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OCEANIC AND CONTINENTAL VEGETATIONAL COMPLEXES IN SOUTHWEST GREENLAND

BY

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WITH 74 FIGURES IN THE TEXT, 4 PLATES AND
AN APPENDIX BY GUNNAR NYGAARD

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INTRODUCTION

The vegetation of Greenland has been investigated during several epochs. The first of these was completely characterized by the investigations of the great Danish plant geographer Eug. Warming, whose classical work on the vegetation of Greenland (1888) became a model for his contemporaries and pupils. The main papers on the vegetation published during the Warming epoch describe Disko (M. P. Porsild 1902), the archipelago of Egedesminde (Kruuse 1898), South Greenland (Rosenvinge 1896), Angmagssalik (Kruuse 1912), Scoresby Sund (Hartz 1895), and Northeast Greenland (Hartz & Kruuse 1911). The picture of the vegetation of Greenland known down to our day is due to these papers, the vegetational units of which were circumscribed by the physiognomies of the plant communities or the prevalent main life-form. In the work Greenland, published in 1928, there is a survey in English of the vegetation of Greenland written by Warming. In this survey the author operates with seven plant-formations, viz. fell-field and steep rocks, dwarf shrub-, lichen- and moss-heath, copses, herb- and grassfield, fresh water communities, moors and meadows as well as shore vegetation. In this work as well as in Warming's pioneer work of 1888 one searches in vain for the snow patch vegetation. Warming (1888, p. 134) evidently was on the point of being aware of this important type, and so was Rosenvinge (*loc. cit.* p. 212—213); but it is Hartz (1895) who is to be credited with having discovered the snow patch vegetation. On pp. 167—171 he describes a "snowdrift vegetation" whose contents of plants is typical in every way. Obviously he obtained his result by his own observations during his wintering on Danmarks Ø in Greenland, for he does not quote Heer (1836), where the concept "Schneetälchen" was introduced into plant geography.

The Warming period was followed by a period characterized by floristic plant geographical works particularly by Ostenfeld and M. P. Porsild. Mainly ecological investigations receded into the background and were not resumed until the 1930's by investigations in Godthaabs-

fjord (TRAPNELL 1933) and the region between Kap Dalton and Angmagssalik (B. 1933b[1])). Ecological work was done in Northeast Greenland as well, a survey by TH. SØRENSEN being published in SEIDENFADEN & SØRENSEN 1937, p. 109 et seq. Whereas TRAPNELL's and SØRENSEN's work are more or less on the lines of the British School (TANSLEY and others), my work from 1933 was particularly influenced by RÜBEL (1930), RAUNKIÆR's various plant geographical works, and MØLHOLM HANSEN (1930). BRAUN-BLANQUET's works (1926, 1928) were used as well; but the classification was still based on a physiognomic life form system, not on a floristic system. However, RÜBEL's "sempervirentiherbosa" were divided into a grassland-herbfield section and a snow patch (snow flush) section. A new factor was the use of OSTENFELD's (1926) distributional types as characterizing elements at the treatment of the vegetation and this idea derived from VAHL (1904) and MØLHOLM HANSEN (1930) was carried further and developed for arctic regions in my later works and by DE LESSE 1952. B. 1938 on p. 290 contains a comparison between the plant geographical mode of classification of vegetation and methods due to the fidelity (exclusiveness) of the species. It is shown that there are important agreements, and it is pointed out that dominants are often rather ubiquitous and therefore do not belong to distributional types which lead to a sensible division of the vegetation. Furthermore the desirability was pointed out of a synthesis of methods of classification which are based on character species (exclusive species) and classifications by means of life-forms, biological types and distributional types.

On the expedition made in 1946 (B. 1949a) a main task had to be analyses of plant communities, which besides providing material for a treatment of the composition and ecology of the vegetation might serve as a basis of discussions of principles. I came to realize more and more that in modern plant sociology, within which unfortunately several "schools" are developing, it should be tried to bridge the gap between the various views by synthesizing the most important principles of the various schools. Only in this way a favourable further development seems possible. It might be objected that the BRAUN-BLANQUET principles after NORDHAGEN, KALLIOLA, and others had accepted them, have now won so general a recognition that no further development is needed as far as principles are concerned; but I cannot share in this view. I consider NORDHAGEN's attempts (1936, 1943) at transferring BRAUN-BLANQUET's principles to Scandinavian vegetations as progress, but giving a basis on which to build further. I find so many weak points in the classifications of vegetation by means of character species that

[1]) Works by the present writer are quoted as B. followed by a year.

I have not been able to subscribe to the views of the BRAUN-BLANQUET school but try to draw its positive aspects into the synthesis mentioned.

My scruples with regard to the current use of character species at the classification of vegetation may be summarized as follows:

(1) The estimate of fidelity is made on a subjective basis, as it depends on the research worker's power of observation, the size of the vegetational area and the literature he knows, besides the choice of analyzed trial areas of the vegetation. If a person knows a small area and a limited part of the literature, many species will seem to him to have a higher degree of fidelity than if he had seen them or read about them within a larger area. The decision of the degree of fidelity is often made in connexion with a comparison of analyses; but even a large number of analyses from a region does not give an objective basis, because the individual analyses are only samples and because consciously or unconsciously a choice is made, by which some spots which are considered to be particularly typical are given precedence to others.

(2) A setting-up of plant communities on the basis of local selectivity in certain species leads to obscurity. There is no doubt that species rich in ecological races (plastic species) are poorly suited to be used as character species, whereas species poor in races or rigid are better suited. As a matter of fact, the contents of races of species are widely different in different parts of their areas, and therefore they are good as character species in one place, bad in others. But even rigid species may in one climate be extremely fastidious, and therefore good character species, whereas in other climates they will ramble and occur in many communities. Therefore communities which are based only on what BRAUN-BLANQUET means by "regionale Treue" will only be of importance within a small area, and it leads to confusion that the character species chosen have another behaviour in other regions. CAIN (1947, p. 197) criticizes this, too.

(3) Ecological selectivity is many-sided, and it depends on an estimate what type of selectivity is emphasized most. Some research workers hold that the relation of the species to pH is more important than the relation of the same species to the microclimate and the humidity of the soil; but who can weigh one against the other? *Cassiope tetragona* has a high degree of exclusiveness to snow cover of a certain duration, but is rather tolerant to pH. NORDHAGEN, who attaches most importance to the relation of the different species to the lime content of the soil, does not use this species as an exclusive species, whereas others, who again and again have convinced themselves of its association with the border zone of snow-patches, feel greatly inclined to use it. One research worker on the basis of their best estimate obtain quite another classification than another will obtain from his best estimate.

Similar and more objections are mentioned by GAMS 1941b.

Let us for a moment consider the purpose of classifications of vegetation. It is a fact that communities, if the underlying environmental factors vary continuously, will imperceptibly merge into one another, without any distinction. In order to describe such a continuous

series the plant sociologist tries to set a number of boundaries in so suitable places as possible, so that as great a perspicuity as possible is obtained. The boundaries he sets can be compared with the artificial lines of the geometrician, for the units cut out only serve to solve this problem: a survey by which the ecology of the individual species can be illustrated and by which part of the vegetation of the earth can be described. The communities are of little interest in themselves.

I have met research workers who would maintain that plant communities were units which would compare with the species, genera, etc., of taxonomy; but if this comparison is valid, it must be such "species" as form interfertile complexes, within which the boundaries between the units may be set more or less arbitrarily. The kind of sociologists who believe in plant communities as a rule are not interested in intermediate forms between the communities which they set up. If a patch of vegetation contains a mixture of character species belonging to two different communities of theirs, they will often consider it to be atypical and omit analyzing it, even if this very patch from the point of view of the ecologist is particularly interesting because he is faced with a combination of factors which make it possible for species of different ecological trends to meet.

As the main purpose of classification of vegetation is that of obtaining a survey which may serve the investigation of the autecology of the species and the plant geography of the earth, it is no use following a system which in a multitude of cases lead to lack of clearness. It must be required that the choice of a species to be used for classification must be preceded by a much more thorough study than the majority of research workers have hitherto made. Above all, widely distributed, more or less plastic species must be avoided or only used for the demarcation of the smallest units, which are only of local interest. Thus, in my opinion, it is unfortunate that NORDHAGEN should use such species as *Dryas octopetala* and *Kobresia myosuroides* as very important exclusive species. I shall return to the occurrence of these species in Iceland below, but in this place only remind of the fact that BRAUN-BLANQUET (1926, Tab. VII) only regards *Dryas* as a "basi-neutrofile Begleiter", but dares not base any main classification on so unreliable a factor. He has difficulties with *Kobresia*, too, because the communities in which it is dominant are partly neutro-basiphilous, partly acidophilous; therefore *Kobresia* becomes a "Begleiter" as well.

During the work at various types of North European vegetation I have tried to extend and develop the use of geographical distributional types at the characterization and demarcation of vegetational units. It proved that geographical types based on the climatic requirements of

the species (biological distributional types) gave important criteria for the classification, but that a still more clear-cut subdivision would be obtained by using types which represented a combination of the biological distributional type as expressive of the demand of the species on the macroclimate and a biological type which was expressive of its demands on the habitat. These ecogeographical types (see B. 1945, pp. 125–128) included such groups as continental xerophytes (steppe species, e. g. *Artemisia campestris*), continental mesophytes (wood-steppe species, e. g. *Campanula persicifolia*), oceanic-suboceanic xerophytes (e. g. *Corynephorus canescens*), widely distributed xerophytes (e. g. *Galium verum*), and widely distributed mesophytes (e. g. *Prunella vulgaris*). Percentage occurrences of such groups enabled the placing of a given vegetation in a greater plant geographical vegetational formation, such as steppes (continental xerophyte vegetation of herbaceous plants), West European dry grassland formation, etc., and if, e. g., there was an equilibrium between the continental and the oceanic elements in a given vegetation, one might in certain cases operate with "transitional communities" (e. g. the Danish *Pulsatilla* grassland) or content onself with ascertaining that this kind of community represented intermediate types.

I conclude that neither the type of total distribution (the geographical guiding species) nor the type of local distribution (the ecological guiding species or character species) is quite adequate, but that great attention should be paid to the ecogeographical type or guiding species as a basis of a clear classification of vegetation. However, I do not intend to discard the two other concepts, on the contrary, they are to be used side by side with the ecogeographical species and so acquire a similar significance as Braun-Blanquet's differential species.

No more do I intend to give up life-forms and biological types. The latter enter as elements in the ecogeographical type and the former are indispensable at plant geographical comparisons between the vegetations of areas far apart the floristic agreement of which is small or nil. I am particularly thinking of life-forms based upon shoot structure and duration of life, less of Raunkiær's life-forms, even though the latter, too, may be of importance in a multitude of cases.

Moreover, two different forms of distributional types will be needed, viz. the biological distributional type and the area type. The former is purely ecological, based on the selection by the species of definite climatic areas (B. 1938), the latter is purely geographical, as it also includes the historical aspect, i. e. the question as to how the species has arisen and as to how far it has succeeded in spreading. Actually the two things have little to do with one another; so the wise thing to do will be to distinguish these two forms of distributional types, if factors of distribution are to be used in vegetational research. The American

element in the flora of Greenland is an area type, whereas the subarctic ("southernmost") element is a biological distributional type. In two climatically related areas, e. g. South Alaska and Southwest Greenland, the biological distributional types will indicate ecological similarity, whereas the area types will stress the contrast.

We need simple abbreviations for the types or groups of species which in various ways are of importance. I suggest using the following ones:

Ar-species: ("Area species") — Area-geographical differential species. Species which in areas with related climatic edaphic conditions by their presence or absence differentiate the related communities. Ex.: *Alchemilla pentaphyllea* Ar-species for the snow-patches of the Alps as contrasted with related Scandinavian communities.

Cl-species: ("Climate species") — Climatic indicators. Species which by association with a definite macroclimate give the vegetation in which they occur a definite ecological-climatic affinity. A biological distributional type is a group of Cl-species. Ex.: *Sarothamnus scoparius* has a suboceanic southern distribution and by occurrence in Danish *Calluna* heaths will contribute to separating these from *Calluna* heaths without southern species, e. g. *Calluna-Vacc. vitis-idaea* heaths.

Hb-species: ("Habitat-species") — Ecological differential species. Species which in a certain area select a definite combination of microclimate and soil or definite hydrospheric factors. Thus, if anything, they correspond to character species or exclusive species. Ex.: *Carex flacca* and *Leontodon hispidus* occur as ecological differential species of mesophilous grasslands on circumneutral-basic soil in Denmark, but are neither continental nor oceanic.

EG-species: ("Ecogeographical species") — Ecogeographical guiding species. Species belonging to a definite biological type (if anything following IVERSEN 1936) as well as a definite biological distributional type. Ex.: *Pulsatilla pratensis* as regards the classification of Danish communities is a southern-continental xerophyte; it draws a given vegetation towards the steppe-formation, whereas e. g. *Jasione montana*, which is a suboceanic hemi-xerophyte, draws it towards the suboceanic dry grassland formation.

An instance from the following treatment of vegetation will illustrate the importance of the four types of guiding species mentioned above. In the continental parts of West Greenland there is a characteristic vegetation on dry rocks. In this vegetation a continental exclusive rock plant like *Dryopteris fragrans* is an EG-species, whereas *Melandrium triflorum*, which enters into many other xerophilous communities and

has a continental-high arctic distribution, is a Cl-species, and *Potentilla tridentata*, which is widely distributed and sub-low arctic and has a certain predilection for rocks, is a Hb-species. In the instance selected *Dryopteris fragrans* will refer the vegetation to a continental-arctic rock-vegetation (the *Saxifraga tricuspidata-Dryopteris fragrans* type), *Melandrium triflorum* will contribute to differentiating this from floristically mainly oceanic rock-formations (the *Veronica fruticans-Sedum annuum* type), and *Potentilla tridentata* will, within the continental area, contribute to differentiating the rock community from other xerophilous vegetations without rock plants. It will, however, as a southern species be able to cause the vegetation in question to be referred to a southern section of the rock-formation. Finally both this species and *Melandrium triflorum* will appear as Ar-species as compared with e. g. the Finnish *Dryopteris fragrans* vegetation.

Braun-Blanquet and his pupils use a system of designations for communities which in several respects is valuable, by adding suffixes to systematic plant names, e. g. *Salicetum*, *Salicion*, and *Salicetalia* to denote a series of more and more comprehensive communities. At first I intended to use a similar method of description, but abandoned the idea for two reasons. In the first place, I consider long designations like e. g. "*Cariceto remotae-Fraxinetum* (Koch 1926) *caricetosum pendulae* Tüxen 1937" as unpractical, and in the second place, I am a decided opponent to suffixed names of authors, which suggest similarity to taxonomic units and involve a possibility of discussions of priority and nomenclature, with which botany would seem to be sufficiently encumbered beforehand. Furthermore, many of the names of authors are used without any justification, as early literature in which the community in question was first mentioned is not considered at all. But I need a series of terms to denote more and more comprehensive communities, terms which are in fairly good agreement with the associations, alliances, and still higher units of Braun-Blanquet, Tüxen, and others. The meaning of my terms appear from the following survey:

1. Sociation individual:	A patch with a given combination and frequency of the species occurring.
2. Sociation: (-soc.)	A plant community with definite dominants in all strata and a related floral list (cf. du Rietz 1930).
3. Sociation group: (-group)	A group of sociations within a vegetational type held together by occurrence or dominance of certain species which appear as ecological differential species (Hb-species).
4. Vegetational type: (-type)	Communities which are held together by a number of EG- and Cl-species and furthermore are characterized by definite life-forms and biological types.

a. Regional type: Vegetational type characterized by EG- and Cl-species belonging to the same or related distributional types and associated with a definite vegetational region.

b. Mixed type: Vegetational type with characteristic mixture of EG- and Cl-species, showing association with different vegetational regions.

c. Extra-regional type: Vegetational type characterized by EG- and Cl-species pertaining to related widely distributed, more or less ubiquitous distributional types, as rule without association with a definite vegetational region.

5. Vegetational complex: (-complex) A collection of related vegetational types irrespective of their physiognomy or life-form, but with the same or closely related types of EG- or Cl-species.

6. Vegetational region: All communities held together by the same EG- and Cl-species, i. e. regional types, but also such extraregional types as occur together with the regional types in question. Different sections of vegetational regions are distinguished on the basis of the presence or absence of Ar-species.

The sociation group almost corresponds to the association and the vegetational type may nearly be the same as the suballiance, while the vegetational complex will often correspond to the order. The vegetational type is the unit which by its highest degree of synthesis of different criteria is of the greatest plant geographical interest. It approaches very nearly to what TANSLEY (1946) terms a formation because it maintains a demand for a uniform physiognomy. The vegetational complex does not maintain this demand; so it comes to correspond to many of NORDHAGEN's alliances. The introduction of the concept vegetational type means a facilitation for everybody who wants to be able to stick to such old concepts as "heath", "copse", etc. He who refuses to attribute any appreciable importance to life-form and physiognomy at the classification of vegetation ought to bear in mind the fact that convergent evolution in climatically related regions has in widely different parts of the earth led to the same life-forms, and that the process leading to the life-forms can be observed already in the species, within which e. g. annual, biennial, and perennial races are distributed according to geographical rules. Therefore the life-form, like biological types on the whole, must be worked into a classification system somewhere.

The fact that species may appear in races with different life-forms and geographical distribution will force the investigator of vegetations and the plant geographer to operate more and more with races and race groups instead of species. This is also brought out in BOJKO's geoecological law (1947) according to which the specific topographical distribution (micro-distribution) of an ecotypic plant species or of a plant

community is a parallel function of its general geographical distribution (macro-distribution), since both are determined by the same ecological amplitudes. Bojko's law describes the foundation on which my eco-geographical types are based and on which all classification of vegetations—also by means of Cl-species only—are based, and furthermore it claims that the unit referred to ecologically and genetically ought to be homogeneous, i. e. it ought to be an ecotype or consist of related ecotypes. It shows that genecological research is not only of importance for systematics and the theory of evolution, but also—and perhaps first of all—will become of importance for plant geography and for vegetational research.

As an adaptation of the demand for ecological and genetic homogeneity in the entities with which I am operating, I have endeavoured to use the comminution of the species of modern systematics in the cases in which it existed and seemed to be applicable. With reference to the detailed mention in B. 1952a subspecies and varieties are used to a great extent, and the units in question are designated with three names in the vegetation tables, e. g. *Ledum palustre decumbens*. On the other hand, the last name may be used if a subspecies enters as an element in the name of a plant community, e. g. the *Ledum decumbens-Calamagrostis lapponica-Galium brandegei* complex to denote a complex characterized by the EG-species *Ledum palustre* ssp. *decumbens*, *Calamagrostis lapponica* var. *groenlandica*, and *Galium brandegei*. The contractions of the names of communities are introduced for the sake of convenience. The ternary designation of the species in the tables is maintained in order to hold the subordinate units together which clearly are closely related and which therefore, also in an ecological respect, in spite of differences, have important properties in common.

MATERIAL AND ANALYTICAL METHODS

During the expedition about 400 analyses of quadrates of the vegetation were made. The sociation individuals selected for the quadrate analyses were to give examples of the communities occurring and give material for an illustration of the variation of these and of their mutual relationship. Some spots, however, were first and foremost analyzed in order to be able to show the way of occurrence of a certain species. Besides analyses of quadrates a number of transect analyses were made, most of which, however, were not very thorough and may only serve to illustrate the zoning of the vegetation in particularly instructive places. Thus no accurate survey or levelling was made, but only notes along a belt transect and occasionally analyses of squares in selected places within the belt.

Where nothing else is stated the surface examined in the analyses of quadrates is 1 sq. m. The degree of cover was analyzed according to the HULT-SERNANDER scale (5 = cover of $^1/_1$—$^1/_2$ of the area, 4 = $^1/_2$—$^1/_4$, 3 = $^1/_4$—$^1/_8$, 2 = $^1/_8$—$^1/_{16}$, 1 = cover below $^1/_{16}$ of the surface, + = the species just present, but with extremely low degree of cover). Within the square metre selected the vegetation was always as homogeneous as possible.

A large number of the commonest lichens and mosses occurring in the analyses were determined on the spot or at the return to the temporary laboratory at the air base in collaboration with the lichenologist M. SKYTTE CHRISTIANSEN, M. Sc., and the bryologist K. HOLMEN, M.Sc. The rest—the more difficult species— were determined after the return of the expedition to Copenhagen by the two specialists mentioned and Miss EVA CLAUSEN, M.Sc. (hepatics) and Mrs. BODIL LANGE, M.Sc. (*Sphagnum*). All the fungi found were determined in Greenland or after the return to Copenhagen of the expedition by Dr. MORTEN LANGE. A number of samples of green algae from various vegetational types were determined by Dr. ROLF GRÖNBLAD, cf. his publication GRÖNBLAD 1952. Samples of diatoms were examined and determined by NIELS FOGED, M.Sc.; cf. FOGED 1953, plankton by Dr. G. NYGAARD, and various blue-green algae by the present writer.

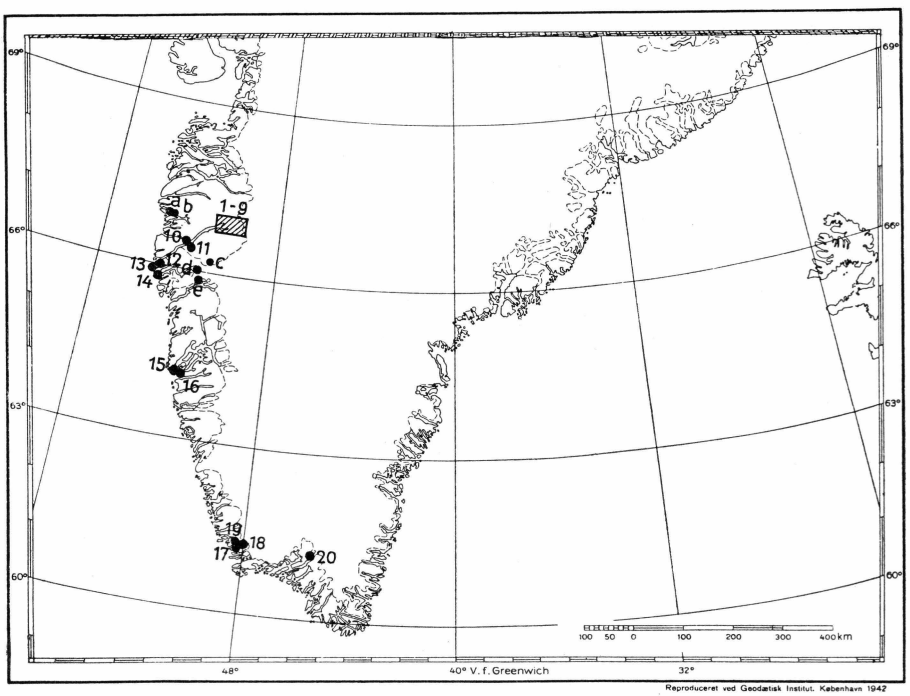


Fig. 1. The area of operations of the expedition in Southwest Greenland. Analyses of vegetation were made in the following places among those indicated on the map: 1—9, see fig. 2. — 10 Itivdlínguaq, — 12 Pâ, — 14 Kangâmiut, — 15 Godthaab, — 16 Store and Lille Malene near Godthaab, — 17 Ivigtut and its surroundings (Guldfjeld), — 18 Grønnedal, — 20 Narssarssuaq.

To each analysis belong notes on slope, exposure, etc., furthermore often a soil analysis or, in the case of lake vegetation, a water analysis. Some of these analyses consisted in a pH determination only, others were more thorough. The more thorough analyses and some microclimatic observations have been treated separately in B. 1949b from geographical and edaphological points of view. In the present paper generally only pH and Lt (electric conductivity [$\varkappa\, 20° \times 10^4$]) will be mentioned in the tables above the corresponding botanical analyses. As to the water analyses the ion contents are expressed in millival./l (cf. B. 1949b).

In the tables the locality in which the analysis was made is indicated with a figure referring to the list of localities found below figs. 1–2.

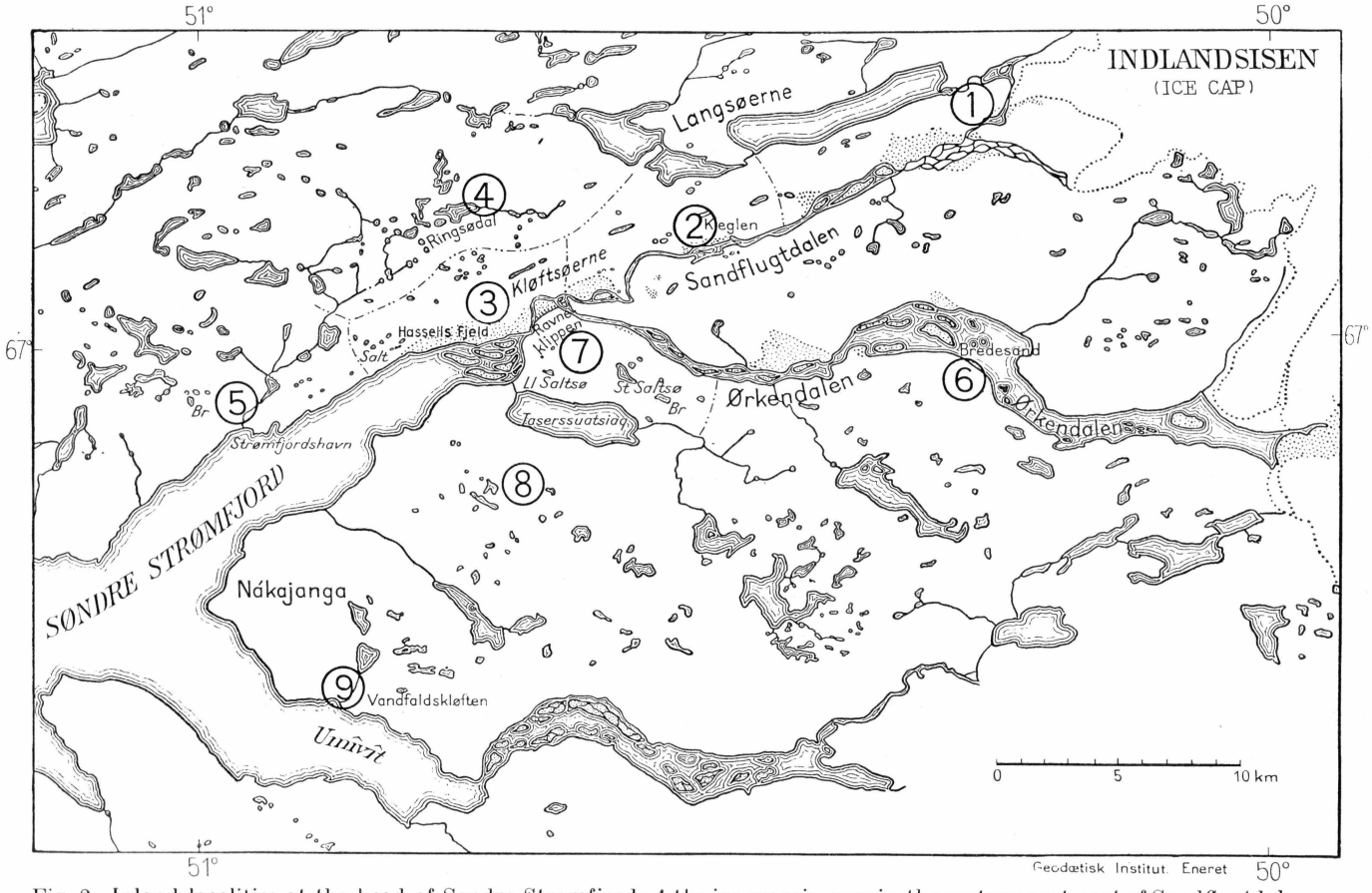


Fig. 2. Inland localities at the head of Søndre Strømfjord: 1 the ice-margin area in the easternmost part of Sandflugtdalen, — 2 the area around Keglen, — 3 Head of the northern fjord branch north of the river, — 4 Ringsødal, — 5 the area near Strømfjordshavn, — 6 Bredesand and the central part of Ørkendalen, — 7 the country between Taserssuatsiaq and the western part of Ørkendalen, — 8 the northeastern part of the Nákajanga peninsula, — 9 the southwestern part of the Nákajanga peninsula.

CLIMATOLOGICAL SURVEY

The analyses of vegetation originate from widely different climatic regimes. On the basis of the climatic measurements now available it is possible to distinguish five climatic types in South-Southwest Greenland. Fig. 3 shows the situation of the stations referred to and an account of the present writer's views as to the approximate extent of the five climatic regimes.

A. Low arctic oceanic regime. Annual precipitation about 500—1000 mm (Table 1). Annual range of temperature between 10° and 18° C. Mean temperature for warmest month 6—8° C. No month with a mean temperature of more than 8° C. Winds everywhere coming with the greatest frequency from the direction of the inland ice (see Table 1), in the six summer months, however, also from the sea. The wind from the sea carries precipitation (in the case of Station 3 it is the southern sea winds which carry precipitation; see fig. 5). Index of humidity (annual precipitation in mm divided by the annual mean temperature on the centigrade scale plus a constant put at 10) is between 60 and 120, and KOTILAINEN's index of oceanity (see KOTILAINEN 1933 and B. 1949b p. 8) is between 60 and 130 (Station 10; see p. 20 and B. 1949b, Table 1).

In this regime are my localities nos. 12, 14, 15, and 16.

B. Low arctic suboceanic regime. The climate intermediary between that of regime A and regime C. Unfortunately only the Station Qôrnoq (5) can give a numerical foundation for the climatic character of the area. This station for the period 1925—40 has an annual precipitation of 426 mm; an annual range of temperature of 18° C. and a mean temperature in July of 10° C. In winter the winds blow from the east, in May—August particularly from the west, carrying moist air. If these figures are compared with earlier measurements from Qôrnoq mentioned in B. 1949b, Table 1, the climate seems to have become warmer and more maritime.

C. Low arctic-subarctic continental regime. Annual precipitation between 100 and about 250 mm (126 at Station 2 and more than

216 at Station 6; see below). The annual range of temperature is 20—30° C. Mean temperature in warmest month about 10° C. Three months with mean temperature above 8° C. The wind blows from the inland ice, at Station 2 parallelly with the longitudinal direction of Sandflugtdalen, cp. fig. 2, only that in May—July there may be westerly winds (fig. 5). Precipitation mainly in connexion with these sea winds, but the greatest amount of precipitation in July—September falls after the westerly winds have culminated. Index of humidity about 20—30, index of oceanity about 4—10.

In this regime are my localities nos. 1—9.

D. Low arctic subcontinental regime. Presumably this regime stretches right into the innermost parts of the Upernivik region, as in the north it comes to be situated behind a high-arctic regime on the outer coast. Annual precipitation between about 200 and 500 mm, annual range of temperature between 20 and 30° C. Mean temperature of warmest month 6—8° C. Approaching to the preceding regime in respect of degree of continentality, but distinct from it by the cooler summer and the slightly higher precipitation. The Holsteinsborg station (B. 1949b, Table 1, (1) in fig. 3) has an annual precipitation of 270 mm, mean annual range 25° C. and mean temperature in July 7.6° C. Index of humidity 52.

I suppose that my Loc. 10 is situated in the southernmost part of Regime D.

E. Subarctic oceanic-suboceanic regime. Annual precipitation 700—1400 mm, annual range of temperature about 15—20° C., mean

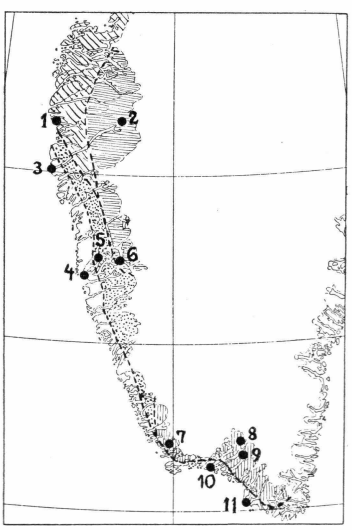


Fig. 3. Map showing the situation of the climatic stations in Southwest Greenland mentioned in the text and a sketch-like attempt at showing the situation of the most important climatic regimes. — Stations: 1 Holsteinsborg, — 2 Head of Søndre Strømfjord, — 3 Cruncher Island at the entrance to Søndre Strømfjord, — 4 Godthaab, — 5 Qôrnoq, — 6 Kapisigdlit, — 7 Ivigtut, — 8 Narssarssuaq, — 9 Igaliko, — 10 Simiutaq, — 11 Nanortalik. — White: low arctic oceanic regime; Dotted: low arctic suboceanic regime; Horizontal hatching: low arctic-subarctic continental regime; Oblique, open hatching: low arctic subcontinental regime; Vertical, dense hatching: Subarctic oceanic-suboceanic regime.

temperature in warmest month between 9 and 11° C., three months with mean temperature above 8° C. In the six winter months there are at Ivigtut (Station 7) southerly and south-easterly winds, which carry precipitation, in summer frequently north-westerly winds. Index of humidity 60—120, index of oceanity about 60—150. The climate at the inland

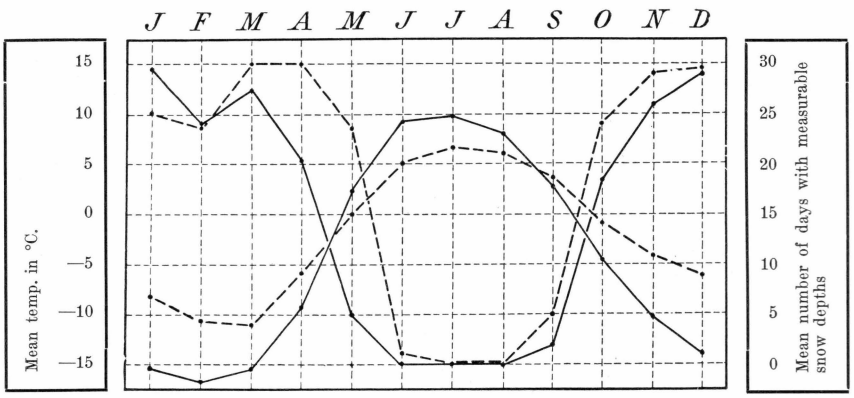


Fig. 4. Curves showing annual range of mean temperature and mean number of days with measurable snow depths at stations 2 (full-drawn curves) and 3 (stippled curves). The two stations give the difference between the entrance to Søndre Strømfjord (3) and the head of the fjord (2).

station Narssarssuaq (8) is mentioned in B. 1949b, figs. 3—4 and Tables 1 and 3. The station Igaliko (9) has a mean temperature in July of 10.9° C. and —5.6 for January. Annual precipitation 841 mm.

In this regime are my localities nos. 17, 18, and 20.

Table 1.

Climatic regime	Station; cf. fig. 3	Annual frequency of wind in per cent.					Mean annual precipitation in mm	Mean annual range of temperature in °C.
		Direction of wind				Calm		
		NW-N	NE-E	SE-S	SW-W			
E	7. Ivigtut[1]	17.3	5.0	22.0	5.9	49.8	1351	15.2
A	11. Nanortalik[1]	39.9	12.7	9.3	26.6	11.5	881	10.5
–	4. Godthaab[1]	17.1	41.0	1.6	28.7	11.7	496	15.4
–	3. Cruncher Island[2]	9.7	55.7	17.4	12.4	4.8	953	17.8
C	2. Head of Søndre Strømfjord[2]	11.0	57.9	8.2	16.1	6.8	126	26.5

[1] 1925—41. [2] 1942—45, 1946—48 (3) and 1941—48 (2).

The agreement between these climatic regimes and the plant geographical grouping in provinces and districts in B. 1952 a is good. The boundary between the continental (C—D) and the oceanic regimes (A—B) takes an oblique course from Holsteinsborg towards the head of Godthaabsfjord. From the latter area unfortunately only a triennial, incomplete series of observations is available (Station 6, Kapisigdlit). Within the period 1939—42 measurements from July—August are missing for two of the years. The annual precipitation, 216 mm, is no doubt too low because of the missing summer observations. The mean temperatures for January and June are —8.3° C. and 8.6° C., respectively. In Qôrnoq (Station 5) the mean temperature rises from 8.2° C. (June) to 10.1° C. (July); so it cannot be premature to count on more than 10° C. at Kapisigdlit in July and a mean annual range of temperature of about 20° C. The scarce measurements are interesting and testify to the fact that the inner parts of Godthaabsfjord approach so closely to really continental climatic conditions that it may be justifiable to draw the continental area (C) so far south.

A comparison between coast- and inland at 67° lat. N. (Stations 1 and 2) shows a comparatively modest climatic difference, as Holsteinsborg has a rather continental climate (see above under D and B. 1949b, Table 1). Therefore it is of great interest to be able to make comparisons with a coastal station at the mouth of the Strømfjord; so I applied to the U.S.A. Weather Bureau in 1948 for material from the station which during the war was founded near the Simiutaq island at the entrance to Søndre Strømfjord. The material I obtained and which is mentioned in B. 1949b under the name of Simiutaq, however, proves to originate from a Simiutaq at the entrance to Tunugdliarfik in South Greenland, of the position of which I was not informed in 1948. Fortunately I can now remedy this error by communicating some observations obtained through the Weather Service of the Greenland Department from the station at the entrance to Søndre Strømfjord. The station is situated on a small island in the skerries immediately south of the Simiutaq island near Søndre Strømfjord and by the Americans was called Cruncher Island. It appears that this station as regards precipitation even exceeds the South Greenland Simiutaq (Station 10). The latter has 844 mm, while Cruncher Island has 953 mm. On the other hand, the range of temperature on the southern Simiutaq is not a little lower, viz. 12.2° as against 17.8° on Cruncher Island.

A comparison between the climate on Cruncher Island, which is situated close to my Loc. 12 (Pá), and the climate at the head of the fjord near the margin of the inland ice, where my main area of investigation is situated, is of considerable interest. The most important conditions appear from figs. 4 and 5 and Table 1. As a supplement to the

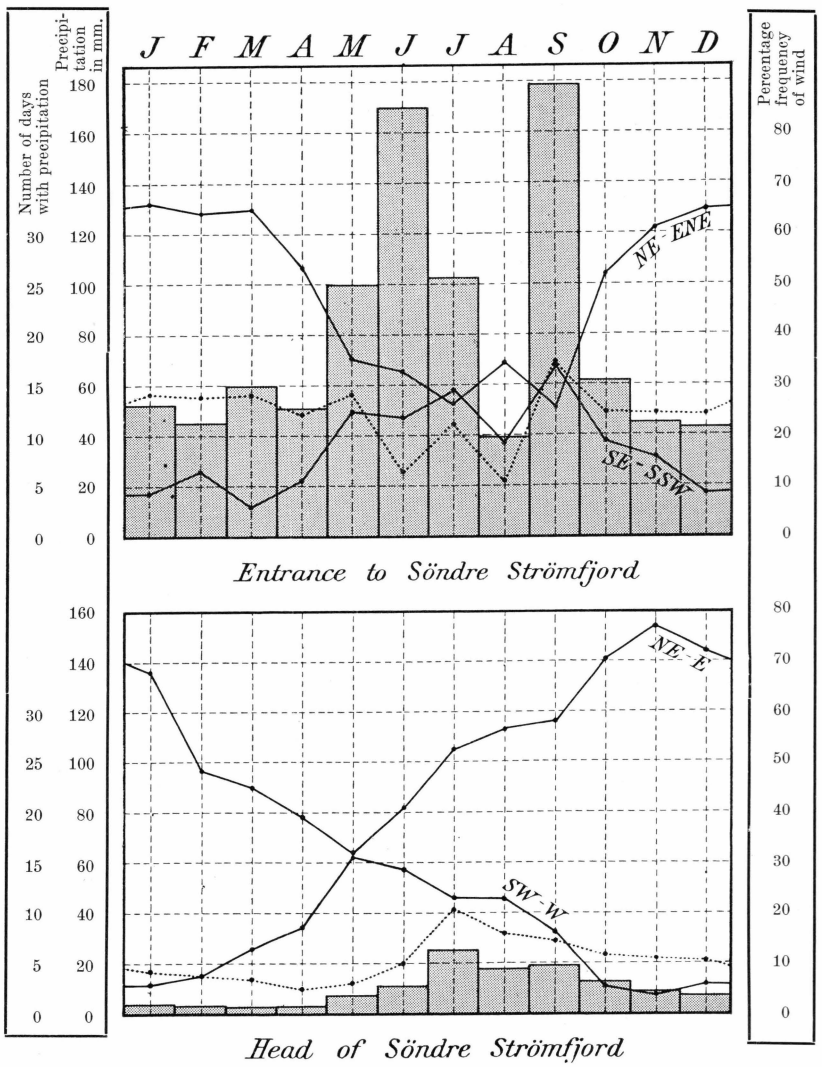


Fig. 5. Conditions of wind, amount of precipitation, and number of days with precipitation at Søndre Strømfjord (Stations 2—3 on fig. 3). Mean precipitation in mm rendered by histograms. Dotted curves: number of days with precipitation. Fully drawn curve: percentage frequency of winds decisive of precipitation. The material refers to measurements within the period 1941—48 (head of the fjord) and 1942—45, 1946—48 (entrance to the fjord).

data of fig. 4 it may be stated that the mean minimum temperature for the coldest month is at —13.7° C. on Cruncher Island and at —21.3° at the head of the fjord. Corresponding mean maxima for the warmest month are 9.9 and 14.6° C. To sum up, it may be said that even if the curves in fig. 4 show a clear thermic contrast between a coastal and

an inland climate, the hygric contrast which appears from fig. 5 is the most important by far. Considering that there is only a distance of 175 km between the two stations, the difference is amazing.

There is no doubt that the high figures for precipitation at Station 3 are connected with the topographical conditions, which remind of those at Ivigtut. High mountains force sea winds coming from the south to give off water. Thus the whole inland area comes to be in rain shadow behind the high mountains and the firn covered upland area east of Evighedsfjord, which no doubt act in a similar way as the coastal mountains. During our stay in the inland we saw on bright days how the clouds settled around the mountains in the west and the firn in the south.

Otherwise it appears from fig. 5 that Cruncher Island in the period 1942—48 has a two-peaked curve of precipitation and that the dip between the two peaks must be connected with a change in August as regards the direction of the wind. The dry inland winds assert themselves here, but in return are completely overcome in September by the southerly sea winds, which make the precipitation culminate at 179 mm for this month. The great summer precipitation there is for that matter independent of the number of days with precipitation, which fluctuates very little during the year. At the head of the fjord conditions are the opposite. There the amount of precipitation and number of days with precipitation run parallel. Is is peculiar that the southwesterly and westerly winds in the inland assert themselves most in the period before the small rain maximum of summer.

Fig. 4 also shows something about snow cover and snow melting. The great fall in the number of days with measurable quantities of snow appears more than a month later on the coast, and the snow of course settles earliest there.

Direct observations of the snow cover and its disappearance at Station 2 (the head of the fjord) in February—June 1953 were made by the Danish Liaison Officer at the air base, Captain ERIK BORREBY and Major W. E. ZIMMERMANN, Weather Staff Officer. The material was provided through the medium of the Naval Command in Copenhagen and gives much important ecological information.

Round the air base six stations were selected, where conditions were observed (Table 2). It appears that the snow cover on the northern slope (Station 1) reaches a depth of more than $^1/_2$ m, culminating at the end of March, while the deepest snow cover appears in February on the southern steep slope (Station 5). The two stations on level ground (Stations 3—4) have the deepest snow cover in the beginning of March. As early as 16 April the greater part of the southern slope is bare of snow; this especially applies where there are no scrubs as at Station 5,

Table 2. Snow cover at six stations round the air base in Søndre Strømfjord, 1953 (western part of Sandflugtdalen).

Date of observation		$^{19}/_{2}$	$^{5}/_{3}$	$^{27}/_{3}$	$^{16}/_{4}$	$^{28}/_{4}$
Conditions of the sky		clear	clear	scattered or broken clouds	scattered or broken clouds	—
Stations						
1. Ravneklippen ("Black ridge", north-east side). Heath covered slope facing north. Slope 32 %. Station always in shadow of the mountain	Air Temp. °C	—21.1	—25.0	—13.9	+8.3	—
	Bottom of snow, Temp. °C	—	—	—11.0	—5.0	—
	Snow Depth cm	47.0	48.3	**59.7**	55.6	only a trace of snow
2. Ravneklippen (western side) underneath the rocky ledges. Slope 18 % facing north on sandy surface between blocks. Exposed to wind and afternoon rays of sun (cf. fig. 36)	Air Temp. °C	—21.1	—25.0	—13.9	+8.3	—
	Bottom of snow, Temp. °C	—	—	—14.0	0.0	—
	Snow Depth cm	17.8	19.1	**27.3**	15.2[1]	only a trace of snow
3. Flat surface at base of Ravneklippen (north-east side) appr. 200 feet from the slope (below station 1). Exposed to afternoon rays of sun	Air Temp. °C	—21.6	—25.0	—13.9	+8.3	—
	Bottom of snow, Temp. °C	—	—	—13.5	—3.0	—
	Snow Depth cm	29.2	**33.0**	20.3	26.7[2]	only a trace of snow
4. Sandy river bed east of the air base on flat surface. A free unprotected area, usually swept by strong easterly winds. Scattered graminoid vegetation	Air Temp. °C	—20.5	—23.3	—13.9	+8.9	—
	Bottom of snow, Temp. °C	—	—	—9.0	0.0	—
	Snow Depth cm	34.6	**36.5**	34.3	25.4	surface covered with water
5. Hassells Fjeld (eastern end) facing south (slope 30 %). Station subjected to rays of the sun during most hours of sunshine. Willow copse and dense herbaceous vegetation	Air Temp. °C	—20.0	—25.0	—13.9	+8.9	—
	Bottom of snow, Temp. °C	—	—	—	0.0	—
	Snow Depth cm	**45.7**	34.6	40.6	25.4[3]	only a trace of snow
6. Hassells Fjeld (centre point) facing south (slope 53 %). Surface area rocky and grassy, dry steppe-like vegetation	Air Temp. °C	—	—25.0	—	+8.9	—
	Bottom of snow, Temp. °C	—	—	—	—	—
	Snow Depth cm	—	17.8[5]	—	only a trace of[4] snow	—

[1] Rivulets of water running down sides of mountain. [2] All layers of snow very wet. [3] Quite a lot of bare spots since last visit (27 march), almost all the snow has disappeared. [4] Most of the ground bare. [5] Under snow cover was a thin layer of ice; evidently ice formation was due to water running down the slope which froze during the early start of winter.

but dry graminoid vegetation (Station 6). By the end of April the lowlands are practically snow-free, small snowfalls, however, being observed 6 May, 13 June, and 16 June. The snow melted fast after these. In the highlands the snow held out longer: on Keglen (the "Sugar Loaf") only heavy drifted spots of snow were found on 26 April, and on the peaks of Nákajanga there were still spots of snow appearing on 10 June.

At the air base snow depths of about 15 cm were measured in March. In April the melting takes place; during the first half of the month the snow depth is on an average about 10 cm, near the end of the month 4—5 cm, and in the last days of the month the snow is gone. April had 4 days with a little rain and 12 with frozen precipitation, in May there were only 5 days with frozen precipitation and 3 with a little rain. Frozen precipitation fell in small amounts only (February 6.4, March 3.1, April 10.9, and May 5.8 mm).

Observations from the air base 1952 communicated to me through the Danish Naval Command show that the snow depths this year were smaller, between 2.5 and 4 cm during the period January—April.

In 1952 and 1953 there was only a constant snow layer from about the beginning of November to the end of April. For half of the year the ground thus was bare of snow. The material from 1953 shows that the southern slope in many places was snow-free in the beginning of April and in 1952 it was, according to information received from the Danish Liaison Officer, snow-free as early as March, while the snow lasted into the first half of May on the northern slopes in the lowlands.

THE ARCTIC-SUBARCTIC OCEANIC VEGETATIONAL REGION

This vegetational region nearly coincides with the climatic regimes (A), (B), and (E) mentioned above. It should, however, be kept in mind that especially in regime (D) there are many patches with an oceanic microclimate which may harbour communities belonging to the oceanic region. Otherwise the region includes the lowlands and the part of the mountain region in which communities with great frequency of sub- and low arctic oceanic Cl-species are prevalent. So far I have not distinguished between a subarctic oceanic and an arctic oceanic region. My material of subarctic communities is not large enough for an appraisal of the problem whether such a distinction would be desirable. My preliminary impression from such a transitional area as Arsukfjord is that this distinction will not be particularly important even though it must be recognized that certain vegetational types are almost completely subarctic, others mainly low arctic as regards floristic composition.

For a species to be counted as an oceanic-suboceanic Cl-species, association is required with climatic regimes (A), (B), and (E) and corresponding areas in East Greenland, and, in the case of presence in area (D), selectivity with regard to the microclimate of the habitat. These Cl-species thus are frequent only in areas with an annual precipitation of more than about 300 mm, an annual range of temperature of below 20°, a humidity index of over about 30, and on oceanity index of over 10. If they are associated with a climate with a mean temperature for July of about 10° C. and more, and 3 months with a mean temperature of 8° C. and more, they may be characterized as subarctic-temperate. If they will stand mean temperatures for July down to about 6° C., they are low arctic. The total distribution as well must agree with the climatic requirements indicated by the Greenland distribution. Above all the species thus ought to avoid the large area which by KÖPPEN (1931, Plate VII) is termed "regenarmes Polargebiet".

Oceanic species, if occurring in Iceland-the Faroes-Scotland, should be frequent here, whereas they should be absent or rare in the Canadian

Eastern Arctic, where even such a southern station as Resolution Island in 62° lat. N has an annual range of temperature of more than 23° C. and a precipitation of 479 mm only.

On account of the important comparison with Scandinavian mountain vegetation it is worth noting the following: The Finse area, the vegetation of which has been described by SAMUELSSON (1916), has a mean precipitation of 890 mm and an annual range of temperature of 16.4°. Thus the climate there corresponds to the low arctic-oceanic climatic region in Greenland. Sikkilsdalen, which has been monographed by NORDHAGEN (1943) has a mean precipitation of 640 mm and an annual range of temperature of 21° C. Its humidity index is 66 and its oceanity index is 38 according to NORDHAGEN. The lower parts of the valley will almost correspond to regime (E) in Greenland, whereas the higher parts will climatically correspond to the low arctic-suboceanic regime (B) in Greenland. On the other hand, the climate in Torne Lapmark, the vegetation of which was already investigated in 1913 by THORE FRIES, will be subarctic-subcontinental at a stage of transition to the continental; for the Karesuando station (333 m above sea level) has an annual precipitation of 307 mm and an annual range of temperature of 27° C. Higher in the mountains conditions there will correspond to climatic regime (D) in Greenland, the peculiar Central Greenland area in which communities with a continental or oceanic flora or mixed types occur, the former, however, each being associated with special microclimates and soils. Many other areas in Northern Scandinavia will correspond to area (D) and give a possibility of the occurrence of mixed types. On the other hand, none of the relatively continental areas in Scandinavia will correspond to area (C) in Greenland. On the whole it is very difficult to find any parallel to this area, a fact for which reasons will be adduced below.

A number of species have an oceanic distribution in Greenland, but otherwise penetrate far into the continents and thus have no permanent connexion with oceanic macroclimates. These plants, however, are distributed in certain categories which reflect dependence on relatively oceanic microclimates where they occur on the large continents. The most important categories are the sylvicolous and the chionophilous species. The former are in the interior of the continents associated with forest-floor or more or less wooded bogs (muskegs), the latter with snow-flushes in mountains. Forest-floors, muskegs, and snowflushes have a relatively high air humidity and an almost constant snow cover in winter, which i. a. gives a low range of temperature. In the following chapters widely distributed sylvicolous or chionophilous species with an oceanic distribution in Greenland are therefore treated as special types of oceanic Cl-species:

(o) Oceanic-suboceanic species which are absent in macroclimatically greatly continental regions (e. g. *Juncus squarrosus* and *Polygala serpyllacea*).

(chi-o) Chionophilous oceanic species which in macroclimatically continental regions select snow-patches in mountainous areas with a relatively high snowfall (cf. the Sayansk Mountains, PRINTZ 1921, p. 41). Ex.: *Sibbaldia procumbens*, *Veronica alpina.*

(sylv-o) Sylvicolous oceanic species which in macroclimatically continental regions are associated with forest-floors and muskegs. Ex.: *Cornus canadensis*, *Lastraea dryopteris.*

Furthermore some oceanic species occur in relatively continental climates as montane-alpine species. There are often places with an oceanic local climate in mountains (e. g. beside brooks in ravines), and often clouds gather preferably around mountain peaks, thus causing these to be subject to more hygric-oceanic conditions. Referring to central parts of Finnish Lappland HUSTICH (1940, pp. 30—31) has called attention to the possibilities given to oceanic species by mountains. On the tops of North Spanish mountains the frequency of oceanic species increases very conspicuously. Species with their main distribution in oceanic climates and advanced montane-alpine occurrences in the interior might, in so far as chionophilous species are not concerned, be termed montane-oceanic (mont-o). *Loiseleuria procumbens* might be mentioned as an example; cf. p. 36.

To avoid misunderstandings it should be stated that oceanic species denote an ecological group and that the majority of low arctic-oceanic species are suboceanic only, i. e. they advance right to the climatic boundaries mentioned above. Among the subarctic-temperate species, on the other hand, there is a number of markedly oceanic species.

In Greenland the oceanic vegetational region includes three regional complexes, which again contain a number of regional vegetational types. Besides, there are representatives of some extraregional types and, particularly in the north and in the interior of the country, some communities which are apprehended as mixed types and mediate the transition to continental and high-arctic vegetational types. Finally it should be emphasized that communities belonging to oceanic complexes or types may very well occur in selected places in areas dominated by continental vegetation and inversely there may be islands of continental types in areas dominated by oceanic vegetation (cf. BRAUN-BLANQUET 1928, p. 314; e. g. on beech-forest exclaves in Mediterranean mountainous regions).

I. The Juncus trifidus-Loiseleuria-Veronica fructicans complex.

Sub- and low-arctic oceanic xerophytic grassland, dwarf-shrub heath, fell field, rock and talus slide vegetation. Soil more or less acid. Snow cover disappearing early, frequently inconstant;

during the summer the vegetation is exposed to wind and low temperatures, or in the case of rock- and slide-vegetation to dryness and relatively higher temperatures.

The complex falls into three vegetational types the first two of which are most closely related. They are characterized by respectively grass-like plants and dwarf-shrubs and may both become open, i. e. they may form what was previously termed fell field (barrens). The third type is best characterized by certain herbs which favour rocks and talus slides, where these are exposed to being dried up.

EG-species (oceanic, sub- and low-arctic xerophytes):

(a) *Juncus trifidus*, *Hierochloë ortantha*, *Luzula spicata*, *Festuca vivipara* (tetraploid), *Minuartia groenlandica* (the last-mentioned species is a xero-mesophyte).
(b) *Loiseleuria procumbens*, *Salix uva ursi*.
(c) *Veronica fruticans*, *Sedum annuum*, *S. rosea*, *Draba rupestris*.

Cl-species, particularly: *Viscaria alpina*, *Thymus drucei*, *Salix herbacea*.
Hb-species which approach to the EG-species: *Diapensia lapponica*, *Potentilla tridentata*.
Other Hb-species, particularly: *Silene acaulis*, *Festuca brachyphylla*, *Papaver radicatum* (coll.), *Luzula confusa*, *Alectoria ochroleuca* and *vexillifera*.
Hb-species for type c: *Woodsia ilvensis*, *Selaginella rupestris*.

a. The Juncus trifidus-Minuartia groenlandica type.

(Low arctic-oceanic xerophytic grasslands and herb-grass fell fields with abundance of lichens and mosses).

In West Greenland towards the north along the coast, at any rate to 67° lat. N., in East Greenland towards the north to Skærgaardshalvø, 68°10′, where the type according to B. 1933 b (no. 30) is represented by a *Carex bigelowii*-soc. with *Juncus trifidus* and *Luzula spicata* as subdominants and, besides, such species as *Potentilla tridentata* and *Viscaria alpina*. Near Angmagssalik frequently in the form of *Juncus trifidus* fell field on gravelly soil. Such a fell field with *Luzula spicata*, *Carex bigelowii*, *Poa glauca*, *Viscaria*, *Campanula rotundifolia*, and *Cerastium alpinum* had soil with pH 4.4. The West Greenland soils were acid as well (see Table 3).

In Central European mountains corresponding vegetations often play a great part (e. g. the *Trifidi-Distichetum tatricum* described by PAWLOWSKI, SOKOLOWSKI & WALLISCH (1927), the *Juncetum trifidi*, KRAJINA (1933)). The corresponding Scandinavian vegetation is by NORDHAGEN (1943) termed *Juncion trifidi scandinavicum*. According to

the same author it reaches its best development where the xerophilous heaths for thermic reasons cease. A corresponding distribution does not seem to occur in Greenland, where both *Juncus trifidus* and *Loiseleuria procumbens* may form sociations on the elevated part of the mountains in the South.

In Iceland a large number of the communities which Mølholm Hansen (1930) and Steindorsson (1936, 1945) have called Melar may be united into a vegetational type which will correspond to the Greenland type in question. The Iceland type will contain plenty of *Juncus trifidus*, *Luzula spicata*, *Silene acaulis*, and *Thymus drucei*, but because of the richer soil, which according to Mølholm Hansen has pH between 6.2 and 6.9, will also include a large number of more calciphilous species, such as *Arabis petraea* (low arctic-oceanic-montane with a disrupted area, North Atlantic-Baltic-North Russian; cf. maps in Holmboe 1937 (Avh. Norske Vidensk. Akad. Mat. Naturv. Kl. 1936, 9) and Busch (1926, Fl. Sibir. et Orient. Extr. 25, p. 460) and *Arenaria ciliata norvegica* (low arctic-oceanic; North Atlantic; map Nordhagen 1935, fig. 10), besides *Dryas octopetala* and two subcontinental species, viz. *Kobresia myosuroides* and *Equisetum variegatum*. The Iceland type rich in species is clearly dominated by oceanic species and has no high arctic-continental species, for which reason its plant-geographical association with the *Juncus trifidus* type is unquestionable.

A very typical lowland occurrence of the *Juncus trifidus-Minuartia groenlandica* type appears from the transect from Pá mentioned on p. 117. Otherwise reference with regard to ecological conditions may be made to the examination of the sociations below. A feature common to these is the occurrence of several species which in general are considered snow-patch plants, e. g. *Salix herbacea*, *Carex lachenalii*, and several cryptogams. This "irregular" occurrence of these is typical of oceanic regions and culminates on the Faroes, where we may often find e. g. *Salix herbacea*, *Oxyria digyna*, and *Alchemilla alpina* as fell-field plants on soil exposed to the wind (B. 1937, Tab. 1). With an increasing degree of continentality the contrast between the vegetational types is intensified.

The EG-species of the vegetational type:

Juncus trifidus. Cl: Low arctic-oceanic; in Eurasia mont-o. Ar: Amphi-Atlantic. — Map of total range in Meusel 1943, pl. 12 f. — Ecology: Oxylophyte (St. John 1922, p. 21); in its climatic optimum area it will very well temporarily stand a soil bare of snow and exposed to the wind; at its climatic boundary in North Labrador it enters zone II of the snow-flushes (Polunin 1948, p. 196); on the Blosseville Kyst I have seen it in herb fields. In Bohemia there is a *Carex bigelowii-Juncus trifidus* soc. with ample *Calluna* and a good number of other species which also suggest protection from snow. There is further here a *Juncus trifidus-Empetrum-Rhacomitrum lanuginosum* soc. with — amongst others — *Vacc. myrtillus*, which also seems to be more protected than the communities exposed to the wind in SW Greenland (cf. Šmarda 1950).

Minuartia groenlandica (*Arenaria groenlandica*). Cl: Low arctic-oceanic, in the south montane-alpine. Ar: East America-Greenland. — For Greenland range see map in B. 1952, p. 67; for total range see fig. 6 in the present paper and FERNALD 1919 in Rhodora 21, pp. 17—21. — Ecology: Oxylophyte on exposed crests in the Laurentian area (ST. JOHN 1922, p. 13), granite ledges and gravel, cracks in rock tops (ABBE 1936, p. 150; FERNALD 1950). In Southeast Greenland strangely enough in river sand (DEVOLD & SCHOLANDER 1933).

Hierochloe ortantha. Cl: Sub-lowarctic oceanic. Ar: East America—Greenland. In Greenland the range very much resembles that of *Vahlodea*, see fig. 14 c. Details in TH. SØRENSEN 1954.

Luzula spicata. Cl: Low arctic, slightly oceanic, outside arctic regions montane-alpine. Rare and selective in climatic regime 3 at the head of Søndre Strømfjord (B. 1952 a). — Ar: Amphi-Atlantic-North Pacific, with wide montane distribution particularly in Central Eurasia and West America; see details in HULTÉN, Fl. Alaska-Yukon No. 352; according to POLUNIN (1940, p. 143) in East America not north of the Arctic Circle or West of longitude 79° W.; cf. detailed dot map in RAUP 1947, Plate XIX. — Ecology: Differential species for *Juncion trifidi* (NORDHAGEN), and exclusive species for *Caricion curvulae* (BRAUN-BLANQUET 1926, p. 263); oxylophyte, which, however, may occur on almost neutral soil. In Greenland it prefers the present vegetational type and is hardly dominant outside it; but otherwise it is found in several communities; therefore only a weak EG-species.

Festuca vivipara, tetraploid North Atlantic type. Here belongs forms with $2n = 28$ found on Lofoten, Scotland, and the Faroes by TURESSON (1931, Hereditas 15, p. 15), and in South Greenland by BÖCHER & LARSEN (1950). No exact statement of the distribution of this species can be given, but the fact that *F. vivipara* in East America has been found only in Labrador and in the south, particularly near the coast, suggests that this is the same type as the one of common occurrence in Southern Greenland, which often has more or less hairy glumes and pales (var. *hirsuta* (Lge) Scholander; see map of Greenland range in B. 1938, p. 212). The tetraploid type includes both hairy and smooth forms and seems to be low arctic-oceanic and ecologically distinct from high arctic viviparous types, which seem to have a higher chromosome number ($2n = 49$ found by FLOVIK in Spitzbergen material) and undoubtedly are closely related to *F. brachyphylla* (*brevifolia*); cf. the *F. brevifolia* var. *vivipara* Roshev. from Taimyr mentioned by TOLMATCHEV 1932. On the Faroes *F. vivipara* dominates in the *Rhacomitrium* heaths and open gravel plains (B. 1937, Tables 1 and 6). This is also the case on Lofoten, where according to DU RIETZ (1925 b, p. 47) it occurs on "extremen Windblössen". As a dominant species the tetraploid *F. vivipara* seems to be fairly characteristic of vegetational types within the *Juncus trifidus-Loiseleuria* complex, but it may be a weak EG-species.

