can be seen to the left. (From photo. by F. Börgesen.)

in such an environment, and only the hardiest and most accommodating species can succeed in the contest.

It is necessary here, as in the case of cliff-vegetation, to distinguish between the lithophyte formation on the surface of the solid rock or the larger stones, and the vegetation which appears where loose soil has gathered. Lichens cover all the rocks and constitute a lithophyte formation which is most strongly developed where the solid rock, as distinct from gravel, forms the plateau (compare Fig. 182); there is, however, no essential difference from the lithophyte formation already described.

The gravel-flats are too unstable to carry any plant-growth. The reproductive bodies (soredia, etc.) of lichens will try no doubt to obtain a hold on the stony gravel; but every storm will set the small stones rolling and the friction will rub the plants off. In the case of larger stones which are not moved by the wind, plant-

growth is equally impossible on account of the grinding action of the finer particles driven by the storm. Gravel and pebbles are consequently nearly always naked.

The settlement of finer particles amongst the gravel and small stones makes it possible for plants to grow there. This vegetation may include phanerogams as well as mosses, if they are hardy enough to maintain an existence on such barren places. The higher and lower plants become allies, as it were, in a common effort to gain ground. It may be that a small tuft of moss is the first outpost on the bare gravel, and in this the seed of a phanerogam takes shelter and germinates. When this seedling becomes larger and more vigorous, it in turn becomes a stronghold from which the moss may extend. Rather more frequently the phanerogam comes first, and the moss follows later to grow in the shelter thus provided. It is not always easy to tell which of these events has happened. To some extent it depends on the species of phanerogam, some being capable of acting as pioneers, whereas others develop best in the moss-carpet. These less hardy species are not true plants of the rocky-flat, strictly speaking, their home is in the Grimmia-heath; but as every little moss-carpet or even a small moss-cushion may be said to be a diminutive Grimmia-heath, it is rather difficult to decide where to draw the line.

Some examples of the rocky-flat formation and its plants may now be given.

1. Sloping, stony rocky-flat on the southern side of Skaalefjæld, Syderö, altitude about 375 m. above the sea. Here and there small patches covered with moss. On the open ground were noted: Plantago maritima, Thymus, Armeria, Saxifraga stellaris (pygmaea), Polygonum viviparum, Ranunculus acer pumila, Luzula spicata, Agrostis canina, Festuca rubra, Arabis petraea, Koenigia, Silene acaulis, Oxyria, Cerastium Edmondstonii, Aira alpina.

2. The mountain above Karagjov near Kvalbö, Syderö, altitude 265 m. The dominant plants on the plateau are *Thymus, Armeria* and *Silene acaulis*; others noted: Polygonum viviparum, Festuca ovina vivipara, Cerastium Edmondstonii, Plantago maritima, Arabis petraea, Ranunculus acer pumila, Festuca rubra, Luzula spicata, Koenigia, Juncus trifidus, Alchimilla alpina, Thalictrum alpinum, Cerastium vulgare alpestre, Juncus triglumis, Empetrum, Viola silvestris, Alchimilla filicaulis vestita, Agrostis vulgaris, Nardus, Selaginella, Saxifraga caespitosa, Aira alpina, A. flexuosa montana, Saxifraga stellaris.

3. Rocky-flat on top of Klakken, Bordö, altitude about 400 m. Species noted: Oxyria, Cochlearia officinalis (forma), Cerastium vulgare alpestre, Saxifraga caespitosa, S. nivalis, S. oppositifolia, Arabis

petraea, Sedum rhodiola, Luzula spicata, Poa alpina vivipara, Cerastium Edmondstonii, Poa glauca, Alchimilla alpina, Aira alpina.

4. Rocky-flat on the southern slope of the mountain, Fuglö, altitude about 510 m. An almost level terrain of loose gravel and stones; here and there tufts of Grimmia somewhat torn by the wind, also occasional solitary flowering plants under the shelter of stones. Cerastium Edmondstonii, Saxifraga caespitosa, Arabis petraea, Thymus, Luzula spicata, Salix herbacea, Festuca ovina vivipara, Silene acaulis, Festuca rubra, Koenigia, Aira alpina, Poa alpina, P. glauca; others occurring in the tufts of moss are: Polygonum viviparum, Pinguicula, Aira

Fig. 190. Flowering cushion of *Silene acaulis* from Glyvernæs on Strömö. (From photo. by F. Börgesen).

flexuosa montana, Galium saxatile, Viola silvestris, Thalictrum, Alchimilla alpina, Nardus, Carex rigida, etc.

5. Malinfjæld on Viderö, Summit-plateau, altitude about 750 m. Flat area with numerous large blocks with loose gravel between. A scattered rocky-flat vegetation with tufts of Grimmia at intervals. Armeria, Cerastium Edmondstonii, Empetrum, Salix herbacea, Luzula spicata, Festuca ovina vivipara, Alchimilla alpina, Arabis petraea, Aira flexuosa montana, A. alpina, Nardus, Polygonum viviparum, Silene acaulis.

6. Summit of Höjefjæld, Bordö, altitude about 650 m. Gravelly and rocky plateau, most of it being »Rudemark« (see p. 886). Luzula spicata, Aira flexuosa montana and vivipara, Polygonum viviparum, Thymus, Silene acaulis, Cerastium Edmondstonii, Sedum rhodiola, Arabis petraea, Koenigia; in the tufts of moss: Alchimilla alpina, Carex rigida, Vaccinium uliginosum, Thalictrum, Lycopodium selago, Armeria, Taraxacum sp., Juncus trifidus.

7. The mountain above Fuglefjord, Österö, about 560 m.

above sea-level. Gradual slope with scattered flowering plants, and wind-torn strips of Grimmia ericoides. The dominant species in the gravel are *Armeria* and *Cerastium Edmondstonii*; others noted: Koenigia, Silene acaulis, Saxifraga stellaris, Salix herbacea, Aira alpina, Polygonum viviparum, Ranunculus glacialis, Arabis petraea, Luzula spicata.

8. The top of the roches moutonnées north of Thorshavn (compare p. 951 and p. 959); 50—75 m. above sea-level. The tops of the knolls are often denuded and barren, with a few scattered flowering plants: Agrostis sp., Aira alpina, Koenigia, Sagina subulata, Silene acaulis, Sedum villosum, Plantago maritima, etc. (This rocky-flat vegetation of the lower region forms a special association, differing from the type in its components).

The species characteristic of the rocky-flat formation may be summarised as follows: *Cerastium Edmondstonii, Silene acaulis, Armeria, Arabis petraea, Cochlearia officinalis forma (alpina* and *micacea), Thymus serpyllum, Koenigia, Ranunculus acer pumila, R. glacialis* (seems to be absent from some islands), *Alchimilla alpina, Sedum villosum, Saxifraga stellaris pygmaea, S. caespitosa, S. oppositifolia, Plantago maritima, Polygonum viviparum, Salix herbacea, Luzula spicata, Aira caespitosa brevifolia, A. alpina, Agrostis canina (montana), Festuca ovina vivipara, Poa alpina vivipara, P. glauca, Sagina subulata* (mostly only in the lower regions); also several less common species: *Sagina nivalis, Juncus biglumis, J. triglumis, Luzula arcuata* and *Saxifraga rivularis.*

Most of these are spot-bound plants. The dicotyledons have strong roots which strike deeply, and are thus adapted to resist the assaults of the wind, whether direct in attempting to uproot the plants, or indirect in removing the loose soil around the plant.

These plants are also in other respects adapted to live under severe conditions. Their aerial organs are low in stature, and thus offer a comparatively small surface to the wind. The same object is attained when, as is frequently the case, the plants of the rocky flat vary from the typical form of their species and assume a dwarfed form; this is the case for example with *Cochlearia, Ranunculus acer, Plantago maritima, Saxifraga caespitosa* and *S. stellaris,* and in a less degree with *Armeria, Alchimilla alpina, Luzula spicata, Aira alpina (vivipara), Poa alpina (vivipara), Agrostis canina* and *Festuca ovina (vivipara).* Some species are distinctly cushion-plants (»Polster-Pflanzen«): *Silene acaulis* (see Fig. 190), *Armeria, Plantago maritima* and *Saxifraga caespitosa.* In others we find a decumbent spreading habit with numerous branches which form a more or less open net-work exposed on the surface, partially covered over

and buried in the soil *(Cerastium Edmondstonii, Arabis petraea, Thymus serpyllum, Saxifraga oppositifolia,* and we may also include as a slightly different type, *Salix herbacea).* This spreading form of growth is particularly adapted for loose gravelly soils, and it reminds one of the decumbent forms assumed by plants like *Lotus corniculatus* and *Viola tricolor* when living on the loose substratum of a sand-dune (cfr. Warming, 1897 b, Fig. 7, p. 82, and V. Wittrock, Acta Hort. Bergiani, Vol. 2, Nr. 1, Fig. 4, p. 45).

None of the species of the rocky flat are provided with long stolons or runners, but those with a spreading branching habit form a transition between the spot-bound type and that which has the power of wandering. Among the decumbent species just mentioned, we can trace a gradual series from the one type to the other, corresponding to the development of accessory roots: *Arabis petraea* comes nearest to the spot-bound type, and *Salix herbacea* is the greatest wanderer. In case of *Agrostis canina,* which frequently has runners, the form met with on the rocky flats is distinctly tufted and has only a few very short runners. Several of these species with a branching growth may propagate by the branches becoming rooted, then, losing their connection with the parent, they form independent plants; this is the case with *Salix herbacea, Cerastium* and *Thymus serpyllum.* Taking them all in all, the plants of the rocky flat will be found to be almost lacking modes of vegetative propagation, except that of pseudovivipary.

The propagation of the species must therefore be effected almost entirely by means of seed and bulbils. As a rule flowers are abundant, and the ripening of fruit is successfully carried out. The flowers of the dicotyledons are nearly all insect-flowers, open and easy of access; self-pollination may also occur in most of them. All the monocotyledons are wind-pollinated, as is also *Salix herbacea.* A remarkably large proportion of the species propagate by means of bulbils, viz.: *Sedum villosum, Polygonum viviparum, Festuca ovina, Aira alpina, Poa alpina,* and occasionally *Aira flexuosa* and *Agrostis canina.*

Koenigia islandica, an annual plant, is quite unique; in spring (April—May) large numbers of its small reddish seedlings can be seen on a perfectly bare surface, which only a short time before was under water; the plant succeds in flowering and fruiting abundantly every year, although the summer is so short; on the

other hand it is very economical in its vegetative development. It is probably self-pollinated.

b. The alpine-bog formation.

The depressions of the mountain-plateaux will naturally receive water from their surroundings, and in the event of the drainage being defective, a small tarn or a bog will be formed. There are, however, few tarns on the plateaux, and their vegetation does not differ essentially from that of the small lakes of the lower regions, except that it is still poorer.

Bogs on the other hand are of more common occurrence, although they play quite a subordinate part when compared to the numerous bogs of the lowland. The upland bogs as a rule closely resemble the lowland, and only those situated at the highest altitudes show a slight variation in their composition. The vegetation of the lowland bogs has already been described, so that we need only add some notes on the upland form.

The chief difference between the alpine bog and the ordinary bog or swamp is the occurrence of *Carex pulla* on some of the islands, as the dominant species in the alpine.

Examples of the alpine-bog formation (Eriophorum-Carex-pulla association):

1. Rejafjæld on Österö; flat stretches at about 400 and 360 m. above the sea. Naked rocky ground with depressions occupied by bog-vegetation or pools. *Eriophorum polystachyum* and *Nardus* alternate as dominant species; *Carex pulla* is subdominant, forming now and then pure growths in shallow moist hollows. There is also much Grimmia hypnoides and a great many large tufts of Sphagnum. Scirpus caespitosus may occasionally be a dominant species.

2. The pass (Skard) above Fuglefjord, Österö, about 495 m. altitude. An extensive wet flat, parts of which are grass-moor association with *Nardus*, *Juncus squarrosus*, *Grimmia* and in places *Scirpus caespitosus*; part of the area is a swamp vegetation of *Eriophorum* and *Sphagnum*; *Carex pulla* is subdominant in both of these associations, but it also forms small pure growths along with *Carex Goodenoughii*.

Carex pulla is a medium-sized sedge with a distinct capacity for wandering. It resembles *Carex Goodenoughii* as regards shoot-structure and method of wandering. It is not common, except in the mountains of Strömö and Österö.

With the exception of the occurrence of this sedge, the peculiarities of the alpine bogs in comparison to those of the lowland are mainly negative. Quite a number of species of the ordinary

bogs are absent or rare in the bogs in the mountains (e. g. *Caltha, Narthecium, Heleocharis*, etc.) The real character-species of the swamps and bogs persist however in the alpine region, namely *Eriophorum, Scirpus caespitosus, Juncus squarrosus* and *Nardus.*

c. The Grimmia-heath formation.

The typical Grimmia-heath consists of a soft greyish-green (when wet a somewhat yellowish-green) carpet of *Grimmia hypnoides* or, more rarely, of *Grimmia ericoides.* Throughout this carpet a few phanerogams occur, and with some other mosses and lichens break the monotony, without being very conspicuous. The formation developed in this manner is found on the more elevated mountain-plateaux, never below 400 m., provided the conditions for its existence are present. The edaphic conditions most needful, in addition to the climatic ones, are a flat surface or a gentle slope with a soil not excessively wet and a fair amount of shelter from storm.

Fig. 191. Grimmia-heath on the top of Skjællingfjæld, Strömö (768 m. altitude). (From photo. by F. Börgesen).

The typical Grimmia-heath never occupies extensive areas on the islands, for the simple reason that few large areas suitable for its development exist at altitudes of 400—500 m.

The formation appears on all the larger islands, but attains its

fullest development on the northern ones. It is a formation which seems to be correlated with an insular and cool climate. Thus in Iceland it holds a more important place, and large areas are covered by it, especially the lava-fields, such as those described by Grönlund (1884, p. 136), Jónsson (1895, p. 70; 1900 p. 68 and p. 85; 1905 p. 40 and p. 53) and myself (Ostenfeld 1899, p. 245).

The typical Grimmia-heath of the Færöes is easily recognised and needs no long description. It passes over gradually into other formations, and presents several more or less distinct transitions, one of which is described below; when this occurs its characteristic features become effaced.

Examples of Grimmia-heath:

1. Klakken on Bordö, 400 m. above the sea. An elongated, flat, gentle slope. *Grimmia*-carpet of *G. hypnoides*, fissured by the wind in many places so that the bare mountain-gravel is exposed. The most common flowering plants in the moss-carpet are *Empetrum* and *Salix herbacea*; rather frequent are: Polygonum viviparum, Thymus, Aira flexuosa montana, Festuca ovina vivipara, Silene acaulis, Luzula spicata and Vaccinium myrtillus pygmaeum; isolated specimens were observed of Potentilla erecta, Viola silvestris, Galium saxatile, Loiseleuria procumbens, Festuca rubra, Lycopodium selago, Ranunculus acer pumila, Nardus, Agrostis canina, Alchimilla alpina, Luzula multiflora, Carex rigida, Pyrola minor (sterile), Thalictrum alpinum, Saxifraga oppositifolia, S. hypnoides, Taraxacum sp., Euphrasia minima, Arabis petraea.

2. Fuglö, the summit-plateau (620 m.). A large and nearly flat expanse with numerous rocks projecting from the *Grimmia*-carpet[1]; phanerogams represented by a few single plants, *Empetrum* being the most frequent; other species noted: Carex rigida, Festuca ovina vivipara, Aira flexuosa montana, Salix herbacea, Thymus, Polygonum viviparum, Armeria, Juncus triglumis (in rather moist places); also the lichens: Thamnolia vermicularis, Cornicularia aculeata, Sphaerophoron fragile, Cladonia sp. and Cetraria islandica.

3. The summit of Mornefjæld, Viderö, about 700 m. An elongated plateau with a thick moss-carpet of *Grimmia hypnoides*; flowering plants few and scattered: Empetrum, Salix herbacea, Polygonum viviparum, Nardus, Alchimilla alpina, Aira flexuosa montana, Agrostis canina, Carex rigida, Taraxacum sp., Vaccinium myrtillus pygmaeum, Loiseleuria, Thymus, Sibbaldia procumbens, Gnaphalium supinum, Festuca ovina vivipara, Vaccinium uliginosum microphyllum, Aira alpina, Alchimilla færöensis, Poa alpina vivipara, Lycopodium selago and Potentilla erecta; also lichens, including Thamnolia vermicularis, Cetraria islandica and Cladonia rangiferina.

4. Holgafjæld on Bordö, slope about 380 m. altitude. *Grimmia ericoides* the dominant species; also present Hylocomia and Grimmia hypnoides (the latter quite a subordinate element in this case). The following are the phanerogams, some of which are rather numerous:

[1] When the term »Grimmia-carpet« is used, it always indicates G. hypnoides.

Polygonum viviparum, Vaccinium myrtillus pygmaeum, Luzula multiflora, Festuca ovina, Thymus, Ranunculus acer, Euphrasia minima, Agrostis sp., Viola silvestris, Taraxacum sp., Thalictrum, Silene acaulis, Luzula spicata, Empetrum, Pyrola minor (sterile), Nardus, Cerastium vulgare alpestre, Rumex acetosa alpina, Alchimilla alpina, Saxifraga hypnoides and Sibbaldia.

5. The summit of Höjefjæld, Bordö, about 650 m. A thick and almost unbroken *Grimmia*-carpet covers the northern corner of the summit-plateau. Only a few individual plants of phanerogams, viz: Salix herbacea, Empetrum, Festuca ovina vivipara, Aira alpina, Carex rigida, Vaccinium uliginosum microphyllum, Thalictrum, Lycopodium selago, Taraxacum sp., Armeria, Juncus trifidus, Alchimilla alpina.

6. Rejafjæld on Österö. Slopes from about 375 to 540 m. above sea-level, with *Grimmia*-heath in patches, and the following flowering plants as secondary species: Salix herbacea, Sibbaldia, Carex rigida, Lycopodium selago, Blechnum (sterile and isolated plants), Rumex acetosa, Anthoxanthum, Luzula multiflora, Viola silvestris, Juncus squarrosus, Lycopodium alpinum, Galium saxatile, Festuca rubra, Agrostis vulgaris, A. canina, Potentilla erecta, Festuca ovina vivipara, Nardus; the following lichens were also noted: Cornicularia aculeata, Sphaerophon, Cetraria islandica, Cladonia rangiferina, C. cervicornis and Thamnolia.

The phanerogams of the Grimmia-heath are derived from various sources, and so may be arranged into groups:

(1) From the development of the Grimmia-heath it is natural to find almost all the species of the rocky-flat (see the list p. 994, but *Koenigia, Ranunculus glacialis,* and *Sedum villosum* do not appear, and the distinctly tufted species are rare).

(2) A certain number of the species from the heather-moor and the grass-moor, namely the hardier ones *(Empetrum, Festuca rubra, Juncus squarrosus, Luzula multiflora, Lycopodium selago, L. alpinum, Galium saxatile, Nardus, Potentilla erecta, Taraxacum (spectabile?), Thalictrum* and *Viola silvestris).*

(3) A few arctic species and varieties which on the Færöes are confined to the higher summits, e. g. *Carex rigida, Sibbaldia procumbens, Loiseleuria procumbens, Vaccinium myrtillus pygmaeum, V. uliginosum microphyllum,* and *Aira flexuosa montana*; the following rare species are also represented here, *Gnaphalium supinum, Pyrola minor* (an extremely peculiar habitat for this plant) and *Luzula arcuata.*

It is noteworthy that a good many of the phanerogams of the Grimmia-heath possess wandering-shoots, adapted to make their way through the moss-carpet (e. g. *Carex rigida, Vaccinium myrtillus, Aira flexuosa, Lycopodium alpinum, Pyrola minor, Thalictrum alpinum,* etc.). Others have the decumbent habit with numerous

branches spreading amongst the mosses *(Loiseleuria, Galium saxatile, Sibbaldia, Empetrum, Thymus).*

Most of the species flower and fruit abundantly. Some which do so only to a limited extent (see p. 916) are capable of propagating vegetatively, e. g. *Pyrola minor*, both *Vaccinium spp.* and those species which form bulbils (see p. 909). *Empetrum* seems to fruit sparingly.

The mosses include several species which belong almost exclusively to the Grimmia-heath, where hidden in the protecting carpets of *Grimmia hypnoides* and *G. ericoides* even the more delicate forms can grow, e. g. *Jungermannia orcadensis, J. Floerkii, Gymnocybe turgida, Dicranum arcticum*, etc. A more detailed treatment of the mosses is not possible from my own notes, and the reader is referred to C. Jensen's paper (1897) which contains lists of the mosses in the Grimmia-heath from the following localities: Slattaratindur (p. 173), Kleivan (p. 181), and Skjællingfjæld (p. 185).

Lichens are not represented by many species, and yet they are more conspicuous in the Grimmia-heath and its transition towards the grass-moor, than in any other formation, except the lithophyte formation. Large fructicose lichens are the most prominent: *Cladonia rangiferina* a. o. *Cladonia* spp., *Cetraria islandica, Sphaerophon fragile, Cornicularia aculeata* and *Thamnolia vermicularis*; this last species is restricted to the mountain-summits, but the others also occur frequently in the lower region.

Transition from Grimmia-heath to grass-moor. This is much more widely distributed than the typical Grimmia-heath, and is briefly referred to under the name »Grimmia-Nardus formation« in several places in my preliminary paper (Ostenfeld 1901). This transition formation is met with, as already stated (p. 953), on flat or slightly sloping areas at altitudes from about 200 to 400 m. above the sea. At lower elevations the grass-moor appears in its typical form with a decided predominance of phanerogams, especially *Nardus*; in the higher region, *Grimmia* and its associate mosses take complete possession. The midway stage between these two extremes is what I call *»the transition formation« (the Grimmia-grass-moor formation).* In its adjustment to external conditions and its dependence on them, this formation is naturally intermediate between the grass-moor and the Grimmia-heath. The soil is more »moory« than the gravelly substratum of the Grimmia-

heath, but less peaty than the grass-moor; so also the water-content is larger than the former, and less than the latter, and so on with other features.

The two principal plants are *Grimmia hypnoides* and *Nardus stricta*, the latter being replaced locally by its allies *Juncus squarrosus* and *Scirpus caespitosus*. The other character-plants have been referred to already, either as elements in the grass-moor, or in the Grimmia-heath, and without repeating them we proceed to illustrate the transition formation by some examples.

1. Mountain-plateau between Velbestad and Thorshavn, near the lakes, about 200 m. altitude. *Grimmia hypnoides, Nardus* and *Cladonia rangiferina* are dominant. Frequent species: Cladonia sp., Juncus squarrosus and Agrostis canina; scattered species: Potentilla erecta, Anthoxanthum, Empetrum, Polygala serpyllacea, Festuca ovina vivipara, Carex Goodenoughii, Viola silvestris.

2. Mountain-plateau above Ördevig on Syderö, about 200 m. above sea-level. Dominant species: *Grimmia* and *Nardus*; others noted were Galium saxatile, Potentilla erecta, Lycopodium alpinum, L. selago, Festuca ovina vivipara, Anthoxanthum. Aira flexuosa, etc.

3. Bergsmunna on Viderö, summit-plateau at about 360 m. Dominant species: *Grimmia* and *Nardus*; frequent species: Lycopodium alpinum, Agrostis vulgaris and Dicranum scoparium; scattered species: Festuca ovina vivipara, Aira flexuosa, Potentilla erecta, Viola silvestris, Selaginella, Galium saxatile, Anthoxanthum, Thymus, Viola palustris; also isolated plants of Alchimilla alpina, Carex pilulifera, Taraxacum sp., Empetrum, Carex rigida and Vaccinium myrtillus pygmaeum. The lichens include Cladonia rangiferina and Sphaerophoron; some of the more subordinate mosses: Polytrichum alpinum, Stereodon ericetorum, several Hylocomia, Isothecium tenuinerve, Ptilidium ciliare, Jungermannia Floerkii, etc.

4. Reiafjæld on Österö; mountain-plateaux at an altitude of 300—350 m. Dominant species: *Grimmia* and *Nardus*; frequent: Festuca ovina vivipara, Scirpus caespitosus, Juncus squarrosus; other species: Polygala serpyllacea, Potentilla erecta, Thymus, Carex pilulifera, C. flava, Agrostis canina, A. vulgaris, Festuca rubra, Empetrum, Galium saxatile, Viola palustris, Lycopodium alpinum, Calluna, Alchimilla alpina, Viola silvestris, Luzula multiflora, Cerastium vulgare alpestre, Anthoxanthum, Thalictrum, Leontodon autumnale, Taraxacum sp.; also the lichens Cornicularia, Sphaerophon and Cladonia sp.

5. Vardebakken above Thorshavn, the summit-plateau, about 300 m. Dominant species: *Grimmia, Nardus* and *Juncus squarrosus*; other species noted: Potentilla erecta, Scirpus caespitosus, Empetrum Carex flava, Festuca ovina vivipara, Sphagna and Cladonia rangiferina.

These examples will suffice to show that the transition formation comprises:

(1) the widely distributed species which occur in the lowland grass-moor and again in the Grimmia-heath of the mountains;

(2) a considerable proportion, but by no means all the species of the grass-moors lower down;

(3) a very small proportion of those species which have their true home on the mountain-summits.

It is possible that the status of this transition formation may be disputed, hence I have introduced it after dealing with the Grimmia-heath, rather than after the grass-moor, so that being acquainted with its allies at higher and lower levels, the nature of the transition may be more evident.

Now that all the natural formations have been examined, we must once more emphasise, that the most gradual transitions exist

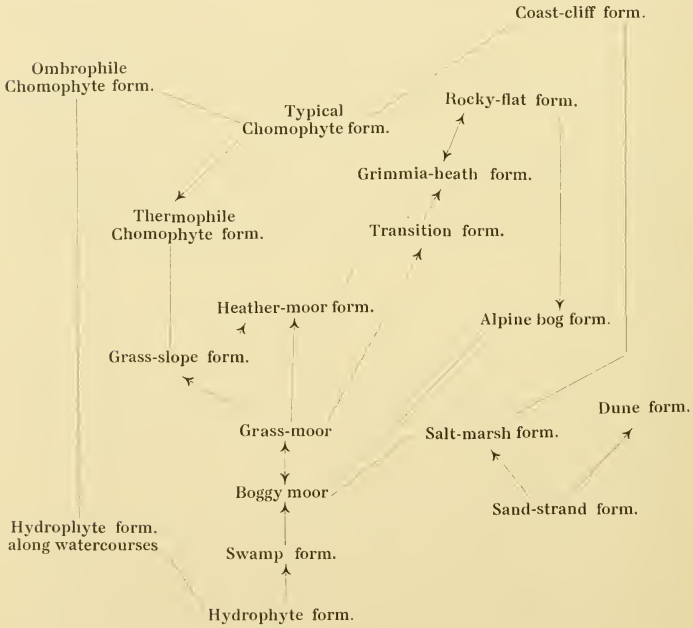

Diagram of the relationship of the natural plant-formations.

The connecting lines indicate the relationship and to some extent the evolution, but no attention need be paid to the varying length of the lines, since these are determined merely by the space at our disposal. The arrows suggest the direction of development.

between them. Since these formations all are so closely related, we may suppose that development from one to the other has proceeded in several directions.

An attempt is made here in the accompanying diagram to illustrate their relationship and the mode of development, and it shows at once how much they are interlinked.

4. The vegetation of the sea-fowl cliffs.

Special reference ought to be made to that vegetation found about the nesting-places of the countless colonies of sea-fowl — auks *(Alcidae)*, sea-gulls *(Larus* spp., especially *L. tridactylus)*, cormorants *(Phalacrocorax* spp.*)* and fulmar petrels *(Fulmarus glacialis)* (see also p. 894).

Places of this kind are unsuited to the growth of many species on account of the acrid excrements of the sea-fowl, but on the other hand certain species are favoured by the abundance of nitrogenous matter present. There is thus what might be called a cultivation of the soil, as a result of the operations of the birds. For this reason I have reserved this vegetation to the end of the series of natural formations, thus indicating its approach to the formations of the cultivated area. It must, however, be regarded as so far natural in that the »cultivation« consists merely in a change in the natural condition of the soil due to the excrements of the birds, and is not the result of methodical treatment.