1. Juncus trifidus sociations.

Observed near Godthaab, Kangâmiut, and Pâ, mostly as fell field on gravelly soil (Table 3, nos. 1—5); also noted from alpine stations in South Greenland. BØGVAD's collection from Iviangiussat at 900 m above sea level mentioned by B. 1952 (Bot. Tidsskr. 49, p. 197) originates from

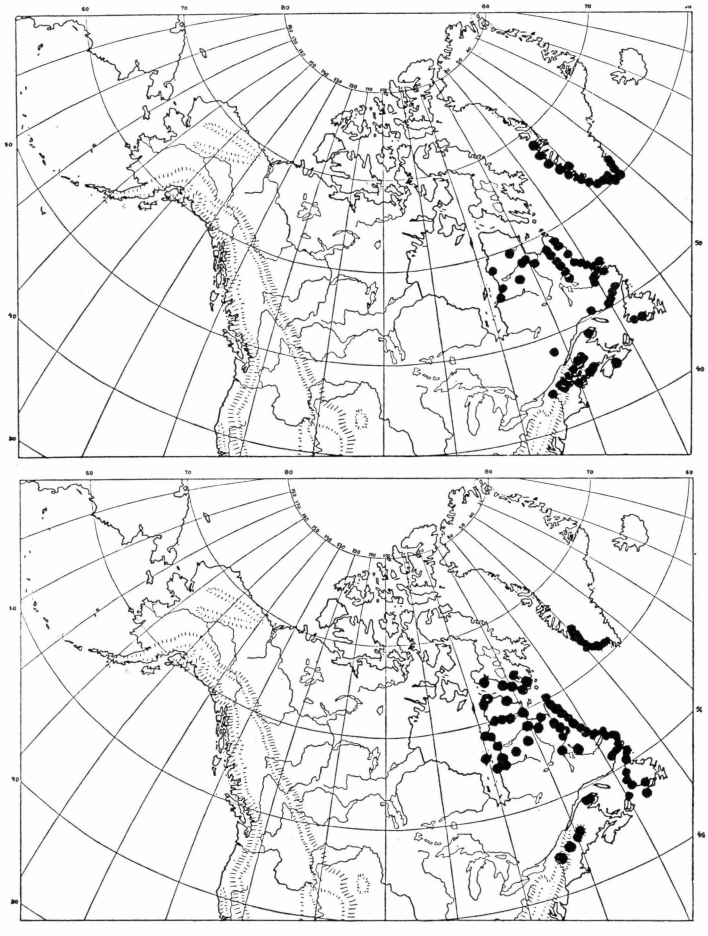


Fig. 6. Total ranges for *Minuartia groenlandica* (above) and *Salix uva ursi* (below). The American occurrences worked out by M. RAYMOND, the Greenland ones from maps in B. 1938 and 1952a. Some of the southernmost stations of *Minuartia groenlandica*, among them that on Nova Scotia, belong to its var. *glabra* (Michx.) Fern. Some of the American area of *Salix uva ursi* have been rendered in RAUP 1943.

a *Juncus trifidus* fell field and includes amongst others *Luzula confusa*, *L. spicata*, *Silene acaulis*, and *Hierochloë orthantha*.

pH and Lt in the soil are low in the West Greenland squares examined. In square no. 2 in Table 3 we furthermore found a potassium value which is very low as compared with those in the majority of soils examined in Greenland.

The spots analyzed in Table 3 nos. 1—3 are rich in epilithic lichens (*Umbilicaria* and *Rhizocarpon* species) and are greatly exposed. No. 4 with plenty of *Cladonia mitis* and no. 5 with plenty of moss were made on more protected soil. The *J. trifidus-Cl. mitis* sociation was also noted

Table 3.

Analysis no.	1	2	3	4	5	6	7	8	9
Locality no.	12	15	15	15	15	15	14	14	15
Slope	0°	0°	0°	0°	10°	0°	15°	0°	15°
Exposure	—	—	—	—	N	—	S	—	W
pH	—	5.0	—	4.7	4.4	4.4	4.3	5.2	4.4
Lt	—	0.2	—	0.4	0.5	—	1.0	0.4	1.1
EG Juncus trifidus	3	2–3	3	5	5	..	..	..	..
– Minuartia groenlandica	+	+	..	..	..	..	..	1	..
– Luzula spicata	+	..	+	+	+	3–4	3	+	+
– Festuca vivipara (cf. p. 30)	..	..	..	..	+	..	..	+	5
– Loiseleuria procumbens	..	1	+	..	..	..	..	..	..
Cl Viscaria alpina	+	..	..	..	..	..	..	..	..
– Salix herbacea	+	2	..	..	2	..	..	1	..
– Agrostis borealis	..	..	..	..	..	+	+	..	..
Hb Diapensia lapponica	..	2	..	..	..	..	..	+	..
– Potentilla tridentata	+	..	..	..	..	..	..	..	..
– Silene acaulis	1–2	..	1	..	..	..	..	..	..
– Luzula confusa	..	..	..	..	+	..	..	+	..
– Festuca cfr. brachyphylla	..	..	..	..	..	1	..	..	..
Betula nana (cf. p. 44)	1	..	..	..	..	..	..	..	..
Carex bigelowii (cf. p. 126)	+	..	..	1	+	2	2	2	..
— lachenalii (cf. p. 126)	..	..	..	..	+	..	..	..	+
Cerastium alpinum	..	..	..	..	..	..	+	..	..
Empetrum nigrum hermaphroditum	1	1	..	1	1	..	+	..	2
Lycopodium selago	..	..	..	..	..	..	1	..	..
Poa pratensis	..	..	..	..	..	..	..	..	+
Polygonum viviparum	..	1	..	..	..	..	..	..	..
Barbilophozia lycopodioides	..	..	..	..	+	+	..	..	+
— hatcheri	..	..	..	..	..		..	..	..
Gymnomitrium corallioides	+	3	..	..	..	..	..	1	..
Lophozia excisa	..	..	..	..	+	..	..	..	..
— ventricosa	..	..	..	..	..	+	..	..	1
Ptilidium ciliare	..	..	..	..	1	..	+	+	+
Scapania curta	..	..	..	..	+	..	..	..	1
Sphenolobus minutus	..	..	..	..	..	..	..	+	..
Temnoma setiforme nemoides	..	..	..	..	..	..	..	+	..
Andreaea rupestris papillosa	..	..	..	..	..	..	..	1	..
Bryum sp.	..	..	..	..	+	..	..	..	..
Ceratodon purpureus	..	+	..	..	..	..	..	..	..
Conostomum tetragonum	..	..	..	+	+	..	..	..	..
Dicranum fuscescens	..	..	..	+	2	+	2	+	4–5
Drepanocladus uncinatus	..	..	..	..	+	..	..	..	+
Polytrichum juniperinum	..	+	..	..	..	..	..	..	+
— piliferum	1	..	+	3	..	+	..	..	..
— strictum	..	..	..	..	2	1	..	+	..

(To be continued)

Table 3 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9
Rhacomitrium lanuginosum	..	+	..	..	+	..	..	5	..
Webera cruda	..	..	..	..	..	+	..	..	..
— nutans	..	..	..	..	+	..	..	..	+
Alectoria nigricans	..	..	..	..	..	..	..	+	..
— pubescens	..	+	+	..	..	..	..	..	..
Candelariella sp.	+	..	..	..	..	..	..	..	..
Cetraria delisei	1	+	..	+	+	..	..	..	..
— islandica (and crispa)	..	..	..	+	+	+	+	+	..
— nivalis	..	..	..	..	..	1–2	..	..	+
Cladonia bellidiflora	..	..	..	+	+	+	2	+	+
— chlorophaea	..	..	..	..	..	..	..	..	+
— coccifera	..	..	..	+	+	+	+	..	..
— cyanipes	..	..	..	..	..	..	..	+	..
— deformis	..	..	..	..	..	..	..	..	+
— delessertii	..	..	..	..	..	..	..	+	..
— furcata	..	..	..	..	..	..	+	..	..
— gracilis chordalis	..	..	..	+	+	..	2	..	..
— mitis	..	..	..	3	+	+	2	+	..
— pyxidata	..	..	..	+	..	..	..	..	..
— rangiferina	..	..	..	..	+	..	+	..	..
— squamosa	..	..	..	..	..	..	+	..	..
— uncialis	..	..	..	+	+	+	..	..	..
Cornicularia aculeata	..	..	+	..	+	+	..	..	+
Lecanora intricata	+	..	..	..	..	..	..	..	..
— polytropa	+	..	+	..	..	..	..	..	..
— polytropa illusuria	..	..	+	..	..	..	..	..	..
Lecidea assimilata	..	+	..	..	..	..	..	..	..
— lapicida	+	..	..	..	..	..	..	..	..
— pantherina	..	..	+	..	..	..	..	..	..
Ochrolechia frigida	1	+	..	2	1	3	..	1	..
(Hb) Parmelia alpicola	..	+	+	..	..	..	..	..	..
Pertusaria oculata	..	..	..	+	..	..	..	..	..
Rhizocarpon copelandii	..	+	1	..	..	..	..	..	..
— geographicum	..	+	1	..	..	..	..	..	..
Solorina crocea	1	..	..	..	..	..	..	..	..
Sphaerophorus globosus	..	..	..	..	..	+	..	1	..
— fragilis	..	..	1	..	..	..	..	..	..
Stereocaulon alpinum	..	..	..	..	..	..	..	+	..
— denudatum	3	+	..	..	..	..	..	..	..
— paschale	..	..	..	..	..	+	..	..	..
Umbilicaria cylindrica	2	3	+	..	..	..	..	..	..
— hyperborea	..	..	+	..	..	..	..	..	..
(Hb) — proboscidea	..	..	+	..	..	..	..	..	..
Omphalia umbellifera	..	..	..	..	..	..	..	..	+
Russula sp.	..	..	..	..	..	..	..	+	..

at Kangâmiut, where amongst others it contained *Trisetum spicatum*, *Carex deflexa*, *Agrostis borealis*, *Cerastium alpinum*, and *Polytrichum piliferum*. Near Godthaab a *J. trifidus-Cetraria nivalis* soc. with *Festuca brachyphylla*, *Agrostis borealis*, and *Polytrichum piliferum* was found to be alternating with the *Luzula* soc. mentioned below. No. 2 with plenty of *Gymnomitrium* reminds of a *Diapensia-Loiseleuria-Cesiolichen* assotion described by DU RIETZ 1925a, p. 36.

At Igaliko in South Greenland, where the soil is often comparatively rich, ROSENVINGE (1896, p. 219) found a gravelly level fell field dominated by *Kobresia myosurioides* and *Juncus trifidus* and with ample occurrence of *Thalictrum alpinum*. A completely corresponding vegetation is found in Iceland (*Juncus trifidus-Elyna* ass. with *Thalictrum* and *Thymus* described by STEINDORSSON, 1946, Table 2, no. 8). As the community, apart from *Kobresia*, does not harbour continental elements, it may be considered a special subtype of the present regional type.

2. Luzula spicata Sociations.

The two West Greenland examples (Table 3 nos. 6—7) are both rich in lichens and contain *Carex bigelowii* and *Agrostis borealis*. It appears from the situation in the transects (see e. g. text below fig. 16) that vegetation of this kind is on more protected and slightly moister soil than *Juncus trifidus* or *Loiseleuria* soc. In both cases the soil was rich in humus. *L. spicata* soc. never covered large areas. In the interior at the head of Søndre Strømfjord *L. spicata* selected moist or shady spots where there was no competition, e. g. in clefts in rock. It was nowhere dominant and was rare everywhere. An attempt at a vegetation rich in lichens with *L. spicata* was noted at an altitude of 300 m on Hassells Fjeld, where a flat rock was overlain by a thin layer of soil and water at times might ooze over the rock. Here it grew in dense *Stereocaulon alpinum* with *Cerastium alpinum* and *Saxifraga cernua*.

3. Festuca vivipara Sociations.

Like *Juncus trifidus*, *Festuca vivipara* (cf. p. 30) is frequent in the dry lichen heaths of South Greenland (ROSENVINGE). Therefore it is probable that there are pure *F. vivipara* sociations rich in lichens there. The places in which I saw *F. vivipara* as dominant were rich in mosses, thus a *F. vivipara-Dicranum fuscescens* sociation on west-facing rocks in the skerries at Godthaab (Table 3 no. 9), and *F. vivipara-Rhacomitrium lanuginosum* soc. at Kangâmiut.

The latter physiognomically reminded of Icelandic *F. vivipara-Rhacomitrium lanuginosum* soc., but was very poor in species as compared with these. From the terrain at Reykjavík airfield I have an analysis of a quadrate of such a sociation on a slightly inclined south-facing slope. The soil was

reddish, with pH 5.9 and Lt 0.7. EG: *F. vivipara* (4); Cl: *Thymus drucei* (2), *Alchemilla alpina* (2), *Salix herbacea* (+), *Gentiana nivalis* (+), *Selaginella selag.* (+); subcontinental species: *Kobresia myosuroides* (+), *Galium boreale* (southern, occurring as a particularly low race, (+)); other species: *Agrostis tenuis* (+), *Empetrum* (+), *Festuca rubra* (1), *Galium verum* (+), *Polyg. vivip.* (+), *Atrichum undulatum* (+), *Drepan. uncin.* (+), *Hylocomium splendens* (+), *H. squarrosum* (2), *Lophozia* sp. (+), *Ptilidium ciliare* (+), *Rhacomitrium lanug.* (3).

Festuca cf. *brachyphylla* (i. e. non-viviparous *F. ovina* coll.) was only noted in a single place as dominant, viz. at a height of 400 m on Guldfjeld at Ivigtut; occurring there with *Carex brunnescens* and *scirpoidea* or in other places with *Potentilla tridentata* and some lichens.

4. Potentilla tridentata Sociations.

These were observed fragmentarily in several places near Godthaab. Near the harbour we analyzed a sociation rich in mosses developed on ledges on an east-facing rock on shallow soil. *Festuca vivipara*, *Luzula spicata*, and *Empetrum* were very frequent there; of scattered occurrence were *Poa pratensis* (low race), *Polyg. vivip.*, *Cerast. alp.*, and *Saxifraga caesp.* The moss carpet consisted of *Polytrichum piliferum*, *P. juniperinum*, *Dicranum* sp., and *Rhacomitrium canescens.* Especially the following lichens were found: *Cladonia mitis*, *rangiferina*, *uncialis*, *furcata*, *ecmocyna*, *coccifera*, and *bellidiflora*, *Stereocaulon alpinum*, besides *Solorina crocea* and *Psoroma hypnorum.* At Pá a *P. tridentata-Rhacomitrium lanuginosum* soc. occurred in dry cracks on the top of some rocks.

5. Minuartia groenlandica Sociations.

The pretty little *Minuartia groenlandica* was seen in several places near Godthaab as almost the only plant in gravel between flat rocks exposed to the wind. It also frequently entered in *Juncus trifidus* soc. and might be the most frequent phanerogam in *Rhacomitrium lanuginosum* carpets in the rocky terrain of the skerries, thus at Kangâmiut partly in cracks filled with gravel (fig. 8) together with *Luzula spicata*, *Festuca vivipara*, *Viscaria*, *Agrostis borealis*, *Plantago maritima*, *Sphaerophorus globosus*, and *Cladonia uncialis*, partly on gravelly soil forming a thin cover over the flat rock (fig. 7 and analysis Table 3 no. 8).

Hustich & Pettersson (1945, p. 35) mention an example of barren land between rocks on the Labrador coast at 53°40′ lat. N. The vegetation fairly approaches the above-mentioned Greenland one containing *Minuartia groenlandica*, *Potentilla tridentata*, *Agrostis borealis*, and others. It had developed on an almost treeless sea-side, while the sheltered side was covered with brushwood (spruce).

b. The Loiseleuria-Salix uva ursi Type.

(Low arctic-oceanic xerophytic dwarf shrub vegetation with abundance of lichens and mosses).

The distribution in Greenland greatly reminds of the preceding vegetational types. The distribution of *Loiseleuria procumbens* and its evasion of the basaltic regions were mentioned in B. 1938. The *Salix uva ursi* sociations form a special subtype which has its distribution in South-Southwest Greenland and furthermore is found in Northeast America (cf. fig. 6).

Similar and closely related vegetational types occur in Iceland, Scandinavia (cf. NORDHAGEN's *Loiseleurieto-Arctostaphylion*), and in Central-European mountains (*Loiseleurieto-Vaccinion*, BRAUN-BLANQUET 1926, p. 287). KRAJINA (1933) refers his *Loiseleurieto-Vaccinion uliginosi* to *Caricetalia curvulae*, which corresponds to my unification of the present type with the *Juncus trifidus-Minuartia* type. Otherwise *Loiseleuria* is absent in the Tatra communities which KRAJINA refers to the alliance mentioned. On occurrence in Northeast America see below.

The vegetational type includes heaths and fell field on acid soil which, as regards exposure to wind and conditions of snow cover, seem to behave almost like the preceding type. The open *Loiseleuria*, *Diapensia*, or *Salix uva ursi* sociations are most exposed and no doubt are often without constant snow cover, whereas the *Empetrum* sociations may be almost constantly snow-covered, but in summer they are greatly exposed to wind (cf. ROSENVINGE 1896, fig. 9 and note on p. 193).

EG-species of the vegetational type:

Loiseleuria procumbens. G: Low arctic-oceanic, montane. Ar: Amphi-Atlantic-North Pacific main area, from which montane wedges penetrate into the continents (Ural, Rocky Mountains, etc.). MEUSEL (1943, 2, d) has a good map of the total range; he has put an ? in the central parts of North America. Evidently it is very rare there and according to A. E. PORSILD 1943 limited to acid pre-Cambrian rocks. Stations for it in Central Canada (Northwest Territories and Great Slave Lake) are included in A. E. PORSILD (1943, 1950) and RAUP (1936). It is considered an oxylophyte by ST. JOHN and others and occurs in almost any bleak or open habitat in Newfoundland (FERNALD 1933). Like *Juncus trifidus*, however, it enters snow-patches in the North.

Salix uva ursi. Cl: Low arctic-oceanic, in the south montane. Ar: East America, South-Southwest Greenland. Map of Greenland range in B. 1938, fig. 30, of total range fig. 6 in the present work. Reaches southern Baffin in the north and in the south St. Paul Island, off Nova Scotia, and the mountains of New York, New Hampshire, and Maine. At its northern limit in Greenland it only grows in the inland; in return it occurs everywhere at Ivigtut in the rainiest region of Greenland, and is found there on the high mountain tops as well as in the lowlands in exposed places. Its absence in the coastal regions



Fig. 7. *Rhacomitrium lanuginosum* covering flat rocky ground at Kangâmiut (Loc.14). In the moss there is plenty of *Minuartia groenlandica*. T.W.B. phot. $^1/_9$ 1946.



Fig. 8. Skerry scenery at Kangâmiut. In the rocky crevices *Rhacomitrium* heath; furthermore small patches of heath dominated by *Empetrum*, *Loiseleuria* or *Diapensia*. T.W.B. phot. $^1/_9$ 1946.

near Godthaab is presumably due to unfavourable conditions of the soil, and perhaps the same applies to the Julianehaab district, where it is also an inland plant. ST. JOHN and FERNALD indeed consider the species an oxylophyte; but it seems evident that A. E. PORSILD (1935) is right in pointing out that it grows on barrens of medium acidity. This is in excellent agreement with POLUNIN (1940), who says that it is characteristic of small glacial deposits containing a plentiful admixture of calcareous material. My two pH values from Ivigtut (5.6 and 5.9) also indicate soils of medium acidity. Probably the leaching of the soil in the skerries may often be so pronounced as to make the species an inland plant. Still, it will not stand conditions at the head of Søndre Strømfjord. In the interior of Labrador Peninsula it grows in open, stony subalpine heath (HUSTICH 1951).

Among the Hb-species *Diapensia lapponica* approaches the requirements of the EG-species and therefore deserves special mention:

Diapensia lapponica. Cl: Low arctic-indifferent (or holding an interesting intermediate position between continental and oceanic). — Ar: North Atlantic (ssp. *obovata* North Pacific-montane; see map in A. E. PORSILD 1951, fig. 5) with a wedge of distribution to Obi Bay along the north coast of Asia (map in BUSCH 1926, Fl. Sibir. Orient. Extr. 64, p. 5) and another to the Keewatin District and Melville Peninsula, where it is very rare (A. E. PORSILD 1943, p. 58, 1950, p. 82; CALDER 1951b). The species is absent in highly oceanic parts of the North Atlantic area such as Southwest Iceland (cf. fig. 135 in GRØNTVED 1942), the Faroes, Scotland, and Southwest Norway (map in HULTÉN 1950), and is rare and alpine in southern Greenland. It is an exclusive highland plant at the head of Søndre Strømfjord (B. 1952a). There it enters in communities with a floristically continental preponderance; the same applies to many places in Scoresby Sund, where according to HARTZ it is common everywhere, and at Kangerdlugssuaq in East Greenland (B. 1933). As *Diapensia* is evidently an oxylophyte and avoids the basalt in Greenland (B. 1938) and is associated with acid soils in rough places, it is an important Hb-species, an Hb-species common to the present complex and to certain communities within the continental complex (p. 150). KRUUSE 1898, p. 378, states that it is typical of the most exposed places in the skerries of Egedesminde, in places where even *Empetrum* must give in.

1. Loiseleuria procumbens Sociations.

Heath and fell field dominated by *Loiseleuria* were observed on the outer coast between 64° and 66° lat. N., often on gravelly soil exposed to intense wind erosion. Table 4 nos. 1—3 gives examples of *Loiseleuria-Empetrum* heaths near Godthaab. Near Ivigtut *Loiseleuria* was seen in a similar vegetation, but there mostly together with *Salix uva ursi.* ROSENVINGE (1896, p. 216) mentions a *Loiseleuria* fell field from the top of a mountain at Narssaq. This sociation amongst others includes *Minuartia groenlandica*, *Juncus trifidus*, *Diapensia*, *Empetrum*, *Vaccinium aliginosum*, *Potentilla tridentata*, and *Silene acaulis.*

Table 4.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Locality no.	15	15	15	14	15	16	14	14	15	15	15	18	17
Slope	0°	0°	10°	5°	0°	5°	10°	0°	5°	0°	5°	10°	5°
Exposure	—	—	SW	SE	—	N	SW	—	W	—	N	W	NE
pH	—	4.5	—	—	—	4.8	—	—	5.2	—	—	5.9	5.6
Lt	—	—	—	—	—	0.3	—	—	0.4	—	—	—	0.4
EG Loiseleuria procumbens	3	4	5	..	+	4	..	2	+	3	2	..	..
– Salix uva ursi	..	..	..	..	..	..	..	..	..	..	..	4	3
– Juncus trifidus	2	1	+	..	+	+	+	+	..	+	+	2	+
– Luzula spicata	..	..	..	..	..	+	..	..	1	+	+	1	+
– Festuca vivipara	..	..	..	..	..	..	..	..	+	..	..	..	..
Cl Thymus drucei	..	..	..	..	..	..	..	..	..	..	..	+	..
– Viscaria alpina	..	..	..	..	..	..	..	..	..	..	+	..	..
– Salix herbacea	+	..	+	+	+	2	+	+	1	1	..	..	..
– Cassiope hypnoides	..	..	..	..	..	+	..	..	..	..	..	..	..
– Carex deflexa (cf. p. 96)	..	..	..	..	..	..	..	..	+	..	..	..	..
– Agrostis borealis	..	..	..	..	..	..	..	..	..	..	+	..	..
– Betula glandulosa rotundifolia	..	..	..	..	..	..	..	..	..	..	..	1	+
Hb Diapensia lapponica	+	1	..	3	2	2	..	..	..	..	..	..	..
– Silene acaulis	1	..	..	..	..	..	..	..	..	..	..	..	..
– Papaver radicatum	..	..	..	..	..	..	..	..	..	..	..	..	+
– Saxifraga oppositifolia	..	..	..	..	..	..	..	..	..	..	..	..	+
– Luzula confusa	+	..	..	+	..	..	..	..	..	+	+	..	..
– Festuca cfr. brachyphylla	..	..	..	..	..	..	..	..	..	+	1	..	..
[1] Carex nardina (cf. p. 138)	..	..	..	..	..	..	..	..	..	..	..	+	..
[1] Minuartia rubella	..	..	..	..	..	..	..	..	..	..	..	+	..
Carex bigelowii	1	+	..	1	+	+	..	..	..	1	+	..	..
— scirpoidea	..	..	..	..	..	..	..	+	..	..	..	..	..
Chamaenerium latifolium	..	..	..	..	..	..	..	..	..	..	..	..	+
Empetrum nigrum hermaphrod.	2	2	3	2	2	4	5	5	5	5	5	..	..
Lycopodium selago	..	..	..	..	..	+	..	1	..	..	..	..	..
Poa glauca	..	..	..	..	..	..	..	..	..	..	..	1	..
Polygonum viviparum	..	..	+	..	..	1	+	..	1	..	..	..	..
Pedicularis flammea	..	..	..	..	..	+	..	..	..	..	..	..	..
Rumex acetosella	..	..	..	..	..	..	..	..	..	+	..	..	..
Salix glauca callicarpaea	..	+	..	..	..	1	1	..	1	..	..	..	..
Vaccinium ulig. microphyllum	..	..	..	4	4	3	..	..	..	..	..	..	..
Barbilophozia lycop. or hatcheri	..	..	..	..	..	+	..	+	+	..	..	..	..
Cephaloziella papillosa	..	..	+	..	..	..	..	..	..	..	..	..	..
— sp.	..	+	..	..	..	..	..	..	+	..	..	..	..
Gymnomitrium concinnatum	..	..	+	..	1	+	..	..	..	..	..	..	..
— corallioides	..	+	+	..	1	..	3	..	..	..	..	..	+
Lophozia alpestris	..	..	+	..	..	..	..	..	..	..	..	..	..
— ventricosa	..	..	..	..	..	..	..	+	+	..	+	..	..
— sp.	..	..	..	..	..	..	..	..	..	..	..	..	+

[1] Continental or with a continental trend.

(To be continued)

Table 4 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Marsupella ustulata	..	..	..	..	+	..	..	..	..	..	..	..	..
Ptilidium ciliare	..	..	+	1	..	+	..	+	..	..	+	..	+
Scapania cfr. scandica	..	..	..	..	..	..	..	..	+	..	..	..	..
— irrigua	..	..	..	..	..	+	..	..	..	..	..	..	..
Sphenolobus minutus	..	..	..	..	..	..	..	1	..	..	..	..	+
Temnoma setiforme nemoides	..	..	..	..	..	..	..	..	..	..	..	..	+
Andreaea rupestris	..	..	..	..	..	1	..	..	..	..	..	..	+
Ceratodon purpureus	..	..	..	..	..	..	..	..	..	..	..	..	+
Conostomum tetragonum	..	..	..	..	..	..	..	..	..	..	..	..	+
Dicranum fuscescens	..	..	..	1	..	+	..	..	+	..	1	..	..
— fuscescens spadiceum	..	..	..	..	..	..	..	2	..	..	..	..	..
— fragilifolium	..	..	+	..	..	..	..	..	..	..	..	..	..
— scoparium	..	..	+	..	..	1	..	..	..	..	..	..	1
Ditrichum flexicaule	..	..	..	..	..	..	..	..	..	..	..	..	+
Drepanocladus uncinatus	..	..	..	..	..	+	..	..	..	..	..	..	+
Pogonatum cfr. capillare	..	..	..	..	..	..	..	..	..	..	..	..	+
Polytrichum alpinum	..	..	..	..	..	+	..	..	..	..	..	..	..
— piliferum	+	+	+	..	+	..	+	..	..	+	..	..	..
— strictum	..	..	..	..	..	..	..	..	..	..	..	..	1
Rhacomitrium heterostichum	..	..	..	..	..	1	..	..	..	..	..	+	..
— lanuginosum	+	..	+	+	+	2	..	..	..	+	..	+	1–2
Webera cruda	..	..	..	..	..	..	..	..	..	..	..	..	+
— nutans	..	..	..	..	..	..	..	..	..	..	..	..	+
Alectoria lanea	..	..	..	..	..	..	..	..	..	..	..	..	+
— minuscula	..	..	..	..	..	..	..	..	..	..	..	1	..
— nigricans	..	..	..	..	..	..	..	..	..	..	..	+	+
(Hb) — ochroleuca	..	..	..	..	..	..	..	..	..	..	..	1	1–2
— pubescens	+	..	..	..	..	..	..	+	..	..	..	1	+
Hb — vexillifera	..	..	..	..	..	..	..	..	..	..	..	..	1
Bacidia microcarpa	..	..	..	..	..	+	..	..	..	..	..	..	..
Buellia atrata	..	..	..	..	..	..	..	..	..	..	..	..	+
Cetraria crispa	..	..	+	..	..	3	..	+	..	..	..	+	..
— cucullata	..	..	..	..	..	..	..	..	..	..	..	1	+
— delisei	..	+	+	+	+	..	..	..	+	..	..	..	..
— glauca	..	..	..	..	..	..	..	..	..	..	..	..	1
(Hb) — hapatizon	..	..	..	..	..	..	..	..	..	..	..	1	..
— islandica	..	+	..	+	..	+	..	+	+	+	..	..	+
— nigricans	..	..	..	..	..	..	..	..	..	..	..	..	+
Cladonia amaurocraea	..	..	..	..	..	..	..	..	..	..	..	..	1
— bellidiflora	..	+	+	..	..	..	..	+	+	..	+	..	..
— chlorophaea	..	+	..	..	..	..	..	+	..	..	..	..	..
— coccifera coll.	..	+	+	..	..	..	..	+	+	+	+	..	+
— ecmocyna	..	..	..	..	..	+	..	..	..	..	..	..	..
— gracilis chordalis	..	..	..	..	..	..	..	..	..	..	..	1	+
— lepidota	..	..	..	+	..	+	..	..	..	..	..	..	..
— mitis	..	+	+?	+	..	1	+	1	+	..	..	..	1
— pyxidata neglecta	..	..	..	..	..	+	..	..	..	..	..	+	..

(To be continued)

Table 4 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Cladonia rangiferina	.	.	.	.	.	.	.	.	.	.	.	.	+
— squamosa	.	+	.	+	.	.	.	+	.	.	.	.	.
— uncialis	.	+	.	+	+	1	.	.	.	.	.	.	.
Cornicularia aculeata	.	+	.	+	.	1	.	.	.	.	.	+	+
(Hb) Haematomma ventosum	.	.	.	.	.	.	.	.	.	.	.	.	+
Lecanora badia	.	.	.	.	.	.	.	.	.	.	.	.	+
— castanea	.	.	.	.	.	+	.	.	.	.	.	.	.
— granatina	.	.	.	.	.	.	.	.	.	.	.	.	+
— intricata	.	.	.	.	.	.	.	.	.	.	.	+	.
— polytropa	.	.	.	.	.	.	.	.	.	.	.	+	.
— polytropa illusoria	.	.	.	.	.	.	.	.	.	.	.	.	+
Lecidea assimilata	.	.	.	.	.	.	.	.	.	.	.	.	+
— dicksonii	.	.	.	.	.	.	.	.	.	.	.	+	+
— elegantior	.	.	.	.	.	.	.	.	.	.	.	.	+
— fuscoatra	.	.	.	.	.	.	.	.	.	.	.	.	+
— soredizodes ochracea	.	.	.	.	.	.	.	.	.	.	.	.	+
Ochrolechia frigida	.	.	+	1	+	2	+	+	+	+	.	+	1
— grimmiae	.	.	.	.	.	.	.	.	.	.	.	.	1
(Hb) Parmelia alpicola	.	+	.	.	.	.	.	.	.	.	.	+	.
— stygia	.	.	.	.	.	.	.	.	.	.	.	.	+
Peltigera malacea	.	.	.	.	.	.	.	.	.	.	.	1	.
— scutata	.	.	.	.	.	.	.	.	.	.	.	.	+
Pertusaria coriacea	.	.	.	.	.	.	.	.	.	.	.	+	.
— oculata	.	.	.	.	.	.	.	+	.	.	.	.	+
Cl Placopsis gelida	.	.	.	.	.	.	.	.	.	.	.	+	+
Psoroma hypnorum	.	.	.	+	.	.	.	.	.	.	.	.	+
Pyrenopsis pulvinata	.	.	.	.	.	.	.	.	.	.	.	+	.
Rhizocarpon chionophilum	.	.	.	.	.	.	.	.	.	.	.	1	1
— copelandii	+	+	.	.	.	.	.	.	.	.	.	1	1
— crystalligenum	.	.	.	.	.	.	.	.	.	.	.	.	+
— geographicum	+	+	.	.	.	.	.	.	.	.	.	+	1
— jemtlandicum	.	.	.	.	.	.	.	.	.	.	.	.	+
— oreites	.	.	.	.	.	.	.	.	.	.	.	.	+
— rittokense	+	.	.	.	.	.	.	.	.	.	.	.	1
Sarcogyne simplex	.	.	.	.	.	.	.	.	.	.	.	.	+
Solorina crocea	.	.	.	+	.	.	.	.	.	.	.	+	.
Sphaerophorus fragilis	.	.	.	.	.	.	.	.	.	.	.	.	+
— globosus	.	+	+	+	.	.	.	.	.	.	.	+	+
Stereocaulon alpinum	.	.	.	.	+	.	.	.	.	.	.	2	.
— denudatum	.	.	.	.	.	.	.	.	.	.	.	+	+
— paschale	.	.	.	.	.	.	.	.	.	.	.	+	.
— rivulorum groenl.	.	.	.	.	.	.	.	.	.	.	.	.	2
Umbilicaria cylindrica	1	.	.	.	.	.	.	.	.	.	.	.	.
— hyperborea	1	+	.	.	.	.	.	+	.	.	.	2	.
(Hb) — proboscidea	.	.	.	.	.	.	.	.	.	.	.	.	1
— torrefacta	.	+	.	.	.	.	.	.	.	.	.	2	1
Laccaria laccata	.	.	+	.	.	.	.	.	.	.	.	.	.
Omphalia rustica	.	.	.	.	.	.	.	+	.	.	.	.	.

2. Sociations Rich in Diapensia-Vaccinium uliginosum microphyllum.

Diapensia for some reason seems often to be associated with *Vaccinium uliginosum microphyllum*. Table 4 nos. 4—6 shows examples from Kangâmiut and the Godthaab region. No. 6 from the northern slopes of Store Malene, 300 m above sea level, is rich in species and dominated by *Loiseleuria-Empetrum*. It included *Cassiope hypnoides* and some *Salix herbacea* and is no doubt almost constantly snow-covered in winter.

Vaccinium-Diapensia heath was also found in the interior in Loc. 3 and 8 at altitudes above 400 m above sea level. There, however, a number of continental species entered in the vegetation and none of the EG- or Cl-species of the present type. The sociations in question are therefore referred to the continental heath type (p. 150), but evidently it constitutes a community which contributes to mediate the transition to the *Loiseleuria-Salix uva ursi* type.

3. Empetrum nigrum hermaphroditum Sociations.

Empetrum heaths in exposed places are a pronounced low arctic-oceanic phenomenon. As we approach to the high arctic regions *Empetrum* becomes more and more characteristic of protected, snow-covered heath on moist soil (*Cassiope tetragona* heath; cf. SØRENSEN 1933, p. 95); in the interior of West Greenland it avoids all dry types of heath. This corresponds to the fact that in central parts of Canada it is confined to upland muskegs and woods and is of no importance at all in the proper tundra (cf. e. g. A. E. PORSILD 1937, p. 136; 1951, p. 16). FERNALD's map as well, now antiquated (1925, p. 248), indicates a thinning-out as regards its occurrence in the interior of North America. The tetraploid subspecies of *Empetrum* thus approaches greatly to those species which on p. 26 were denoted as sylvicolous or chionophilous oceanic species, which also agrees very well with the suboceanic behaviour of the diploid subspecies (cf. B. 1943, p. 49).

ROSENVINGE mentions and pictures dry wind-exposed *Empetrum* heaths from South Greenland, and KRUUSE 1898 mentions them from the skerries of Egedesminde. I saw *Empetrum* fell field and greatly exposed *Empetrum* heaths everywhere on the skerries between Godthaab and Sukkertoppen. Five examples from Godthaab and Kangâmiut have been included in Table 4 (nos. 7—11). The vegetation resembles the preceding communities, but may be poorer in *Loiseleuria*, *Juncus trifidus*, and lichens. *Rhacomitrium lanuginosum* is of no importance, but there are "*Rhacomitrium* heaths" with abundance of *Empetrum*; a good example is pictured in fig. 9. Besides *Empetrum*, *Luzula confusa*, *Festuca vivipara*, and *Diapensia* were frequent there.



Fig. 9. North-facing slope of rock near Kangâmiut. Vegetation dominated by *Rhacomitrium lanuginosum*. In the foreground left of the ravine, *Empetrum-Loiseleuria* heath. T.W.B. phot. $^1/_9$ 1946.

Trapnell (1933) mentions *Cetraria* mats with *Minuartia groenlandica*, *Loiseleuria*, and *Empetrum* and barrens or mats of *Diapensia*, sometimes with *Loiseleuria*, *Juncus trifidus*, *Luzula* sp., *Alectoria*, *Gymnomitrium corallioides*, and others, which shows that the present type of heath at any rate is found mid-fjord in the Godthaab region, there in the middle and lower montane zone. Farther into the fjord *Dryas integrifolia* joins in a corresponding vegetation.

Hustich & Pettersson (1945, pp. 35—36) from the coast of Labrador mention dry *Empetrum* heaths with, amongst others, *Salix uva ursi*, *Potentilla tridentata*, *Diapensia*, *Loiseleuria*, *Minuartia groenlandica*, and *Arctostaphylos alpina*. An offshoot of the vegetational type reaches as far as the most northerly point of the mainland of Quebec at 62°65′ lat. N.; cf. Polunin (1948, p. 227); there, too, *Arctostaphylos alpina* is important. This widely distributed species is considered an exclusive species for the corresponding Scandinavian heath (Kalliola 1939), but is very rare in Southwest Greenland. In the region near Sukkertoppen, where it has an isolated area (Gelting 1934, fig. 34), it has been collected by geodesists from an exposed mountain top.

4. Salix uva ursi Sociations.

Two examples from Arsuk Fjord of fell field dominated by this species of willow are found in Table 4 nos. 12—13. Fig. 10 shows how

poor in plants such a vegetation looks on a superficial consideration. The number of species per square metre is, however, very great, about 40—70, which no doubt is due partly to the failing competition between the species, partly to the fact that the soil is not very acid. Floristically the vegetation is distinct from the preceding ones by including such species as *Carex nardina*, *Minuartia rubella*, *Papaver*, and *Ditrichum*, which indicates an approach to continental fell field communities (see p. 138).

Most sociations are rich in lichens and apart from the epilithic species are dominated by *Stereocaulon alpinum* or *Cetraria nivalis-Alectoria ochroleuca* or by others, such as *Alectoria vexillifera* (dominant on shore rocks west of Ivigtut; cf. the occurrence on stony plains near the sea on Læsø, Denmark) or *A. nigricans*. The latter species and *Salix uva ursi*, *A. ochroleuca*, and *Rhacomitrium lanuginosum*, were found as dominants in an alpine fell field community at Grønnedal near Arsuk Fjord. *Juncus trifidus*, *Saxifraga oppositifolia*, and *Grimmia commutata* also occurred in the latter community.

A special sociation from the top of Guldfjeld near Ivigtut was found on fine-gravelled, level, greatly wind-exposed soil. The plants only covered 10 per cent. of the surface. The gravel particles were kept together by *Alectoria pubescens*. Besides this species and *Salix uva ursi* the following species were found: *Potentilla tridentata* (dwarfish), *Juncus trifidus*, *Luzula spicata*, *Gymnomitrium concinnatum*, *Polytrichum alpinum*, *Stereocaulon denudatum*, *S. rivulorum groenlandicaum*, and *Solorina crocea*. *Diapensia*, *Dryas integrifolia*, and *Papaver radicatum* were seen in other places with *Salix uva ursi* and brownish-black gravel-binding lichens, e. g. *Cetraria hepatizon*.

ROSENVINGE (1896, pp. 188 and 217) mentions *Salix uva ursi* as characteristic of fell field, but never saw it on heath. The same is my impression from Greenland. POLUNIN's statements from the Canadian Eastern Arctic (1948), however, suggest that the species can enter in dense vegetation there (e. g. *Empetrum-Vaccinium* heath), although there, too, it is most frequent in barrens. The species in Canada shows its mesotrophic trend by its being able to enter into *Dryas* barrens together with, e. g. *Salix reticulata*. Frequent accompanying species of *Salix uva ursi* in this area are *Hierochloë alpina* and *Arctostaphylos alpina*. Both some of POLUNIN's examples and ROSENVINGE's example from Qíngua Tunugdliarfik testify to an approach to continental barren communities, which is no doubt connected with the edaphic requirements of the species. At Qíngua Tunugdliarfik *Salix uva ursi*, *Loiseleuria*, *Juncus trifidus*, and *Thymus drucei* meet with *Rhododendron lapponicum* and *Kobresia myosuroides* on the same gravelly expanse.

5. Betula glandulosa rotundifolia Sociations.

Whereas *Betula nana* in Greenland seems to be represented by a continental population, this cannot be stated about its deputy in South Greenland, *B. glandulosa* var. *rotundifolia* Regel. This variety has been



Fig. 10. *Salix uva ursi* fell field with abundant *Alectoria ochroleuca* and *A. nigricans* on mountain plateau above Grønnedal near Arsuk Fjord. T.W.B. phot. $^{9}/_{7}$ 1946.

considered a species, *B. exilis* (Sukatchev 1911), a subspecies of *B. nana* (ssp. *exilis*, cf. Hultén 1950—51), and a variety of *B. nana* as well (Ledebour 1846—51). Undoubtedly a revision covering all North American material of "*B. glandulosa*" is needed. Whereas *B. glandulosa* s. str. seems to be a continental shrub (see map 442 in Hultén l. c.) the small-leaved var. *rotundifolia* which approaches *B. nana* in so many respects may behave as an oceanic-montane species, as it probably chiefly occurs in the mountains of the interior as well as along the coast (Hultén p. 573). In arctic East America only var. *rotundifolia* occurs (Polunin 1940, p. 173) and in the most Atlantic areas the closely related *B. michauxii*, which has a range highly reminding of *Salix uva ursi* (see map in Rousseau & Raymond 1950). The var. *rotundifolia* only reaches the southeastern part of Baffin, which is in good agreement with its distribution in Greenland, where it only reaches the Fiskenæsset district (map fig. 31 in B. 1938). The fact that var. *rotundifolia* in South Greenland reaches the tops of mountains and grows in fell field on wind-exposed soil almost shows that its northern limit in Greenland cannot

be determined by the summer temperature, but must be determined by the increasing degree of continentality towards the north. It behaves like an oceanic and southern race of *Betula nana* in the widest sense. At its northern limit in Baffin Island *B. glandulosa rotundifolia* is rare, only noted in sheltered situations (CALDER 1951 a). Its behaviour thus slightly reminds of that of *Juncus trifidus* (see p. 29).

Table 5 includes examples of two kinds of *B. glandulosa rotundifolia* sociations from Southern Greenland, viz. one rich in *Cladina* and another rich in *Rhacomitrium lanuginosum*. Both of them most naturally belong to the present complex because they may include scattered *Loiseleuria* and *Juncus trifidus* besides such an Hb-species as *Alectoria ochroleuca*. However, high frequency of the, if anything, subcontinental *Cladonia alpestris* (see map in LYNGE 1921) in nos. 2—3 suggests relationship with less oceanic heaths.

The heath rich in *Cladina* corresponds to what previous authors mostly called "lichen heath". This has a remarkable distribution in Greenland, as it is mainly associated with the climatic regimes E and B, the sub-low arctic, suboceanic areas. The wealth of lichens is great both in the oceanic (A) and in the continental regions (C), but the dense reindeer-lichen heath (often with *Cetraria* species and *Stereocaulon paschale*) is neither a skerry heath nor a real continental heath. It has an enormous distribution in boreal areas in Eurasia and North America, but there especially in connexion with open coniferous forest, where the air humidity presumably is not particularly low.

The three *Rhacomitrium* heaths near Ivigtut (nos. 4—6) are without the good EG-species, so their position is not evident. The moss carpet was of the same luxuriance as that on Faroese *Rhacomitrium* heaths, but the floristic composition is different. Such species as *Cetraria nivalis*, *Alectoria ochroleuca*, and *Aulacomnium turgidum* are missing from the vegetation in the Faroes (B. 1937). ROSENVINGE (1896, p. 213) also mentions *Rhacomitrium* heaths, thus from the Ivigtut region, but his examples include such species as *Salix herbacea*, *Phyllodoce*, *Nephroma arcticum*, and *Solorina crocea*, which indicate closer relationship with heaths of the *Phyllodoce* type.

c. The Veronica fruticans-Sedum annum Type.

(Sub-low arctic oceanic, xerophytic talus-slide and rock vegetation).

This type has several important species in common with the two preceding types. The similarity is due to correspondence in soil, which is stony-gravelly, the failing competition between species, and the drying-up of the substratum in summer. The difference is mainly in

Table 5.

Analysis no.	1	2	3	4[1]	5	6
Locality no.	17	17	17	17	17	17
Altitude	300	80	50	200	150	150
Slope	0°	0°	10°	20°	35°	30°
Exposure	—	—	W	SE	E	E
pH	—	4.1	4.5	4.8	4.2	—
Lt	—	—	0.4	1.1	—	—
EG Loiseleuria procumbens	2	..	..	..	..	..
– Juncus trifidus	..	..	2	..	..	..
– Festuca vivipara	..	..	..	..	..	+
Cl Betula glandulosa rotundifolia	3	+	3	3	2	1
Hb Diapensia lapponica	+	..	..	..	..	..
Carex bigelowii	..	..	..	1	1	..
Empetrum nigrum hermaphroditum	2	+	..	1	..	..
Salix glauca callicarpaea (var.)	1	..	..	..	..	..
Vaccinium ulig. microphyllum	+	+	..	2	2	1
Barbilophozia lycopodioides	..	+	..	..	..	..
Ptilidium ciliare	..	+	1	..	+	+
Aulacomnium turgidum	..	..	..	+	+	+
Ceratodon purpureus	..	+	..	..	..	..
Conostomum tetragonum	..	+	..	..	..	..
Dicranum fuscescens	+	2	..	+	1	..
— scoparium	..	..	2	..	..	..
Hylocomium schreberi	..	+	1	+	..	..
Polytrichum juniperinum	..	+	..	..	..	..
Rhacomitrium lanuginosum	+	+	1	5	5	5
Webera nutans	..	+	..	..	..	..
Alectoria ochroleuca	+	..	1	+	..	+
Cetraria crispa	..	..	..	+	..	..
— cucullata	..	..	+	+	..	..
— islandica	2	2	1	+	+	1
— nivalis	+	1	1	1	+	1
Cladonia alpestris	..	4	4	..	+	..
— bellidiflora	..	1–2	..	..	..	..
— deformis	..	+	..	..	..	..
— ecmocyna	..	..	+	..	..	..
— gracilis	1	1	..	..	..	..
— mitis	3	..	..	..	..	..
— rangiferina	2	3	4	+	..	..
— sylvatica	..	..	..	+	..	..
— uncialis	..	..	+	1	+	..
Ochrolechia frigida	..	+	..	+	..	..
Sphaerophorus globosus	..	+	..	..	..	..
Stereocaulon alpinum	2	..	1	+	..	..
Lactarius glyciosmus	..	+	..	..	..	..
Omphalia umbellifera	..	+	..	..	..	+

[1] Flat of 4 square metres.

the fact that communities belonging to the *Veronica-Sedum* type are exposed to greater heat in summer and a more constant snow cover in winter, to which should be added the instability of the substratum, which is characteristic of at any rate some of the communities of this type.

NORDHAGEN (1943) distinguishes between a talus-slide vegetation (*Veronica-Poion*) and a rock vegetation (*Saxifragion cotyledonis*). There are evidently Greenland communities which correspond to these alliances; but a sharp distinction between rock and slide vegetation does not seem imperative, as so many species both in Norway and in Greenland are common to these vegetations and as the "unsettled" condition of the substratum is the only important distinctive factor, a factor which even occurs in all degrees from zero, where the similarity between rock and slide vegetation approaches identity.

EG-species of the vegetational type:

Veronica fruticans. Cl: Sub-low arctic, oceanic, montane in Europe. — Ar: North Atlantic-European, absent in America. Details in B. 1938, p. 178. Absent at the head of Søndre Strømfjord (B. 1952). — Ecology: guiding species in the Norwegian *Veronico-Poion glaucae*, growing on a substratum rich or poor in lime, but always rich in nutrients (NORDHAGEN 1943, p. 544). Very frequent in the basalt regions south of Scoresby Sund on warm rocks and screes, particularly at stages in the succession leading to herb fields (cf. B. 1933 b, p. 6, fig. 6 V, Tables 8, 15, 18).

Sedum annuum. Cl and Ar: Almost as the preceding species; see B. 1938, p. 110. — Ecology: at its northern limit in East Greenland on dry warm rocks and slides (B. 1933, pp. 49 and 116). Important in the European *Sempervivetum arachnoidea* (CHODAT & ANAND 1936 in Ber. Schweiz. Bot. Ges. 46).

Sedum rosea (*Rhodiola r.*). As a collective species widely distributed (see HULTÉN, Fl. Alaska Yukon no. 693), but in Greenland undoubtedly represented by a North Atlantic-montane type, which in East America only reaches Baffin Land in the north and in West Greenland only reaches the Disko region and barely halfway into Søndre Strømfjord. The wide East Greenland distribution (B. 1938, p. 54) may suggest eastern immigration of the Greenland plant. — Ecology: The species prefers rocks and slide vegetation and occurs e. g. in large populations in south-facing scree along stony beds of rivulets formed by melting snow in spring time but dry in summer (see fig. 147 in B. 1938). As, however, the species is very tolerant to conditions of humidity at its station and as regards distribution reaches continentally arctic areas, it must be considered a weak EG-species, and at any rate it is as much EG-species for the *Polystichum-Asplenium* type mentioned on p. 70.

Draba rupestris. Cl: Low arctic-oceanic. Ar: North Atlantic; in North America only Labrador-Ungava. Absent at the head of Søndre Strømfjord. — Ecology: NORDHAGEN (1943, p. 571) uses it as differential species for rock vegetation as distinct from slide vegetation, but in East Greenland the species is also common in scree, between blocks, and in various less dense heaths. POLUNIN (1940, p. 242) mentions it from dry and exposed gravelly areas.

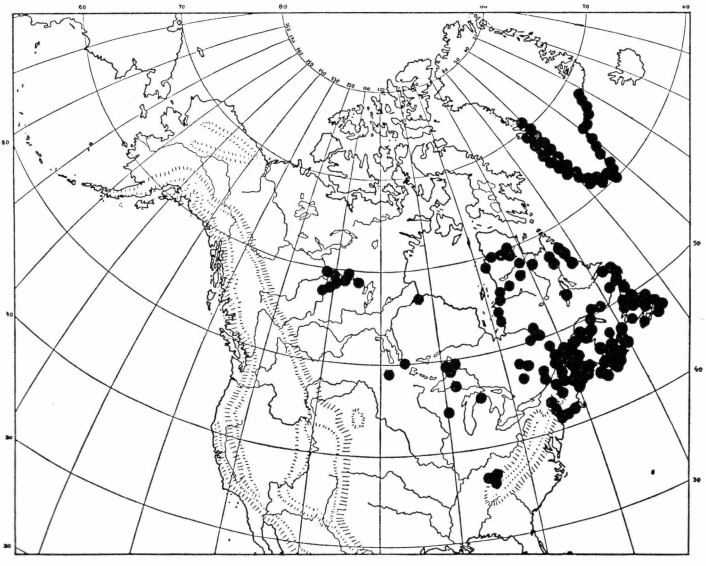


Fig. 11. Total range of *Potentilla tridentata*. American area after map made by Dr. M. RAYMOND, Greenland area after map in B. 1938.

Among the Cl- and Hb-species the following ones approach to the EG-species and therefore ought to be mentioned separately:

Thymus drucei (Ronn. em. Jalas.). Cl: Sub-low arctic oceanic. Ar: North Atlantic; absent in America. Maps: Greenland B. 1938, fig. 95, Norway JALAS (1947), world PIGOTT 1951 in "The Study of Distrib. Brit. Plants", fig. 22, p. 93. — Ecology: Often particularly frequent on dry rocks and in slide vegetation, but also in the preceding types and the following complex, although rare there as a dominant species. In Ireland in quite different communities (e. g. fixed dunes and grasslands with *Antennaria dioeca* and *Sesleria*).

Potentilla tridentata. Cl: Sub- and low arctic, perhaps with a slightly oceanic trend apparent by its higher frequency near the coasts and by the fact that the northern limit in America is at 60° lat. N., while in Greenland it is at 71°. The species reaches to the head of Søndre Strømfjord and in America towards the west to Lake Athabasca and Dakota. Ar: East America-Greenland; see fig. 11 and B. 1938, fig. 70. — Ecology: ST. JOHN (1922) rightly characterizes it as an indifferent oxylophyte, i. e. neutro-acidophilous. It avoids basalt in Greenland, but favours granite-gneiss rocks and shallow soil on rocks; but it may occur on loess in continental areas as well (see p. 196) and according to RAYMOND on sand dunes in Canada. It is presumably most frequent in the present complex, but is not at all bound to it.

Selaginella rupestris. Important as an Hb-species, but with a temperate distribution, therefore perhaps differential species for a southern subtype.

Provided preponderance of the EG- and Cl-species mentioned above, non-oceanic species like *Saxifraga aizoon* and *tricuspidata* will appear as Hb-species in the present type.

Table 6.

Analysis no. (see below on p. 51)	1	2	3	4	5	6
EG Veronica fruticans	..	..	..	f	f	..
– Sedum annuum	f	f	f	f	..	..
– — rosea	..	+	f	f	..	..
– Draba rupestris	..	..	..	..	+	..
– Loiseleuria procumbens	..	..	..	+	..	+
– Juncus trifidus	..	..	..	+	..	..
– Luzula spicata	+	..	f	f	..	..
– Festuca vivipara	f	..	..	..	..	..
Cl Thymus drucei	..	+	f	d	+	..
– Roegneria doniana virescens	..	..	+	..	..	..
– Viscaria alpina	+	..	f	..	..	..
– Alchemilla alpina	..	..	f	..	..	..
– Arabis alpina	..	..	..	..	+	..
– Draba incana	+	..	+	..	..	..
– Antennaria canescens	..	..	..	..	+	..
– Gentiana nivalis	..	..	..	+	..	..
– Erigeron borealis	+	..	..	..	..	..
– Salix herbacea	..	..	..	f	..	..
– Betula glandulosa rotundifolia	+	..	..	+	..	..
– Botrychium lanceolatum	..	..	+	..	..	..
Hb_1 Potentilla tridentata	f	f	+	f	..	+
– Woodsia ilvensis	..	f	d	..	f	+
– Selaginella rupestris	..	d	..	..	..	..
– Juniperus communis nana	d	+	f	f	..	+
Hb_2 Saxifraga aizoon neogaea	..	..	f	f	f	+
– — tricuspidata	..	..	..	..	..	f
– Draba aurea	..	..	..	+	..	..
– Minuartia rubella	..	..	..	..	+	..
– Carex nardina	..	..	..	..	+	..
– — glacialis	..	..	..	..	..	f
– Hierochloë alpina	..	..	..	..	..	+
Hb_3 Saxifraga nivalis	..	..	+	..	..	+
– — tenuis	..	..	..	..	+	+
– — caespitosa	..	..	..	f	+	+
– — oppositifolia	..	..	..	+	+	+
– Papaver radicatum	..	..	..	f	..	..
– Chamaenerium latifolium	..	..	..	f	..	..
– Diapensia lapponica	..	..	..	+	..	+
– Poa glauca	..	+	..	f	f	..
Botrychium lunaria	..	..	+	..	..	..
Campanula rotundifolia	f	..	+	f	..	+
Carex scirpoidea	..	..	f	..	+	+
Cerastium alpinum	..	+	..	f	+	..
Chamaenerium angustifolium	..	..	+	..	..	..
Deschampsia flexuosa	..	+	+	..	..	..
Draba nivalis	..	..	..	+	..	..

(To be continued)

Table 6 (continued).

Analysis no. (see below)	1	2	3	4	5	6
Dryas integrifolia	..	..	..	+	+	f
Euphrasia frigida	+	..	..	+	..	..
Festuca brachyphylla	+	+	..	..	..	+
Oxyria digyna	..	..	..	+	..	..
Poa alpina	..	..	..	..	+	..
Rumex acetosella	..	f	+	..	..	..
Salix glauca callicarpaea	+	..	..	d	..	..
Silene acaulis	..	..	..	f	..	..
Trisetum spicatum	..	..	+	+	+	+

1: Loc. 18, south-facing slope; vegetation rich in lichens.
2: – 20; cf. details in B. 1948. Important cryptogams: *Rhacomitrium canescens*, *Hedwigia ciliata*, *Polytrichum piliferum*, *Stereocaulon alpinum*.
3: Loc. 20, southwest-facing slope; mosses and lichens, particularly: *Rhacomitrium canescens*, *Polytrichum piliferum*, *P. juniperinum*, *Rhytidium rugosum*, *Thuidium abietinum*, *Hylocomium splendens*, *Aulocomnium turgidum*, *Stereocaulon alpinum*, *Cetraria crispa*, *C. cucullata*, *Cladonia rangiferina*, *C. mitis*, *C. gracilis*.
4: Talus slide vegetation in South Greenland according to Rosenvinge 1896, p. 222.
5: Slope of diabase ridge between Store Malene and Lille Malene, Loc. 16. On the stones abundant *Caloplaca elegans*; furthermore *Cetraria nivalis*, *Rhacomitrium lanuginosum*, species of *Tortella*, *Encalypta*, and *Hedwigia*; cf. fig. 12.
6: Sloping diabase ridge near Pá, Loc. 12. pH measured at 5.1—5.2, Lt. 0.6.

d dominant, f frequent, + present.

Hb 1 species with distinct preference for dry rocks and gravel,
Hb 2 species with a more or less continental distribution,
Hb 3 species with a wide arctic distribution and with a certain preference for rock and slide vegetation, but not thermophilous.

Hartz (1894, p. 15) mentions a vegetation on loose gravel in Qíngua, Tasiussaq (61°45′) consisting mainly of *Saxifraga* species, *Papaver*, *Rhododendron*, *Campanula rotundifolia*, *Chamaenerium latifolium*, *Sedum annuum*, and *S. rosea*. In the southern part of West Greenland such a vegetation is mainly found on greatly weathering rocks, e. g. diabase. Therefore there is nothing strange in the fact that a few subcontinental species, such as *Rhododendron lapponicum*, with a preference for neutral-basic soils make their appearance. Rosenvinge's interesting list from slide vegetations in South Greenland (1896, p. 222) also includes such species, viz. *Saxifraga aizoon* and *Draba aurea*. Out of these I actually found the former as an almost constant element, while *Draba aurea* was observed scattered in loose slide at Grønnedal and Narssarssuaq.

In Table 6 three lists from typical rock vegetation in South Greenland are compared with Rosenvinge's list of slide vegetation and two lists of the flora on diabase dykes near Godthaab and the mouth of the Strømfjord. The last analysis (no. 6) does not belong to the vegetational type, but is interesting by being a transitional stage between this and the corresponding continental type (see p. 154). The vegetation includes *Loiseleuria* and *Saxifraga tenuis*, which are both absent in the inland vegetation. The notes are from the dry part of this diabase ridge.



Fig. 12. Diabase ridge between Store Malene and Lille Malene near Godthaab. In the background the northern slopes of Store Malene with large perennial snow drifts. T.W.B. phot. $^{20}/_{7}$ 1946.

At its foot there was a moister vegetation which belongs to the *Polystichum lonchitis-Asplenium* type mentioned on p. 70, as there was much *Polystichum lonchitis*, *Potentilla crantzii*, *Chamaenerium angust.*, *Leucorchis albida*, *Veronica wormskjoldii*, *Erigeron borealis*, and others. Near Grønnedal similar communities with *Polystichum*, *Sedum rosea*, *Potentilla crantzii*, *Cystopteris*, *Chamaenerium angustifolium* were seen, and in rock crevices in the immediate neighbourhood, *Asplenium viride*, *Tortella inclinata*, and *Nostoc commune.*

1. Sedum annuum Sociation.

Observed on south-facing stony-gravelly river slope behind Ivigtut. The most important plants were the following: *Gentiana nivalis*, *Veronica fruticans*, *V. wormskjoldii*, *Luzula spicata*, *Viscaria*, *Antennaria hansii*, *Poa glauca*, *Trisetum*, *Campanula rotundifolia*, and *Euphrasia frigida.*

2. Thymus drucei Sociation.

Mentioned as slide vegetation by ROSENVINGE. Approach to such a sociation seen near the above-mentioned diabase ridge near Godthaab. KAI LARSEN, M.Sc., has told me about a rock vegetation observed by him in Southwest Greenland and dominated by *Thymus drucei.*

3. Potentilla tridentata Sociation.

Seen in several places in rock crevices; often with *Juniperus* and *Luzula spicata*, lichens, and *Rhacomitrium* species, cp. also p. 35.

4. Woodsia ilvensis Sociation.

See Table 6 no. 3. Includes a few individuals of *Roegneria doniana* var. *virescens*, which has a North Atlantic distribution (see MELDERIS 1950).

5. Selaginella rupestris Sociation.

See Table 6 no. 2 and B. 1948 for figures of degree of coverage and ecological notes besides the distribution of the dominant. This is a temperate species and a pronounced xerophyte; it also grows in granite rock vegetation, e. g. in Manitoba (SCOGGAN 1950); but there associated with continental rock plants (cf. p. 155).

c_1. Scrub-like Vegetation Associated with the Veronica-Sedum Type.

Juniperus communis nana soc. Observed at Narssarssuaq and Grønnedal on warm soil, particularly on shallow gravel and soil over rock. Cf. Table 6 no. 1. Mentioned by KRUUSE (1912, p. 229) from Angmagssalik. Cf. also Norwegian *Juniperus-Cotoneaster* sociations mentioned by NORDHAGEN 1943, pp. 558—559.

Salix glauca callicarpaea soc. Mentioned by ROSENVINGE (1896). Personally I have only seen approaches to slide vegetation dominated by willows. Where the willow immigrates to loose scree, it will soon stabilize the soil so much that a scrub develops which is so dense that it does not contain any species typical of unstable soil.

II. The Alchemilla-Phyllodoce-Scirpus austriacus Complex.

Sub- and low arctic oceanic meso-(hygro)phytic grassland, herb- and dwarf-shrub vegetation as well as associated scrubs. Soil more or less acid, snow cover of medium duration, constant in winter.

This large important complex is divided into 6 vegetational types, each with its dominant life form or biological types. Five of the types also—although sometimes in the form of special sociations—appear as undervegetation in scrubs, for which reason a similar number of scrub types will have to be considered. These, however, are best treated in connexion with the low vegetational types with which they are floristic-

ecologically related. The EG-species are partly oceanic sub-low arctic mesophytes, often with a montane distribution on the continents, partly more widely distributed forest plants which in Greenland have an oceanic southern distribution. Particularly the sylvicolous element is very characteristic of a large number of the communities of the complex. The delimitation from the vegetational complex of the snow beds is very difficult as there may be every possible transitional type. I have, however, put the boundary where a distinctly subarctic element in the vegetation disappears. Otherwise the complex includes the classical herb-field as apprehended by WARMING and ROSENVINGE, the grass slope as described by ROSENVINGE, and the type of heath which in my work of 1933b was termed "moist heath, rich in species, on slope facing south".