The sea-fowl cliffs are almost inaccessible to man, and to be able to traverse them, as the fowlers do, requires that life-long experience from childhood onwards, so often spoken of in legends and folklore. A stranger visiting the Færöes for one short summer has no such experience, and this combined with the fact that the other vegetation gave me quite enough to do, is my apology for these fragmentary and scanty notes on the sea-fowl cliffs. They certainly deserve a more thorough investigation.

Most of the sea-fowl, which form the colonies, nest on extremely narrow shelves on vertical cliffs facing the sea. There they sit, side by side, in countless numbers. Scarcely a vestige of vegetation can be found in such places, except perhaps an odd rock-plant here and there in some crevice. The plants which appear here are those found generally in crevices, but more especially those of the sea-cliffs (see p. 931). One plant, however, is met with in its

wild condition almost exclusively on the sea-fowl cliffs; this is »Kvan« — *Archangelica officinalis* (see also p. 894). This large and handsome umbelliferous plant is used as a vegetable and esteemed a great dainty by the Færöese, being cultivated in small gardens (Kvan-yards) near their houses. In its wild form it is a character-plant of the sea-fowl cliffs. It may grow on the narrow terraces, but it thrives best on the »Ur« (talus) below the cliffs.

It is really on the »Ur«, that we find the vegetation which is most markedly influenced by the birds. A peculiarity of an »Ur« situated beneath a sea-fowl cliff is, that in nearly every case it is occupied as a nesting place by the puffin *(Fratercula arctica)*, which makes deep holes or burrows for its nest. A »Puffin-Ur« is easily recognised even from a distance, by its peculiar glaucous tint, which stands out in sharp contrast to the fresh green of the general vegetation. This colour is due to a particular form of *Festuca rubra*, which grows in masses among the blocks of the »Ur« and forms a grass-carpet, while its roots and rhizomes are closely interwoven into a firm turf.

A description of the vegetation in an »Ur« on the east side of Nolsö has already been given (p. 980). Part of this same »Ur« was inhabited by puffins, and here the vegetation had quite a different appearance. The dominant species was the glaucous form of *Festuca rubra*, with some *Agrostis vulgaris, Rumex acetosa, Stellaria media, Sagina procumbens, Cerastium vulgare, C. tetrandum* and *Montia lamprosperma*. These are almost all species which occur again as a part of the weed-vegetation to be considered later, and their presence in the »Ur« can be explained by similarity of conditions arising from a heavily manured soil. The »Ur«, as already described, is the habitat of a large number of mosses, which grow luxuriantly among the fallen rocks. In the case of the Puffin-Ur, mosses are comparatively scarce and to some extent the species are different. Some moss samples which I brought away from the Puffin-Ur at Nolsö were submitted to C. Jensen, who identified the following: *Hypnum Stockesii, H. sericeum, Isothecium myosuroides, Weissia maritima, Grimmia apocarpa, Porella rivularis, Lophocolea cuspidata* and *Stereodon resupinatum* (compare with list of mosses (p. 980).

Traces of the influence of birds upon vegetation were found on a mountain-terrace above the Puffin-Ur just described. Here (about 260 m. above sea-level), we found several large specimens of

Archangelica in bloom, a luxuriant growth of *Urtica dioica*, and some *Stellaria media* and *Poa annua*; this little plant-society, exactly the same as might be met with in a »Kvan-yard« in the village, was here on this elevated ledge side by side with the plants usual to such ledges, *Sedum rhodiola, Armeria, Oxyria*, etc.

My notes from Bordö include an unusually rich vegetation of flowering plants on Holgafjæld, just below the summit, on the side towards south-west (about 475 m. above the sea); this in all probability owed its existence to the excrements of the sea-fowl. Among others, we observed vigorous specimens of *Pyrola minor* in bloom, a plant which elsewhere we always found in a dwarfed and sterile condition (cfr. Ostenfeld 1907, p. 843).

While sailing amongst the islands, we frequently observed glaucous-green patches on the Urs and grass-slopes, and thus we became quite convinced that this form of *Festuca rubra*, manured by the sea-fowl, was the cause of this colour. This was very evident, for example, on the northern point of Kunö (Nakken).

The cliff-frequenting sea-fowl are not the only birds which affect plant-growth, for the eider-ducks *(Somateria mollissima)*, which nest in colonies on certain islets, have also an influence on the composition of the vegetation. Thus on the islets near Kirkebö on Strömö, there is a great abundance of *Melandrium rubrum* along with luxuriant specimens of *Cochlearia officinalis*, and other plants.

B. FORMATIONS IN THE CULTIVATED AREA.

J. Bernatsky (1904, p. 5) defines culture-formations as: »formations whose elements have not come in by natural agencies, but have been artificially introduced.« Thus a cornfield, a plantation, and such like are culture-formations. My own conception of a culture-formation is somewhat wider, in that I would include formations which may have appeared naturally within an area enclosed for cultivation, and are kept, through the agency of man, in a state different from that which they would be in if left to themselves. The Færöese home-field, the so-called »Bö« which will be described later, is an example of this kind of culture-formations. We should also include the weed-vegetation in the gardens and around the houses.

The study of the culture-formations has this advantage over that of the natural formations, that our knowledge of their deve-

lopment is more precise. Thus when we were considering the natural formations of the Færöes, we were constantly obliged to be content with suspecting or guessing how development had proceeded in the past, and what is now going on. On the other hand we know much more about the development of the culture-formations.

The greater part of the cultivated area on the Færöes consists of the enclosures locally known by the name »Bö« or, if only recently brought under cultivation, »Trö«. The distinction between these two names is mainly a technical one, hence in this paper the word »Bö« is used to include the »Trö« as well as the »Bö« proper.

Information on the methods of cultivation[1] may be found in several of the older books (e. g. Landt's description) and in more recent accounts, such as those of L. Bergh (1906) and P. Feilberg (1900). I have also obtained a large amount of valuable information direct from the »Kongsbonde« Just Jacobsen.

The first step in taking new land into cultivation is to fence it with a stone wall in order to protect the vegetation from constant grazing by sheep. The surface is then made more uniform by removing loose stones and roughly levelling it; ditches are also dug. Sometimes the turf is pared off, and any stones collected during the operations spread as a layer over the sub-soil; then the green turf is laid on with the grassy side downwards. In this way the rough grass is smothered, and in a primitive way an efficient drainage is secured. The grass-turf is afterwards broken up by hacking it, and the field is ready for further cultivation. When the field is very wet, a most original method is often employed to free it from superfluous moisture. Care is taken when digging and turning the turf to make a series of narrow ridges, sometimes only about 3—4 meters wide, and with a sloping surface. In the words of P. Feilberg's picturesque description (1900, p. 158): »The tranverse section of a Færöese meadow shows a profile resembling a row of large saw-teeth; each »Ager«[2] is made up of a long ascending slope, ending above in an abrupt steep scarp, which is generally cut down far enough below the lower edge of the next

[1] See also the historical survey (p. 869 et seq.).

[2] »Ager« in this case is equivalent to the English »ridge« or »rigg«. (Note by W. G. Smith).

»Ager«, to form a small channel for leading off water; the later cultivation consists in a simple operation, namely, at intervals of a few years, to file the saw-teeth, if I may call it so; in other words, a few feet of soil are dug from the steep edge and spread over the long slope of the next »Ager«.«

The process may be illustrated by a diagram thus:

The soil having been prepared, potatoes are planted generally for two years in succession (occasionally their place is taken by turnips). In the third year barley or bigg (exceptionally oats) is sown mixed with a small quantity of grass-seeds. This »grass-seed« is simply the sweepings from the floors of the hay-barns. It is quite exceptional to find any systematic sowing of pure grass-seeds, but at Thorshavn and Kirkebö I have seen fields sown with foreign grass-seed: *Dactylis glomerata, Festuca pratensis, Alopecurus pratensis, Trifolium pratense* and *T. hybridum.* The general practice, however is to harvest the first crop of corn and then leave the field alone. Whether the so-called »grass-seed« has been sown or not, some weeds always grow among the corn, and these spread rapidly when left in possession during the following year. At the same time other plants are migrating in from the neighbourhood, and although the annual plants may dominate at first they are gradually ousted by the perennial grasses and herbs; thus in the course of a few years the »Bö« has developed into its typical form, that of a grass-meadow generally with a wealth of flowering herbs. The »Bö« remains in this condition for several years (often half a score), and the only cultivation it receives during this period consists in keeping the artificial drainage in repair, in mowing it every summer, and in supplying some natural (farm-yard) manure (which was of course given also during the earlier years).

These are the main facts relating to the treatment of the cultivated land on the Færöes, and this is not the place to enter more fully into the purely agricultural side of the matter or to offer any criticism on the methods of cultivation. It is sufficient for our purpose to describe the plant-associations, which are fostered in this

way. The most important of these is the grass-meadow, and this is also the main object of cultivation. The growing of corn is of minor importance, and may be regarded rather as a preliminary stage in laying down the land to grass. The potatoe and turnip crops, however, are of some importance.

The grass-meadow, or to use its local name the Bö, will be considered first, as it is the formation of the cultivated area, which

Fig. 192. Bö on Kolter with a wealth of flowers; the ditches dividing the narrow field-ridges can be faintly seen in the distance. (From photo. by F. Börgesen).

most approximates to a natural formation, especially the grass-slope and the grass-moor.

a. The Bö formation (Grass-meadow).

The plants of the Bö form a dense, light-green carpet, with numerous flowering herbs (yellow *Ranunculi*, white *Bellis*, etc.) relieving the green of the grasses. The surface of the Bö is seldom flat, but is generally more or less undulating, and intersected by numerous drainage channels of the kind described above. The appearance before mowing is very variegated and attractive, numerous flowers bestowing a character very distinct from that of an ordinary meadow, and recalling the upland meadows and pastures around a Norwegian »sæter« or the Swiss »Alpen«.

The dominant grasses of the Bö formation are five in number:

Agrostis vulgaris, Poa pratensis, Holcus lanatus, Holcus mollis and *Anthoxanthum.* The most frequent secondary grass-like plants are *Festuca rubra, Agrostis stolonifera, Poa trivialis, Luzula multiflora, Equisetum silvaticum* and in the moister Bö's *Juncus lamprocarpus, Carex Goodenoughii* and *Equisetum palustre.*

The »flowering« herbs form a goodly array. *Trifolium repens* is both common and characteristic. The following may be given

Fig. 193. Bö at Kvannesund. (From photo. by E. Warming).

as being frequent: *Ranunculus acer, R. repens* (in the younger and moister Bö's), *Bellis perennis, Rumex acetosa, Leontodon autumnalis, Lychnis flos cuculi, Alectorolophus minor* and *Euphrasia borealis.* Among the numerous less important species some merit special mention as they hardly ever occur outside the Bö; they are *Vicia cracca, Lathyrus pratensis, Myosotis arvensis, M. versicolor, Viola tricolor, Achillea millefolium* and *Tussilago farfarus.* Several of the last-named have doubtless been introduced by man, in fact this is probably true of most of them.

All the species of the Bö are common plants of the fields and meadows in the northern part of Central Europe, for example with us in Denmark[1]. None of them are specially northern in character.

[1] *Euphrasia borealis* is, however, an exception; its place being taken in Europe by other species of *Euphrasia* (e. g. *E. brevipila* Burnat & Gremli).

Mosses occur frequently, but not always, in the undergrowth, especially if the Bö is a moist one. The dominant species are *Hylocomia*, but in addition, a number of other mosses have their habitat here, and rarely if ever appear outside the home-field. As examples of these we may mention: *Lophocolea bidentata, Hypnum praelongum, H. rutabulum, Polytrichum nanum,* and, somewhat less restricted, *Catharinea undulata, Astrophyllum undulatum* and *Bryum pallens.*

Lichens are of no importance. Fungi belonging to the *Agaricaceae* are fairly numerous, but unfortunately I cannot give much information about them. Most of the *Agaricaceae* given in E. Rostrup's list of Færöese Fungi (1901) were probably collected from the Bö, thus I recollect *Panaeolus campanulatus* and *Tricholoma sulphureum.*

As regards vegetative propagation amongst the phanerogams, we find that the dominant grasses include: 1⁰ distinctly cæspitose species *(Holcus lanatus* and *Anthoxanthum)*; 2⁰ cæspitose species with runners *(Agrostis vulgaris)*; and 3⁰ distinctly wandering species *(Poa pratensis* and *Holcus mollis).*

Similarly the »flowering« herbs show much variety in vegetative structure, and as examples ranging from spot-bound to wandering species we may mention, *Ranunculus acer, Bellis perennis, Trifolium repens* and *Ranunculus repens.*

Flowering and fruiting occur abundantly in the grasses and the grass-like plants; but the fruiting does not seem to be so good in the case of several of the »flowering« herbs, such as *Lathyrus pratensis, Vicia cracca* and *Trifolium repens*[1].

The lack of insects suitable for pollination, may account for this (see further pp. 915—917). The more simple types of entomophilous flowers form seed very well; so also do the two annual parasites, which are presumably self-pollinating like many of the other species.

The appearance of the Bö varies in the same way as any formation, according to the soil-moisture, the age, etc.

Some examples of the »Bö« taken from the different islands will illustrate this variation; notes are also included on those examples at Kirkebö, where foreign seed was sown.

[1] I cannot say how *Tussilago* flowers and fruits, as I have only observed it in the summer.

1. Rather dry Bö at the head of the Trangisvaagfjord, Syderö. *Anthoxanthum*, *Festuca rubra*, *Holcus lanatus*, *Agrostis stolonifera* and *Trifolium repens* are dominant species. Secondary species are: Rumex acetosa, Potentilla anserina, Cerastium vulgare, Holcus mollis, Angelica silvestris and Plantago lanceolata.

2. Moist Bö at the same place as the preceding. Dominant species *Equisetum palustre* and *Carex Goodenoughii*; the grasses mentioned in Ex. 1 are in this case subdominant. Other species noted: Ranunculus acer, a small amount of Juncus effusus, Potentilla erecta,

Fig. 194. Sloping Bö in Thorshavn; the ground here is not ditched as usual. The hay has been mown, and lies drying in small heaps. (From photo. by author).

Caltha, Eriophorum polystachyum, Luzula multiflora, Epilobium palustre, Triglochin palustre, Ranunculus flammula, Euphrasia borealis.

3. Rather dry Bö on a ledge near Frodebö, Syderö. Dominant species: *Holcus lanatus*, *H. mollis*, *Agrostis vulgaris*, *Poa pratensis* and *Trifolium repens*. Secondary species: Myosotis versicolor, Rumex acetosa, Cerastium vulgare, Alectorolophus minor, Ranunculus acer, Anthoxanthum and Euphrasia borealis; no moss on the ground.

4. Kirkebö on Strömö; Bö with no foreign grass-seed. Dominant species: *Anthoxanthum*, *Agrostis vulgaris* and *Holcus lanatus*; subdominant: Trifolium repens, Luzula multiflora, Ranunculus acer, Leontodon autumnale, Bellis; scattered: Poa pratensis, Rumex acetosa, Equisetum arvense, Cerastium vulgare, Plantago lanceolata, Euphrasia borealis, Alectorolophus minor.

5. Kirkebö on Strömö; Bö sown with foreign grass-seed. Dominant species: *Phleum pratense*, *Holcus lanatus* and *Festuca pratensis*; in places *Poa trivialis* and *Agrostis vulgaris*. *Ranunculus repens* and *Trifolium pratense* dominate in the bottom. Other species noted: Anthoxanthum, Rumex domesticus (isolated), R. acetosa, Cerastium vulgare, Trifolium hybridum, Bellis, Dactylis, Alopecurus pratensis and Potentilla anserina — a motley mixture of indigenous and foreign species.

6. Bö at Sjov, Strömö. Dominant species: *Holcus lanatus*, *Agrostis*, *Anthoxanthum* and *Holcus mollis*; subdominant: Equisetum silvaticum and Trifolium repens; scattered: Rumex acetosa, Ranunculus acer, Angelica silvestris, Luzula multiflora, Plantago lanceolata and Alectorolophus. On the whole this Bö has few »flowers« and hardly any moss in the bottom.

7. A younger Bö at the same place as the preceding. Dominant species: *Holcus mollis* and *Ranunculus acer*; subdominant: Holcus lanatus, Agrostis vulgaris and Anthoxanthum; scattered: Rumex acetosa, Poa trivialis, Stellaria media and Cardamine hirsuta.

8. Bö in Thorshavn; the surface sloping slightly, and the soil rather dry. Dominant species: *Agrostis vulgaris*, *Anthoxanthum* and *Holcus lanatus*; subdominant: Rumex acetosa, Plantago lanceolata, Luzula multiflora, Ranunculus acer and Alectorolophus; scattered: Cerastium vulgare, Poa pratensis and Bellis.

In another Bö *Holcus mollis* was among the dominant species, but as a rule it is subordinate to the three species mentioned above.

As a Bö gets older, *Holcus lanatus* gradually disappears.

9. Bö at Næs parsonage, Österö. Dominant species: *Agrostis vulgaris* and *Holcus lanatus; Anthoxanthum* is subdominant. Scattered species: Rumex acetosa, Holcus mollis, Ranunculus acer, R. repens, Luzula multiflora, Poa trivialis, Carex Goodenoughii, Juncus lampocarpus, Caltha, Equisetum arvense, E. palustre.

10. Bö at Klaksvig, Bordö. The fields on the whole are moist and poor in »flowering« herbs; and this example is typical of most of the northern islands (Nordreöer). Dominant species: *Agrostis vulgaris*, *Anthoxanthum*, *Luzula multiflora*, *Rumex acelosa*, and *Ranunculus acer*. Other species noted: Holcus lanatus, Alectorolophus, Alopecurus geniculatus, Epilobium palustre, Poa trivialis, Caltha (mostly in the ditches), Holcus mollis, Ranunculus repens, Cerastium vulgare, Lychnis flos cuculi, Equisetum silvaticum, Juncus lampocarpus, Viola palustris, Carex Goodenoughii and Potentilla erecta. Abundance of moss in the bottom.

The roof vegetation I regard as a special form of the Bö formation. Nearly all the Færöese houses are thatched with turf (see Fig. 195) and this carries a luxuriant verdure which may be regarded as composed of a selection of the plants from the Bö. The grass-turf used is certainly often obtained outside the home-fields, but the relatively dry situation on the roof where it is

placed, as well as the nearness of the houses to the grass-fields favours the development of grasses; the vegetation thus becomes a distinct grass-formation of a rather uniform type. The most frequent grasses on the roofs in Thorshavn, for example, were *Agrostis vul-*

Fig. 195. Street in Thorshavn showing grass-vegetation on the roofs. (From photo. by H. G. Simmons).

garis and *Festuca rubra.* They occurred either as pure growths or mixed together, occasionally with small patches of *Holcus mollis, Anthoxanthum* and *Poa pratensis.* An almost complete absence of »flowering« herbs is a peculiarity not easily explained; only very rarely did we see even a single flower on a roof.

b. **The corn and potato fields, together with the weed-vegetation in the gardens and around the houses (Ruderal vegetation).**

The climate of the Færöes is not well suited for the cultivation of cereals, because the temperature in summer is much too cold.

A hardy variety of barley or bigg has been grown, however, since ancient times, but it has always been difficult to get it ripe, and generally it has been necessary to harvest the crop and then dry it artificially. Nor has cereal culture increased in importance in recent years; it is still, as it was in former days, mainly useful as a means for securing the formation of the Bö.

The principal cereal is the six-rowed barley or bigg *(Hordeum vulgare)*. Fields of oats *(Avena sativa)* are sometimes seen, while Tartarian oats *(A. orientalis)* and two-rowed barley *(Hordeum distichum)* may be cultivated, but very rarely. The oats are generally cut and used as green fodder.

The cultivation of potatoes *(Solanum tuberosum)* has increased to some extent in recent years, and with good reason, even though neither the climate nor the soil are especially adapted for this plant. Turnips *(Brassica rapa rapifera)* also furnish good crops and should have a future before them.

Unfortunately I can give no information as to what varieties of these cultivated plants are used; they are probably not very well known, and do not seem to have been investigated.

Weeds grow luxuriantly *in the arable fields,* partly as a result of the moist climate, since this favours the growth of weeds, and partly because no great care is taken to suppress them. Nor is this necessary, since the grass-meadow which follows, is developed by natural selection from such weeds as may be present and succeed in the struggle for existence. Certain of these weeds only appear in the arable area or round the houses and in the gardens, thus *Galeopsis tetrahit, Brassica campestris, Lamium purpureum, L. intermedium, L. dissectum, Anchusa arvensis, Senecio vulgaris, Spergula arvensis* and *Cirsium arvense,* as well as some others which have been recorded only once or twice. If there was any reason for assuming that a large proportion of the species of the Bö formation were introduced by man, then this supposition is even more probable in the case of the weeds just mentioned. With the exception of *Cirsium arvense* which is rarely seen in bloom and

hardly ever sets seed, all these species are annuals. This is also the case with a number of other species which are frequently dominant weeds in the arable fields, but which also occur in other formations (e. g. *Stellaria media, Montia, Cardamine hirsuta*).

Some notes may serve as illustrations:

1. Barley-field at Frodebö, Syderö. *Galeopsis tetrahit* in abundance, and Brassica campestris sparse.

2. Field of Tartarian oats at Kirkebö, Strömö. Common weeds: *Avena sativa, Montia lamprosperma, Stellaria media* and *Poa trivialis*. Rather more scattered: Polygonum aviculare, Atriplex sp., Sinapis alba, Galeopsis tetrahit and Brassica campestris.

3. Oat-field at Kirkebö, Strömö. *Galeopsis, Ranunculus repens* and *Stellaria media* in great abundance; also noted as less common: Hordeum distichum, Rumex acetosa, R. domesticus, R. obtusifolius and Polygonum aviculare.

4. Barley-field at Thorshavn. *Stellaria media* most frequent; common are: Ranunculus repens, Spergula arvensis, Poa trivialis; scattered: Holcus lanatus, Cerastium vulgare, Senecio vulgaris and Alectorolophus minor.

5. Oat-field at Thorshavn. *Galeopsis tetrahit* was most frequent; also noted: Brassica campestris, Cardamine hirsuta, Rumex acetosa, Holcus lanatus, Agrostis vulgaris, leaf-rosettes of Anthoxanthum, Myosotis versicolor, Stellaria media, Ranunculus acer, R. repens (in patches) and Cerastium vulgare.

The weed-vegetation of the gardens and around the houses, the so-called Ruderal vegetation, is closely related to the weed-vegetation of the cultivated fields. Both these associations have in common a great number of annual species, all dependent on human activity.

They do not attain perfect vigour except when growing on recently tilled, loose soil (»new land«), and are unable to maintain themselves for any length of time against the encroachments of other plants unless assisted by man's regular cultivation of the soil. The following plants belong to this group in addition to the species already mentioned (p. 1014): *Capsella bursa pastoris, Cerastium glomeratum, Poa annua* and (to some extent) *Juncus bufonius* and *Polygonum aviculare* — these being annuals; also the perennials, *Rumex crispus, R. obtusifolius, R. domesticus* and *Agropyrum repens.*

Tanacetum vulgare, Aegopodium podagraria and *Urtica dioica* might also be included, but with some limitations.

Some examples of the weed-vegetation may be quoted from my notes from Kirkebö on Strömö. Around the houses the following were common: *Rumex domesticus, R. obtusifolius, Urtica*

dioica, Capsella, Poa annua, Polygonum aviculare, Ranunculus repens and *Cerastium glomeratum.*

A large patch of *Cirsium arvense* growing to a height of $1^1/_2$ metres was seen along with *Rumex crispus, Tanacetum vulgare, Agropyrum repens, Brassica campestris* and *Senecio vulgaris.*

On a path in the Bö, among other plants there was *Plantago major,* which was observed in this station by E. Rostrup as early as 1867; since then it has persisted here without being distributed any further. *Anchusa arvensis* presents a similar case; it was also found in 1867 as a weed in a potato field at Sand on Sandö, and we saw it there still 30 years after. These species have ripened their fruits year after year. Certain other weeds have not fared so well, and have consequently disappeared from the Færöese flora. Thus Lyngbye in 1817 found *Agrostemma githago* as a weed in fields at Skjælling on Strömö, and *Lolium perenne* at Ejde on Österö (see Ostenfeld 1907, p. 860), but neither of them has since been observed at those places.

Rostrup in 1867 collected *Brassica nigra, Geranium molle, Veronica hederifolia, Agrostis spica venti* and *Raphanus raphanistrum* at Thorshavn, but we could not find even a single specimen of them. Several other examples of a similar kind might be added.

In this formation phanerogams alone have been noticed, because mosses and lichens do not favour a substratum so recently formed and so liable to change as the soil of fields and gardens.

Some few mosses, however, have their habitat here and deserve recognition, for example *Funaria hygrometrica* and *Bryum argenteum,* but they are not particularly abundant.

c. The metamorphic formation.

The transformation of a cornfield into a Bö or meadow takes two or three years, during which period there is a characteristic vegetation, consisting of a mixture of a large number of weeds with some of the species of the meadow. During the year of the corn crop the weeds occupy the ground so that during the next year they are entirely dominant. After this they are superseded gradually by the species of the meadow, which come in more slowly, but none the less surely. This mixture of plants which occupies the field in these years of struggle, I have named the »metamorphic formation«.

The fight lies in the first instance between the annuals and the perennials, until the latter gain the upper hand. Amongst the perennials those species which propagate vegetatively will eventually prove the stronger, and drive away several of the more distinctly tufted plants, such as *Rumex obtusifolius*, *R. domesticus*, *Alopecurus geniculatus* and *Holcus lanatus*.

The commonest of the annual species are the following: *Galeopsis tetrahit*, *Stellaria media*, *Cardamine hirsuta* (the form *campestris* which is generally annual), *Poa annua* and the annual form of *Montia lamprosperma*.

The following are the most frequent of the spot-bound perennial species: *Poa trivialis*, *Ranunculus acer*, *Rumex acetosa*, *R. obtusifolius* and *R. domesticus*, *Alopecurus geniculatus*, *Holcus lanatus*, *Plantago lanceolata*, *Anthoxanthum* and *Cerastium vulgare*. *Agrostis vulgaris* and *Bellis* are perennial species with limited powers of vegetative propagation, while *Ranunculus repens* and *Agrostis stolonifera* are perennials with widely wandering runners and stolons.

The occurrence and frequency of these species will be better seen from some examples.

1. The Bö of the parsonage in Kvalbö, Syderö.

a) The field where corn was cultivated last year. Dominant species: *Stellaria media*, *Cardamine hirsuta*, *Poa trivialis*, *Ranunculus repens* and *Cerastium vulgare*; subdominant: Galeopsis, Rumex acetosa and Poa annua; scattered: Bellis, Alopecurus geniculatus, Ranunculus acer and Agrostis stolonifera.

b) Another field, probably a year older, and with a moist soil. Dominant species: *Rumex acetosa*, *Ranunculus repens* and *Caltha*; Poa trivialis was subdominant, and the other species noted included Rumex domesticus, Holcus lanatus, Anthoxanthum and Agrostis vulgare.

c) A third, a young field, had as dominant species: *Ranunculus repens*, *Rumex acetosa* and *Poa annua*; secondary species: Ranunculus acer, Plantago lanceolata and Cerastium vulgare, with local patches of Holcus lanatus, Poa trivialis, Anthoxanthum and Agrostis vulgaris.

2. The Bö at the head of the Trangisvaag-fjord, Syderö; field under cultivation last year. Dominant species: *Stellaria media* and *Galeopsis tetrahit*; secondary species: Ranunculus repens, Poa trivialis, P. annua, Holcus lanatus (isolated plants), Rumex obtusifolius (only young plants with leaves), Agrostis vulgaris, Alopecurus geniculatus, also some potato plants from tubers overlooked in gathering the crop.