EG-species (oceanic sub-low arctic meso(-hygro)phytes).

1 (o and mont-o): *Agrostis borealis*, *Anthoxanthum odoratum alpinum*, *Vahlodea atropurpurea*, *Carex stylosa*, *C. norvegica norvegica*.
Sorbus decora americana, *Phleum commutatum*, *Leucorchis albida straminea*, *Alchemilla alpina*, *A. filicaulis*, *A. glomerulans*, *Epilobium hornemannii*, *E. lactiflorum*, *Veronica wormskjoldii*, *Rhinanthus groenlandicus*; *Taraxacum croceum*, *Hieracium alpinum*, *H. hyparcticum*, *Erigeron borealis*, *Gnaphalium norvegicum*, *Botrychium lanceolatum*.
Polystichum lonchitis, *Asplenium viride*.
Lycopodium alpinum, *Cornus suecica*, *Phyllodoce coerulea*.

2 (sylv-o, besides *Scirpus caespitosus austriacus*, which has an oceanic distribution in Greenland, but in the interior of the continents occurs in muskegs and wooded bogs): *Deschampsia flexuosa*, *Carex deflexa*, *Luzula parviflora*, *Dryopteris filix-mas*, *D. dilatata*, *Lastraea phegopteris*, *L. dryopteris*, *Streptopus amplexifolius*, *Listera cordata*, *Coptis trifolia*, *Viola selkirkii*, *Chamaenerium angustifolium*, *Angelica archangelica*, *Cornus canadensis*, *Pirola minor*, *Galium triflorum*.

Cl-species: *Luzula spicata*, *Festuca vivipara*, *Viscaria alpina*; *Veronica fruticans*, *Sedum rosea*, *Arabis alpina*, *Draba incana*; *Carex atrata*; *Potentilla crantzii*; *Salix herbacea*, *Betula glandulosa rotundifolia*, *Sibbaldia procumbens*, *Antennaria canescens*, *Erigeron uniflorus*, *Veronica alpina*; *Bartsia alpina*, *Viola palustris*.

Hb-species: *Poa nemoralis*, *Stellaria calycantha*, (*Thalictrum alpinum*), *Lycopodium annotinum*, *Ledum groenlandicum* (cf. p. 96).
Carex brunnescens; *C. macloviana*, *Luzula multiflora-frigida*, *Viola adunca-labradorica*; *Ranunculus acer*, *Habenaria hyperborea*, (*Poa alpina*).

a. The Agrostis borealis-Anthoxanthum alpinum Type.

(Sub-low arctic oceanic mesophytic and medium chionophilous grasslands or grass-lichen mats).

I have only seen this vegetational type typically developed in the Ivigtut region and on a transitory visit to Narssarssuaq. I must therefore in no small degree base my statements on ROSENVINGE (1896), and as

his presentment does not satisfy the demands of modern sociology it will be obvious that the material is slender. The name of the type and the EG-species selected indicate the possible delimitation of it; but I am aware that the treatment of the type is fairly provisional and count on alterations when South Greenland has been investigated with modern methods.

The distribution in West Greenland of this vegetational type cannot be established exactly, but everything seems to indicate that north of the Godthaabsfjord it is found along the outer coast to the Holsteinsborg region. The northernmost sociations, however, are rather atypical and ought to be separated from the rest as a special subtype. In East Greenland the northern limit is presumably somewhat north of Angmagssalik. Between 68° and 69° there were only feeble attempts at the northern subtype.

Besides pure graminoid sociations I have made the type include such *Alchemilla alpina* sociations as are rich in grasses or sedges, whereas the sociations rich in herbs dominated by this species are referred to the herb-field type (b).

Outside Greenland a corresponding or related vegetation has been described from Norway (*Nardeto-Caricion rigidae*, see NORDHAGEN 1943), Northern Sweden (*Deschampsio-Anthoxanthion*, see GJÆREVOLL 1950, p. 392), Central European mountains (Tatra, see PAWLOWSKI, SOKOLOWSKI & WALLISCH 1928, p. 242, KRAJINA 1933, p. 100), and even from a region as far south as the Appenines (cf. LÜDI 1943).

The EG-species of the vegetational type:

Agrostis borealis. Cl: Low arctic suboceanic-montane with scattered stations in the Canadian lowlands (but there near larger lakes). Absent from Central Eurasia and the coasts of the Polar Sea where precipitation is low, as the plant which CAJANDER (1903) with an added ? terms *A. borealis* hardly belongs to this species. — Rare according to CALDER at the head of Frobisher Bay, Baffin Island; and extremely rare and selective at the head of Søndre Strømfjord. — Ar: North Atlantic-North Pacific with montane radiations; curiously enough absent in Iceland. For details see fig.13, where most American occurrences are drawn in from a map kindly worked out by Dr. M. RAYMOND. The occurrence of the various varieties of the species found in America are not indicated on the map; on these see FERNALD 1933. — Ecology: According to NORDHAGEN the species shows great concentration on the grass heaths of the snow beds. In Christian IX Land it was associated with herb fields and protected heaths as a subordinate element; noted with high frequency in *Carex bigelowii-Salix herbacea* sociation in scree at vertical rocky wall (B. 1933, p. 50). In Tatra on rather dry steep granite rocks with pH 5.1—6.7 (KRAJINA 1933, p. 59); typical oxylophyte according to ST. JOHN 1922.

Anthoxanthum odoratum alpinum. Cl-Ar: The name refers to the diploid boreal subspecies, which so far is known only from the North Atlantic area and the Alps at high altitudes (BÖCHER & LARSEN 1950 and unpublished

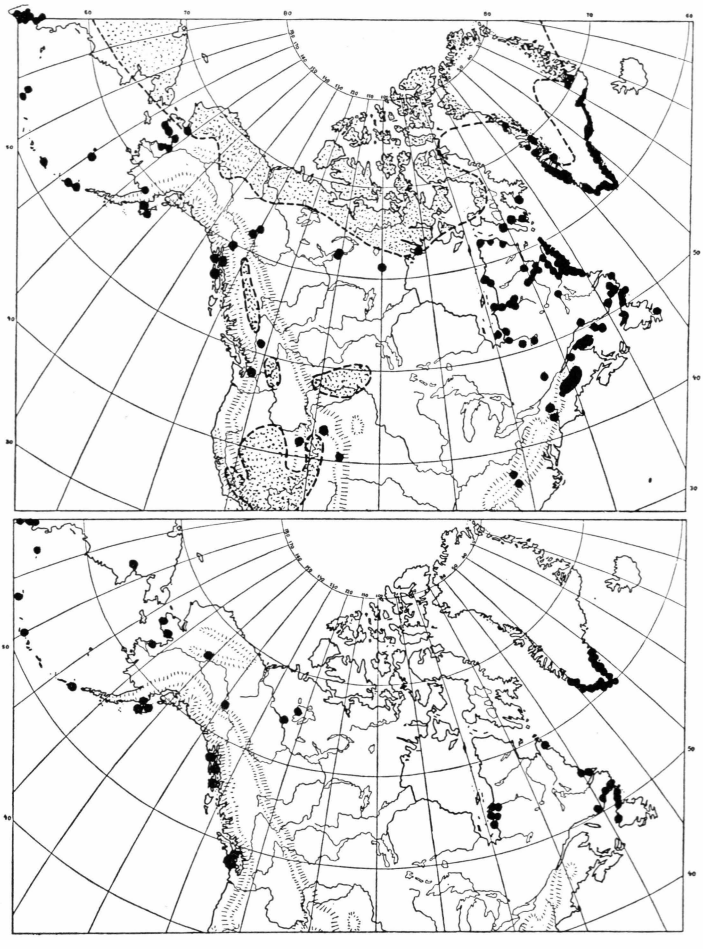
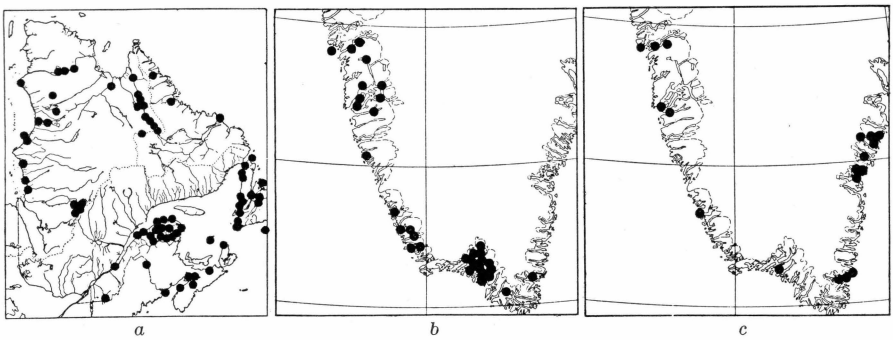


Fig. 13. Above, American-Greenland distribution of *Agrostis borealis* as compared with material of maps in HULTÉN, RAUP (1930), B. (1938), information in CALDER (1951a), and in the case of America made up to date and supplemented by M. RAYMOND. The isohyet for 250 mm annual precipitation is drawn in order to mark out the areas poorest in rain (dotted areas). Below, distribution of *Carex stylosa* after maps in B. 1938, HULTÉN 1942 (Fl. Alaska and Yukon), and RAYMOND 1950.

material by the same authors). The Greenland area is remarkable, with the northern limit farthest north on the east coast as in the case of *Nardus* and *Athyrium alpestre* (maps in B. 1938). — Ecology: Diploid plants very frequently die when cultivated in Denmark, whereas the tetraploids survive. — Very typical of grassy mountain slopes and flat depressions in lichen mats in South Greenland according to ROSENVINGE 1896, pp. 168 and 210.

Deschampsia flexuosa is a widely distributed acidiphilous forest plant, which, however, is absent in continental areas, e. g. large parts of Central Canada and most of Central Asia. The variety *montana* seems to be North Atlantic-montane, sub-low arctic; in Greenland there are hardly any other races than this.



a b c

Fig. 14. a—b distribution in East America and Greenland of *Viola labradorica* (*V. adunca* var. *minor* according to FERNALD). The map of the East American area prepared by Dr. M. RAYMOND. — c Greenland distribution of *Vahlodea atropurpurea*; East Greenland area from map in DEVOLD & SCHOLANDER 1933.

Carex stylosa. Cl: Sub-low arctic oceanic, with very scattered occurrence in continental areas around the Great Bear Lake and the mouth of the Kolyma River. Absent in the innermost branches on the South Greenland fjords (POLUNIN 1943, p. 372). Ar: American, transgressing into eastern Asia and southern Greenland. For details see fig. 13 and map in B. 1938, p. 230, to which should be added another station in the Kap Farvel area (B. 1952, Bot. Tidsskr. 49, p. 197). — Ecology: According to ROSENVINGE frequent on grassy mountain slope and in grass field; according to DEVOLD & SCHOLANDER (1933) in Southeast Greenland also on slopes with ericaceous plants. ST. JOHN has it as a typical oxylophyte.

Vahlodea atropurpurea. Cl: Low arctic-oceanic. Ar: North Atlantic, but absent in Iceland. In the North Pacific area ssp. *latifolia* (see A. E. PORSILD (1951, p. 86)), which also has a wide montane West American distribution. In Greenland very scattered but probably frequent near the northern limits (fig. 14c). — Ecology: NORDHAGEN (1943) mentions it with reservation as guiding species for his *Nardeto-Caricion*, while GJÆREVOLL terms it an important character species. In Southeast Greenland, however, it often grows at so moist stations that the vegetation has the character of *Sphagnum* bog (DEVOLD & SCHOLANDER). ROSENVINGE (1887, pp. 211—212) mentions it from the Sukkertoppen region as occurring in moist sedge meadow at the bottom of a valley, in moist scrubs and on moist slopes, where it is found associated with *Anemone richardsonii.* WORMSKJOLD collected it in alder groves in Godthaabsfjord. This species, too, is a typical oxylophyte according to ST. JOHN.

Lycopodium alpinum; see details on p. 95.

Viola labradorica Schrank may be reckoned as an Hb-species which perhaps approaches to the EG-species. Here we come up against great difficulties, however, as *V. labradorica* by many workers is considered to be only a variety of the widely distributed *V. adunca* Sm. FERNALD (1950, p. 1041) thus terms it *V. adunca* var. *minor* and states that it occurs at both moist and dry stations. It seems as if the Greenland plant behaves as an ecologically well-defined unit, whereas the occurrence of *V. adunca-labradorica* in America offers a picture of some confusion: *V. adunca* is considered an oxylophyte

by ST. JOHN, but according to A. E. PORSILD it is found on calcareous slopes. *V. labradorica* according to ST. JOHN occurs in localities rich in lime, while ABBE 1936 notes it from moist sphagnous tundra. The distribution in America proves to be markedly subarctic-montane (see map fig. 14a); but hardly with an oceanic trend. The Greenland plant according to ROSENVINGE (who calls it *V. muehlenbergiana*) is associated with rather dry and probably also acid soil; for he mentions it as found especially on lichen mats and in *Deschampsia flexuosa* soc. with *Carex stylosa* and *brunnescens*. The distribution (fig. 14b) is not strictly subarctic, as a number of stations are situated on the outer coast.

1. Deschampsia flexuosa Sociations.

Patches of grass vegetation with *Deschampsia flexuosa* as dominant were found at Ivigtut, in Grønnedal, and at Narssarssuaq. In the last-mentioned place the vegetation was found in open spaces surrounded by birch scrubs. In some places *Cladonia mitis*, in others *Hylocomium schreberi* was dominant in the ground layer. This fluctuation between dominance of lichen and moss, however, did not invite a sharp distinction between "lichen heath" and "grassy slope"; for this the difference did not seem great enough. Diploid *Anthoxanthum* might in some places be as abundant as *Deschampsia*; in rare cases it was more frequent.

The type rich in mosses found at Ivigtut (Table 7 no. 4) occurred on a north-facing slope surrounded by heath belonging to the *Phyllodoce* type, and obviously was snow-covered a little longer or more constantly than the latter. A *Betula glandulosa rotundifolia-Cladina-Hylocomium schreberi* sociation was found at the top of a big morainic hill on the southern side of the Arsuk Fjord; a *Deschampsia-Hylocomium schreberi* sociation with *Coptis* followed farther down the north-facing slope and merged into a scrub of *Salix glauca callicarpaea* at the base. A *Deschampsia*-moss-lichen soc. richer in species was found in a third place, viz. in a glade in the willow scrubs in the Ivigtut valley (Table 7 no. 3). The glade was probably due to rather shallow soil on rock.

The type rich in lichens was analysed in Grønnedal, where it occurred at a rather dry station and on a slightly moist level closer to the river (cf. fig. 15) passed imperceptibly into an *Alchemilla alpina-Deschampsia* sociation. The lichen carpet was dominated by *Stereocaulon paschale*, *Cladonia mitis* and *rangiferina*; cf. further Table 7 no. 2.

Near the northern limit of *Deschampsia flexuosa* at Pá (66° lat. N.) the species was seen in two places in vegetation of a more pronounced snow-patch character. On a luxuriant heath slope a flat depression was found which was dominated by *Deschampsia* with *Lycopodium alpinum*, *Alchemilla alpina*, and *Cladonia ecmocyna* as the most important companions. In another place near a perennial snow drift there was nearest to this a snow-patch vegetation of *Salix herbacea*, *Carex bigelowii*, *Gna-*



Fig. 15. Grønnedal near Arsuk Fjord. *Deschampsia flexuosa* soc. rich in lichens, which below (in the foreground) is supplanted by an *Alchemilla alpina* soc. rich in grasses. T.W.B. phot. $^{9}/_{7}$ 1946.

phalium supinum, and *Sibbaldia*. In a zone outside this there was a dense grass mat of *Deschampsia* almost without any other species.

Hartz (1894, p. 23) mentions a lichen heath from the Tasermiutfjord area with *Juniperus* and *Deschampsia flexuosa* as dominants and further with *Nardus*, *Agrostis borealis*, *Luzula spicata*, *L. multiflora*, *Carex capitata arctogena*, *C. bigelowii*, *Viscaria*, *Campanula rotundifolia*, *Chaemaenerium angustifolium*, and others.

2. Anthoxanthum odoratum alpinum Sociations.

Occur in the Julianehaab region as what Rosenvinge termed lichen grass-field and may besides *Deschampsia flexuosa* contain *Alchemilla alpina*, *Carex macloviana*, *Botrychium lunaria*, *B. lanceolatum*, *Agrostis canina*, and *Lycopodium alpinum*. In other places, where perhaps there are fewer lichens, we find *Calamagrostis canadensis langsdorfii* besides *Carex stylosa*, *brunnescens*, *scirpoidea*, *Viola labradorica*, *Polygonum viviparum*, and others.

3. Nardus stricta Sociations.

Are of importance only in Southeast Greenland and in the Tasermiut region in South Greenland (cf. DEVOLD & SCHOLANDER 1933, pp. 143 and 163; HARTZ 1894). They may cover rather large areas and as a rule are very poor in species. As accompanying species in dry sociations are mentioned e. g. *Alchemilla alpina* and *Potentilla tridentata*, while *Scirpus caespitosus austriacus* and *Juncus squarrosus* are found in the moister sociations (cf. the *Scirpus austriacus* type p. 103).

4. Carex bigelowii Sociations.

Such were seen only on small patches in Southwest Greenland, but are of great importance at Angmagssalik; cf. analyses 32—33 in B. 1933 b, in which *Chaemaenerium angustifolium* is subdominant. The vegetation there, however, forms a transition to the xerophilous grassland type (see p. 28), while in West Greenland it reminded more of GJÆREVOLL's *Caricetum bigelowii* from Lapland (1950, p. 396).

5. Calamagrostis canadensis langsdorfii Sociations.

In favourable, moist places, often connected with scrub. Described from South Greenland by ROSENVINGE (1896, p. 170), who mentions *Phleum commutatum*, *Viola palustris*, *Streptopus*, *Epilobium lactiflorum* as accompanying species, and from the Godthaabsfjord by TRAPNELL (1933, p. 309, and Plate XVIII), who mentions *Alchemilla filicaulis* and *Angelica archangelica* as companions or *Deschampsia flexuosa* as co-dominant and *Poa pratensis*, *Luzula*- and *Carex*-species and *Pirola minor* as accompanying species. Because of the floristic contents of these sociations, they belong to the present complex. Other *Calamagrostis canadensis langsdorfii* sociations, which will be mentioned below, belong to a continental type. Sociations with much *Phleum commutatum* or *Alchemilla-Angelica-Streptopus* belong to the following vegetational types.

6. Alchemilla alpina Sociations Rich in Grasses.

A *Betula glandulosa rotundifolia-Cladina* soc. was observed on the driest level beside the river in Grønnedal, followed by the *Deschampsia-Stereocaulon paschale* soc. mentioned above, which again was followed by an *Alchemilla alpina-Deschampsia* soc.; see Table 7 no. 1. An *Alchemilla alpina* soc. rich in grasses was also seen near Godthaab, there close to a south-facing rock (fig. 16) and bordering on an *Agrostis borealis-Dicranum* soc., which because of its station farther from the rock no doubt had a longer snow-cover than the *Alchemilla* soc. The latter was very dense so that hardly any cryptogams could assert themselves. About a corresponding Norwegian vegetation NORDHAGEN (1943, p. 245) writes that *Alchemilla alpina* has its greatest density in the periphery of snow-patch vegetations, where it shows great affinity to *Deschampsia flexuosa*.

Table 7.

Analysis no.	1	2	3[1]	4	5	6	7	8
Locality no.	18	18	17	17	15	15	15	15
Slope	15°	5°	0°	25°	15°	10°	10°	20°
Exposure	SW	SW	—	N	S	S	N	N
pH	4.9	4.6	—	—	—	—	—	4.5
EG Agrostis borealis	..	..	..	..	+	4—5	4	..
— Deschampsia flexuosa montana	3	2	4	4	1	..	+	..
— Carex norvegica norvegica	..	..	1	..	..	..	..	..
— Hieracium alpinum	..	+	..	..	..	..	..	..
— Gnaphalium norvegicum	..	..	1	..	..	..	..	..
— Taraxacum croceum	1	..	1	..	..	..	..	..
— Rhinanthus groenlandicus	..	..	+	..	..	..	..	..
— Chamaenerium angustifolium	+	..	2	..	..	..	..	..
— Alchemilla alpina	4	..	..	..	5	..	..	..
— Coptis trifolia	..	..	..	1	..	..	..	..
— Phleum commutatum	..	..	+	..	..	..	..	..
— Lycopodium alpinum	..	..	1	..	..	..	..	..
Cl Luzula spicata	+	..	+	..	+	1	..	1
— Festuca vivipara	..	..	..	..	+	1—2	+	+
— Viscaria alpina	..	..	..	..	+	+	..	..
— Loiseleuria procumbens	..	+	..	..	..	..	..	..
— Betula glandulosa rotundifolia	1—2	+	..	1	..	..	..	..
Hb Carex brunnescens	+	..	+	..	..	..	..	..
— Ledum groenlandicum	..	..	..	1	..	..	..	..
Calamagr. canad. langsdorfii	..	..	..	+	..	..	..	..
Campanula rotund. (coll.)	..	..	1	..	..	..	..	..
Carex bigelowii	1	..	..	..	..	..	..	2
— lachenaiii	..	..	..	..	..	1	+	..
Empetrum nigrum hermaphr.	..	..	..	1	..	2	1	..
Luzula confusa	..	..	..	..	..	..	+	..
Lycopodium selago	..	..	..	+	..	..	..	..
Poa pratensis (low race)	..	..	..	..	..	..	..	3—4
Polygonum viviparum	+	..	..	..	..	..	..	..
Rubus chamaemorus	..	..	..	..	..	..	..	2
Trisetum spicatum	..	..	..	..	+	..	..	..
Barbilophozia lycopodioides	+	+	+	+	..	+	..	1—2
— hatcheri	..	..	..	..	..		..	
Lophozia alpestris major	..	..	..	..	..	..	..	+
— ventricosa	..	..	..	..	..	+	+	..
Ptilidium ciliare	+	+	..	+	..	+	..	+
Scapania sp.	..	..	..	..	..	..	..	+
Brachythecium albicans groenl.	..	..	1	..	..	..	..	..
?Hb — reflexum	1	..	..	..	..	..	..	..
Dicranum fuscescens	..	+	..	..	..	3	3	2
— scoparium	2	..	..	..	..	..	..	..
Drepanocladus uncinatus	..	..	..	..	..	+	+	+
Hylocomium splendens	..	..	2	..	..	..	..	..

[1] 4 square metres.

(To be continued)

Table 7 (continued).

Analysis no.	1	2	3[1]	4	5	6	7	8
Hylocomium schreberi	1	+	4	5	..	..	..	3—4
Polytrichum alpinum	..	..	..	..	..	..	..	1
— piliferum	..	..	..	..	+	..	..	..
— strictum	..	..	..	..	..	+	..	..
Pseudoleskea incurvata	..	+	..	..	..	..	..	..
Webera nutans	..	+	..	..	..	..	..	..
Cetraria crispa	..	+	..	..	..	+	..	+
— islandica	2	+	..	..	..	..	..	..
Cladonia bellidiflora	..	..	..	..	..	+	2	+
— chlorophaea	+	..	..	..	..	+	..	..
— coccifera pleurota	+	..	..	..	..	+	+	+
— crispata	+	..	..	..	..	..	..	..
— ecmocyna	1	..	..	..	..	+	..	..
— gracilis	+	..	1	..	..	+	..	+
— mitis	1	3	3	..	..	+	..	+
— rangiferina	+	3	2	..	..	+	..	+
— pyxidata neglecta	..	+	..	..	..	..	..	..
— uncialis	..	+	..	..	..	..	..	+
Lecidea granulosa	..	+	..	..	..	..	..	..
Ochrolechia frigida	..	..	..	..	..	+	..	+
Peltigera aphthosa	+	..	..	1	..	..	..	..
— malacea	..	..	..	+	..	..	..	..
Sphaerophorus globosus	..	..	..	..	..	..	..	+
Stereocaulon alpinum	1	..	1	..	+	..	..	..
— paschale	+	4	..	..	..	..	..	..
Galera vittaeformis	..	..	..	..	..	..	..	+
Omphalia umbellifera	..	..	..	..	..	..	+	..

[1] 4 square metres.

7. Agrostis borealis Sociations.

TRAPNELL (1933, p. 313) mentions from Godthaab what he terms a Dwarf Herb-Grass Mat, which no doubt is a snow-patch vegetation rich in grasses and perhaps related to the *Agrostis borealis* soc. which the present writer saw in several places near Godthaab, either, as mentioned above, in connexion with an *Alchemilla alpina* soc. or wedging in between a *Salix herbacea* snow-patch vegetation and a drier *Empetrum* heath which is sooner bare of snow (see the two analyses in Table 7 nos. 6—7 and profile transect pp. 118). This and the following sociation are clearly distinct from the preceding ones by having a much more arctic flora and by approaching considerably to the snow-patch vegetations. Thus they correspond to the low-growing more arctic herb-field sociations which in the north replace the subarctically marked herb-fields with their relatively high growth; cf. pp. 83—84.

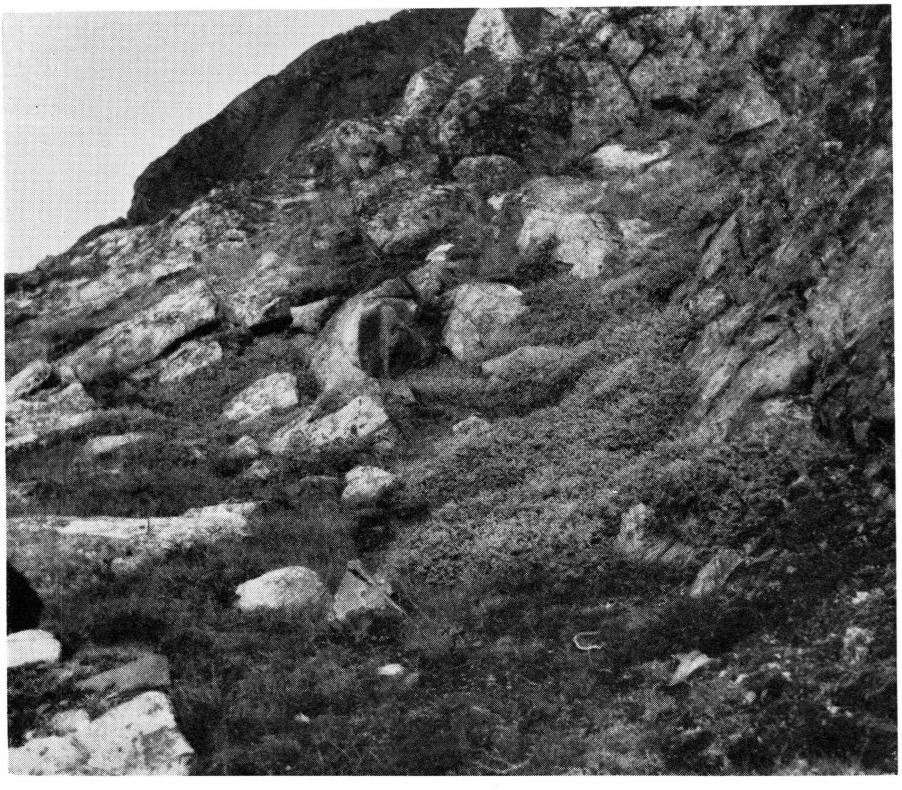


Fig. 16. South-facing slope east of Godthaab. Close to the firm rock on the right there is an *Alchemilla alpina* soc. rich in grasses which farther away from the rock is supplanted by an *Agrostis borealis-Dicranum fuscescens* soc. Outside the picture on the left this is followed by first a *Luzula spicata* soc., then a *Juncus trifidus* soc., and finally an open *Loiseleuria-Diapensia* soc. T.W.B. phot. $^{6}/_{9}$ 1946.

In the continental area at the head of Søndre Strømfjord *Agrostis borealis* was found only beside a water vein which had found its way down over a sunny escarpment. It partly entered sporadically in communities dominated by *Kobresia simpliciuscula* and *Carex scirpoidea* and partly itself dominated on very small spots close to rocks which forced the water up to the surface. There an *Agrostis borealis-Distichium capillaceum* soc. had developed which contained a mixture of continental and a few species of common occurrence in the coastal mountains, *viz. Luzula spicata* and *Poa alpina*. It is mentioned in more detail on p. 263.

8. Poa pratensis-Hylocomium schreberi Sociation.

This sociation is placed here because of its ecological relationship to those above. It was found near Godthaab on small patches between the rocks beside the sea, thus in a place where the rare *Rubus chaemaemorus* entered in the vegetation (Table 7, no. 8). This species is found in the southwestern part of Greenland as a skerry plant and does not enter the interior of the

country, a fact which probably is connected with rather a recent immigration into Greenland by means of birds. Otherwise the dominant was a low race of *Poa pratensis* which reminded of ssp. *irrigata*. If a number of quadrates had been examined, it would no doubt have been possible to elucidate the relationship of the sociation satisfactorily.

a_1. Scrub or Low Forest Vegetation Associated with the Agrostis borealis-Anthoxanthum Type.

The low birch scrub of South Greenland (*Betula pubescens*, Greenland race complex) was only superficially examined at Narssarssuaq during the Expedition, but it appeared there so as to leave no room for doubt that the vegetation of field and ground strata mostly was closely related to the above-mentioned grassland vegetation. Below the 3—4 m high, crooked trees especially *Deschampsia-Hylocomium* sociations were found in which e. g. *Coptis* or *Lastraea dryopteris* and *phegopteris* might play an unimportant part. ROSENVINGE (1896, pp. 144—145) also mentions *Deschampsia* and *Anthoxanthum* and the *Hylocomium* species as the most important ground flora dominants in the birch woods, and HARTZ supplements the picture by adding *Nardus*, *Poa nemoralis*, and *Roegneria doniana virescens* as important understorey plants at the Tasermiut Fjord.

Copses of *Salix glauca callicarpaea* more rarely have a grassy ground vegetation. At Ivigtut, it is true, there were small patches with *Deschampsia flexuosa-Hylocomium schreberi-splendens*, but as a rule the vegetation was so rich in nongraminoid species that it might as well be referred to the herbaceous copses (cf. Table 8, nos. 13—14). This applied in a still higher degree in places where the ground flora was dominated by *Poa nemoralis* and *pratensis domestica* (cf. fig. 23).

A slightly deviating field layer on moist terrain near a spring behind Ivigtut is perhaps best mentioned here. In thick moss cushions, particularly of *Drepanocladus uncinatus* and *Polytrichum alpinum* the most important vascular plants were *Festuca rubra* and *Poa pratensis domestica*; scattered *Corallorhiza trifida* was found there, too.

b. The Streptopus-Lastraea phegopteris Type.

(Subarctic sylvicolous-oceanic and hygrophilous fern- and high-growing herb-vegetation).

WARMING's and ROSENVINGE's herb-field can be divided into a number of communities, which can be characterized both plant-geographically and as regards life-form. If we keep to vegetations rich in herbs but without continental or high arctic species, there is first the *Streptopus-Lastraea* type with preponderance of subarctic sylvicolous

species, absence of chionophilous species, and with several erect long-shoot species and fewer rosette plants. Next, there is the *Alchemilla vulgaris-Phleum commutatum* type with a mixture of sub- and low arctic species, particularly medium chionophilous species of the rosette or semirosette type, and finally there are types with preponderance of arctic, greatly chionophilous, very low species (snow-patch vegetation; see p. 108).

The absence of a distinct snow-patch element in the *Streptopus-Lastraea* type makes the latter remind of the high-perennial meadows of Scandinavia where NORDHAGEN (1943, p. 314) emphasizes the absence of such species. The great sylvicolous element in the "*Mulgedion*" of Scandinavia contributes to the similarity; but it cannot be denied that the Greenland communities are extremely poor in species as compared with the Scandinavian ones, to say nothing of the Central European montane high-perennial meadows. The most important species common to the Greenland and the Scandinavian communities are presumably *Angelica archangelica*, *Epilobium lactiflorum* (which in Greenland is found far north in the herb-fields of East Greenland), *Chamaenerium angustifolium*, *Pirola minor*, and the *Lastraea* species. In the southwest it seems that the *Streptopus-Lastraea* type continues on the southern part of the Labrador coast, connected there with coniferous forest (cf. HUSTICH & PETTERSSON 1943, p. 39).

The EG-species of the vegetational type:

Lastraea dryopteris (*Dryopteris linnaeana*) and *L. phegopteris* are widely distributed boreal forest plants, which in Greenland have an oceanic distribution with an oblique northern limit from the interior of the Godthaabsfjord towards the north in the direction of Holsteinsborg (fig. 21 in B. 1938). The limit is presumably due to a need of a certain air humidity or a special condition of humus in the soil. It is characteristic that both species, like *D. dilatata* as well, avoids the Athabasca-Great Slave Lake region (RAUP 1930, p. 205) and that *L. phegopteris* according to the map in FOMIN (1930) is absent between Lake Baikal and the area of hardwood forest along the east coast of China. It reaches the northernmost Scandinavia, but becomes rare towards the east in Kola and then sends a wedge into Asia in the southern part of the area of coniferous forest. The North American area of *L. dryopteris* is mapped in RAUP 1947, Plate XIII. Both *Lastraea* species have an oligotrophic trend and are found on KALELA's oligotrophic high-perennial meadow (1939, p. 218).

Dryopteris filix-mas. According to MANTON (1950) this is an allotetraploid species, which together with diploid relatives forms a complex the distribution and demarcation of the types of which are not sufficiently known. Still, *D. filix-mas* has an ecologically characteristic distribution: HULTÉN's map (1950, no. 55) shows that in the north of Scandinavia it is most frequent along the west coast. In Iceland GRØNTVED's map (1942, fig. 26) and in Greenland my map (1938, fig. 20) show a similar connexion with west coasts, as is typical of several thermophilous species at their northern limit. Conditions remind of the distribution of Mediterranean-Atlantic species (*Ilex aquifolium*

and others). The American distribution (FERNALD 1950, p. 36; M. BROUN 1938 Index North Am. Ferns, p. 67) resembles that of *Streptopus* (fig. 17) by having a gap west of the large lakes, but is different from it by going north only to Newfoundland in the east and British Columbia in the west. It grows in cool rocky woods and on talus slopes, often in calcareous regions. However, it is hardly a calciphilous species.

Dryopteris dilatata, too, which in the northern part of West Greenland avoids the inland and is a widely distributed forest plant, naturally enters the present type as an EG-species even though it is rarely observed as an important element in the vegetation. HOLM (1887) mentions it as occurring abundantly in *Angelica* vegetation near Frederikshaab together with *Asplenium viride* and others.

Streptopus amplexifolius. Cl: Subarctic-montane of a hygric-oceanic distributional type, disappearing from the areas poor in rain in North America, but wedging into the continent along the large lakes. Ar: mainly American, but also occurring in East Asia and from the Pyrenees to the Alps; maps in FASSETT (1935), who also gives an account of the variation and refers the Greenland plant to var. *americanus* Schultes. Fig. 17 shows the distribution of all varieties. — Ecology: In America growing in moist woods and thickets and both associated with acidophilous and non-acidophilous species. HUSTICH & PETTERSSON mention it from spruce forest with a 15 cm deep humus layer together with *Phyllodoce*, *Linnaea*, *Lastraea dryopteris*, *Deschampsia flexuosa*, and *Trientalis*, while A. E. PORSILD (1951) mentions it from alpine moist meadows in Yukon together with *Veratrum eschscholtzii* and (1939, p. 155) from birch copses in Alaska together with *Habenaria hyperborea*.

Viola selkirkii is also associated with cool rocky slopes or rich woods and has a gap in Central North America (see fig. 17). According to ROSENVINGE it is characteristic of the willow scrubs of the outer coast. Its small distribution in Greenland (map in B. 1938 and 1951 c), however, is undoubtedly historically conditioned; it ought to be able to grow in the inland in South Greenland south of Kap Thorvaldsen. — *Galium triflorum* has a wide distribution in forests across North America, but its northern limit turns south of Hudson Bay (map 47 in FERNALD 1925). In Greenland it ranges along the outer coast to Godthaab (map fig. 96 in B. 1938). Neither this species nor *Viola selkirkii* thus are inland plants there, which is remarkable as they behave alike in Scandinavia and are absent in West Norway (maps 1264 and 1631 in HULTÉN 1950). This may be a parallel to the case of *Luzula parviflora*, which is continental in Scandinavia (B. 1951 c), but in Greenland at its northern limit follows the coast and in America does not appear until the oceanically marked coast of Labrador. This species, too, is associated with damp woods and slopes. The West Greenland races (populations) in these three cases are not continental. Presumably they either held their own during the last Glacial Age in the southwest corner of Greenland (cf. the distribution of *Viola selkirkii*) or they immigrated from the Atlantic coast of America. The absence of the three species in Iceland and their behaviour in West Norway suggest immigration of the Scandinavian populations from the east, i. e. from Asiatic or Central Russian refugia, the biotype populations of which presumably were continental.

Pirola minor. Cl-Ar: Widely distributed subarctic forest plant which in Greenland has an oceanic distribution and in the north reaches the boundary

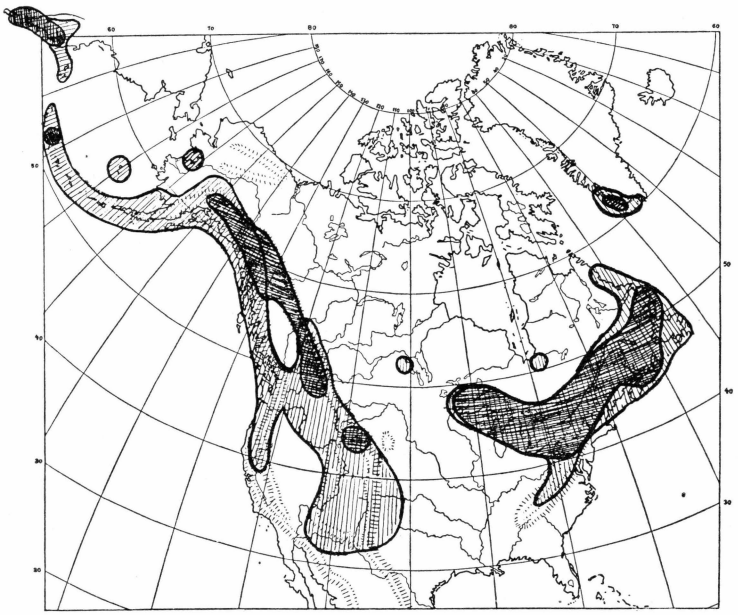


Fig. 17. American-Greenland distribution of two species connected with moist woods and cool rocky slopes, *Streptopus amplexifolius* (hatching parallel to longitudinal degrees) and *Viola selkirkii* (hatching parallel to latitudinal degrees). Distribution of the former in America after FASSETT (1935).

of the low arctic area; maps in B. 1938 (Greenland), RAUP 1947, Plate XXXII (North America), and A. E. PORSILD 1951, fig. 3 (circumpolar distribution). — In Greenland frequent in this and the next vegetational types and thus overlapping EG-species for these. — *Chamaenerium angustifolium.* Almost like the preceding species as regards distribution (see RAUP, *loc. cit.*, Plate XXXI), but also occurring in the preceding type. The Greenland race, which by FERNALD is apprehended as a variety, is subarctic East American-Greenlandic and wedges up along the coast to Central Baffin; in the north of West Greenland also only along the coast (B. 1948, fig. 75, B. 1952 a). — *Coptis trifolia* seems to be a good EG-species for the whole complex. This species, too, is a rather widely distributed forest plant, but seems to be rare in the Athabasca-Slave Lake region (RAUP 1936). Its Alaska distribution (HULTÉN, map 568) as well as its Greenland distribution (B. 1938, fig. 40) shows a markedly oceanic trend.

Angelica archangelica must be considered an EG-species associated with the present type and the type mentioned on p. 87 from springs. Its behaviour in Greenland thus corresponds completely to that in Norway (cf. NORDHAGEN 1943). The Greenland material seems to fall under ssp. *norvegica* (Rupr.) Nordh., which thus is seen to have a North Atlantic distribution or, if related forms in the mountains of Eurasia are adduced, a North Atlantic-montane Eurasian distribution. It ought to have been included in Group 11 in HULTÉN (1950), but may by mistake have been referred to Group 14. Its frequency in Iceland and the Faroes, its oceanic trend in Scandinavia (map 1344 in HULTÉN), and in West Greenland (B. 1952) shows that it is a subarctic and suboceanic species. Peculiarly enough it is the only species with any association

with forest and scrub which, apart from *Betula pubescens*, has a European Ar-type. In the next vegetational type conditions are completely reversed; there the European species dominate among the EG-species.

1. Streptopus amplexifolius Sociations.

Observed on the coast of the Arsuk Fjord on a very luxuriant talus slope, below a steep rock wall. The soil under the vegetation was rich in mull far down with pH 5.7 and Lt 1.4. The potassium value (31) and the phosphoric acid value (19) suggest great richness in nutrients. The vegetation was growing on a south-facing slope and was about 70 cm high, with *Streptopus*, *Angelica*, and *Chamaenerium* in the uppermost storey, below that particularly *Lastraea phegopteris*, and at the bottom a layer of moss consisting of *Pseudoleskea incurvata-Brachythecium trachypodium* (cf. Table 8 no. 1). The Oribatid and Collembola fauna in the soil was immensely rich (21 species, 1818 individuals; HAMMER 1952, no. 10). Obviously it is almost completely the same vegetation as is mentioned by HARTZ (1894, p. 9) from Qíngua, Kuánersôq, where the following species were observed: *Streptopus*, *Lastraea phegopteris*, *Dryopteris filix-mas*, and *Chamaenerium angustifolium* besides *Angelica*, *Alchemilla vulgaris*, *A. alpina*, *Potentilla crantzii*, *Cornus suecica*, *Erigeron borealis*, *Hieracium alpinum*, *Leucorchis albida*, *Habenaria hyperborea*, *Carex scirpoidea*, *Polystichum lonchitis*, and others. The vegetation found by HARTZ at Tigssaluk (1894, p. 16) is clearly related to the one mentioned. It includes *Angelica*, *Streptopus*, *Dryopteris filix-mas*, *D. dilatata*, *Epilobium lactiflorum*, *Ranunculus acer*, *Gentiana aurea*, and others. Unfortunately conditions of dominance are not particularly mentioned there. ROSENVINGE (1896, p. 162) on the other hand mentions a *Streptopus* soc. with *Alchemilla vulgaris* and *Lastraea phegopteris* at an altitude of 500 feet above sea level near Tunuarmiut in the Tunugdliarfik Fjord, sheltered and in part shaded by a vertical rock wall.

2. Dryopteris filix-mas Sociation.

Observed in connexion with the preceding sociation, but along a runnel below a corner in the steep wall (fig. 18). In the season of snow melting water will run down here and presumably will sooner rid the vegetation of snow, and furthermore wash a little of the soil away so that the bottom becomes somewhat more mineral and stony. The runnel was completely dry on July 11, 1946. The dominant was accompanied by *Angelica*, *Chamaenerium angustifolium*, *Galium triflorum*, *Ranunculus acer*, *Hieracium hyparcticum*, *H. rigorosum* (abundant in spots), *Rhinanthus groenlandicus*, and *Polystichum lonchitis*.

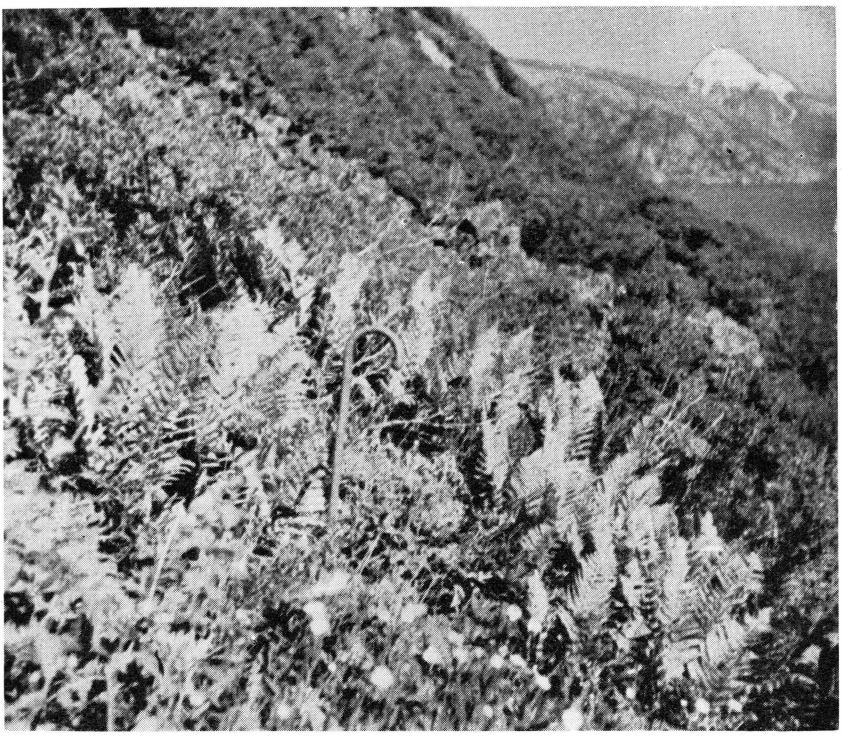


Fig. 18. Luxuriant slope facing south by the Arsuk Fjord near Grønnedal. Beside the walking-stick *Dryopteris filix-mas* forms knee-high growths. In front of the stick flowering *Ranunculus acer*. In the background willow scrub and in the distance the snow-covered peak of the mountain Kungnait at Arsuk, which reaches an altitude of 1395 m above sea level. T.W.B. phot. $^{11}/_{7}$ 1946.

3. Lastraea phegopteris Sociations.

Occurring close to the two preceding sociations, but very close to the vertical rock and on rather shallow soil over the rock. The same situation was observed as far north as near Kangâmiut, where *L. phegopteris* was dominant in a fringe under a south-facing rock. Secondary species were low-growing *Salix glauca callicarpaea*, *Alchemilla alpina*, *Taraxacum croceum*, *Calamagrostis canadensis langsdorfii*, *Campanula rotundifolia*, *Sibbaldia*, and a single northern continental species, *Hierochloë alpina*. *Lastraea dryopteris* was found near them, but did not enter in association with its relative. The zonation in front of the rock wall was very characteristic: (1) *L. phegopteris* soc., below that (2) *Alchemilla alpina* soc., followed downwards by (3) *Sibbaldia-Gnaphalium norvegicum* soc., and then by (4) *Empetrum-Phyllodoce* soc. and at the foot of the slope on less steep and almost level ground by (5) *Salix herbacea*

soc. rich in hepatics. There can be no doubt that the melting begins at no. 1 and ends at no. 5.

4. Lastraea dryopteris Sociation.

Observed at Pâ (see p. 80 no. 2) under similar circumstances as the *L. phegopteris* sociation at Kangâmiut. To judge from the accompanying plants and environmental conditions the *L. dryopteris* soc. was exposed to greater moisture (dripping from above, percolation) than the *L. phegopteris* sociations. Also mentioned by HARTZ (1894, p. 17) from Ivigtut.

5. Chamaenerium angustifolium Sociations.

Such sociations have been described from the southeast coast of Greenland on favourably exposed slopes, often near scrubs (B. 1933, pp. 25 and 35; DEVOLD & SCHOLANDER p. 163). There were approaches to similar sociations in a few places near the Arsuk Fjord and Pâ, where a *C. angustifolium* soc. was being established on a rocky, favourably exposed slope. The vegetation had points of resemblance with the *Veronica fruticans* type and included the following xerophilous rock plants: *Woodsia ilvensis*, *Cystopteris fragilis*, a little *Botrychium lunaria*, *Dryopteris dilatata* (between blocks), *Arabis alpina*, *Phleum commutatum*, *Angelica*, *Alchemilla glomerulans*, *Poa alpina*, etc.

The sociations (2—5) mentioned above may very nearly be characterized as mesophytic rock- and talus-slide vegetation. A community which would correspond to the *Veronica-Sedum* type in the preceding complex. It is possible that we ought in time to operate with a particular mesophytic *Polystichum lonchitis-Asplenium viride* type, named after the species which would be its chief EG-species. As mentioned above, p. 52, there is in the Arsuk Fjord a markedly open rock- and talus-slide vegetation on favourably exposed, not too dry ground, protected by snow in winter, in which occur both of the EG-species suggested. The same applies to the Angmagssalik region (see KRUUSE 1912, p. 245). It applies to this type of slide vegetation that by succession it may be able to develop into communities belonging especially to the present or the following vegetational type. The distribution of the two species suggested is low arctic-oceanic montane; see map of the Greenland distribution (B. 1938, figs. 18 and 22) and for *Polystichum lonchitis* FERNALD (1937, p. 207) and FOMIN (1930).

b_1. Scrub or Low Wood Vegetation Connected with the Streptopus-Lastraea Type.

Most scrubs and thickets rich in herbs are connected with the *Streptopus-Lastraea* type, particularly if *Angelica* is included among the characteristic elements of this type. It should be noted that among species forming wood or scrub there are two with an oceanic trend and

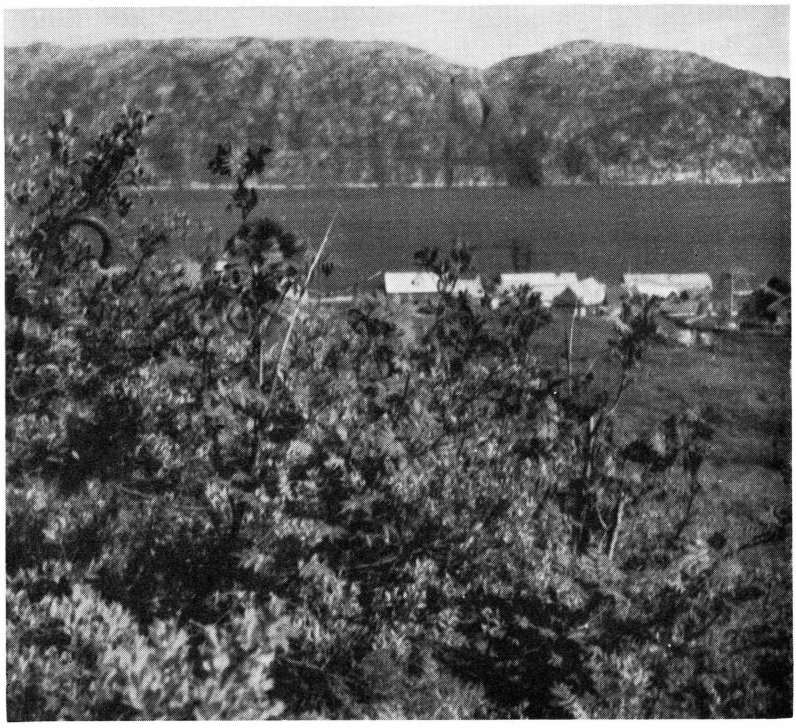


Fig. 19. Growth of *Sorbus decora groenlandica* in willow scrub on the slopes behind Ivigtut. T.W.B. phot. $^{10}/_{7}$ 1946.

one, viz. *Alnus crispa*, with a slightly continental trend (see discussion in B. 1949b pp. 16—18 and map of its American distribution in RAUP 1947, Plate XXII). The two slightly oceanic species are *Betula pubescens*, about which, however, it is difficult to make any definite statement as the Greenland population seems to hold a position apart. The Greenland *Sorbus* is something special, too. BÖCHER & LARSEN found that it was tetraploid while its relative *S. americana* is diploid; it reminds of this species as well as *S. decora*, and therefore future investigations perhaps will show it to be an allotetraploid. The distribution described for it by FERNALD (1950, p. 760), however, is very interesting; it shows a decidedly Atlantic East American-Greenland species growing in the southwest corner of Greenland and the stretch from Southern Labrador to Northern New England. According to HUSTICH it is very rare in the interior of Labrador, where it grows in a small mountain valley.

1. Betula pubescens Scrub.

Scrub of birch with a meadow-like undergrowth was rare at Narssarssuaq. Some of the small patches of this type observed contained

Angelica, *Alchemilla glomerulans*, *Chamaenerium angustifolium*, *Ranunculus acer*, *Rumex acetosa* and others, some other patches were dominated by one of the *Lastraea* species. In one place there was a good deal of *Dryopteris filix-mas* at the edge of the scrub.

2. Sorbus decora groenlandica Scrub.

The mountain ash as a rule occurs interspersed in the willow scrub of the lowlands or as a subordinate element in the birch scrub of South Greenland. Behind Ivigtut it might, however, form connected patches of scrub surrounded by willow scrub. These scrubs of mountain ash would reach a height of up to three metres. An example of the ground flora in such a rather dense scrub is seen in Table 8, no. 9 (*Lastraea dryopteris* soc. with *Angelica*, *Galium triflorum*, and others). In another place with a more illuminated ground *Angelica* was more frequent; among other species were *Alchemilla glomerulans*, *Ranunculus acer*, *Streptopus*, *Stellaria calycantha*, *Rhinanthus groenlandicus*. Among the mosses *Marchantia polymorpha* was noted.

3. Salix glauca callicarpaea Scrub.

Willow scrubs with a floor rich in herbs or a floor of ferns play a great part in the southern part of Greenland, while they are absent, e. g. in skerry terrain as at Godthaab and Kangâmiut. At Pá there were a few small, low scrubs with a herbaceous ground flora and several of the EG-species; but in the continental area at the head of Søndre Strømfjord all good EG-species had disappeared, the only one left being *Angelica*, sometimes associated with *Thalictrum alpinum* in some of the moistest scrubs. For many reasons these scrubs in spite of ecological similarity to those of the coastal regions are reckoned as belonging to a special type (cf. p. 86).

In Table 8 no 10 a *Cornus suecica-Streptopus-Lastraea* soc. is described. Other combinations near Ivigtut were the following: (a) *Lastraea dryopteris-Hylocomium squarrosum-splendens-schreberi* soc. with *Deschampsia flexuosa*, *Streptopus*, *Alchemilla filicaulis*, *Polygonum viviparum*, *Nephroma arcticum*, *Barbilophozia lycopodioides*, and *Polytrichum alpinum*; (b) willow scrub with mountain ash interspersed: *Streptopus* soc. with *Angelica*, *Alchemilla glomerulans*, *Sedum rosea*, *Chamaenerium angustifolium* and *latifolium*, *Galium triflorum*, *Thalictrum alpinum*, *Veronica wormskjoldii*, *Oxyria*, *Carex bigelowii*, *Polygonum viviparum*, *Lycopodium annotinum*, and *Pedicularis flammea*; (b) was found close to a river, while (a) was found on a moist sloping mountain side. *Listera cordata*, too, was seen in these luxuriant lowland scrubs on a sloping ground. A low willow scrub on a favourably exposed slope at an altitude

Table 8.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Locality no.	14	14	14	14	14	17	17	18	17	17	18	18	17	17
Slope	20°	25°	20°	30°	25°	30°	40°	35°	0°	20°	5°	15°	0°	0°
Exposure	S	S	S	S	S	SW	S	SW	—	SW	W	SE	—	—
pH	—	—	—	5.3	4.9	—	—	5.7	5.6	5.8	6.3	6.0	5.1	—
Lt	—	—	—	—	—	—	—	1.4	—	—	—	—	1.3	—
EG Sorbus decora groenlandica.	..	..	..	..	..	..	..	..	5	..	..	..	..	..
Salix glauca callicarpaea ..	..	..	1	2	..	..	..	..	1	3–4	3–4	3–4	5	4
EG (sylv.) Streptopus amplexifol.	..	..	..	..	..	..	..	5	..	2	..	..	..	..
— Angelica archangelica	..	..	..	..	..	1	3	3	2	1	3	4	2	1
— Lastraea dryopteris	..	..	+	+	..	..	..	..	5	2	..	..	..	..
— — phegopteris	..	..	..	..	..	..	..	5	..	..	..	..	..	..
— Chamaenerium angustifol. .	..	+	+	..	..	..	2	1	+	+	..	..	..	..
— Galium triflorum	..	..	..	..	..	..	..	+	2	..	..	..	..	..
— Pirola minor	+	..	..	..	..	+	..	..	..	..	..	..	..	..
— Coptis trifolia	..	..	..	..	..	+	..	..	+	+	..	..	..	..
— Deschampsia flexuosa mont.	..	..	..	..	..	+	+	..	..	1	1	1	4	4
— Luzula parviflora	..	..	..	..	..	..	..	..	..	+	..	..	..	..
EG Alchemilla alpina	1	+	5	5	5	5	5	2	..	..	..	..	..	..
— — filicaulis	..	..	..	..	..	..	..	..	1	..	..	1	..	..
— — glomerulans	..	..	..	..	..	1	+	..	..	2	2	1	..	1
— Gnaphalium norvegicum...	2	2	..	+	..	..	1	..	..	..	..	..	..	..
— Hieracium hyparcticum ...	..	..	..	+	..	+	2	1	1	..	..	..	..	..
— Taraxacum croceum coll...	2	2	1	1	1	1	1	2	..	+	..	2	+	1
— Rhinanthus groenlandicus .	..	..	..	..	..	1	+	1	+	+	+	..	..	..
— Erigeron borealis	..	..	..	..	..	+	..	..	..	..	..	..	..	..
— Veronica wormskjoldii.....	..	..	..	..	..	+	+	..	..	..	..	1	+	..
— Phleum commutatum	..	..	..	2	..	+	+	..	..	..	..	..	..	..
— Agrostis borealis.....	..	..	..	..	..	..	..	..	..	..	+	..	..	..
— Botrychium lanceolatum...	..	..	..	..	..	..	+	..	..	..	..	..	..	..
— Cornus suecica	..	..	..	..	..	..	..	..	..	3	..	..	..	..
— Phyllodoce coerulea.....	..	..	+	..	2	..	..	..	..	..	..	..	..	..
— Lycopodium alpinum.....	..	..	+	..	+	..	..	..	..	..	..	..	..	..
Cl Sedum rosea	..	..	..	..	+	+	..	+	..	..	..	..	..	..
— Veronica fruticans	..	..	..	..	..	+	..	..	..	..	..	..	..	..
— Arabis alpina.....	..	..	..	..	..	+	..	..	..	..	..	..	..	..
— Potentilla crantzii	..	..	..	..	..	+	..	..	..	..	..	..	..	1
— Sibbaldia procumbens.....	5	5	..	..	..	..	..	..	..	..	..	..	..	..
— Veronica alpina.....	..	..	..	+	..	..	..	..	..	+	..	..	..	..
— Viola palustris.....	..	..	..	..	..	..	..	..	..	+	..	..	+	..
— Bartsia alpina.....	..	..	..	..	..	..	..	..	..	..	..	1	..	..
— Carex atrata	..	..	..	..	..	..	..	..	..	..	..	..	1	1
— Salix herbacea.....	..	1	..	..	+	..	..	..	..	..	..	..	..	..
— Betula glandulosa rotundifol.	..	..	..	..	..	..	..	..	..	1	..	2	..	..
Hb Ledum groenlandicum.....	..	..	..	..	..	..	..	..	..	1	..	..	+	..
— Poa nemoralis.....	..	..	..	..	..	+	+	..	+	1	1	+	2	..

(To be continued)

Table 8 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hb Poa alpina	..	..	..	..	..	+	..	..	..	+	..	+	+	..
— Carex brunnescens	..	..	..	+	..	..	..	..	..	+	..	..	..	..
— Luzula multiflora frigida	..	..	..	..	..	+	..	..	..	..	..	..	..	..
— Thalictrum alpinum	..	..	..	..	..	+	+	..	+	..	2	2	1	1
— Ranunculus acer	..	..	..	..	..	..	..	..	..	..	2	..	..	..
— Stellaria calycantha	..	1	..	..	..	..	..	..	..	..	+	..	+	..
— Habenaria hyperborea	..	..	..	..	..	..	..	..	..	..	1	..	..	..
— Lycopodium annotinum	..	..	..	..	..	..	..	..	1	1	..	..	.	..
Calamagr. canad. langsdorfii	+	1	1	+	1	..	..	..	..	..	..	..	1	..
Campanula rotundifolia coll.	+	..	+	..	+	..	+	+	+	+	+	1	+	+
Cardamine pratensis	..	..	..	..	..	..	..	..	..	..	+	..	..	..
Carex bigelowii	..	..	+	..	..	..	..	..	..	..	..	1	..	..
— scirpoidea	..	..	..	..	+	..	..	..	..	..	..	..	..	..
Cerastium alpinum	+	..	..	+	..	..	..	..	..	..	..	..	..	..
Chamaenerium latifolium	..	..	..	..	..	+	..	..	..	..	..	..	..	..
Empetrum nigr. hermaphrod.	..	..	..	..	+	..	..	..	..	+	..	..	..	..
Poa pratensis	1	2	+	1	..	..	..	+	1	..	..	..	..	..
Polygonum viviparum	..	..	+	+	+	+	..	..	..	+	+	1	1	+
Salix arctophila	..	..	+	..	..	..	..	..	..	..	..	..	..	..
Vaccinium ulig. microphyll.	..	..	..	..	+	..	..	..	..	+	..	..	1	..
Barbilophozia lycopodioides	..	..	..	..	+	+	..	..	+	..	+	1	..	..
Aulacomnium palustre	..	..	..	..	..	..	..	..	..	..	1	..	..	..
Brachythecium albicans groenlandicum	..	..	..	..	..	2	4	..	1	3	..	..	1	..
?Hb — reflexum (forma)	..	1	..	..	..	..	..	..	..	..	..	..	..	..
— salebrosum	..	..	..	+	1	3	2	..	5	..	+	1	..	..
?Hb — trachypodium	..	..	..	..	..	..	..	4	..	..	..	..	..	..
Climacium dendroides	..	..	..	..	..	..	..	..	..	..	1	..	..	..
Dicranum fuscescens	..	..	..	..	..	..	..	..	..	+	..	..	..	..
Drepanocladus uncinatus	..	..	..	..	..	..	..	+	+	..	..	3	3	1
Hylocomium pyrenaicum	..	..	..	..	..	..	..	..	..	1	..	..	..	..
— schreberi	..	..	..	..	..	..	..	..	+	1	..	..	1	4
— splendens	..	..	..	..	..	..	..	..	+	1	5	..	..	4
— squarrosum	..	..	..	..	..	+	..	..	+	+	1	..	+	+
Oncophorus wahlenbergii	..	..	..	..	..	..	..	..	+	..	..	..	..	..
Polytrichum alpinum	..	..	..	..	..	..	..	..	+	..	..	..	..	..
— hyperboreum	..	..	+	..	+	..	..	..	..	..	..	..	..	..
Pseudoleskea incurvata (filamentosa)	..	..	..	..	..	1	..	3	..	..	..	2	..	..
?Hb Ptilium crista-castrensis	..	..	..	..	..	..	..	..	1	..	..	..	..	..
Rhacomitrium heterostichum	..	..	..	..	+	..	..	..	..	..	..	..	..	..
— lanuginosum	..	..	..	..	+	..	..	..	..	..	..	..	..	..
Tomenthypnum nitens	..	..	..	..	..	..	..	..	..	..	1	..	..	..
Tortula norvegica	..	..	..	..	..	..	..	..	..	..	..	1	..	..
— ruralis	4	..	+	..	..	+	..	+	..	..	..	..	..	..