3. The Bö at Sjov, Strömö; field under cultivation last year. The dominant species are: *Alopecurus geniculatus*, *Poa trivialis* and *P. annua*. Stellaria media is subdominant; other species noted: Galeopsis, Bellis, Ranunculus repens, Rumex domesticus, Brassica campestris and Agrostis vulgaris.

4. The Bö at Thorshavn; potato field last year. *Stellaria media* and *Ranunculus repens* are the commonest species. Agrostis vulgaris, Rumex acetosa, R. obtusifolius, R. domesticus, Plantago lanceolata and Holcus lanatus also occurred besides a few potato plants.

5. The Bö at Klaksvig, Bordö; potato field last year. *Galeopsis, Stellaria media* and *Poa trivialis* are dominant; other species are Alopecurus geniculatus, Ranunculus repens, Holcus mollis, H. lanatus, Rumex acetosa, Poa annua and Agrostis vulgaris.

It will be evident from these examples, that the plants which are most frequently dominant, are species from the weed-vegetation, viz.: *Stellaria media, Galeopsis, Ranunculus repens, Poa annua, P. trivialis, Alopecurus geniculatus* and *Cardamine hirsuta.* All these belong to the group of plants which make their appearance as pioneers on »new land«.

The examples show further how the dominant species of the Bö formation are in process of immigration; they appear first in scattered patches (see Ex.'s 1 c. and 4), and we can imagine them covering more and more ground, and ousting the first arrivals. The younger Bö formation (e. g. Ex. 7, p. 1012) still shows the final stages of the struggle, which results invariably in the development of the typical Færöese home-field, the Bö.

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CONTENTS.

Note. In the greater part of the paper the species which produce above-ground runners have been named »epiterrean« instead of »epiterranean«, those with stolons or rhizomes in the ground »subterrean« instead of »subterranean«.

GARDENING AND TREE-PLANTING

BY

F. BÖRGESEN.

When we look back to what is written in the older literature, e. g. by Landt[1], regarding the condition of gardening in the Færöes, it cannot be denied that considerable progress has been made during the past century and that interest for horticulture and planting has been greatly awakened, especially in recent years.

So late even as 1867 when Rostrup visited the islands, the interest taken in gardening was hardly worth mentioning. After describing the *Angelica*-gardens in which the Færöese cultivate their favourite plant, *Angelica Archangelica*, Rostrup continues (l. c. p. 12): »It is only at a few places, chiefly in Thorshavn and round manses, that gardens are found with other kinds of herbs and also with shrubs and small trees, which however do not succeed in growing higher than the sheltering stone-wall or other fence which serves as protection. The trees that thrive best are various species of willow *(Salix pentandra, nigricans, alba* and *viminalis),* maple *(Acer pseudoplatanus)* and rowan *(Sorbus aucuparia* and *hybrida),* old and sturdy specimens of which were found especially in the Governor's garden in Thorshavn.«

As evidence of what care and attention can do in the way of horticulture, Rostrup speaks further of the garden laid out by the catholic priest Bauer outside Thorshavn, in which a wealth of small trees and shrubs etc. was found.

As mentioned, however, considerable interest for gardening has begun to show itself in later years and several pretty, small gardens can now be found round the houses in most of the villages.

[1] Landt, Jørgen, Forsøg til en Beskrivelse over Færøerne, Kjøbenhavn 1800. On p. 328 he writes as follows: »Gardening is quite neglected in the Færöes, it is really only the Thorshavn people who stimulated by the example of the magistrate and commandant, have become prominent for their ever increasing gardens, especially in recent years. In the country, on the other hand, a kitchen or vegetable garden is seldom seen, except some belonging to clergymen.«

A point of special interest connected with the Færöese gardens lies in this, that it is only in them that we find trees on the Færöes, the islands as is well-known having not a trace of woods or copses. Vegetation on the Færöese hills consists mainly of herbaceous plants, as also of low ericaceous shrubs, mosses and lichens; of woody plants a little larger only some few species are found growing wild. Thus *Rosa mollis* occurs at some few places on Strömö and Österö, *Salix phylicifolia* on one or two of the islands, chiefly near streams and *Juniperus communis* var. nana on Strömö, Österö, Vaagö and Svinö. In the gardens on the other hand we find quite a number of planted trees and shrubs and we can thus obtain some information as to how these stand the Færöese climate.

As the intention here is to give some details of what is cultivated in gardens, I shall first of all describe the trees and shrubs and their condition and in connection with this the possibilities of planting woods in the Færöes, then the remaining cultivated, herbaceous flowering plants and lastly the vegetables.

The laying out of gardens including the planting of trees in them was in the beginning by no means an easy matter. In the chapter »Om Skov og Forsøg med Træplantning«, Landt (l. c.) gives a detailed description of the first »experiments in sowing and planting trees and shrubs in the Færöes, but almost all with little success«. And looking at the matter more closely, this was really not surprising; for one thing, the voyage from Denmark or Norway to the islands by sailing-ship was apt to be of long duration, so that the plants which were sent off in spring often only reached their destination late in summer. Thus, the period remaining for growth that year was much shortened, to the harm of the plants, and naturally they suffered considerably likewise by their long stay on board ship. A second and more especial cause of failure was that no one had any experience whatsoever of what species were best suited to the Færöese climate, which is by no means favourable to the growth of trees. The result was naturally that most of them died within a short space of time. Landt narrates, for example, that he took with him over 30 kinds of trees and shrubs from the Botanical Gardens when he went from Copenhagen to the Færöes in 1791; but according to his own statement only a very few remained alive the next year and with exception of some willows and a few others, all the rest died one after the other in the following years. In 1793 he got a number of different trees sent

from the plantation at Frederiksberg, amongst them some fruit trees, but these also died in a short time. We can therefore scarcely go wrong in concluding that no tree-vegetation of any importance existed in the Færöese gardens at the beginning of the last century.

It was only gradually as experience was gained of what species could be successfully planted and of how the soil should be treated, that better results were obtained. The soil as a rule is

Fig. 196. *Angelica* and willows growing in Thorshavn (F. B. phot.).

very moist, often peaty and sour; it must therefore be carefully dug over, drained and if possible chalked and manured, but it can then become a very good loamy soil indeed. By carefully attending to the new-planted trees and procuring for them the best possible protection whilst at the same time keeping the soil free from the ever-present, numerous weeds, success was gradually obtained. Of older gardens with relatively large and successful tree-plantations may be mentioned those of the resident magistrate and the High School, those of the merchants Lützen and Restorf and the one already spoken of which was planted 40 years ago by Pastor Bauer on the way out to Sandegærde.

The trees most usually planted in the gardens are: rowan (*Sorbus aucuparia* and *scandica* etc.), maple *(Acer pseudoplatanus)*, further various species of willow *(Salix alba, capræa, incana,*

phylicifolia, purpurea, viminalis etc.), which are as a rule however only large bushes, and more rarely birch *(Betula odorata)*, ash *(Fraxinus excelsior)*, beech *(Fagus silvatica)*, elm *(Ulmus montana)*,

Fig. 197. Maple *(Acer pseudoplatanus)* in a garden at Thorshavn; photographed in the month of July. The dead parts of the shoots are seen over the roof of foliage (F. B. phot.).

alder *(Alnus glutinosa)* and a few others. But little planting of conifers has been done except in most recent years; yet in Thorshavn and its surroundings some few, older trees are to be found of the silver fir *(Abies pectinata)*, white spruce *(Picea alba)* and larch *(Larix decidua)*[1]; in addition to these, the common spruce

[1] I am unfortunately unable to determine whether this is the Siberian form.

(Picea excelsa), mountain pine *(Pinus montana)* and a few others have also been tried.

How do these different trees stand the raw-cold climate of the

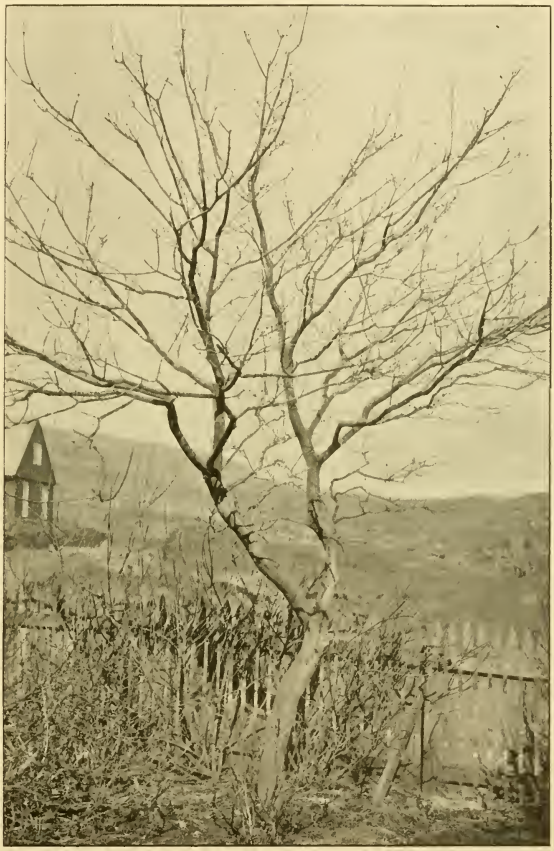

Fig. 198. Maple *(Acer pseudoplatanus* L.*)* in the High School garden at Thorshavn; photographed late in April. (F. B. phot.).

Færöes? If we examine for example a maple in summer time, we notice that a quantity of dead terminal shoots project out over the leafy covering (Fig. 197). The uppermost of the previous year's growth are

dead, the new leaf-bearing shoots arise only from their lowest buds, — a phenomenon well-known wherever the endeavour is made to transplant more southerly and more delicate species to a northerly climate not suited to them. This fact, that the shoots do not succeed in maturing and thus die far down, very probably acts most harmfully on the branching, and the leafless tree thus obtains a somewhat erratic and irregular appearance from the many short as well as bent and broken branches which appear in this way.

And as with the maple, so also with most of the other leafy trees planted, only much worse as a rule. Of the trees hitherto tried the one that seems to stand the Færöese climate best is the Scandinavian rowan; where it is placed somewhat in shelter it grows wonderfully well, which corresponds of course to its condition on our barrenest heaths; after the Scandinavian rowan comes the maple, which though it suffers a great deal yet attains a considerable growth; indeed, the largest tree on the Færöes at present is certainly a maple.

In 1898 I was at the Færöes early in spring and the trees were then not quite out, so that I had a good opportunity of observing somewhat closely how the different species had stood the winter. On April 24th I visited various gardens in Thorshavn for this purpose; of the notes taken I give the following:

Maple. The shoots of the year seem always to die far down, so that it is usually only 1 or 2 of the lowest buds which develop. In spite of this bad treatment however the tree attains comparatively speaking fairly considerable dimensions. The maple figured (fig. 198), which stands in the garden of the High School, is ca. 18½ feet high[1], the height of the trunk to the first branch is ca. 4 feet and its circumference ca. 25 inches. The age of the tree is not exactly known but is probably about 30 years. This maple, however is far from being the largest on the islands. The largest specimen is most probably that in the late Consul Hansen's garden in Frederiksvaag, Thorshavn; this measures ca. 25 feet in height, height of the trunk to the first branch ca. 8 feet and its circumference ca. 2½ feet.

Scandinavian Rowan. The tops of the shoots are in general quite undamaged. One tree in Nolsös garden in Thorshavn is

[1] The measurements of some of the trees mentioned were kindly given me by Vice-Consul O. Finsen, chemist in Thorshavn.

ca. 20 feet high, height of the trunk to the lowest branch ca. 9 feet and its circumference about 2 feet, but there are possibly still larger specimens.

Common Rowan. The ends of the shoots die somewhat far down as a rule, but there are some fairly large trees of about the same dimensions as the Scandinavian rowan; the tree is often grown up against the walls of the houses.

Elm. The shoots die at the tips. There are trees of at least 12 feet in height; but it is not much planted.

Fig. 199. Larch (*Larix decidua* Mill.) in bud. Some of the shrubs to the left and behind are beech, to the right maple. The garden was laid out about 40 years ago. The place is exposed but sheltered from the west wind by a high stone dike; yet the stems show the direction and influence of the west wind. (F. B. phot.).

Birch. The tips of the shoots die somewhat far down; only small specimens are found.

Willow. The year's shoots die far down; it remains usually only a shrub with more or less decumbent stem.

Alder. The tops of the shoots die down somewhat; one specimen measured ca. 8—9 feet.

Ash. The shoots seem to mature; only small trees have been seen (ca. 8—9 feet).

Beech. The shoots do not seem to die at the ends but they are in general short and thin; some specimens, most probably the largest on the islands, planted by Pastor Bauer about 40 years ago probably, are almost of a man's height, shrub-like and the stem below is ca. 3—4 inches in diameter (see fig. 199, where the

shrubs behind and to the left of the larch are the beeches referred to).

In addition to the leafy trees mentioned there are naturally various others which have been planted experimentally, e. g. oak, horse-chestnut, different fruit-trees etc.

Of the conifers, the larch is at present the one which reaches the greatest dimensions. Fig. 199 shows a specimen in Pastor Bauer's garden. As can be seen from the photograph, it has a right powerful, bare trunk with a broad pine-like crown; and the young larches in other gardens seemed also disposed to take the same form, due probably to the influence of the wind when the tree reaches so high as to be beyond shelter. The photograph was taken in the beginning of May and shows the tree in bud. The dimensions of the tree were: height ca. 13 feet, height of trunk ca. 5 feet and its circumference 2 feet 9 inches; another larch in the same garden is ca. 15 feet high.

A little out from Thorshavn there is a small park called »Bines Kilde«, planted in a hollow of the ground. The place lies about 120 feet above the sea but is well sheltered against the north and west winds; it was laid out ca. 40 years ago. Here in the lea of leafy trees, especially maple, some silver firs and white spruces were planted later; they were ca. 8—10 feet high, certainly among the largest found on the Færöes. Both kinds were growing strongly with about foot-long year's shoots and of a fresh green down almost to the ground.

In addition to these conifers, some Scotch pines and mountain pines have been planted in recent years round about in the gardens; e. g. some ca. 10 year old mountain pines of about 3 feet high are planted in Mr. Restorf's garden outside Thorshavn; they were growing on a somewhat exposed slope, very close together and appeared quite vigorous, but elsewhere most of the pines in the gardens looked quite pitiable except where they stood on sheltered spots[1].

A number of smaller trees and shrubs have also been planted and where the conditions are good they generally do well. Thus there are some fairly large elders up to 8 feet high; the tips of the

[1] It should be mentioned however that the reason why the young conifers generally grow so badly must at least often be ascribed to this, that the specimens planted are too large and especially have grown too quickly. These suffer greatly by the change and transport. By using plants grown on the Færöes, much better results will certainly be attained.

shoots however die far down; it is said to blossom usually but seldom bears ripe fruit. The red-berried elder is also frequently planted and thrives fairly well. Hawthorn bushes grow fairly large under the shelter of stone dikes. We frequently find also various Ribes species *(R. alpinum, sanguineum, aureum)* which grow excellently, as also the red-currant and gooseberry, both of which do well and often assume considerable dimensions, as e. g. the well-

Fig. 200. Gooseberry bushes at Elvevejen in Thorshavn. (F. B. phot.)

known gooseberry bushes at Elvevejen in Thorshavn. The red currant ripens as a rule, though this does not happen every year with the gooseberry. The black currant is seldom planted, but may sometimes ripen. Further, of garden shrubs more or less commonly planted, we find laburnum, snowberry, *Weigelia,* barbary with huge leaves and almost without thorns, *Rubus spectabilis* and *Spiræa sorbifolia* and other species, *Rosa rugosa* and other species etc. — all thriving fairly well wherever the conditions are in any way favourable. Several of these bushes often flower very richly but scarcely every year for all of them. The well-known observation that trees and bushes after a specially sunny summer blossom the more abundantly in the following year has been proved by experience to hold good also in the Færöes, and one may thus see

the phenomenon of many trees and shrubs flowering richly even in a very cold and damp summer, if only the previous summer was good, whilst conversely on the other hand sometimes but very few flowering shrubs can be found there in a good summer.

It appears from this summary of the trees and shrubs most commonly planted, that there is only a very small number in which the year's shoots generally ripen; in most these die more or less far down and the trees thus usually have the appearance of shrubs or bushes; it is only when they stand in sheltered and favourable places that they reach larger dimensions. If we now ask, what is the reason for this and more generally why there are no woods in the Færöes, the answer must certainly be, that it is due to the very damp, stormy, island climate of the Færöes and the low, but very uniform temperature throughout the year[1]. The relatively very low summer temperature in conjunction with the gray sky usually prevalent at that season, much fog, rain and but little sun cause the growth to proceed extremely slowly. The shoots of the year are still growing slowly throughout the summer, which should almost be regarded as a continued spring, and they therefore do not succeed in ripening, so that when the first touch of frost comes in autumn, it is only the very lowest parts of the shoot which are so far developed that they can stand the winter. And the relatively very high winter temperature, which with south-west winds especially may be considerable, is no less harmful to the growth of the trees. If there should be somewhat long periods of mild weather, growth may easily begin especially towards the end of winter just to be stopped abruptly by returning cold, and these changes may be repeated several times; the temperature is indeed very variable on the whole and quickly changes according to the prevalent direction of the wind.

To this must be added the extremely stormy climate; the great force of the wind, especially the powerful gusts, must be in high

[1] The average annual temperature (30 years data) is 6.5° C. In the winter months, December—March, 3.2—3.4° C. is the average temperature. The spring is cold, April with 5.5° C. and May with 7.2° C.; in June the average rises to 9.7° C. and in July and August the true summer months it reaches 10.8°; in September it sinks slowly to 9.4°, in October to 6.7° and lastly in November to 5.0°. As these figures show, the islands have a long but relatively very warm winter and a relatively short and cold summer. With regard to the climate of the Færöes, see further Willaume-Jantzen: Færöernes Klima (Geografisk Tidsskrift, 15. Bd., p. 29, and Atlanten, 2. Aarg., Nr. 21, p. 194).

degree unfavourable to any possible planting of woods. At present they are only planted under the lea of houses, cliffs, stone-walls etc. and as soon as the trees grow up to the height of the shelter their further upward growth is stopped. If for example we view Thorshavn from the sea we do not see much of trees or gardens even there; they lie hidden behind the houses, and whatever has been planted where the conditions of shelter were bad appears quite miserable. Even the Scandinavian rowan, which is a hardy, wind-resisting tree, is bent down in the direction of the wind.

As it is certain that there have been no woods on the Færöes during the present geological period, a fact witnessed to by the peaty bogs, I do not believe that it will be possible to »cover the Færöese hills with woods« on any large scale, as has sometimes been suggested in the Færöese journals within recent years. As the natural conditions at the Færöes are nearly akin to those of the Shetlands, it seems to me of interest by way of comparison to quote what Edmondston writes in the introduction (p. XVIII) to his Flora of Shetland[1]: »I do not think it probable that planting will ever become a successful occupation in Shetland«, and as the main obstacles in the way, he mentions the short duration of the summer and the early appearance of frost in autumn. During a very short visit to Shetland in 1902 I only saw some very modest plantations of maple at Lerwick; they were planted under the shelter of a stone-wall and all the shoots that reached up over this were dead. Yet some few gardens are nevertheless to be found in the neighbourhood of Lerwick, according to Feilberg[2], who visited the Færöes and Shetland in 1899. Thus on p. 88 of his pleasant description of his journey, he mentions the fine garden of the Danish Consul Hay with its (for Shetland) exceptionally large trees, ca. 10 feet high firs, maple, willow and elder, but he adds in a note: »it must be admitted, under the shelter of high walls«. On p. 63, in showing that the lack of trees is a characteristic of both groups of islands, Feilberg writes: »and the reason is probably the same at both places; the damp summer in conjunction with the mild weather of autumn and winter which occasions no stoppage in the growth; the young shoots thus without hardened woody

[1] Thomas Edmonston: A Flora of Shetland. Aberdeen 1845.

[2] P. Feilberg: Fra Lier og Fjelde. Breve til Hjemmet 1899. Trykt som Manuskript. Kjøbenhavn 1900.

substance are quite defenceless against the frequent attacks of frost in the months of spring.«

To return however to the Færöes, where according to my experience at least the trees planted are much more numerous and stronger than at Shetland, as appears also from the account given above, it will certainly be possible, where the conditions of shelter are somewhat good, to lay out small plantations here and there in the valleys and to cultivate gardens near dwellings. But this demands great care in the choosing and treatment of the soil, intelligent watching of what is planted and a prudent choice of the species of trees in order to reach a satisfactory result; and the planting of woods can scarcely ever be considered as a rennmerative undertaking.

I shall not discuss here more in detail the question of the choice of species for planting, but it must appear from the foregoing that the experiments should be made chiefly with species of rowan (especially *Sorbus scandica* and allied species), maple and a few others. It is remarkable that the birch which might well have been expected to be very suitable seems to fair right badly at the Færöes. At least we do not find it common in the gardens and in the few examples I have seen, the ends of the shoots were dead. The main reason is certainly that the birch cannot stand the mild Færöese winter.

For the rest, referring as regards the choice of species of trees to C. E. Flensborg's paper »Om Plantning paa Færöerne« (Hedeselskabets Tidsskrift, 23. Aarg. 1903, p. 82), I should like just to mention in this connection, that it might be worth while possibly to experiment with some of the Tierra del Fuego trees. On studying for example the summary tables given by C. Skottsberg[1] of the average temperature there in the different months, it cannot be denied, that the resemblance with the Færöes is very great, and not only as regards temperature but also in the heavy rainfall and the gray, cloudy sky. In Tierra del Fuego, as is well-known[2], we find quite a flourishing and partly evergreen forest vegetation consisting of two species of beeches, *Nathofagus antartica* and *N. betuloides*, and two other trees *Drimys Winteri* and *Maytenus magellanica*.

[1] C. Skottsberg: On the zonal distribution of south Atlantic and antartic vegetation (The Geographical Journal for December 1904).

[2] vide Skottsberg: Some remarks upon the geographical distribution of vegetation in the colder southern Hemisphere (»Ymer«, 1905).

It would be extremely interesting to experiment with these trees in the Færöes. Whether a satisfactory result would be obtained is however far from being certain beforehand, as in addition to the temperature and dampness there is also another very essential factor, to be considered, namely, the influence of the wind on vegetation. The Falkland Islands, for example, where the climate is likewise very similar to that of the Færöes, are quite without woods,

Fig. 201. Flower garden at the manse in Kvivig. *Polygonum Bistorta, Digraphis arundinacea, Geranium, Iris, Lilium* etc, (F. B. phot.).

and the principal reason for this is stated by Skottsberg to be the exceedingly strong, south-west wind which blows continually. And in describing the vegetation of Tierra del Fuego he writes (»Ymer«, l. c., p. 421): »In some places near the sea and exposed to the terrible wind, as the peninsula near Ushuaia, Gable Islands etc., I saw a formation of boggy grassland . . . .«, that is, no forest there. The many and strong winds of the Færöes will certainly place great obstacles in the way of all planting of trees and it is assuredly due not least to the wind's influence that there are no trees on the islands.

Some years ago a piece of ground in the neighbourhood of Thorshavn was enclosed for the purpose of forming a plantation

and a number of different leafy trees and conifers were even planted; but lack of attention and on the whole lack of interest in the matter caused this first attempt to be quite a failure. The fence had partly fallen so that sheep could easily wander in and they had thus nibbled off most of the shoots, and the last year (1902) I visited the place there were only some few stumps remaining. I have only mentioned this case in order to emphasize again, that a good result can scarcely be attained without warm interest in the matter and constant attention. It is just the neighbourhood of Thorshavn which may, I believe, be considered as amongst the best ground for planting, and now that an application has been made to our »Hedeselskab« from the Færöese side and planting has begun there, there will certainly be forthcoming under expert guidance as good results as the Færöese climate permits.

Turning now to the herbaceous, flowering plants we find a number in the Færöese gardens and many thrive quite excellently. Only some of the commonest need be mentioned here.

First of all, to mention some of the perennial plants, we find: *Aconitum Napellus,* several species of anemones, *Aquilegia vulgaris, Armeria, Astrantia major,* auriculas, daisies with large flowers, *Betonica, Campanula, Centaurea montana, Dianthus plumarius semperflorens, Digitalis purpurea, Hesperis matronalis, Holeja japonica, Phlox decussata, Polygonum Bistorta* and *cuspidatum, Potentilla, Primula, Ranunculus aconitifolius, Spiræa*-species, *Symphytum officinale, Trollius europæus, Veronica spicata* and several others.

As borders to the garden-beds are often used *Primula grandiflora* and *Saxifraga umbrosa.* We also find several species of *Iris,* daffodils and narcissi, *Crocus,* hyacinths and tulips etc. In well cared-for gardens, where these plants are grown in any way sheltered places, they all succeed remarkably well and often present a very rich and lasting show of flowers, as the cool damp air with little sun aid greatly in preserving the blossoms. These are also often of very large size.

Also a number of annual summer plants are naturally tried and many of them thrive very well and flower richly in the summer months. Among these may especially be mentioned: *Acroclinum roseum, Bartonia aurea, Calendula officinalis, Carduus marianus, Centaurea Cyanus, Chrysanthemum, Convolvulus, Eschscholtzia californica, Entoca viscida, Gypsophila paniculata, Malope grandiflora, Nemophila, Nigella damascena, Nolana, Papaver, Reseda odorata,*

Saponaria, *Schizanthus* and *Tagetes erecta*. Some species as Asters, *Godetia* etc. are more difficult and thrive only in warm summers.

Finally, we may glance at the vegetables of the kitchen garden; experiments have also been made with several of these with as might be expected varying results, as the quality is naturally very much conditioned each year by the nature of the summer.

Fig. 202. A man laying potatoes (F. B. phot.).

The information I have comes chiefly from Thorshavn and from Sands Præstegaard (Todnæs) on Sandö. At the latter a number of vegetables have succeeded excellently, which must be ascribed in part to the good situation in a broad valley opening to the south and the good soil. Here for example the cauliflower grows well as a rule with quite large heads, red cabbage may be good if with small heads, on the other hand common cabbage but seldom opens and thus like savoy is not generally successful. Green cabbage grows remarkably well. Chervil and parsley do well and beetroot may be quite large, though not every year. Carrots grow excellently. Spinach is cultivated with varying success, sometimes it is quite good, as a rule the leaves and the plant as a whole

remain but small and it soon runs to seed; on the other hand the New Zealand spinach *(Tetragonia expansa)* thrives excellently. Here as everywhere in the island radishes do remarkably well and are to be had during the whole summer. Rhubarb which is also grown in most of the districts has quite good, large stalks. Horse-radish is also good. Turnips thrive well and sorrel grows to good size. On the other hand root-celery is not very successful, the tubers being no larger than walnuts, and leeks are grown but they are thin. Peas might do well but are seldom seen.

Almost the same vegetables have been tried in Thorshavn and they have all succeeded well there, though the somewhat less favourable conditions have made their influence felt. From information kindly given me by Consul Lützen in Thorshavn, I take the following notes. Cauliflower sown in pots in February and planted out later grow heads as large as a closed fist. Brussels sprouts are not successful. The cabbage may begin to form heads but does not come to anything. On the other hand green cabbage does excellently. Beans are seldom sown and hardly ever come to anything. Broad beans *(Faba vulgaris)* grow well. Radishes thrive well and may be ready in the beginning of June. I have seen strawberries in a few gardens; they sometimes give ripe fruit. From information most kindly sent me by Mr. Dione Isakssen of Thorshavn, who deserves much credit for the progress of horticulture in the Færöes in recent years, I may also mention that lettuce is cultivated and thrives well. Root celery was tried by Lagtingsmand Degn with somewhat good results and celery is common and grows excellently. »As to spinach, I may say that it has been for me one of the easiest plants to grow and has never failed.«

Lastly, I may say a few words concerning the potato-culture. It is true that the potatoes are generally grown in fields and in large quantities, so that they should rightly be considered under agriculture, but they are also grown in the gardens and in any case the method of cultivation is quite suited to gardens. Before the cultivation of potatoes the ground has as a rule been used for grass, and the same piece of ground is often used two or three years in succession for the potato-growing. As shown in the accompanying picture the ground is treated very carefully, furrows ca. 9 inches deep are made with ca. 2 feet between each furrow. In these some old manure is first laid and then on the top of this

the potatoes, in which when planted the eyes and shoots are large. If the weather permits, planting begins in the second half of April, but if the weather is unfavourable planting is sometimes postponed until towards the end of May. The early sorts are mostly used and if planted at the end of April or beginning of May, they are ready to be taken up in August and in good summers sometimes the lifting begins at the end of July. Late potatoes are not successful, but on the other hand intermediate sorts do well if the summer is good. The quality is however rather poor; but if the potatoes are planted on sandy soil as on Sand, Kvalbö and at a few other places they become firm, mealy and well-tasting; for the rest, all depends upon whether the summer is dry or damp.