(To be continued)

Table 8 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Cetraria islandica	..	..	..	..	..	..	+	..	..	..	..	1	..	..
Cladonia ecmocyna	..	..	..	..	..	..	+	..	..	..	..	..	..	..
— lepidota	..	..	..	..	..	..	..	..	..	..	..	+	+	..
Peltigera canina	..	..	..	..	..	..	..	..	..	..	..	..	+	..
— rufescens	..	..	..	..	..	..	..	..	..	..	..	+	..	..
Stereocaulon alpinum	..	..	..	..	..	..	+	..	..	..	} 1		..	..
— paschale	..	..	..	..	..	..	..	..	..	..	}		..	..

of 250 metres above sea level near Ivigtut (c) also belonged to this type by being dominated by *Angelica-Streptopus* and having abundant *Veronica wormskjoldii*, *Leucorchis albida*, *Sedum rosea*, and *Potentilla crantzii*, but besides it was adorned by *Pirola grandiflora*, which is chiefly connected with continental willow scrubs and has a subcontinental, wide arctic distribution, and by *Polystichum lonchitis*, which, however, kept to a rock outcrop in the scrub.

In the literature from earlier times there are several descriptions which remind of vegetation belonging to the present type. Hartz (1894, pp. 14—15) has a good example from Qíngua, Tasiussaq (61°45′), where amongst others *Viola palustris*, *Pirola minor*, *Coptis*, *Listera cordata*, *Stellaria calycantha* and *longipes*, *Luzula parviflora*, and *Habenaria hyperborea* enter in the ground flora of the scrub. *Stellaria longipes* there is the only representative of a slightly continental floral element.

Rosenvinge (1887, p. 212) from Tuapagtalik near Sukkertoppen mentions a scrub with *Angelica archangelica*, in which *Anemone richardsonii* occurred abundantly together with, amongst others, *Phleum commutatum*, *Carex brunnescens*, *Vahlodea atropurpurea*, and *Equisetum silvaticum*. On Præstefjeldet near Holsteinsborg as well this anemone occurs in scrub and herb field according to Warming and others. The strange relic-like occurrence of this species in Greenland is mentioned in more detail in B. 1951 c. It is no subarctic species, but is sub-low arctic (Raup 1947, map Plate XXIV), and perhaps it is only a low arctic race that is found in Greenland. In America it grows on the forest floor together with *Ranunculus lapponicus*, *Cornus canadensis*, *Pirola minor*, and others (A. E. Porsild 1939, p. 151) beside alpine brooks and as a snow-patch plant together with *Cerastium cerastioides* and *Ranunculus nivalis* (see Polunin 1948, pp. 218—219). In Northern Asia it grows in moist *Salix hastata* scrubs together with e. g. *Juncus castaneus* and *Sanguisorba officinalis* (Cajander 1903, p. 77).

3. Alnus crispa Scrubs.

These were found as a kind of low gallery forest along the lower course of the river through Grønnedal and in small patches in the terrain behind Ivigtut. In the former place the scrubs were above a man's height (fig. 20) and rather dark. At some distance from the river they were

replaced by lower willow scrubs. The ground flora mainly reminded of the *Lastraea* sociations in the willow scrubs, but as a rule the individuals were so widely scattered that they could not be said to form sociations. The chief species were *Lastraea dryopteris*, *Thalictrum alpinum*, *Poa nemoralis*, *Angelica*, *Taraxacum* cfr. *croceum*, *Campanula rotundifolia*, *Carex bigelowii*, *Lycopodium selago*, and *Rhinanthus groenlandicus*. Only the first-mentioned species occurred in fairly large patches. The moss flora was rich, particularly including the ubiquitous *Drepanocladus uncinatus*, as well as *Hylocomium splendens*, *H. squarrosum*, *Dicranum scoparium*, *Brachythecium salebrosum*, and *Ptilidium ciliare*.

During the ascent of Guldfjeld near Ivigtut a small alder scrub which was only about one metre in height was found in a ravine at an altitude of about 250 metres. It covered the sunny side of the ravine, while the shady side had an open herbaceous vegetation on gravel (p. 126) and the stony bed of the brook in the middle was full of *Chamaenerium latifolium* and *Arabis alpina*. The alder scrub was not dense and the ground stratum was meadow-like, especially consisting of *Poa nemoralis*, *Sedum rosea*, *Alchemilla filicaulis*, *Potentilla crantzii*, *Coptis*, *Veronica wormskjoldii*, *Campanula rotundifolia*, *Taraxacum*, and *Salix arctophila*.

TRAPNELL (1933, p. 309) from Godthaabsfjord mentions mixed willow-alder scrubs with grasses, ferns, *Potentilla crantzii*, *Brachythecium* sp. in the field and ground layer. Unfortunately he does not give any list of species, but the vegetation seems to remind of that near Ivigtut.

On the occurrence of American biotypes of *Alnus crispa* in *Pinus banksiana* upland forests in Canada, see RAUP 1935, p. 35.

c. The Alchemilla vulgaris-Phleum commutatum Type.

(Sub-low arctic oceanic, mesophytic, medium chionophilous herb vegetation).

This type corresponds to the greater part of the classical Warmingian herb field, as WARMING did not know very much about high arctic herbaceous vegetation. The type is found in East Greenland as far north as 68°33′ on the outer coast (B. 1933b under the name of *Taraxacetum crocei*) and may also be found on Gaaseland in Scoresby Sund (HARTZ 1895, pp. 266—67). In West Greenland there is a similar advanced post in South Disko (see PORSILD 1902), but otherwise the northern limit is at Holsteinsborg or a little farther north (cp. HOLM 1887, p. 315). The type is missing in the inland north of 66° lat. N. From Scandinavia there are numerous descriptions and analyses of vegetation which is very closely related to the present type. In recent literature references may be made particularly to KALELA 1939, NORDHAGEN 1943, and GJÆRE-



Fig. 20. *Alnus crispa* scrub in Grønnedal, Arsuk Fjord. On the slope in the background there is above *Alnus* a zone with low willow scrub, which is gradually replaced by *Betula glandulosa rotundifolia* scrub or heath. In front of the walking-stick on the right, low *Salix glauca callicarpaea* and right of this, *Betula glandulosa rotundifolia*. T.W.B. phot. $^{9}/_{7}$ 1946.

VOLL 1950. NORDHAGEN terms the Norwegian vegetation *Alchemillion glabrae chionophilum*. GJÆREVOLL terms the North Swedish vegetation *Ranunculo-Anthoxanthion*. It is uncertain whether a similar vegetation is found in Northeast America. Most EG-species of the vegetation there are rare or absent. HUSTICH & PETTERSSON from the coast of Labrador mention a vegetation in which *Alchemilla filicaulis* enters, but it contains so many boreal, widely distributed American species (*Agropyrum trachycaulon*, *Habenaria dilatata*, *Castilleja septentrionalis*, *Solidago macrophylla*, *Aster foliaceus*) and has so few species in common with Greenland (*Streptopus*, *Luzula parviflora*) that it must be referred to a special American vegetational type.

The North Atlantic area of some of the main EG-species is shown in fig. 21. Most of them furthermore have areas in mountains, particularly in Eurasia. The range of the species chosen gives an impression of the sub-low arctic-oceanic area in Greenland and the areas which outside Greenland will stand a comparison with this. The transition to the continental area takes place on the outer coast in the region between

Holsteinsborg and Nûgssuaq and between 68°30′ and 71′ in East Greenland. Similar transitional areas are found partly in South Labrador-Newfoundland-Gulf of St. Lawrence, partly along the north coast of the Kola peninsula east to Novaya Zemlya-North Ural.

EG-species of the vegetational type:

Alchemilla filicaulis. Cl: subarctic-oceanic. Ar: North Atlantic, montane European. See fig. 21, which is based on detailed maps in B. 1938, SAMUELSSON 1943, RAYMOND 1950, and HULTÉN 1950. — Ecology: for Greenland see B. 1933b.

Alchemilla glomerulans. Cl: subarctic-oceanic, but approaching the continental areas in Scoresby Sund, South Disko, and North Russia. Ar: North Atlantic, montane European. Maps: B. 1933a, SAMUELSSON 1943, HULTÉN 1950. — Ecology: for Greenland see PORSILD 1902, KRUUSE 1911, B. 1933b.

Alchemilla alpina. Cl: sub-low arctic oceanic. Ar: North Atlantic (absent in North America), montane European. Map fig. 21, based particularly on detailed maps in B. 1938 and HULTÉN 1950. — Ecology: While the two species mentioned above are markedly mesophytic meadow plants and thus good EG-species, *A. alpina* has a somewhat different ecology, as besides in meadow-like vegetation it also occurs in communities rich in grass (cf. type a). Its occurrence there is presumably connected with the fact that it will stand greater dryness, poverty, and acidity of the soil. However, it undoubtedly reaches its richest development in the present type.

Phleum commutatum. This tetraploid, sub-low arctic species, which especially has been investigated by NORDENSKIÖLD (1945, Acta Agricult. Suec., I, 1), according to this author has a very wide distribution. The map accompanying her presentment, however, is rather misleading, because the species is absent along the arctic coasts of the continents and in the interior of the continents is connected with mountains or the shores of large lakes. HULTÉN (Fl. Alaska-Yukon no. 97) is of opinion that the West American material belongs to a special variety. The East American area is small, mainly restricted to South Labrador, Newfoundland, and the Gulf of St. Lawrence, besides mountains in Maine and New Hampshire. Next, the species like *Polystichum lonchitis* is localized at Lake Superior (FERNALD 1935). Everywhere it is a meso-hygrophytic meadow plant. NORDHAGEN has it as differential species of his *Alchemillion.* Besides, reference is made to the map fig. 21 below and detailed maps in B. 1938 and HULTÉN 1950.

Leucorchis albida (including the West Atlantic ssp. *straminea*). Cl: subarctic-oceanic. Ar: North Atlantic, montane European. The map in LÖVE 1950, p. 36 (see fig. 21) has an isolated occurrence in North Russia. In West Greenland reaches Disko and in East Greenland Mikis Fjord (collected there by H. G. Wager, Herb. Brit. Museum). — Ecology: NORDHAGEN (1943) mentions the main species as differential species for *Caricion atrofuscae-saxatilis*; in Denmark it is also, however, found on moist heath (B. 1943, pp. 33, 34, 86). The main species seems to be a meso-eutrophic bog plant, whereas the ssp. *straminea* may mainly be connected with the present vegetational type.

Gnaphalium norvegicum. Cl: sub-low arctic oceanic. Ar: North Atlantic-montane; reaches Atlantic East America, perhaps even East Baffin, and in the east, North Russia-Ural. In West Greenland along the coast to about 66°30′ and in South Disko; not in the continental inland. — Ecology: Found

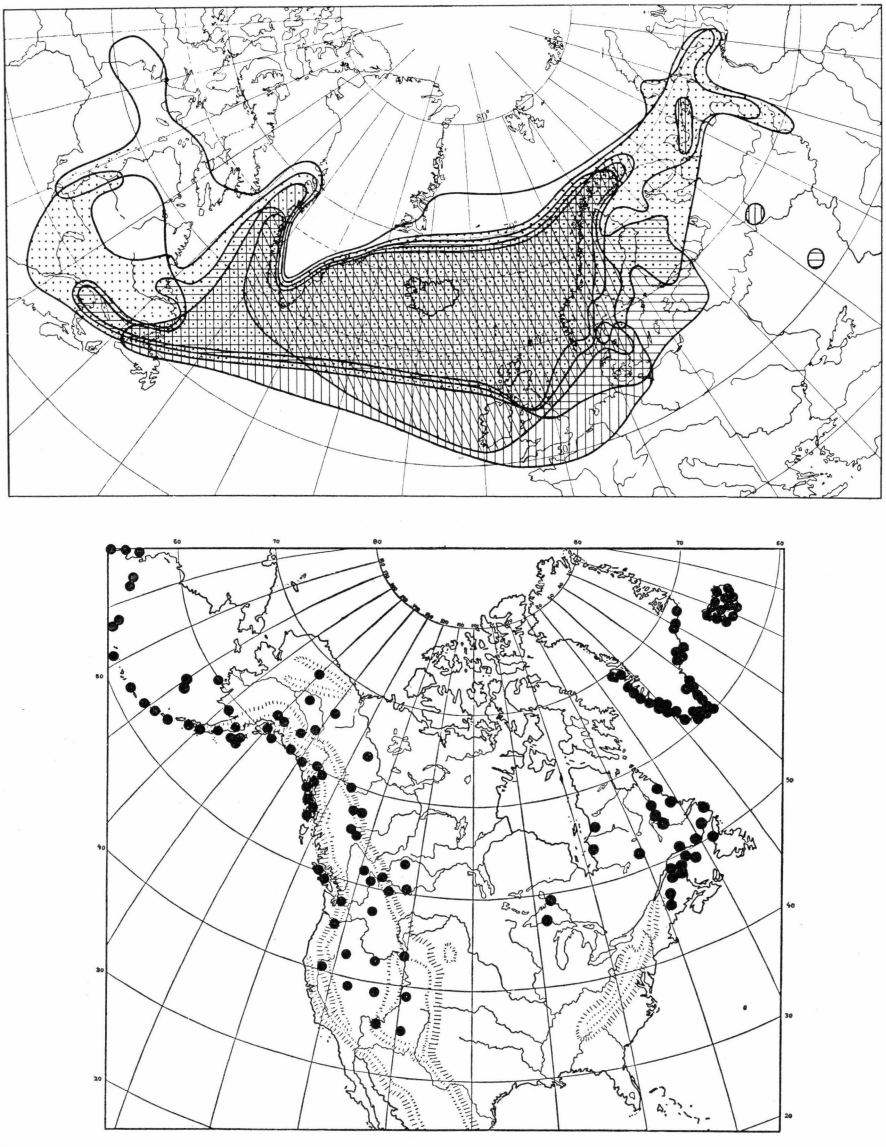


Fig. 21, above. Map showing the North Atlantic range for *Sibbaldia procumbens* (area without hatching), *Phleum commutatum* (dotted area), *Leucorchis albida* (incl. ssp. *straminea*) (vertical hatching), *Alchemilla filicaulis* (horizontal hatching), and *A. alpina* (oblique hatching). — Below, distribution in America-Greenland of *Phleum commutatum*. American stations according to M. Raymond.

in the present type and there often in sociations which represent a considerable step towards extreme snow-patches.

Erigeron borealis is also sub-low arctic-oceanic with a North Atlantic distribution and is a typical herb-field plant; the same is true of *Taraxacum croceum* (coll.), or, as perhaps it is to be termed, *Taraxacum lapponicum*,

which in America is very frequent within the parts of the East that are oceanically influenced (cp. HAGLUND 1943, Rhodora 45, p. 343); but which according to RAUP 1947, Plate XXXVII, and FERNALD 1950 may also occur at two stations in the Rocky Mountains and one on Lake Athabaska.

Rhinanthus groenlandicus (*R. minor* ssp. *groenlandicus*). Cl: Subarctic-oceanic. Ar: North Atlantic. To the map in LÖVE 1950, fig. 17 should be added occurrence on the mountains of South Scandinavia, and the Greenland distribution should be made to agree with the map fig. 98 in B. 1938. — Ecology: concentrated to the present and the preceding vegetational types.

Veronica wormskjoldii. Cl: Subarctic-oceanic, montane. Ar: American-Greenlandic. For details see FERNALD in Rhodora 41, pp. 450—451; MEUSEL 1943, map Plate 13b; HULTÉN, Fl. Alaska-Yukon no. 1032; RAUP 1947, map Plate XXXIV. — The species is tetraploid and clearly distinct from *V. alpina* and *V. pumila*, which are both diploid; cf. BÖCHER & LARSEN 1950 and in the case of *V. pumila* LARSEN 1954. — Ecology: meadow plant connected with the present and the preceding type; also in West American mountains on meadows and in subalpine scrubs. Will stand being cultivated in Denmark, whereas *V. alpina* will more frequently perish.

Botrychium lanceolatum. Cl: Subarctic-oceanic, montane. Ar: Mainly North Atlantic-North Pacific, absent in Central parts of N. America and Asia; world range in KORNAS 1953, Greenland distribution in B. 1938. — Ecology: Occurs in the present and the preceding types as well as in talus-slides (Table 6).

A species closely related to the EG-species is *Potentilla crantzii*, which has an oceanic trend (cf. B. 1938, LÖVE 1950, fig. 12) and is very important in the present type, but not bound to it as NORDHAGEN's *Potentilleto-Polygonion viviparae* and certain *P. crantzii* sociations at the head of Søndre Strømfjord (p. 203) are without the EG-species of the present vegetational type. — In this connexion *Carex atrata* may be mentioned, which, indeed, has an oceanic distribution in Greenland and there is bound to the present complex with concentration in herb fields and scrubs, but which in Norway behaves in a different way and in the Gross Glockner region is supposed to be the character species for *Kobresia myusuroides* communities (G. and J. BRAUN-BLANQUET 1931, p. 42). A map of the distribution of *Carex atrata* and related species is found in RAYMOND 1951, p. 7.

At Pá (66° lat. N.) at the entrance to the Strømfjord herb fields were very typically developed; a short description therefore is suitable as an introduction to the discussion of the sociations: The chief species there were *Alchemilla alpina*, *A. glomerulans*, *Pirola minor*, *Taraxacum croceum*, *Hieracium hyparcticum*, *Gnaphalium norvegicum*, *Potentilla crantzii*, *Bartsia alpina*, *Veronica alpina*, *Sedum rosea*, *Epilobium anagallidifolium*, *Angelica archangelica*, *Coptis*, *Thalictrum alpinum*, *Phleum commutatum*, *Poa alpina*, *Carex bigelowii*, *C. scirpoidea*, *Luzula parviflora*, *Polygonum viviparum*, and *Cerastium alpinum*. There was a good number of rather different sociations; in one place on the southern slope of the mountain the following distribution was observed:

(1) Vertical rock, often moist because of melt water oozing down.
(2) At the foot of the rock a narrow fringe of a *Lastraea dryopteris* soc. with *Alchemilla*, *Angelica*, *Phleum*, *Coptis*, *Gnaphalium norvegicum*.



Fig. 22. South-facing river bank in Grønnedal in the Arsuk Fjord. At the walking-stick and south of it, herb field dominated by *Alchemilla glomerulans* or *Taraxacum croceum* with abundance of *Phleum commutatum* and *Carex bigelowii*. On the left *Salix glauca callicarpaea* scrub with *Angelica*. *Pedicularis flammea* was found in small moss cushions immediately beside the river. T.W.B. phot. $^{9}/_{7}$ 1946.

(3) On the southern slope below (2), snow-cover of long duration; moist soil: *Gnaphalium supinum-Sibbaldia* soc. (rich in mosses) with *Epilobium anagallidifolium*.

The same place, but drier and snow-covered for a less prolonged period: *Phyllodoce* heath with *Ledum groenl.*, *Lycopod. annotin.* and *alp.*

The same place along a vein of water through the heath: *Scirpus caesp. austriacus*.

(4) Farther down the slope, where the snow-cover probably is not of so long duration, but where the soil is very moist because the water is forced up by a projecting rock terrace: *Alchemilla glomerulans-Sedum rosea* soc. with *Angelica* and *Taraxacum croceum*.

(5) A place with almost level ground above the edge of the terrace: mossy marsh with *Eriophorum angustifolium*.

(6) On moist southern slope below the edge of the terrace: *Salix glauca callicarpaea* scrub, dense and very poor in species.

The appearance of the herb field here correspond completely to what Kruuse 1912 and B. 1933b tell about the herb field in Southeast

Greenland. In South Greenland the occurrence is mostly different. The vegetation there is not firmly attached to southern slopes and is frequently replaced by the willow scrubs so that it mainly comes to accompany the courses of rivers and brooks like a fringe between these and the scrubs (fig. 22). In winter large masses of snow no doubt accumulate in the hollow between the two edges of the scrubs on both sides of the streams; during the melting of the snow the scrubs will therefore presumably thaw out first, while the herb fields are bared later; the soil below them will for a prolonged time be percolated by the melt water, and in summer the seepage continues through rainy periods. If the slope is facing south, the snow will of course melt there first, and through the summer the soil will receive more heat. Therefore, when the river takes an east-western course a great difference between the two herb-field fringes will often be observed. On the Arsuk Fjord the north-facing herb field might be of a special type, in which *Pirola minor* was extraordinarily dense and in which a more arctic element asserted itself in the form of such species as *Cerastium alpinum*, *Saxifraga caespitosa*, *Trisetum spicatum*, and *Salix herbacea*. The herb-field fringe might sometimes completely give out on north-facing steep banks and be replaced by low willow scrub with a ground layer consisting mainly of *Hylocomium splendens* and *Thuidium abietinum*.

1. Alchemilla vulgaris Sociations.

Observed at Pâ (see above p. 81 no. 4) and furthermore in Grønnedal, in the latter place in patches along the river and on a slope below a south-facing rock near the *Streptopus* soc. mentioned. The chief species there was *A. glomerulans*, but also *A. filicaulis* and *A. alpina* were frequent. Other important species were: *Polygonum viviparum*, *Potentilla crantzii*, *Veronica wormskjoldii**, *V. fruticans*, *Sedum rosea*, *Gnaphalium norvegicum**, *Thalictrum alpinum*, *Bartsia*, *Pirola minor*, *Phleum commutatum*, *Carex scirpoidea*, *C. atrata*, *Poa nemoralis**, *Poa pratensis domestica*, *Deschampsia flexuosa**, *Draba incana**, *Arabis alpina*, *Leucorchis albida**, *Habenaria hyperborea**, *Cystopteris fragilis*, *Dryopteris dilatata**, and *Lastraea dryopteris*. The species marked with an asterisk separate this *Alchemilla* vegetation from the types found in Southeast Greenland (B. 1933b, Tables 5—7), while in return there were in these a good number, particularly more arctic species which were absent in the South Greenland vegetation, e. g. *Poa alpina*, *Trisetum*, *Cerastium alpinum*, and *Erigeron unalaschensis*. *Alchemilla vulgaris* sociations seem to require a relatively high pH, but hardly occur on basic soil. This is perhaps the reason why they do not play so great a part in regions of Archean rock as in basalt regions (e. g. Mikis Fjord).

M. P. Porsild (1902, p. 112) from Sinigfik in South Disko mentions a herb vegetation connected with willow scrub in which *Alchemilla glomerulans* is mentioned first and therefore presumably was dominant. Among the EG-species it only included *Taraxacum croceum*; furthermore there were a good number of widely distributed species such as *Oxyria*, *Trisetum*, *Equisetum arvense* (var.), a few of the oceanic low arctic species, *Veronica alpina* and *Arabis alpina*, a southerly spring-bog species, *Epilobium hornemannii*, and two subcontinental species, *Pirola grandiflora* and *Stellaria longipes*. The following mosses are mentioned: *Mnium affine*, *Timmia norvegica*, *Plagiothecium* sp. and *Brachythecium* sp., besides *Marchantia polymorpha*.

2. Alchemilla alpina Sociations.

These play a comparatively great part in Southwest Greenland and e. g. near Godthaab are almost the only representative of the herb field. Table 8 nos. 3—7 show three examples from Kangâmiut, which is situated close to the northern limit of *A. alpina*, and two from the Ivigtut valley. There is rather a great difference, as the South Greenland examples are richer in species than the northern ones and have a dense moss layer particularly consisting of *Brachythecium salebrosum* and *B. albicans* var. *groenlandicum*.

At the northern limit of *A. alpina* in East Greenland the species enters sporadically in herb field and heath of the *Phyllodoce* type, but it was seen as dominant only in places in which the herb field was stabilizing itself on the scree (cf. B. 1933b, Table 18). Perhaps it is crowded out as a dominant by the large-leaved *Alchemilla* species as soon as these immigrate.

In Iceland there are as usual greatly deviating sociations. The rich soil gives a possibility of many calciphilous species, but on the other hand does not exclude *A. alpina*, which is extremely common. Near Reykjavík I noted the following composition on a square metre between large blocks on a low crag: *Alchemilla alpina* 4, *Festuca vivipara* 1, *Thymus drucei* 1, *Empetrum* 2—3, *Dryas octopetala* 2, *Thalictrum alpinum* +, *Potentilla tabernaemontani* + (cf. map in Löve 1950, p. 45), *Galium pumilum islandicum* +, *Agrostis canina* +, *Festuca rubra* +, *Selaginella selaginoides* +, *Rhacomitrium lanuginosum* 4, *Ptilidium ciliare* +. There is hardly any doubt that such a vegetation does not belong to the present type, but that it should rather be compared with the *Empetrum* sociations mentioned on p. 100.

3. Taraxacum croceum Sociations.

While such sociations play a great part e. g. in South Disko and on the Blosseville Coast, only approaches to them were seen in the lowlands near the Arsuk Fjord. There were small patches beside the river

through Grønnedal (fig. 22); the accompanying plants there were *Sibbaldia*, *Viola palustris*, *Pirola minor*, and *Coptis*. A dense moss carpet indicated rather great humidity and fairly prolonged snow-cover. A *T. croceum* sociation on a southwest-facing slope beside a mountain lake in the alpine zone on Guldfjeld near Ivigtut was more typically developed and covered larger expanses. Co-dominants there were *Sibbaldia* and *Salix herbacea*; frequent species were *Pirola minor*, *Phleum commutatum*, *Gnaphalium norvegicum*, *Alchemilla alpina*, and *Coptis*. Such a vegetation reminded somewhat of the *Taraxacum croceum* herb fields in East Greenland which attain to their best development north of the limit of the *Alchemilla vulgaris* species, e. g. in d'Aunay Bugt and at Kap Dalton (B. 1933b), but which, if anything, belong to the snow-patch complex.

4. Sibbaldia procumbens Sociations.

Most sociations dominated by *Sibbaldia procumbens* are included in the snow-patch complex. There are, however, some sociations in which such species as *Gnaphalium norvegicum* and *Taraxacum creceum* are very frequent and in which the most important EG-species of the snow-patch complex are absent. Such sociations occur on favourably exposed soil both at Godthaab and Kangâmiut (cf. Table 8 nos. 1—2) and in the present complex are placed as a sociation which mediates the transition to the snow-patch complex. At Godthaab such *Sibbaldia* sociations alternated with *Alchemilla alpina-* and *Cornus suecica*-sociations.

From the Angmagssalik region an analysis is available of a *Salix herbacea-Carex bigelowii* sociation with abundant *Sibbaldia* and such species as *Alchemilla glomerulans*, *Viola palustris*, *Epilobium anagallidifolium*, *Phleum commutatum*, and *Gentiana nivalis* (B. 1933b no. 22). This, too, belongs to the herb field rather than to the snow-patch sociations (cf. the high frequency percentage of southern species).

c_1. Scrub or Vegetation of Low Willows Connected with the Alchemilla-Phleum commutatum Type.

1. Salix glauca callicarpaea Scrubs.

A large number of willow scrubs have so many sylvicolous species that a connexion with the preceding type comes natural. A good number of them, however, have a ground flora in which *Deschampsia flexuosa* or *Poa nemoralis* alone represents the forest element, as *Angelica*, as mentioned above, is unreliable because of its association also with the spring-bog vegetation as well. Table 8 has four examples without any appreciable sylvicolous element (nos. 11—14); the two first of these, at



Fig. 23. Slightly sloping terrain percolated by water near the Arsuk Fjord. The willow scrub has been burnt off. Between the charred branches *Poa pratensis domestica*, *Poa nemoralis*, and *Ranunculus acer* are seen. Leaves of *Angelica archangelica* may be seen almost in the centre of the picture. T.W.B. phot. $^{10}/_{7}$ 1946.

any rate, are more closely attached to the present type than to the preceding one. No. 11 originates from a very typical meadow-like scrub. It was found on an almost level area near the Arsuk Fjord (fig. 23); the willow shrubs had been burnt off there, and the ground flora had profited by this because of the ampler access of light. With its abundance of vigorous flowering *Ranunculus acer* mixed with *Cardamine pratensis* it highly resembled a Danish meadow. The area was characterized by percolation of water, which favoured such species as *Climacium*, *Aulacomnium palustre*, and *Tomenthypnum nitens*. *Habenaria hyperborea*, too, was remarkably common in several places.

An offshoot of the willow scrubs of the coastal regions was found along the river which connects the lakes in Ringsødal with the innermost part of Søndre Strømfjord (Loc. 4—5). The vegetation was atypical, without any sure EG-species; its highly local occurrence was estimated to be conditioned

by a relatively oceanic microclimate under the willows along the constantly water-bearing river. *Thalictrum alpinum*, which is circumpolar, but most frequent in oceanic areas, and which is particularly frequent in the present complex, was the only species suitable for a plant-geographical placing of the scrub. Two quadrates of the ground flora had the following composition: *Thalictrum alpinum* (4—5, 4), *Calamagrostis canadensis langsdorfii* (+, 2), *Carex scirpoidea* (—, 1), *Chamaenerium latifolium* (—, 1), *Equisetum arvense* (—, 1), *Poa pratensis iantha* (2, —), *Polygonum viviparum* (+, +), *Stellaria longipes-monantha* (+, —), *Brachythecium salebrosum* (3, 1).

d. The Epilobium hornemannii-Saxifraga stellaris Type.

(Sub- and low-arctic oceanic hygrophytic herb-moss vegetation and associated willow vegetation on very wet ground with percolating or running water).

This type is best known through early workers' investigations, for which reason my contribution is confined to some few supplementary observations and an attempt at bringing the communities into relationship with the rest of the Greenland vegetation. The type as regards the higher plants shows close relationship with the *Alchemilla-Phleum* type. As, however, it also shows relationship with types within the snow-patch complex and has several rather independent EG- and Hb-species, it comes most natural to operate with a special type the most essential elements of which are the spring-bog hygrophytes. The type will be closely connected with NORDHAGEN's "Quellfluren" (1936, pp. 27—29), KALELA's "Quellwiesen" (1939, pp. 267—377, apart from the *Arctagrostis latifolia* meadow) and the vegetation which NORDHAGEN (1943) terms *Mniobryo-Epilobion hornemannii.*

The type is only fully developed on the coastal mountains, but from there sends offshoots with an atypical floristic composition to the mossy brook sides or percolated marshes of the inland. In the most continental regions at the head of Søndre Strømfjord it is absent, but there is a mixed type, in which *Angelica* and *Montia* alone represent a floral element with an oceanic trend. This mixed type occurs in the continental area as so strange a community that one feels inclined to compare it with oasis vegetation. It is most closely associated with the present vegetation and is mentioned in an appendix to the treatment of the *Epilobium-Saxifraga stellaris* type (p. 89).

The EG-species of the Vegetational Type:

Epilobium hornemannii. Cl: Sub-low arctic, montane with a slightly oceanic trend. Ar: Absent in the central parts of Eurasia and America, where, however, it is found in Minnesota. In West Greenland particularly in the south, furthermore sporadically along the coast to South Disko and, according to M. P. PORSILD (1920), at a single station at the head of Nordre Strømfjord

(Sarfarssuaq). HULTÉN's map (1950) shows that it reaches the central parts of North Finland. Ecology: According to A. E. PORSILD, both in Alaska and Yukon in herb mats and moist moss beside springs, just as in Greenland. In Norway guiding species for NORDHAGEN's *Mniobryo-Epilobion.*

Saxifraga stellaris. Cl-Ar: A sub-low arctic oceanic species with a North Atlantic, European montane distribution. In America only on the southern part of the coast of Labrador. Maps in B. 1938, fig. 57 (Greenland) and LÖVE (1951, fig. 5, world range). — Ecology: Very frequent in mossy meadows along running water and having been observed to grow in this way both in Greenland, the Faroes, Ireland, and the Alps. The species, however, is so frequent in the snow-patch complex, too, that it cannot be considered a good EG-species.

Montia lamprosperma. Cl: Subarctic oceanic. Ar: North Atlantic, North Pacific; see map in HULTÉN (1950, Group 22), to which should be added stations at Angmagssalik and the Umanak district in Greenland (see map in B. 1938, fig. 35). — Ecology: Probably most important in the present type, but on account of its occurrence in the following type it is a less good EG-species.

Mniobryum (*Webera*) *albicans* var. *glaciale.* This perhaps my be included among the EG-species. At any rate it is an ectremely important Hb-species (cf. NORDHAGEN 1943). The main species is, if anything, a cosmopolitan, but the variety seems to be associated with sub-low arctic areas and alpine areas rich in precipitation. STEERE (1947) only mentions it from the coast of Labrador and Agpatok Island. In Scoresby Sund it has been found at Kap Stewart (JENSEN 1897), but it penetrates farther to Gaaseland (HARTZ). — A description of a Central European *Mniobryetum albicantis* is available from Hrubý Jesiník in Bohemia (ŠMARDA 1950).

Overlapping EG-species for this type and some of the communities of the snowpatch complex, most closely associated with the latter:

Epilobium anagallidifolium; see p. 112. *Sedum villosum*; see p. 127.
Cerastium cerastioides; see p. 111. *Koenigia islandica*; see p. 127.

Hb-species are especially *Philonotis* species, *Stellaria calycantha*, locally also *Cardamine pratensis.*

1. Angelica or Epilobium hornemannii in Spring-Bogs Dominated or Characterized by Mniobryum albicans var. glaciale.

This type of spring vegetation has been described by M. P. PORSILD (1902) from Disko and by KRUUSE (1912) from the Angmagssalik region, i. e. from the area on both coasts for the northern limit of *Epilobium hornemannii.* It appears from PORSILD's description that *Mniobryum alb. glaciale* mostly together with *Philonotis fontana* forms large moss carpets in all "unartuts", i. e. springs with water which constantly has a temperature above the mean temperature of the place. In these "hot" springs *Epilobium hornemannii* and *Marchantia polymorpha* occur fairly constantly. Furthermore it appears from HARTZ's (1894) and PORSILD's descriptions that *Angelica* as well can be found in these *Mniobryum*

springs, thus corresponding to conditions in Norway (NORDHAGEN's *Mniobryo-Archangelietum*). The springs in Disko among other southern species contain e. g. *Leucorchis albida*, *Gentiana aurea* (PORSILD p. 189), *Hedwigia ciliata* (PORSILD p. 118) and such herb-field species as *Taraxacum croceum*, *Alchemilla glomerulans*, *Stellaria calycantha*, and others (HARTZ 1894 pp. 55—56, PORSILD pp. 181—182). In Disko there are also, however, such high arctic species as *Alopecurus alpinus* and *Ranunculus nivalis* (PORSILD p. 117) and in places where they are frequent it may therefore be a question of a mixed type, as the two species mentioned belong more closely to communities of a high arctic character. Besides, the Disko springs contain such low arctic oceanic species as *Arabis alpina*, *Cerastium cerastioides*, *Veronica alpina*, and *Epilobium anagallidifolium* and furthermore such widely distributed species as *Oxyria*, *Saxifraga cernua*, and *Equisetum arvense*.

KRUUSE's descriptions from the Angmagssalik region (*loc. cit.* pp. 76—77, 84—95, 245) give a copious picture of the *Angelica* spring vegetation; the moss cover especially consists of *Philonotis fontana*, *Bryum* sp., *Mniobryum alb.*, *Mnium cinclidioides*, *Marchantia*, and *Anthelia juratzkana*. Together with *Angelica* he mentions *Comarum palustre*, *Alchemilla glom.*, *filicaulis*, *wichurae*, *Saxifraga stellaris*, *Cerastium cerastioides*, *Stellaria calycantha*, *Phleum commutatum*, *Salix herbacea*, and others. A completely corresponding moss vegetation in Iceland is mentioned by HESSELBO (1918, pp. 550—555).

2. Epilobium lactiflorum, E. annagallidifolium, E. palustre, and Saxifraga stellaris in Mossy Spring-Bogs without Mniobryum.

On the species of *Epilobium* in mossy meadows beside springs see B. 1933b, pp. 5, 7, and 9—10 (Knud Rasmussens Land). N.B. In part really hot springs with such thermophilous species as *Epilobium palustre* and *Sagina saginoides*. On springs near Ũnartoq in South Greenland with *E. palustre*, *Sagina procumbens*, *Ranunculus acer*, *Juncus squarrosus*, and many others, see HARTZ 1894, p. 20. On other South Greenland mossy meadows with *E. palustre*, *Montia*, *Koenigia*, *Comarum palustre*, *Cardamine pratensis*, and *Ranunculus hyperboreus* see ROSENVINGE 1896, p. 245.

Own observations in the case of West Greenland are confined to *E. anagallidifolium* × *hornemannii* in dense moss cushions which hung over a vertical rock from which water was constantly dripping. The moss especially consisted of *Batramia ithyphylla*, *Webera cruda*, and *Leiocolea muelleri*. This observation originates from Kangâmiut.

Saxifraga stellaris in moss along water courses was observed in several places near Ivigtut. The vegetation there might contain *Deschampsia alpina*, *Oxyria*, or *Montia*. I have seen a similar vegetation at Tugtilik in Southeast Greenland, there without *Montia*, but in return with *Saxifraga aizoides*, which is very rare in the present complex.

Sedum villosum is not common in Greenland as a whole; I have myself observed it to be frequent only in the southern part of Knud Rasmussens Land, on basalt, which is in agreement with its great frequency on the Faroes-

Iceland. In Wiedemanns Fjord and Mikis Fjord it occurred on moist clay between boulders and on moist, south-facing rocks. The last occurrence remind of one on Disko, where M. P. PORSILD (1902, p. 197) found it on a moist rock wall of tufa. To my knowledge there are no observations from Greenland of this species as dominant in moss beside springs as NORDHAGEN found it in Sikkilsdalen. NORDHAGEN even mentions that the species has its absolute optimum in spring-bogs, which is not at all in agreement with the impression from the coastal regions of the North Atlantic. Perhaps the fact is that the species in subalpine, slightly oceanic or continental areas to a higher degree requires constantly running water. This explanation is supported by the only occurrence of *Sedum villosum* at the head of Søndre Strømfjord, where it was completely attached to a small vein of water which oozed down over a south slope and settled there in moss cushions in the moistest places. The vegetation there was without any appreciable similarity to the Norwegian one (cf. p. 263); only *Polygonum viviparum*, *Euphrasia frigida*, *Agrostis borealis*, *A. canina*, and *Juncus castaneus* are common to the two vegetations.

Willow Scrubs or Low Willow Vegetation Associated with the Epilobium hornemannii-Saxifraga stellaris Type.

Willow scrubs associated with the springs seem to occur in Disko. WARMING's description of a scrub at the foot of a slope on very moist soil at Søndre Kangerdluarssuk (1888, pp. 30—32) tells about multitudes of *Angelica*, but otherwise does not make any definite statement as to whether the vegetation belongs to the spring scrubs. HARTZ's description (1894, p. 15) of a scrub with *Angelica* at Qíngua, Tasiussaq comes nearer, for there both *Saxifraga stellaris*, *Pinguicula*, *Tofieldia*, and *Sphagnum* with *Oxycoccus* are mentioned.

The repent *Salix arctophila*, which is associated with moist soil, may dominate communities which are most naturally connected with the present and the preceding type. At Kangâmiut there were e. g. rather large areas in a valley with a *S. arctophila-Phleum commutatum* soc. full of the hybrid between *Epilobium anagallidifolium* and *E. hornemannii* besides *Carex bigelowii*, *Salix herbacea*, and others. The sociation occurred in an area intersected by small brooks along these. More similar to the herb fields was a vegetation in the moss along the river through Grønnedal near Ivigtut. *S. arctophila* was dominant there together with *Carex bigelowii*; besides there were scattered *Leucorchis albida straminea*, *Bartsia*, *Phleum commutatum*, *Saxifraga stellaris*, and *Empetrum*.

d_1. The Angelica-Stellaria longipes Type.

This is a mixed type with *Angelica* together with the subcontinental *Stellaria longipes* (including *monantha*).[1] An important, sometimes domi-

[1] In the tables *Stellaria longipes* is listed as *S. longipes-monantha* in order to indicate that these two microspecies are the most important in the area. A collection recently brought to Denmark by C. VIBE from the head of Søndre Strømfjord for the supplementing of my own finds show that the two species and intermediate forms occur in the same population, sometimes intermixed. Furthermore, *S. ciliatosepala*, which is a more high arctic species, occurs intermixed with the others in two of the twenty samples.

nant species is the widely distributed, sub-low arctic *Calamagrostis canadensis langsdorfii*. The last-mentioned species, as is to be mentioned below (p. 251), can dominate ecologically related continental communities completely without *Angelica*. The *Angelica-Stellaria* type forms a transition to these continental communities, but occurs itself in the continental area in places where running water creates locally hygric oceanic conditions. It seems that there is a whole series of communities which fill in the sphere between the herb fields and spring vegetations of the coastal regions and the continental communities. As an example reference may be made to a vegetation pictured in TRAPNELL (1933, Plate XVIII), where an open, moist willow scrub with *Calamagrostis canadensis langsdorfii*, *Angelica*, *Equisetum arvense*, and *Alchemilla filicaulis* is shown.

At the head of Søndre Strømfjord the mixed type was observed only in Ringsødal (Loc. 4) in the interalpine zone as a brook- or streamlet-vegetation.

The inland community which resembled the moss meadow of the coastal regions most was found beside a stream which connected three of the lakes in the valley. The two lower lakes are seen in fig. 24. From the upper lake to the middle one the terrain fell off rather steeply towards the northwest, and there was a 2—3 m tall scrub of *Salix glauca callicarpaea* (with rather narrow, only slightly hairy leaves); the scrub contained glades in which the water percolated through the soil and where *Angelica* two metres in height stood in cushions of *Mnium rugicum* (Table 9 no. 1 and fig. 24). Where the water flowed from the lake towards the scrub there was a mesotrophic bog (*Carex rariflora-Betula nana-Sphagnum squarrosum* soc. with *Aulacomnium palustre*, *Eriophorum angustifolium* and *Menyanthes*); beside the stream *Calamagrostis canad. langsdorfii* was found. Where the water below the scrub on less strongly sloping ground gathered into small streams, these were surrounded by *Salix arctophila-Carex rariflora-Aulacomnium palustre* soc. with scattered *Ranunculus lapponicus*. The dense parts of the scrub had only scattered small vegetative shoots of *Angelica* and patches of *Stellaria longipes* as ground layer dominant, in other—drier—places especially *Equisetum arvense* or *Pirola grandiflora*. Apart from *Angelica* there were no typical representatives of the herb field or spring vegetation of the coastal regions, but the place offered a possibility of the occurrence of *Oxyria digyna*, which is rare in the most continental part of the inland, and of meso-hygrophilous species like *Saxifraga cernua* and *Polygonum viviparum*. The greatly percolated soil was very suitable for *Angelica*, which crowded out the *Calamagrostis* species from a dominant position.

Beside a small stream which connected the middle lake with the lower one (on the isthmus seen in the background in fig. 24) there was no willow scrub, but a small strip of *Angelica* vegetation in the moss



Fig. 24. *Angelica archangelica* vegetation above a man's height in a glade in a three metre high willow scrub beside a small stream in Ringsødal at the head of Søndre Strømfjord. T.W.B. phot. $^{24}/_{8}$ 1946.

along the stream. This vegetation was more exposed to light than that in the glade mentioned above and contained abundant *Galium brandegei* (see p. 283) and *Calliergon cordifolium* (both southern species) and scattered *Montia* and *Calamagrostis neglecta* (Table 9 no. 2). In this place there was any transitional stage to the lake-shore vegetation which is mentioned below under the *Ledum-Calamagrostis lapponica-Galium* type (p. 285) as the bank of the stream also displayed much *Comarum palustre* and *Menyanthes* besides an *Eriophorum angustifolium* soc. with scattered *Betula nana* and *Angelica*. Scattered individuals of *Angelica* were also found in the *Salix arctophila* vegetation rich in moss on the bank of the lower lake, there together with *Carex saxatilis* coll. Of importance beside the stream was also a *Calamagrostis canad. langsdorfii* meadow almost without any other species; it was replaced upwards by a moist *Betula* heath with *Calamagrostis lapponica groenlandica*, *Pedicularis labradorica*, and *Aulacomnium turgidum*.

Table 9.

Analysis no.	1	2	3	4
Locality no.	4	4	4	4
Slope	20°	0°	0°	0°
Exposure	NW	—	—	—
pH	5.4	—	5.6	—
Salix glauca callicarpaea	2—3	..	4	..
EG Angelica archangelica	5	5	5	3
— Montia lamprosperma	..	+	..	..
EG Galium brandegei	..	4	..	..
— Calamagrostis lapp. groenlandica	..	..	+	..
Cl — neglecta [1]	..	1	..	..
— Stellaria longipes-monantha	+	1	1—2	1
— Pirola grandiflora	+	..	+	..
Hb Cardamine pratensis	..	..	..	1
Calamagrostis canad. langsdorfii	+	+	..	5
Campanula rotundifolia coll.	..	..	+	..
Carex rariflora	..	+	..	..
Cerastium alpinum	..	..	+	..
Equisetum arvense	+	+	..	..
Oxyria digyna	+	..	2	..
Poa pratensis iantha	+	1	..	+
— glauca glaucantha	..	..	+	..
Polygonum viviparum	+	1	1	..
Lophozia alpestris major	..	+	..	..
Brachythecium salebrosum	..	..	2	..
Calliergon cordifolium	1	2	..	..
— stramineum	..	..	..	1—2
Climacium dendroides	..	..	2	..
Drepanocladus aduncus	..	..	..	2
— revolvens	..	..	..	
— uncinatus	..	+	1	..
Mnium affine	..	..	2	..
— rugicum	5	4	..	2
Webera nutans	..	..	..	1

[1] Continental EG and Cl species.

Farther east in Ringsødal *Angelica* is met with under similar circumstances, and the vegetation which it characterizes contributes to forming a characteristic patchwork which repeats itself in the places of outlet from and inlet to the lakes. In the east the water did not, however, flow through the ground layer; it was rather the question of slow percolation. In the scrubs there were partly an *Angelica* soc. with abundant *Oxyria* (Table 9, no. 3), partly other combinations, e. g. a *Cystopteris-Calamagrostis canad. longsdorfii-Angelica* soc., in which the



Fig. 25. *Calamagrostis canadensis langsdorfii* forms a tall tussocky vegetation interspersed with stately individuals of *Angelica archangelica*. In the background a 2—3 m high scrub of *Salix glauca callicarpaea* (with narrow, almost glabrous leaves). Ringsødal. T.W.B. phot. $^{17}/_{8}$ 1946.

two last-mentioned species occurred in a vegetative state, a *Calamagrostis-Angelica* soc., and a *Calamagrostis-Equisetum arvense* soc. Outside the scrubs there were rather large areas with a very characteristic community of knee-high tussocks of *Calamagrostis* with 1—1.2 m high *Angelica* and mosses and *Cardamine pratensis* on the spaces between the tussocks (Table 9, no. 4, and fig. 25). Immediately beside the stream this vegetation passed into a *Carex rariflora-Salix arctophila* soc., which included occasional *Eriophorum angustifolium*, *Ranunculus lapponicus*, *R. hyperboreus*, *Comarum palustre*, *Menyanthes*, or a little *Equisetum variegatum*.

Westwards the Ringsødal valley continues in another valley which leads down towards Strømfjordshavn. There the scenery repeats itself;

but the *Angelica* occurs more scattered, perhaps because we approach to the bottom of the valley of the Strømfjord with its drier climate. Beside the inlet to a larger lake there was a willow scrub the ground flora of which was dominated by *Calamagrostis canad. langsdorfii* and included much *Polygonum viviparum*, *Climacium*, *Mnium rugicum*, and scattered *Angelica* and *Pirola grandiflora*.

e. The Phyllodoce coerulea-Lycopodium alpinum type.

(Sub-low arctic oceanic, medium chionophilous dwarf-shrub vegetation rich in mesophytes and mosses; soil acid, very rich in humus).

Heaths rich in moss, on thick mor. Very important vegetational type on the coastal mountains of Southwest Greenland and in Southeast Greenland. An exact description of the distribution of the type can hardly be given, but the map of the distribution of *Phyllodoce* (B. 1938, fig. 89) presumably in broad outline indicates the distribution as this species does not seem to occur much outside the present complex. There are mixed types with *Cassiope tetragona* and *Phyllodoce* together in a certain region where the areas of these species are overlapping, but there is no doubt that these two heath shrubs on the whole replace one another nearly as is the case of the two *Ledum* species. HARTZ (1895, p. 270) from Gaaseland in Scoresby Sund mentions an example of a *Cassiope tetragona* heath which belongs to the mixed type, with *Phyllodoce*, *Cassiope hypnoides*, *Sibbaldia*, and *Juncus trifidus* pointing towards the *Phyllodoce-Lycopodium* type, and *Cassiope tetragona*, *Dryas octopetala* (coll.), *Draba hirta*, and *Equisetum variegatum* (called *E. scirpoides*) pointing towards continental heaths.

Outside Greenland a large number of the heaths which NORDHAGEN (1936, 1943) term *Phyllodoco-Myrtillion* may be paralleled with the present Greenland type. In the Scandinavian alliance there is a great sylvicolous element the species of which are very much used as differential species, an oceanic element particularly in the form of *Cornus suecica* and *Phyllodoce* and a moderately continental element, particularly in the form of *Pedicularis lapponica* and *Betula nana*, which in spite of wide distribution (see map in HULTÉN 1950) still, also in Scandinavia, seems to be represented by continental biotypes; cf. G. KNABEN's ecological explanation of its scarcity towards the coast in Southern Norway (1950, pp. 98—99). Of course what NORDHAGEN terms "oceanic bilberry heath" with *Cornus* is closely related to the Greenland type, but furthermore there is a good number of those heaths that unfortunately are called "continental bilberry heath", which, when disregarding the large number of non-oceanic and non-continental species, are dominated by

oceanic species. I should have reserved the term "continental bilberry heath" for such as lack oceanic species, but which may have certain continental species, e. g. a very great number of the Scandinavian *Betula nana-Myrtillus* heaths. In my survey of heaths (1943, p. 105) I have accordingly divided the Scandinavian *Phyllodoco-Myrtillion* so that a *Myrtillus* group without *Phyllodoce* and other oceanic species is segregated out. The reason why the "*Phyllodoce* group" there is said to be characterized by a mixture of oceanic and continental besides widely distributed species is that I had then from my experiences in Greenland to consider *Betula nana* a species with continental climatic requirements, a judgment which still seems correct, even though the Greenland population may make greater demands on the degree of continentality.

The EG-species of the vegetational type:

Phyllodoce coerulea. Cl: Low arctic-oceanic, montane. Ar: North Atlantic-North Pacific with radiations along the Arctic Ocean to Ural and through Hudson Bay to Central Keewatin (A. E. Porsild 1943, p. 58). To Hultén's map (1937, fig. 7) should be added the last-mentioned station besides the area 71°—74° in West Greenland and 71°—72° in East Greenland; cf. map fig. 89 in B. 1938. A discussion of the distribution is found in B. 1951 c. — Ecology: B. 1933 b, p. 61, mentions *Phyllodoce* and *Lycopodium alpinum* and *annotinum* as character species for the Southeast Greenland snow-covered heath rich in species, i. e. a heath belonging to the present vegetational type. Nordhagen (1936) uses *Phyllodoce* as the only character species in the Scandinavian *Phyllodoco-Myrtillion.*

Lycopodium alpinum. Cl: Low arctic-oceanic, montane. Ar: treated by Hultén 1950 in the same group as *Phyllodoce*; like the latter *L. alpinum* has wide gaps in Siberia and North America. According to Polunin 1940 the statement from Baffin should be cancelled in the detailed description of the distribution in Hultén, Fl. Alaska & Yukon: the species is found only in the oceanically influenced areas from northern Labrador (Abbe 1936) to the Gaspé peninsula besides on an island in James Bay; see details on map in Raup 1947, Plate XIV. In West Greenland it avoids the inland at 67°. — Ecology: With concentration in the present type and in the *Agrostis-Anthoxanthum* type, often in communities which form transitional stages to the snow-patch complex. Kalliola 1939 mentions it together with *Lycopodium annotinum* and *Hieracium alpinum* as differential species for Finnish heaths belonging to the *Phyllodoce-Myrtillion*; he also mentions it as dominant in the *Lycopodium alpinum-Solidago-Deschampsia flexuosa* soc., as a transitional form between *Deschampsia-Anthoxanthum* grasslands and the *Phyllodoce* heaths.

Cornus suecica. Cl: Subarctic-oceanic. Ar: North Atlantic, North Pacific. Map in Tolmatchew 1932. Greenland range and details in B. 1938 (fig. 80).

Hieracium alpinum. This North Atlantic species perhaps is particularly frequent in the present vegetational type within the complex and plays a great part in Southeast Greenland (B. 1933 b), while in West Greenland it is found only in the southern regions, south of the glacier of Frederikshaab (B. 1938, map on p. 195).

Carex deflexa can be considered an, if anything, sylvicolous-oceanic EG-species. As its relative *C. pilulifera*, which in Europe shows an oceanic trend (see map 378 in HULTÉN 1950) *C. deflexa* in Greenland behaves like an oceanic species (map in B. 1952 a); but in America it is distributed across the continent in the northern part of the forest zone (map in RAUP 1947, Plate XVIII) and touches the arctic areas in Keewatin and on Great Bear Lake (A. E. PORSILD 1943). In East America it goes north only to Pompus Head in Southern Labrador (HUSTICH & PETTERSSON) and from there leaps to Greenland, where its northern limit is at Pâ. FERNALD 1950 mentions it from woods, clearings, and turfy slopes, and MARIE-VICTORIN 1935 from "lieux ouverts", which does not convey any appreciable idea as to ecology. It is, however, beyond doubt that the species is acidophilous, even if ST. JOHN 1922 considers it neutro-acidophilous. He reports it from dry thickets and edges of dry woods, and RAUP 1936 from dry rock crevices and sandy shores. As the species in Greenland is most frequent in the present complex, with concentration in the heaths, and is not mentioned by ROSENVINGE at all from the scrubs or lichen heaths of South Greenland, this might suggest that the Greenland biotypes, which indeed are much isolated, are ecologically different from the total American population.

Similar problems crop up at investigations into *Ledum groenlandicum* (*L. latifolium*), which is rather characteristic of the present type. It has a subarctic distribution in America and is met with across the whole continent (map in RAUP 1947, Plate XXXII). Towards the west it enters abundantly in Pacific coast bogs (OSVALD 1933); at Athabasca-Great Slave Lake it is dominant under *Picea mariana* in muskegs which as secondary species have e. g. *Equisetum scirpoides*, *Carex gynocrates*, *Orchis rotundifolia*, *Habenaria hyperborea*, *Linnaea borealis* (RAUP 1935, p. 39). In East America it is found on the whole of the coast of Labrador, but avoids the continental regions farther north; from there it leaps to the oceanically influenced parts of Southwest Greenland (map in B. 1952 a). It would seem that it was oceanic biotypes who had colonized the Greenland areas, for in this country it is fairly rare in the interior of the southern coastal regions and very rare and in part alpine in the interior near the Søndre Strømfjord (B. 1952 a), while it is immensely frequent along the coast. Add to this the feature which is strange to an American muskeg plant, that it seems to be absent from corresponding communities in Greenland. ROSENVINGE does not mention it from moist vegetations in South Greenland (*loc. cit.* pp. 243—249); nor was it found by me in the bog at Narssarssuaq mentioned on p. 102 which ought to be a good locality for the species. The Greenland biotypes therefore again may have a special ecology. All things considered, *Ledum groenlandicum* in Southwest Greenland becomes of a similar importance as *Vaccinium myrtillus* in Scandinavia; for it is very characteristic of snow-covered heaths rich in species and with sylvicolous species, but is not restricted to the oceanic heaths, as it e. g. is very frequent in the Godthaabsfjord together with *Betula nana* (cf. p. 276) in a heath type which is without oceanic species. At Ivigtut, too, there are similar heaths, which, however, are dominated by *Betula glandulosa rotundifolia* (cf. Table 10, no. 2).

1. Cornus suecica Sociation.

This sociation occurs near Godthaab as a variant of the snow-covered heath, but never covering extensive areas. The example Table 10,

no. 4 from an east-facing rock slope is rich in *Empetrum-Vaccinium*. The vegetation alternated with *Alchemilla alpina* and *Sibbaldia* sociations. Near the quadrate were *Luzula multiflora frigida* and *Pirola minor* as well. Examples of corresponding Scandinavian vegetation are found e. g. in KALELA 1939, Table 14.

Table 10.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Locality no.	17	17	17	15	16	14	14	14	15	16	12	15	15	15
Slope	30°	35°	25°	45°	15°	35°	30°	25°	20°	20°	20°	0°	10°	8°
Exposure	NE	NE	W	E	SW	S	S	S	S	SE	SE	—	W	N
pH	—	4.1	4.3	4.8	4.3	—	4.9	—	—	5.3	—	4.5	5.2	—
Lt	—	—	0.6	0.5	1.3	—	0.6	—	—	0.3	—	2.4	0.4	—
EG Phyllodoce coerulea	..	..	2	..	4	4	4	2	+	+	1	..	..	..
— Lycopodium alpinum	..	..	..	..	..	1	1	..	1	2–3	4	..	..	..
— Cornus suecica	..	..	..	5	4	..	..	..	..	..	..	..	..	..
— Alchemilla alpina	..	..	..	..	1–2	..	..	..	..	1	..	..	..	..
— Agrostis borealis	..	..	..	..	..	+	+	..	..	..	+	..	..	..
— Taraxacum croceum	..	..	..	..	..	..	..	..	..	+	..	..	..	..
— Hieracium hyparcticum	..	..	..	..	1	..	..	..	..	..	..	..	..	..
— Carex deflexa	..	..	..	..	..	+	+	+	1–2	..	+	..	+	..
— Deschampsia flexuosa mont.	..	..	1	+	1	..	..	..	2	+	..	..	..	..
— Coptis trifolia	+	..	+	+	+	..	+	..	..	..	..	..	..	..
Cl Loiseleuria procumbens	..	..	..	..	..	..	2	1	..	..	+	..	+	..
— Betula glandulosa rotundifol.	..	4–5	5	..	..	..	..	..	..	..	..	..	..	..
— Luzula spicata	..	..	..	1	..	..	..	..	..	..	+	+	1	..
— Festuca vivipara	..	..	..	..	..	..	..	..	..	+	..	+	+	..
— Viscaria alpina	..	..	..	..	..	..	..	+	..	..	..	..	..	..
— Salix herbacea	+	..	..	..	..	1	..	+	..	..	1	..	1	2–3
— Veronica alpina	..	..	..	..	..	..	..	+	..	..	..	..	..	..
— Antennaria canescens	..	..	..	..	..	..	+	..	..	..	..	..	..	..
— Gnaphalium supinum	..	..	..	..	..	..	+	..	..	..	..	..	..	..
— Potentilla crantzii	..	..	..	..	..	..	..	..	..	+	..	..	..	..
— Bartsia alpina	..	..	..	..	..	+	..	+	..	..	..	..	..	..
Hb Ledum groenlandicum	..	3	1	..	..	..	+	..	..	+	..	..	..	..
— Lycopodium annotinum	2	..	1	..	2	..	..	..	..	..	..	..	..	..
— Thalictrum alpinum	..	..	..	..	..	..	..	..	..	+	..	..	..	..
Hierochloë alpina (cf. p. 139)	..	..	..	..	..	..	+	..	..	..	..	..	..	..
Calamagr. canad. langsd.	..	..	..	..	..	..	..	..	..	..	..	+	..	..
Campanula rotundif. (coll.)	..	..	..	..	..	..	+	..	..	..	..	..	..	..
Carex bigelowii	+	2	..	..	1	+	+	1	..	1	1	+	..	+
Cerastium alpinum	..	..	..	+	..	..	..	+	..	..	..	..	..	..
Empetrum nigrum hermaphr.	4	..	2	2	1	1	2	3	3	3	5	3	5	5
Festuca brachyphylla	..	..	..	..	..	..	..	..	..	..	+	..	..	..
Poa glauca	..	..	..	..	..	..	..	+	..	..	..	..	..	..
— pratensis var.	..	..	..	2	..	..	..	..	..	..	..	2	..	..
Polygonum viviparum	..	..	..	1	+	+	+	1	..	+	+	..	1	..

(To be continued)

Table 10 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Rubus chamaemorus	..	..	..	..	..	..	..	..	..	..	..	4	..	..
Salix glauca callicarpaea	1	..	2	2	3	2	..	..	1	..	+	..	1	+
Vaccinium ulig. microphyll.	4	..	4	3–4	2	2	+	2	..	3	..	..	..	..
Barbilophozia lycopodioides	2	+	1	..	+	+	+	..	+	..	+	1	1	..
— hatcheri	..	..	..	..	..	..	?	..	..	..	..	..	?	..
Cephalozia pleniceps	..	..	..	..	..	+	..	..	..	..	..	..	..	..
Cephaloziella sp.	..	..	..	..	..	..	..	..	..	..	..	..	+	..
Diplophyllum taxifolium	..	..	..	..	..	..	+	..	..	..	..	..	..	..
Lophozia alpestris major	..	..	..	..	..	+	+	..	..	..	..	..	..	..
— ventricosa	..	..	..	..	..	..	..	..	..	..	..	+	1	..
— sp.	..	..	..	+	..	..	..	..	..	..	+	..	..	+
Ptilidium ciliare	..	..	..	..	..	..	..	..	1	+	..	+	..	+
Scapania curta	..	..	..	..	..	+	..	..	..	..	..	..	..	..
— cfr. scandica	..	..	..	..	..	..	..	..	..	..	..	..	+	..
Aulacomnium turgidum	..	..	..	..	..	..	+	..	..	..	..	..	..	..
Bartramia ithyphylla	..	..	..	1	..	..	..	..	..	..	..	..	..	..
?Hb Brachythecium reflexum	..	..	..	..	+	..	..	..	..	..	..	..	..	..
— salebrosum	..	..	..	..	..	..	..	..	..	+	..	..	..	..
— sp.	..	..	+	+	..	..	..	..	..	..	..	..	..	..
Bryum sp.	..	..	..	..	..	..	..	..	..	..	+	..	..	..
Conostomum tetragonum	..	..	..	..	..	..	..	..	..	..	..	..	..	+
Dicranum bonjeani	..	..	1–2	..	..	..	..	..	..	..	..	..	..	.
— fuscescens	4	3	..	1	..	..	2	..	3	1	1	2	1	4
— scoparium	..	..	1–2	1	1	+	..	..	..	..	..	..	..	.
Drepanocladus uncinatus	..	..	..	..	..	..	+	+	..	..	..	+	3	+
Hylocomium schreberi	5	5	5	..	..	..	..	..	..	..	..	1	..	..
— splendens	+	1	..	..	..	..	..	..	..	..	..	..	..	..
Plagiothecium sp.	..	..	..	+	..	..	..	..	..	..	..	..	..	..
Polytrichum alpinum	+	..	..	..	..	..	..	..	..	..	..	+	1	..
— hyperboreum	..	..	..	..	..	..	..	..	..	..	..	2	..	..
— juniperinum	..	..	..	..	..	+	..	..	..	..	..	..	..	..
— piliferum	..	..	..	..	..	..	+	..	..	..	+	..	..	..
Rhacomitrium canescens	..	..	..	..	..	..	+	..	..	..	..	..	..	..
Webera nutans	..	..	..	1	..	+	+	+	+	..	..	..	..	.
Cetraria delisei	..	..	..	+	..	..	..	..	..	..	1	..	..	+
— islandica	1	1	..	+	..	..	..	..	+	..	..	+	..	..
Cladonia bellidiflora	+	..	+	..	..	..	..	..	+	..	1	+	..	..
— coccifera	..	..	..	+	..	..	+	..	..	..	+	+	+	+
— ecmocyna	+	..	..	..	..	..	..	..	..	+	1	..	..	+
— gracilis	..	..	..	..	..	..	+	..	+	..	..	..	..	+
— mitis	..	..	..	+	..	+	+	..	+	+	..	..	+	+
— pyxidata neglecta	..	..	..	..	..	..	..	..	..	+	..	..	..	..
— rangiferina	+	..	..	..	..	..	..	..	..	..	..	..	..	..
— uncialis	..	..	..	..	..	..	..	..	..	..	..	..	..	+
Cornicularia aculeata	..	..	..	..	..	..	..	..	..	..	..	+	..	..
Nephroma expallidum	1	..	..	..	..	..	..	..	..	..	..	..	..	..

Table 10 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ochrolechia frigida	..	..	..	..	..	..	..	..	+	..	1	+	+	1
Peltigera aphthosa	+	..	1	..	..	..	..	..	..	..	..	..	..	..
— malacea	+	2	1	+	..	..	..	..	..	..	..	..	..	..
(C$_4$) — scabrosa	1	..	..	+	..	1	..	..	..	..	..	..	..	..
— sp.	..	..	..	..	..	..	..	+	..	..	..	..	..	..
Psoroma hypnorum	..	..	..	+	..	..	..	..	..	..	..	..	..	+
Rinodina mniaraea	..	..	..	..	..	..	..	..	..	..	+	..	..	..
Solorina crocea	..	..	..	+	..	..	..	..	..	..	..	..	..	..
Stereocaulon alpinum	..	..	..	..	..	..	..	..	..	+	..	..	..	..

2. Phyllodoce coerulea Sociations.

Observed near Godthaab, Pâ, and Kangâmiut. Analysis no. 5 in Table 10 is a *Phyllodoce-Cornus* sociation with *Alchemilla alpina* and *Lycopodium annotinum* from Lille Malene near Godthaab. There are no analyses available from Pâ, but a *Phyllodoce* heath with *Ledum groenlandicum* and *Lycopodium alpinum* and *annotinum* is mentioned in the profile on p. 81 no. (3). Analyses nos. 6—7 in Table 10 originate from Kangâmiut; both have a slightly developed ground layer. No. 7 contains *Loiseleuria* with covering 2, which shows that this species as on similar degrees of latitude in East Greenland also enters snow-covered, protected heaths. The soil below this heath had a potassium value of 16 and a phosphoric acid value of 0.3; the phosphoric acid value is the lowest among the values from Greenland; in continental heaths, on soils with a similar pH, humidity, and snow cover, the phosphoric acid values varied between 6.6 and 10.0. On the oribatid and collembolan fauna on heath no. 7 see Hammer (1952, no. 8, unfortunately, by an error, called "Calluna heath").

3. Empetrum (Vaccinium)-Lycopodium alpinum Sociations.

A fairly frequent combination near Pâ (profile transect p. 118, Table 10, no. 11) and on Lille Malene (Table 10, no. 10), where other patches than the one analyzed also included *Pirola minor* and *Sibbaldia*. There were also pure *Lycopodium alpinum* sociations both there and on Guldfjeld near Ivigtut, in both places as a zone between the heath proper and snow-bed vegetation.

4. Empetrum-Vaccinium uliginosum microphyllum Sociations.

Most heaths belonging to the present vegetational type from Southeast Greenland can be characterized as *Empetrum-Vaccinium* heaths rich

in species (cf. B. 1933b, Tables 20—21). They contain a large number of the EG-species of the complex and of the EG-species of the type: *Phyllodoce*, *Lycopodium alpinum*, and *Hieracium alpinum*. Completely corresponding heaths are found in Southwest Greenland (e. g. Table 10, no. 8), but I was surprised to observe that often they were not so rich in species as the East Greenland ones. The example Table 10, no. 1, the placing of which appears from transect III on p. 118, shows the type poor in species. The quadrate examined included none of the EG-species of the type; scattered *Phyllodoce*, however, was found near it among the other two dwarf-shrubs. The poverty in species may be due to the fact that the heath in the less arctic Southwest Greenland to a higher degree is expelled to the poorest soil, while the scrubs and herb fields spread over the more fertile soil.

5. Empetrum nigrum hermaphroditum Sociations.

Medium moist heaths, often rich in mosses and snow-covered and protected in winter, often play a great part in the vegetational carpet in skerry and coastal mountain scenery (fig. 26). While an example like the one given i Table 10, no. 9 with abundant *Carex deflexa* and the two most important EG-species are easily grouped within the present vegetational type, this is more difficult as regards nos. 12—14, where most EG-species are absent. These heaths, however, include no continental species, but several low arctic-oceanic ones, for which reason it comes most natural to associate them with the *Phyllodoce-Lycopodium* type. Furthermore I have no doubt that by analyzing more and larger quadrates, I should often have brought in the EG-species, although as very subordinate species.

The ground layer of the *Empetrum* heaths varies considerably. A very important species is *Dicranum fuscescens*, particularly in the north; in the south it is subject to severe competition from *Hylocomium schreberi*, which e. g. at Ivigtut may nearly reign supreme. Amongst other ground-layer dominants I have near Godthaab seen *Barbilophozia lycopodioides* and *Ptilidium ciliare*. At Ivigtut near the vegetation Table 10, no. 1 an *Empetrum-Nephroma arcticum* soc. was noted in which *Phyllodoce*, *Hylocomium splendens*, *H. schreberi*, *Polytrichum alpinum*, and *Dicranum fuscescens* occurred.

Among the sociations listed in Table 10 an *Empetrum-Rubus chamaemorus* soc. (no. 12) is particularly deviating. It was found beside a projecting skerry rock which is no doubt used as an observation post for sea-birds. These may be supposed to have spread the cloudberry to the place and their excrements are no doubt the cause of the high conductivity value of the soil (cf. B. 1949b, p. 31).

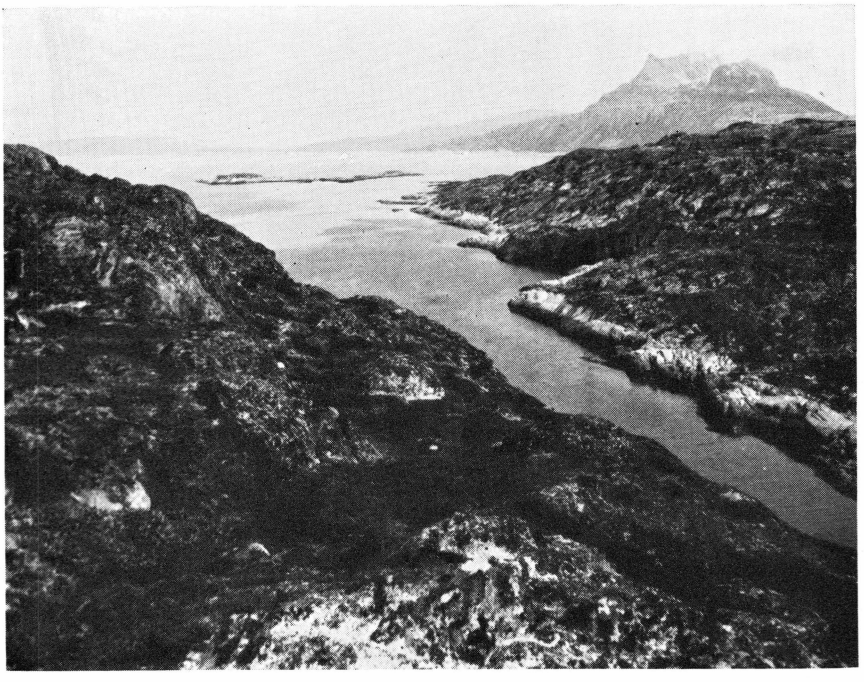


Fig. 26. *Empetrum* heaths cover the majority of the rocks east of Godthaab. The picture shows both medium moist heaths rich in moss which very often belong to the *Phyllodoce-Lycopodium* type, and on the crests of the rocks drier, wind-swept heaths with, e. g., *Alectoria vexillifera*. The mountain Sadlen ('the Saddle') in the Godthaabsfjord is seen in the background on the right. T.W.B. phot. $^{8}/_{9}$ 1946.

6. Betula glandulosa rotundifolia Sociations.

Betula glandulosa sociations rich in mosses play rather a great part near the Arsuk Fjord and probably also in greater areas of South Greenland. They were found on north- and west-facing slopes and in some places might contain abundant *Phyllodoce*, in other places abundant *Ledum groenlandicum*, in both cases with *Hylocomium schreberi* as ground layer (see Table 10, nos. 2—3). Besides the quadrates analyzed I have from a moist, southwest-facing slope near Grønnedal noted a *Betula glandulosa rotundifolia-Hylocomium schreberi-Cladonia* heath with *Ledum groenlandicum*, *Vaccinium uliginosum microphyllum*, *Empetrum*, *Juniperus*, *Salix glauca callicarpaea*, *Deschampsia flexuosa*, and *Festuca vivipara*. Rosenvinge (1896, p. 190) says that *Phyllodoce* and *Ledum groenlandicum* particularly occur in heaths in the coastal regions, and that *Ledum* besides heat and shelter requires a certain humidity in the soil. I am under the same impression, but I think that heat is of subordinate importance. Some of the most luxuriant *Ledum* vegetations were just

found on north-facing slopes. The combination *Betula gland. rotundifolia-Ledum groenlandicum* was also found in glades in the luxuriant willow scrubs, where rocks projected and made the soil too shallow for scrubby growth. In such places there is great air humidity and undoubtedly a thick, constant snow-cover in winter.

7. Vaccinium uliginosum microphyllum Sociations.

It is perhaps characteristic of the coastal regions that such sociations are very rare. It may be due to the increased power of competition of *Empetrum* in the oceanic areas. In my notes there is only a single little typical sociation dominated by *Vaccinium uliginosum* and *Cetraria delisei*; it was found on moist shallow soil on rock beside a spring near Ivigtut and included *Salix arctophila*, *Empetrum*, *Betula gland. rotundifolia*, *Carex bigelowii*, and *Scirpus caespitosus austriacus* besides *Drepanocladus uncinatus*.

8. Vaccinium uliginosum microphyllum-Betula glandulosa rotundifolia Soc. Rich in Sphagnum.

A glade with a bog-like vegetation was discovered within a birch scrub at Narssarssuaq in South Greenland. The ground was very tussocky. The physiognomy of the vegetation with its often nearly knee-high tussocks, with large quantities of *Sphagnum* (particularly *S. acutifolium*, probably also some *S. warnstorfii*) and dwarf shrubs, approached to the character of a bog. *Vaccinium uliginosum* and *Betula glandulosa rotundifolia* were the most important dwarf shrubs, often hard pressed by *Salix arctophila*, while *Empetrum* was subordinate. Dominant mosses furthermore were *Aulacomnium palustre* snd *Brachythecium* sp.; frequent species were e. g. *Hylocomium schreberi*, locally also *Paludella squarrosa*. Among the lichens, which especially occurred on the driest parts, particularly *Stereocaulon paschale*, *Cladonia mitis* and *lepidota* were frequent, while there were scattered *Nephroma expallidum*, *Cetraria islandica*, *C. nivalis*, and *Psoroma hypnorum*. The herbaceous flora suggested the following vegetational type (*Tofieldia pusilla*, *Pedicularis flammea*, *Carex scirpoidea*); it included a single oceanic species, *Deschampsia alpina*, and a subcontinental one, *Equisetum variegatum*, besides *Carex rariflora* and *Equisetum arvense*. In spite of the physiognomy such a community is far from being an oligotrophic bog; it has a mesotrophic character. The absence of EG-species makes it difficult to group it; but preliminarily it is grouped best in connexion with the preceding heaths and the following communities (type f).

d_1. Scrubs Associated with the Phyllodoce-Lycopodium Type.

Small areas of the willow scrubs near the Arsuk Fjord had a ground layer dominated by heath shrubs. Particularly *Betula glandulosa rotundifolia*, *Ledum groenlandicum*, *Empetrum*, and *Lycopodium annotinum* might be abundant. In one place a *Lycopodium annotinum-Hylocomium schreberi-splendens* soc. with *Ledum groenlandicum*, *Chamaenerium angustifolium*, *Angelica*, *Poa nemoralis* and *pratensis* was seen. Small bits of scrubs of *Betula pubescens* near Grønnedal had in the ground layer *Lycopodium annotinum*, *Vaccinium uliginosum microphyllum*, *Betula gland. rotundifolia*, *Lastraea dryopteris*, *Deschampsia flexuosa*, *Coptis*, and *Hylocomium schreberi*.

f. The Scirpus austriacus Type.

(Sub-low arctic suboceanic deer sedge bogs on acid and peaty soils).

This type may be a member of a complex of oceanic fens and bogs. Provisionally, however, it is placed in connexion with the preceding type, as it often borders such heaths and rarely is without dwarf shrubs; it certainly occurs, on still more humid soil, and preferably where soil water is slowly percolating. Several of the species which distinguish the type from the preceding one (*Pinguicula*, *Tofieldia pusilla*, *Pedicularis flammea*) are widely distributed sub-low arctic species. They appear, if anything, as Hb-species common to this type and to communities within the *Carex inserrulata-Juncus arcticus* complex (pp. 227—265). They are further differential species for the mesotrophic sociation group within the present vegetational type. It has previously been described from Greenland (see below), Finland (Kalela 1939, p. 296; Kalliola 1939, p. 95), and Norway (Nordhagen 1943), and there are related communities in the Alps; see e. g. Guinochet 1938, Table 29. Kalela's analyses originate from the transitional area between a suboceanic and a more continental region. His analysis no. 8 from the more continental area can be counted as a mixed type, since *Scirpus caespitosus austriacus*, *Leucorchis albida*, and *Bartsia* here meet with such species as *Carex atrofusca* (cf. p. 238) and *parallela*. His other analyses resemble the mesotrophic communities from Greenland, but are richer in species. No. 1 is related to the herb fields (*Angelica-Alchemilla glomerulans*). In the continental, mostly wooded bogs of North Karelia *Scirpus caespitosus austriacus* is often abundant. The vegetation there, however, shows an essentially different composition (*Carex lasiocarpa*, *Ledum palustre*, *Calluna*, etc.); see Blagowesčenski (1936). It does not belong to the present type, but from continental quarters approaches to the mixed type.

Only one EG-species:

Scirpus caespitosus austriacus: Cl-Ar: Circumpolar, but sporadic in continental areas and most frequent on coasts and in mountainous regions. The oceanic trend is evident in Alaska (HULTÉN, map 213), East America (FERNALD 1933, map 10), Greenland (B. 1938, fig. 128; 1952 a, p. 67), Iceland, where according to GRØNTVED (1942, p. 182) it is not recorded from the central plateau, Scandinavia, where HULTÉN's map (1950, map 290) shows decreasing frequency towards the east and very rare occurrence in the regions of Sweden, where the southerly-continental species are concentrated. — Ecology: Wide-ranging, according to NORDHAGEN (1943, p. 448) without any special value as an indicator of the contents of nutrient of the substratum and its acidity. If anything, however, it tends towards the oligotrophic side. Its continental occurrences seem to a considerable degree to be in forest bogs or muskegs (see RAUP 1936, 1947, p. 126), where the microclimate may be relatively oceanic (cf. the occurrence of *Calluna* in forest bogs at its eastern limit).

1. Mesotrophic Scirpus caespitosus austriacus Sociations.

ROSENVINGE (1896, p. 248) has a description of a South Greenland vegetation, KRUUSE (1912, pp. 118—19) and B. (1933b, pp. 68—70) descriptions of a Southeast Greenland vegetation and DE LESSE (1952, p. 74) a short description of a Northwest Greenland deer sedge bog belonging to this sociation group. Two of these are rendered for comparison in Table 11, nos. 3—4. Nos. 1—2 in the same table are examples from Ivigtut and Grønnedal. Nos. 1—3 are rich in dwarf shrubs, no. 4 has a few of the particular species of South Greenland (*Drosera rotundifolia*, *Carex goodenowii*).

Transitions to vegetation belonging to the continental *Carex inserrulata-Juncus arcticus* complex clearly occur in the interior of South Greenland. ROSENVINGE (*loc. cit.*) thus from similar communities as the one rendered in Table 11 mentions such species as *Primula egaliksensis* (for its range see Rhodora vol. 30, p. 97), *Carex microglochin*, *Scirpus pauciflorus*, *Juncus arcticus* ssp. *arcticus*, and *Lomatogonium*, which point towards or refer the vegetation to the continentally stamped complex.

The four analyses are somewhat different in the case of the cryptogams. No. 1 consisted of a mosaic of *Scirpus* tussocks and small interjacent expanses, where the peaty soil was black owing to a cover of Cyanophyceae. Other species found there were particularly *Pinguicula*, *Eriophorum*, and *Calliergon sarmentosum*.

The abundance of this moss and *Drepanocladus badius* in the vegetation points towards relationship with North Finnish *Scirpus austriacus* "braunmoore" (KALELA 1939, pp. 487—93). In no. 2 *Sphagnum rubellum* is dominant, but the mesotrophic character of the bog is emphasized by abundance of *Tomenthypnum nitens*.

The mesotrophic vegetation was found as a fragment along a brook

Table 11.

Analysis no.	1	2	3	4
Locality no.	17	18	[1]	[2]
pH	4.9	6.3	—	—
EG Scirpus caespitosus austriacus	5	3–4	!!	!!
— Bartsia alpina	..	1	+	..
— Hieracium alpinum	..	..	+	..
— Angelica archangelica	..	+	..	..
— Agrostis borealis	..	..	+	..
Cl Selaginella selaginoides	..	..	..	+
— Betula glandulosa rotundifolia	2	+	..	..
Hb_1 Ledum groenlandicum	1	..	..	..
— Habenaria hyperborea	..	+	..	..
— Thalictrum alpinum	..	1	..	+
Hb_2 Tofieldia pusilla	1–2	1	+ – !	..
— Pinguicula vulgaris	1–2	..	+ – !	+
— Pedicularis flammea	+	1	+ – !	..
— Saxifraga aizoides	..	..	..	+
— Carex capillaris	..	1	+	..
— Triglochin palustre	..	..	..	+
Hb_3 Oxycoccus quadripetalus microphyllus	..	..	..	+
— Drosera rotundifolia	..	..	..	+
— Carex goodenowii	..	..	..	+
Carex bigelowii	+	2	+	..
— rariflora	..	..	..	+
— scirpoidea	1	..	+ – !	..
Empetrum nigrum hermaphroditum	1	+	!	..
Eriophorum angustifolium	+	..	..	+
Lycopodium selago	..	+	+	..
Polygonum viviparum	..	1	+	..
Salix arctophila	1–2	3–4	..	..
— glauca callicarpaea	..	+	+	..
Silene acaulis	..	..	+	..
Vaccinium uliginosum microphyllum	1–2	1	!	..
Cephaloziella sp.	..	..	+	..
Nardia scalaris	..	..	+	..
Odontoschisma elongatum	+	..	..	..
— macounii	..	..	..	+
Orthocaulis kunzeanus	+	..	..	..
Ptilidium ciliare	+	..	..	..
Riccardia pinguis	..	..	..	+
Scapania hyperborea	..	..	+	..
Aulacomnium palustre	..	1	!	..
— turgidum	1	..	..	..
Brachythecium salebrosum	..	+	..	..
Bryum cirratum	..	..	+	..

[1] B. 1933 b, Table 20, no. 44. [2] Rosenvinge 1896, p. 248.

(To be continued)

Table 11 (continued).

Analysis no.	1	2	3	4
Calliergon sarmentosum	1	..	..	..
Campylium stellatum	..	+	..	+
Cinclidium subrotundum	..	..	..	+
Climacium dendroides	..	+	..	..
Dicranum bergeri	1–2	..	..	..
— fuscescens	+	..	..	..
— scoparium	+	+	..	..
Hb Drepanocladus badius	2	..	!¹	..
— revolvens	2	..	..	..
— revolvens intermedius	..	..	..	+
— uncinatus	1	..	..	..
Hylocomium schreberi	+	..	..	..
— splendens	..	1	..	..
Hypnum pratense	..	+	..	..
Oncophorus wahlenbergii	2	..	..	+
Paludella squarrosa	..	2	..	..
Philonotis caespitosa	..	..	+¹	..
Polytrichum alpinum	+	..	..	..
Rhacomitrium hypnoides	1	..	..	..
Sphagnum rubellum	..	5	..	..
— sp.	1	..	..	..
Tomenthypuum nitens	..	4	..	..
Cetraria islandica	+	..	..	..
Cladonia mitis	..	..	!	..
— uncialis	+	..	..	..
Nephroma arcticum	..	1	..	..
Stigonema mamillosum	!	..	..	..
Dichothrix gypsophila	!	..	..	..
Calothrix braunii	+	..	..	..
— weberi	+	..	..	..
Nostoc sphaericum	+	..	..	..
Gloecapsa alpina	+	..	..	..
Cymbella incerta	!	..	..	..
Eunotia praerupta	+	..	..	..
— fallax	+	..	..	..
Frustullina rhomboidea saxonica	+	..	..	..
Navicula petersenii	+	..	..	..
43 other species of diatoms (cf. FOGED 1953).	+	..	..	..

Hb_1: Hb species with connexion to the present complex. Hb_2: Hb species also in the Carex inserrulata-Juncus arcticus complex. Hb_3: Hb species with oligotrophic tendency occurring in South Greenland only.

[1] The determination of these mosses in B. 1933 b is erroneous.

at the foot of Lille Malene near Godthaab. Other species seen there were *Scirpus*, *Tofieldia pusilla*, *Pinguicula*, *Bartsia*, and *Pedicularis flammea*.



Fig. 27. Fragmentarily developed oligotrophic *Scirpus caespitosus austriacus* sociation near the Godthaabsfjord, developed where water percolates over bedrock. T.W.B. phot. $^{9}/_{9}$ 1946.

2. Oligotrophic Scirpus caespitosus austriacus Sociations.

Such sociations were only seen fragmentarily near slowly oozing water in the rocky terrain near Godthaab (fig. 27) and Ivigtut. They were not examined in detail, but in both localities, besides mosses, practically only *Eriophorum angustifolium* and *Carex rariflora* were seen to be associated with the deer sedge. The group is related to the moist *Nardus* sociations with *Scirpus caespitosus austriacus* snd *Juncus squarrosus*; cf. p. 60.

Scirpus caespitosus austriacus was not seen as a dominant in the continental area at the head of the Søndre Strømfjord. The only place where it was found, was in hollows between lengthy, sinuous tussocks with heath of *Vaccinium uliginosum microphyllum*, *Empetrum*, *Salix arctophila*, and *Cassiope tetragona* at 600 m altitude on Nákajanga (Loc. 8). It occurred there with *Pedicularis flammea*, some *Cetraria delisei* and *Gymnomitrium concinnatum*. The soil under the *Scirpus* tussocks on August 10th was much dried up; the plant was low and did not seem to thrive.

Willow scrubs associated with this type are hardly found. Still I saw at Ivigtut a moist scrub percolated by small brooks. The ground layer was poor there apart from the mosses; on certain parts *Salix arctophila*, however, might appear as dominant together with mosses under the tall-growing willows. Otherwise there was only a little *Polygonum viviparum* and some *Pedicularis flammea*, which is a frequent companion of *Scirpus caespitosus*.

III. The Deschampsia alpina-Gnaphalium supinum-Cassiope hypnoides Complex.

Oceanic arctic snow-patch (or snow-bed) vegetation and related vegetations on wet soil.

It is not quite easy to delimit this complex especially from its high arctic counterpart, which after a study especially of SEIDENFADEN & SØRENSEN (1937) I shall call the *Saxifraga foliolosa-Ranunculus sulphureus* complex; for there are some sociation groups or subtypes characterized by medium arctic species which below are grouped in connexion with the present complex, but which might almost as well be associated with the high arctic complex. Schematically it seems that communities with dominance of high arctic EG-species (i. e. hygrophilous high arctic species) are assigned to the high arctic complex while communities with dominance of low arctic oceanic species which are hygro- and chionophilous, are assigned to the low arctic complex. As soon as the subarctic element asserts itself to any appreciable degree, we get transitions especially to the preceding complex.

I have broken with the past by also including in the complex certain communities which previously have often been grouped as "bogs". Just as the high arctic complex appropriately may include what SØRENSEN terms "denuded bogs", the low arctic complex ought to include such communities as e. g. the *Equisetum arvense rivulare* vegetation occurring on a flat polygon field with species like *Salix herbacea*, *Koenigia*, *Minuartia biflora*, *Cerastium cerastioides*, *Poa alpina vivipara*, *Juncus biglumis*, and others mentioned in B. 1933b, p. 95 from Knud Rasmussens Land. This particular community forms a connecting link between the Icelandic *Koenigia-Sedum villosum* "flag"-communities with their rather large subarctic element (see analyses in SØRENSEN 1942) and the high arctic "denuded bogs" with *Deschampsia brevifolia*, *Cerastium regelii*, *Saxifraga foliolosa*, and other high arctic species. As the Icelandic vegetation does not include a single high arctic species, but is dominated by low arctic oceanic species, and these are even to a great extent snow-patch plants, I propose that the Icelandic *Koenigia-Sedum villosum* "flag"-community be associated with the present complex (see p. 127), while the "denuded bogs" of Northeast Greenland enter into the *Saxifraga foliolosa-Ranun-*

culus sulphureus complex. The Icelandic soil for that matter gives a possibility of strange combinations of species. In the flag-community mentioned oceanic snow-patch plants thus are combined with *Carex bicolor*, *C. microglochin*, *C. capillaris*, and *Juncus triglumis*, all of them character species in NORDHAGEN's *Caricion bicoloris atrofuscae*. Approaches to such a greatly mixed vegetation on moist clay surfaces, however, occur also in the southern part of the inland of Greenland (see ROSENVINGE 1896, p. 248), It is interesting that the Icelandic flags according to SØRENSEN contain so great amounts of *Montia lamprosperma*; for this offers a possibility of a new connexion with a peculiar vegetation which no doubt first of all has been described by M. P. PORSILD (1902, p. 151) from Disko. Near a *Puccinellia phryganodes* saltmarsh he found on a fresher soil a moss vegetation with e. g. *Leptobryum pyriforme* and a luxuriant occurrence of *Montia* and *Koenigia*. Completely corresponding communities have later been described by POLUNIN (1948) from southernmost Baffin Land, again from a zone above the saltmarsh proper.

The *Deschampsia alpina-Gnaphalium-Cassiope hypnoides* complex in Greenland falls into three vegetational types, which may be termed marsh snow-patches, herb snow-patches, and dwarf-shrub snow-patches. The first is dominated by graminoid plants, the others by dwarfish herbs and dwarf-shrubs. Everywhere bryophytes, in particular liverworts, play a great part. Sharp distinctions between the types do no exist. Two of the types have subtypes with medium arctic species.

EG-species (oceanic low arctic-medium arctic hygro-chionophilous species): *Deschampsia alpina*, *Carex rufina*, (*C. lachenalii*), *Gnaphalium supinum*, *Sibbaldia procumbens*, *Veronica alpina* (typical form with glabrous fruits); — *Cassiope hypnoides*, *Salix herbacea*.

EG-species common to this and type d in the preceding complex: *Cerastium cerastioides*, *Epilobium anagallidifolium*, *Montia lamprosperma*, *Sedum villosum*, *Koenigia islandica*.

EG-species of the subtype a_1: *Erigeron unalaschensis*, *Draba crassifolia*, *Antennaria porsildii*, *A. angustata* Greene, (*A. canescens*).

EG-species of the subtype c: *Poa alpina vivipara*, *Ranunculus glacialis*.

Cl-species, particularly: *Phleum commutatum*, *Festuca vivipara* (Atlantic race), *Agrostis borealis*, *Alchemilla alpina*, *Lycopodium alpinum*.

Hb-species, particularly: *Phippsia algida*, *Sagina intermedia*, *Saxifraga tenuis*, *S. rivularis*, *Ranunculus pygmaeus*, *Cardamine bellidifolia*; several bryophytes; approaching to the Hb-species: *Cladonia ecmocyna*.

The boundaries of the areas in N. America—Greenland of a number of important EG-species are shown in fig. 28. As these species are ecologically closely related, we may here really speak of progressive areas. The boundaries are situated round each other and resemble climatic curves.

An interesting feature is the wedge which advances along Hudson Strait and crosses the northern part of the inland sea of Hudson Bay to East Keewatin. This wedge is seen in several other maps as well (*Sibbaldia* fig. 21) and is presumably due to invasion from the east of a more oceanically stamped climate. The —26° C. January isotherm actually forms a large curve against west of this region (KENNETH HARE & MONTGOMERY 1949 (Arctic, 2, p. 85)). Otherwise the figure indicates that the complex is highly characterized by eastern European species, a fact which contributes to showing its relationship with the *Alchemilla-Phleum* type.

a. The Cerastium cerastioides-Veronica alpina Type.

(Low arctic oceanic herb snow-patch vegetation).

This type, which in Southeast Greenland plays a fairly great part in the vegetational carpet, was far from being so dominant in the lowlands of Southwest Greenland and was practically completely absent in the lowlands along the Arsuk Fjord. However, there is no doubt that somewhat up on the mountains it will be frequent in the whole area of the coastal mountains towards the north to the Disko-Nûgssuaq region, and farthest nord (e. g. already at Kangâmiut) it also occurs at sea level.

The communities which in Scandinavia correspond to the Greenland ones under the present type occur in the alliance which NORDHAGEN proposes to call *Ranunculeto-Oxyrion*, but which partly consists of herb fields with a great subarctic element, partly of more chionophilous communities. Among these is the association which NORDHAGEN terms *Saxifrago-Ranunculetum nivalis*, like GJÆREVOLL's *Ranunculetum nivalis* a mixed type, as *Ranunculus sulphureus* and *nivalis*, which are mainly associated with the high arctic snow-patch complex, occur there together with *Gnaphalium supinum*, *Veronica alpina* and numerous other low arctic oceanic species. We have corresponding mixed types in South Disko and on Gaaseland in Scoresby Sund, from where HARTZ (1895, p. 269) mentions a tussocky boggy vegetation with *R. sulphureus*, *nivalis*, *Saxifraga foliolosa*, *Cerastium cerastioides*, *Salix herbacea*, and *Potentilla crantzii*.

Like the corresponding Norwegian communities the Greenland ones require a constantly moist, preferably slowly percolated soil near snow drifts. They are also markedly oligotrophic as most of the dwarf-shrub snow-patches. They are absent on the Oviks-mountains in Jämtland (GJÆREVOLL 1949), and slightly represented in the valley Sikkilsdalen (NORDHAGEN 1943, p. 286). In Greenland they are absent in the interior of the Godthaabsfjord (TRAPNELL 1933) as well as the inland at 67° lat. N.

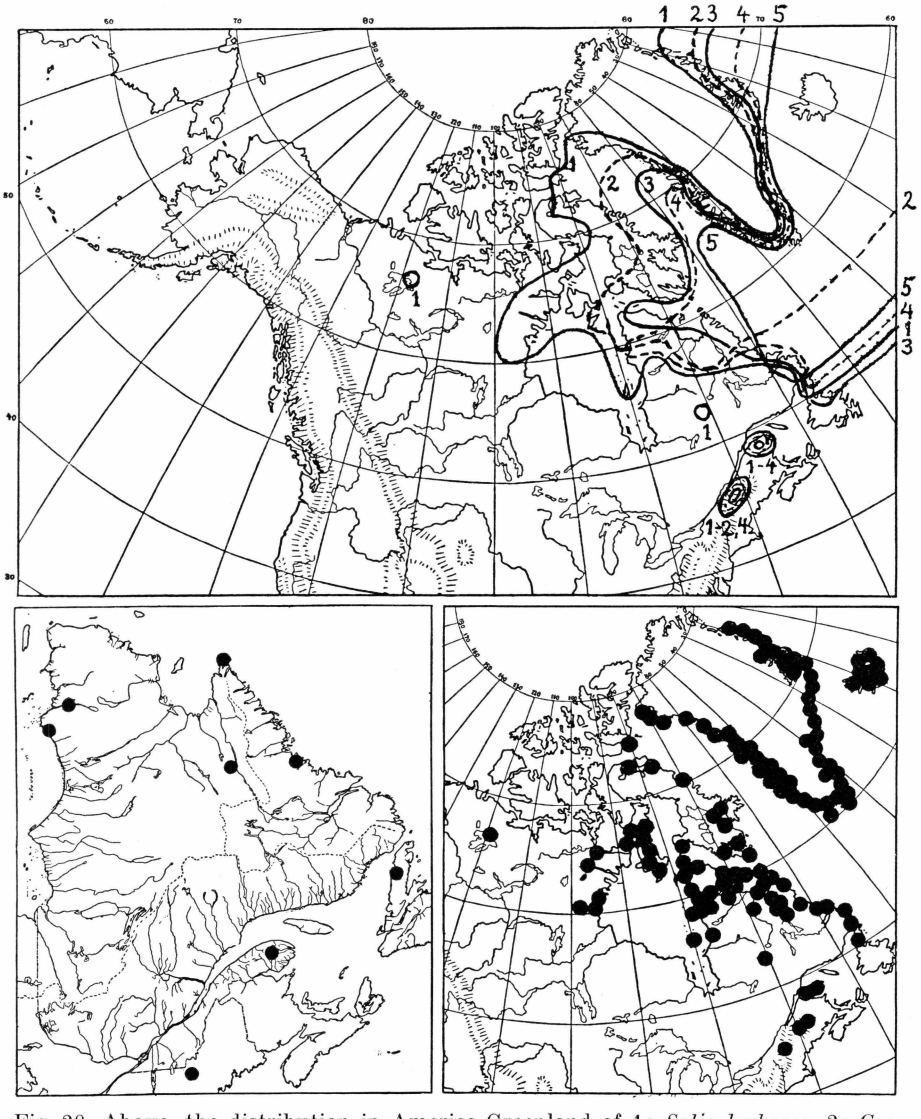


Fig. 28. Above, the distribution in America-Greenland of 1: *Salix herbacea*, 2: *Cassiope hypnoides*, 3: *Cerastium cerastioides*, 4: *Gnaphalium supinum*, 5: *Saxifraga stellaris*. — Below on the left, American stations for *Gnaphalium supinum* (according to M. RAYMOND); below on the right, detail map of stations for *Salix herbacea*. American stations according to kind information from M. RAYMOND.

The EG-species of the vegetational type:

Cerastium cerastioides. Cl: Low arctic-oceanic. Ar: North Atlantic, montane; see map fig. 28 and for Greenland map fig. 36 in B. 1938. Greenland plants are associated with snow-patches and springs, while plants occurring in the Alps are also frequent in talus-slides.

Veronica alpina (typical with glabrous fruits). Cl: Low arctic-oceanic, montane. Ar: North Atlantic, in America only in South Baffin-North Labrador

(FERNALD 1939, POLUNIN 1940). — Ecology: Shows pronounced concentration on snow-patches of the present type; not seen as a dominant in herb field belonging to the *Alchemilla-Phleum* type.

Epilobium anagallidifolium. Cl: Low arctic-oceanic, montane. Ar: With a wide gap in North America between the western mountains and Hudson Bay (RAUP 1947, map Plate XXXI). Isolated station in Victoria Land. Probably a corresponding gap in Northern Asia.

Sibbaldia procumbens. Cl: Low arctic-oceanic, montane. Ar: Circumpolar, or nearly so; cf. B. 1952a and fig. 21. Maps in MURAVJEVA (1936, Fl. Syst. Pl. Vasc. Acad. Sci. URSS 1(2) and RAYMOND (1950). It is probably that among the EG-species which is most frequent in herb fields and therefore of less importance as a guiding species. Cf. Table 8, nos. 1—2.

Gnaphalium supinum. Cl: Low arctic-oceanic, montane. Ar: North Atlantic, European, montane. Maps, see fig. 28 and for Greenland SEIDENFADEN & SØRENSEN 1937, fig. 54; B. 1938, fig. 194. — Ecology: Typical snow-patch plant, but according to GJÆREVOLL (1949) acidophilous and therefore very frequent in dwarf-shrub snow-patches. It also occurs in snow-patches of an extreme oceanic, southern type on the tops of Faroese mountains (cf. Table 10 in B. 1937), but in the Scottish Highlands it may occur on *Rhacomitrium* heath in a very exposed position (PIGOTT 1951, p. 54).

1. Cerastium cerastioides Sociations.

Such sociations occurred on steep mossy banks of small brooks and in humid snow-patches with abundant supply of melting ice. The first-mentioned habitat, which in the lowlands in the south could be the only one left for the type, might have a somewhat different vegetation with more frequent occurrence of such species as *Carex bigelowii*, *C. lachenalii*, *Ranunculus pygmaeus*, and *Saxifraga rivularis*. I could not, however, find any appreciable difference between this bank vegetation and the wet snow-patches on a nearly plane ground. Even though vegetation of this type has been noted several times in my journals, only four quadrate analyses were made, which are rendered in Table 12. One of them is even dominated by *Salix herbacea* with *Cerastium* and *Oxyria* as secondary species. From one of the quadrates (no. 3) a soil analysis is available, which showed pH 5.3, the conductivity value 0.4, the potassium value 5.2, and the phosphoric acid value 2.4. The potassium and phosphoric acid values are relatively low, which shows that *Cerastium cerastioides* must have rather a wide range as regards the contents of nutrients in the soil, for it also occurred in an especially coprophilous snow-patch vegetation, which e. g. was widespread around the unhygienic out-station Kangâmiut. The coprophilous sociation there besides *Cerastium cerastioides* also included *Koenigia*, *Oxyria*, *Stellaria media*, and *Polygonum aviculare*, occasional *Stellaria calycantha*, which also was seen in a similar vegetation as that in Table 12, no. 3 together with i. a. *Saxifraga nivalis* and *Carex lachenalii*.

Table 12.

Analysis no.	1	2	3	4
Locality no.	14	14	15	15
Slope	—	—	10°	10°
Exposure	—	—	N	N
EG Cerastium cerastioides	2	2–3	3	3
— Veronica alpina	+	+	..	..
— Epilobium anagallidifolium	+	+	..	..
— Sibbaldia procumbens	..	..	1	..
— Gnaphalium supinum	..	1	+	..
— Salix herbacea	4	..	+	1
Cl Phleum commutatum	+	..	..	..
— Festuca vivipara	..	..	..	1
— Taraxacum croceum	+	..	..	..
Hb Ranunculus pygmaeus	+	..	+	..
— Saxifraga rivularis	..	..	+	..
Calamagrostis canad. langsdorfii	1	..	..	..
Carex bigelowii	..	..	..	1
Lycopodium selago	..	..	..	1
Oxyria digyna	1–2	..	..	..
Poa pratensis (coll.)	..	..	3	3
Polygonum viviparum	..	..	+	..
Lophozia ventricosa	..	..	1	2–3
(Hb) — alpestris	2	3–4	1	..
Hb Pleuroclada albescens			..	..
Scapania irrigua	..		..	..
Bartramia pomiformis	..	1	..	..
Brachythecium salebrosum	1	..	..	..
— sp.	..	+	..	..
Bryum sp.	..	1	..	..
Dicranum fuscescens	..	..	..	4
— majus	..	..	3	..
Drepanocladus uncinatus	4	2	4–5	2
Polytrichum alpinum	1	1	+	1
Rhacomitrium heterostichum affine	..	1	..	..
Webera sp.	..	+	..	..
Cladonia bellidiflora	..	..	..	+
(Hb) — ecmocyna	..	..	..	1
— uncialis	..	..	..	+

2. Gnaphalium supinum Sociations.

Observed at Pá containing abundant *Sibbaldia* and *Epilobium anagallidifolium*. Near the Godthaab colony in the east beside the fjord there was often a *Salix herbacea-Gnaphalium supinum* soc. containing *Sibbaldia* or *Veronica alpina* (cf. e.g. the profile transect II (5) mentioned

on p. 118). On the northern slopes of Store Malene (Loc. 16) snow-beds of this type began being frequent at a height of 300—400 m above sea level. They were found along projecting, often vertical rocks, and as co-dominants together with *Gnaphalium* might have *Brachythecium glaciale* (Hb) or *Polytrichum alpinum*. In one place *Brachythecium* was accompanied by abundant *Barbilophozia lycopodioides*, *Bryum* sp., *Oxyria*, *Sibbaldia*, *Lycopodium selago*, and *Taraxacum croceum*. On corresponding vegetation in the Alps see G. & J. BRAUN-BLANQUET 1931, Table 4, nos. 4—7, GUINOCHET 1938, Table 10.

3. Sibbaldia procumbens Sociations.

Such sociations were observed at Godthaab, Kangâmiut, and Pâ. At Pâ a *Carex bigelowii-Sibbaldia* soc. with *Gnaphalium supinum* and *Salix herbacea* as subdominants was seen. At Godthaab *Veronica alpina* and *Gnaphalium supinum* were subdominants in a pure *Sibbaldia* mat and a similar sociation was observed at Kangâmiut, where this vegetation was inserted between an *Alchemilla alpina* soc. (south-facing) and a *Cerastium cerastioides-Oxyria* soc. which nestled round a large precipitated rock and profited by the shadow of the rock.

a_1. The Erigeron unalaschensis-Draba crassifolia Subtype.

(Herb snow-patches characterized by medium arctic species lacking in the southernmost part of the low arctic area; soil comparatively rich).

This vegetation is considered a subtype because it contains a large share of the species of the *Cerastium-Veronica* type; it may also contain a few of the species of the *Saxifraga foliolosa-Ranunculus sulphureus* complex, particularly *Ranunculus nivalis*, which is actually absent in northernmost Greenland and in North America has a gap or is rare along the Arctic Ocean between the Mackenzie River delta and North Baffin (map in RAUP 1947) and therefore approaches to the EG-species of the subtype.

The two most important species of the subtype have an interesting distribution, which is shown in fig. 29. It is very conspicuous that the areas of the two species almost cover one another, a fact which further is evident from their distribution in Northern Scandinavia (cf. HULTÉN 1950). With these, furthermore, *Antennaria porsildii* is associated (cf. B. 1938, map fig. 105), which, however, is now also known from an alpine station in South Greenland (POLUNIN), as well as *A. angustata* Greene (cf. A. E. PORSILD 1950, pp. 11—12 and map no. 6). There is no doubt that these EG-species avoid greatly oceanic areas, but they are certainly not continental, either; they are satisfied with conditions in

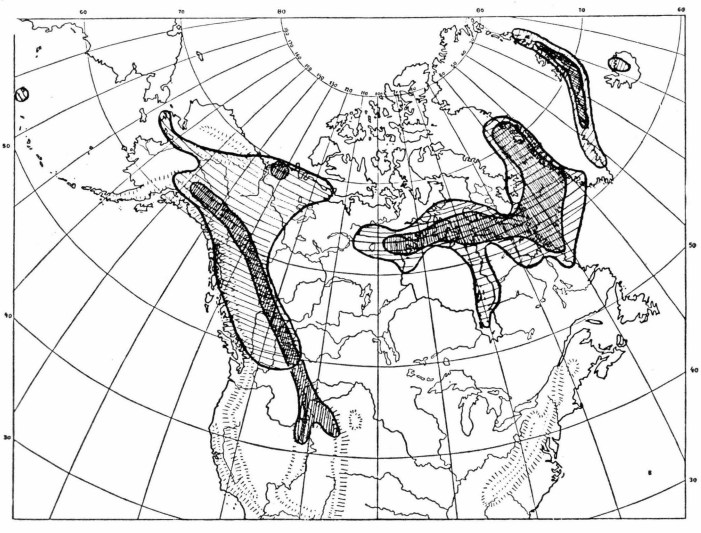


Fig. 29. America-Greenland area of *Erigeron unalaschensis* (open hatching) and *Draba crassifolia* (dense hatching). The distribution of the former is shown on the basis of a map in RAUP 1947, that of the latter in Greenland on the basis of a map in GELTING (1934).

the northernmost, least oceanic part of the low arctic-oceanic area and corresponding areas in the western mountain ranges in America. Furthermore, they enter somewhat into the coastal regions of the high arctic area and therefore are fully qualified for being termed medium arctic.

Antennaria canescens comes very close to being admitted among the EG-species. It is, however, more southerly, but hardly appears as a dominant in the southern sociations of the *Cerastium-Veronica* type; thus it has its optimum in the *Erigeron-Draba* subtype, although it may swerve and be found in certain heaths as quite a subordinate element. In America it is associated with South Baffin-North Labrador, from where it passes along Hudson Strait to East Keewatin (A. E. PORSILD 1943, p. 69). Its distribution there coincides with that of the two species after which the type is named (see fig. 29).

Vegetation belonging to this subtype has recently been described by DE LESSE 1952, pp. 52—58, from Eqe at 69°42′—48′ in West Greenland and may further occur in the skerries of Egedesminde (cf. KRUUSE 1898, p. 373). According to DE LESSE the community contains i. a. *Draba crassifolia*, *Erigeron unalaschensis*, *Antennaria glabrata*, *Minuartia biflora*, *Ranunculus pygmaeus*, *Phippsia algida*, and *Cardamine bellidifolia*. In Knud Rasmussens Land in East Greenland it plays not quite a small part (see eg. g. HARTZ & KRUUSE 1911, p. 346 "herby slope"). My examples (B. 1933b, Tables 10 and 26) testify to the presence of sociations dominated by *Potentilla crantzii* with abundant *Taraxacum croceum*, *An-*

tennaria canescens and *Sibbaldia* (no. 20), *Salix herbacea* soc. with *Thalictrum alpinum* (no. 19), *Sibbaldia-Oxyria* soc. with *Veronica alpina*, *Gnaphalium supinum*, *Cerastium cerastioides*, *Polytrichum norvegicum*, and others (nos. 67—68). The last-mentioned sociation appeared in part on manured soil. Everywhere it was snow-patches rich in low species; only *Potentilla crantzii* could in some places make the vegetation remind of the more southerly high-growing herb mats. The sociations mentioned in my earlier paper did not contain any high arctic species. The EG-species were represented by *Erigeron unalaschensis* (often very abundantly), *Draba crassifolia*, *Antennaria porsildii* and *canescens*.

Draba crassifolia is not exclusively associated with snow-patches, but may e. g. on Gaaseland in Scoresby Sund be found in luxuriant herb field together with, amongst others, *Alchemilla glomerulans*, *Sibbaldia*, *Veronica alpina*, *Hieracium alpinum*, a rare variety of *Ranunculus auricomus*, and others (HARTZ 1895, p. 266). In other places in Gaaseland it occurs on gravelly snow-patches together with *Arabis alpina*, *Cerastium cerastioides*, *Draba alpina*, *Oxyria*, and others (HARTZ p. 269).

From Spitzbergen HADAČ 1946, p. 151, mentions *Trisetetum spicati*, which seems to belong to the subtype by 100 per cent. constancy for *Erigeron unalaschensis*, *Minuartia biflora*, and *Ranunculus pygmaeus*. The pH values are between 5.3 and 6.1.

POLUNIN (1948, p. 196) describes snow-patches at Port Burwell in Northern Labrador, which in zone III has a vegetation belonging to the subtype. It is a dense *Salix herbacea* mat with no less than 29 flowering plants, among them the two species after which the subtype is named, all EG-species for the *Cerastium-Veronica* type, *Taraxacum croceum*, and *Deschampsia alpina*, among the more arctic species only *Ranunculus nivalis* and *Draba alpina*. On Wakeham Bay as well POLUNIN found communities which belong here: a snow-patch with abundant *Draba crassifolia* and *Parnassia kotzebuei*. A damp run-off area in this snow-patch was dominated by *Anemone richardsonii*. Have we not got a completely corresponding community on Præstefjældet near Holsteinsborg, where WARMING (1888, p. 39) rejoiced in this species, which with its beautiful yellow flowers "adorns the green cover"?

By occurrence of *Draba crassifolia*, *Sibbaldia*, *Thalictrum alpinum* there is some relation to mesophytic meadow associations in Colorado. These associations are rich in species and show soil reactions varying from pH 5.0 to 6.0; cf. COX 1933, pp. 346—347.

In Norway *Draba crassifolia* occurs as character species for snow-patches on gravel rich in lime, a community which NORDHAGEN (1936) associates with the "*Arabidetalia coeruleae*" set up by RÜBEL. Apart from *Draba alpina* and *crassifolia* the Norwegian vegetation does not seem to have many species in common with the present subtype. *Sagina caespitosa*, however, is mentioned by NORDHAGEN together with *Draba crassifolia* as a character species, which may be in very good agreement with a single occurrence of the *Sagina* species near Godthaab, in what may be described as a gravelly snow-patch vegetation, and with POLUNIN's description of the behaviour of the species in America (1940, p. 206). The Greenland distribution (B. 1952 a) and its amphi-

Atlantic distribution combined with its occurrence in the Rocky Mountains and its attitude towards the pH of the soil suggest that it should be considered an EG-species for the subtype.

b. The Salix herbacea-Cassiope hypnoides Type.

(Low arctic oceanic dwarfshrub snow-patch vegetation).

This is one of the most important vegetational types of Southwest Greenland, but in South Greenland (climatic regime E) it is mainly alpine and only very fragmentarily developed in the lowlands. As an acidophilous vegetation requiring a snow cover of long duration it is attached to the outer coast, but from there it radiates to the northern slopes or alpine areas of the inland; in climatic regime C it is only alpine and never typical; cf. p. 123. On the whole it corresponds to the Scandinavian *Cassiopeto-Salicion herbacea* latest treated by NORDHAGEN (1936, 1943) and GJÆREVOLL (1949).

The EG-species of the vegetational type:

Cassiope hypnoides. Cl: Low arctic-oceanic. Ar: North Atlantic; see map in RAYMOND 1950, fig. 7 and fig. 28 (2), and for Greenland B. 1938, fig. 84. — Ecology: Greatly acidophilous, perhaps more xerophilous and more capable of tolerating solifluction than *Salix herbacea*; see GJÆREVOLL p. 58.

(*Salix herbacea.* The map fig. 28 (1) shows that this is a North Atlantic species; it is clearly most frequent in the low arctic area, but it ranges far north and appears there in communities belonging to the high arctic snow-patch complex. Thus it is no good EG-species, not least because in the south in the most oceanic areas it deviates and mixes as a subordinate element into all kinds of non-chionophilous communities (cf. Tables 3—4). It also occurs abundantly in several communities which ecologically belong to the preceding type).

As an introduction to the description of the vegetation I shall first mention a number of profile transects, which amongst other things show the situation of the snow-patch vegetation in the terrain in relation to other communities within the oceanic low arctic region.

I. Near Pâ (Loc. 12) on gravelly moraines:
   (1) Flat gravelly field above shallow valley; exposed to the wind; *Juncus trifidus-Stereocaulon denudatum* soc. Table 3, no. 1.
   (2) Upper part of southeast slope: *Empetrum-Betula nana-Ochrolechia frigida* soc. with *Diapensia*, *Luzula spicata*, *L. confusa*, *Carex bigelowii*, *Hierochloë alpina*, *Ptilidium ciliare*, *Dicranum* sp., *Polytrichum piliferum*, *Cladonia mitis*, *C. bellidiflora*, *coccifera*, *gracilis*, *uncialis*, *Stereocaulon alpinum*, *Sphaerophorus globosus*, *Cetraria nivalis*, *crispa*, and *delisei*.

(3) Lower part of the same slope: *Empetrum-Lycopodium alpinum* soc. with *Phyllodoce*, *Carex deflexa*, and *Salix herbacea*; see Table 10, no. 11.
(4) Flat valley below the slope: *Salix herbacea-Ochrolechia frigida* soc. with very scattered dwarfish *Empetrum*, *Betula nana*, *Loiseleuria*, *Carex bigelowii*, besides abundant *Gymnomitrium corallioides* and some *Cetraria delisei* and *Solorina crocea*.

II. Godthaab (Loc. 15). On the fjord east of the colony; evenly sloping expanse in front of north-facing rock wall. No. 1 closest to the rock wall, no. 4 near the shore.

(1) *Cerastium cerastioides-Poa pratensis-Dicranum-Lophozia* soc. Table 12, no. 4.
(2) *Salix herbacea-Dicranum fuscescens* soc. rich in *Polytrichum norvegicum*. Table 13, no. 4.
(3) *Agrostis borealis-Dicranum fuscescens-Polytrichum* soc. Table 7, no. 7.
(4) *Empetrum* soc. with scattered *Loiseleuria*, *Juncus trifidus*, *Viscaria*, and other species.
(5) In front of east-facing rock the same locality bordering down on nos. 2—3 in the zonation above: *Salix herbacea-Gnaphalium supinum* soc. with *Sibbaldia* and *Veronica alpina*.

III. Ivigtut (Loc. 17). Ravine with steep slopes. The following zones on the slope in front of a northeast-facing rock.

(1) *Salix herbacea-Anthelia juratzkana* soc. with *Carex bigelowii*, *Deschampsia alpina*, *Sibbaldia*, *Gnaphalium supinum*, *Gymnomitrium corallioides*, *Conostomum tetragonum*, *Dicranum fuscescens*, *Drepanocladus uncinatus*, and *Polytrichum alpinum*.
(2) *Salix herbacea-Carex bigelowii-Hylocomium schreberi-Drepanocladus uncinatus* soc. with *Lycopodium selago*, *L. alpinum*, *Empetrum*, *Deschampsia flexuosa*, *Polygonum viviparum*, *Polytrichum alpinum*, *Nephroma arcticum*, and *Cetraria islandica*.
(3) *Empetrum-Vaccinium uliginosum microphyllum-Hylocomium schreberi-Dicranum* soc. Table 10, no. 1. Or *Empetrum-Nephroma arcticum* soc. with *Phyllodoce*; see p. 100.
(4) Low scrub of *Salix glauca callicarpaea* with *Empetrum-Hylocomium schreberi* undervegetation and scattered *Calamagrostis canadensis langsdorfii*.

These examples show to how high a degree the West Greenland vegetation in the low arctic oceanic region resembles that of Scandinavia. The Scandinavian monographs of vegetation contain profiles (e. g. SAMUELSSON 1916, p. 22) which approach very nearly to that described above. Nos. I 4, II 2, and III 1—2 in the three profiles belong to the present vegetational type, no. III 1, however, approaching to the preceding type, to which at any rate II 1 belongs. Thus it is nearly always



Fig. 30. Rocky scenery near Kangâmiut. In the valley in the foreground there is a varied snow-patch vegetation, mainly *Salix herbacea* sociations with very few vascular plants. On the rocky slope in the background, which faces north, there are especially *Empetrum* heath and snow-patches. The high arctic *Saxifraga foliolosa* is found in a few places in these. T.W.B. phot. $^1/_9$ 1946.

the *Salix herbacea-Cassiope* type that borders on the heath. I 3 and III 3 absolutely belong to the *Phyllodoce-Lycopodium alpinum* type, while I 1 and II 4 belong to the *Juncus trifidus-Loiseleuria* complex. No. I 2 is a mixed heath type, which will be mentioned below.

1. Salix herbacea Sociations.

Table 13 shows a grouping of analyses in which *Salix herbacea* is absolutely dominant. There are nine examples from the oceanic regions and two from the continental area, where *Salix herbacea* is extremely rare and only occurs in alpine stations. These two examples originate from steep north-facing slopes at an altitude of 4—500 metres above sea level, the others from the lowlands.

At Ivigtut *Salix herbacea* snow-patches were of no great importance in the lowlands; places with a snow-cover of comparatively long duration were characterized by communities belonging to the *Deschampsia flexuosa-Alchemilla-Phyllodoce* complex. The two analyses nos. 1 and 2 in

Table 13 originate from two kinds of localities, which together with the occurrence in the profile transect III above show to what places the present vegetational type is referred in the lowlands in the subarctic area.

No. 1 originates from a lengthy shallow depression on Guldfjeld at a height of 150 m above sea level. The depression followed the slope of the mountain and from below in spring would look like a "vertical" streak of snow. At the bottom of the depression there was a pure moss snow-patch (cf. GJÆREVOLL's *Polytrichion norvegici*); this was followed by the *Salix herbacea* vegetation, and then by a *Betula gland. rotundifolia* heath rich in mosses. Along north-facing rocks in the depression there were patches of *Gymnomitrium corallioides* soc. or streaks with dominant *Cassiope hypnoides*. — Higher on the mountain the importance of the snow-patch vegetation increased. There it included, amongst other species, scattered *Lycopodium selago*, *Luzula confusa*, *Agrostis borealis*, and *Carex bigelowii*.

No. 2. The moss dominant: *Dicranum bonjeani*. The vegetation is situated along a north-exposed vertical rock in the lowlands. The place in spring will appear as a horizontal streak of snow.

At Godthaab, Kangâmiut, and Pâ the *Salix herbacea* snow-patch vegetation was one of the communities in the lowlands which covered the terrain, and there it was varied as regards the moss dominants, which alternated between *Dicranum fuscescens*, *D. glaciale*, *Drepanocladus uncinatus*, and *Anthelia-Gymnomitrium* (Table 13, nos. 3—9). Besides the combinations mentioned in the table two sociations were observed at Godthaab which mediate a direct transition to communities of the *Juncus trifidus-Loiseleuria* complex. One was found on sandy, easily penetrable soil. There *Salix herbacea* and *Juncus trifidus* were dominants of the same status. But the vegetation furthermore contained

Table 13.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11
Locality no.	17	17	15	15	14	14	14	14	14	4	8
Slope	25°	0°	25°	10°	5°	5°	0°	5°	15°	30°	40°
Exposure	ESE	—	NW	N	N	S	—	N	S	N	N
pH	—	—	—	—	5.2	—	4.4	5.2	4.7	—	—
Lt	—	—	—	—	0.7	—	0.5	0.2	0.6	—	—
EG Salix herbacea	5	5	5	5	5	5	5	4	5	2–3	4
— Cassiope hypnoides	+	..	..	..	..	2	..	..	..	..	..
— Deschampsia alpina	..	..	..	..	2	..	..	..	..	..	..
— Sibbaldia procumbens	..	+	..	..	..	..	..	..	..	..	..
Cl Lycopodium alpinum	..	1	..	..	..	..	..	..	2	..	..
— Agrostis borealis	..	1	..	1	..	..	..	..	..	..	..
— Alchemilla alpina	..	+	..	..	..	..	..	..	..	..	..
— Festuca vivipara	..	..	..	+	..	..	..	+	..	..	..

(To be continued)

Table 13 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11
Cl (sylv.) Deschampsia flexuosa	+	1	..	+	..	..	..	..	..	..	..
— Coptis trifolia	..	..	..	..	..	..	..	..	+	..	..
— Pirola minor	..	..	..	..	..	..	..	..	+	..	..
[1] Pirola grandiflora	..	..	..	..	..	..	..	..	..	..	1
[1] Hierochloë alpina	..	..	..	..	..	..	..	..	..	..	1
[1] Poa arctica	..	..	..	..	..	..	..	..	..	..	1
Carex bigelowii	4	2	..	..	..	..	..	..	..	..	..
Calamagr. canad. langsdorfii	..	1	..	..	..	..	..	..	1	..	..
Cerastium alpinum	..	..	..	..	..	..	..	..	+	..	..
Empetrum nigrum hermaphr.	..	..	+	1	..	..	..	..	+	..	..
Poa pratensis (coll.)	..	..	1	..	..	..	..	+	..	..	..
Polygonum viviparum	+	..	..	1	..	+	..	+	+	..	..
Salix glauca callicarpaea	..	..	+	..	..	..	..	..	..	..	..
Hb Anthelia juratzkana	..	..	..	..	..	..	..	4	..	1	..
Barbilophozia hatcheri	..	..	..	..	..	..	..	..	..	2	2
— lycopodioides	2	1	+	+	..	..	..	..	1		
Blepharostoma trichophyllum	..	..	..	..	..	..	..	..	..	+	..
Cephalozia pleniceps	..	..	..	..	..	..	..	..	..	+	..
(Hb) Gymnomitrium concinnatum	..	..	..	..	..	..	..	3	..	..	1
— corallioides	..	..	..	..	..	..	..	..	..	1	..
(Hb) Lophozia alpestris	..	..	..	..	..	2	2	1	1	+	..
— ventricosa	..	..	..	2	1	..	..	..	..	..	+
— sp.	..	..	+	..	..	..	..	..	..	..	..
Hb Pleuroclada albescens	..	..	..	+	+	2	1	1	1	..	..
Ptilidium ciliare	+	..	+	..	..	..	..	..	..	..	1
Sphenolobus minutus	..	..	..	..	..	..	..	..	..	+	1
Tritomeria quinquedentata	..	..	..	..	..	..	..	..	..	..	1
Aulacomnium turgidum	..	..	..	..	..	..	..	..	..	1	4
Brachythecium reflexum	1–2	..	..	..	..	..	..	..	..	..	..
Bryum sp.	..	..	..	..	..	..	..	..	3	..	..
Ceratodon purpureus	..	..	..	..	..	..	..	..		..	..
Calliergon sarmentosum	..	..	..	..	..	..	..	1	..	..	..
(Hb) Conostomum tetragonum	..	..	..	..	..	2	..	2	..	..	..
Dicranum bonjeani	..	5	..	..	..	..	..	..	..	..	..
— cf. fragilifolium	..	..	..	..	..	..	..	..	2	..	..
— fuscescens	1	..	1	5	4	+	..	..	2	4	..
?EG — glaciale	..	..	..	..	..	..	4	3	..	..	..
— scoparium	1	..	1	..	..	..	..	..	..	..	1
Ditrichum flexicaule	..	..	..	..	..	..	..	..	..	..	1
Drepanocladus uncinatus	2	+	4	..	..	3	1	1	..	2	2
Hylocomium pyrenaicum	2	..	..	..	..	..	..	..	..	..	..
— splendens	..	..	..	..	..	..	..	..	..	1	2
— squarrosum	2	..	..	..	..	..	..	..	..	..	..
Polytrichum alpinum	2	3	1	..	1	+	..	+	..	..	2
[1] — hyperboreum	..	..	..	..	..	..	+	..	..	3	..
Hb — norvegicum	..	..	..	3	..	..	..	+	..	..	..

[1] More or less continental species.