SOME NOTES ON THE AGRICULTURE OF THE FÆRÖES

BY

P. FEILBERG.

In the town hall at Lerwich in Shetland there are some excellent paintings on glass depicting scenes of the landing of Harald Haarfager at Haraldswick about A. D. 870, when the proud Norse Sea-King conquered the Shetland and the Orkney Islands and a part of Scotland, the memory of which conquest is still perpetuated in the Scandinavian origin of many of the names of the places. These islands, together with the Færöes, belonged to Norway and afterwards to Denmark until by the marriage-settlement of Sept. 8, 1468, between James III of Scotland and the Danish princess Margrethe, daughter of Christian I, they were given in pledge as her dowry — a pledge which was never redeemed.

Thus, during 600 years, these two groups of islands, the Færöes and the Shetlands, groups which are of about the same size[1], belonged collectively to the Scandinavian crown, and it is of interest to note how their development, especially with regard to agriculture, during the 400 years which have elapsed since the separation, has been influenced by the different conditions under which the inhabitants have been living.

Nature works, when left to her own devices, on the basis of soil and climate only; but, by awakening culture, a new factor is added, the utilisation of natural advantages through labour and intelligence, a factor which is very different in the different parts of the world and is governed by numerous circumstances which can only approximately be summed up.

The inhabitants of the Færöes are fishermen in a still greater degree than are those of the Shetlands, and in the former islands the interests attached to the fisheries are to the agricultural interests

[1] The Shetland Islands about 1475 square kilometres; the Færöes about 1325 square kilometres.

as 3 to 1. But the »fishing-line« and the »spade« have always been antagonistic; they will always require different qualities in their respective users — so different that clever fishermen are generally bad farmers, and vice-versâ. Now the people of the Færöes have made very rapid progress, especially during the last twenty years, in all departments concerned with the utilisation of the abundance of fish contained in the sea; consequently it is not astonishing that the agricultural development of the country has been somewhat slow, but this is unwise, because here, as is the case in the Shetland Islands agriculture ought to afford good support to the leading industry of the islands, namely the fisheries (Sandö and the environs of Thorshavn may be mentioned as exceptions; the conditions favourable to the development of agriculture, which exist in the former place have proved that clever fishermen can also be good farmers; and in the latter place the agricultural products are sold at very high prices owing to the fact that good means of transport have been established). As is well-known, fishing cannot be carried on successfully at all seasons of the year, nor by people of all ages; consequently, wherever fishing is the sole employment of the inhabitants, much time and much energy will be wasted which might have been employed very advantageously in turning to account the productive qualities of the soil, which in the Færöes, in spite of the northern position of the islands, and, of their mighty rock formations[1] — mighty in comparison with the Shetland Islands — show as great power of grass-production as those of the latter islands.

With respect to the season of growth the summary of the amount of rainfall and of heat shows the following figures in regard to the Shetlands: —

	April	May	June	July	August	September
Mean heat.....	5·9° C.	7·9° C.	10·7° C.	11·9° C.	12·1° C.	10·6° C.
Mean rainfall mm..	50	40	39	59	83	79

The corresponding figures for Thorshavn (The Færöes) are: —[2]

Mean heat.....	5·5° C.	7·2° C.	9·7° C.	10·8° C.	10·8° C.	9·4° C.
Mean rainfall mm..	93	88	77	87	100	134

As may be seen, the heat is somewhat less and the rainfall much greater in the Færöes than in the Shetlands; the rich peaty

[1] The highest point in the Færöes is Slattaretind: 882 metres. The highest point in the Shetlands is Roenshill: 441 metres.

[2] See Willaume Jantzen, Færöernes Klima: Atlanten, 1905, p. 194.

formation which covers large areas in the group of islands is much thicker in the Shetlands than in the Færöes.

The peculiar barren moorland which occurs as the last link in the Scotch and Shetland Highland-formation, is only slightly represented in the Færöes, but the picture which meets the eye most frequently is that of high plateaux torn up by storms and covered by gravel and stones, here and there interrupted, however, by green hill-slopes covered by a fairly rich vegetation of grasses, Cyperaceæ, and other plants[1].

The naturally-formed permanent pasture land, the grassy slopes and the meadows of the Færöes constitute the wealth of the islands; better cannot be found in the Shetlands, while that of Iceland is far from being as good, and only in Western Norway may similar pastures sometimes be met with; but it is peculiar to them all that the grasses and other fodder plants which occur in them are often highly nutritious, this is for instance the case with *Juncus squarrosus,* which plays the same rôle in the Færöes[2], as the small *Elyna Bellardi* in Iceland; while *Aira cæspitosa*, a species of grass af very little importance in southern latitudes, becomes a valuable fodder plant towards the north. The following analysis from Iceland[3] may serve as an example: —

Contents when destitute of water	Hay from Iceland			Common hay from Denmark Average Percentage
	Achilliæa millefolium Percentage	Aira cæspitosa Percentage	Dry meadows Percentage	
Nitrogenous matter..... ...	10·94	11·85	12·50	9·21
Fat	4·05	3·53	3·32	1·89

Grasses, Cyperaceæ, rushes, and a few leguminous plants form the main part of the vegetation of economic importance, the latter has been fully and satisfactorily described by C. H. Ostenfeld in his paper The Land-Vegetation of the Færöes, under »The moor formation« (p. 947); »The grass-slope formation« (p. 962); and »Formations in the cultivated Area« (p. 1005); of which »The Bö formation (Grass meadow)« (p. 1008) should especially be noted. In the above-mentioned places all those peculiarities pertaining to the vegetation which are useful to agriculture have been

[1] See Botany of the Færöes, p. 33.

[2] See The flora of the Færöes, p. 41, in the earlier part of this book.

[3] See Tidsskr. f. Landokonomi 1898: P. Feilberg, Islands Fremskridt.

so thoroughly accounted for that it is unnessary to do it here; I shall only add that in uncultivated places the sour peaty soil is generally that which is predominant and which gives the vegetation its own stamp, but here the same peculiarity may be noticed as in the enclosed fields (tun[1]) in Iceland, that good drainage and ample manure convert the naturally sour, peaty soil into really good mould, which is able to yield very satisfactory crops of our common species of grass; of these, however, *Dactylis* and *Lolium* occur more rarely, while, as mentioned above *Agrostis* is very common and *Poa pratensis, Holcus lanatus, H. mollis, Anthoxanthum*, and *Festuca* species are of frequent occurrence, as also *Trifolium repens.*

Freshly sown pastures generally consist of species of grass, amongst which *Agrostis* is the most conspicuous; and not until the surface of the soil in the course of time has become somewhat hardened does a greater variety of species occur, and where the existing conditions — a somewhat ample supply of inorganic nutritive substances — permit, the main vegetation, as is the case in the marshes, consists of *Trifolium repens.* While the naturally formed pastures are very valuable, the cultivated land, owing to the lonely situation of the Færöes, their decidedly rocky character, and their scanty inhabitants, is not of much importance and consists of only three per cent. of the entire area of the islands, as against 27 per cent. in Shetland. A noteworthy peculiarity is, that from the time at which both the groups of islands belonged to the Danish crown, the division into »Marks« has been retained as a basis for the assessment of taxes: these being in the Shetland Islands 14000 »Marks«, in the Færöes 2400 »Marks« or only about one sixth part, which doubtless corresponds with their different value, occasioned by the more southern position of the Shetland Islands, their more uniform surface, and their closer proximity to the mainland.

The description we have of the latter islands from 1839[2] shows that the Shetlands of that time agree, in many points, with the Færöes of to-day: no roads; only a relatively rare connection with the surrounding world; meagre instruction for the young, etc.

[1] »Tun« in Iceland is the enclosed fields which has been manured, as »Böen« in the Færöes.

[2] Reminiscences of a voyage to Shetland, Orkney and Scotland by Christian Ployen. Monson Lerwick, 1898.

Agricutural development, considered in all its aspects, is connected with intellectual development, and as regards this latter the Shetlands have made very great progress during the last fifty years by the fact of their being closely connected with Scotland, e. g. through the same kind of schools, while in the Færöes circumstances have for various reasons been less favourable to a corresponding progress. But on the other hand the inhabitants of the latter islands have been leading a more independent life and have thereby preserved peculiarities and possibilities of development, which have disappeared under the prevailing feudal system in Scotland, where the large landed proprietors and rich merchants have gradually bought up almost all land, and turned the former class of »udalers« into tenants under landlords, who, from the time of Patrick Stuart († 1615) have been aiming at the abolition of all the allodial lands — a system of land-tenure which originated from Norway[1], and which exists to this day in the Færöes.

As an advantage of the landed-proprietor system may be mentioned the fact that a number of improvements as regards external circumstances, the accomplishment of which requires power and funds, are able to be carried out; for example in the Shetlands, roads have been made, harbours built, good houses erected, etc.; but its less advantageous aspect is, that it often results in the inhabitants becoming oppressed and dependent, which has also been the case in the Shetlands until our own time, when The Crofters Commission (1886) began its excellent work, and which has placed the inhabitants of the Shetlands below those of the Færöes in regard to manly and independent development.

It is also a noticeable fact that while the population of Shetland has diminished in number during the last generation, that of the Færöes has increased considerably.

All these circumstances should be taken into consideration when discussing the agriculture of the Færöes. The natural conditions for the development of agriculture, as also the social conditions under which the work of civilisation is carried on, are both of equal importance to the production of agricultural results.

[1] Shetland by Robert Cowie, Aberdeen, 1896.

The Distribution of Property.

As mentioned above, the cultivated area of the Færöes consists only of a small fraction of their surface. Before the new assessment of 1899 had been introduced, which is based on a preceding valuation of the entire landed property of the islands at 425,874 taxation »Marks« or normal »Marks« (each taxation »Mark« assessed at 1000 Kroner), the enclosed fields (Böen) only were registered, and according to the old registration, to each »Mark« belonged as an inseparable appendix, a field (Hauge[1]) outside the enclosed field; a corresponding share in the cliffs inhabited by sea-fowls belonging to the town; a share in that part (one-fourth) of the captured Caaing Whales and other whales which was the due of the land belonging to the town in question, and other manorial rights and privileges belonging to the landed property.

The value of these old »Marks« varies somewhat, and they do not contain any fixed acreage but the size of a »Mark« belonging to an enclosure may on an average be reckoned at about one hectare. To the largest town belong 97 old »Marks«, to the smallest 4; there are in all 90 towns. The fields outside the enclosures, as also the flocks of sheep grazing on them, are in many places the joint property of the people, which can result in very peculiar circumstances; such as that the flock belonging to a field like the above, and consisting of, say, 400 sheep may be the joint property of 40 persons, of which one may possess $^1/_6$ to $^1/_8$ and another $^1/_{384}$ part of the flock.

The enclosed fields are as yet almost everywhere divided according to the »runrig«[2] system, so that an owner may have a number of small plots of land far distant from each other; but here a change is in contemplation, that of a division of the land, which is a condition of primary importance for the possibility of introducing an improved state of cultivation.

About one-half of all the properties belongs to the State which, for a cheap rent, gives them, as a heritable lease to the farmer; and conditions are more favourable as regards these properties than as regards allodial land, although here also the joint use of the fields outside the enclosures (the scatholds) and the division of the enclosed fields into small plots may often occasion inconveniences.

[1] The Færöese »Hauge« answers to the »scathold« of Scotland.

[2] In the Shetland Islands and in Scotland this in the name for the dividing of the lands in cases where no parcelling out has taken place.

The Utilisation of the Soil.

The raising of cereals (barley) was formerly of greater importance than is now the case, as owing to the improved means of conveyance cheap supplies may now be had from other places. The following is the mode of cultivation[1]: — Towards spring, by means of the peculiar Færöese spade, the turf is loosened on the piece of ground intended for the cultivation of cereal crops; the slices which have been loosened are from 1 to 3 feet square and 3 inches thick. The manure, which consists of sea-weed or of cattle-manure, is then carried to the land in question either by men or by horses, in two baskets made specially for the purpose and placed on a pack-saddle. When the manure has been scattered under the turf and the latter has been turned with the grassy side downwards, the soil is ready for sowing, which generally begins after April 14th. When sowing is over the more or less tough slices of turf are by means of a light spade cut into fairly small pieces. Then the soil is flattened with a wooden board devised specially for the purpose, and it is then quite prepared — it is both harrowed and rolled! Where this mode of cultivation is applied, trenches, some 6 to 9 inches deep, are dug at intervals of 12 feet. On account of the late ripening, the grain is dried in the so-called »Sodnhuse«[2] after the ears have been pulled off by an iron comb. At present about 800 acres of land are supposed to be under cereal cultivation.

The hay-crop is of the greatest importance to the agriculture of the Færöes; and there is about 120,000 cwt. of hay produced yearly per 8000 acres, or on an average about 15 cwt. per acre. Where the drainage is good and the land is well-manured the yield may reach 20, 30, or 40 cwt. per acre. The value of the crop is however often somewhat diminished partly because the grass is allowed to become over-ripe before it is cut, and partly on account of the frequent and prolonged periods of rain which do not permit the grass to dry.

Potato and root-crops give a fairly good yield per 300 or 400 acres, and there are instances of a crop of 500 bushels of potatoes per acre; but even if the potato-crops on an average yielded only

[1] Landbruget og Husdyrbruget paa Færøerne af Landbrugskonsulent Effersø. København, 1886.

[2] Houses in which grain is dried artificially (in an oven).

half as much as that, it may be said that the cultivation of them, more than of anything else, is of importance to the small tenant because even the poorest can always get a piece of ground upon which to cultivate the potatoes needed for himself and his family — often on a rocky flat which is thereby brought under cultivation for the first time. Roots-crops are too little grown to be of importance, and in this particular the Færöes are far behind the Shetland Islands, where in 1898 root-crops covered 4900 acres of land.

Where during late years, some progress may be noticed as regards these departments, it is in a great measure due to the work done by the consulting agriculturist appointed by government[1] who goes from town to town and assists the people by advice and practical help to a better utilisation of the soil and of the live stock. His efforts, however, have been unable to lessen the drawbacks occasioned by the large parcelling out of the allodial land; when a man has his property scattered in from 50 to 100 different places good drainage is difficult to carry out, though the latter is an essential condition of cultivation in the Færöes, on account of the humidity of the climate; also the small lots into which the properties are divided prevent the use of draught animals.

Domestic Animals.

The Færöese horned cattle are mountain cattle, but not of any especially decided character; alive, they weigh from 400 to 500 English pounds, and the average amount of milk yielded by each cow hardly exceeds 200 gallons a year. Their chief fodder is hay from the enclosed fields, but the supply of food during winter as well as the arrangement of the cow-sheds are very deficient. During the summer the food may be fairly good, but great want is felt of the excellent, fenced-in pastures which are to be found in the Shetlands and which permit regular feeding. The cows, about 3000 in number, generally graze during summer in that part of the outside fields (the scatholds) which is nearest to the town. In several places, during the greater part of the time from Oct. 15th to the end of November, cows are allowed to graze untethered in enclosed fields. The milk is rich, and the production of butter might be increased considerably so that the importation of butter and margarine, which is now extensive, might be rendered

[1] R. B. Efferso, who has obtained part of his agricultural training in Scotland.

unnecessary. Cattle are bred mainly for the sake of the milk. Meat production and fattening — as in the Shetlands — are not of much importance. In a few places, however, e. g. at Myggenæsholm, where the pastures are particularly rich, a bullock may produce 500 pounds of meat and 70 pounds of tallow.

The Færöese sheep is of peculiar appearance; it somewhat resembles the Iceland sheep, and has like the latter a short tail. In colder and more exposed districts the hairs are long and the wool fine; the reverse is the case in milder districts. During summer the sheep graze in outside fields (the scatholds); in the hot season, after midsummer, far up on the hills; in the other seasons of the year in the low-lying regions; from Oct. 25th to May 14th they are allowed to seek their food in the enclosures belonging to the scatholds in question; especially in early spring they resort to the enclosures to strengthen themselves with the fresh, shooting grass, which they may well need after their scanty winter fare! But as may easily be understood the hay-crop of the enclosed fields does not increase in quantity by the first shoots of the grass being thus bitten off!

The total number of live stock as regards the Færöes and the Shetlands was in 1898 as follows: —

	The Shetlands[1]	The Færöes
Sheep	98,150	106,465
Horned Cattle	19,219	4,516
Horses	5,712	706
Pigs	2,895	

Thus the number of sheep in the Færöes as in the Shetlands consists usually of about 100,000. But fattening is not carried on systematically in the former as is the case in the latter islands, though it would doubtless be of importance in some places.

It is usual for the flocks to be out all the year round, and during winter considerable losses are often sustained during continuous rain and gales, as the sheep are generally left to find food for themselves as best they can; in only a few districts do they get a supply of hay, a provision which ought to be more widely made as it would heighten the security of the flocks and increase the profits of sheepfarming; at present it is chiefly the wool and the

[1] Agricultural Returns, 1898.

lambs for the market that are of value; of the latter about 30,000 are produced yearly at a value of 7 to 8 shillings per head.

The sheep are not shorn, but the wool is torn off, this is necessitated by the fact that the wool is in itself so short that even so slight an extra shortening as would be occasioned by the shearing would lessen its value considerably; besides, the sheep would die of cold if the shearing took place before they began to shed their coat. Many attempts at improvements by »black face« and other kinds have been made, but hitherto no better results have been arrived at, than those attained by the local breeds, which on the whole are excellently adapted to the climate and to the prevailing conditions; only it is to be regretted that their number is so large that there is not an edequate supply of food for them during winter so that when spring comes they are weakened and losses are consequently inevitable.

As may be seen from the above table there are only a few horses in the Færöes; roads being very rare, they are not much used and are of rather poor quality; but here also attempts at improvement are being made by means of Norse stallions of the seaside breed. During summer the horses graze in the outside fields; in some few places they are kept in stables during winter, in others they go loose in the enclosed fields and shift for themselves.

Production and Sale.

The gross returns of the agriculture may be valued at about one million Kroner (one third of the amount being the result of sheep rearing) of which, however, a small precentage only is possibly converted into cash. The fisheries yield about 3 million, of which the greater part may be reckoned as net profit. There is no doubt whatever that agriculture, which, as mentioned above, has lately been neglected somewhat on account of the great development of the fisheries, deserves to be helped forward both by the government and by the inhabitants, as it would be an excellent supplement to the other means of livelihood of the islanders.

The greatest obstacles in the way of improvements in regard to the departments mentioned above are the disadvantageous cir-

cumstances pertaining to property and the deficient education of the people; the former may be remedied in time; but there are great difficulties in regard to the latter, on account of the lonely situation of the Færöes and the peculiarities of the language. The people of the Færöes do not speak modern Danish, but an Old Norse dialect; but Danish is the language of the churches, law-courts and schools.

FIELD-NOTES ON THE BIOLOGY OF SOME OF THE FLOWERS OF THE FÆRÖES

BY

EUG. WARMING.

HITHERTO no notes on the flower-biology of the Færöes have been published. While staying there in 1897 there were so many other things which claimed my attention, that I had very little opportunity of making notes upon the subject; the greater number of those made by me are from Trangisvaag on Syderö. But although the notes are scanty I have thought it better to give them in the following pages as an initial, although small, introduction to a study which undoubtedly especially deserves to be carried on exhaustively and through a longer period. As may be seen from the list of the insect-fauna of the Færöes which forms the appendix to the present paper, that fauna presents certain very remarkable features, viz. the absence of diurnal *Lepidoptera* (for the solitary individual mentioned, as well as another which is reported to have been observed, was probably accidentally introduced at a recent date); or again the great scarcity of bees and humble-bees. What significance these facts have with regard to the fertilisation of the flowers and the seed-production of the plants are questions which must be answered in the future; with regard to both points many observations are still wanting.

The plants are mentioned in alphabetical order.

Alectorolophus minor (Ehrh.) Wimm. et Grab. — Fl. p. 51.[1] — In rainy weather (Trangisvaag, July 25) the stigma was seen to be situated just within the entrance to the upper lip, and the anthers below. Pollen could be found on the edges of the upper lip, and the stigma might be seen to touch the anthers with its underside and to be covered with quantities of pollen; consequently, spontaneous self-pollination occurs.

[1] Reference is made throughout to Ostenfeld's Phan., Bot. of the Færöes, vol. I.

Alsine verna Bartl. var. **hirta** (Wormsk.) Lge. — Fl. p. 59. — In the closed flower the reddish anthers were situated in the throat, just above the stigmas. (Trangisvaag, July 27).

Alchimilla alpina L. — Fl. p. 76. — (Trangisvaag, July). The yellowish-green flowers are about $2^1/_2$ mm. in diam. They appear to be somewhat protandrous; at any rate the stigma is still well within the flower at a time when the anthers begin to dehisce. The stamens are always erect and the anthers are remote from the stigma.

Alchimilla faeroënsis (Lge.) Buser. — Fl. p. 76. — (Trangisvaag, July 16). The flowers are somewhat larger than those of *A. alpina*; they measure across as much as 5 mm.; they seemed to be protandrous, and the pollen-grains appeared to be normal.

Angelica silvestris L. — Fl. p. 79. — (Trangisvaag, Viderejde, Kvalbö). The flowers are white, and have a rather pleasant scent. They are visited by numerous flies (*Aricia variabilis, Hilara chorica, Scatophaga litorea*, *Fucellia fucorum*), and a moth. The flowers appear to be only slightly protandrous or else homogamous.

Arabis petraea (L.) Lam. — Fl. p. 66. — (Trangisvaag, July 16). Homogamous. Spontaneous self-fertilisation can take place only with difficulty, because the anthers stand below the stigma. Even very early the style was seen to protrude beyond the flower, and the stigma to be thus placed a little above the anthers. The flower was 6—8 mm. in diameter.

Armeria elongata (Hoffm.) Koch. — Fl. p. 50. — (Trangisvaag, July). The flowers are homogamous or slightly protandrous. In the earlier stages of flowering, the stamens are spread out, almost touching the corolla, and the styles also spread widely, but they alternate with the stamens. The small stigmas occur at the same height as the anthers, but spontaneous self-pollination can at this stage take place only with great difficulty. In older flowers the stamens are twisted, and bend inwards towards the middle of the flower, between the twisted styles; spontaneous self-pollination is then possible.

Bellis perennis L. — Fl. p. 44. — In dense fog the capitula are closed.

Brunella vulgaris L. — Fl. p. 47. — (Trangisvaag). The pollen is protected from rain. The anthers containing the white pollen

stand around the stigma, and ripen a short time before it. Homogamy also occurs. Spontaneous self-pollination takes place.

Cakile maritima Scop. var. **latifolia** (Poir.). — Fl. p. 66. — (Kvalbö, July). Has a delicious perfume, which recalls that of vanilla. The anthers of the longer stamens turn laterally towards the shorter stamens at an early stage; they are all above the stigma. Spontaneous self-pollination may easily take place. Usually all the flowers set fruit.

Caltha palustris L. — Fl. p. 74. — (Frodebö on Syderö, July 19). The flower is 32—40 mm. in diameter. Drops of honey may be seen upon the bases of the ovaries. The flowers are visited by flies. At Trangisvaag, Mykledal and Kvannesund (Aug. 5) the specimens were usually found fruiting.

Cardamine pratensis L. — Fl. p. 66. — (Trangisvaag, July). The flower reaches a diameter of 21 mm. It is homogamous. The anthers of the longer stamens are above or on the same level as the stigma; they turn very decidedly towards the shorter stamens, so that it would appear to be difficult for their pollen to be transferred to the stigma. The anthers of the shorter are situated below the stigma, or their upper ends may stand on a level with the latter, in which case contact with the latter transfers pollen to it.

Cardamine hirsuta L. — Fl. p. 66. — (Trangisvaag, July). Spontaneous self-pollination is inevitable, and every flower sets fruit. The stigma protrudes from the bud. In recently expanded flowers, of which the petals are still fairly erect, the longer stamens are bent inwards and the anthers, which are open, are standing above the ripe stigma; the anthers of the shorter stamens are not yet open. Later on, the shorter stamens grow up and the stigma is carried up among the anthers of the longer stamens.

Cerastium Edmondstonii (Wats.) Murb. et Ostenf. — Fl. p. 60. — (Trangisvaag, July; Fuglö, Aug.). Appears to be homogamous or slightly protandrous. Spontaneous self-pollination occurs. The flowers set ripe fruit.

Cerastium vulgare Hartm. — Fl. p. 61. — (Trangisvaag, July). Homogamy or slight protandry. The antisepalous stamens, while the petals are as yet standing erect and the diameter of the flower is only 4 mm., begin to bend inwards towards the middle of the flower, and finally lie close to the stigmas, which even at that

time can retain the pollen, or soon become able to do so. Then the antipetalous stamens perform similar movements, and their anthers open before those of the antisepalous stamens have been emptied of their pollen.

Cirsium palustre (L.) Scop. — Fl. p. 44. — (Frodebö on Syderö, July). Protandry, as is usual in the Compositæ.

Cochlearia officinalis L. — Fl. p. 67. — (Trangisvaag, July; Lervik, Aug.). The diameter of the flower is at first only about 5 mm., and the petals are erect; the anthers are open, and by the curving of their filaments are placed above the stigma, which appears to be ripe. Afterwards the stamens spread out and the anthers are thus removed from the stigma. The diameter of the flower is then as much as 10 mm. Spontaneous self-pollination, by direct contact of the anthers and stigma, has not been observed to occur. All the flowers set fruit, and many germinating plants may be found.

Empetrum nigrum L. — Fl. p. 68. — Ripe fruit in August, at Kvannesund.

Epilobium lactiflorum Hausskn. — Fl. p. 69. — (Trangisvaag). The snow-white flowers have erectly-spreading petals; they are homogamous. The anthers of the longer stamens are pressed close to the stigma, to which they transfer pollen and into which pollen-tubes(?) are put from them. The anthers of the shorter stamens are situated below the stigma. The flowers set ripe fruit.

Epilobium montanum L. — Fl. p. 70. — (Trangisvaag, July). Homogamy or slight protogyny. Spontaneous self-pollination takes place by the anthers of the longer stamens touching the stigmas. The anthers of the shorter antipetalous stamens stand at the level of the stigma or slightly below it, and they also can shed pollen upon it. Much pollen may be found upon the stigma, especially its underside, and the anthers may adhere to it. Large, red winter-buds are developed as early as August 1st.

Epilobium palustre L. — Fl. p. 70. — (Trangisvaag, July; Lervik, Aug.). Homogamy and spontaneous self-pollination. The white anthers adhere to the white stigma.

Erica cinerea L. — Fl. p. 46. — (Trangisvaag, July; Thorshavn, Aug.). The flower is deeper red in colour than that of Calluna and Erica Tetralix. The pores of the anthers are formed even in the bud, and just before the anthers dehisce the pollen already

lies loose in them. The stigma appears to be ripe at that time and spontaneous self-pollination would have been possible if the pollen had been dry enough to fall out, but this does not appear to be the case. In a recently expanded flower with a still very narrow throat, the stigma occupies the mouth and is able to retain the pollen. In a somewhat more open flower, the stigma protrudes farther, and the pollen can be seen scattered in the interior of the corolla. The flower contains much honey. In a still further expanded flower the viscid stigma protrudes about one mm. beyond the throat towards the upper side of the flower. The stamens can be seen further down. The flower appears, therefore, to be very slightly protogynous. Some corollas are found which have been bitten by insects.

Euphrasia borealis (Towns.) Wettst. — Fl. p. 56. — (Trangisvaag, July). Large-flowered. The upper lip is lilac in colour, with 4—6 darker, purple-coloured stripes; the lower lip is whitish, with a yellow spot and a few dark purple stripes. Even in very young, scarcely-expanded flowers, the style protrudes and carries the stigma forward, well before the throat of the corolla. The anthers stand behind the stigma. There is scarcely a distance of $1^1/_2$ mm. between the stigma and the underlip. Even in the bud the pollen-grains lie loose in the anthers and may easily be removed. In older, widely open flowers the anthers have separated from each other and the style was found pushed to one side, perhaps by insect-visitors; these, however, have not been observed. The plant sets fruit.

Euphrasia scotica Wettst. — Fl. p. 56. — (Trangisvaag). Small-flowered. Appears to resemble the preceding in all essential characters.

Fragaria vesca L. The fruit ripens readily on Vaagö.

Galeopsis Tetrahit L. — Fl. p. 48. — (Trangisvaag, July). Flowers rose-red with a glaring yellow and purple-coloured spot on lower lip. They are homogamous; they vary somewhat in size. In the smaller flowers the stigma is situated between the lower anthers, and in the larger flowers it is on a level with the higher anthers or even above them.

Galium saxatile L. — Fl. p. 51. — Protandrous, with the stamens at first curved somewhat inwards, afterwards turned outwards. Direct contact of anthers and stigma has not been observed. The plant sets fruit abundantly.

Geranium silvaticum L. — Fl. p. 68. — (Trangisvaag, July). Protandrous. In its first stage the flower is about 20—22 mm. in diameter, the petals stand erectly, and the styles are not expanded; later on the diameter increases to about 24 mm., and the styles elongate, but do not yet spread, and the anthers are turned outwards. The antisepalous stamens are the first to ripen. Some of the antipetalous stamens are sterile.

Habenaria viridis (L.) R. Br. — Fl. p. 93. — (Trangisvaag, July). The symmetry of the flowers is oblique. They are brownish-green.

Haloscias scoticum (L.) Fr. — Fl. p. 80. — (Trangisvaag, July). In many umbels the innermost flowers are staminate, the outer hermaphrodite. The anthers of the staminate flowers extend almost beyond the hermaphrodite flowers and may shed pollen upon them (geitonogamy); the staminate flowers shed their pollen at a time when the stigmas of the hermaphrodite flowers are ripe. The petals are partly pale-red, partly white; the anthers are dark-purple in colour. Flowers distinctly protandrous. Many flies *(Aricia variabilis)* visit the flowers and suck honey from them, as was the case in *Angelica*.

Honckenya peploides (L.) Ehrh. — Fl. p. 61. — (Trangisvaag, Höjvig, July). Diœcious. The staminate flowers are 8—13 mm. in diameter, and have small, yellow nectaries, rich in honey; the petals equat, or somewhat excel, the sepals in size. At first the antisepalous stamens are erect, then they bend backwards; then the antipetalous stamens follow them. The pistillate flowers are green; their petals are much smaller than the sepals. The diameter is only 4—6 mm. Fruit is set abundantly, even by quite small and entirely green pistillate flowers. Pollination by insects must inevitably take place, although none were observed.

Hypericum pulchrum L. — Fl. p. 68. — (Trangisvaag, July). The younger flowers are 15—16 mm. in diameter, the older 20 mm. Homogamous. The styles spread widely among the orange-coloured or reddish-yellow anthers. Spontaneous self-pollination is improbable. Honey is absent.

Juncus lampocarpus Ehrh. — Fl. p. 91. — (Trangisvaag, July). Even in rainy weather the perianth-leaves project like a star. The flowers are protogynous. The styles are twisted and longer than the stamens.

Juncus squarrosus L. — Fl. p. 91. — (Trangisvaag, July). Pro-

togynous. The styles are long and white and exceed the stamens in length. The perianth-leaves project like a star after the flower has expanded. Pollen is shed and may lie in masses on the perianth-leaves.

Leontodon autumnale L. — Fl. p. 45. — (Trangisvaag, Lervik). Is visited by *Eristalis nemorum*. In dense fog the capitula were closed.

Linum catharticum L. — Fl. p. 69. — (Trangisvaag, July). The flower is homogamous. Spontaneous self-pollination takes place easily.

Lobelia Dortmanna L. — Fl. p. 48. — (Sand, Aug.). The corolla is pale violet-white in colour. Fruit is set abundantly. Spontaneous self-pollination appears to take place.

Lychnis flos cuculi L. — Fl. p. 63. — (Trangisvaag). The flower is 42—50 mm. in diameter. Distinctly protandrous. The anthers are white and contain white pollen. The antisepalous stamens dehisce first, then the antipetalous stamens, and lastly the stigmas ripen. The flowers set fruit, which is large even in the middle of July. Was found fruiting abundantly at Viderejde.

Matricaria inodora L. var. **phaeocephala** Rupr. — Fl. p. 45. — The capitula attain a diameter of 45 mm.

Melandrium rubrum (Weig.) Garcke. — Fl. p. 63. — (Trangisvaag). The staminate flowers are 21—23 mm. in diameter. The pollen is white.

Menyanthes trifoliata L. — Fl. p. 47. — (Trangisvaag). Short-styled.

Montia rivularis Gmel. — Fl. p. 73. — (Trangisvaag). In the small, white flowers of this plant spontaneous self-pollination takes place, as the white anthers touch the stigma.

Myosotis repens Don. — Fl. p. 43. — (Trangisvaag, July). Within the yellow, shiny ring round the throat, the anthers are seen to project, so that the proboscis of an insect can scarcely be thrust in without touching them. Ultimately the stigma is on a level with the anthers. Spontaneous self-pollination must be able to take place.

Narthecium ossifragum (L.) Huds. — Fl. p. 81. — (Trangisvaag). The flower is 15 mm. in diameter. The perianth-leaves project like a star, afterwards they bend backwards. Yellowish-red pollen lies loose in the open anthers. There is no honey to be seen. The stamens are erect and spreading. The stigma stands above the anthers in the middle of the flower. Spontaneous self-pollination appears to be able to take place only with great difficulty.

Oxyria digyna (L.) Campd. — Fl. p. 71. — (Trangisvaag, July). Flowers drooping and wind-pollinated, somewhat protogynous. Staminate and pistillate flowers also occur. Fruits abundantly, sometimes every flower sets seed.

Papaver radicatum Rottb. — Fl. p. 70. — (August). In the young, still half-closed, homogamous flower spontaneous self-pollination takes place.

Pedicularis palustris L. — Fl. p. 56. — (Trangisvaag, July). The flowers appear to resemble the Danish ones. In a young, still unexpanded flower the white anthers are unopened and filled with loose, white pollen. The stigma is above them, not yet ripe. If the anthers are opened artificially the pollen falls out. In older flowers, which still contain pollen, the stigma is situated above the anthers, but somewhat nearer to the mouth, below the upper lip. The stigma does not stand out freely. Spontaneous self-pollination appears to take place.

Pinguicula vulgaris L. — Fl. p. 48. — (Trangisvaag). July 16, flowering almost over. Spontaneous self-pollination occurs, being due to the stigma rolling backwards, down into the pollen of the open anthers. *Ustilago antherarum* appears to be common.

Plantago maritima L. — Fl. p. 49. — (Trangisvaag). The anthers are white and the styles are yellowish. Slight protogyny. Is visited by *Scatophaga stercoraria*.

Polygala serpyllacea Weihe. — Fl. p. 71. — (Trangisvaag, July). The flowers are closed for the most part. Spontaneous self-pollination undoubtedly takes place; masses of pollen may be seen upon the stigma, which have undoubtedly been shed from the anthers of the same flower. Fruit is often set in every flower.

Potamogeton polygonifolius Pourr. — Fl. p. 95. — (Trangisvaag). Wind-pollination takes place. The flowers were setting fruit July 26th.

Potentilla erecta (L.). — Fl. p. 77. — (Trangisvaag, July). The flower is 13—16 mm. in diameter. The petals spread horizontally. The anthers are remote from the pistils in the middle; they do not dehisce in rainy weather. The flowers are visited by *Aricia variabilis*.

Potentilla anserina L. — Fl. p. 77. — (Trangisvaag). The diameter of the flower is 20—25 mm. Honey is secreted at the yellow

bases of the stamens. The innermost anthers may shed pollen upon the outermost stigmas. Appears to be homogamous, and is visited by flies. The fruit is of a fair size as early as July 25th.

Ranunculus acer L. — Fl. p. 74. — (Syderö, July; Mygledal, Aug.). The diameter of the flower appears to vary greatly; in specimens from rocky flats it measured 15—18 mm., in specimens from the lowlands (Trangisvaag, Kvalbö, Lervik) as much as 3 cm. Homogamy occurs. Spontaneous self-pollination must be difficult because the stamens are spreading; the outermost stigmas may, however, be dusted with pollen from the innermost, more erect stamens. The plant sets fruit; it is visited frequently by several species of flies *(Hilara chorica, Aricia variabilis, Eristalis nemorum, Anthomyia triquetra, Homalomyia spathulata).*

Ranunculus Flammula L. — Fl. p. 74. — (Trangisvaag, July). The flower is 18—23 mm. in diameter. Homogamy or protandry occurs. The outermost pistils thrust their stigmas between the inner stamens, and spontaneous self-pollination can thus take place. Occasionally the plants appeared to be protogynous. At Viderejde and Mygledal it is seen fruiting abundantly in August.

Ranunculus repens L. — Fl. p. 76. — (Trangisvaag, July 22). Visited by *Aricia variabilis* and by another species of *Diptera.*

(**Rhinanthus**, vide **Alectorolophus**).

Sagina procumbens L. — Fl. p. 63. — (Trangisvaag). Appears to be somewhat protogynous. Spontaneous self-pollination takes place. 5-merous flowers also occur.

Sagina subulata (Sw.) Prsl. — Fl. p. 64. — (Trangisvaag, July). Homogamous. Flowers very small (the diameter is about 4 mm.).

Saxifraga hypnoides L. — Fl. p. 79. — (Trangisvaag). The flower is from 11 to 17 mm. in diameter; when, as in rare instances, the petals are spreading, the diameter is as much 22 mm. The petals are erect and divergent, and yellowish-green in colour. Highly protandrous; antisepalous stamens ripen before the antipetalous, but the stigmas may ripen before the antipetalous petals have completed their development. Honey is secreted abundantly. Spontaneous self-pollination may occur. The flowers are visited by *Aricia variabilis* and *Atractodes vestalis.*

Saxifraga nivalis L. — Fl. p. 79. — (Trangisvaag). The young flower is about 6—7 mm. in diameter, but in the pistillate stage

it has increased and the diameter is now about 9 mm. The plant is decidedly homogamous, and for a long period. Spontaneous self-pollination occurs by the anthers touching the stigma. The pollen is pale minium-red. The disk is greenish and shiny.

Saxifraga stellaris L. — Fl. p. 79. — (Trangisvaag, July; Vestmanhavn and Lervik, Aug.). The diameter of the flower is 11—15 mm. The white, upward-curving petals have two large orange-coloured spots above their bases. Slight protandry. Much honey is secreted and the plant sets fruit abundantly, from almost every flower.

Scilla verna Huds. — Fl. p. 93. — (Trangisvaag, July 18). The flowers are pale-purple. Their diameter is from 12 to 14 mm. The perianth-leaves spread somewhat in a starlike manner, but during the final stages of flowering they bend upwards. The stamens, which are erect or slightly spreading, turn the slits of their anthers slightly upwards. The plant is homogamous. The anthers are always somewhat remote from the styles which are in the middle of the flower and are bent backwards. Spontaneous self-pollination appears to be able to take place only with great difficulty. Insects doubtless visit the flower in search of the honey which is seen in large drops between the ovary and the stamens. The plants set fruit.

Sedum Rhodiola D. C. — Fl. p. 65. — (Trangisvaag). Ripe fruit is produced, and is set as early as July.

Sedum villosum L. — Fl. p. 66. — (Trangisvaag). The flower is about 7—8 mm. in diameter. The petals are pale rose-red with yellow bases; they darken with age. Yellow honey-glands occur outside the pistils. The flower is protandrous; the antisepalous stamens are the first to develop and they bend inwards towards the middle of the flower; there the anthers shed much pollen, where the stigmas are to be found which have ripened before the antipetalous stamens bent inwards. Spontaneous self-pollination is not only possible, but almost inevitable, if insect-pollination does not occur early; sometimes the anthers are found in direct contact with the stigma.

Sibbaldia procumbens L. — Fl. p. 78. — Ripe fruit is formed.

Silene acaulis L. — Fl. p. 64. — (Trangisvaag, July). The pistillate flowers are very small, measuring 6—7 mm. across; the staminate flowers are 11—12 mm. in diameter, and a rudimentary pistil occurs at their base. The pistillate flowers are deeper red than are the staminate.

Stellaria uliginosa Murr. — Fl. p. 65. — (Trangisvaag). The flower is 4—5 mm. in diameter. The petals are smaller than the sepals. The plant is at first protandrous and then becomes homogamous.

Succisa pratensis Moench. — Fl. p. 46. — The plant is slightly protandrous. The style varies in length. The flower is visited by flies.

Thymus serpyllum L. — Fl. p. 48. — (Trangisvaag). The hermaphrodite flowers are decidedly protandrous; the pistillate flower, which has a long projecting style, secrets honey so abundantly that it may almost reach to the throat of the corolla. Flies visit the flowers.

Trifolium repens L. — Fl. p. 71. — At Trangisvaag a *Hadena* sp. was seen in a flower.

Vaccinium Vitis idæa L. — Fl. p. 57. — (Vestmanhavn). Is said to set ripe fruit.

Veronica Beccabunga L. — Fl. p. 56. — Has a ring of hairs around the throat of the corolla. Appears to be homogamous.

Veronica officinalis L. — Fl. p. 57. — (Trangisvaag). The diameter of the flower is 7—8 mm. The corolla is pale-lilac with stripes of a darker colour. Homogamous. The anthers and the stigma occur at the same level, but as the stamens are spreading, insect-pollination appears to be necessary for the setting of fruit.

THE INSECT-FAUNA OF THE FÆRÖES

BY

I. C. NIELSEN.

The insect-fauna of the Færöes consists of European or North-European species. Judging from the specimens in hand, it is, as regards the number of its species far inferior to other countries which lie in the same latitude, as well as Greenland; but this will almost certainly be altered by further collecting. As is the case in other northern faunas, thus also here the most conspicuous Order is the Diptera, noteworthy both as regards the number of its species (90) and as regards the quantity of the individuals; the Nematocera and the Muscidæ are especially richly represented. After the flies follow the Coleoptera, with 78 species, of which, however, a few have been introduced; all these species live in sheltered places under stones or moss, in the ground, in dung, or in water. Of the 27 species of the Hymenoptera, 25 are parasitic forms, and one is phytophagous, while bees are represented by only one Humble-bee, which is evidently very rare, as but one specimen of it has been obtained.

Among the Lepidoptera (15 species) there occurs but one representative of the Rhopalocera, viz. *Vanessa cardui* L., of which species only one old specimen exists in the Museum in Copenhagen. In this scarcity of butterflies the Færöes agree with Iceland, while the fauna of Greenland contains 4 species. The Neuroptera number 5 species, but no Pseudoneuroptera have hitherto been found in the Færöes. The Orthoptera are represented by one species of Forficula, and the Hemiptera by 4 Heteroptera and 3 Homoptera.

The following list has been compiled from H. I. Hansen's catalogue (Faunula Insectorum Færöensis. Naturhistorisk Tidsskrift 1881, 3. R., Bd. 13, p. 229), to which have been added the species collected subsequently by Professor Dr. Eug. Warming and Dr. C. H. Ostenfeld.

Coleoptera.

Carabidæ.

Bradycellus cognatus Gyll.
Amara aulica Pz.
Pterotichus diligens Sturm.
P. strenuus Pz.
P. nigrita Fabr.
P. vitreus Dej.
Calathus melanocephalus Linn.
C. cisteloides Illig.
Olistopus rotundatus Payk.
Loricera pilicornis Fabr.
Carabus catenulatus Fabr.
Nebria brevicollis Fabr.
N. Gyllenhalii Schönh.
Patrobus septentrionis Dej.
Trechus obtusus Er.
Bembidium bipunctatum Linn.
B. Bruxellense Wesm.
Notiophilus biguttatus Fabr.

Dytiscidæ.

Hydroporus pubescens Gyll.
Agabus alpestris Heer.

Hydrophilidæ.

Helophorus grandis Illig.
H. aqvaticus Linn.
Hydrobius limbatus Fabr.
Cercyon flavipes Fabr.
Megasternum bolitophagum Marsh.

Staphylinidæ.

Aleochara languinosa Grav.
A. moesta Grav.
Autalia puncticollis Sharp.
Ocalea castanea Er.
Homalota fungi Grav.
H. elongatula Grav.
H. circellaris Grav.
H. germana Sharp.
H. analis Grav.
H. melanocera Thoms.
H. atramentaria Gyll.
H. gregaria Er.
Tachinus rufipes de Geer.
T. marginellus Fabr.
Qvedius fuliginosus Grav.
Q. umbrinus Er.
Q. boops Grav.
Philonthus fimetarius Grav.
P. marginatus Fabr.
Othius fulvipennis Fabr.
O. melanocephalus Grav.
Lathrobium fulvipenne Grav.
Stenus speculator Bois & Lacord.
S. unicolor Erichs.
Lesteua bicolor Fabr.
Homalium deplanatum Gyll.
H. rivulare Payk.

Cryptophagidæ.

Cryptophagus scanicus Linn.
C. saginatus Sturm.
C. dentatus Hbst.
C. sp.
Atomaria apicalis Erichs.

Lathridiidæ.

Lathridius minutus Linn.

Dermestidæ.

Attagenus pellio Linn.

Byrrhidæ.

Simplocaria metallica Sturm.

Scarabæidæ.

Aphodius alpinus Scop.
A. ater de Geer.

Elatheridæ.

Hypolithus riparius F.

Lampyridæ.

Helodes minuta Linn.

Anobiidæ.

Ptinus fur L.
Niptus crenatus F.
Anobium molle Linn.
A. domesticum Foucr.

Curculionidæ.

Otiorynchus maurus Gyll.
O. arcticus O. Fabr.
O. atroapterus de Geer.
Barynotus Schönherri Zett.
Tropiphorus mercurialis Fabr.
Pissodes pini L.
Apion cruentatum Walt.

Cerambycidæ.

Gracilia minuta Fabr.

Chrysomelidæ.

Chrysomela staphylea Linn.

Tenebrionidæ.

Tribolium confusum Dup.

Hymenoptera.

Tenthredinidæ.

Nematus obductus Htg.

Ichneumonidæ.

Ichneumon gradarius Wesm.
I. albicinctus Grav.
Phaeogenes ophthalmicus Wesm.
Stylocryptus sp.
Phygadeuon fumator Grav.
Ph. cylindraceus Ruthe.
Hemiteles sp.
H. sp.
Mesoleius sp.
Atractodes vestalis Curt.
A. gilvipes Holmgr.
A. bicolor Grav.
A. exilis Curt.
Cymodusa antennator Holmgr.
Sagaritis zonata Grav.

Braconidæ.

Perilitus similator N. ab Es.
Aphidius proteus Walk.
Dacnusa sp.
D. sp.
Opius procerus Wesm.
Alysia livida Halid?
Microgaster glomeratus N. ab Es.

Proctotrupidæ.

Proctotrupes sp.

Pteromalinidæ.

Lamprotatus splendens Thoms.

Cynipidæ.

Eucoila sp.

Apidæ.

Bombus sp.

Diptera.

Bibionidæ.

Scatopse notata L.
Dilophus femoratus Meig.
Bibio pomonæ F.
B. lacteipennis Zett.

Cecidomyidæ.

C. sp.

Mycetophilidæ.

Sciara carbonaria Meig.
S. fucata Meig.
S. pulicaria Meig?
Lasiosoma hirta Meig.

Tipulidæ.

Tipula lutescens Fabr.
T. parvicauda H. I. Hansen.
T. paludosa Meig.
T. subnodicornis Zett.
Amalopis unicolor Schin.
Tricyphona immaculata Meig.
Dasyptera nodulosa Meig.
Trichosticha trivialis Meig.
T. flavescens L.
Trichocera maculipennis Meig.
T. hiemalis de Geer.
Limnophila trinotata Meig.
L. nemoralis Meig.

Chironomidæ.

Ceratopogon niveipennis Meig.
Chironomus niger H. I. Hansen.
C. lucens Zett.
C. fuscipes Meig.
C. variabilis Stæg.
Tanypus culiciformis Linn.
T. nebulosus Meig.
T. sp.

Psychodidæ.

Psychoda phalænoides Linn.

Empidæ.

Clinocera stagnalis Halid.
Hilara chorica Fall.

Dolichopidæ.

Dolichopus planitarsis Fall.
D. plumipes Scop.

Liancalus virens Scop.
Hydrophorus inqvalipes Macq.
Sympychnus annulipes Meig.

Lonchopteridæ.

Lonchoptera trilineata Zett.

Syrphidæ.

Platycheirus albimanus Fabr.
P. clypeatus Meig.
Syrphus mellinus Linn.
Sericomyia lappona Linn.
Eristalis nemorum Latr.
E. intricarius Linn.
Helophilus pendulus Linn.

Muscidæ.

Calliphora erythrocephala Meig.

Anthomyidæ.

Aricia incana Wiedm.
A. variabilis Fall.
Spilogaster anceps Zett.
Limnophora sp.
Anthomyia triqvetra Wiedm.
Homalomyia lepida Fall.
H. spatulata Zett.
Coenosia mollicula Fall.
Schoenomyza litorella Fall.

Scatophagidæ.

Fucellia fucorum Fall.
Scatophaga stercoraria Linn.
S. litorea Fall.
S. villipes Zett.
S. sqvalida Meig.

Helomyzidæ.

Helomyza geniculata Zett.
Tetanocera umbrarum Linn.
Themira putris Linn.
T. minor Halid.

Sepsidæ.

Piophila casei Linn.

Ephydrynidæ.

Notiophila cinerea Fall.
Hydrellia griseola Fall.
H. modesta Loew.
Parydra qvadripunctata Meig.
P. pusilla Meig.
Scatella qvadrata Fall.
S. sibilans Halid.
S. stagnalis Fall.

Drosophilidæ.

Drosophila graminum L.

Agromyzidæ.

Agromyza vagans Fall.
Phytomyza flavoscutellata Fall.

Choropinæ.

Chlorops sp.
Oscinis sp.

Barborinæ.

Borborus geniculatus Macq.
B. nitidus Meig.
B. eqvinus Fall.
B. niger Meig.
Sphaerocera subsultans Fabr.
Limosina sylvatica Meig.
L. fontinalis Fall.
L. crassimana Halid.
L. sp.
Coelopa frigida Fall.

Phoridæ.

Phora nigricornis Egg.

Lepidoptera.

Nymphalidæ.

Vanessa cardui L.

Hepialidæ.

Hepialus humuli L.

Noctuidæ.

Agrotis pronuba L.
Charæas graminis L.
Mamestra dentina Esp.
Hadena Sommeri Lefbr.
H. exulis Lefbr.
H. monoglypha Hufn.

Geometridæ.

Cidaria munitata Wallgr.
C. designata Rott.
C. adæqvata Btk.
C. albulata Schiff.

Botidæ.

Scoparia ambigualis Tr.

Crambidæ.

Crambus sp.

Tineidæ.

Tinea fuscipunctella Haw?
T. sp.

Neuroptera.

Limnophilidæ.

Limnophilus griseus Linn.
L. sparsus Curt.
Anabolia areata Kol.

Hydropsychidæ.

Plectocnemia conspersa Curt.

Rhyacophilidæ.

Rhyacophila dorsalis Curt.

Orthoptera.

Forficulidæ.

Forficula auricularia Linn.

Thysanura.

Machilidæ.

Machilis maritima Leach.

Collembola.

Deegeriadæ.

Deegeria sp.

Hemiptera.

Acanthidæ.

Pithanus Märkelii Schäff.
Salda litoralis Linn.

Corixidæ.

Corixa præusta Fieb.
C. carinata Sahlb.

Jassidæ.

Acocephalus flavostriatus Donov.
Jassus sordidus Zett.

Coccidæ.

Orthesia cataphracta Oliv.

THE DISTRIBUTION OF THE MARINE ALGÆ OF THE ARCTIC SEA AND OF THE NORTHERNMOST PART OF THE ATLANTIC

BY

F. BORGESEN AND HELGI JÓNSSON.

We have jointly composed the following paper on the distribution of the Marine Algæ of the Arctic Sea and of the northernmost part of the Atlantic for the purpose of comparing the Færöese and the Icelandic Marine Algæ-flora with that of the neighbouring coast.

Besides the Algæ of the Arctic Sea we have included those species from along the coasts of Europe which occur in the North Atlantic to the north of a line drawn from Lindesnæs in Norway to the boundary between England and Scotland, and from the American coasts of the Atlantic those from the coasts of New England mentioned by Farlow (16) and Collins (12). The south limit we have chosen is not a distinctly phytogeographical one, but we have chosen it because it is apparently quite unnecessary to include a larger area for the purpose of investigating, how far the Marine Algæ-flora of the Færöes and Iceland agree with that of the neighbouring coasts.

The fact that the Algæ of the different countries have in many respects been differently treated, makes it very difficult to draw up a list like the one in question. But, as may be seen in our foot-notes, we have, as far as possible, tried to overcome these difficulties and to clear up several doubtful species.

Regarding the books most used we refer to the following list of Literature.

Our best thanks are due to Mr. M. Foslie of Trondhjem for a revised list of the calcareous Algæ of the area in question and for many important informations on Norwegian Algæ, and to Mr. E. Norum of Haugesund for sending us an unpublished list of the Phæophyceæ from the environs of Haugesund. Above all we are highly indebted to Dr. L. Kolderup Rosenvinge for much valuable information.

We mention in our list the Algæ-flora of the following seas and countries:

1. The Siberian Sea from the Behring's Strait (eastward) to the Taymyr peninsula and Spitzbergen (westward).
2. The Murman Sea and the Kara Sea surrounding Novaja Zemlia.
3. The White Sea.
4. Spitzbergen.
5. Jan Mayen and Bear Island have the same rubric for the sake of convenience.
6. East Greenland.
7. West Greenland.
8. Arctic America.
9. N. E. Iceland, the East coast and the North coast of Iceland about from Lónsheiði to Hornbjarg.
10. S. W. Iceland, the south coast and west coast of Iceland about from Hornbjarg westward to Lónsheiði eastward.
11. Finmark.
12. Nordland.
13. West Norway.
14. The Færöes.
15. Shetland.
16. Scotland (incl. the Orkneys).
17. The northern Atlantic coast of North America (cfr. Farlow 16).

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* in the rubric West Norway signifies that the species occurs in South Norway.

** in the rubric Scotland signifies that the species is found in England.

*** in the rubric North America signifies that the species is known from the southern Atlantic coasts of North America.

For the signs A, B, C, D, E in the first rubric we refer to the groups of Algæ mentioned later below on (see p. XV).

In the list the Færöese species are printed in italics.