(To be continued)

Table 13 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11
Polytrichum strictum	..	..	..	..	..	..	..	..	2	..	..
Rhacomitrium heterostichum affine	..	2	..	..	..	..	..	..	..	..	..
Sphagnum compactum	..	..	..	..	..	..	1	..	..	..	..
[1] Timmia austriaca	..	..	..	..	..	..	..	..	..	1	1
— megapolitana	..	..	..	..	..	..	..	..	..	..	+
Webera cruda	..	..	..	..	..	..	..	..	..	..	1
— cf. cucculata	..	..	..	..	..	..	..	1	..	..	..
Cetraria delisei	..	..	..	..	+	..	1	..	1	..	..
Cladonia bellidiflora	..	+	+	..	1	..	..	+	..	..	..
— coccifera	..	..	+	+	+	..	..	+	+	..	..
(IIb) — ecmocyna	..	+	+	..	1	..	..	+	+	..	..
— mitis	..	..	+	1	1	+	..	..	+	..	..
— rangiferina	..	..	..	..	..	..	..	..	+	..	..
— uncialis	..	..	+	..	..	..	..	..	..	..	..
Crocynia neglecta	..	..	..	..	..	..	..	+	..	..	..
[1] Dactylina arctica	..	..	..	..	..	..	..	..	..	+	..
Lecidea caesioatra	..	..	..	..	..	..	..	+	..	..	..
Ochrolechia frigida	..	..	+	+	+	..	..	+	..	..	..
Peltigera aphthosa	..	..	..	..	..	..	..	..	..	..	1
— malacea	..	..	+	..	..	..	..	..	..	..	..
Pertusaria oculata	..	..	..	+	..	..	..	..	..	..	..
Psoroma hypnorum	..	..	1	..	..	1	..	..	..	..	..
Stereocaulon alpinum	..	..	+	..	..	..	..	..	+	..	..
Cortinarius collinatus pumila	..	..	..	..	..	..	..	+	..	..	..
Hebeloma mesophaeum	..	..	..	..	..	..	..	1	..	..	..
Laccaria laccata	..	..	+	..	..	..	..	+	..	..	..
Omphalia umbellifera	..	..	..	..	..	..	..	+	..	..	..

[1] More or less continental species.

some *Empetrum*, *Loiseleuria*, *Luzula spicata*, and *Polygonum viviparum*, and hardly any cryptogams, so it is, if anything, to be referred to the *Juncus-Loiseleuria* complex. The other was found on shallow soil over rock. Dominants were *Salix herbacea*, *Sphaerophorus globosus* and *Rhacomitrium hypnoides*. Otherwise there were only cryptogams, viz. *Polytrichum piliferum*, *P. hyperboreum*, *Cynodontium polycarpum*, *Cephaloziella papillosa*, *Gymnomitrium* sp., and the lichens *Alectoria jubata* and *pubescens*, *Cornicularia aculeata*, *Crocynia neglecta*, *Parmelia saxatilis*, *P. omphalodes*, *Psoroma hypnorum*, and *Ochrolechia frigida*.

The collembolan and oribatid fauna in the soil of vegetation no. 9 is mentioned in HAMMER 1952 (no. 9).

At Itivdlinguaq (Loc. 10) near the western edge of the continental area *Salix herbacea* was also seen in some places in the lowlands along

tall steep north-facing rocks. The vegetation was rich in mosses and might contain *Equisetum arvense*, in one place *Luzula* cf. *multiflora frigida* and in another some few specimens of *Saxifraga foliolosa*. This species and *S. tenuis* were also seen in the highlands on Store Malene near Godthaab in a *Salix herbacea-Carex bigelowii* soc. Such a vegetation gives a high arctic species like *S. foliolosa* its last chances in the south, and perhaps is a poor offshoot of a mixed type farther north in West Greenland, where high arctic and low arctic EG-species appear in a more equal mixture.

The two examples from the highlands of the continental area (nos. 10—11) are situated on the borders of the vegetational type and are not typical, if anything, a mixed type. *Salix herbacea* is the only representative of a slightly oceanic element, and in no. 11 the continental-arctic species already make their appearance and the moss flora is deviating by the occurrence of amongst others *Timmia austriaca*, *Ditrichum flexicaule*, and *Aulacomnium turgidum*.

Carex bigelowii, which so frequently appears as a dominant together with *Salix herbacea*, also often accompanied this species in the continental area, e. g. on level ground near north-facing rocks; see the profile transect mentioned on p. 180. In some places it might get the upper hand so that it became the most important phanerogam of the snow-patch vegetation. On Hassells Fjeld (Loc. 3) at a height of 400 m above sea level there was a *Vaccinium uliginosum* heath rich in mosses and tussocky as a consequence of snow cover and solifluction. In a depression with a flat bottom there were large spaces between the tussocks and there appeared a *Carex bigelowii* soc. with rather scattered *Salix herbacea*, a few small shoots of *Vaccinium*, some individuals of *Polygonum viviparum* and *Pirola grandiflora* and a dense moss cover, curiously enough particularly consisting of a moss like *Grimmia funalis*, but also with a snow-patch moss like *Polytrichum alpinum* besides scattered *Aulacomnium turgidum*, which is almost unavoidable in the continental area. Finally there were some *Stereocaulon alpinum* and a *Peltigera* species.

In a few places in the continental highlands *Salix herbacea* sociations rich in lichens were further observed on level ground near *Cassiope tetragona* heaths (see p. 170). The lichen dominant was always *Stereocaulon alpinum*; in some places, however, *Cetraria delisei* was nearly as important. *Cladonia lepidota* might also play a certain part. In several places the lichen carpet was cracked in polygons.

2. Cassiope hypnoides Sociations.

Sociations of this type in East Greenland are found towards the north at any rate to Scoresby Sund (see Hartz 1895, p. 270; Hartz & Kruuse 1911, p. 407 (*Anthelia* soc. with *Cassiope hypnoides*, etc.)). They were observed in several places farther south (B. 1933b, p. 81). In the

north *Cassiope hypnoides* may enter as a subordinate element of the *C. tetragona* heaths and thus may sometimes contribute to the formation of mixed types.

Cassiope hypnoides heaths were seen as small patches at Kangâmiut and Pâ. They do not play any part in the lowlands in Southwest Greenland south of the Godthaab region. *Salix herbacea* sociations rich in *Cassiope hypnoides*, however, are frequently found in the highlands near Godthaab (cf. TRAPNELL's "Salix Moss mats" with *Cassiope*). I saw such *Salix-Cassiope* sociations on Store Malene at an altitude of about 300 m above sea level, and furthermore good examples of *Cassiope hypnoides-Carex bigelowii-Polytrichum norvegicum* sociations. In various patches of such sociations there were scattered *Lycopodium selago*, *Polygonum viviparum*, *Salix herbacea*, and repent forms of *S. glauca callicarpaea*. The moss stratum might contain large amounts of *Drepanocladus uncinatus*, *Dicranum fuscescens*, *Polytrichum juniperum*, and *Conostonum tetragonum*, besides some *Cladonia lepidota* and *mitis*. A vegetation from East Greenland related to this sociation has been described in B. 1933b no. 62.

3. Carex bigelowii-Salix herbacea Sociations with Admixture of Species from the Deschampsia alpina-Carex rufina Type.

This community is described last because if forms the transition to the following vegetational type. It is found on more or less flat terrain at the bottom of valleys, where the snow gathers. The vegetation is very tussocky, nearly as people imagine a tundra. As regards Southeast Greenland a corresponding vegetation has been described in B. 1933b, p. 101 and Plate 5, fig. 1. There are *Carex bigelowii-Salix herbacea* sociations rich in mosses which may contain some wet-soil plants, particularly species from the *Deschampsia alpina-Carex rufina* type. These, however, especially occur between the tussocks, so we actually have a patchwork of communities from the two types. NORDHAGEN (1943, pp. 250—255) mentions a corresponding tussocky snow-patch vegetation under the name of *Carex bigelowii-lachenalii* association. The hygrophilous element of this vegetation agrees very well with the species which especially grow between the tussocks in Greenland. The vegetation also resembles the "Torfhügelmoore" of the Alps; cf. GAMS 1941a.

At Pâ the tall sinuous tussocks seem primarily to have been formed by solifluction, but secondarily by melt water when in May it gathers between the tussocks and flows away. As many as five communities could be distinguished on the tussocks: on the tops, a very low mossy scrub of *Salix glauca callicarpaea*, next, a narrow zone with an *Empetrum* heath rich in mosses, then the same with *Phyllodoce* or *Salix arctophila-Carex bigelowii* soc. with *Pedicularis lapponica*, below that at the bottom

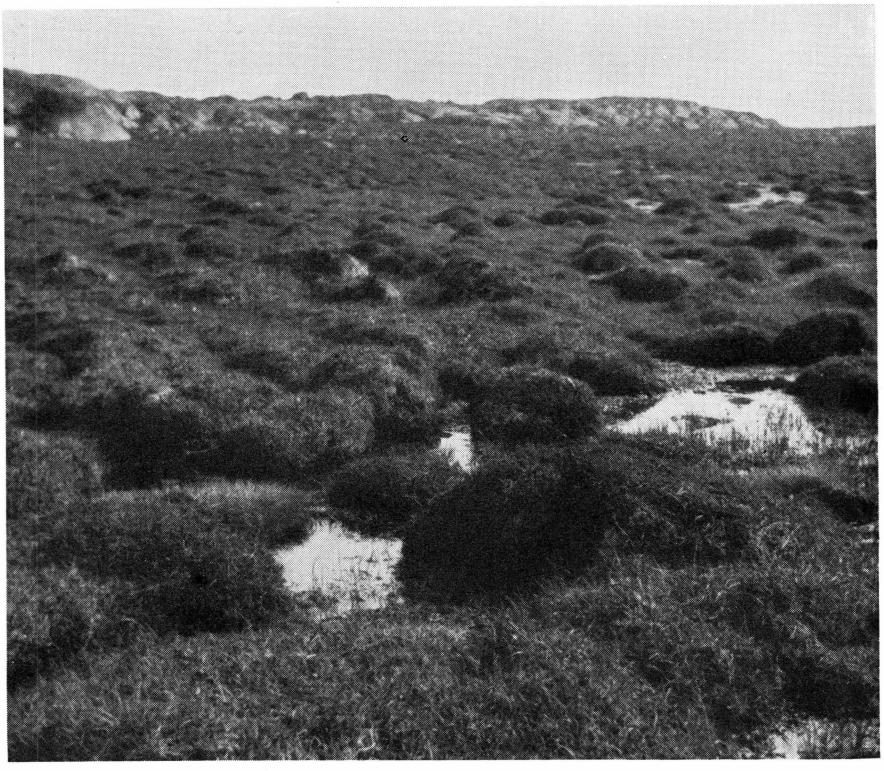


Fig. 31. Tussocky snow-patch vegetation in valley near Godthaab after heavy rain during the preceding days, which has produced the puddles between the tussocks. These are especially overgrown with *Carex bigelowii*, *Salix herbacea* and mosses. T.W.B. phot. $^{6}/_{9}$ 1946.

the snow-patch communities, viz. *Salix herbacea-Carex bigelowii* soc., or *S. herbacea-Cassiope hypnoides-Gymnomitrium* soc. with much *C. bigelowii*. Between the tussocks there was solifluction clay with *Deschampsia alpina* and *Juncus biglumis*.

Near Godthaab there was a similar tussock vegetation on slightly sloping ground in the valleys. On the tussocks there was wet heath, often of a boggy character (*Sphagnum*), dominated by *Empetrum*, *Vaccinium uliginosum*, *Salix arctophila*, in spots with some *Phyllodoce*. On the upper part of the sides of the tussocks or on low tussocks there was a *Salix herbacea-Carex bigelowii-Gymnomitrium concinnatum-corallioides* soc., with *Cassiope hypnoides* or *Carex rariflora* or scattered *Saxifraga stellaris* (fig. 31). The combination *S. herbacea-Sphagnum*, with *Polygonum viviparum* and *Salix arctophila* as subdominants, was also observed. In some places *Scirpus caespitosus austriacus* and *Tofieldia pusilla* were frequent on the lower part of the slopes of the tussocks. *Scirpus* and *Carex rariflora* were also found on wet soil between the tussocks.

Carex bigelowii reaches its highest frequency in this type of snow-bed vegetation. It is undoubtedly one of the most important species in the low arctic-oceanic vegetational region. Considered as a species it is, however, very problematic. It is circumpolar, but the typical plant is, if anything, North Atlantic. As an adequate account of the species is not available so far, I have not dared to list the species as a low arctic oceanic Cl-species, but shall content myself with adducing a few facts which seem to indicate that such a labelling will prove justifiable: (1) typical *C. bigelowii* in East America has a distribution corresponding to that of *Salix herbacea* (see RAYMOND 1951, map on p. 6), (2) the typical plant is to a great extent in the continental area at 67° lat. N. in West Greenland supplanted by ssp. *hyperborea*; see B. 1952a, pp. 50—51, (3) in Siberia it is replaced by a subspecies which TOLMATCHEW calls *C. rigida inferalpina* (Læst.) Gorodk., and which resembles ssp. *hyperborea*.

On northern slopes there is not rarely a *talus slide vegetation* which by succession presumably will be able to develop into snow-patch vegetation. I have in Southwest Greenland seen approaches to a sociation of *Oxyria* on north-facing screes. At Ivigtut and Godthaab there was often quite scattered vegetation between gravel and blocks in the highlands and there the following snow-patch plants were observed: *Saxifraga rivularis*, *Ranunculus pygmaeus*, *Cardamine bellidiflora*, and *Cassiope hypnoides*, and furthermore *Saxifraga oppositifolia*, *S. cernua*, *S. caespitosa*, *Silene acaulis*, *Draba rupestris*, *Papaver radicatum*, and *Luzula confusa*. *Cassiope* and the *Draba* species are the only representatives of the oceanic element. It is the widely distributed arctic species which characterize the vegetation. It should probably, however, be ranged under the present complex; cf. the remark on p. 70 about the proposed *Polystichum-Asplenium* type in the preceding complex.

c. The Deschampsia alpina-Carex rufina Type.

(Sub- and low arctic oceanic marsh snow-patches and related wet-soil vegetation).

It is presumably justifiable to denote all snow-patch vegetation on humid, mostly mainly mineral soil as marsh snow-patch vegetation. At any rate "bog" is not a suitable term, as this word is used about soil which is very rich in humus (peat formation).

The EG-species of the type are *Deschampsia alpina*, which in America-Greenland has a low arctic-oceanic distribution (map fig. 114 in B. 1938), but which in Eurasia possesses more arctic races with different chromosome numbers, — and *Carex rufina* with a North Atlantic, low arctic distribution and no doubt a distributional wedge through Hudson Strait to Keewatin, from where it is mentioned by A. E. PORSILD.

Associated with these is *Carex lachenalii* (*C. bipartita*), which, however, goes so far north and enters into so many other communities that it can at most be an extremely weak EG-species. This species is absent in North

America between Keewatin and Great Bear Lake. Furthermore, it is rare in Northern Siberia and has often there been mistaken for *C. amblyorhyncha*. It should also be mentioned that in the inland at the head of Søndre Strømfjord it is exclusively alpine and extremely rare.

EG-species with eutrophic tendencies are further the North-Atlantic, montane European *Sedum villosum*, and *Koenigia islandica*, which, however, approaches the medium-arctic oceanic distributional types and has a number of stations along the Arctic Coast of Asia (details in HULTÉN 1941—50 no. 455).

Vegetation of this type has only been seen fragmentarily in Southwest Greenland and only in places where there were perennial snow drifts in the surrounding terrain, i. e. in the highlands near Godthaab and southwards and nearly at sea level at about 66° lat. N. at the mouth of the Strømfjord. Observations are restricted to notes on the occurrence of *Deschampsia alpina*, *Saxifraga stellaris*, *Carex lachenalii*, and *C. rufina* (× *bigelowii*) on moist clay beside snow drifts and beside a small lake on the top of Guldfjeld at Ivigtut, and occurrence at Pâ of *Deschampsia alpina* and *Juncus biglumis* on solifluction clay between tussocks (see p. 125). It may be added that at Kangâmiut on humid soil between blocks in a scree there was approach to a *Deschampsia alpina* soc. with *Poa alpina*, *Saxifraga rivularis*, *Oxyria*, and *Cerastium cerastioides*.

The vegetational type is found in the Southeast Greenland areas of Archean rock, e. g. at Angmagssalik in run-off gulches or small runnels in bogs (B. 1933b, no. 93 with much *Calamagrostis neglecta*, *Deschampsia alpina*, *Cerastium cerastioides*, and *Saxifraga stellaris*). Related vegetation has been described from oceanic parts of the Norwegian mountains (*Caricetum rufinae* in NORDHAGEN 1943, pp. 270—71, and GJÆREVOLL 1950, p. 404; *Deschampsietum alpinae* has been described from Finse by SAMUELSSON 1916 and from Krekja by NORDHAGEN, *loc. cit.* p. 292).

All these communities are more or less oligotrophic, while corresponding communities in Iceland and the Faroes bear the stamp of the richer soil and therefore form a special sociation group, differentiated especially by *Koenigia* and *Sedum villosum*. B. 1937 from Husareyn near Torshavn mentions a *Sedum villosum* soc. on moist gravel, with *Saxifraga stellaris*, *Thalictrum alpinum*, *Koenigia*, and *Juncus triglumis*, and others. Later SØRENSEN (1942, Table 1, nos. 1—2) has described a corresponding vegetation from the Icelandic highlands, which, however, also includes *Deschampsia alpina* and *Cerastium cerastioides*. It may seem peculiar to associate these open sociations on moist gravel or clay with snow-patches, particularly as vegetation of this kind undoubtedly can be bare of snow in winter. The floristic agreement cannot, however, be disregarded, and it teaches us that the snow cover is not decisive of quite a number of the species of the snow-patches.

The Icelandic lowland communities described by STEINDORSSON (1936, p. 453) and SØRENSEN (1942) under the term of *Koenigia* flag, because of a large boreal-temperate element of especially *Sagina nodosa*, *Cerastium caespitosum*, *Agrostis stolonifera*, *Montia*, and others, besides several species from the arctic-continental marsh-fen complex (*Carex bicolor*, *C. microglochin*)

is best apprehended as a mixed type (the *Sedum villosum-Sagina nodosa* type) connected with the complex. As mentioned above, this type may be present in South Greenland and sends an offshoot, curiously poor in species, towards the north in the above-mentioned *Montia-Koenigia* sociations on the shore (p. 109).

c_1. The Ranunculus glacialis-Poa alpina vivipara Subtype.

(Marsh snow-patches and related wet-soil vegetation characterized by medium-arctic, oceanic species).

This subtype bears a relation to the type mentioned above similar to that which the *Erigeron-Draba crassifolia* subtype bears to the *Cerastium-Veronica* type. It also forms a connecting-link with the high arctic *Deschampsia brevifolia-Cerastium regelii* type within the *Saxifraga foliolosa-Ranunculus sulphureus* complex.

The two EG-species, *Ranunculus glacialis* and *Poa alpina vivipara*, have an oceanic, North Atlantic distribution, but are absent in the southernmost parts of the low arctic area or the lowest parts of the mountains. In return they penetrate a good distance into the coastal regions in the high arctic area (cf. B. 1938, fig. 43 and p. 216).

This subtype is restricted to East Greenland, but out of Greenland is found on the Faroes and in Iceland, Spitzbergen, and Scandinavia (see e. g. GJÆREVOLL's *Phippsietum* (1950, Table 15)). From Knud Rasmussens Land there are descriptions in B. 1933b, nos. 55, 74—75, 85, 87—88, and p. 73. It is a question of open sociations on solifluction soil and on clay in front of melting snow drifts or moist clay, which when dried-up cracks into polygons. Important species are *Ranunculus glacialis*, *Carex lachenalii*, *Phippsia algida*, *Cerastium cerastioides*, *Sagina intermedia*, *Minuartia biflora*, *Poa alpina vivipara*, *Saxifraga cernua. Koenigia*, *Equisetum arvense rivulare*, *Juncus biglumis*, and *Ranunculus hyperboreus* may also appear there. The subtype is found even as far north as 73°30′ lat. N. (HARTZ 1895, p. 118), although mixed with species from the high arctic complex (*Deschampsia brevifolia*, *Saxifraga foliolosa*, *Alopecurus alpinus*).

From the mountain tops of the Faroes B. 1937, p. 165, describes sociations on solifluction soil dominated by *Ranunculus glacialis-Koenigia* and including *Armeria maritima*, *Saxifraga hypnoides*, *Desch. alpina*, and *Poa alp. vivipara.*

IV. Extraregional Types Occurring in the Arctic-Subarctic Oceanic Vegetational Region.

The majority of the communities found on soil not particularly rich in salts can be associated with the regional types mentioned above. But as soon as we come across communities on soil by the sea rich in salts, or purely hydrophytic communities, it appears that widely distributed species are predominant. These species are often circumpolar and apparently independent of the degree of continentality. In many cases they also have a wide north-southerly range, and in extreme cases they cannot even be termed arctic-subarctic, but temperate-arctic. In spite

of the wide distribution these species are ecologically so much specialized that they may be considered EG-species for extraregional vegetational types.

a. The Puccinellia phryganodes-Stellaria humifusa Type.

(Arctic-subarctic salt marsh vegetation).

On the Expedition there was little possibility of studying this type as we actually saw only fragmentarily developed spots of vegetation in the form of pure *Puccinellia phryganodes* patches or *Puccinellia-Stellaria humifusa* soc., e. g. on the skerries near Godthaab. In Loc. 9 in the inland the same species were found, but also *Potentilla egedii* and *Carex glareosa* besides small poorly developed carpets of *Carex ursina.*

The type corresponds to the vegetation treated by KALELA 1939 as "*Puccinellia phryganodes*-wiese" and by HADAČ (1946) as *Puccinellietalia phryganodes*, and it seems that it may be divided into two sociation groups, a northern, arctic-continental one, differentiated especially by *Carex ursina* (which is absent in Iceland, the oceanic parts of Greenland and Labrador; see map 3 in RAYMOND 1951; and arctic Siberia west of Novaya Zemlya) and occurrence of *Carex aquatilis stans*, *Dupontia fisheri*, and *Phippsia algida* (cf. HADAČ, *loc. cit.*, and SEIDENFADEN & SØRENSEN 1937, p. 134),—and a southern group especially characterized by *Potentilla egedii.* Descriptions of Greenland saltmarshes are found e. g. in HARTZ & KRUUSE (1911, p. 360—61, Dunholm near Scoresby Sund: *Puccinellia phryganodes*, *Phippsia*, *Carex glareosa*, *C. subspathacea*, *C. ursina*, *Cochlearia groenlandica*, *Stellaria humifusa*), in KRUUSE (1912), B. 1933b (Angmagssalik), and DEVOLD & SCHOLANDER (1933, p. 156, Dronning Marias Dal).

b. The Honckenya diffusa-Mertensia maritima Type.

(Sub-low arctic coastal beach vegetation).

The most important EG-species of this type are no doubt *Honckenya peploides diffusa* and *Mertensia maritima.* Vegetation belonging to the type has especially been described from Disko by M. P. PORSILD (1902, pp. 135—140), from the Canadian Eastern Arctic by POLUNIN (1948, pp. 95 and 222), and from the Canadian Arctic coast by JOHANSEN (1924). The wide distribution of the two EG-species is shown in COOPER (1936), while LÖVE (1950) has a map of the distribution of *Elymus mollis.* This species is probably the most important one forming sociations in the vegetational type, but it is not a good EG-species, as it may enter quite different vegetational types in the inland or contribute to forming a kind of mixed type there (see p. 203).

We saw examples of the *Honckenya-Mertensia* type on the skerries near Godthaab (*Elymus* and *Festuca rubra* sociations), and in Loc. 3 in the inland there were approaches to such a vegetation (p. 204 and Table 23, nos. 1—10).

TRAPNELL (1933, Plate 21) has a beautiful picture of an *Elymus* soc. from the Godthaabsfjord. From South Greenland I have seen a photograph taken by Professor C. A. JØRGENSEN in the Lichtenau Fjord (Agdluitsoq), where the oceanic-subarctic *Ligusticum scoticum* enters abundantly into an *Elymus-Festuca rubra* soc. on the rocks closest to the fjord. ROSENVINGE mentions that this species and *Lathyrus maritimus* are particularly important in the shore vegetation in the fjords of South Greenland; therefore they can no doubt be used for a delimitation of a special southern sociation group with an oceanic trend.

c. The Myriophyllum alterniflorum-Subularia Type.

(Subarctic-temperate meso-oligotrophic vegetation of hydrophytes, as a rule without floating leaves; isoetids frequently present).

Preliminarily I suggest this type as an element of an extraregional complex of freshwater vegetation (cf. p. 291). The type may perhaps be subdivided according as isoetids or elodeids are predominant. A subarctic sociation group can be differentiated from temperate sociations by such species as *Sparganium hyperboreum* and *S. angustifolium*.

Apart from the two species after which the type is named the EG-species of the type must be *Isoëtes echinospora* and *lacustris*, perhaps *Callitriche hamulata* and *Sparganium angustifolium* besides, south of Greenland, e. g. such species as *Lobelia dortmanna* and *Eriocaulon septangulare*.

Fragments of this vegetational type were seen in small pools at Ivigtut and Godthaab in the form of scattered individuals of *Isoëtes echinospora* and *Hippuris*. An ampler flora is mentioned by HARTZ (1894, p. 16) from Neria and Sermiligârssuk. In lakes there he found *Isoëtes echinospora*, *Hippuris*, *Sparganium hyperboreum* and *Callitriche verna* or *Myriophyllum alterniflorum* and *Potamogeton gramineus*. ROSENVINGE (1896) states that just the lakes in the coastal regions in South Greenland have a specially frequent occurrence of *Myriophyllum alterniflorum*, *Isoëtes*, *Sparganium hyperboreum*, and *Callitriche hamulata*. From Angmagssalik there are descriptions of a *Subularia* soc. and a *Sparganium angustifolium* soc. (KRUUSE 1912, B. 1933b, Table 33).

Thus information is scarce about this type in Greenland. No analyses of pH or ion contents in the waters are available. We are further quite ignorant of the plankton vegetation of the lakes and there is only casual

information of the sessile algal vegetation. A vegetation of blue-green algae from a shallow pool at Ivigtut is described in B. 1950 (Medd. om Grønl. 147, no. 5, p. 4) and has been supplemented in GRØNBLAD 1952, pp. 14—15 (desmids) and FOGED 1953 (diatoms). The dominant was *Tolypothrix saviczii* occurring especially together with some species of *Stigonemaceae*. The flora of diatoms includes several oligotrophic species, *Surirella delicatissima*, *Cyclotella*, and *Melosira distans*, which like several of the desmids and the blue-green algae perhaps can be used as Hb-species for the vegetational type.

THE ARCTIC-SUBARCTIC CONTINENTAL VEGETATIONAL REGION

This region forms a contrast to the preceding one. It ranges from northernmost Greenland, which has a high arctic climate (annual precipitation below 250 mm; annual mean range of temperature about 25—40°; mean temperature of warmest month below 6° C.), to regions with a climate corresponding to regimes C and D in fig. 3, and from there sends outposts or little typical representatives into regime B, which is a typical transitional climate and no doubt is also found a little up on the mountains in the interior of South Greenland. In regime A there is in the north and at alpine stations a few outposts of hygrophilous high arctic communities.

Just as it was not considered very expedient to distinguish between a sub- and a low arctic oceanic region, I have refrained from distinguishing between different continental regions. There are certain continental regional types which have mainly high arctic EG-species, others with sub-low arctic species. A distinction is, however, made difficult by the not few species which are of nearly equal frequency from north to south, if only the climate is continental (e. g. *Melandrium triflorum*). I have therefore preliminarily contented myself with distinguishing between two sections, one without high arctic species, but with a few subarctic ones (B, p. 184), the other with high arctic species and no subarctic ones (A, p. 137).

In B. 1952b an account was given of the vertical zonation which in the inland appears by a great floristic difference between the lowlands and the highlands. Of course the communities which are characteristic of the highlands will have some EG- or Cl-species which as regards distribution go far north in the high arctic area, while the lowland communities may contain low and even subarctic EG- and Cl-species. The highlands harbour sociations (e. g. of *Salix herbacea*; see Table 13, nos. 10—11) with a slight oceanic element, and further a widely distributed arctic element (*Ranunculus pygmaeus*, *Saxifraga rivularis*), which is missing in the lowlands. Therefore it seems most natural to begin the description with such complexes as are particularly found in the high-

lands, as these have most points of similarity with the complexes mentioned in the oceanic region.

Being a continental Cl-species requires association with climatic regimes C—D, selective or rare occurrence in B—E and absence or extremely rare occurrence in A. Furthermore a similar behaviour is required in East Greenland (i. e. occurrence in the inland at Angmagssalik and Kangerdlugssuaq, but main distribution north of about 69° lat. N.), rare occurrence or absence in Iceland, the Faroes, the most oceanic parts of Western Norway, South Labrador, and South Alaska. Selective occurrence (i. e. conditioned by lime) in West Newfoundland ought to be permitted. Finally, of course, frequent occurrence in continental areas is required, especially the large arctic area poor in precipitation north of the 250 mm isohyet. Figs. 32—33 show the distribution of some arctic continental species. Among these *Dryas integrifolia* must be supposed to be rather tolerant to a certain degree of oceanity. It was, however, a rare plant where I saw it at Angmagssalik, Godthaab, or Ivigtut, bound to places without competition on mineral, moderately acid soil. *Lesquerella arctica* can be used as a type example of an arctic continental species. In the case of Greenland and East America something similar holds good of *Pedicularis lanata.* Here, however, we find the interesting fact which has previously been shown for *Anemone richardsonii* and other species (B. 1951 c): the species is indifferent to the degree of continentality of the climate in West America-East Asia. Supported by HULTÉN's theory of radiation from Beringia (1937) I explain the contrast by assuming that the species during its migration across the continent towards the east to Greenland has lost all oceanically inclined biotypes. Species of this kind constitute a contrast to such Eurasian species which by migration over the North Atlantic arch of islands (the Faroes-Iceland-Greenland) towards the west seem to have become oceanic (e. g. *Nardus stricta*; cf. B. 1938). Among the continental Cl-species in Greenland *Pedicularis lanata* may be characterized as locally continental; se further p. 149.

With reference to figs. 4—5 and Table 1 it may be summarized that the climate in the continental area (regime C) is extremely dry, characterized by continual winds from the inland ice (cf. fig. 34). The winter temperature (—16.7 as mean of the coldest month) is surprisingly high, a fact which deserves comment. A combination of a desert-like low precipitation with a sub-low arctic temperature climate in which the winter temperature is not below —17, is not, to my knowledge, found anywhere else. Stations in the American Eastern Arctic between 60° and 76° lat. N. have all regardless of situation near coasts a January mean temperature of —19 or below and a wide annual range of temperature. They have also all of them higher values of precipitation. We

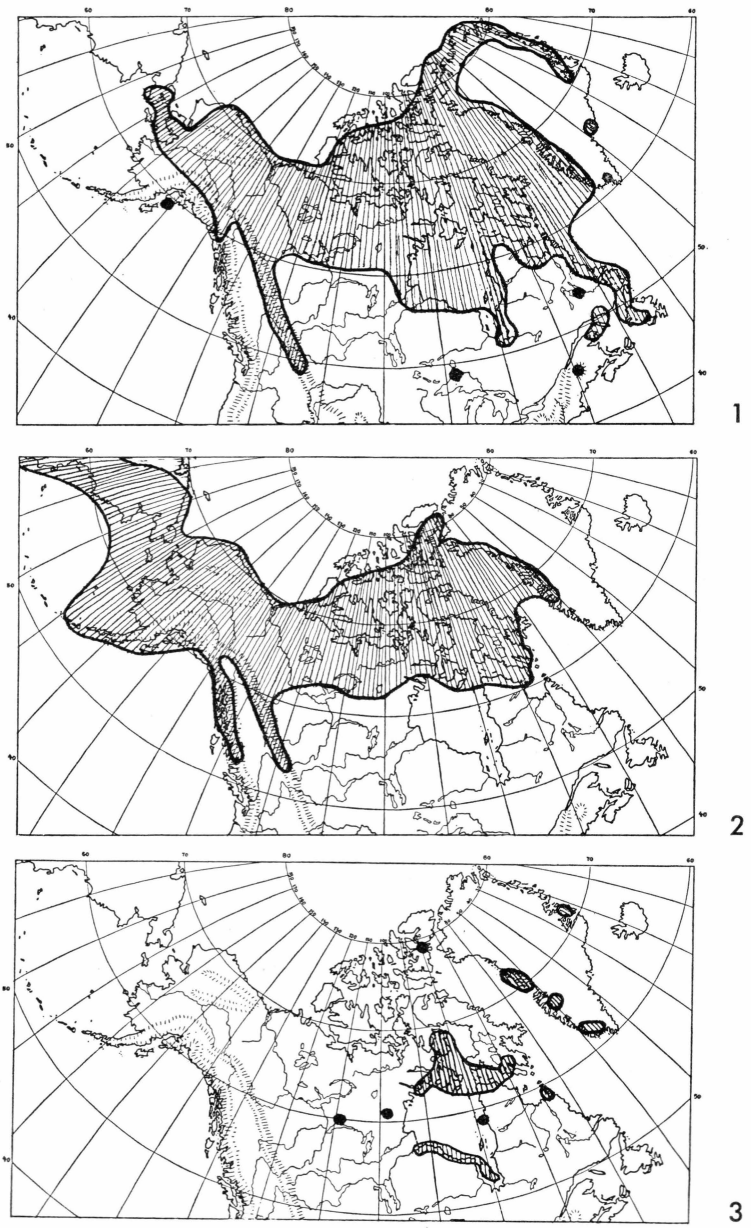


Fig. 32. Maps showing American-Greenland ranges of a number of arctic, more or less continental species. — 1. *Dryas integrifolia*, 2. *Pedicularis lanata*, 3. *Arabis arenicola*. The maps drawn with support from maps in FERNALD 1926, RAUP 1930, 1947, A. E. PORSILD 1947, 1950, HULTÉN 1941—50, and B. 1938 and 1952a.

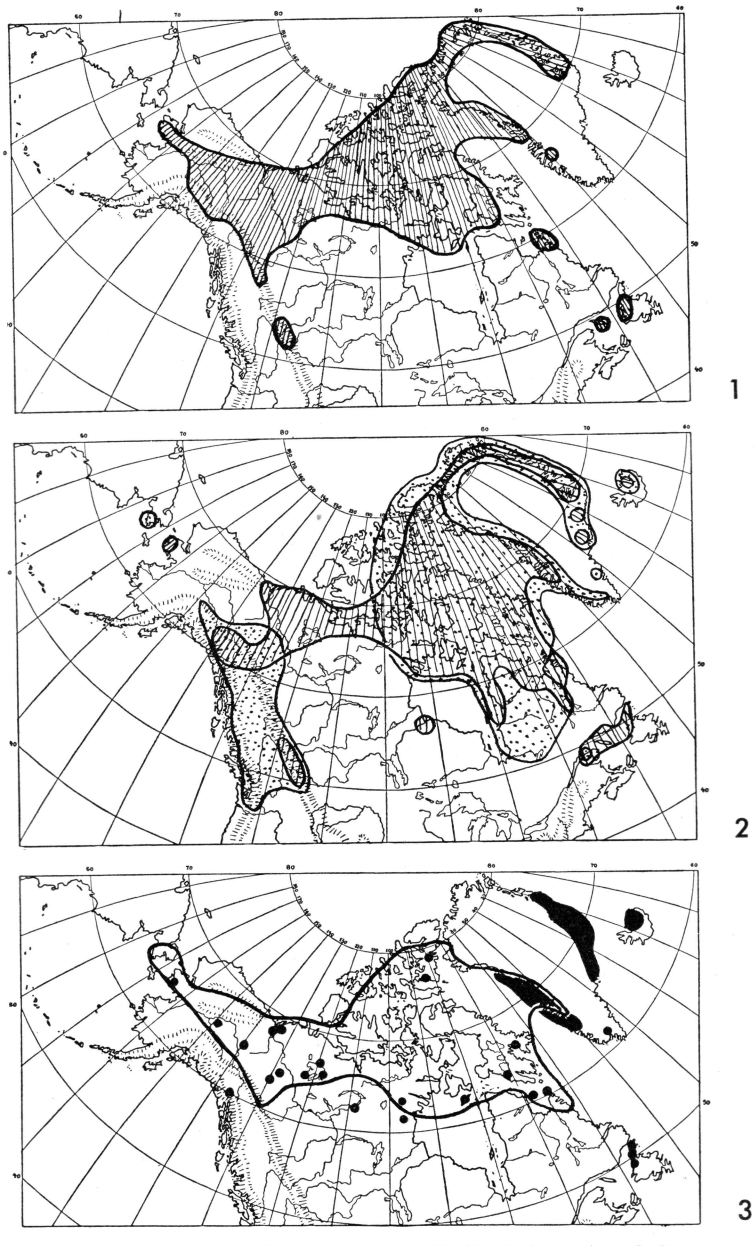


Fig. 33. 1. *Lesquerella arctica*, 2. *Carex nardina* coll. (dotted area) and *Carex rupestris* (north-south hatching), 3. *Carex glacialis* (black dots and black areas), *Antennaria ekmaniana* (area inside black line). The maps drawn with support from maps in Fernald 1926, Raup 1930, 1947, A. E. Porsild 1947, 1950, Hultén 1941—50, and B. 1938 and 1952a.

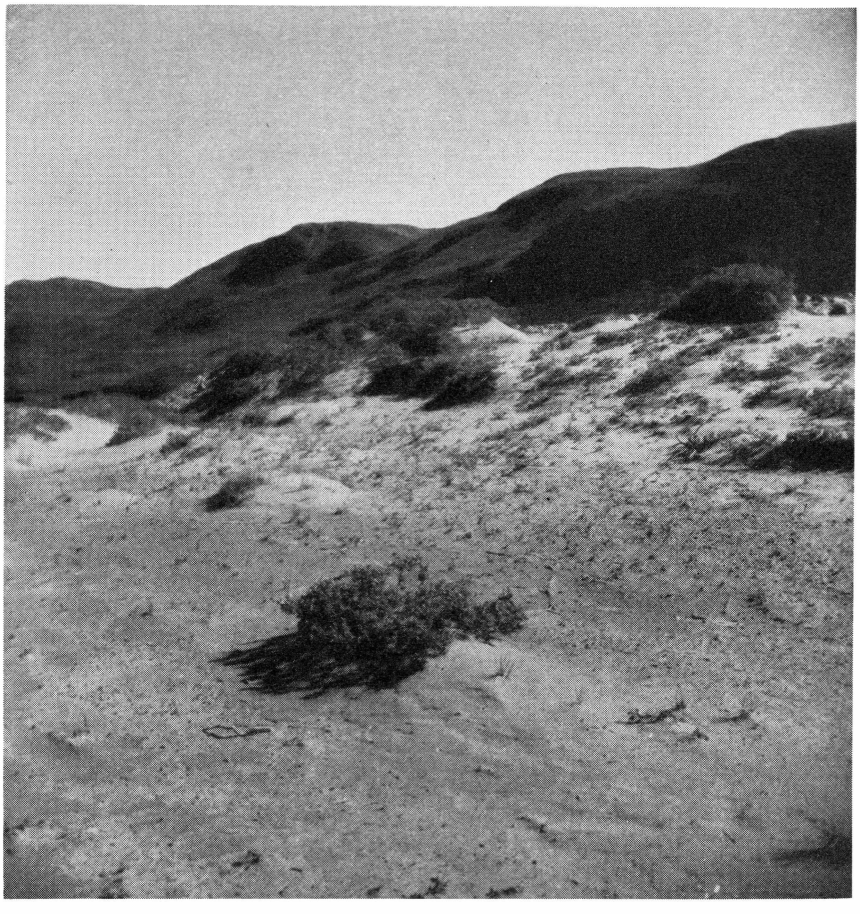


Fig. 34. Rather long dunes with an east-westerly direction in Sandflugtdalen. The photograph especially shows sheltered sides with recently settled drift-sand. Behind the dip between the large dune and the low dune on the extreme left is seen a little of a stony-gravelly slope which faces east and is exposed to vigorous pressure of the wind. The dunes are covered by and in part formed in the shelter of shrubs of *Salix glauca callicarpaea*. Initial stages of the dune formation are seen in the foreground. T.W.B. phot. Aug. 1946.

shall go north as far as areas about 80° lat. N. before the amount of precipitation falls to similar low values as at the head of Søndre Strømfjord, but then the summer is short and cold there, and the annual mean range of temperature is between 40° and 50° C. (see RAE 1951, Arctic *4*, p. 26). In the interior of Northern Canada, too, where the precipitation in certain places may approach to low values as at the head of Søndre Strømfjord, there is a much wider annual range of temperature and much colder winters. The special continental climatic type at the head of Søndre Strømfjord must be due to the fact that the prevalent easterly

winds during the winter half-year (fig. 5) are often relatively warm foehn winds, which lose height from the elevated plateau of the inland ice towards the sea. The climate thus is conditioned by the presence of an inland ice and must probably have existed in many places during the Ice Age, when inland ice bordered on large masses of land. Now, such a climate is just as unique as the inland ice of Greenland. The occurrence of a number of plants in the ice-margin area of Greenland must be considered in relation to this fact (cf. remarks on the distribution of *Carex supina* ssp. *spaniocarpa* on pp. 186 and 189).

A. Complexes with High Arctic and Widely Ranging Arctic Continental Species.

I. The Carex nardina-Lesquerella-Saxifraga tricuspidata Complex.

Arctic continental, xerophytic grassland, dwarf shrub heath, fell field, rock- and talus-slide vegetation. Soil moderately acid-basic, snow cover inconstant or disappearing early, strong or moderate exposure to wind, in the case of rock- and slide-vegetation to desiccation and relatively high temperatures during summer.

This complex is rather comprehensive and covers very large areas, particularly in North Greenland. It includes both fell fields, dry heaths, and psammophilous communities. Characteristic rock- and talus-slide vegetation has been referred to a special type (the *Saxifraga tricuspidata-Dryopteris fragrans* type), a parallel to the previously mentioned low arctic-oceanic *Veronica fruticans-Sedum annuum* type.

The most typical representatives of the present complex are found in North Greenland; it is what Seidenfaden & Sørensen (1937) have termed dry barren ground or arctic cold desert. In America there are representatives of the complex in what A. E. Porsild 1951 calls rock desert communities, which are especially dominated by such species as *Dryas integrifolia*, *Oxytropis arctobia*, *Carex rupestris*, and lichens. Even as far south as Colorado alpine fell fields of a related type are found, with species like *Festuca brachyphylla*, *Carex rupestris*, *Calamagrostis purpurascens*, and *Saxifraga flagellaris* (Cox 1933).

It is obvious that in North Greenland and adjoining parts of the American archipelago there is a purely high arctic barren vegetation which might suitably be apprehended as a special type and termed the *Poa abbreviata-Draba subcapitata* type; it goes south to Disko-Nûgssuaq and in East Greenland to the nunataks between Scoresby Sund and Kangerdlugssuaq (H. Wager, unpublished material). A slightly more

southerly, more pronounced continental, North American rock desert might perhaps be described as an *Oxytropis arctobia* type.

The southernmost offshoots of the complex are found in the inland in climatic regime C, especially on the mountain plateaux and in the large river valleys on open sand or clay. They are described below as three vegetational types.

EG-species (continental, high arctic-widely distributed arctic xerophytes): *Poa abbreviata*, *Draba subcapitata*, *Braya purpurascens*, *Lesquerella arctica*, *Draba cinerea*, *Saxifraga tricuspidata*, *Potentilla pulchella*, *Antennaria ekmaniana*. — *Carex nardina*, *C. glacialis*, *Hierochloë alpina*. — Greenland races or biotypes of *Pedicularis lanata*.

Cl-species: Especially continental species from the *Calamagrostis purpurascens-Artemisia borealis-Arctostaphylos*-complex; furthermore *Rhododendron lapponicum*, *Poa arctica*, *Potentilla nivea*, *Campanula uniflora*, *Tofieldia coccinea*, *Armeria scabra sibirica*.

Continental arctic species which frequently occur as dominants, but which are not exclusive to the complex: *Carex rupestris*, *Dryas integrifolia*.

Hb-species: Particularly *Papaver radicatum*, *Festuca brachyphylla*, and in the south *Diapensia lapponica*.

a. The Carex nardina-Hierochloë alpina Type.

(Xerophytic continental fell fields and grasslands with rare occurrence of high arctic species).

This type is found towards the south to the interior of Godthaabsfjord, from where TRAPNELL (1933, pp. 308 and 331) mentions it as "Dryas Mat Barren" and says that it occurs in alpine areas. Important species are *Carex nardina*, *Alectoria ochroleuca*, and *Cetraria nivalis*. It seems, however, that the type merges into a mixed type with contents of *Juncus trifidus* and *Salix uva ursi* (cf. further remarks on *Salix uva ursi* sociations with *Carex nardina* on p. 44). Near Søndre Strømfjord *Campanula uniflora* and *Tofieldia coccinea* occur in the vegetation on the mountain plateaux and differentiate it from the lowland communities. These species, however, are more closely connected with other types.

From North Scandinavia NORDHAGEN (1935, pp. 35—42) mentions a *Carex nardina-Ochrolegia-Cesia* sociation which clearly is related to the Greenland *C. nardina-Hierochloë* type, i. a. by including *Campanula uniflora*, but which otherwise is differentiated by the occurrence of *Oxytropis lapponica* and others. Examples of corresponding North American vegetation are found in POLUNIN 1948, e. g. p. 166.

EG-species of the vegetational type:

Carex nardina. Cl: Arctically widely distributed, slightly continental. Ar: The main distribution comprises the large woodless area northeast of the

American timber line; cf. fig. 33, (2). According to A. E. PORSILD there is a gap at Great Bear Lake, where the timber line actually approaches closest to the Arctic Ocean. Most material from West America may belong to var. *hepburnii*; cf. map in RAUP 1947. — Ecology: Pronouncedly xerophytic and resistent to black frost. SØRENSEN (1933) and NORDHAGEN (1936) consider the species to be calciphilous, which, however, should no doubt be modified into neutro-basophilous.

Potentilla pulchella. Cl: High arctic and therefore rare in the south in the warmer inland. Completely avoids the oceanically influenced parts of Greenland besides Iceland and Labrador. Ar: Greatly approaches to the preceding species, as the typical species goes west to high latitudes west of Hudson Bay, but farther west is supplanted by var. *gracilicaulis* (A. E. PORSILD 1943). — Ecology: Dry open clay, sand, and gravel, mostly snow-bare in winter; hardly on acid soil anywhere.

Lesquerella arctica. Cl: High arctic continental. Ar: See fig. 33 (1) and for Asiatic occurrence TOLMATCHEW 1932. In the south both in east and west in America the spp. *purshii* (Wats.) Porsild (A. E. PORSILD 1951b, p. 191). — Ecology: Pronouncedly xerophytic, calciphilous.

Carex glacialis. Cl: Arctically widely distributed, somewhat continental, not found in North Greenland. Ar: Circumpolar; cf. fig. 33 (3). — Ecology: Calciphilous xerophyte, resistent to black frost.

Hierochloë alpina. Cl: Arctically widely distributed, somewhat continental. — Ar: Circumpolar. The distributional type of the species has been made much clearer after SØRENSEN (1954) has pointed out that the South Greenland *Hierochloë* belongs to a particular species, *H. ortantha*, which has an oceanic distribution (see p. 30). The exclusively alpine occurrence of *H. alpina* at the head of Søndre Strømfjord is also very characteristic and indicates an arctic species which approaches closely to the high arctic ones. — Ecology: Acidophilous xerophyte, but not quite reliable as an EG-species, as it may occur on medium dry, in winter no doubt constantly snow-covered soil.

Carex rupestris and *Dryas integrifolia*, the distribution of which is seen in figs. 32—33 are widely distributed, slightly continental arctic species, which often occur as dominants in the present type. They are also, however, found in quite different communities and even on humid soil. *Dryas* is found on soil from moderately acid to extremely basic, and somewhat similar conditions are found in the case of *C. rupestris* (Table 14). The latter is considered a character species in grasslands on soils rich in lime in the Alps (G. & I. BRAUN-BLANQUET 1931, p. 38).

Among the Hb-species there is reason to note some lichens which are common to this type and the *Juncus trifidus-Loiseleuria* sociations, but which otherwise in the inland are very important as differential species towards the xerophilous lowland sociations; this especially applies to the *Sphaerophorus* species, *Alectoria ochroleuca* and *lanea.*

1. Carex nardina, Dryas-Carex nardina, or Dryas Sociations.

The combination of *Dryas* and *Carex nardina* is very important; it is found on exposed, stony-gravelly soil on plateaux or mountain tops, but also in the lowlands on the broad river plains, where the wind

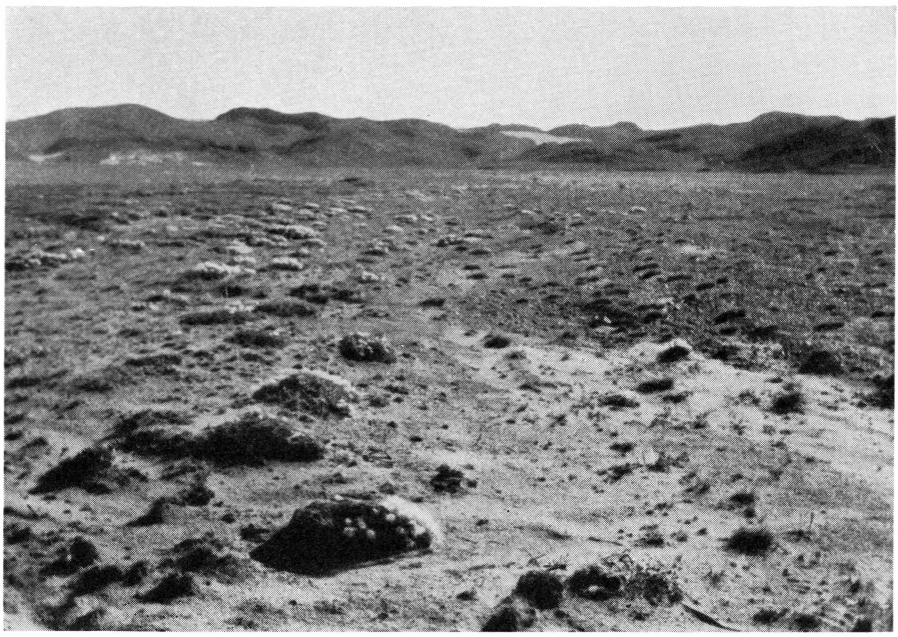


Fig. 35. Large river plain at the east end of Sandflugtdalen (Loc. 1). A small piece of a glacier from the inland ice is seen in the background. *Dryas integrifolian* with ripe fruits and numerous tussocks of *Carex nardina* are seen on the gravelly plain. T.W.B. phot. $^{26}/_{8}$ 1946.

whirls the sand away so that the gravel and the small stones are left (fig. 35). This special lowland type is nearly without cryptogams and constitutes a natural sociation group, the composition of which appears from the following examples:

(1) Sandflugtdalen, Loc. 1 (fig. 35). Dominants are scattered cushions or tufts of *Dryas integrifolia*, *Carex nardina*, and *Saxifraga oppositifolia*. Sporadic: *Calamagrostis purpurascens*, *Kobresia myosuroides*, *Silene acaulis*, *Chamaenerium latifolium*, a few specimens of *Polygonum viviparum*, *Salix glauca callicarpaea*, and *Helvella arctica*.

(2) Sandflugtdalen, Loc. 2. Open sand plain, especially with *Dryas* and *Silene acaulis*. *Dryas* forms low dunes and *Silene* vaulted tussocks. In both cases wind erosion takes place at the same time. Both species start as small cushions which soon become higher than their surroundings and exposed to erosion. They grow along the periphery and are capable of keeping up with the removal of sand and therefore grow obliquely downwards in all directions and come to enclose a sand cone or a hemisphere of sand (cf. a similar behaviour of *Lecidea* and *Stereocaulon* sp. in Danish dune areas). *Dryas* is also, however, capable of forming genuine dunes with settling of sand and growth through the sand.

(3) Sandflugtdalen in front of Ravneklippen, Loc. 7 (fig. 36). There was violent erosion there and at the same time depositing of a considerable dune up the steep rock, which has been formed by previous river erosion.



Fig. 36. Large cone of drift sand deposited in front of Ravneklippen (Loc. 7). Small dunes are formed below by *Salix glauca callicarpaea*. In the foreground there is a desert-like erosion area, where *Potentilla pulchella* so far has its southernmost known station in Greenland. T.W.B. phot. $^{9}/_{8}$ 1946.

Dominants: *Dryas*, *Carex nardina*, *Calamagrostis purpurascens*, *Silene acaulis*; scattered *Chamaenerium latifolium*, a few individuals of *Honckenya peploides diffusa* and *Potentilla pulchella*.

(4) Ørkendalen near Bredesand, Loc. 6. Large desert-like erosion areas with large stone blocks and gravelly expanses from which the sand has drifted away. Behind the stones small oblong dunes gather on the sheltered side (the west side). There *Dryas* and *Carex nardina* form colonies. These species are also the most important on the more exposed gravelly expanses, where there also were scattered *Chamaenerium latifolium*, *Calamagrostis purpurascens*, *Artemisia borealis*, *Silene acaulis*, *Arabis arenicola*, and *Rumex acetosella*.

(5) The west end of Ørkendalen. Small dune area south of the riverbed. *Dryas* formed low dunes and on the wind-exposed sandy and gravelly expanses between the east-west directed dune ramparts there was an

open vegetation consisting particularly of *Carex nardina* and with much *Silene acaulis*, *Rumex acetosella*, *Artemisia borealis*, *Dryas*, *Armeria scabra sibirica*, *Calamagrostis purpurascens*, and a few specimens of *Lesquerella arctica* (southernmost station in Greenland). *Elymus mollis* and *Arabis arenicola* were found there, too, but not in the most exposed places.

Arabis arenicola occurs as an interspersed species from the *Arabis arenicola-Taraxacum lacerum* subtype described on p. 164. *Rumex acetosella* and *Chamaenerium* are undoubtedly the best species to differentiate this sociation group from the following one, which is associated with the barren grounds of the highlands. For that matter, there is good reason to remind of the great similarity which can be ascertained between the sand-drift vegetation mentioned above and the vegetation described by KRUUSE from Klitdalen near Hurry Inlet (HARTZ & KRUUSE 1911, pp. 384—401). On the stony plains in this place there are *Dryas octopetala* (coll.), *Chamaenerium latifolium*, *Lesquerella arctica*, *Arabis arenicola*, *Armeria*, *Silene acaulis*, and *Carex nardina*. Besides by the fact that the *Dryas* species is different, the vegetation differs from that of West Greenland by having such species as *Braya purpurascens* and *Arenaria ciliata pseudofrigida*.

From the sociation group rich in lichens found on the mountain plateaux there are in Table 14 first four examples (nos. 1—4), which contain abundant *Carex nardina*. The analyses speak for themselves. On the basis of a comparison with the vegetation in Table 3 there may, however, be reason to call attention to the constancy for *Thamnolia* and *Poa glauca*, the sparser occurrence of liverworts and *Rhacomitrium lanuginosum* and the complete absence of *Empetrum*. The occurrence of the vegetation on the mountains appears from the profile transect on p. 170, no. (5). The material of fell fields rich in *Carex nardina* may otherwise be supplemented by the following notes:

(1) Nákajanga ridge, 600 m above sea level, Loc. 8. *Carex nardina* soc. rich in lichens; frequent: *Diapensia*, *Silene acaulis*, *Dryas*, *Armeria*, *Tofieldia coccinea*, or *Dryas*(-*Diapensia*) soc. with much *C. nardina*, *C. rupestris*, *Pedicularis lanata*, and *Campanula uniflora*.

(2) Nákajanga ridge, as above. Open vegetation on clay (solifluction soil) surrounded by heath. *Saxifraga oppositifolia* abundant together with *Silene*, *Dryas*, and *Carex nardina*.

(3) Peak east of Hassells Fjeld, 470 m above sea level, Loc. 3. Besides the examples in Table 14 nos. 2 and 9 there was in this place on the eastern slope of the peak a strongly wind-swept fell field dominated by *Dryas* and *Carex nardina* and more sporadic occurrence of *Saxifraga oppositifolia*, *Poa glauca*, and *Lesquerella arctica*.

Lesquerella arctica was especially abundant in vegetation of the same type as that in Table 14, no. 9, which is situated on a dyke, the soil of which is mentioned in detail in B. 1949b, p. 43, and which is characterized by high pH and phosphoric acid values. The latter was 34, while in vegetation of

Table 14.

Analysis no.	1	2	3	4	5	6	7	8	9
Locality no.	3	3	8	8	3	3	8	8	3
Altitude in m	450	470	650	500	500	470	600	700	400
Slope	0°	20°	0°	0°	10°	20°	0°	15°	0°
Exposure	—	NE	—	—	E	SE	—	SW	—
pH	6.4	—	7.0	6.3	5.9	6.1	—	5.9	7.4
Lt	0.3	—	0.6	0.3	0.4	0.3	—	0.4	0.7
EG Carex nardina	2	2	2	2	+	..	..	..	+
— — glacialis	..	..	..	..	+	..	..	..	..
— Hierochloë alpina	..	..	..	..	..	..	1	..	..
— Lesquerella arctica	..	..	..	..	..	..	..	..	+
— Pedicularis lanata	..	1–2	..	..	..	..	1	..	..
Cl Campanula uniflora	..	..	+	..	..	..	..	..	..
— Potentilla nivea	..	..	..	+	..	1	+	+	..
— Armeria scabra sibirica	..	..	..	..	..	..	+	..	..
— Carex rupestris	..	..	2	..	..	..	3	4	..
— Dryas integrifolia	3	3	2–3	2	3–4	3	2	..	+
— Rhododendron lapponicum	1	..	..	..	..	..	..	..	..
— Carex supina spaniocarpa	+	..	..	..	+	1	..	..	1
— [1] Kobresia myosuroides	..	..	..	..	..	..	1	2	..
— Calamagrostis purpurascens	..	..	..	..	..	+	..	..	1
— Artemisia borealis	+	..	..	..	..	+	..	..	+
Hb Papaver radicatum	..	..	+	..	..	..	..	..	..
— Draba nivalis	..	..	..	..	..	+	..	..	..
— Silene acaulis	1	1	+	..	..	..	1	..	..
— Saxifraga oppositifolia	..	1	..	..	..	..	..	..	..
— Festuca brachyphylla	..	..	+	1	..	..	+	..	..
Campanula rotundifolia (coll.)	..	..	..	..	..	..	..	+	..
Cerastium alpinum	..	..	..	+	..	..	..	..	..
Minuartia rubella	..	..	+	..	..	..	..	..	..
Poa glauca	+	..	+	1	..	1	..	1	+
Polygonum viviparum	..	..	+	+	..	..	+	1	..
Vaccinium ulig. microphyllum	1	..	..	..	2	..	..	..	..
Cephaloziella byssacea	..	..	..	..	+	..	..	..	..
Gymnomitrium corallioides	+	..	+	..	+	..	..	..	..
— sp.	..	..	+	..	..	..	..	..	..
Lophozia alpestris	..	..	..	..	+	..	..	..	..
Bryum sp.	..	..	..	..	..	..	..	+	..
Ceratodon purpureus	..	..	..	..	+	+	..	..	..
Dicranum fuscescens	..	..	+	..	..	..	..	1	..
— scoparium	..	..	..	..	+	..	..	..	..
Distichium sp.	+	..	..	..	..	..	..	..	..
Ditrichum flexicaule	..	+	..	..	..	..	..	..	..
Drepanocladus uncinatus	..	..	..	..	..	..	..	1	..
(Cl) Encalypta rhabdocarpa	..	+	..	..	..	..	..	..	..

[1] Species with optimum development in the Calamagrostis-Artemisia-Arctostaphylos complex.

(To be continued)

Table 14 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9
(Cl) Polytrichum hyperboreum	..	..	..	..	..	..	..	+	..
— piliferum	+	..	+	..	+	1	+	..	..
Rhacomitrium lanuginosum	..	..	..	..	..	..	..	+	..
Rhytidium rugosum	..	..	..	..	..	..	..	1	..
Thuidium abietinum	..	..	..	..	..	..	..	1	..
Tortella sp.	+	..	..	..	..	..	..	..	..
Tortula ruralis	..	..	..	..	+	..	..	+	..
Webera longicolla	..	..	+	..	..	..	..	..	..
— nutans	..	..	..	..	+	..	..	..	..
Alectoria jubata	..	..	1	1	+	..	..	..	1
(Hb) — lanea	..	..	1	..	+	2	1	..	..
— nigricans	..	+	..	..	..	..	..	..	..
(Hb) — ochroleuca	+	..	1	1	+	+	1	..	..
— pubescens	..	..	1	2	+	1	..	..	..
Candelariella placodizans	+	..	..	..	..	..	..	..	..
— sp.	..	+	..	..	..	..	..	..	+
Cetraria crispa	..	..	..	..	..	+	..	..	..
— cucullata	+	+	..	..	..	..	..	+	..
— nivalis	..	..	+	..	1	+	1	1	..
Cladonia coccifera	..	..	..	..	+	+	..	+	+
— gracilis	..	..	+	..	..	..	+	1	..
— mitis	..	..	..	..	..	..	1	4	..
— pyxidata neglecta	+	..	+	..	..	+	..	+	+
— sp.	..	..	..	..	..	..	..	1	..
Collema tenax corallinum	+	..	..	..	..	..	..	..	..
Cornicularia aculeata	+	..	..	..	..	+	..	..	..
(Hb) Haematomma ventosum lapponicum	..	..	..	1	..	..	..	..	..
Lecanora epibryon	..	..	1	..	..	..	..	..	..
— polytropa	+	..	..	..	..	..	..	..	..
Lecidea cf. berengeriana	..	..	..	..	+	..	..	..	..
— globifera	..	..	..	..	..	..	..	..	1
— rubiformis	..	+	..	..	..	..	..	..	..
Ochrolechia frigida	..	..	..	..	+	..	+	..	..
(Cl) Parmelia austerodes	..	..	..	..	..	..	+	..	..
— omphalodes	..	..	1	..	..	..	..	..	..
Peltigera erumpens	..	..	..	..	+	..	..	..	..
— malacea	..	..	..	..	..	..	1	1	..
Psoroma hypnorum	..	..	..	..	+	+	..	..	..
Rhizocarpon geographicum	1	..	2	2	+	1	..	..	..
— disporum	+	..	..	..	..	..	..	..	..
— jemtlandicum	..	..	..	..	+	..	..	..	..
(Hb) Sphaerophorus fragilis	..	..	+	1	..	..	1	..	..
(Hb) — globosus congesta	..	..	..	1	..	..	..	..	..
Stereocaulon alpinum wala-moënse	1	2	..	1	..	2	3	4	..
— denudatum	..	..	1	..	2	1		..	3

(To be continued)

Table 14 (concluded).

Analysis no.	1	2	3	4	5	6	7	8	9
Thamnolia vermicularis	..	+	+	..	+	+	+	..	+
Umbilicaria hyperborea	+	..	+	..	+	..	..	..	..
(Hb) — proboscidea	+	..	..	..	..	..	..	..	..
— torrefacta	..	..	..	1–2	..	..	..	..	1
Russula sp.	+	..	..	..	..	..	..	..	..

a similar type, but on normal Archean rock, it was at 7.8 (Table 14, no. 2), 16.0 (Table 14, no. 1), or 20.0 (Table 14, no. 6). The fell field rich in *Lesquerella* besides the species mentioned in the analysis might contain a little *Saxifraga tricuspidata* and *Silene acaulis*. The vegetation clearly reminds of a fell field with *Lesquerella* described by HARTZ (1894) from Kingigtoq on weathered sandstone at an altitude of 590 m above sea level. The fell field there is, however, still richer, with species like *Erigeron compositus*, *Papaver radicatum*, *Draba nivalis*, and *Minuartia rubella*.