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Faeröes	Shetland	Scotland	Atlant. N.-America
Rhodophyceæ.																	
Bangiaceæ.																	
E3 Erythrotrichia investiens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *E. ceramicola*	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	+
E3 E. ciliaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
C *Bangia fuscopurpurea*[1]	.	.	.	.	.	.	+	.	+	+	+	+	+	+	+	+	+
E1 *Porphyra leucosticta*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+
C *P. umbilicalis*[2]	.	+	.	.	.	.	+	.	+	+	+	+	+	+	+	+	+
D *P. coccinea*	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	+
B2 *P. miniata*	.	+	+	+	.	+	+	+	+	+	+	+	+	+	.	+	+
B2 *Conchocelis rosea*	.	.	.	.	.	+	+	.	+	+	+	.	*	+	.	+	.
E3 Goniotrichum elegans	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	+	+
E3 G. ramosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Helminthocladiaceæ.																	
C Chantransia microscopica[3]	.	.	.	.	.	+	+	.	+	.	+	.	*	.	.	+	.
D *Ch. Alariæ*	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	.	+
E3 Ch. Chylocladiæ	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
B2 *Ch. efflorescens*	.	+	+	+	.	+	.	.	.	.	+	.	*	+	.	**	+
D *Ch. Daviesii*	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+
C *Ch. secundala*[4]	.	+	.	.	.	.	+	.	+	+	+	+	+	+	+	+	+
B2 *Ch. virgatula*	.	.	.	.	.	.	+	.	.	+	+	.	*	+	+	+	+
E2 Nemalion multifidum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
E3 N. helminthoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 Helminthora divaricata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
Chætangiaceæ.																	
E3 Scinaia furcellata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Gelidiaceæ.																	
D *Choreocolax Polysiphoniæ*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+
E3 Ch. tumidus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
B2 *Harveyella mirabilis*	.	.	.	.	.	+	+	.	.	.	+	.	*	+	.	+	+
E3 Naccaria Wigghii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 Gelidium crinale	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
E2 G. pusillum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 G. aculeatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 G. pulchellum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 G. attenuatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 G. corneum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 G. latifolium	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
E3 Pterocladia capillacea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Gigartinaceæ.																	
E1 *Chondrus crispus*	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+
D *Gigartina mamillosa*	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+	+
E2 Phyllophora rubens	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
B2 *P. Brodiæi*	+	+	+	+	+	+	+	+	+	+	+	.	+	+	.	+	+
E3 P. Traillii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
D *P. membranifolia*	.	.	.	.	.	.	.	.	.	+	.	+	+	+	.	+	+
E2 Gymnogongrus Griffithsiæ	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
E2 G. norvegicus[5]	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
B2 *Actinococcus subcutaneus*	.	.	.	.	+	+	+	.	+	+	+	.	*	+	.	+	+
E3 A. aggregatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**	+
E3 A. peltæformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**	+

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Faeröes	Shetland	Scotland	Atlant. N. America
E2 Colacolepis incrustans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E1 *Callophyllis laciniata*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.
E2 Callymenia reniformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
A C. sanguinea	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
D *Callocolax neglectus*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.
A Ceratocolax Hartzii	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.
C *Ahnfeltia plicata*	+	+	+	+	.	.	.	+	+	+	+	+	+	+	.	+	+
D *Sterrocolax decipiens*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+
Rhodophyllidaceæ.																	
D *Cystoclonium purpurascens*	.	+	+	.	.	.	.	.	+	+	+	+	+	+	+	+	+
E2 Catenella Opuntia	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.
E3 Agardhiella tenera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
A Turnerella Pennyi[6]	.	+	.	+	+	+	+	+	+	.	+	+	+	.	.	.	.
B2 *Euthora cristata*	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
E2 Rhodophyllis appendiculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 Rh. bifida	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.
B1 *Rh. dichotoma*	.	+	+	+	+	+	+	+	+	+	+	+	+	+	.	.	+
Sphærococcaceæ.																	
E2 Sphærococcus coronopifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 Gracilaria confervoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 G. multipartita	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**	+
E2 Calliblepharis ciliata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 C. jubata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 Hypnea musciformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Rhodymeniaceæ.																	
B2 *Rhodymenia palmata*	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
E2 Rh. Palmetta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
B1 *Halosaccion ramentaceum*[7]	+	+	+	+	+	+	+	+	+	+	+	+	.	+	.	.	+
E3 Cordylecladia erecta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 Lomentaria uncinata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
D *L. rosea*	.	.	.	.	.	.	.	.	.	+	.	.	+	+	.	+	+
E1 *L. clavellosa*	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	+	.
E1 *L. articulata*	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.
E2 Champia parvula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
E2 Chylocladia kaliformis	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.
E2 Ch. ovalis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E1 *Plocamium coccineum*	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	+	?
Delesseriaceæ.																	
E2 Nitophyllum Gmelini	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 N. Bonnemaisonii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
E2 N. Hilliæ	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E1 *N. laceratum*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.
E2 N. punctatum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	***
E2 N. uncinatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 Grinnellia americana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
D *Delesseria alata*[8]	.	.	.	.	.	.	.	+	.	+	+	+	+	+	+	+	+
A D. Baerii	.	+	+	+	+	+	+	+	+	.	?	.	.	.	.	.	.
E2 D. Hypoglossum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	***
A D. Montagnei[9]	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	+

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Faeröes	Shetland	Scotland	Atlant. N.-America
E2 D. ruscifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *D. sanguinea*	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+	.
B2 *D. sinuosa*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
E2 Caloglossa Leprieurii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Bonnemaisoniaceæ.																	
E2 Bonnemaisonia asparagoides	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.
Rhodomelaceæ.																	
E2 Laurencia cæspitosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 L. obtusa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E1 *L. pinnatifida*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.
E2 Chondria atropurpurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E2 Ch. dasyphylla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
E3 Ch. littoralis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	?
E2 Ch. tenuissima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
E3 Polysiphonia subtilissima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E2 P. fibrata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 P. macrocarpa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *P. urceolata*	.	+	+	.	.	.	+	.	+	+	+	+	+	+	+	+	+
E2 P. vestita	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
D *P. violacea*[10]	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+
E1 *P. Brodiæi*	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.
E2 P. Olneyi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E2 P. Harveyi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E2 P. spinulosa	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
E2 P. elongella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
C *P. elongata*[10]	.	.	.	+	.	.	+	.	.	.	+	+	+	+	+	+	+
E3 P. Richardsoni	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 P. fruticulosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *P. fastigiata*[11]	.	.	.	?	.	.	.	.	.	+	+	+	+	+	+	+	+
E3 P. variegata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**	+
A P. arctica	+	+	+	+	+	+	+	+	+	+	+	.	.	.	.	.	.
D *P. atrorubescens*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+
E2 P. simulans	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
E3 P. subulifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *P. nigrescens*[12]	.	+	+	.	.	.	.	.	+	+	+	+	+	+	+	+	+
E1 *Pterosiphonia parasitica*	.	.	.	.	.	.	.	.	.	+	.	+	+	+	.	+	?
E3 Pt. thuyoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E1 Bronguiartella byssoides	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.
E3 Bostrychia rivularis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E3 B. scorpioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 Dasya elegans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E2 D. arbuscula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	***
E2 Heterosiphonia coccinea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
B2 *Rhodomela lycopodioides*	+	+	.	+	.	+	+	+	+	+	+	+	+	+	.	+	.
D *Rh. subfusca*[13]	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+
B1 Rh. larix	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
B2 *Odonthalia dentata*	+	+	+	+	+	.	.	+	+	+	+	+	+	+	+	+	+
Ceramiaceæ.																	
E3 Sphondylothamnion multifidum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	***
D Spermothamnion Turneri	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	+	+

		Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Faeröes	Shetland	Scotland	Atlant. N.-America
E3	S. strictum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3	S. barbatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3	Ptilothamnion Pluma	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2	Griffithsia Bornetiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E2	G. corallinoides	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	+	.
E1	*G. setacea*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.
E3	G. tenuis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E3	Halurus equisetifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	?
E2	Monospora pedicellata	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
E2	Pleonosporium Borreri	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
E1	*Callithamnion scopulorum*	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.
E2	C. tenuissimum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D	*C. polyspermum*	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	?
D	C. Hookeri	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.
E3	C. acrospermum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2	C. tetragonum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	?	+	+
E2	C. Brodiæi	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	+	.
E2	C. Baileyi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
D	*C. arbuscula*	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	+	.
E2	C. byssoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
D	C. roseum	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	+
E1	*C. corymbosum*	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	+
E1	*C. granulatum*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.
E2	Scirospora Griffithsiana	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	+	+
E2	Compsothamnion thuyoides	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
E3	C. gracillimum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D	*Plumaria elegans*	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.	+	+
B1	*Ptilota pectinata*	.	+	+	+	+	+	+	+	+	+	+	.	.	+	.	.	+
B2	*P. plumosa*	.	+	+	+	.	.	.	.	+	+	+	+	+	+	+	+	.
C	*Antithamnion Plumula*	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+
E3	A. cruciatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
D	*A. floccosum*	.	.	.	.	.	.	+	.	+	+	+	+	.	+	.	+	+
E3	Spyridia filamentosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**	+
E2	Ceramium fastigiatum	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	+
E2	C. tenuissimum	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	+	+
E2	C. echionotum	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	+	.
E3	C. pennatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2	C. Hooperi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
D	C. Deslongchampii	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	+	.
D	C. circinnatum	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	+	+
E2	C. arborescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2	C. ciliatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.
C	*C. rubrum*	.	+	.	+	.	.	+	.	+	+	+	+	+	+	+	+	+
E2	C. flabelligerum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
D	C. diaphanum	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	+
D	*C. acanthonotum*	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	+	.
E2	Microcladia glandulosa	.	.	.	.	.	.	.	.	.	.	.	?	.	.	.	+	.
D	*Rhodochorton seiriolanum*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	**	.
A	Rh. spetsbergense	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
C	*Rh. membranaceum*	.	.	.	.	+	+	+	.	+	+	+	.	.	+	.	+	+
B1	*Rh. penicilliforme*	.	+	.	+	+	+	+	.	+	+	+	+	.	+	.	.	.
D	Rh. minutum	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	**	.
D	Rh. repens	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Faröes	Shetland	Scotland	Atlant. N.-America
C *Rh. Rothii*[14]	.	+	.	+	.	+	+	+	+	+	+	+	+	+	+	+	+
E2 Rh. floridulum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Gloiosiphoniaceæ.																	
E2 Gloiosiphonia capillaris	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
Dumontiaceæ.																	
D *Dumontia filiformis*	.	+	.	.	.	.	.	.	+	+	+	+	+	+	+	+	.
E3 Dudresnaya coccinea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
A Dilsea integra	+	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.
D D. edulis	.	.	+	+	.	.	.	.	.	+	.	+	+	.	+	+	.
Nemastomaceæ.																	
E2 Halarachnion ligulatum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
D *Furcellaria fastigiata*	.	+	+	+	.	.	.	.	.	.	+	+	+	+	+	+	.
E3 Nemastoma Bairdii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**	+
Rhizophyllidaceæ.																	
D *Polyides rotundus*	.	+	+	.	.	.	.	.	.	.	+	+	+	+	.	+	+
Squamariaceæ.																	
D Petrocelis Middendorfii	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
D P. cruenta	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+
D P. Hennedyi	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.
A P. polygyna	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
A Cruoria arctica	.	.	.	.	+	+	+	.	.	+	.	.	.	.	.	.	.
E1 *C. pellita*	.	.	.	.	.	.	.	.	.	+	.	+	+	+	.	+	.
D *Cruoriella Dubyi*	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	?
B1 Peyssonnelia Rosenvingii	.	.	.	.	.	+	+	.	+	+	+	.	.	.	.	+	+
D *Rhododermis elegans*	.	.	.	.	.	+	+	.	.	.	.	.	.	+	.	**	.
D Rh. parasitica	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.
Corallinaceæ.																	
D *Phymatolithon lævigatum*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+
D *Ph. polymorphum*	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	.
D Ph. investiens	.	.	.	.	.	?	.	.	.	.	+	.	.	.	.	.	.
B1 *Ph. compactum*	.	+	.	+	.	+	+	+	+	+	+	+	+	+	.	.	+
E2 Lithothamnion membranaceum	.	.	.	.	.	.	.	.	.	.	.	?	+	.	.	+	.
D *L. Lenormandi*	.	+	+	.	.	.	.	.	.	+	+	+	+	+	.	+	+
B1 *L. læve*	.	.	+	+	.	+	+	+	+	+	+	+	+	+	.	.	+
A L. flavescens	.	+	.	+	.	.	.	.	+	.	+	.	.	.	.	.	.
A L. foecundum	.	+	.	+	.	+	+	+	+	.	+	.	.	.	.	.	+
E2 L. Sonderi	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
A L. arcticum	.	+	.	.	.	.	.	+?	.	.	.	.	.	.	.	.	.
B2 *L. glaciale*	.	+	.	+	+	+	+	+	+	+	+	+	+	+	.	+	+
D L. intermedium	.	.	.	.	.	.	+	.	.	.	+	+	+	.	.	.	+
D L. fornicatum	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.
B1 L. tophiforme	.	.	+	.	.	.	+	.	+	+	+	+	.	.	.	.	.
D L. norvegicum	.	.	.	.	.	.	.	.	+	+	+	+	+	.	.	+	.
E2 L. calcareum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *Lithophyllum Crouani*	.	.	.	.	.	.	.	.	+	+	+	+	+	+	.	+	.
E2 L. orbiculatum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
D *L. incrustans*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-Amerika	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Faeröes	Shetland	Scotland	Atlant. N.-America
E2 L. pustulatum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
D *L. macrocarpum*	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+
D *L. hapalidioides*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.
E2 Melobesia farinosa	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
E2 M. Lejolisii	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
E2 M. minutula	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
E2 Corallina rubens	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	**
E3 C. squamata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *C. officinalis*	.	+	+	.	.	.	.	.	+	+	+	+	+	+	+	+	+
C *Hildenbrandia rosea*	.	+	+	+	.	+	+	.	+	+	+	+	+	+	+	+	+
Phæophyceæ.																	
Myrionemaceæ.																	
B1 *Lithoderma fatiscens*	+	+	+	+	.	+	+	.	+	+	+	.	+	+	.	+	.
D L. lignicola	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
D *Petroderma maculiforme*	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.
B1 *Sorapion Kjellmani*	.	+	.	.	.	+	+	.	.	.	.	.	.	+	.	.	.
B1 Ralfsia ovata	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.
B2 *R. clavata*	.	.	.	.	.	+	+	.	+	+	.	.	+	+	.	+	+
E2 R. pusilla	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
D *R. verrucosa*	.	.	.	.	.	.	+	.	+	+	.	+	+	+	.	+	+
B1 R. deusta	.	+	.	.	.	+	+	+	+	+	+	+	.	.	.	.	+
B1 Myrionema Laminariæ	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.
D *M. vulgare*	.	.	.	.	.	.	.	.	+	+	+	+	+	+	.	+	+
D *M. Corunnæ*	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	+
E2 M. balticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
D *M. foecundum*	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	+
B1 *M. globosum*	.	.	.	.	.	+	+	.	+	+	.	.	.	+	.	+	+
E2 M. intermedium	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
D *M. færoense*	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.
D *M. speciosum*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
D Hecatonema maculans	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
D *Chilionema reptans*[15]	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	+	+
E2 Ch. ocellatum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	**	.
E2 Ascocyclus orbicularis	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
D A. islandicus	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
E2 Microspongium gelatinosum	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+
Ectocarpaceæ.																	
D *Microsyphar Polysiphoniæ*	.	.	.	.	.	.	+	.	.	+	.	.	.	+	.	**	.
D *M. Zosteræ*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
B1 *Ectocarpus æcidioides*	.	.	.	.	.	+	+	.	+	+	+	.	.	+	.	+	+
B1 E. helophorus	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.
E2 E. Chordariæ	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
D E. Turnerellæ	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
E3 E. Zanardinii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D E. Pringsheimii	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	+	+
D *E. Stilophoræ*	.	.	.	.	.	.	+	.	+	+	.	.	+	+	.	**	.

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Færöes	Shetland	Scotland	Atlant. N.-America
E2 E. sphæricus	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	+	·
E3 E. parasiticus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
D E. terminalis	·	·	·	·	·	·	·	·	·	·	+	+	+	·	·	+	+
C *E. littoralis*[16]	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
D E. nanus	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
D *E. velutinus*	·	·	·	·	·	·	·	·	·	·	·	·	+	+	·	+	·
E3 E. simplex	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
E2 E. subcorymbosus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
E3 E. Crouani	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
E3 E. Laudsburgii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
D *E. lucifugus*	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
B2 *E. tomentosoides*	·	·	·	·	·	·	+	·	+	+	·	·	+	+	·	+	+
D E. borealis	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
B1 E. ovatus	·	·	·	+	·	+	+	·	·	·	+	+	·	·	·	+	+
E2 E. globifer	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	+	·
E3 E. distortus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
D *E. tomentosus*	·	·	·	·	·	·	·	·	·	+	·	+	+	+	+	+	+
C *E. confervoides*	·	+	+	+	·	+	+	·	+	+	+	+	+	+	·	+	+
C *E. siliculosus*[17]	·	·	·	·	·	+	+	·	+	+	+	+	+	+	+	+	+
E2 E. lutosus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
D *E. dasycarpus*	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	**	+
D E. penicillatus	·	+	·	·	·	·	+	·	+	+	+	+	+	·	·	+	+
E2 E. Mitchellæ	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	**	+
D E. draparnaldioides	·	·	·	·	·	·	·	·	·	·	·	+	+	·	·	+	+
A E. pycnocarpus	·	·	·	·	·	+	+	·	·	·	·	·	·	·	·	·	·
D *E. fasciculatus*	·	·	·	·	·	·	·	·	·	+	+	+	+	+	+	+	+
E3 E. Sandrianus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+
D *E. granulosus*	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	+
E3 E. secundus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
D *E. Hinksiæ*	·	·	·	·	·	·	·	·	·	+	·	·	+	+	·	+	·
E3 Sorocarpus uvæformis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+
E2 Acinetospora pusilla	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+	·
Myriotrichiaceæ.																	
E2 Myriotrichia repens	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	+	·
E2 M. clavæformis	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	+	+
D M. filiformis	·	·	·	·	·	·	·	·	·	·	+	+	+	·	·	+	+
E3 M. densa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Elachistaceæ.																	
E3 Halothrix lumbricalis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+
E2 Myriactis Haydeni	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	**	·
E3 M. stellulata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
E3 M. Areschougii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
E3 M. pulvinata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+
B2 *Leptonema fasciculatum*	·	·	·	·	·	+	+	·	+	+	+	·	+	+	·	+	+
E2 Elachista stellaris	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	+	+
B2 *E. fucicola*[18]	+	+	+	+	+	+	+	·	+	+	+	+	+	+	+	+	+
E3 E. flaccida	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
D *E. scutulata*	·	·	·	·	·	·	·	·	·	·	·	·	+	+	+	+	·
E2 Giraudia sphacelarioides	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	**	·

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Faeröes	Shetland	Scotland	Atlant. N.-America
Sphacelariaceæ.																	
B1 *Sphacelaria britannica*	.	.	.	.	.	+	+	.	+	+	+	.	.	+	.	+	?
D S. radicans	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	+	?
D S. olivacea	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
D *S. cæspitula*	.	.	.	.	.	.	.	.	.	.	.	.	*	+	.	.	.
E3 S. plumigera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 S. plumula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
B1 S. racemosa	+	+	+	+	.	+	+	+	.	.	+	+	.	.	.	+	+
E3 S. tribuloides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *S. furcigera*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
E2 S. bipinnata	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	**	.
D *S. cirrhosa*	.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	+
B1 *Chætopteris plumosa*	+	+	+	+	.	+	+	+	+	+	+	+	+	+	.	+	+
E3 Halopteris filicina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 H. scoparium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *Cladostephus spongiosus*	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	+
E2 C. verticillatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Punctariaceæ.																	
B1 Phæosaccion Collinsii	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	+	+
A Omphalophyllum ulvaceum	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.	+
D *Desmotrichum undulatum*[19]	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+
E2 D. balticum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E1 *Punctaria latifolia*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+
B2 *P. plantaginea*	.	+	.	+	.	+	+	.	+	+	+	+	+	+	.	+	+
E2 Asperococcus bullosus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.
E1 *A. echinatus*	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+
E3 A. scaber	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 A. compressus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
B2 *Isthmoplea sphærophora*	.	.	+	.	.	+	+	.	+	+	+	+	+	+	+	+	+
E2 Litosiphon pusillus	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
D *L. Laminariæ*	.	+	.	.	.	.	.	.	.	.	.	+	+	+	.	+	.
B2 *L. filiforme*	.	.	.	.	.	.	+	.	+	+	.	.	+	+	.	+	.
E2 Stictyosiphon brachiatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
B2 *S. tortilis*	.	+	+	+	.	+	+	+	+	+	+	+	+	+	.	+	.
E2 S. subsimplex	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E2 Striaria attenuata	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
D *Phæostroma parasilicum*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
B2 Ph. pustulosum[20]	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	+	.
B1 Symphyocarpus strangulans	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	+	.
A Kjellmania subcontinua	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
A Coelocladia arctica	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
B1 Delamarea attenuata	.	.	.	+	.	+	+	.	.	.	+	.	.	.	.	.	+
C *Scytosiphon lomentarius*[21]	.	+	.	.	.	+	+	.	+	+	+	+	+	+	+	+	+
D *Phyllitis zosterifolia*	.	.	.	.	.	.	+	.	+	+	.	.	.	+	.	+	+
C *Ph. fascia*	.	+	+	.	.	+	+	+	+	+	+	+	+	+	+	+	+
Dictyosiphonaceæ.																	
B1 Coilodesme bulligera	.	.	.	.	.	+	+	.	+	+	+	.	.	.	.	.	.
E2 Gobia baltica[22]	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D *Dictyosiphon Ekmani*	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.	+	+
D D. Mesogloia	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.
D D. Chordaria	.	.	.	.	.	.	+	.	+	+	+	.	+	.	.	+	.

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Færöes	Shetland	Scotland	Atlant. N.-America
A D. corymbosus	.	+	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.
B2 *D. hippuroides*	.	+	+	+	.	.	+	+	+	+	+	+	+	+	.	+	+
B1 D. hispidus	.	+	.	+	.	.	+	.	.	.	+	.	.	.	.	+	+
B2 *D. foeniculaceus*	.	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+
E2 D. Macounii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Desmarestiaceæ.																	
B2 *Desmarestia viridis*	.	+	+	+	.	+	+	.	+	+	+	+	+	+	+	+	+
B2 *D. aculeata*	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
E1 *D. ligulata*	.	.	.	.	.	.	.	.	.	+	.	.	+	+	+	+	
E2 Arthrocladia villosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
Sporochnaceæ.																	
E2 Sporochnus pedunculatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Chordariaceæ.																	
E1 *Leathesia difformis*[23]	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+	+
A Myriocladia callitricha	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
E2 M. Zosteræ	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
E3 Mesogloia Griffithsiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	***
D M. vermicularis	.	+	.	.	.	.	.	.	.	.	.	+	+	.	+	+	+
D *Castagnea virescens*	.	+	+	.	.	.	+	.	+	+	+	+	+	+	.	+	+
E2 Chordaria divaricata	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
B2 *Ch. flagelliformis*	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+
E2 Stilophora rhizodes	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
E3 S. tuberculosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
D Spermatochnus paradoxus	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.
E3 S. Lejolisii	.	.	.	.	.	.	.	.	.		.	.	.	.	.	+	.
Chordaceæ.																	
B2 *Chorda filum*	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B2 *Ch. tomentosa*	.	.	.	.	.	.	+	.	+	+	+	.	+	+	.	+	+
Laminariaceæ.																	
B1 Sacchorhiza dermatodea	.	+	+	+	+	+	+	.	+	+	+	.	.	.	.	.	+
E2 S. bulbosa	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.
A Laminaria Solidungula	+	+	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.
A L. Agardhii[24]	.	+	+	+	+	.	.	.	.	.	+	.	.	.	.	.	.
D *L. sacharina*	.	?	+	.	.	+	.	.	+	+	+	+	+	+	+	+	+
B1 *L. færöensis*	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.
B1 L. longicruris	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	+
A L. cuneifolia	+	.	?	.	.	.	+	.	.	.	.	.	.	.	.	.	.
A L. groenlandica[25]	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	+
A L. nigripes[26]	+	+	.	+	.	+	+	.	+	.	+	.	.	.	.	.	.
B2 *L. digitata*	.	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+
D *L. hyperborea*	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+	.
B1 Agarum Turneri	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	+
D *Alaria esculenta*	.	.	.	+	.	+	.	.	+	+	+	+	+	+	+	+	+
B1 *A. Pylaii*	.	+	+	+	+	+	+	.	+	+	+	+	.	+	.	.	+
A A. oblonga	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
A A. dolichorachis	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
A A. elliptica	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W Iceland	Finmark	Nordland	West Norway	Faeröes	Shetland	Scotland	Atlant. N.-America
Cutleriaceæ.																	
E1 Cutleria multifida	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.
Tilopteridaceæ.																	
B2 Haplospora globosa[27]	.	+	.	+	.	+	.	.	.	.	+	.	+	.	.	+	+
E2 Scaphospora Kingii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E2 Tilopteris Mertensii	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.
Fucaceæ.																	
D *Fucus spiralis*	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+	+
D F. ceranoides	.	.	.	+	.	.	.	.	.	.	.	+	+	.	+	+	+
B2 *F. inflatus*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	.	+
D F. serratus	.	+	+	+	.	.	.	.	.	+	+	+	+	.	+	+	?
C *F. vesiculosus*	.	+	+	.	.	+	+	.	+	+	+	+	+	+	+	+	+
D *Pelvetia canaliculata*	.	.	+	.	.	.	.	.	.	+	+	+	+	+	+	+	.
C *Ascophyllum nodosum*[28]	.	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+
D *Himanthalia lorea*	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.
E1 *Halidrys siliquosa*	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	?
E3 Bifurcaria tuberculata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 Cystosira ericoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 C. granulata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E3 Sargassum bacciferum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
E3 S. Filipendula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Dictyotaceæ.																	
E3 Taonia Atomaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
E2 Dictyota dichotoma	.	.	.	.	.	.	.	.	.	.	.	.	+		.	+	.

[1] We have referred *Bangia crispa* to this species.

[2] We refer *Porphyra amethystea* Kütz. to *P. umbilicalis.*

[3] This species has been collected by Helgi Jónsson at Kolbeinsá in N. W. Iceland, but no reference to it has yet been published.

[4] Found by F. Børgesen 1905 near Christianssund.

[5] As *Gymnogongrus Torreyi* (Ag.) J. Ag. is not sufficiently known, we prefer to omit it from the list.

[6] We have seen several specimens of *T. rosacea* J. Ag. from Spitzbergen in the collection of the Botanical Museum in Copenhagen. Some of these specimens have been collected by Berggren and determined by J. Agardh, and some have been communicated by J. Agardh. As these plants fully agree with the description of *T. Pennyi, T. rosacea* must be considered as identical with this species. (Cfr. J. Agardh, Species, Genera et Ordines Algarum. Vol. 3 p. 221).

[7] According to original specimens, *Halosaccion pubescens* Foslie is to be considered as belonging to the form series of *Halosaccion ramentaceum* nearest related to f. *subsimplex.*

[8] Including *Delesseria angustissima* (Turn.) Grev.

[9] This species has only been found cast ashore on the coast of New England.

[10] Dr. L. Kolderup Rosenvinge has most kindly told us that *P. Schübelerii* Fosl. is a form of *P. elongata* and that he considers *P. fibrillosa* (Dillw.) Grev. as a form of *P. violacea.*

[11] Only found washed ashore in Spitzbergen.

[12] As several writers have indicated different species as *P. pulvinata*, we do not know what is meant by *P. pulvinata* Boye (7). We have therefore not mentioned it in our list.

[13] *Rhodomela virgata* appears to belong to this species.

[14] Including *Rhodochorton parasiticum* Batt. and *Rh. sparsum* (Carm.) Kjellm.

[15] *Chilionema* sp. in Borgesens flora (8) is, we think, referable to this species.

[16] Mr. Foslie has kindly informed us that *Ectocarpus obovatus* Fosl. is a form of *Ectocarpus littoralis*.

According to the original specimens *Ectocarpus Landsburghii* Fosl. is identical with *Ectocarpus littoralis* var. *varia* (Kjellm.).

[17] Having examined the original specimens of *Ectocarpus Hansteenii* we are of opinion that this species belongs to *E. siliculosus*.

[18] We have followed J. Agardh (Till Algernes Systematik, IV p. 15) in referring *Elachista Grevillei* Harv. to *E. fucicola*.

[19] Including *Punctaria tenuissima* Grev.

[20] To this species we refer both *Ph. æquale* (Oltm.) Kuck. and *Ph. prostratum* (Gran) Kuck.