Table 14, nos. 5—6 show two instances of purer *Dryas* fell field. Especially on the lower mountain plateaux *Carex nardina* had completely receded into the background and a mixed type arose in which *Dryas*, *Carex glacialis*, *Saxifraga tricuspidata*, and lichens (*Alectoria-Sphaerophorus*) were mixed with many of the xerophytes of the lowlands. In this connexion the fell field on the top of Keglen in Sandflugtdalen (cf. fig. 37) may suitably be mentioned. On the dry, slightly sloping incline facing the inland ice there were many, but scattered, greatly wind-eroded cushions of *Dryas* and scattered individuals of *Kobresia myosuroides*, *Poa glauca*, *Calamagrostis purpurascens*, *Artemisia borealis*, *Carex supina*, *C. nardina*, *Saxifraga tricuspidata*, *Rhododendron*, and *Vaccinium uliginosum microphyllum*. On the southern side of the peak, which was only 300 m above sea level, *Carex nardina* and *Dryas* were absent, while *Carex supina* and *Artemisia* became more frequent. Furthermore, *Potentilla nivea*, *Melandrium triflorum*, and *Carex glacialis* occurred there.

In order to illustrate the placing of the *Dryas* fell field in relation to other vegetation an analysis along a profile laid over a flat ridge at an altitude of 430 m on Hassells Fjeld was made. The *Dryas* vegetation there (1) contained very lille *Carex nardina* and none of the high arctic species. It was transitional to the vegetations which are referred to the *Artemisia-Calamagrostis Arctostaphylos* complex. The profile cut through the following sociations:

(1) Smooth southeast-facing incline: *Dryas* fell field, especially with *Carex supina spaniocarpa* and *Calamagrostis purpurascens*.

(2) Flat plain. As the wind has the same direction as the slope below, there is relatively good shelter there, which gives a possibility of a *Vaccinium*

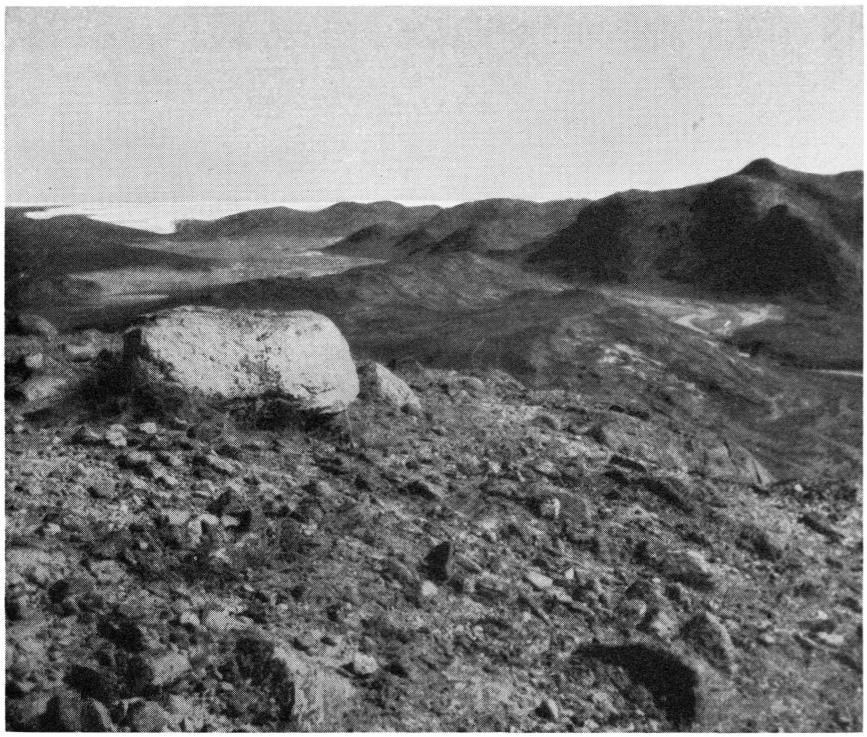


Fig. 37. Top of Keglen. In the background the eastern part of Sandflugtdalen and the inland ice. The vegetation at the top consists either of *Dryas* fell field or an open highland variant of the *Carex supina* steppe. T.W.B. phot. $^{5}/_{8}$ 1946.

uliginosum microphyllum-Betula nana-Alectoria-Cetraria heath in which *Hierochloë alpina* and *Kobresia myosuroides* are frequent.

(3) Lowermost part of slightly sloping southeast-facing incline above (2): Open *Vaccinium* heath with scattered *Betula*, *Dryas*, *Silene acaulis*, *Calamagrostis purpurascens*, and lichens.

(4) Southeast slope and top of crest: Open steppe-like vegetation especially of *Carex supina spaniocarpa*, *Calamagrostis purpurascens*, *Artemisia*, *Poa glauca*, *Potentilla nivea* and *chamissonis*; a little *Carex nardina*.

(5) Upper part of northwest slope bordering on (4): *Dryas* heath rich in lichens, with *Calamagrostis purpurascens* and *Kobresia*.

(6) Middle part of the same slope: *Vaccinium* heath rich in lichens, with *Dryas*, *Empetrum*, and *Salix glauca callicarpaea*.

(7) The lowermost somewhat steeper part of the same slope: *Betula nana-Ledum palustre decumbens* soc. with *Vaccinium*, *Aulacomnium turgidum*, *Cetraria nivalis*, *islandica*, *cucullata*, *Cladonia amaurocraea*, *C. lepidota*, and *Peltigera rufescens*.

The profile illustrates how *Empetrum*, *Ledum*, and *Salix*, besides *Aulacomnium turgidum*, *Cladonia lepidota*, *Cetraria islandica*, and *Peltigera rufescens*, depend on the northern exposure there.



Fig. 38. Above the north-facing slope of Nákajanga ridge there is an alpine fell field dominated by *Carex rupestris* and numerous lichens. The lake Taserssuatsiaq is seen in the background. T.W.B. phot. $^1/_8$ 1946.

Near Itivdlínguaq there were lowland fell fields on gravelly soil influenced by the wind near the large lake. *Dryas* formed scattered cushions, which were dead in the middle or dead all over; in the spaces between the cushions there was abundance of the almost black *Parmelia alpicola*, which tied the gravel particles together.

An analysis of the collembola and oribatid fauna in vegetation no. 5 Table 12 is found in HAMMER 1952 (no. 7). There are only seven species.

2. Carex rupestris Sociations.

Patches with *Carex rupestris* as dominant on dry wind-exposed soil were seen only on Nákajanga ridge at altitudes above 450 m above sea level. The sociation was mostly more protected than the preceding ones, and not rarely it became a "lichen heath". Table 14, no. 8 gives an example of a lichen heath with *Cladonia mitis* and *Stereocaulon alpinum walamoense* as dominants, while no. 7 is more in the character of a fell field. The latter vegetation is seen in the foreground in fig. 38; on more

protected terrain it passes into a *Hierochloë* sociation rich in lichens (cf. below).

Carex rupestris might also dominate patches of a somewhat different character. On north-facing slopes where rocks were overlain by quite a thin layer of soil, the species was found in a dense moss-lichen carpet the composition of which suggests snow cover and less dry soil. Such patches were frequent at Itivdlinguaq and on the north side of Nákajanga ridge at an altitude of 300 m above sea level. In the latter place the moss-lichen carpet was composed of *Aulacomnium turgidum*, *Rhacomitrium lanuginosum*, *Cladonia mitis* and *uncialis*. A similar vegetation was found on a very steep north-facing slope below Lake Taserssuatsiaq close to the level of the sea. The sedge there appeared in a carpet consisting mainly of *Hylocomium splendens-Rhacomitrium canescens*. Other species noted were *Aulacomnium turgidum*, *Stereocaulon alpinum*, *Carex supina*, *C. scirpoidea*, *Minuartia rubella*, *Saxifraga cernua* and *aizoon* (very near an open rock surface). It will probably prove justifiable that such communities are associated with other complexes such as the present one.

3. Hierochloë alpina Sociations.

Below the open *Carex rupestris* sociation rich in lichens on Nákajanga ridge mentioned above there was on level, stony, gravelly ground a *Hierochloë-Cetraria-Cladina* soc., a veritable lichen heath, the dominants of which were *Cetraria cucullata*, *nivalis*, *Cladonia mitis*, and *Stereocaulon alpinum*. The inevitable *Aulacomnium turgidum* also occurred there, and heath shrubs sent scattered shoots up out of the lichen carpet (especially *Vaccinium vitis idaea minus*, *Betula nana*, and *Rhododendron*), the vegetation thus effecting a transition to the next vegetational type. Near Itivdlínguaq a type was found which formed a stage of transition to the rock communities. It had developed in crevices in dry rocks which were filled with earth, and the community had *Poa glauca* as co-dominant besides more scattered *Saxifraga tricuspidata*, *Taraxacum lacerum*, *Campanula uniflora*, *C. rotundifolia*, and *Melandrium triflorum*.

As far out as the maritime area near Pâ there were also small patches of *Hierochloë* lichen heath. The lichen carpet consisted of *Cetraria nivalis-Alectoria ochroleuca* or *Cladonia-Stereocaulon*. In the latter case the soil was less dry and the vegetation was no doubt snow-covered in winter.

Silene acaulis as a dominant in fell fields was an exception which was only observed on the upper crest of Hassells Fjeld at an altitude of 300 m, in a place where it seemed that the soil in spring might be percolated by melting snow but later would dry up very much. The *Silene* tussocks stood scattered and there were no other plants, which suggests that great moisture in spring keeps such species as *Carex supina*, *Artemisia borealis*, and others away. These species are otherwise unavoidable on the southern slope of this mountain.

b. The Rhododendron-Pedicularis lanata Type.

(Xerophytic continental dwarf shrub vegetation with rare occurrence of high arctic species).

This type of heath bears a similar relation to the preceding type as the *Loiseleuria* heaths to the *Juncus trifidus* fell fields. It occurs on the highest parts of the mountain plateaux more than 500 m above sea level on less exposed soil than the *Carex nardina-Hierochloë* type (cf. profile on p. 145, nos. 1—3). Lower down, where level ground may be completely covered with heath, it is found on the more prominent ridges or expanses sloping slightly towards the south or east. There it imperceptibly merges with different lowland heath types (see p. 223). Ecologically it is very different from the humid heaths with *Rhododendron-Dryas* (cf. p. 230).

Towards the south the *Rhododendron-Pedicularis lanata* type is found as far as the highlands in the interior of the Godthaab region (*Alectoria ochroleuca* mat with abundant *Vaccinium uliginosum microphyllum* or with *Rhododendron lapponicum* and scattered xerophytic herbs; Trapnell 1933, p. 308). A number of the heaths which Polunin 1948 describes from the American Eastern Arctic are naturally associated with this type.

In contrast to the preceding type the soil is often rich in humus, at any rate in the upper layer. Measurements of pH indicate moderately acid to neutral soil, but certain deviating *Dryas* heaths grow on ultrabasic soil.

It is difficult to find special EG-species for this type, which thus must be considered a heath characterized by the EG-species of the complex. There is, however, reason to mention here a few important or more characteristic species of the vegetation:

Rhododendron lapponicum is a widely distributed arctic species, showing its continental trend in Alaska and Scandinavia and by being absent in Iceland. Ecologically it has a wide range, but is hardly found on soil poor in lime. As regards the humidity scale it ranges almost from one extreme to the other (cf. p. 228).

Pedicularis lanata. In connexion with the remark on p. 133 it may be mentioned that the Greenland population is partial to rocky flats and open heath which is often bare of snow in winter. About its occurrence between 71° and 73° lat. N. in Greenland M. P. Porsild 1912 writes that it is "frequent in the basalt area in the coastal districts and on the mountains in the interior of the fjords, but was searched for in vain in the lowlands."

The species is obviously calciphilous, but still it occurs on neutral soil on the mountain plateaux on Nákajanga and at Loc. 3. It might seem to be a good EG-species because it occurs so often on the alpine *Vaccinium* heath, but it is also found quite isolated on open gravelly barrens and will probably also occur on humid soil, although this can hardly be said to be typical of it.

Antennaria ekmaniana. The map fig. 33 (3) which is based on a map in A. E. PORSILD 1950 and stations mentioned in B. 1952a, shows that this is a widely distributed arctic continental species. PORSILD says that in North America it is "restricted to non-calcareous soils on rocky, lichen-covered slopes". I have also seen it in places of this type (e. g. on the north side of the top of Keglen), but also on *Dryas* heath on Nákajanga, where the soil, if anything, must be assumed to be neutral or slightly acid. POLUNIN (1948, p. 226) mentions it (as *A. labradorica*) from a dry *Vaccinium* heath where both *Dryas* and *Pedicularis lanata* occur sporadically, which does not either suggest that it should be markedly acidophilous or calcifugous. In Ørkendalen I saw *A. ekmaniana* on a steep north-facing slope, if anything as a rock plant, together with *Minuartia rubella.*

1. Vaccinium uliginosum microphyllum Sociations.

Heaths of small-leaved *Vaccinium uliginosum* with dominance of lichens play a prominent part on level ground in the highlands around the head of Søndre Strømfjord. They hold there a position as central as that of the *Kobresia myosuroides* sociations on the level areas of the lowlands.

The best examples were found on Nákajanga ridge, where, however, only a single quadrate was analyzed (Table 15, no. 7, fig. 39). In other places on the same mountain plateau *Rhododendron* was just as frequent as *Vaccinium* and the heath there contained *Pedicularis lanata*, *Tofieldia coccinea* and a little *Papaver radicatum.* Where the heath bordered on the more constantly snow-covered *Cassiope tetragona* heath, *Rhacomimitrium lanuginosum* might become dominant together with the *Cetraria* and *Stereocaulon* species; cf. the profile on p. 170, no. (3). Otherwise reference is made to Table 15, nos. 1—6, which originates from the mountains north of Sandflugtdalen.

2. Diapensia-Vaccinium uliginosum microphyllum Sociation.

Diapensia plays an appreciable part only in the inland on the highest mountains. On Hassells Fjeld only a small patch was seen below a vertical rock, which cast a shadow during the greater part of the afternoon (Table 15, no. 8). The vegetation like the one from Nákajanga (Table 15, no. 9) was half-open, transitional to being a fell field. The occurrence is very characteristic in the profile on p. 170, no. (4) between medium snow-covered *Vaccinium* heath and the completely open *Dryas-Carex nardina* fell field. The analysis in Table 15, no. 9 originates from subneutral soil, which is remarkable for a vegetation rich in *Diapensia.* In the neighbourhood I even noted a patch of half-open *Diapensia-Rhododendron-Dryas* heath (with *Stereocaulon*) which no doubt also occurs on neutral soil.

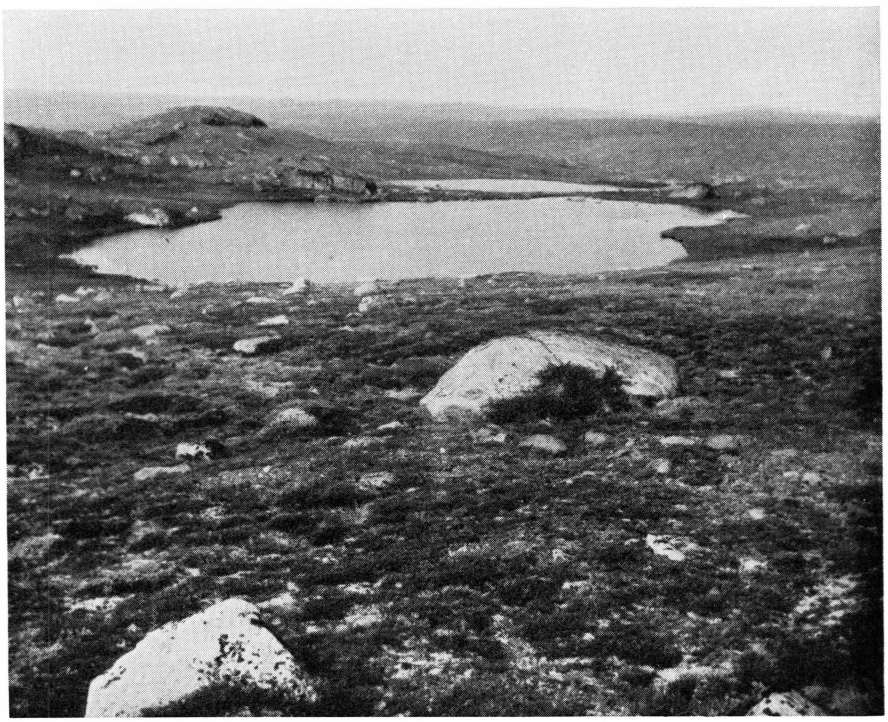


Fig. 39. View of the highland plateau on Nákajanga ridge. The heath in the foreground is about 650 m above sea level and is dominated by *Vaccinium uliginosum microphyllum* and lichens. The two lakes in the background have in many places mossy banks with *Carex rariflora*, *saxatilis*, and *holostoma*, but no vegetation of aquatic plants apart from a little *Scorpidium scorpioides*. T.W.B. phot. $^{10}/_{8}$ 1946.

3. Dryas- and Rhododendron Sociations.

Approaches to a heath dominated by *Rhododendron lapponicum* and with contents of the EG-species of the complex were seen in several places in small patches on Nákajanga, but such patches were nowhere analyzed. Not until the lower parts of the mountains at heights of about 200—400 m above sea level do we find real *Rhododendron* heaths, but there the EG-species are absent and instead there is much *Kobresia*, which involves another reference (see p. 223). On the other hand *Dryas* frequently forms heaths which must be referred to the present type. First of all this applies to alpine *Dryas* sociations rich in lichens such as the following ones:

(1) Itivdlínguaq, 200 m above sea level, Loc. 10. *Dryas-Carex rupestris-Alectoria ochroleuca* soc. with much *Cetraria nivalis*.

(2) Nákajanga, 650 m above sea level, Loc. 8. *Dryas-Alectoria ochroleuca* soc. with *Cetraria nivalis*, *Ochrolechia frigida*, *Stereocaulon*. Scattered *Antennaria ekmaniana*, mostly on gravelly open patches.

Table 15.

Analysis no.	1	2	3	4	5	6	7	8	9	10
Locality no.	4	3	3	3	3	3	8	3	8	3
Altitude in m	400	370	400	400	400	450	650	400	450	200
Slope	15°	0°	10°	10°	10°	0°	0°	0°	0°	0°
Exposure	E	—	S	SE	S	—	—	—	—	—
pH	—	5.5	—	—	—	—	—	5.4	6.7	8.2
Lt	—	0.8	—	—	—	—	—	0.4	0.4	1.3
EG Carex nardina	..	..	..	2	..	1	+	..	+	..
— — glacialis	..	..	..	..	..	+	..	..	+	2
— Hierochloë alpina	..	+	+	+	..	..	+	..	..	..
— Pedicularis lanata	..	..	..	..	..	..	1	..	..	..
— Saxifraga tricuspidata	..	..	+	..	..	..	..	..	..	..
Cl Tofieldia coccinea	..	..	..	..	..	..	..	..	2	..
— Poa arctica	+	..	..	..	..	..	..	+	+	..
— Carex rupestris	..	..	..	..	..	..	..	..	+	..
— Cassiope tetragona	..	..	..	..	..	..	1	..	..	..
— Rhododendron lapponicum	2	..	..	+	+	..	1	2	1	..
— Dryas integrifolia	+	..	..	1	+	1	..	..	+	5
— Betula nana	..	1	1	..	..	..	..	..	1	..
— Pirola grandiflora	..	+	..	..	+	..	..	..	..	..
— Pedicularis lapponica	..	..	..	..	+	..	..	..	..	..
— Calamagrostis purpurascens	..	..	..	..	..	..	..	..	..	1
— Carex supina spaniocarpa	..	..	..	+	..	+	..	..	..	..
— Kobresia myosuroides	2	1	+	..	+	1	..	1	..	..
Hb Diapensia lapponica	..	..	..	..	..	..	2	3	4	..
— Silene acaulis	..	..	..	..	+	+	..	..	..	..
[1] Carex capillaris	..	..	..	1	..	..	..	..	..	..
Carex bigelowii	..	..	..	..	..	..	..	1	..	..
Cerastium alpinum	..	..	..	..	+	+	..	..	..	..
Luzula confusa	+	+	..	..	+	..	..	+	+	..
Pedicularis hirsuta	..	+	..	..	..	..	..	..	..	..
Poa glauca	+	..	+	..	+	..	..	..	..	..
Polygonum viviparum	..	+	..	+	+	..	..	+	..	..
Salix glauca callicarpaea	..	1	+	1	..	..	..	1	..	..
Vaccinium ulig. microphyllum.	5	5	5	5	5	4–5	4	3	2	..
Barbilophozia lycop. or hatcheri	+	..	..	..	..	..	..	..	+	..
Cephaloziella sp.	+	+	..	..	..	..	..	..	..	..
Lophozia ventricosa	..	+	..	..	..	..	..	..	..	..
Aulacomnium turgidum	+	+	..	..	..	..	..	+	+	..
Ceratodon purpureus	..	..	..	..	..	..	..	+	..	+
Dicranum elongatum	+	..	..	..	..	..	..	..	..	..
— fuscescens	+	1	..	..	..	..	..	..	+	..
Distichium capillaceum	..	..	..	1	..	..	..	..	..	..
Hypnum revolutum	..	1	..	..	..	..	..	..	..	..
Polytrichum juniperinum	+?	..	..	..	..	..	..	..	+	..
— piliferum	..	..	..	..	..	..	..	1	+	..

[1] A calciphilous species, but not a Hb-species.

(To be continued)

Table 15 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10
Tortula ruralis	+	..	1	..	+	..	1	..	..	..
Webera cruda	+	1	..	..	..	..	..	..	..	..
Alectoria jubata	2	..	..	..	..	..	..	..	1	..
(Hb) — lanea	1	1	+	..	..	..	..	..	1	..
— minuscula	..	..	..	..	..	..	..	..	+	..
— nigricans	..	..	..	..	..	..	..	..	1	..
(Hb) — ochroleuca	+	+	1	..	2	2	2	..	2	+
Cetraria crispa	1	..	+	..	..	..	..	1	..	..
— cucullata	3	..	2	..	1	+	1	1	1	1
— nivalis	2	..	+	+	1	2	2	..	2	1
Cladonia amaurocrea	..	..	..	..	+	..	..	..	..	..
— cariosa[1]	..	..	..	+	..	..	..	..	..	..
— ecmocyna	+	..	..	..	..	..	..	..	..	..
— gracilis	+	+	..	..	..	..	..	..	..	..
— mitis	..	..	..	..	+	..	..	..	..	..
— pyxidata	..	..	..	+	..	..	..	..	..	..
— uncialis	..	+	..	..	..	..	..	..	..	..
Cornicularia aculeata	..	+	..	..	..	..	..	..	..	+
Crocynia neglecta	..	..	..	+	..	..	..	..	..	..
Lecanora polytropa	..	..	..	..	..	..	..	..	+	..
Ochrolechia frigida	..	..	..	..	..	..	..	2?	2	..
Peltigera malacea	1	1	2	..	+	..	..	..	..	..
Pertusaria coriacea	..	..	..	..	..	..	..	..	+	..
Physcia muscigena	..	..	..	+	..	..	..	..	..	..
Psoroma hypnorum	..	+	..	..	..	..	..	..	..	..
Rhizocarpon geographicum	..	..	..	..	..	..	..	..	2	..
— grande	..	..	..	..	..	..	..	..	+	..
— rittokense	..	..	..	..	..	..	..	..	+	..
(Hb) Sphaerophorus globosus	..	..	..	..	..	1?	..	..	1	..
Stereocaulon alpinum	..	..	1	+	3	2	2	2	..	+
— denudatum	..	..	..	..	..	2			1	..
Thamnolia vermicularis	1	..	..	+	..	..	..	..	..	..

[1] Widely distributed and continental.

(3) Nákajanga, 500 mm above sea level, Loc. 8. *Dryas-Sphaerophorus globosus* soc. with scattered *Saxifraga tricuspidata*, *Poa glauca*, *Festuca brachyphylla*, *Carex supina spaniocarpa*, *Melandrium triflorum*, *Draba nivalis*, *Campanula rotundifolia*, and *Cerastium alpinum*.

Table 15, no. 10 is a *Dryas-Carex glacialis* sociation on strongly basic soil. It was found on a dry, wind-eroded expanse beside a small salt lake near the harbour road (cf. p. 300). The analysis shows the closed heath, but there were also, in the neighbourhood, open fell fields with a similar flora and furthermore *Plantago maritima juncoides*, which grew on the gravelly spots between the *Dryas* cushions. This vegetation

forms a transition to the *Dryas* heaths which occur near the salt lakes, but which lack the species characteristic of the present complex.

c. The Saxifraga tricuspidata-Dryopteris fragrans Type.

(Arctic continental xerophytic talus-slide and rock vegetation).

This vegetational type corresponds to the *Veronica fruticans-Sedum annuum* type of the coastal mountains and has *Potentilla tridentata*, *Woodsia ilvensis*, *Saxifraga aizoon*, and others in common with that type. Mixed types in which e. g. *Veronica fruticans* and *Saxifraga tricuspidata* meet in the same sociation are found in transitional areas (e. g. near Turner Sund; see HARTZ & KRUUSE 1911, p. 352), but cause little difficulty as it is a question of intermixture of two geographically vicarious communities. The delimitation from the *Carex nardina-Hierochloë* type and the *Artemisia-Calamagrostis-Arctostaphylos* complex is more difficult. SEIDENFADEN & SØRENSEN (1937) have a community which they have termed "dry disintegrating summits and crests", and which is related to dry rock vegetation as well as the *Artemisia-Calamagrostis-Arctostaphylos* complex, but which presumably is best interpreted as a high arctic offshoot of the latter, differentiated by such species as *Lesquerella arctica* and *Draba cinerea*. The difficulty of demarcating the present type from the dry communities which are not characteristic rock or slide communities is brought out well in Table 16, which shows the flora of scattered vascular plants found on weathering rocks and between blocks on the uppermost mountain tops in the inland near Søndre Strømfjord. There are only two saxicolous plants there, but a copious representation from each of the two dry communities mentioned. It appears that *Saxifraga tricuspidata* is constant on such peaks. It may not be an exclusive oreophyte, but where it enters into the *Carex nardina-Hierochloë* type it is nearly always possible to find rock, stone, or coarse gravel below it. It is also a characteristic fact that it is practically completely absent on loess or sand in the steppe-like communities (cf. Table 20, 22, and 24).

The *Saxifraga tricuspidata-Dryopteris fragrans* type penetrates far into North America. From Chesterfield on Hudson Bay POLUNIN (1948, p. 270) mentions a vegetation on a rough slope of gravel and boulders dominated by *Hierochloë-Saxifraga tricuspidata* and including *Vaccinium vitis-idaea minus* and *Dryopteris fragrans*. The community is of a more arctic character than those of mine from West Greenland as it contains *Poa arctica*, *Salix arctica*, *Draba nivalis*, *D. hirta*, and *Potentilla nivea subquinata*. Even as far south as Central Manitoba there are related communities, probably independent types with a subarctic stamp in which

Table 16. Plant lists from five mountain tops inland.

Locality no.	2	3	3	8	8
Altitude in m	300	500	470	650	700
1. Saxifraga tricuspidata	+	+	+	+	+
— aizoon neogaea	..	..	+	..	..
2. Carex nardina	..	..	+	+	+
— glacialis	+	..	..	+	..
— rupestris	..	..	..	+	+
Hierochloë alpina	+	+	+	+	+
Draba cinerea	..	..	..	..	+
Lesquerella arctica	..	..	+	..	..
Dryas integrifolia	+	..	+	+	+
Potentilla nivea	..	+	..	..	+
Rhododendron lapponicum	..	..	..	+	..
Pedicularis lanata	..	..	..	+	+
Campanula uniflora	..	..	..	..	+
Arnica alpina angustifolia	..	+	..	..	..
3. Artemisia borealis	+	+	+	+	+
Calamagrostis purpurascens	+	+	+	+	+
Carex supina spaniocarpa	+	..	..	+	+
Kobresia myosuroides	+	+	..	+	+
Potentilla chamissonis	+	..	+	+	+
Melandrium triflorum	+	..	..	..	..
4. Campanula rotundifolia (coll.)	..	..	..	+	+
Cerastium alpinum	+	+	..	..	+
Diapensia lapponica	..	..	..	+	+
Luzula confusa	..	..	..	..	+
Poa glauca	+	+	+	+	+
Polygonum viviparum	..	..	+	..	+
Silene acaulis	..	..	+	+	+
Vaccinium ulig. microphyllum	..	..	..	..	+

(1) Oreophytes. (2) Species associated with types a and b. (3) Species associated with the *Artemisia-Calamagrostis-Arctostaphylos* complex. (4) Other species.

Saxifraga tricuspidata, *Poa glauca*, and *Woodsia ilvensis* are associated with *Selaginella rupestris*, *Heuchera* species, *Cryptogramme acrostichoides* and several other southern species (Scoggan 1950, p. 89).

EG-species of the vegetational type:

The two species *Saxifraga tricuspidata* and *Dryopteris fragrans* after which the type is named belong to a widely distributed arctic distributional type and as regards distribution have remarkable points of resemblance. It appears from the material of maps in Kalliola (1937), Gelting (1934, 1941), Raup (1947), and B. (1938) that both are rather widely distributed in Alaska, where they do not seem to consist of continental races only; in East America, on the other hand, they are rare or completely absent from the Atlantic coast of Labrador, and in West Greenland they are absent in the south-



Fig. 40. Itivdlínguaq. In the foreground a south slope with loose gravel between greatly weathering rocks. *Saxifraga tricuspidata* dominates together with *Artemisia borealis* and *Calamagrostis purpurascens*. In the background the small creek which cuts in from Søndre Strømfjord in the direction of the Itivneq fjord. T.W.B. phot. $^{24}/_{7}$ 1946.

western oceanic part. This highly indicates radiation from Beringia towards the east with a simultaneous depletion of oceanic races. But the species also reached further, viz. to the Scoresby Sund area in East Greenland, where they have a very small relic-like area. The populations found there have perhaps further under glacial conditions lost all southern biotypes. — Ecology: Both species prefer dry rocky ground and require slightly acid-neutral (-basic) soil rich in nutrients.

Draba cinerea may very nearly be termed an EG-species. It is a widely distributed arctic continental species with a high arctic trend (see map in RAUP 1947, Plate XXV) and prefers dry rocks and screes, but it may also occur in other communities of dry soil (cf. SEIDENFADEN & SØRENSEN 1937, p. 112).

1. Saxifraga tricuspidata Sociation.

This name is used about the vegetation from Itivdlínguaq pictured in fig. 40. It is found on a greatly weathering sunny slope of rock. *Saxi-*



Fig. 41. *Dryopteris fragrans* sociation among blocks at the foot of Hassells Fjeld. Besides the fern, *Campanula rotundifolia*, *Calamagrostis purpurascens*, and *Melandrium triflorum* are seen. T.W.B. phot. $^{7}/_{8}$ 1946.

fraga tricuspidata there had *Artemisia borealis* and *Calamagrostis purpurascens* as co-dominants. Other important species were *Silene acaulis*, *Poa glauca*, *Potentilla chamissonis*, *Carex supina spaniocarpa*, *Campanula rotundifolia*, and *Vaccinium uliginosum microphyllum*. A single very large individual of *Arctostaphylos uva ursi* and a few lanky specimens of diploid *Arabis holboellii* joined the more frequent species. The pH of the soil was measured at 7.6.

2. Dryopteris fragrans Sociations.

These sociations probably constitute the most typical ones within the complex. A particularly fine example was found among large blocks at the foot of the south-facing slopes of Hassells Fjeld; see fig. 41 and Table 17, nos. 1—5. *Saxifraga tricuspidata* was constant, and might cover as much space as the fern. Otherwise the flora showed close agree-

Table 17.

Analysis no.	1	2	3	4	5	6	7	8
Locality no.	3	3	3	3	3	3	2	3
Slope	5—20°					25°	30°	10°
Exposure	S					S	S	S
pH	6.2—6.3					—	6.0	6.2
Lt	0.8					—	0.5	0.4
EG Dryopteris fragrans	3	4	4	4	5	..	..	..
— Saxifraga tricuspidata	3	2	2	3	1	1	2	2
Cl Vaccinium vitis-idaea minus	..	..	..	..	..	..	..	3
— Draba cinerea	..	..	..	..	..	..	..	+
— — hirta	..	..	..	..	..	..	+	..
— Artemisia borealis	1	..	..	..	..	1	..	..
— Calamagrostis purpurascens	3	2	1	2	1	+	2	+
— Carex supina spaniocarpa	..	..	1	..	..	2	1	+
— Arabis holboellii	..	..	..	..	..	+	..	..
— Melandrium triflorum	+	..	1	1	1	+	..	..
— Potentilla chamissonis	1	1	1	+	1	2	..	..
— — nivea	..	..	..	..	..	..	1	..
Hb Woodsia ilvensis	..	..	..	..	..	3	4	..
— Saxifraga aizoon neogaea	..	..	..	..	..	..	+	..
— Potentilla tridentata	..	..	..	..	..	..	..	2
Campanula rotundifolia (coll.)	+	..	1	1	..	..	+	+
Cerastium alpinum	1	+	..	2	1	..	1	+
Festuca brachyphylla	..	..	..	..	..	..	1	+
— rubra	..	..	..	..	1	..	..	..
Euphrasia frigida	..	..	..	..	..	..	+	+
Poa glauca	..	1	2	1	1	1	1–2	..
Rumex acetosella	..	..	..	..	..	..	2	..
Viscaria alpina	..	..	..	..	..	..	1–2	+
Cephaloziella sp.	1	..	..	..	..	1	..	+
Aulacomnium turgidum	..	..	..	..	+	..	..	..
Barbula recurvirostris	..	..	..	..	..	+	..	..
— sp.	..	..	..	..	..	..	1	..
Bryum sp.	..	..	+	..	..	+	..	+
Ceratodon purpureus	+	+	1	+	+	..	..	..
Dicranum elongatum	..	1	..	1	1	..	..	..
?EG or Cl Encalypta brevicolla	..	..	..	..	..	..	1	..
— ciliata	..	..	..	..	..	+	..	..
Hypnum cupressiforme vaucheri	1	..	..	..	+	..	..	..
Polytrichum piliferum	1	+	..	1	2	+	2	1
Rhacomitrium canescens	..	..	..	..	1	..	..	..
Alectoria cf. lanea	..	..	..	..	1	..	..	..
Cetraria nivalis	..	..	..	..	..	..	..	2
— nigricans	..	..	..	..	..	..	..	1
Cladonia amaurocraea	..	..	..	..	..	..	..	+
— cariosa[1]	..	..	..	..	..	..	..	+

[1] Widely distributed and continental.

(To be continued)

Table 17 (continued).

Analysis no.	1	2	3	4	5	6	7	8
Cladonia coccifera	+	..	+	+	..	..	..	+
— gracilis	1	..	..	+	+	..	..	..
— lepidota	..	..	..	..	..	..	..	+
— pyxidata	2	+	2	1	1	3	1	2
Collema tenax corallinum	..	..	..	..	..	1	..	..
Cornicularia aculeata	..	..	..	..	..	..	..	2
Hb[2] Diploschistes scruposus	..	..	..	..	..	+	..	+
Hb[2] Heppia lutosa	..	..	..	..	..	1	..	..
Lecidea wulfenii[1]	..	..	..	..	..	..	..	+
Nephroma expallidum	..	..	..	..	1	..	..	..
Peltigera canina	1	..	1	..	..	1	..	..
— erumpens	1	..	..	..	1	1	..	+
— lepidophora	..	..	..	..	..	..	1	..
— malacea	..	..	..	1	..	..	..	+
— rufescens	..	..	..	..	..	..	1	+
— Physcia muscigena	..	..	..	..	..	..	..	+
— Psoroma hypnorum	..	..	..	..	+	..	..	..
— Stereocaulon alpinum	1	1	2	2	3	+	+	..
— alpinum walamoense	..	..	..	..	..	..	..	3
Lycoperdon sp.	..	..	..	..	..	..	+	..
Soil algae cf. p. 207	+	..	..	..	..	..	..	..

[1] On dead vegetable substances.
[2] Widely distributed continental Hb species associated with loess soil.

ment with the *Artemisia-Calamagrostis-Arctostaphylos* complex, even though the cryptogams were not quite the same. *Dryopteris fragrans* sociations also occurred near Strømfjordshavn, mostly in dry rock crevices and containing *Woodsia ilvensis*, *Saxifraga tricuspidata*, *Potentilla tridentata*, *Viscaria*, *Campanula rotundifolia*, *Draba cinerea*, *D. aurea*, *Arnica*, *Poa glauca*, *Cystopteris* (undoubtedly ssp. *dickieana*), and a little *Saxifraga cernua*. At Itivdlínguaq *Dryopteris fragrans* grew in long, dry rock crevices, so densely that no other species could assert themselves. In other places there, on some dry ledges of rocks, there was more room, so that also a number of other species might occur: *Saxifraga tricuspidata*, *Woodsia ilvensis*, *Potentilla chamissonis*, *P. tridentata*, *Artemisia*, *Calamagrostis purpurascens*, *Kobresia myosuroides*, *Carex supina spaniocarpa*, *Campanula rotundifolia*, *Dryas integrifolia*, *Saxifraga aizoon*, *Arnica*, *Viscaria*, *Sedum rosea* (tender specimens; the continental limit of the species), and *Papaver radicatum*.

3. Woodsia ilvensis Sociations.

Two examples are included in Table 17 (nos. 6—7). Like patches with dominant *Saxifraga aizoon* and *tricuspidata* this fern sociation is

as a rule developed on shallower soil over the rock than the preceding soc. A thin layer of loess covers the rock and the vegetation harbours several typical loess lichens (*Heppia lutosa*, *Diploschistes*). On the southern side of Ravneklippen (no. 7) also *Minuartia rubella*, *Erigeron compositus*, a little *Pirola grandiflora* and *Thamnolia vermicularis* was found near the quadrate examined.

M. P. PORSILD (1902, p. 214) from Evqitsoq on Disko mentions a related rock vegetation including *Woodsia*, *Cystopteris*, *Dryopteris fragrans*, *Saxifraga aizoon*, *Trisetum spicatum*, *Viscaria*, *Campanula rotundifolia* and *Potentilla crantzii* var. *langeana*.

4. Vaccinium vitis idaea minus Sociations.

This form of rock vegetation was not so frequent and occurred in less dry and warm places. However, it belongs rather to the present type than to the preceding one. The example in Table 17, no. 8 originates from Hassells Fjeld at an altitude of 250 m above the sea, while nos. 1—5 in the same table come from about 50—70 m above the sea. The rock was covered with a very thin layer of soil rich in humus. Close to the quadrate *Trisetum spicatum* was found in the same kind of vegetation. Cowberries also grew at the foot of the northern slope of Nákajanga together with *Stereocaulon* and *Saxifraga tricuspidata*, and in one place a little *Potentilla tridentata*, on very shallow soil over the rock. There might also in this place be small lichen mats of *Cladinae*, *Stereocaulon*, *Cetraria nivalis* and *cucullata* besides *Rhacomitrium lanuginosum* in which cowberry and the saxifrage species occurred. As soon as the layer of humus on the rock increased in thickness, *Betula nana*, *Vaccinium uliginosum microphyllum*, and *Salix glauca callicarpaea* made their appearance and formed a dense heath one foot high.

In connexion with the sociations above it may be mentioned that in Ørkendalen, about 100 m above the bottom of the valley, there was a place with a scree of large stones the blocks of which were mostly covered by moss. The exposure was northerly, but some of the blocks had horizontal surfaces, and there it was dry enough for *Carex supina spaniocarpa* and *Saxifraga tricuspidata* to grow in a carpet of *Drepanocladus uncinatus*, *Tortula ruralis*, and *Rhacomitrium canescens*, with scattered *Peltigera malacea* and *Stereocaulon alpinum*.

II. The Poa arctica-Arnica angustifolia-Cassiope tetragona Complex.

Arctic-high arctic continental mesophytic and medium chionophilous grassland, herb and dwarf-shrub vegetation.

Ecologically this complex corresponds to the *Deschampsia flexuosa-Alchemilla-Phyllodoce* complex of the oceanic regions. It seems that grasslands within the continental complex are of small importance. The

herb type as well is far from playing the same part as the corresponding low arctic oceanic vegetation. Thus the heath is the most important type within the continental complex.

I have included *Poa arctica* in the name of the complex because besides being arctic with a continental trend it belongs to the best mesophytes, which avoid the driest as well as the most humid places. I have no material myself which can be fitted into a "*Poa arctica* type", but I suppose that it would include the *Poa arctica* sociations in the surroundings of snow-patches in the Disko Bugt area (cf. DE LESSE 1952, fig. 2V) as well as certain coprophilous *Poa arctica* sociations mentioned in POLUNIN (1948, p. 236), certain mesophytic *Luzula confusa-L. arctica* sociations, and the communities which by HARTZ & KRUUSE (1911, p. 364) were termed grassy slope and by SEIDENFADEN & SØRENSEN (1937, pp. 121—122) grassy brinks. Perhaps the grassland from sandy soil in Disko mentioned by M. P. PORSILD (1902, pp. 166—67) might be included, too. Outside Greenland related vegetation may occur in Norway (cf. the *Poa arctica-Luzula arcuata-Alectoria*-soc. recently described by NORDHAGEN, 1954).

The complex, especially as a *Cassiope tetragona* heath, is very widely distributed and is one of the most important plant communities of North Greenland. In the south it is found as far as the interior of the Godthaabsfjord, where the *Cassiope* species according to TRAPNELL (1933, p. 331) is associated with the highlands.

EG-species (continental, high arctic or widely distributed arctic mesophytes as well as dwarf-shrubs preferring habitats with a snow-cover of medium duration and in summer a medium water content in the soil): *Poa arctica*, *Carex misandra*, *Luzula arctica*; *Arnica alpina angustifolia*, *Campanula uniflora*, *Erigeron eriocephalus* (Greenland-American type), ?*Taraxacum umbrinum*.
Arabis arenicola, *Taraxacum lacerum*.
Cassiope tetragona; *Tofieldia coccinea*; *Dactylina arctica*.

Cl-species particularly: *Hierochloë alpina*, *Potentilla nivea*, *Stellaria longipes-monantha*, *Pirola grandiflora*, *Rhododendron lapponicum*, *Saxifraga tricuspidata*, *Pedicularis lapponica*.

a. The Arnica angustifolia-Campanula uniflora Type.

(Arctic continental mesophytic herb vegetation).

This type is only found fragmentarily developed in the inland at the head of Søndre Strømfjord. We find there the last southern outposts of a community which farther north plays not quite a small part. I am especially thinking of SEIDENFADEN & SØRENSEN's xerophilous herb slope, quite a good name, as the community grows on drier soil than the low arctic-oceanic herb fields, but still perhaps not quite felicitous, as the species are not typical xerophytes. In East Greenland HARTZ

(1895) has both from Jameson Land, Neill Klinter, and Kobberpynt described communities which clearly belong to the *Arnica-Campanula uniflora* type, even though this type there, as near Søndre Strømfjord, must compete severely with other communities, especially such as belong to the *Artemisia-Calamagrostis-Arctostaphylos* complex. A small piece of *Arnica* soc. was seen in 1932 as far south as in d'Aunay Bay (B. 1933 b, fig. 17). From West Greenland very little information is available. HARTZ (1894, p. 47) mentions a small patch with dominant *Campanula uniflora*; this is all that I have been able to find. From Northeast America there are a description of an *Arnica* soc. from Wolstenholme (POLUNIN 1948, p. 229) and from the same place (p. 232) a description of a "flower slope", on which amongst others *Astragalus alpinus*, *Polygonum viviparum*, *Campanula uniflora*, *Poa arctica*, and *Pedicularis lapponica* are frequent, while *Arnica*, *Potentilla hyparctica*, *Erigeron eriocephalus*, *Carex capillaris*, and others are less frequent. Very few slightly oceanic species (*Luzula spicata* and *Salix herbacea*) penetrate into this community and no genuine herb field species.

EG-species of the vegetational type.

Arnica alpina. As this species must be considered a collective species and as the various units are not sufficiently well known as regards distribution and ecology I shall in this place restrict myself to stating that the Greenland units together have an arctic-continental distribution and that ssp. *angustifolia* Maguire, which occurs in the arctic-American archipelago, Greenland, and Spitzbergen (map fig. 11 in HULTÉN 1949), is hardly the only race in Greenland, as different chromosome numbers have been ascertained there. The West Greenland plants I had before me, presumably all belonged to ssp. *angustifolia.* They occurred both in alpine herbaceous vegetation and in scrubs and *Kobresia* soc. in the lowlands. The species therefore is not reliable as an EG-species.

Campanula uniflora. Widely distributed arctic with a continental and high arctic trend, thus markedly alpine in the southern parts of Greenland. The map in FERNALD (1929) shows a gap in arctic Northwest America and this gap has held out in spite of later energetic collections (cf. A. E. PORSILD 1951, p. 295). The species occurs in the Aleutian Islands and in Northern Iceland (by mistake stated to be missing there in B. 1951 c, p. 377), but these occurrences must be considered as advanced outpost stations of a species with its main distribution in the continental parts of arctic America and Greenland. — Ecology: Characteristic of SØRENSEN's xerophilous herb field, but in the south further as a fell-field species (cf. p. 138). I saw it in small fragments of arctic herbaceous vegetation at Itivdlínguaq and on the northern slopes of Nákajanga (Loc. 8).

Erigeron eriocephalus. The Greenland population probably belongs to the same type as the one found in North America. RAUP's map of its distribution there (1947, Plate XXXV) indicates a pronounced continental, if anything, high arctic species. In West Greenland as far south as to an alpine station near Holsteinsborg; not found in the interior at 67° lat. N. Also

characteristic of the xerophilous herb mat of Northeast Greenland, but like the preceding species in the south also occurring as a fell-field plant or in brook gravel and fresh morainic soil (M. P. Porsild 1920).

?*Taraxacum umbrinum*. There is too little material to decide whether this species will do as an EG-species, but there is much to indicate that this is so (cf. B. 1952 a).

In the interior around Søndre Strømfjord *Melandrium affine* might almost be termed an Hb-species of an alpine herbaceous vegetation. Here, however, it occurs in a border area, where it seeks out somewhat special habitats. In its main distributional area, which, in spite of occurrences in Southern Alaska, is high arctic-continental (cf. details in Fernald in Rhodora 34, p. 22), it is little selective and therefore can hardly be used as EG-species for any community. It is, however, worth noting that it is mentioned as especially frequent in the xerophilous herb mat in Northeast Greenland (Seidenfaden & Sørensen 1937, p. 119).

The only typical example of a vegetation belonging to this type is found on Nákajanga ridge at a height of 500 m above sea level. On a scree below a south-facing rock, where a constant but early melting snow-cover was to be expected, was found especially a low, repent race of *Salix glauca callicarpaea*, besides *Arnica alp. angustifolia*. Other important species were *Campanula rotundifolia* and *Draba lanceolata*; there were scattered occurrences of *Taraxacum umbrinum*, *Draba aurea*, *Potentilla nivea subquinata*, *Pirola grandiflora*, *Saxifraga tricuspidata*, *Artemisia borealis*, *Melandrium triflorum*, and *Kobresia myosuroides*, to mention the continental arctic species first. Arctic widely distributed species of scattered occurrence were *Trisetum spicatum*, *Cerastium alpinum*, *Polygonum viviparum*, *Saxifraga cernua*, *S. nivalis*, and *Chamaenerium latifolium*. Finally *Cystopteris* was found. Unfortunately it was not collected, so it cannot be decided whether the plants belonged to ssp. *dickieana* or the southern subspecies.

The flora which in some inland places was found on north-facing rocks in the mountains was of a slightly different character. It might be completely of the character of a snow-patch vegetation (fig. 48) or approach to the character of the herb field. The northern exposure caused the soil to be less dry than in the above-mentioned community. The following examples can be adduced:

(1) Hassells Fjeld, 400 m above sea level, Loc. 3. Arctic continental species: *Arnica*, *Potentilla nivea*, *Melandrium affine*, *Hierochloë alpina*, *Draba cinerea*, *Saxifraga tricuspidata*. Widely distributed-arctic: *Luzula confusa*, *Polygonum viviparum*, *Silene acaulis*, *Cerastium alpinum*, *Papaver radicatum*, *Saxifraga nivalis*, *oppositifolia*, *cernua*, and *rivularis*, besides *Cystopteris*. *Saxifraga rivularis* grew in crevices in the rock together with *Solorina crocea*, which is rare in the continental area. *Peltigera venosa* and *Anoectangium aestivum* were found on almost vertical parts of the rock.

(2) Bredesand, about 150—200 m above sea level, steep north-facing slope, Loc. 6. Arctic continental species: *Arnica*, *Melandrium affine*, *Potentilla*

nivea, *Pirola grandiflora*, *Saxifraga tricuspidata*, *Artemisia*. Widely distributed: *Poa glauca* (frequent), *Campanula rotundifolia*, *Cerastium alpinum*, *Polygonum viviparum*, *Saxifraga cernua*, and *Pedicularis hirsuta*.

a_1. The Arabis arenicola-Taraxacum lacerum Subtype.

(Mesophytic medium arctic continental herb vegetation on open calcareous sand, gravel, or clay).

This subtype is not set up without hesitation and its connexion to the complex is not made without vacillation, particularly because the communities mostly border directly on the *Carex nardina-Dryas* vegetation and may contain *Carex nardina* and other xerophytes.

Arabis arenicola approaches to the low arctic-continental species; its greatly disrupted area (see fig. 32 (3)) falls within the main distributional area of *Carex nardina* and its gaps are presumably due to the requirements of the species for basic-neutral soil (the occurrences near Hudson Bay seem to coincide with gaps in the Laurentian Shield). It is characteristic of open sand on the large river plains and of moraines close to the ice margin. As a rule the soil on which it grows is new-formed by glacier, river, or sea, and the vegetation is quite open. Rarely it enters the central parts of snow-patches (see DE LESSE 1952, pp. 54—55). The map fig. 32 (3) has been brought up to date by addition of finds mentioned by GARDNER (1946, p. 22), CODY (1950, Canad. Field Naturalist 64, 2), and CALDER (1951 a and b).

Taraxacum lacerum is a widely distributed arctic, slightly continental species. Its American-Greenland area is shown by RAUP (1947, Plate XXXVII) and is mentioned by FERNALD (1933, p. 378). Like the preceding species it is connected with new soil on beaches, river plains, open clay, etc., and it is no doubt calciphilous (growing e. g. on gravelly limestone barrens on St. John Island).

The two species occurred in Sandflugtdalen, together or apart, mostly on completely open sand where this was not particularly exposed to the east wind and was not particularly dry. Especially *Armeria scabra sibirica*, *Rumex acetosella*, and *Chamaenerium latifolium* might occur together with the two EG-species. A little *Carex maritima* might also begin to crop up, and in a single place *Braya linearis* was seen. Both there and in Ørkendalen there were rather large areas with *Chamaenerium latifolium-Rumex acetosella* sociations or pure *Chamaenerium* soc., which because of scattered occurrence of one of the two EG-species seemed to belong to the subtype (fig. 42). An open sociation of *Taraxacum lacerum* was seen partly on sand in the valley in Loc. 1—2, partly on large clay hills beside the fjord (Loc. 3 and 7).

The subtype evidently occurs at Eqe in Disko Bugt (DE LESSE 1952, p. 67 no. 18) and presumably in South Greenland on moraines and in clayey-sandy river valleys (ROSENVINGE 1896, pp. 229—233), although



Fig. 42. *Chamaenerium latifolium* forms the principal part of the vegetation between low dunes covered with *Salix glauca callicarpaea*. Sandflugtdalen. TWB phot. Aug. 1946.

the picture there is somewhat confused by a few oceanic species (*Juncus trifidus*, *Viscaria*). POLUNIN's examples from calcareous manured gravel or from a zone above the shore vegetation proper on Hudson Bay (1948, pp. 150 and 239) clearly belong to the subtype. HARTZ's gravelly fell field at Patoot (1894, p. 50), where *Arabis arenicola* occurs at a height of 940 m above sea level together with *Phippsia algida*, *Draba alpina*, and others, may be more doubtful as a member of the subtype.

b. The Cassiope tetragona-Dactylina arctica Type.

(Arctic continental mesophytic and medium chionophilous dwarf-shrub vegetation rich in mosses and lichens).

This is the important arctic heath type. Its very great importance appears from all earlier reports on North Greenland vegetation and from POLUNIN's descriptions from the arctic American archipelago. Everybody who has seen *Cassiope tetragona* in the arctic regions will find that it is a matter of course that great importance is attributed to this species as an ecological guiding species. Therefore it seems very

strange that NORDHAGEN (1936) attaches less importance to *Cassiope tetragona* and instead makes such species as *Kobresia myosuroides* and *Dryas octopetala* form corner stones in his system. As a result he has the *Cassiope* heaths of North Scandinavia distributed to two alliances. One of these, "*Elynion*", comes to range between so widely different elements as *Carex nardina* sociations, which according to NORDHAGEN "im Winter einer starken Deflation und äusserst niedrigen Temperaturen ausgesetzt sind", and *Cassiope* heaths, which also in Scandinavia are considered to be constantly snow-covered in winter (see THORE FRIES 1913, pp. 69 and 90). I should prefer to treat all *Cassiope tetragona* heaths as one large vegetational unit and to subdivide this.

EG-species of the vegetational type:

The best EG-species are *Cassiope tetragona* and the lichen *Dactylina arctica*, which in the part of West Greenland known to me was a faithful follower of *Cassiope* and which also in Northeast America is frequent in *Cassiope* heaths. The nearly overlapping areas of these species in America-West Greenland appear from fig. 43, which also shows the related, but more southerly distribution of *Pirola grandiflora*. This is not an EG-species, but it is of a certain value as a differential species for the southernmost *Cassiope* heaths.

Three species can be considered as weak EG-species, viz. *Tofieldia coccinea*, *Carex misandra*, and *Luzula arctica*, the distribution of which agrees with that of the good EG-species, but which also occur in other communities than *Cassiope* heaths within the complex and also sometimes are found in communities belonging to the complexes I and III. According to SEIDENFADEN & SØRENSEN *Tofieldia coccinea* is a *Cassiope*-heath plant, but at the head of Søndre Strømfjord it also grows in fell fields and not too dry wind-eroded heaths (Table 14).

As to distribution of all EG-species they have an Atlantic gap which at least comprises South Labrador, South Greenland, Iceland, and South Scandinavia, but which in the case of *Dactylina* is much wider (see LYNGE 1933). Still, all species must be characterized as circumpolar and high arctic-continental with the restriction that *Luzula arctica* in Northwest America is replaced by a variety (*latifolia*) the distribution of which is oceanic-montane. Details concerning the various species:

Cassiope tetragona. Distribution maps: Fig. 43, RAUP (1947), B. 1933a. — Ecology: Everywhere in places with a medium long snow cover. Most pH values from *Cassiope* heaths are between 5 and 6.5 (Table 16 and HADAČ 1946, p. 161).

Carex misandra. Distribution: Greenland SEIDENFADEN & SØRENSEN 1937, B. 1938, Quebec RAYMOND 1951, fig. 4, Alaska HULTÉN 1941—50, map 311.

Luzula arctica. Distribution: Greenland B. 1952a; see further A. E. PORSILD 1951, p. 129, HULTÉN 1941—50, map 349a-b. — Ecology: HADAČ 1946 considers it a character species of the so-called *Caricion nardinae*, which in Spitzbergen comprises mesophytic communities, among them *Cassiope* heaths, on which *L. arctica* attains to a constancy percentage of 90.

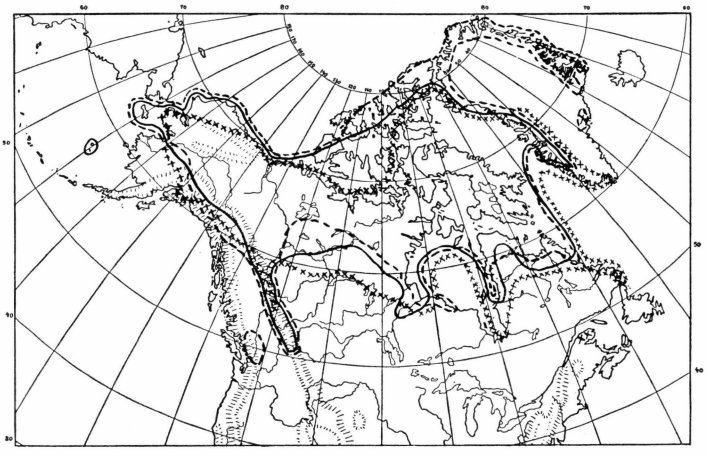


Fig. 43. Distribution in America-Greenland of *Dactylina arctica* (——), *Cassiope tetragona* (-----), and *Pirola grandiflora* (×××) drawn on the basis of maps in LYNGE (1933), RAUP (1947), and B. (1933a and 1938). In Quebec-Labrador the distribution of *Cassiope tetragona* has been corrected by M. RAYMOND, who states that the species is found isolated in Caribou Island, a wind-swept island immediately north of Newfoundland.

Tofieldia coccinea. Distribution maps: Greenland B. 1938 and 1952 a. HULTÉN's map of the occurrences in Alaska show a wide oceanic distribution (the Aleutian Islands), which is connected with the fact that he does not distinguish between the oceanic-alpine species or subspecies *T. nutans* and the continental *T. coccinea*; cf. A. E. PORSILD 1939, p. 213.

Dactylina arctica. Distribution maps: LYNGE 1933 and fig. 43. Besides on *Cassiope* heaths this species occurs in related heath vegetation with *Empetrum* or *Vaccinium uliginosum microphyllum* as dominants, but belonging to the complex (see e. g. POLUNIN 1948, pp. 271 and 193); it may also be found in adjoining snow-patch vegetation (cf. p. 122). At the head of Søndre Strømfjord it was an exclusive highland plant, which on north-facing slopes did not occur until at altitudes of 300 m above sea level.

1. Cassiope tetragona Sociations without Dryas.

In the inland around Søndre Strømfjord these sociations were not observed until at Itivdlínguaq, where they especially occurred on north-facing slopes and, a little up on the mountains, also on horizontal ground. An example of such a *Cassiope-Empetrum* heath on level ground is seen in fig. 44, while another horizontal *Cassiope* heath with *Dryas* will be mentioned below. Farther into the fjord in Loc. 1—9 the *Cassiope* heath was mainly alpine and exclusively found on north slopes and horizontal streaks along north-facing steep rocks. With a single exception all *Cassiope* heaths on the lower parts of the mountains were found on steep north slopes and were very rich in mosses. This characteristic occurrence is illustrated in B. 1949a fig. 12.



Fig. 44. Itivdlínguaq. In the foreground dense, tall *Cassiope tetragona-Empetrum* heath with *Ledum palustre decumbens*, *Betula nana*, *Vaccinium uliginosum microphyllum*, *Salix glauca callicarpaea*, and in small spaces between the dwarf-shrubs: *Cerastium alpinum*, *Chamaenerium latifolium*, *Pedicularis flammea*, and *Tofieldia pusilla*. T.W.B. phot. $^{24}/_{7}$ 1946.

The place where *Cassiope tetragona* in the lower parts of the mountains deviated from its association with the northern slopes was very instructive. A ravine on the south slope of Hassells Fjeld runs parallel with the mountain range in the direction east–west and its bottom rises evenly to about 300 m above sea level, where there is a corner, after which the ravine continues steeply farther up towards the mountain plateau. At this corner there was a *Cassiope* heath particularly rich in species. It occurred in the following profile transect laid across the ravine:

(1) Bare south-facing steep wall.

(2) Southeast-facing slope below steep wall: Low dry willow scrub with *Potentilla crantzii*, *Cerastium alpinum*, *Cystopteris*, *Trisetum spicatum*, *Melandrium triflorum*, and *Polygonum viviparum* (cf. pp. 202—203).



Fig. 45. *Cassiope tetragona* heath rich in lichens on the Nákajanga plateau 650 m above sea level; cf. Table 18, no. 11. In the foreground much *Stereocaulon*. T.W.B. phot. $^1/_8$ 1946.

(3) The same slope farther down: *Kobresia myosuroides* soc. rich in species, several of the species of the willow scrub.

(4) Slightly sloping southeastern incline near the bottom of the ravine: *Rhododendron lapponicum* heath.

(5) Northern part of the bottom of the ravine, which slopes slightly towards the WSW: *Cassiope tetragona* heath (Table 18, no. 8).

(6) Southern part of the bottom of the ravine under great influence from the shadow of a steep north-facing rock-wall at the other side of the ravine: *Calamagrostis lapponica groenlandica-Hylocomium splendens* soc.

(7) Steep north-facing rock-wall: *Pirola grandiflora-Hylocomium splendens* soc., at the foot of which *Saxifraga cernua* occurred.

(8) Top of rocky ridge which demarcates the ravine towards the south: *Kobresia myosuroides* soc. poor in species.

(9) Southern steep slope of rocky ridge, continuing direct in the south slope of the whole mountain: Dry willow scrubs, *Kobresia* or *Carex supina spaniocarpa* sociations.

There can be no doubt that the *Cassiope* heath is conditioned by the fact that snow accumulated in the corner of the ravine and was protected from melting too fast by the shadow of the north-facing wall, which especially in the spring must reach far across the bottom of the ravine. Nos. 2—3 melt out first, nos. 6—7 last.

Fig. 45 indicates the situation of a *Cassiope* heath rather rich in lichens (Table 18, no. 11) on the Nákajanga mountain plateau. Round and above the walking-stick there is *Cassiope* heath, on the right, below the slope, nearly in the centre of the picture there is a patch with a *Salix herbacea-Stereocaulon* sociation. Left of the picture on horizontal ground above the slope there was a *Dryas-Carex nardina* fell field. This is almost an object-lesson, so clear is it. A profile examination also from the Nákajanga plateau at a similar altitude above sea level is of a similar character. The profile begins with an almost vertical north-facing rock-wall, where there were moss cushions of *Calliergon sarmentosum* and others and in many places not a little *Conostomum tetragonum*, which was rare in the inland. The profile passed through the following sociations:

(1) Streak along the foot of the rock: vegetation rich in mosses (especially *Dicranum bonjeani*, *Calliergon stramineum*, *Paludella squarrosa*, *Sphagnum russowii*, and further, *Polytrichum norvegicum*, and *Lophozia* species), in which there were scattered *Saxifraga rivularis*, *foliolosa*, *Ranunculus pygmaeus*, *Oxyria*, and *Poa* sp.
(2) *Cassiope tetragona-Salix herbacea-Polytrichum hyperboreum* soc. (Table 18, no. 7), at a short distance from the foot of the rock.
(3) Outside the preceding soc.: *Vaccinium uliginosum microphyllum-Rhacomitrium lanuginosum-Stereocaulon alpinum* soc. with scattered *Cassiope tetragona*, *Rhododendron*, *Cetraria nivalis* and *cucullata*.
(4) Still farther away from the rock: Open *Vaccinium uliginosum microphyllum-Diapensia* heath rich in *Alectoria ochroleuca*, *Cetraria nivalis* and *cucullata*.
(5) *Dryas-Carex nardina* fell field rich in *Alectoria ochroleuca*, *jubata*, and *lanea*. Scattered *Pedicularis lanata* and *Silene acaulis*.