[21] According to an original specimen in the Botanical Museum at Copenhagen *Coilonema filiforme* Fosl. is identical with *Scytosiphon lomentarius*. *Chordaria attenuata* Fosl. referred by Foslie to the genus *Scytosiphon* (p. 97 footnote) has also proved to be *Scytosiphon lomentarius*.

[22] Mr. Foslie has informed us that the material of *Gobia baltica* from Finmark is in too bad a condition to be determined.

[23] As *Leathesia crispa Harv.* is insufficiently known we have not mentioned it in the list. (Cfr. J. Agardh, Till Allgernes Systematik. IV, p. 40).

[24] The specimens of *Laminaria Agardhii* from Rhode Island in Phyc. Bor. Am. Nr. 1083—1084 are too young to be determined.

[25] We think that *Laminaria caperata* from the coast of New England most probably belongs to *L. groenlandica*.

[26] We are indebted to Mr. Foslie for having given us an opportunity of examining an original specimen of *Laminaria Gunneri* Fosl. The specimen in question however proved to be identical with *L. nigripes β atrofulva*. We have moreover received from Mr. Foslie eight undetermined specimens of a *Laminaria* washed ashore at Berlevaag in East-Finmark. These specimens were gathered in February—March and had welldeveloped sorus in the lower part of the Lamina. The greater part of the specimens had fully typical muciparous canals in the stipe but only a few of them were destitute of the canals. These specimens also agree very well with *L. nigripes* and thus it seems to us, that Foslie is not right in thinking that the Norwegian specimens are different from the Spitzbergan ones (cfr. Foslie, p. 59), nor Kjellman in omitting this species in his »Handbok i Skandinaviens hafsalgflora«.

[27] *Scaphospora arctica* Kjellm. belongs without doubt to *Haplospora globosa* Kjellm.

[28] We refer *Ascophyllum Mackaii* as a variety to *A. nodosum*.

This list contains 226 (+ 15) species of Rhodophyceæ and 181 (+ 9) species of Phæophyceæ, in all 407 (+ 24) species. Regarding the investigation of the distribution of the different species we have laid the greatest stress upon finding the southern boundary of those species which belong most strictly to the colder waters or the Arctic Sea, and the northern limit of those characteristic of the Boreal Region of the Atlantic, viz: the area which is limited to the south by the tropic of cancer and to the north by the Arctic Sea. With regard to the southern distribution of the Boreal Algæ we have as the following grouping will show, not followed them farther southwards than to the Mediterranean and the Atlantic coast of North Africa, as we thought that this area would be sufficient to give an opinion on their phytogeographical significance in regard to our papers on the Algæ-vegetation of Iceland and the Færöes. In the following grouping of the Algæ we have taken no consideration of the Algæ strictly belonging to America, as we did not think our knowledge of their distribution sufficient, but we have however included them within a paranthesis in the groups to which they appear to belong.

With regard to the following grouping we shall mention more particularly the Arctic group and especially the southern limit of the area of the Arctic Alga-flora.

The polar circle has previously (e.g. by Kjellman and Reinke) been regarded as the southern limit of the Arctic Alga-flora as regards the Norwegian coast, while the limit near to the American coast has been set much more southwards (e.g. Kjellman and Rosenvinge). The Arctic Alga-flora has thus been limited in highly different manner on either side of the Atlantic. No doubt the limit as regards the American coast is almost correct, while the polar circle cannot be used as a limit next to the Norwegian coast[1], as may be seen from the hydrographical conditions of the north of Norway and from the Algæ-flora of Nordland and Finmark. The Alga-flora of the north of Norway belongs phyto-geographically to the Boreal area of the Atlantic, and it passes without any distinct limit into the arctic Alga-flora to the north and east of Norway. The south limit of the Arctic Alga-flora thus goes to the north of Norway, and following it westwards we shall see, that it turns considerably southwards and touches the south-east point of Iceland, where the boundary both hydrographically and phytogeographically is

[1] This has been pointed out by Simmons (Bot. Not. 1904 p. 216).

fairly sharply marked. From here the boundary line goes to the north of Iceland between Iceland and Greenland and then turns considerably southwards to the north Atlantic coast of America. It is quite impossible for us to set the limit on the American coast, but we suppose that a large border-area is to be found which possibly extends southwards to Cape Cod (cfr. Farlow). Regarding Iceland and Norway the southern limit of the Arctic Algæ-flora will nearly coincide with that of the Isotherm of 4° C. for a year in Mohn's hydrographical map (tab. XVI).

The main points are: The Boreal flora of the Atlantic extends far into the northern Polar Sea on the coast of Europe, whereas, on the coast of America the Arctic flora extends far southwards into the Atlantic, which also corresponds with the hydrographical conditions.

A. THE ARCTIC GROUP (cfr. above).

Rhodophyceæ.

Callymenia sanguinea Schmitz.
Ceratocolax Hartzii K. Rosenv.
Turnerella Pennyi (Harv.) Schmitz.
Delesseria Baerii (Post. et Rupr.) J. Ag.
D. Montagnei Kjellm.
Polysiphonia arctica J. Ag.
Rhodochorton spetzbergense Kjellm.
Dilsea integra (Kjellm.) K. Rosenv.
Petrocelis polygyna (Kjellm.) Schmitz.
Cruoria arctica Schmitz.
Lithothamnion flavescens Kjellm.
L. foecundum Kjellm.
L. arcticum Kjellm.

13 species.

Phæophyceæ.

Ectocarpus pycnocarpus K. Rosenv.
Omphalophyllum ulvaceum K. Rosenv.
Kjellmania subcontinua K. Rosenv.
Coelocladia arctica K. Rosenv.
Dictyosiphon corymbosus Kjellm.
Myriocladia callitricha K. Rosenv.
Laminaria solidungula J. Ag.
L. Agardhii Kjellm.
L. cuneifolia J. Ag.
L. groenlandica K. Rosenv.
L. nigripes J. Ag.
Alaria oblonga Kjellm.
A. dolichorhachis Kjellm.
A. elliptica Kjellm.

14 species.

B. THE SUBARCTIC GROUP.

Subdivision I.

The species we refer to this subdivision are common in the Arctic Sea, rather common in the cold-boreal area of the Atlantic Ocean as far south as to the Færöes and Nordland; some of them occur, but rarely, as far south as England.

Rhodophyceæ.

Rhodophyllis dichotoma (Lepech.) Gobi.
Halosaccion ramentaceum (L.) J. Ag.
[Rhodomela larix (Turn.) Ag.]
Ptilota pectinata (Gunn.) Kjellm.
Rhodochorton penicilliforme (Kjellm.) K. Rosenv.
Peyssonellia Rosenvingii Schmitz.
Phymatolithon compactum (Kjellm.) Fosl.
Lithothamnion læve (Strömf.) Fosl.
L. tophiforme Unger.

8 + 1 species.

Phæophyceæ.

Lithoderma fatiscens Aresch.
Sorapion Kjellmani (Wille) K. Rosenv.
Ralfsia ovata K. Rosenv.
R. deusta (Ag.) J. Ag.
Myrionema Laminariæ (K. Rosenv.) Jóns.
M. globosum (Rke.) Fosl.
Ectocarpus aecidioides K. Rosenv.
E. helophorus K. Rosenv.
E. ovatus Kjellm.
Sphacelaria britannica Sauv.
S. racemosa Grev.
Chætopteris plumosa (Lyngb.) Kütz.
Phæosaccion Collinsii Farl.
Symphyocarpus strangulans K. Rosenv.
Delamarea attenuata (Kjellm.) K. Rosenv.
Coilodesme bulligera Strömf.
Dictyosiphon hispidus Kjellm.
Saccorhiza dermatodea (De la Pyl.) J. Ag.
Laminaria færoensis Borgs.
L. longicruris De la Pyl.
Agarum Turneri Post. et Rupr.
Alaria Pylaii (Bory) J. Ag.

22 species.

Subdivision 2.

This subdivision includes species, which are either common in the Arctic Sea and the northern Atlantic from West-France—England northwards or if not common at least equally frequent.

Rhodophyceæ.

Porphyra miniata (Ag.) Ag.
Conchocelis rosea Batt.
Chantransia efflorescens (J. Ag.) Kjellm.
Ch. virgatula (Harv.) Thur.
Harveyella mirabilis (Reinsch) Schm. et Rke.
Phyllophora Brodiæi (Turn.) J. Ag.
Actinococcus subcutaneus (Lyngb.) K. Rosenv.
Euthora cristata (L.) J. Ag.
Rhodymenia palmata (L.) Grev.
Delesseria sinuosa (G. et W.) Lam.
Rhodomela lycopodioides (L.) Ag.
Odonthalia dentata (L.) Lyngb. } not in
Ptilota plumosa (L.) Ag. . . . } Greenland.
Lithothamnion glaciale Kjellm.

14 species.

Phæophyceæ.

Ralfsia clavata (Carm.) Farl.
Ectocarpus tomentosoides Farl.
Leptonema fasciculatum Rke.
Elachista fucicola (Vell.) Aresch.
Punctaria plantaginea (Roth) Grev.
Isthmoplea sphærophora (Harv.) Kjellm.
Litosiphon filiforme (Rke.) Kuck.
Stictyosiphon tortilis (Rupr.) Rke.
Phæostroma pustulosum Kuck.
Dictyosiphon hippuroides (Lyngb.) Kütz.
D. foeniculaceus (Huds.) Grev.
Desmarestia viridis (Müll.) Lam.
D. aculeata (L.) Lam.
Chordaria flagelliformis (Müll.) Ag.
Chorda filum (L.) Stackh.
Ch. tomentosa Lyngb.
Laminaria digitata (L.) Lam.
Haplospora globosa Kjellm.
Fucus inflatus L.

19 species.

C. THE BOREAL-ARCTIC GROUP.

The species of this group are common in the Arctic Sea and the Boreal area of the Atlantic at least as far south as to the Atlantic coast of North Africa, probably some of them have a far greater southern distribution. The species marked with an * might possibly be considered as cosmopolitan.

Rhodophyceæ.

Bangia fuscopurpurea (Dillw.) Lyngb.
Porphyra umbilicalis (L.) J. Ag.
Chantransia microscopica (Näg.) Fosl.
Ch. secundata (Lyngb.) Thur.
Ahnfeltia plicata (Huds.) Fries (not in Greenland).
Polysiphonia elongata (Huds.) Harv. (not common in the Arctic Sea).
* Antithamnion Plumula (Ellis) Thur.
Ceramium rubrum (Huds.) Ag.
Rhodochorton membranaceum Magn.
R. Rothii (Turt.) Näg.
Hildenbrandia rosea Kütz.

11 species.

Phæophyceæ.

*Ectocarpus littoralis (L.) Lyngb.
E. confervoides (Roth) Le Jol.
*E. siliculosus (Dillw.) Lyngb.
*Scytosiphon lomentarius (Lyngb.) J. Ag.
*Phyllitis fascia (Müll.) Kütz.
*Fucus vesiculosus L.
Ascophyllum nodosum (L.) Le Jol.

7 species.

D. THE COLD-BOREAL GROUP.

The species of this group have their area of distribution from West France-England northward to South Iceland, the Færöes and Nordland-Finmark. Some few species have occasionally been found in the Arctic Sea, especially in the White Sea and the Murman Sea and some few reach as far south as to the Mediterranean or North Africa.

Rhodophyceæ.

Erythrotrichia ceramicola (Lyngb.) Aresch.
Porphyra coccinea J. Ag.
Chantransia Alariæ Jónss.
Ch. Daviesii (Dillw.) Thur.
Choreocolax Polysiphoniæ Reinsch.
Gigartina mamillosa (G. et W.) J. Ag.
Phyllophora membranifolia (G. et W.) J. Ag.
Callocolax neglectus Schmitz.
Sterrocolax decipiens Schmitz.
Cystoclonium purpurascens (Huds.) Kütz.
Lomentaria rosea (Harv.) Thur.
Delesseria alata (Huds.) Lam.
D. sangvinea (L.) Lam.
Polysiphonia urceolata (Lightf.) Grev.
P. violacea (Roth) Grev.
P. fastigiata (Roth) Grev.
P. atrorubescens (Dillw.) Grev.
P. nigrescens (Huds.) Harv.
Rhodomela subfusca (Woodw.) Ag.
Spermothamnion Turneri (Mert.) Aresch.
Callithamnion polyspermum (Bonnem.) Ag.
C. Hookeri (Dillw.) Ag.
C Arbuscula (Dillw.) Lyngb.
C. roseum (Roth) Harv.
Plumaria elegans (Bonnem.) Schmitz.
Antithamnion floccosum (Müll.) Kleen.
Ceramium Deslongchampsii Chauv.
C. circinatum (Kütz.) J. Ag.
C. diaphanum (Lightf.) Roth.
C. acanthonotum Carm.
Rhodochorton seiriolanum Gibs.

Rh. minutum (Suhr) Rke.
Rh. repens Jónss. (endemic in Iceland).
Dumontia filiformis (Fl. Dan.) Grev.
Dilsea edulis Stackh.
Furcellaria fastigiata (L.) Lam.
Polyides rotundus (Gmel.) Grev.
Petrocelis Middendorfii (Rupr.) Kjellm. (endem. in Finmark).
P. cruenta J. Ag.
P. Hennedyi (Harv.) Batt.
Cruoriella Dubyi (Cr.) Schmitz.
Rhododermis elegans Cr.
Rh. parasitica Batt.
Phymatolithon lævigatum Fosl.
Ph. polymorphum (L.) Fosl.
Ph. investiens Fosl.
Lithothamnion Lenormandi (Aresch.) Fosl.
L. intermedium Kjellm.
L. fornicatum Fosl.
L. norvegicum (Aresch.) Kjellm.
Lithophyllum Crouani Fosl.
L. incrustans Phil.
L. macrocarpum (Ros.) Fosl.
L. hapalidioides Fosl.
Corallina officinalis L.

55 species.

Phæophyceæ.

Lithoderma lignicola Kjellm. (endem. in Finmark).
Petroderma maculiforme (Wollny) Kuck
Ralfsia verrucosa (Aresch.) J. Ag.
Myrionema vulgare Thur.
M. Corunnæ Sauv.
M. foecundum (Strömf.) Fosl.
M. færoense Borgs. (Iceland, Færöes).
M speciosum Borgs. (endem. in Færöes).
[Hecatonema maculans (Collins) Sauv.]
Chilionema reptans (Cr.) Sauv.
Ascocyclus islandicus Jónss. (endem. in Iceland).
Microsyphar Polysiphoniæ Kuck.
M. Zosteræ Kuck.
Ectocarpus Turnerellæ Fosl.
E. Pringsheimii Rke.
E. Stilophoræ Cr.
E. terminalis Kütz.
E. velutinus (Grev.) Kütz.
E. nanus Kjellm. (endem. in Finmark).
E. lucifugus Kuck.
E. borealis Kjellm. (endem. in Nordland).
E. tomentosns (Huds.) Lyngb.
E. dasycarpus Kuck.
E. penicillatus (Ag.) Kjellm.
E. draparnaldioides Cr.
E. fasciculatus (Griff.) Harv.
E. granulosus (Engl. Bot.) Ag.
E. Hincksiæ Harv.
Myriotrichia filiformis Harv.
Elachista scutulata (Sm.) Dub.
Sphacelaria radicans Harv.
S. olivacea Pringsh.
S. cæspitula Lyngb.
S. furcigera Kütz.
S. cirrosa Ag.
Cladostephus spongiosus (Lightf.) Ag.
Desmotrichum undulatum (J. Ag.) Rke.
Litosiphon Laminariæ (Lyngb.) Harv.
Phæostroma parasitica Borgs. (endem. in Færöes).
Phyllitis zosterifolia Rke.
Dictyosiphon Ekmani Aresch.
D. Mesogloia Aresch.
D. Chordaria Aresch.
Mesogloia vermicularis Ag.
Castagnea virescens (Carm.) Thur.
Spermatochnus paradoxus (Roth) Kütz.
Laminaria saccharina (L.) Lam.
L. hyperborea (Gunn.) Fosl.
Alaria esculenta (L.) Grev.
Fucus spiralis L.
F. ceranoides L.
F. serratus L.
Pelvetia canaliculata (L.) Dec. et Thur.
Himanthalia lorea (L.) Lyngb.

53 (+ 1) species.

E. THE WARM-BOREAL GROUP.

The most part of the species referred to this group go at least as far south as to the Mediterranean and the Atlantic coast of North Africa. According to the different distribution northwards

we have divided the group in three parts, mostly for the sake of convenience with regard to our works on the Alga-vegetation of Iceland and the Færöes, but no capital phytogeographical importance is connected to this division of the group.

1. The following species go as far north as to South Iceland, the Færöes or Northern Norway, and at least as far south as the Mediterranean and North Africa.

Rhodophyceæ.

Porphyra leucosticta Thur.
Chondrus crispus (L.) Stackh.
Callophyllis laciniata (Huds.) Kütz.
Lomentaria clavellosa (Turn.) Gaill.
L. articulata (Huds.) Lyngb.
Plocamium coccineum (Huds.) Lyngb.
Nitophyllum laceratum (Gmel.) Grev.
Laurencia pinnatifida (Gmel.) Lam.
Polysiphonia Brodiæi (Dillw.) Grev.
Pterosiphonia parasitica (Huds.) Falkenb.
Brongniartella byssoides (G. et W.) Bory.
Griffithsia setacea (Ell.) Ag.
Callithamnion scopulorum Ag.
C. corymbosum (Sm.) Lyngb.
C. granulatum Ag.
Cruoria pellita (Lyng.) Fr.

16 species.

Phæophyceæ.

Punctaria latifolia Grev.
Asperococcus echinatus (Mert.) Grev.
Desmarestia ligulata (Lightf.) Lam.
Leathesia difformis (L.) Aresch.
Cutleria multifida (Smith) Grev.
Halidrys siliquosa (L.) Lyngb.

6 species.

2. The following species are distributed from North Scotland (incl. the Orkneys) and West Norway southward. The most of the species occur at least as far south as to the Mediterranean and the Atlantic coast of North Africa, probably some of them go farther south. Some of the species occur not farther south than to England and West France.

Rhodophyceæ.

Nemalion multifidum (W. et M.) J. Ag.
Helminthora divaricata (Ag.) J. Ag.
Gelidium crinale J. Ag.
G. pusillum Le Jol.
G. corneum Lam.
G. latifolium Born.
Phyllophora rubens (G. et W.) Grev.
Gymnogongrus Griffithsiæ (Turn.) Mart.
G. norvegicus (Gunn.) J. Ag.
Colacolepis incrustans Schmitz.
Callymenia reniformis (Turn.) J. Ag.
Catenella Opuntia (G. et W.) Grev.
Rhodophyllis appendiculata J. Ag.
Rh. bifida (G. et W.) Kütz.
Sphærococcus coronopifolius (G. et W.) Ag.
Gracilaria confervoides (L.) Grev.
Calliblepharis ciliata (Huds.) Kütz.
C. jubata (G. et W.) Kütz.
Rhodymenia palmetta (Esp.) Grev.
Champia parvula (Ag.) Harv.
Chylocladia kaliformis (G. et W.) Hook.
Ch. ovalis (Huds.) Hook.
Nitophyllum Gmelini Grev.
N. Bonnemaisoni Grev.
N. Hilliæ Grev.
N. punctatum (Stackh.) Grev.
N. uncinatum (Turn.) J. Ag.
[Grinnellia americana (Ag.) Harv.]
Delesseria Hypoglossum Lam.
D. ruscifolia (Turn.) Ag.
[Caloglossa Leprieurii (Mont.) Ag.]

Bonnemaisonia asparagoides (Woodw.) Ag. (the occurrence of this species in Iceland is doubtful).
Laurencia cæspitosa Lam.
L. obtusa (Huds.) Lam.
[Chondria atropurpurea Harv.]
Ch. dasyphylla (Woodw.) Ag.
Ch. tenuissima (G. et W.) Ag.
Polysiphonia fibrata (Dillw.) Harv.
P. macrocarpa Harv.
[P. vestita J. Ag.]
[P. Olneyi Harv.]
[P. Harveyi Bail.]
P. spinulosa Grev.
P. elongella Harv.
P. simulans Harv.
Dasya arbuscula (Dillw.) Ag.
Heterosiphonia coccinea (Huds.) Falkb.
[Griffithsia Bornetiana Farl.]
G. corallinoides (L.) Batt.
Monospora pedicellata (Sm.) Sol.
Pleonosporium Borreri (Sm.) Näg.
Callithamnium tenuissimum (Bonnem.) Kütz.
C. tetragonum Ag.
C. Brodiæi Harv.
[C. Baileyi Harv.]
C. byssoides Arn.
Seirospora Griffithsiana Harv.
Compsothamnion thuyoides (Sm.) Näg.
Ceramium fastigiatum Harv.
C. tenuissimum (Lyngb.) J. Ag.
C. echionotum J. Ag.
[C. Hooperi Harv.]
C. arborescens J. Ag.
C. ciliatum (Ellis) Ducl.
C. flabelligerum J. Ag.
Microcladia glandulosa (Sol.) Grev.
Rhodochorton floridulum (Dillw.) Näg.
Gloiosiphonia capillaris (Huds.) Carm.
Halarachnion ligulatum (Woodw.) Kütz.
Lithothamnion membranaceum (Esp.) Fosl.
L. Sonderi Hauck.
L. calcareum (Pall.) Aresch.
Lithophyllum orbiculatum Fosl.
L. pustulatum (Lam.) Fosl.
Melobesia farinosa Lam.
M. Lejolisii Ros.
M. minutula Fosl. (endem. in West Norway).
Corallina rubens L.

69 + 9 species.

Phæophyceæ.

Ralfsia pusilla (Strömf.) Batt.
Myrionema balticum (Rke.) Fosl.
M. intermedium Fosl. (endem. in West Norway).
Chilionema ocellatum (Rke.) Sauv.
Ascocyclus orbicularis (J. Ag.) Magn.
Microspongium gelatinosum Rke.
[Ectocarpus Chordariæ Farl.]
E. sphæricus Derb. et Sol.
[E. subcorymbosus Farl.]
E. globifer Kütz.
[E. lutosus Harv.]
E. Mitchellæ Harv.
Acinetospora pusilla (Griff.) Born.
Myriotrichia repens Hauck.
M. claváeformis Harv.
Myriactis Haydeni (Gatt.) Batt.
Elachista stellaris Aresch.
Giraudia sphacelarioides Derb. et Sol.
Sphacelaria bipinnata (Kütz.) Sauv.
Cladostephus verticillatus (Lightf.) Ag.
Desmotrichum balticum Kütz.
Asperococcus bullosus L.
A. compressus Griff.
Litosiphon pusillus (Carm.) Hav.
Stictyosiphon brachiatus (Griff.) Born.
[S. subsimplex Holden.]
Striaria attenuata Grev.
Gobia baltica Rke.
Dictyosiphon Macouni Farl.]
Arthrocladia villosa (Huds.) Dub.
Sporochnus pedunculatus (Huds.) Ag.
Myriocladia Zosteræ (Lyngb.) J. Ag.
Chordaria divaricata Ag.
Stilophora rhizodes (Ehrh.) J. Ag.
Saccorhiza bulbosa (Huds.) De la Pyl.
[Scaphospora Kingii Farl.]
Tilopteris Mertensii (Smith) Kütz.
Dictyota dichotoma (Huds.) Lam.

32 + 6 species.

3. These species have their northern limit in South Scotland and occur southward to North Africa or farther south. Some of them however do not go farther south than to England, West-France and some other have not been found as far north as Scotland.

Rhodophyceæ.

Erytrotrichia investiens Bornet.
E. ciliaris (Carm.) Batt.
Goniotrichum elegans (Chauv.) Le Jol.
G. ramosum (Thwaites) Hauck.
Chantransia Chylocladiæ (Batt.) (endem. in Scotland).
Nemalion helminthoides (Vell.) Batt.
Scinaia furcellata (Turn.) Bivona.
Choreocolax tumidus Reinsch.
Naccaria Wigghii (Turn.) Endl.
Gelidium aculeatum (Grev.) Batt.
G. pulchellum (Grev.) Kütz.
G. attenuatum (Hook.) Thur.
Pterocladia capillacea (Grev.) Born.
Phyllophora Traillii Holmes.
Actinococcus aggregatus Schmitz.
A. peltæformis Reinsch.
[Agardhiella tenera (J. Ag.) Schmitz.]
Gracilaria multipartita (Clem.) J. Ag.
Hypnea musciformis (Wulf.) Lam.
Cordylecladia erecta (Grev.) J. Ag.
Lomentaria uncinata Menegh.
[Chondria littoralis Harv.]
[Polysiphonia subtilissima Mont.]
P. Richardsoni Hook. (endem. in Scotland).
P. fruticulosa (Wulf.) Spreng.
P. variegata (Ag.) Zanard.
P. subulifera (Ag.) Harv.
Pterosiphonia thuyoides (Harv.).
[Bostrychia rivularis Harv.]
B. scorpioides (Gmel.) Mont.
Dasya elegans (Mart.) Ag.
Sphondylothamnion multifidum (Huds.) Näg.
Spermothamnion strictum (Ag.) Ard.
S. barbatum (Ag.) Born.
Ptilothamnion pluma (Dillw.) Thur.
[Griffithsia tenuis Ag.]
Halurus equisetifolius (Lghtf.) Kütz.
Callithamnion acrospermum J. Ag.
Compsothamnion gracillimum (Harv.) Näg.
Antithamnion cruciatum Ag.
Spyridia filamentosa (Wulf.) Harv.
Ceramium pennatum Arn.
Dudresnaya coccinea Born.
Nemastoma Bairdii Farl.
Corallina squamata Ellis et Sol.

40 + 5 species.

Phæophyceæ.

Ectocarpus Zanardinii Cr.
E. parasiticus Sauv.
E. simplex Cr.
E. Crouani Thur.
E. Landsburghii Harv.
E. distortus Carm. (endem. in S. Scotland).
E. Sandrianus Zanard.
E secundus Kütz.
Sorocarpus uvæformis Pringsh.
Myriotrichia densa Batt.
Halothrix lumbricalis (Kütz.) Rke.
Myriactis stellulata (Griff.) Batt.
M. Areschougii (Cr.) Batt.
M. pulvinata Kütz.
Elachista flaccida (Dillw.) Aresch.
Sphacelaria plumigera Holmes.
S. plumula Zan.
S. tribuloides Menegh.
Halopteris filicina (Grat.) Kütz.
H. scoparium (L.) Sauv.
Asperococcus scaber Kuck.
Mesogloia Griffithsiana Grev.
Stilophora tuberculosa (Horn.) Rke.
Spermatochnus Lejolisii (Thur.) Rke.
Bifurcaria tuberculata Stackh.
Cystoseira ericoides (L.) Ag.
C. granulata (L.) Ag.
[Sargassum bacciferum (Turn.) J. Ag.
[S. filipendula Ag.]
Taonia Atomaria (G. et W.) Ag.

28 + 2 species.

The following table shows how many species of each group, each flora in question contains.

	Number of species			A			B1			B2			C			D			E1			E2			E3		
	Rhodophyceæ	Phæophyceæ	All in All	Rhodophyceæ	Phæophyceæ		Rhodophyceæ	Phæophyceæ		Rhodophyceæ	Phæophyceæ		Rhodophyceæ	Phæophyceæ		Rhodophyceæ	Phæophyceæ		Rhodophyceæ	Phæophyceæ		Rhodophyceæ	Phæophyceæ		Rhodophyceæ	Phæophyceæ	
The Siberian Sea	10	13	23	3	6	9	1	3	4	4	3	7	2	1	3												
The Murman Sea	37	35	72	7	4	11	5	8	13	10	12	22	7	6	13	8	5	13									
The White Sea	26	26	52	2	1	3	5	5	10	8	11	19	3	5	8	8	4	12									
Spitzbergen	31	29	60	7	3	10	6	8	14	10	12	22	6	3	9	2	3	5									
Jan Mayen and Bear Island	17	11	28	5	2	7	4	2	6	7	5	12	1	2	3												
East Greenland	32	46	78	8	5	13	7	18	25	11	14	25	5	7	12	1	2	3									
West Greenland	41	63	104	8	10	18	8	19	27	11	18	29	10	7	17	4	9	13									
Arctic America	24	15	39	6	1	7	6	5	11	8	7	15	3	2	5	1	0	1									
North East Iceland	45	55	100	5	3	8	8	11	19	11	18	29	10	7	17	11	15	26	0	1	1						
South West Iceland	65	60	125	3	0	3	8	11	19	12	18	30	9	7	16	26	22	48	6	2	8	1	0	1			
Finmark	65	60	125	4	3	7	8	13	21	14	15	29	11	7	18	26	19	45	2	3	5						
Nordland	70	53	123	1	0	1	7	5	12	8	12	20	9	7	16	36	25	61	9	4	13						
West Norway	101	89	190	1	0	1	4	2	6	9	18	27	9	7	16	39	33	72	12	6	18	27	23	50			
The Færöes	83	72	155	0	0	0	6	8	14	14	17	31	10	7	17	38	35	73	15	5	20	0	0	0			
Shetland	49	38	87	0	0	0	0	0	0	6	9	15	8	6	14	21	14	35	11	5	16	3	4	7			
Scotland	184	128	312	0	0	0	1	11	12	13	18	31	11	7	18	46	35	81	15	6	21	67	23	90	31	28	59
The Atl. coast of North-Amer.	109	93	202	2	2	4	6	13	19	11	16	27	10	7	17	30	26	56	3	3	6	27	20	47	20	6	26

SUPPLEMENT.

As the distribution of the Chlorophyceæ and Cyanophyceæ is at present insufficiently known, and these groups of Algæ are very variously dealt with, we have been of opinion that no satisfactory result would be obtained by including in our list all the species, which have been reported from the area mentioned above (see above p. II). Hence we only give those species which are known from Greenland, Iceland and the Færöes, that is, species from a somewhat limited area, the Algæ-flora of which has been described under the same system of classification. The occurrence of these species within the larger area, however, is also stated in the following list.

We mention these groups of Algæ here, because when the species are classified on the same system, a comparison may be made between different floræ-districts just as well as for any other group of Algæ. We give these groups in a supplement, however, as we only refer to species from a part of the whole area we chose for our purpose.

Regarding the names of authors of species we refer to the Algæ-floræ of Greenland, Iceland and the Færöes (8, 31, 32, 45—47 in our Bibliography).

Chlorophyceæ.	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Færöes	Shetland	Scotland	Atlant. N.-America
Protococcaceæ.																	
B2 Chlorochytrium Cohnii	.	.	.	.	.	+	+		.	+	.	.	.	.		.	+
B2 Ch. dermatocolax	.		.		.	+	+	.	+	+	.	.	.		.	+	.
B1 *Ch. inclusum*	+	+	+	+	+	+	+	.	+	+	+	.	.	+	.	+	.
B1 Ch. Schmitzii	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	+
D Codiolum Petrocelidis	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+
B2 *C. gregarium*[29]	.	.	.	+	.	.	+	.	+	.	+	.	.	+	.	**	+
D *C. pusillum*	.	.	.	.	.	.		.	+	.	+	.	.	+	.	.	+
Ulvaceæ.																	
B2 *Percursaria percursa*	.	.	.	+	.	+	+	.	.	+	+	+	+	+	.	+	+
D Enteromorpha aureola	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	+
E1 *E. Linza*	.	.	.	.	.	.	.	.	.	+	.	.	+	+	+	+	+
C *E. intestinalis*[30]	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
C *E. clathrata*	.	.	.	+	.	.	.	.	+	+	+	+	+	+	?	+	+
A Monostroma groenlandicum	.	.	.	.	.	+	+	.	+	+	.	.	.	.	.	.	+
B2 *M. Grevillei*	.	+	+	+	.	+	+	.	+	+	+	+	.	+	.	+	+
B1 *M. undulatum*	.	.	.	.	.	.	+	.	+	+	+	+	.	+	.	+	+
A M. leptodermum		+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	+
B1 *M. fuscum*		+	+	+	.	+	+	+	+	+	+	+	+	.	+	+	+
C *Ulva Lactuca*	.	+	.	+	.	.	+	.	+	+	+	+	+	+	+	+	+

		Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Faeröes	Shetland	Scotland	Atlant. N.-America
	Prasiolaceæ.																	
D	*Prasiola crispa *marina*	.	.	.	.	.	.	+	.	.	+	+	.	.	+	+	**	.
D	*P. furfuracea*	.	.	.	.	.	.	.	.	+	+	+	.	.	+	.	.	.
D	*P. stipitata*	.	.	.	.	.	.	.	.	+	+	+	+	.	+	.	+	.
	Ulothricaceæ.																	
B1	Ulothrix subflaccida	.	.	.	.	.	+	+	.	+	.	.	.	*	.	.	.	.
B1	*U. consociata*	.	.	.	.	.	+	+	.	+	.	+	.	*	+	.	.	.
A	U. scutata	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
B1	*U. pseudoflacca*	.	.	.	.	.	+	+	.	+	+	.	.	*	+	.	.	.
B2	*U. flacca*	.	.	.	.	.	+	+	+	+	+	+	.	+	+	+	+	+
	Chætophoraceæ.																	
B2	Pseudendoclonium submarinum	.	.	.	.	.	.	.	.	+	.	.	.	*	.	.	.	+
D	Epicladia Flustræ	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	+
D	*Entoderma Wittrockii*	.	.	.	.	.	.	+	.	+	+	+	.	.	+	+	+	+
B1	Acrochæte parasitica	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	**	.
D	*A. repens*	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	+	.
A	Arthrochæte penetrans	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
B2	*Bolbocoleon piliferum*	.	.	+	.	.	+	+	.	+	+	+	+	*	+	.	+	+
B2	*Pilinia maritima*	.	+	.	+	.	.	+	.	.	.	+	.	.	+	.	.	+
	Mycoideaceæ.																	
D	Ochlochæte ferox	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	+	.
A	Chætobolus gibbus	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.
B2	*Ulvella fucicola*	.	.	.	.	.	+	+	.	+	+	.	.	.	+	+	**	.
B2	*U. confluens*	.	.	.	.	+	+	+	.	.	.	.	.	.	+	.	**	.
B2	*Pringsheimia scutata*	.	.	.	.	.	+	+	.	.	+	.	.	+	+	.	+	+
	Cladophoraceæ.																	
B2	*Urospora mirabilis*	.	+	.	+	.	+	+	.	+	+	+	+	*	+	+	+	+
B1	U. Hartzii	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	
A	U. crassa	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	
B2	*U. Wormskioldii*[31]	.	.	.	.	.	.	+	.	+	+	.	.	.	+	.	+	+
C	*Chætomorpha tortuosa*	.	.	.	.	.	+	+	.	+	+	+	+	+	+	+	+	+
B2	*Ch. Melagonium*	.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
C	*Rhizoclonium riparium*	.	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+	+
B1	Rh. pachydermum	+	+	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.
B2	*Spongomorpha vernalis*[32]	.	.	.	.	.	.	+	.	.	+	.	.	.	+	.	.	.
D	*Acrosiphonia albescens*[33]	.	.	.	.	.	.	.	.	+	+	?	+	.	+	.	+	.
B2	*A. incurva*	.	.	.	.	.	+	+	.	+	+	+	.	.	+	.	.	.
D	*A. flagellata*	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.
D	*A. grandis*	.	.	.	.	.	.	.	.	.	.	+	.	.	+?	.	.	.
D	A. flabelliformis	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
B1	*A. hystrix*[34]	.	.	.	.	+	+	+	.	+	+	+	.	.	+	.	.	+
B1	A. penicilliforme	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.	.
B2	*Cladophora rupestris*	.	+	+	.	.	.	+	.	+	+	+	+	+	+	+	+	+
B2	C. hirta	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	**	+
B2	*C. sericea*	.	.	.	.	.	.	+	.	+	+	.	.	+	+	.	+	+
D	C. glaucescens	.	.	.	.	.	.	.	+	.	+	+	+	+	.	.	+	+
C	*C. gracilis*	.	.	.	.	.	+	+	+	+	+	+	+	+	+	.	+	+
	Gomontiaceæ.																	
C	*Gomontia polyrhiza*	.	.	.	.	.	+	+	.	+	+	+	.	.	+	.	+	+

	Siberian Sea	Murman Sea	White Sea	Spitzbergen	Jan Mayen and Bear Island	East Greenland	West Greenland	Arct. N.-America	N. E. Iceland	S. W. Iceland	Finmark	Nordland	West Norway	Færöes	Shetland	Scotland	Atlant. N.-America
Phyllosiphonaceæ.																	
B2 *Ostreobium Queketti*	.	.	.	.	+	+	+	.	+	+	+	.	.	+	.	+	+
Bryopsidaceæ.																	
E *Bryopsis plumosa*	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	+
Derbesiaceæ.																	
D *Derbesia marina*	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	**	.
Vaucheriaceæ.																	
B2 *Vaucheria coronata*	.	.	.	.	.	.	+	.	.	.	+	.	.	+	.	+	.
B2 V. intermedia	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
B2 V. sphærospora[35]	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	+	.
Valoniaceæ.																	
D *Valonia ovalis*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.
Cyanophyceæ.																	
Chroococcaceæ.																	
E *Chlorogloea tuberculosa*	.	.	.	.	.	.	.	.	.	.	.	.	*	+	.	.	.
Chamæsiphonaceæ.																	
E *Dermocarpa violacea*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+
D *D. Farlowii*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
B2 *Pleurocapsa amethystea*	.	.	.	.	.	+	+	.	+	+	.	.	.	+	.	**	.
E *Hyella cæspitosa*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+
D *H. endophytica*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Oscilllatoriaceæ.																	
C *Spirulina subsalsa*	.	.	.	.	.	.	+	.	+	+	+	.	.	+	.	+	+
D Plectonema norvegicum	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	**	.
E *Phormidium autumnale*	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	**	+
C Oscillatoria amphibia	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	**	+
C O. tenuis	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+
E *Lyngbya lutea*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+
E *Microcoleus tenerrimus*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	**	.
Rivulariaceæ.																	
E *Calothrix æruginea*	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+
C *C. scopulorum*	.	+	.	+	.	+	+	.	+	.	+	.	+	+	.	+	+
C *Rivularia atra*	.	.	.	.	.	.	+	.	.	+	+	.	+	+	.	+	+

[29] *Codiolum pusillum* f. *americana* (in Phyc. Bor. Am. Nr. 869) is identical with *C. gregarium*.

[30] Including *E. prolifera* Fl. Dan. (cfr. Børgesen, 8).

[31] Specimens of *Urospora collabens* from Cumbrae and from New England (Phyc. Bor. Am. Nr. 970) belong to *U. Wormskioldii*.

[32] The specimens referred to *Spongomorpha lanosa* (Børgesen, 8, p. 513) belong to *S. vernalis*.

[33] As the specimens referred to *A. Binderi* (Kütz.) Kjellm. (Borgesen, 8, p. 509) have a few slightly hooked branches they may most properly be considered as belonging to *A. albescens*.

[34] Including *A. flaccida* from the Færöes (cfr. Borgesen, 8 and »Om Algevegetationen ved Færoernes Kyster«, København og Kristiania 1904, p. 94 footnote).

[35] This species has been taken by Jónsson at Búðir in S. W. Iceland, but it has not previously been mentioned from Iceland.

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MAP

OF

FÆRÖERNE

(THE FÆRÖES)

from

The Danish Government Survey

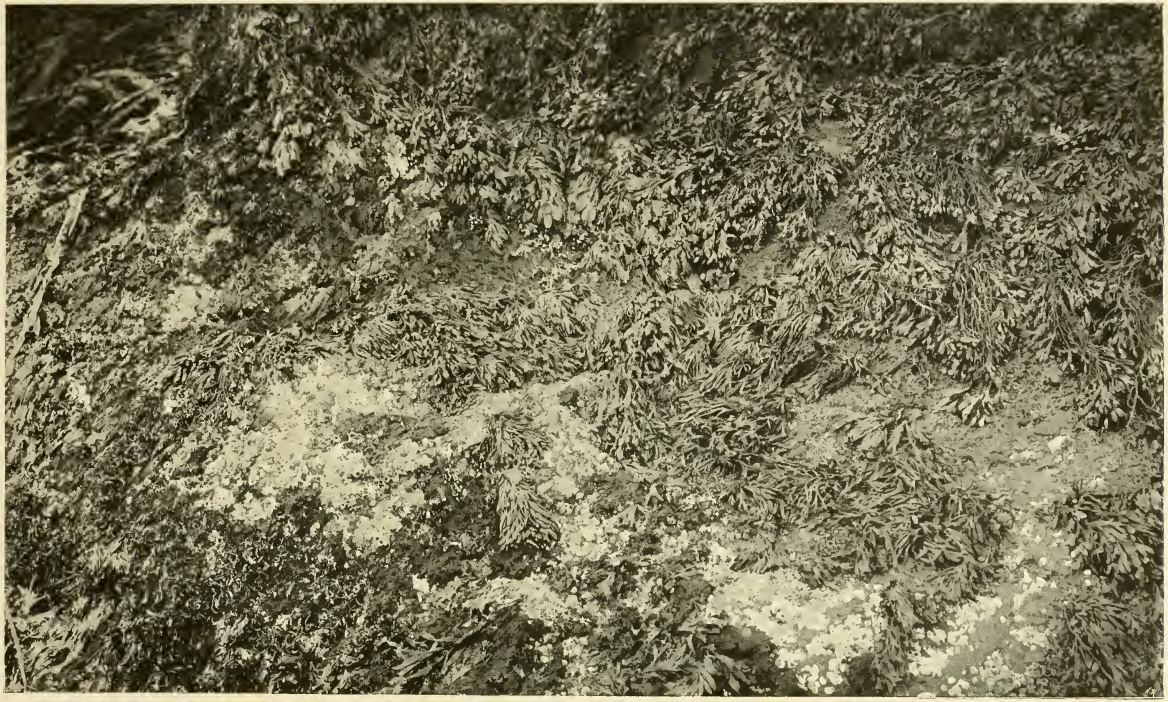
1895-99

Copenhagen 1900

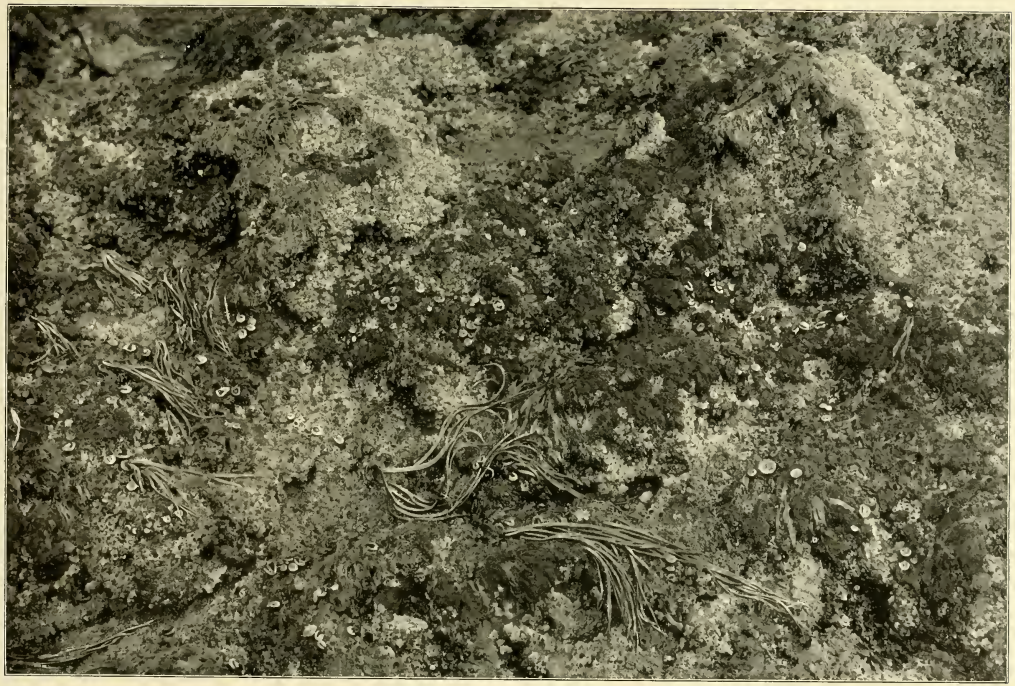
Harald Tofte del.

Det Hoff[illegible]

Porphyra-association growing on a rock of about 30 feet high, at the north coast of Viderö. (F. Börgesen phot.)



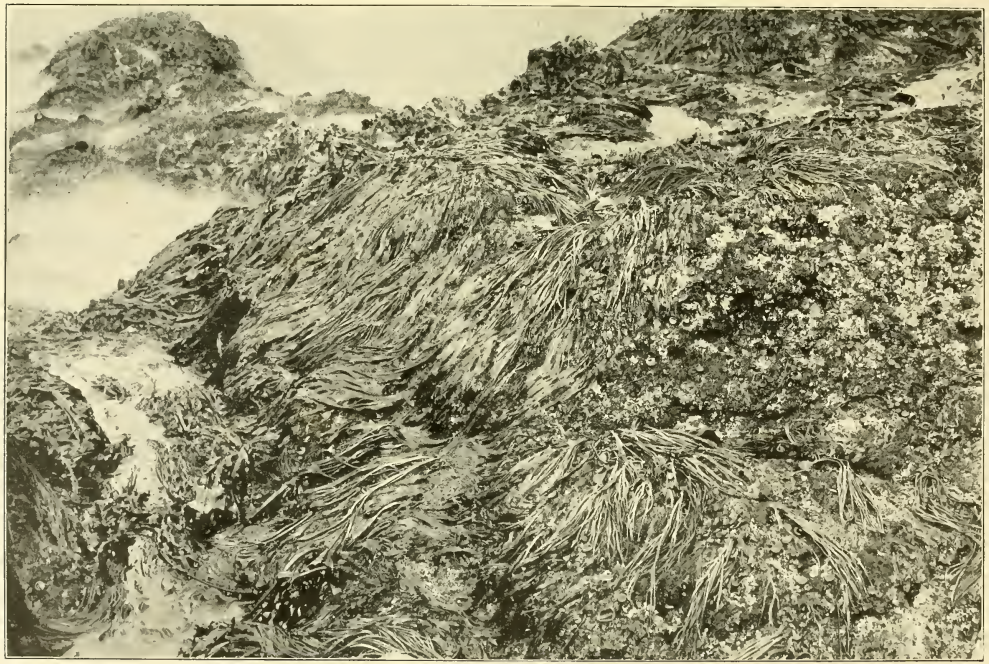
Fucus spiralis and below it *Fucus inflatus* (transitional form to f. *disticha*) on a slightly sloping rocky coast at Gliversnæs on the east coast of Strömö. *Porphyra umbilicalis* is found between the *Fucus*-plants and among the balani we see *Ceramium acanthonotum* and *Callithamnion arbuscula*: at the bottom to the left lastly the *Gigartina*-association. (F. Börgesen phot.)



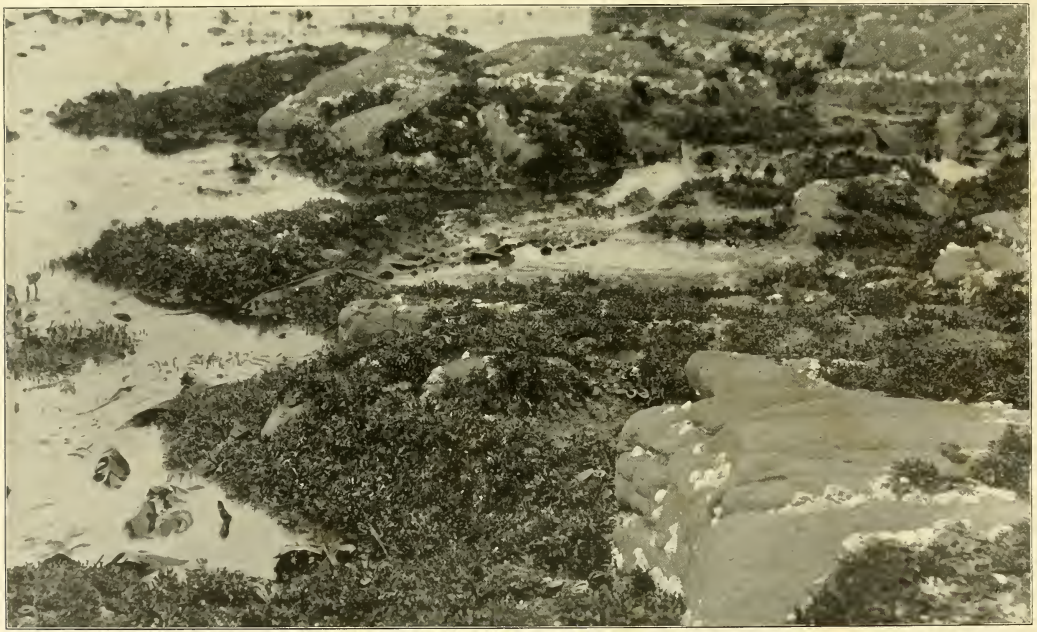
Callithamnion-association consisting of *Callithamnion arbuscula* and *Ceramium acanthonotum* on a precipitous rock at Viderejde on Viderö. Among the principle algæ we find *Corallina* together with large and small *Himanthalia* plants some of which also with receptacles besides balani. At the top of the plate *Porphyra umbilicalis* is seen. F. Börgesen phot.)

Rhodymenia-association on a sloping rock near Gliversnæs on the east coast of Strömö. Among the *Rhodymenia* we find uppermost *Fucus spiralis* f. *nana*, and farther down a few *Fucus inflatus* f. *disticha*. (F. Börgesen phot.)

Laminaria digitata-association on a rocky coast near Midvaag on Vaagö. On the rocks to the right is *Rhodymenia* and below it *Gigartina*. To the left *Laminaria hyperborea* appears above the surface of the sea. (F. Börgesen phot.)



Himanthalia-association on a precipitous rock at Viderejde on Viderö. The sea may break on the outer rock at the top of the plate to the left. Among the *Himanthalia* are young *Alaria esculenta*, and to the right, among the balani, *Callithamnion arbuscula*. (F. Börgesen phot.)



Gigartina-association on horizontal rocks near Frodebö on Syderö. Among *Gigartina* we see button-like *Himanthalia*-plants and in or a little above the surface of the sea appear *Alaria esculenta* and *Laminaria hyperborea*. (F. Börgesen phot.)

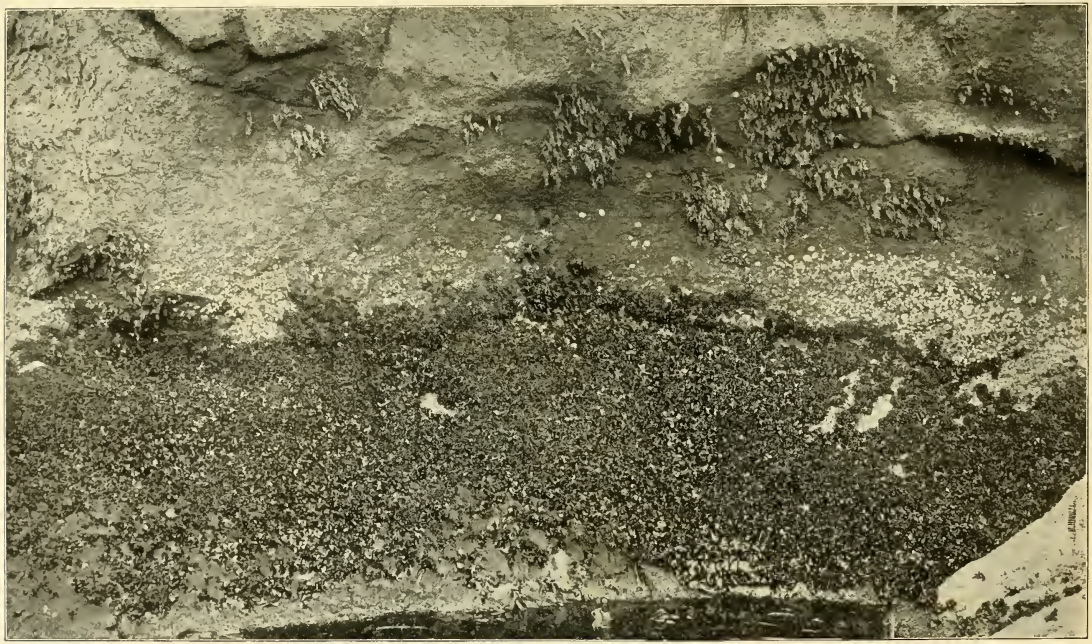
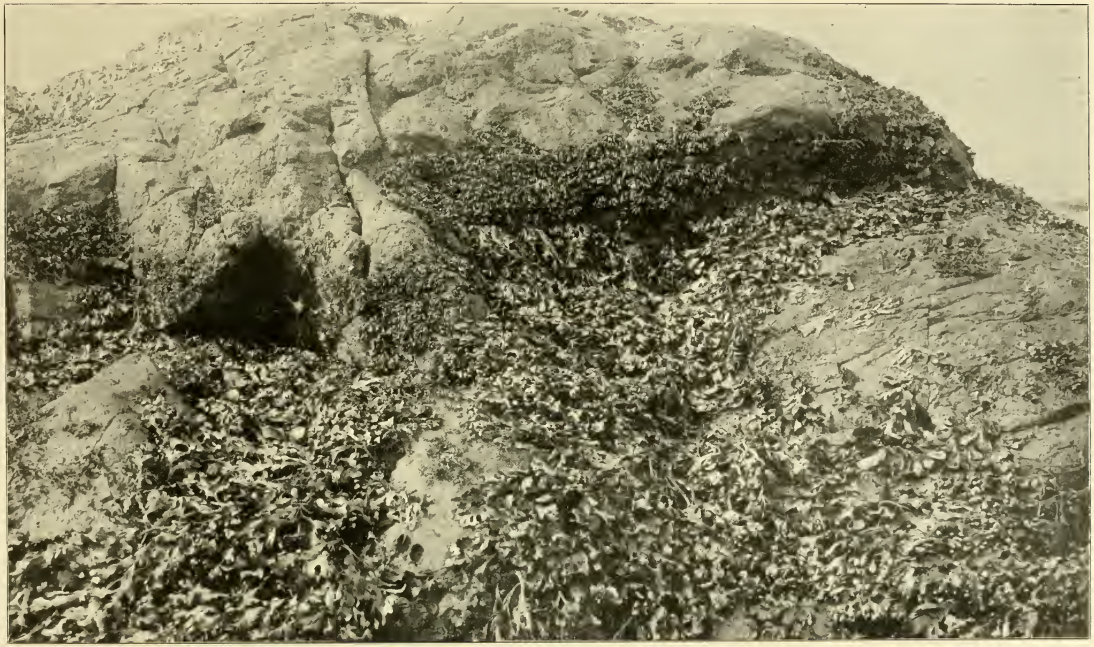


Illustration of a rocky coast near Midvaag on Vaagö. Uppermost we see *Porphyra umbilicalis* hanging down the rocks. Under the belt of balani a large *Rhodymenia*-association and at the bottom of the plate to the left *Acrosiphonia albescens* close by the littoral pool (F. Börgesen phot.)

Corallina-formation on a rock at the entrance of Arnefjord on the coast of Bordö. *Gigartina* and *Alaria esculenta* are seen among *Corallina;* in the littoral pool to the left is *Laminaria digitata.* (F. Börgesen phot.)



Pelvetia canaliculata and below it *Fucus vesiculosus* on a stone at Glibre in Skaalefjord (Österö). (F. Börgesen phot.)

Ascophyllum nodosum on stones in Vestmanhavn on Strömö. *Fucus vesiculosus* is seen uppermost on the stone in the middle of the plate and also on the stone to the right. (F. Börgesen phot.)

Fucus vesiculosus and below it *Ascophyllum nodosum* on a sloping coast between the rocks of the small inlets on the east coast of Strömö between Thorshavn and Höjvig. (F. Börgesen phot.)