Otherwise the composition of the various *Cassiope* heaths poor in *Dryas* appears from the material in Table 18, nos. 1—11. They all originate from the innermost part of the fjord. The high constancy for *Pirola grandiflora*, *Stellaria longipes-monantha*, and *Rhododendron* is characteristic. The following species may be dominant together with *Cassiope*: *Vaccinium uliginosum microphyllum*, *V. vitis-idaea minus*, *Empetrum*, *Salix herbacea*, *Hylocomium splendens*, *Aulacomnium turgidum*, *Rhytidium rugosum*, *Polytrichum hyperboreum*, and *Alectoria lanea*. The material clearly consists of a sociation group rich in mosses and one rich in lichens. The latter is only frequent on the plateau at a high altitude and often contains some *Rhacomitrium lanuginosum*. Among the

Table 18.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12
Locality no.	6	8	3	8	8	8	8	3	3	7	8	8
Altitude in m	50	50	500	500	550	600	650	300	500	250	650	350
Slope	25°	30°	40°	50°	25°	30°	15°	15°	20°	35°	30°	40°
Exposure	N	N	N	N	N	N	N	WSW	N	NE	N	NW
pH	—	6.5	5.2	—	—	5.2	—	5.8	5.4	—	—	5.2
Lt	—	0.9	0.7	—	—	0.3	—	1.0	0.4	—	—	0.7
EG Cassiope tetragona	4	3	3	4–5	2–3	3–4	3	4	3	5	5	2
— Luzula arctica	..	..	..	..	..	..	..	+	..	..	..	..
— Poa arctica	..	..	..	..	..	+	1	..	+	..	+	..
Cl Rhododendron lapponicum	+	3	..	..	..	1	..	1	1	1	..	..
— Ledum palustre decumbens	..	..	..	1	1	1	..	..	..	..	..	..
— Betula nana	1	1	..	..	2	2	..	..	1	..	..	..
— Vaccinium vitis-idaea minus	..	..	2	3	2	3	..	..	..	2	..	..
— Dryas integrifolia	..	..	..	..	..	..	..	+	..	..	..	..
— Pirola grandiflora	+	1	2	1	..	..	+	1	..	+	2	..
— Pedicularis lapponica	..	..	..	..	1	..	..	+	..	..	..	..
— Ranunculus lapponicus	..	..	..	..	1	..	..	..	..	..	..	..
— Stellaria longipes-monantha	+	..	+	..	+	+	+	+	..	..	..	..
— Kobresia myosuroides	..	..	..	..	..	..	..	+	..	..	..	..
— Carex norvegica inserrulata	..	..	..	..	..	..	..	+	..	..	..	..
Carex bigelowii	1	..	..	..	..	..	2	..	..	..	..	1
Chamaenerium latifolium	..	..	..	..	..	..	..	+	..	..	..	..
Cerastium alpinum	..	..	..	..	..	..	..	+	..	..	..	..
Empetrum nigrum hermaphrod.	..	2	2	..	2	4	..	..	..	..	2	1
Equisetum arvense	1	1	..	..	..	1	..	+	..	1	..	..
Lycopodium annotinum	..	..	..	..	..	..	..	..	..	..	..	3
Luzula confusa	..	..	..	..	..	+	+	+	+	..	..	..
Pedicularis hirsuta	..	..	..	..	..	..	..	..	+	..	..	..
Poa pratensis iantha	+	..	..	..	..	..	..	..	..	+	..	..
Polygonum viviparum	..	+	..	..	..	..	+	+	..	..	..	+
Salix glauca callicarpaea	2	..	..	..	..	..	..	1–2	..	..	..	2
— arctophila	..	..	..	..	..	..	..	..	..	..	..	2
Tofieldia pusilla	..	+	..	..	..	..	..	+	..	..	..	
Vaccinium ulig. microphyllum	3	2	..	..	..	..	..	3–4	4	..	..	1
Salix herbacea (cp. 117)	..	..	..	..	..	..	3	..	..	..	..	..
Barbilophozia lycopodioides and hatcheri	..	..	..	+	+	1	1	..	+	+	1	..
Cephaloziella sp.	..	..	..	..	..	..	..	+	..	+	..	..
Leiocolea muelleri	+	+	..	..	..	..	..	..	..	..	..	..
Lophozia alpestris major	..	..	..	..	..	..	..	+	..	+	..	+
— ventricosa	..	..	..	+	..	..	..	..	..	..	..	..
Orthocaulis kunzeanus	..	..	..	..	+	..	..	..	..	..	..	..
Plagiochila asplenioides	1	..	..	..	..	..	..	..	..	..	..	..
Pleuroclada albescens	..	..	..	..	..	..	..	..	..	..	..	+
Ptilidium ciliare	..	..	..	+	+	1	1	..	1	+	+	..
Scapania curta	..	..	..	..	..	..	..	..	+	..	..	..
Sphenolobus minutus	..	..	..	+	..	..	..	..	..	..	..	..

(To be continued)

Table 18 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12
Tritomaria quinquedentata	..	+	..	..	..	..	..	..	..	..	..	..
Aulacomnium turgidum	1	+	1	2	5	5	1	1	..	+	..	..
Dicranum angustum	..	..	1	..	..	..	2	..	..	..	2	..
— elongatum	+	..	..	..	..	..	..	..	..	+	..	..
— fuscescens	..	..	..	1	..	2	..	..	1	..	..	..
— scoparium	..	1	..	..	1	..	..	+	1	..	..	..
— strictum	..	..	..	..	..	1	..	..	..	..	..	..
Drepanocladus uncinatus	1	2	1	1	1	+	+	1	..	..	+	1
Hylocomium splendens	5	5	5	3	4	3	+	3	..	..	1	..
Hypnum callichroum	..	+	..	..	1	..	..	..	..	..	..	..
Polytrichum alpinum	..	..	..	..	1	..	..	..	..	..	..	..
(Cl) — hyperboreum	..	..	..	..	..	..	5	..	..	..	1	..
— juniperinum	..	..	+	..	..	..	..	..	..	..	..	..
— strictum	..	..	..	+	..	1	..	..	+	1	..	1
Rhacomitrium lanuginosum	..	..	..	..	..	+	..	..	..	..	1	..
Rhytidium rugosum	..	..	1	4	..	1	..	..	..	2	..	..
Sphagnum sp.	..	..	..	..	..	..	..	..	..	..	..	1
(Cl) Timmia austriaca	..	+	..	..	..	..	..	..	..	..	..	5
Tomenthypnum nitens	1	..	..	..	..	..	..	1	..	..	..	..
Webera cruda	..	+	..	..	..	..	..	..	..	+	..	..
— nutans	..	..	..	1	..	..	..	..	..	+	+	..
Alectoria lanea	..	..	..	..	..	..	..	..	+	4	..	..
— nigricans	..	..	..	..	..	..	..	..	+	..	..	..
— ochroleuca	..	..	..	..	..	..	..	..	1	1	..	..
Buellia disciformis muscorum	..	..	..	..	..	..	..	..	+	..	..	..
Cetraria cucullata	..	..	..	1	..	..	+	..	1	2	1	..
— islandica	..	..	..	..	..	..	1	..	..	..	..	..
— nivalis	..	..	..	..	..	..	+	+	+	..	1	..
Cladonia chlorophaea	..	..	..	..	..	?1	..	..	..	..	..	..
— coccifera	..	..	..	..	..	..	+	..	..	..	..	..
— gracilis	..	..	..	..	..	..	+	..	..	..	1	..
— pyxidata	..	..	..	..	..	..	+	+	+	..	+	..
Cornicularia aculeata	..	..	..	..	..	..	..	..	+	..	1	..
EG Dactylina arctica	..	..	..	..	..	2	1	..	+	..	1–2	..
Nephroma expallidum	..	..	..	..	..	..	..	2	+	..	..	..
Ochrolechia frigida	..	+	..	..	..	..	..	..	..	..	1	..
Parmelia omphalodes	..	..	..	..	..	..	..	..	+	..	..	..
Peltigera aphthosa	..	1	3	1	1	1	1	1	+	..	..	..
— canina	1	1	..	..	..	1	..	..	..	..	..	..
— erumpens	..	..	..	..	..	..	+	..	+	+	..	..
— leucophlebia	..	..	..	..	..	1	..	1	..	..	..	1
— malacea	..	..	..	..	..	..	..	..	+	+	1	..
Psoroma hypnorum	..	+	..	..	..	..	..	..	+	..	..	..
Rinodina roscida	..	..	..	..	..	..	..	..	+	..	..	..
Stereocaulon alpinum	..	..	..	..	..	1–2	2	..	1–2	..	2	..
Thamnolia vermicularis	..	..	..	..	..	..	..	..	..	+	+	..

heaths rich in mosses the *Cassiope-Hylocomium splendens* soc. is the most important. Other combinations, which do not appear from the table, are a *Cassiope-Salix herbacea-Sphagnum* soc. (probably *S. girgensohnii*) observed at an altitude of 600 m on Nákajamga ridge and from the same area a *Cassiope-Salix herbacea-Polytrichum norvegicum* soc., both from the immediate surroundings of snow-patches. The combination of dominant *Cassiope tetragona* and *Salix herbacea* can be interpreted

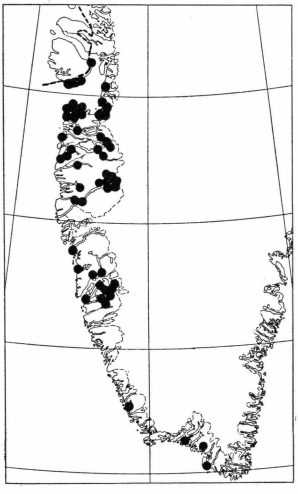


Fig. 46. *Vaccinium vitis-idaea* ssp. *minus* in Southern Greenland. The species is also known from a few stations in the Thule district. The eastern limit of the basalt is indicated by a dotted line.

as a mixed type as the two species have widely different distributions. In general *Salix herbacea*, where it occurs in *Cassiope* heath of the inland, is a comparatively subordinate element. The mixed type furthermore occurs at Eqe (cf. DE LESSE 1952, p. 51), and may be rather widespread.

Table 18, nos. 3—6 contain abundant *Vaccinium vitis-idaea minus*, which was especially frequent in *Cassiope* heaths rich in mosses. It is considered a Cl-species, because the Greenland population, if anything, behaves like a low arctic-continental species with concentration in the area between Disko Bugt and the interior of the Godthaabsfjord (fig. 46). On the whole it does not, however, seem to be continental, as there are too many stations for it in Atlantic East America (map in RAUP 1947). The Greenland population avoids the basalt on Disko-Nûgssuaq and was also calcifugous near Søndre Strømfjord. Therefore it is good as a differential species for *Cassiope* heaths on acid soil rich in humus. It is characteristic that it is absent in no. 2, where pH is 6.5 and *Rhododendron* makes its appearance as a co-dominant.

The deviating *Cassiope* heath in Table 18, no. 8 is particularly rich in species, which is no doubt due to the exposure and the comparatively rich soil. By its content of *Dryas* it forms a transition to the *Cassiope-Dryas* heaths mentioned below.

M. P. PORSILD (1902, p. 212) mentions a heath from Disko, which, if anything, belongs to the present sociation group, even though *Dryas* is mentioned in the floral list; for otherwise it includes e. g. *Ledum palustre decumbens*, *Empetrum*, *Pirola grandiflora*, *Hylocomium splendens*, and even such oceanic species as *Antennaria canescens* and *Cassiope hypnoides* associate with *Cassiope tetragona* as in other places *Salix herbacea*.

A *Rhacomitrium lanuginosum-Stereocaulon alpinum* soc. (with *Cetraria cucullata*) was seen in a few places on very shallow raw humus soil overlying rock between 350 and 550 m above sea level on Nákajanga (Loc. 8). As it frequently contained *Dactylina arctica*, this pure cryptogamic vegetation is perhaps placed best within the present vegetational type. It is no doubt related to the moss-lichen heath described by SUMMERHAYES & ELTON 1928, pp. 231—232, from Spitzbergen, the dominant of which is *Rhacomitrium lanuginosum* and which also includes *Dactylina arctica* and scattered phanerogams, especially *Luzula confusa* and *Salix polaris*. Furthermore, it may be related to the *Rhacomitrium* heath rich in *Hierochloë* described by DE LESSE 1952, p. 51, although the latter occurs on drier spots.

The transition to the low arctic heaths dominating the north slopes of the lower parts of the mountains is effected by *Ledum palustre decumbens* sociations with *Cassiope* as subdominant. Two examples of such sociations may be given:

(1) Nákajanga, Loc. 8, 600 m above sea level. *Ledum decumbens* heath with *Cassiope tetragona*, *Vaccinium uliginosum microphyllum*, *Polygonum viviparum*, *Cetraria cucullata*, *Alectoria* sp., *Stereocaulon alpinum*, *Dactylina arctica*, and *Aulacomnium turgidum*. Almost level ground.

(2) Hassells Fjeld, Loc. 3, 470 m above sea level. *Ledum decumbens-Betula nana-Vaccinium vitis-idaea minus* heath with *Cassiope tetragona*, *Empetrum*, *Pedicularis lapponica*, *Poa arctica*, *Aulacomnium turgidum*, *Hylocomium splendens*, *Dicranum* ssp., and scattered in the moss, *Dactylina arctica*. North slope.

2. Cassiope tetragona Sociations with Dryas.

The combination of *Cassiope tetragona* with a *Dryas* species is important and is found in North Scandinavia (cf. NORDHAGEN 1936, p. 39, VIII), in Spitzbergen and Northeast Greenland, (cf. HARTZ & KRUUSE 1911, pp. 385 and 405, HADAČ 1946, p. 161) where *D. octopetala* (coll.) occurs, and in West Greenland and Northeast America, where it is *D. integrifolia*; see below and POLUNIN 1948. *Cassiope-Dryas integrifolia* heaths are found towards the south as far as the interior of the Godt-

haab region; they were rare in the inmost part of the Søndre Strømfjord region, but were seen in several places near Itivdlínguaq. Farther north in Greenland they are no doubt common. Unfortunately there was no time for making analyses near Itivdlínguaq, but I have a note on a *Cassiope-Dryas-Betula nana* heath situated on almost level ground, where there was much *Carex misandra*, *C. rupestris*, and *Tofieldia coccinea*, and where the cryptogams especially consisted of *Stereocaulon denudatum*, *Cetraria nivalis*, and *Alectoria ochroleuca*. The heath was drier and perhaps more exposed to the wind than the mossy *Cassiope* heath, but is hardly bare of snow in winter. In another place near Itivdlínguaq I noted *Armeria scabra sibirica* and *Ledum groenlandicum* in a similar *Cassiope* heath rich in lichens, with *Dryas* and *Carex rupestris*. At the head of the fjord the combination *Cassiope-Dryas* was only seen at a high altitude on the Nákajanga plateau. Other combinations, in which *Cassiope* was more subordinate, however, were more frequent there. For instance, I saw there a *Dryas-Rhododendron-Vaccinium uliginosum microphyllum* heath with some *Cassiope tetragona* and scattered *Pedicularis lanata*, *Armeria*, *Tofieldia pusilla*, *Carex misandra*, *C. scirpoidea*, *Equisetum variegatum*, *Polygonum viviparum*, and a moss-lichen layer consisting of *Stereocaulon alpinum*, *Ochrolechia frigida*, *Alectoria ochroleuca*, *A. lanea*, *A. nigricans*, *Cetraria nivalis*, *Thamnolia vermicularis*, *Aulacomnium turgidum*, *Tomenthypnum nitens*, *Drepanocladus uncinatus*, *Dicranum angustum*, *Ditrichum flexicaule*, and *Hypnum revolutum*.

This *Cassiope-Dryas* sociation group is apparently rich in lichens and is situated on drier, less acid soil rich in humus. HADAČ's analyses from Spitzbergen, which evidently belong here, originate from soil with pH between 5.5 and 6.9, the great majority of values being above 6, while my heaths from the head of Søndre Strømfjord (Table 18) only in rare cases are found on soil with pH above 6 and, if so, show approach to HADAČ's analyses by containing much *Rhododendron*. A comparison between HADAČ's, NORDHAGEN's, and POLUNIN's analyses of *Cassiope-Dryas* heaths, for that matter, shows no small agreement between these analyses and with the two examples from West Greenland mentioned above. In Spitzbergen and Northeast Canada *Luzula arctica* is particularly important and almost constant; *Carex misandra* is extremely important in the Canadian examples, but little prominent in Spitzbergen. The Norwegian and Canadian sociations are floristically differentiated from the Greenland ones by the occurrence of *Salix reticulata*, which is absent in Greenland. In Spitzbergen and Norway *Salix polaris* is often abundant, while *Salix arctica* appears as an important component on the North Greenland and arctic Canadian heaths belonging to the present sociation group.

The *Cassiope tetragona* heath mentioned by A. E. PORSILD 1945, pp. 6—7, from the westernmost part of the Northwest Territories near the borders of Yukon are no doubt related to the group rich in *Dryas*. *Luzula arctica* is mentioned as exclusive species in this heath; but otherwise the heath is well differentiated from those mentioned above by the occurrence of a number of Asiatic-American Ar-species with an arctic-continental distribution (*Oxytropis maydelliana*, *Senecio atropurpureus*, *Saussurea angustifolia*, *Potentilla biflora*), which according to HULTÉN's material of maps avoid the southern oceanic areas in Alaska. These species are joined by the circumpolar, high arctic-continental *Eutrema edwardsii* (map 21 in FERNALD 1929). *Pedicularis capitata* and *Thalictrum alpinum* also occur here, the latter being most frequent in oceanic areas, but further circumpolar, low arctic.

III. The Saxifraga foliolosa-Ranunculus sulphureus Complex.

Arctic continental snow-patch vegetation and related marsh vegetations on wet soil.

On the relation of this complex to the arctic oceanic snowpatch complex see p. 108. The species after which the complex is named already indicate that the arctic-continental complex comprises both snow-patches proper and marshes which especially arise in connexion with melting snow-drifts. The vegetation can even become a community of scattered herbs occurring on moist clay or solifluction soil and, if so, is not always protected by snow in winter. With the support of especially SUMMERHAYES & ELTON (1928) and SEIDENFADEN & SØRENSEN (1937) a distinction may be made between a marsh type, which suitably may be termed the *Deschampsia brevifolia-Cerastium regelii* type, and a hygrophilous herb type, which may be called the *Draba micropetala-Ranunculus sulphureus* type, but which perhaps ought to be subdivided so as to correspond to SEIDENFADEN & SØRENSEN's ecosystems X and XI. The complex does not seem to include any dwarf shrub type. Even the *Salix polaris* snow-patches on Spitzbergen (HADAČ 1946, p. 147) and the alpine *Salix arctophila* sociations and related communities in the inland of West Greenland (cf. Table 18 no. 12) may probably be closest associated with the *Cassiope tetragona* heaths.

Due to the modest contingent of EG-species on the mountain tops at the head of Søndre Strømfjord the representatives of the complex there are little typical, and, therefore, the vegetation must to a great extent separated from the others on the basis of the widely distributed Hb-species. The continental snow-patches around Søndre Strømfjord are best characterized by *Saxifraga foliolosa* and the moss *Timmia austriaca*, which are both used in the name of the particular type which it is proposed to set up.

The EG-species are mostly high arctic and more or less continental, as the high arctic climate regardless of the relatively high humidity

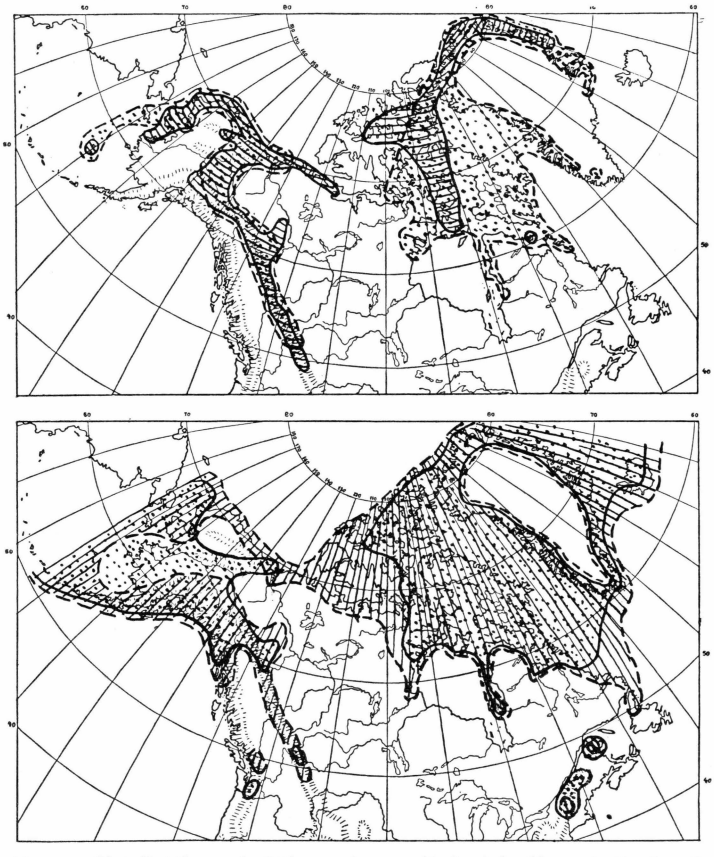


Fig. 47. Above, distribution of *Minuartia rossii* (hatched) and *Draba fladnizensis* (dotted area). Below, distribution of *Saxifraga rivularis* coll. (dotted area) and *Cardamine bellidifolia* (hatched area). American ranges according to RAUP 1947.

of the air found near the outer coasts is continental, with a wide range of the annual mean temperature and a low precipitation. Several of the species appear as outer-coast species in the south, a fact which is mainly expressive of their hygrophily. They may be particularly sensitive to a drying-up of the soil in summer. Fig. 47 shows the American-Greenland distribution of two of the EG-species. The eastern area of *Minuartia rossii* nearly coincides with the area of *Cerastium regelii*, cf. map fig. 7 in GELTING 1934. LÖVE 1951, fig. 6 has a circumpolar map of *Saxifraga foliolosa*, on which, however, the area in North America is exaggerated, thus the species is absent in Southwest Mackenzie (RAUP 1947). Still, it seems to be the EG-species which, besides *Timmia austriaca*, goes farthest south both in Greenland and America. The *Timmia* species is very widely distributed, but with so high a frequency in arctic continental regions that it seems allowable to use it as EG-species for the southern type around the Strømfjord.

A comparison between the distributions of the EG-species and the Hb-species, two of which are seen in fig. 47 below, shows that these represent a wider expansion towards the Atlantic regions. Both EG- and Hb-species are forced northwards in America just where the timber line crosses the arctic circle. This also appears from the distribution of *Oxyria digyna*, which as regards America has been mapped by FERNALD (1933, p. 93) and RAUP (1947, Pl. XXII).

Several of the species from the preceding complex appear as Cl-species, e. g. *Luzula arctica* and *Carex misandra*, but most important is the admixture of species from the high arctic bog and swamp complex, for which I provisionally propose the name of the *Arctagrostis latifolia-Dupontia fisheri-Carex stans* complex. This complex has been described by REGEL 1935 from Novaya Zemlya and a fine example from Northeast Greenland is pictured in GELTING 1934, p. 190. There are no representatives at the head of Søndre Strømfjord, but the complex reaches south as far as Sydostbugten in the Egedesminde District.

EG-species (high arctic-widely distributed arctic, continental, hygro-chionophilous species): *Deschampsia brevifolia*, *Cerastium regelii*, *Minuartia rossii*; (*Saxifraga hieraciifolia*).
Saxifraga foliolosa, *Ranunculus sulphureus*, (*R. nivalis*), *Draba micropetala*, *D. lactea-fladnizensis*, (*Melandrium apetalum*).
(*Timmia austriaca*, *Polytrichum hyperboreum*).

Cl-species: *Luzula arctica*, *Carex misandra*, *Poa arctica*, *Stellaria crassipes*, *Eutrema edwardsii*; *Alopecurus alpinus*, *Arctagrostis latifolia*.

Hb-species: *Phippsia algida*, *Sagina intermedia*, *Cardamine bellidifolia*, *Ranunculus pygmaeus*, *Saxifraga rivularis*, *S. tenuis*, *Juncus biglumis*.
Lycopodium selago.

Medium arctic species with an oceanic trend, which may occur in the south in coastal regions as important admixtures: *Draba crassifolia*, *Erigeron unalaschensis*, *Ranunculus glacialis*, *Poa alpina vivipara* (southern races).

Other species with a mainly low arctic oceanic distribution: *Koenigia islandica*, *Salix herbacea*.

a. The Saxifraga foliolosa-Timmia austriaca Type.

(Arctic continental snow-patch vegetation rich in mosses).

As basis of comparison and as starting-point there may be reason to mention an analysis from a snow-patch in Northern Baffin mentioned in POLUNIN 1948, pp. 75—76. The following EG-species were recorded there: *Saxifraga foliolosa*, *S. hieraciifolia*, *Ranunculus sulphureus*, *R. nivalis*, *Draba fladnizensis* coll., *Minuartia rossii*, and *Timmia austriaca*. There are many Cl-species, e. g. *Arctagrostis latifolia*, *Alopecurus alpinus*, *Luzula arctica*, *Eutrema*, *Potentilla hyparctica*, and many Hb-species,

e. g. *Phippsia*, *Cardamine bellidifolia*, *Juncus biglumis*, *Saxifraga cernua*, *S. rivularis*, and *Oxyria*. As compared with this analysis, the Søndre Strømfjord snow-patches are extremely poor. The only EG-species there are the two species after which the type is named and rarely, on the highest peaks, *Draba lactea*; but there are a good number of Hb-species, viz. *Ranunculus pygmaeus*, *Saxifraga rivularis*, and *Lycopodium selago*, all of them exclusive highland species, with which are associated *Oxyria*, *Saxifraga cernua*, *Poa pratensis rigens* (see B. 1952 a), numerous liverworts, and rarely *Carex lachenalii*. *Salix herbacea* appears as the only representative of the low arctic oceanic snow-patch type. Finally it is characteristic that a southern sylvicolous species like *Lycopodium annotinum* becomes an Hb-species in these continental snow-patches; cf. B. 1952 a, pp. 18 and 62.

EG-species of the vegetational type:

Saxifraga foliolosa. There is reason to call attention to the fact that this species in the complex has a wide distribution in all types, both marshes and genuine snow-patches, and that it also enters into certain types of bogs and swamps which cannot be considered as belonging to the complex; see e. g. the occurrence in Norwegian *Carex atrofusca* bogs (Nordhagen 1943, p. 461). On a northern slope at Kangamiut it formed a sociation rich in mosses in which *Deschampsia alpina* and *Carex lachenalii* were frequent. Thus it was not reliable as an EG-species.

Timmia austriaca is a similar case. This moss in Greenland has its main distribution in the north and in the inland. According to K. Holmen the species is frequent in Pearyland, where it often enters in snow-patch vegetation. In America it is frequent in Ellesmere, Devon Island, Baffin, and goes south to Northern Quebec and Southhampton Island. It goes particularly far south in the western mountains, but is absent in the Atlantic areas around Newfoundland (Steere 1937, map fig. 1, 1947, p. 445). It also occurs in Novaya Zemlya and Spitzbergen. In the latter place it enters into *Drepanocladus uncinatus* snow-patches (Summerhayes & Elton 1923, pp. 224—27). Hadač (1946) also mentions it from *Poa alpina vivipara* snow-patches together with *Ranunculus sulphureus*, *R. nivalis*, *Saxifraga hieraciifolia*, and other species, while its var. *arctica* is frequent in his "*Tomenthypnetum*", a community which is considered seasonally hygrophilous. Gjærevoll 1950b reports it as constant in *Salix polaris-Poa alpina vivipara* snow-patches rich in *Sauteria alpina* and on basic soil. Hartz (1895, p. 267) mentions *Timmia austriaca* from his luxuriant herb field on Gaaseland in Scoresby Sund. There it enters into a vegetation together with many low arctic-oceanic species, no doubt a mixed type, for Hartz mainly mentions the southern species and does not give a complete list of plants. Hesselbo 1918 says that the species is frequent particularly in Northern and Eastern Iceland and that it may e. g. be dominant under birches in Hallormstaðirskogur. He also mentions it from *Betula nana* heath (*loc. cit.* p. 590). Thus it shows a deviating behaviour in Iceland.

Polytrichum hyperboreum. As a dominant perhaps a weak EG-species, see p. 183.

The treatment of this sparse high alpine vegetation must on the whole be based on the investigations of some transects. One of these profiles was situated at a north-facing rock on Nákajanga and has already been mentioned on p. 170 (see no. 1 there). In front of another north-facing rock on the Nákajanga plateau the following zones were found (about 700 m above sea level):

(1) At the foot of the rock on a small northern slope: *Saxifraga foliolosa*, *Silene acaulis*, a little *Salix herbacea*, and *Polygonum viviparum* in a dense moss cover of *Drepanocladus uncinatus*, *Distichium capillaceum*, *Thuidium abietinum*, *Timmia austriaca*, *Webera cruda*, *W. nutans*, and *Tortula ruralis*.

(2) Below the small slope on level ground slightly below the level of (3); the place controlled by the shadow from the rock, like (1), but distinct from the former vegetation by poorer conditions of draining during the period of melting of the snow. The only phanerogam: *Ranunculus pygmaeus*. Moss cover very low, dominated by *Gymnomitrium concinnatum* and *Anthelia juratzkana*. Other important species are *Polytrichum alpinum*, *Lophozia alpestris*, *L. ventricosa*, *Drepanocladus exannulatus*, *Webera nutans*, and *Cetraria delisei*.

(3) Tussocky area on level ground at a short distance from the rock: *Salix herbacea-Carex bigelowii-Stereocaulon alpinum* sociation with *Poa arctica*, *Pedicularis lapponica*, and a few specimens of *Saxifraga nivalis*.

Along a third north-facing wall, which is seen in fig. 48 the following sociations were found:

(a) *Saxifraga foliolosa-Calliergon stramineum* soc. without other phanerogams. In a stripe nearest to the wall.

(b) *Oxyria digyna* soc. (rich in mosses) with *Ranunculus pygmaeus*, *Lycopodium selago* (in some places abundant), *Saxifraga cernua*, *S. foliolosa*, *Poa pratensis rigens*.

(c) *Oxyria-Poa pratensis rigens-Ranunculus pygmaeus* soc. (rich in mosses) with *Saxifraga rivularis*.

Moss samples from b—c especially consisted of *Drepanocladus uncinatus*, *Dicranum angustum*, *Polytrichum norvegicum*, and *Tritomaria quinquedentata*; of secondary importance were *Dicranum fuscescens*, *Bryum* sp., *Ptilidium ciliare*, *Peltigera* sp., *Stereocaulon alpinum*, *Cladonia pyxidata* and *coccifera*.

The soil under the moss carpet had pH 5.6 and a conductivity value of 0.3. Round the snow-patch vegetation proper there was a transitional zone with a *Cassiope tetragona-*(*Salix herbacea-*)*Polytrichum norvegicum* soc.

The communities mentioned will in spring appear as horizontal snow stripes along north-facing rocks. The snow-patch flora on Nákajanga is not, however, restricted to these places, but also appears on



Fig. 48. Snow-patch on Nákajanga ridge at an altitude of 600 m above sea level. Especially various *Oxyria* sociations. In the foreground transition to *Cassiope tetragona* heath. M. Lange phot. $^{10}/_{8}$ 1946.

the slopes of small V-shaped grooves on the northern slopes right down to about 300 m above sea level. In one case the southeast-facing slope was full of *Oxyria* and *Ranunculus pygmaeus*, while the northwest-facing slope had a *Timmia austriaca* sociation, in which *Lycopodium annotinum* and *Salix arctophila* crept in the moss and *Cassiope tetragona* stood in scattered patches. The snow-patch moss *Pleuroclada albescens* was also found there (see Table 18, no. 12).

Lycopodium annotinum on Nákajanga was furthermore found on a snow-protected heath with *Hylocomium splendens* as moss dominant, mostly together with *Empetrum*, *Cassiope tetragona*, a little *Betula nana*, and very rarely *Ledum groenlandicum*. On Hassells Fjeld *Lycopodium annotinum* was found again on a snow-patch heath, as appears from the following mention of this locality.

Hassells Fjeld was not high enough to give possibilities of snow-patches to any appreciable extent. A single place, however, was very interesting and was analyzed in detail. Along a north-facing vertical rock at an altitude of nearly 500 m there was an expanse sloping towards the north where it was bounded by a tarn. The level ground grew narrower and narrower and finally gave out, while the vertical rock continued into the lake. Three zones were found where the slope between rock and tarn was broad:

(1) Along the foot of the rock: *Oxyria-Timmia austriaca* soc. with *Ranunculus pygmaeus*, *Saxifraga cernua*, *S. nivalis*, and a little *Pedicularis hirsuta*.

(2) Then a narrow fringe with *Cassiope tetragona-Hylocomium splendens* soc., which farther from the rock became a poorly developed *Cassiope* heath almost without moss. Otherwise the vegetation included *Polygonum viviparum*, a little *Poa pratensis rigens*, *Pirola grandiflora*, and *Equisetum scirpoides*.

(3) Still farther from the rock, at an abrupt transition, there was a wind-eroded fell-field vegetation of *Carex nardina* and *Dryas*.

At the end of the sloping expanse there was besides the northern slope a western slope down towards the surface of the lake, with an inclination of 15°. The *Oxyria-Timmia* soc. nearest to the rock-wall was there supplanted by an *Oxyria-Bryum* soc., the composition of which appears from Table 19. Outside the latter, in continuation of the *Cassiope* heath there were two sociations which spread out on the slightly sloping incline towards the north and the west. Closest to the *Oxyria-Bryum* soc. there was dominant *Poa pratensis rigens*, partly in *Hylocomium splendens*, partly in a carpet of *Polytrichum hyperboreum*, *P. alpinum*, *Dicranum scoparium*, and *Lophozia alpestris major*. Farther down there was a snow-patch heath of repent *Salix glauca callicarpaea* with *Lycopodium annotinum* and *Polytrichum hyperboreum* as co-dominants.

Polytrichum hyperboreum seems to be especially frequent in the continental snow-patches (see Table 13, no. 10) and on heaths in the

Table 19. Snow-patch on Hassells Fjeld (Loc. 3); cf. Text.

Oxyria digyna	4	Tritomaria quinquedentata	1
Ranunculus pygmaeus	1–2		
Poa pratensis rigens	1–2	Bryum sp.	5
Cerastium alpinum	+	Distichum capillaceum	+
Polygonum viviparum	+	Drepanocladus uncinatus	+
Barbilophozia lycopodioides	+	Polytrichum alpinum	2
Lophozia alpestris major	1	— strictum	1
		Webera proligera	+



Fig. 49. Small valley close to the margin of the inland ice. (Loc. 1). The greatly shaded slope beside the steep rock on the right permitted lowland occurrences of *Cassiope tetragona* and, close to the rock, *Timmia austriaca*. T.W.B. phot. $^{26}/_{8}$ 1946.

immediate neighbourhood of these (see above and Table 18, no. 7). On the north-facing slopes of the Nákajanga area at an altitude of 500 m it was seen to form pure moss snow-patches together with *Hylocomium splendens*. Other species there were *Stereocaulon alpinum*, *Solorina crocea*, *Andreaea rupestris*, and a small amount of *Dactylina arctica* and *Nephroma expallidum*. *Polytrichum hyperboreum* is neither mentioned by NORDHAGEN (1943) nor GJÆREVOLL (1949, 1950b), which, in connexion with its behaviour in Greenland, its absence in Iceland, and its frequency in the Canadian Eastern Arctic, seems to indicate that it is a continental-arctic species. The pure moss snow-patches which it assists in forming may therefore suitably be placed in the present type. Such communities also seem to occur in Finnish Lapland (see HUSTICH 1940, p. 69).

In front of another north-facing rock on Hassells Fjeld, immediately along the foot of the rock there was a small dried up runnel with *Saxifraga rivularis*. This was followed by a slightly sloping north-facing expanse dominated by the low *Poa pratensis* which has been called var. *rigens*, and furthermore *Polygonum viviparum*, both growing in a carpet of *Hylocomium splendens* var. *alaskanum* and *Polytrichum* sp. Species of scattered occurrence there were *Stellaria longipes-monantha*, *Pirola grandiflora*, *Luzula confusa*, and *Cassiope tetragona*. *Peltigera leucophlebia* was frequent. Farther from the rock there was another furrow made by melting snow. It was also quite dry in summer and *Saxifraga rivularis* was growing there as well, besides *Ranunculus pygmaeus*.

Snow-patch vegetations of the kind mentioned above are associated with the highlands, it is true, but may also occur in a greatly impoverished form in the lowlands. This especially applied to the terrain

close to the ice cap. Beside a steep shaded wall a stripe of *Timmia austriaca* (fig. 49) was seen, in which there was a little *Saxifraga cernua*. On the rock itself this saxifrage was growing together with *S. nivalis* and *S. caespitosa*; but neither *Oxyria*, *Saxifraga rivularis*, *Ranunculus pygmaeus*, nor *Lycopodium selago* was found there or in other places so far down.

Beside a glacier fed river foaming along the ice margin *Saxifraga foliolosa* was seen on the north-facing bank growing in extensive cushions of *Calliergon stramineum*; cf. (a) p. 180.

This type may also be considered to include a sociation from the Egedesminde skerries mentioned by KRUUSE (1898, p. 381), which approaches to SØRENSEN's concept "denuded bog". It was found where the wind, while sweeping the snow together into drifts, clears the ground in front of them so that the place in winter is rough, but in spring is quite drenched. The floral list includes *Saxifraga cernua*, *S. foliolosa*, *Cardamine bellidifolia*, *C. pratensis*, *Cochlearia groenlandica*, *Ranunculus pygmaeus*, *Oxyria*, *Koenigia*, *Equisetum arvense*, *Lycopodium selago*, and a few others.

B. Complexes with Sub- and Low Arctic as Well as Widely Ranging Arctic Continental Species.

IV. The Artemisia borealis-Calamagrostis purpurascens-Arctostaphylos uva-ursi Complex.

Sub-low arctic continental xerophytic grasslands and dwarf shrub vegetation as well as associated willow scrubs.

Within Section B this complex is described first. In the lowlands and on the southern slopes of the mountains up to about 400—500 m above sea level it replaces the *Carex nardina-Lesquerella-Saxifraga tricuspidata* complex and plays an important part in the Strømfjord region. It also occurs in places, though hardly typically, farther south in the inland near Godthaab as well as farther north in the surroundings of Eqe (DE LESSE 1952, p. 63). In Northeast Greenland it occurs around the inner branches of Scoresby Sund (cf. HARTZ 1895) and from there it sends out offshoots of a more arctic character as far north as the area around Danmarks Havn (cf. SEIDENFADEN & SØRENSEN 1937).

The *Artemisia* and *Calamagrostis* species are very suitable to name the complex, for they are ecologically wide-ranging and occur in all the vegetational types of the complex without otherwise escaping this to any appreciable degree. As regards *Arctostaphylos uva-ursi* it is the American-Greenland population or races that are considered (see p. 217).

The complex is divided into three vegetational types: (a) the *Carex supina-Potentilla chamissonis* type, (b) the *Braya linearis-Gentiana detonsa* type, and (c) the *Arctostaphylos-Betula nana* type. Type (a) is a xerophilous grassland, a sub-low arctic steppe; Type (b) contains halophilous species and differs from the two others by its particularly high frequency of hapaxanthous species; it is a low arctic salt steppe. Both types of steppes have been allowed to include *Dryas* sociations. The reasons why these, as was also the case of the *Carex nardina-Hierochloë* type, are not treated as a special vegetational type is, in the first place, that the *Dryas* "heaths" in question do not differ by much else than the occurrence of *Dryas*, in the second place, that *Dryas* as regards life-form differs from the Bicornes dwarf shrubs by sometimes developing into a kind of suffruticose chamaephyte. Time and again the extreme branches die away after black frost. The *Arctostaphylos-Betula* type, on the other hand, is a heath of dwarf shrubs which do not die back. Therefore, *Dryas* soc. should either constitute independent heath types or be treated in connexion with such heaths or grasslands which have a related flora and ecology.

Various dry willow scrubs are associated with the complex; they will be discussed together after the description of the three vegetational types.

EG-species: (1) Continental sub-low arctic xerophytes: *Carex supina spaniocarpa*, *Roegneria violacea*, *Arabis holboellii*, (*Halimolobos mollis*), *Artemisia borealis*, *Antennaria affinis*, *Arctostaphylos uva-ursi* (American races).

(2) With a widely ranging arctic-continental distribution: *Calamagrostis purpurascens*, *Potentilla chamissonis*, *Erigeron compositus*, (*Melandrium triflorum*).

(3) Associated with the ultrabasic-halobous type: *Braya linearis*, *Torularia humilis*, (*Draba lanceolata*), *Gentiana detonsa groenlandica*, *Puccinellia deschampsioides*.

Cl-species, especially: *Kobresia myosuroides*, *Rhododendron lapponicum*, *Dryas integrifolia*, *Betula nana*, *Arnica alpina*, *Draba aurea*, *Primula stricta*.

(a). The Carex supina spaniocarpa-Potentilla chamissonis Type.

(Low-subarctic continental xerophytic grassland without halophilous species; "low arctic steppe vegetation").

This vegetational type shares the rule of the lowlands with the *Ledum decumbens-Calamagrostis lapponica-Galium brandegei* complex, but the latter is referred to northern slopes and semihumid and boggy areas beside lakes. On dry, medium dry, level to south-facing ground we have the "brownish" steppe, often alternating with willow scrubs and dry heaths belonging to the same complex as the steppe. This

patchwork vegetation of steppe and dry scrubs and heaths is independent of ground water; it is a result of the climate of the region and must be considered a lowland climax vegetation.

The inland ice of Greenland, like the North European Quaternary ice-sheets, has oceanic fronts and continental fronts. Magnificent examples of oceanic fronts occur in Southeast Greenland, where the ice reaches the sea on long stretches, only broken by capes which come to stand as semi-nunataks. On oceanic fronts the ice mainly comes up against topographic obstacles, whereas along the continental fronts it also has to fight the climate. Glaciologists reckon with the occurrence of extensive steppe areas along the continental front of the inland ice in Northern Europe during the Ice Age; so it is of great interest that in Greenland there is a recent steppe vegetation in the immediate neighbourhood of a continental front. Whereas similar areas in continental Northeast Greenland (cf. FRISTRUP 1952, 1953) because of the more arctic climate undoubtedly offers a less good basis of a comparison with Northern Europe, the Strømfjord area is situated so comparatively far south that the comparison becomes of considerable interest. The comparison concerns the ecological conditions along the West Greenland ice margin and the physiognomy of the vegetation, its life forms, etc., less its floristic composition as the latter is completely dominated by the American floral element.

Unfortunately no detailed descriptions of any related American vegetation are available. It appears from A. E. PORSILD's remarks (1937, pp. 131 and 134) that such a vegetation may occur. There is, however, hardly any great similarity; for this the climatic conditions along the West Greenland ice front are too special or unique (cf. p. 133).

The EG-species of the vegetational type:

Carex supina spaniocarpa. Cl: Low arctic-subarctic continental. Ar: The subspecies according to HULTÉN American-Greenlandic. The distribution of the main species in Eurasia is seen on map in MEUSEL 1943, Plate 63d; it is much more southerly ("subboreal-meridional-continental") and enters into communities without a single arctic element, but with numerous southern and continental species; see KLIKA 1933, p. 729; PRINTZ 1921, p. 23. The American range (fig. 51 after dot-map recently worked out by Dr. M. RAYMOND) is not connected, and even within the wide area between Alaska and Hudson Bay, stations are scattered. This fact compared with the completely dominant part played by the species along the continental ice front in Greenland suggests that the conditions which North America can offer the species at the present time do not suit it very well. — Ecology: The species reaches the areas of Archean rock near Hudson Bay, which no doubt corresponds to the fact that in Greenland it is frequent on slightly acid soil and avoids ultrabasic soil. It is extremely tolerant as regards conditions of temperature; for it goes high into the mountains and far north, but it has undoubtedly



Fig. 50. *Kobresia myosuroides* steppe alternating with dry, low willow and dwarf-birch scrubs. In the centre of the picture a valley with a glacier tongue of the inland ice. Behind it a marginal morainic mound is seen and close to the latter the vegetation-covered mountain. T.W.B. phot. $^{26}/_{8}$ 1946.

optimum conditions on south-facing lowland steppes in the continental area of West Greenland, where the temperature in summer gets very high about noon.

Potentilla chamissonis (*P. nivea* ssp. *chamissonis*). Cl-Ar: Widely distributed arctic with a somewhat high arctic trend; main distribution in continental parts of Greenland, but certainly there divided into numerous races, which require further investigation (see details in HULTÉN 1945, fig. 7; BÖCHER & LARSEN 1950, B. 1952 a). — Ecology: Nearly as in the preceding species, but will also stand greatly basic soil.

Calamagrostis purpurascens. Cl: Widely distributed arctic continental. Ar: American with radition to Greenland and Asia. The map fig. 51 shows the distribution in America-Greenland according to RAUP 1947; HULTÉN 1941—30, III; POLUNIN 1940 and B. 1938. SØRENSEN's demonstration (1954) of the fact that the southern collections from Greenland belong to a particular species has been considered, too. — Ecology: The species is basophile, and in America, apart from a single station, avoids the oligotrophic area around Hudson Bay. The Greenland population has undoubtedly immigrated through the region north of the area of Archean rock and has perhaps been deprived of southern races during this migration (cf. its wide southward distribution in West America and the occurrence of the species as an important component

in continental coniferous forests in Canada, RAUP 1946, pp. 38—40). The species is EG-species for the whole complex, but is dominant in the first two types only.

Artemisia borealis. Cl: Low arctic continental. Ar: Circumpolar. Very frequent in the continental area of West Greenland (map in B. 1951 c), but strangely rare in many places in America, where its distribution is disrupted (fig. 51, above). — Ecology: The Greenland population does not reach high arctic areas, but ascends to the peaks in the regions in which it occurs. Ecologically it seems to differ from the population in e. g. Novaya Zemlya, from where REGEL 1932 mentions *A. borealis* as occurring on a *Saxifraga oppositifolia* tundra of a high arctic character and together with species which are not xerophytes (e. g. *Luzula arctica*, *Saxifraga hirculus*, *Deschampsia alpina*). Otherwise the Greenland race behaves almost like the preceding species, but its optimum is more clearly in the most xerothermous sociations.

Roegneria violacea. Cl-Ar: MELDERIS' critical work (1950) suggests that this is a species with an American-Greenland, subarctic-continental distribution. Its very sporadic appearance in Greenland suggests perglacial survival (B. 1950). On Hassells Fjeld it is associated with the most xerothermous sociations of the vegetational type.

Arabis holboellii. Cl-Ar: American-Greenland species complex with a sublow arctic continental distribution. In America avoiding the oligotrophic area around Hudson Bay; cf. map in B. 1951 b. — Ecology: As the preceding species (this only applies to the Greenland plant, viz. *A. holboellii* var. *holboellii* and var. *tenuis* (cf. B. 1954)).

Halimolobos mollis (*Arabidopsis mollis*, *Arabis hookeri*). Cl-Ar: As the preceding species, but with a still more disrupted range; see B. 1951 c. — Ecology: Nearly like the preceding species, but also appears as an anthropochorous species (M. P. PORSILD 1932) and in ornitho-coprophilous vegetation (DE LESSE 1952, p. 77).

Antennaria affinis. Cl-Ar: Endemic Greenlandic, low arctic continental. Distribution not continuous (B. 1952, fig. 20). In the Strømfjord area in three different stations associated with the present type.

Erigeron compositus. Cl: Widely distributed, arctic continental. Ar: American-Greenland species, with its main distribution in the Rocky Mountains; see details in fig. 32 in MARIE-VICTORIN 1938; B. 1938, fig. 106, and SEIDENFADEN & SØRENSEN, fig. 56. As regards Greenland a single locality should be added at Kangerdlugssuaq on the east coast (Wager) and numerous localities around Søndre Strømfjord. — Ecology: SEIDENFADEN & SØRENSEN mention the species from the northern outpost of the type in Northeast Greenland (their ecosystem III), but furthermore from dry barren ground together with *Poa abbreviata* and other high arctic species. As in the Søndre Strømfjord area it just avoided the alpine barrens, but was concentrated in the lowlands in the present type, the Northeast Greenland population may be supposed to belong to another ecotype or perhaps to another apomictic microspecies; cf. BÖCHER & LARSEN 1950, who for the often tall-growing West Greenland race found the chromosome number $2n = 63$, and HOLMEN 1952, who found $2n = 54$ in material from Peary Land. In America it is said to have a little ecological plasticity and to occur exclusively on raw crumbling stone and gravel or windswept cliffs (DANSEREAU 1952, p. 361).

Melandrium triflorum can very nearly be considered an EG-species for the complex, but this only applies to the Strømfjord population, which

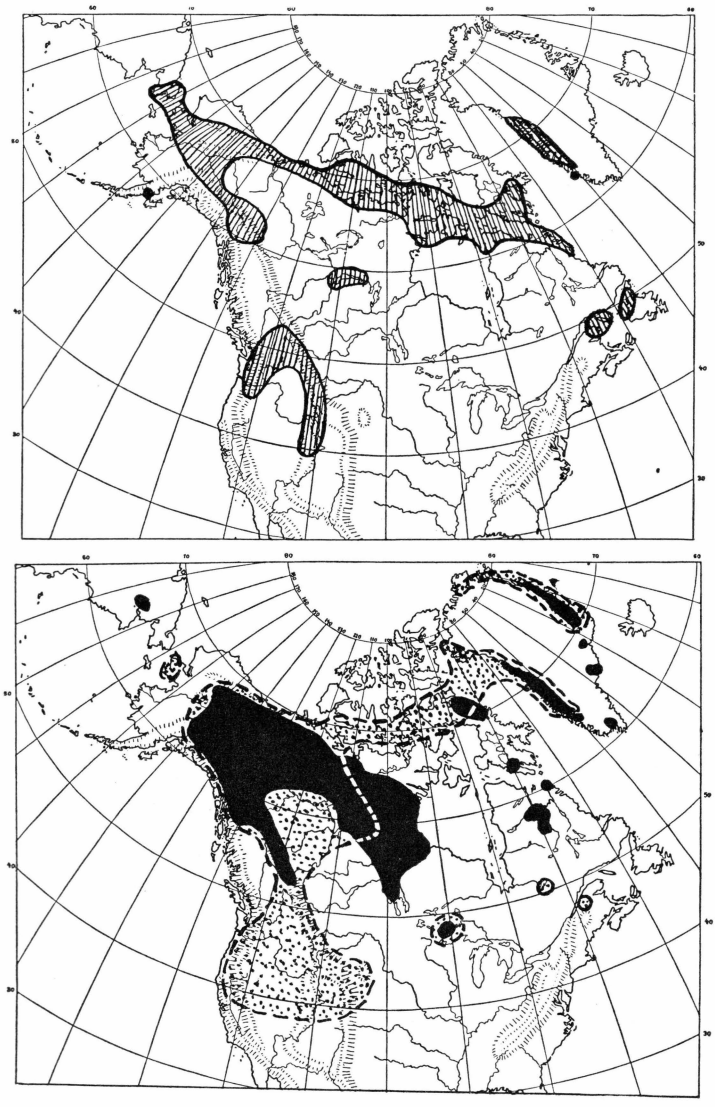


Fig. 51. Above, the American-Greenland distribution of *Artemisia borealis*. Below, *Carex supina* ssp. *spaniocarpa* (black areas) and (dotted areas) *Calamagrostis purpurascens* excluding ssp. *arctica*, which is a more oceanic race; cf. HULTÉN 1941—50.

behaves differently from e. g. the Northeast Greenland one. As a whole the species is endemic Greenlandic, widely distributed arctic-continental, around Søndre Strømfjord with a clear predilection for the steppe-like communities, but in Northeast Greenland with association with bird places and dry clayey flats (SEIDENFADEN & SØRENSEN).

The description of the large number of sociations will start with the most xerothermous ones, which are joined together to form the following sociation group.

a_1. The Roegneria violacea-Arabis holboellii Sociation Group.

The sociations mentioned below occur on dry gravel or sand, but most frequently on loess. The surface of the soil is exposed to considerable oscillations in temperature and because of southern exposure are heated considerably on sunny days (B. 1949b, Table 4). In winter the snow cover may be thin and disappear early (table 2 (6)). pH varies between 6.1 and 7.6 and the conductivity value between 0.4 and 1.1. Fig. 52 gives an impression of the very considerable deposits of loess, which can be covered by the representatives of the sociation group.

1. Carex supina spaniocarpa Sociations.

Pure *Carex supina spaniocarpa* sociation. The chief sociation of the southern slopes is a rather open grassland (total covering 60–90 per cent.), on which the cryptogams are mostly poorly developed. The occurrence of small black spots on the cracked loess soil is very characteristic. They especially consist of various blue-green algae and a *Cephaloziella* species; see further p. 207. Table 20 contains eight instances of pure *Carex supina* sociations (nos. 1—8).

Potentilla chamissonis-Carex supina soc. A variant of the preceding sociation, which occurs in small patches. Table 20, nos. 9—10.

Carex supina-Cetraria cucullata soc. Table 20, no. 11. A rare combination which was observed on a narrow strip of land between two lakes; see profile on p. 255—256.

Carex supina-Stereocaulon alpinum soc. Table 20, no. 12. On the level river plain in Sandflugtdalen. In small plate-shaped depressions in the plain this sociation was found above. It was followed by a *Calamagrostis purpurascens-Stereocaulon* soc. (cf. Table 20, no. 13) and below there was a *Kobresia myosuroides* soc. (Table 22, no. 6), a very instructive and typical distribution.

The transition to the *Carex nardina-Hierochloë* type is formed by *Carex supina* sociations with alpine species. Northeast of Keglen at an altitude of 350 m the alpine element consisted of *Pedicularis hirsuta* and *Sphaerophorus fragilis*; on the southern slope of Hassells Fjeld at an altitude of nearly 500 m of *Arnica* and *Hierochloë alpina*.

On the transition to bare south-facing rock, where the loess over solid rock forms a very thin layer, *Carex supina* sociations will be supplanted by a narrow extreme fringe without phanerogams, but dominated especially by *Cladonia pyxidata pocilla*, *Diploschistes scruposus*, and *Caloplaca citrina*.



Fig. 52. *Carex supina-Calamagrostis purpurascens-Artemisia borealis* steppe on extensive south-facing loess deposits near Strømfjordshavn. — On the left, the last willow shrubs before the connected steppe vegetation begins. T.W.B phot. $^{3}/_{8}$ 1946.

2. Calamagrostis purpurascens Sociations.

These are very important and in some places (fig. 54) form a kind of "tall grass prairie", while the *Carex supina* sociations appear as pronounced "short grass prairie". The dryness of the soil also seems to be somewhat smaller under the *Calamagrostis* vegetation, which often manifests itself by the fact that there are willow scrubs in the neighbourhood (fig. 53). But as in the *Carex supina* steppe the surface of the soil is cracked in small polygons and often has the small black spots of Cyanophyceae. The slightly greater humidity and perhaps a slightly richer soil in some places give conditions of growth to a tall race of diploid *Campanula rotundifolia*. Such a species as *Erigeron compositus* is more frequent where *Calamagrostis* is dominant. In some places it grew together with *Calamagrostis* in a small zone along the edge of depressions covered by *Arctostaphylos* heath (cf. fig. 8 in B. 1949b). Table 20, nos. 13—18 show various examples of *Calamagrostis purpurascens* sociations. With the exception of the first, from the more

Table

Analysis no.	1	2	3	4	5	6	7	8
Locality no.	3	3	3	7	3	3	3	3
Altitude in m	75	75	75	100	75	100	100	100
Slope	35°	40°	35°	30°	35°	30°	40°	35°
Exposure	SE	SE	SE	S	SE	SE	SE	SE
pH	7.6	—	6.8	—	—	—	—	—
Lt	0.8	—	0.7	—	—	—	—	—
Total covering per cent	90	60	90	60	80	80	60	60
EG Carex supina spaniocarpa	4	4	4	4	5	5	5	4
— Calamagrostis purpurascens	2	1	2	..	..	1	..	..
— Roegneria violacea	..	1	1	..	..	..	+	..
— Potentilla chamissonis	1	..	1	+	..	+	..	+
— Artemisia borealis	..	1	..	..	..	+	..	+
— Arabis holboellii	1	1	..	..	3	+	..	..
— Halimolobos mollis	1	1	..	2	3	..	+	..
— Antennaria affinis	..	..	..	..	..	..	..	..
— Erigeron compositus	..	..	..	..	..	3	..	..
Cl Melandrium triflorum	1	..	1	+	..	..	..	+
— Kobresia myosuroides	..	..	..	..	..	..	..	..
— Draba aurea	..	..	1	..	..	..	..	..
— Cystopteris fragilis dickieana	..	..	+	..	..	..	..	..
— Saxifraga tricuspidata	..	..	..	..	..	..	..	..
Campanula rotundifolia (coll.)	..	..	2	..	..	..	..	..
Cerastium alpinum lanatum	..	..	2	..	+	..	..	..
Euphrasia frigida	..	..	..	..	..	..	..	..
Festuca brachyphylla	..	..	..	..	..	..	..	..
Poa glauca	..	..	..	..	1	..	1	..
Trisetum spicatum (coll.)	..	..	..	..	..	..	..	..
Cyanophyceae and Cephaloziella sp. on the surface of the soil (p. 207)	+	..	..	..	+	+	+	..
Bryum sp.	..	..	..	..	..	..	..	..
Ceratodon purpureus	..	..	..	..	..	+	..	..
Distichium capillaceum	..	..	..	..	..	..	..	..
Ditrichum flexicaule	..	..	..	..	..	..	..	..
Encalypta cfr. ciliata	..	..	..	..	..	..	..	..
Hypnum revolutum	..	..	..	..	..	..	..	..
Polytrichum piliferum	..	..	..	..	..	..	..	..
Rhacomitrium canescens	..	..	..	..	..	..	..	..
Tortula ruralis	..	1	..	..	+	..	..	..
Webera nutans	..	..	..	..	..	..	..	..
Alectoria lanea	..	..	..	..	..	..	..	..
Hb[1] Caloplaca citrina	+	1	..	1	1	+	+	+
— elegans	..	1	..	..	..	..	..	..
Hb[1] — stillidiciorum	..	..	..	..	..	..	..	..
Cetraria cucullata	..	..	..	..	..	..	..	..
— nivalis	..	..	..	..	..	..	..	..

[1] See note on p. 194.

20.

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3	3	5	2	2	3	3	3	3	3	3	3	3	3	10
100	75	150	90	90	50	75	75	120	120	100	100	75	75	80
40°	35°	10°	0°	0°	30°	35°	35°	35°	30°	35°	35°	40°	40°	45°
SE	SW	ESE	—	—	S	SE	SE	SW	SW	SE	SE	S	S	S
—	6.7	6.5	—	—	7.0	—	—	—	—	—	—	—	—	7.6
—	0.6	0.4	—	—	1.0	—	—	—	—	—	—	—	—	0.9
70	100	100	90	80	90	100	95	100	100	70	60	80	85	60
3	4	3	3	3	+	1	2	3	+	2	1	..	..	..
..	1	..	+	4	5	5	4	4	5	..	..	..	1	2
..	..	..	..	..	..	..	..	..	..	..	..	4	4	..
4	4	+	..	..	2	2	2	3	1	1	..	..	..	3
+	..	..	+	..	..	1	2	1	3	4	4	3	2	2
..	..	..	..	..	..	1	..	..	..	..	..	..	..	2
..	..	..	..	..	..	..	..	..	..	..	+	1	1	..
..	..	..	..	..	..	..	..	+	..	..	..	..	..	..
..	..	..	..	..	..	1	1	2	+	..	..	..	+	2
+	..	..	..	1	+	..	1	+	1	..	..	..	+	+
..	..	..	..	1	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	+	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
..	..	..	..	..	..	1	3	..	2	..	..	..	+	..
..	+	+	..	..	..	..	2	..	1	..	..	..	..	1
..	..	..	..	..	..	+	..	..	1	..	..	..	..	..
..	..	..	..	+	..	..	..	..	..	..	..	..	..	..
1	1	2	+	..	+	..	+	1	..	1	+	+	1	1
..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
..	1	..	..	+	..	..	+	2	..	..	+	..	..	..
..	..	..	..	+	+	..	..	..	..	..	+	..	..	..
..	..	..	..	+	..	..	..	..	..	..	..	+	+	..
..	..	..	..	+	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	+	+	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	..	..	..	..	..
..	..	..	..	..	+	..	..	..	..	..	..	..	..	..
..	..	..	+	+	..	..	..	..	..	..	..	..	..	..
..	..	..	..	+	..	..	..	..	..	..	..	..	..	..
+	..	..	..	+	+	..	..	..	..	1	+	..	..	..
..	..	..	..	+	..	..	..	..	..	..	..	..	..	..
..	..	+	..	..	..	..	..	..	..	..	..	..	..	..
+	..	..	..	..	..	..	..	+	+	+	1	1	1	..
..	..	..	..	..	..	..	..	..	..	+	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	+	..	..	..
..	..	4	..	+	..	..	..	..	..	..	..	..	..	..
..	..	1	..	..	+	..	..	1	..	..	..	..	..	..

(To be continued)

Table 20

Analysis no.	1	2	3	4	5	6	7	8
Cladonia amaurocraea	..	..	..	..	..	..	..	..
— cariosa[2]	..	..	..	..	..	..	..	..
— chlorophaea	..	..	..	..	..	..	..	..
— coccifera	..	..	..	..	..	..	..	..
— gracilis	..	..	..	..	..	..	..	..
— lepidota	..	..	..	..	..	..	..	..
— mitis	..	..	..	..	..	..	..	..
— pyxidata	..	2	2	..	..	+	..	1
Cornicularia aculeata	..	..	..	2	..	..	..	..
Collema tenax corallinum	..	..	..	..	..	..	..	..
Dermatocarpon sp.	..	..	..	..	..	..	..	..
Hb[1] Diploschistes scruposus	..	..	..	..	..	..	..	..
Hb[1] Endocarpon pusillum	..	+	..	..	..	..	..	..
Lecanora epibryon	..	..	..	..	..	..	..	..
Peltigera cfr. canina (var.)	..	..	..	+	..	..	..	..
— erumpens	..	..	..	..	..	..	+	..
— lepidophora	..	..	..	..	..	..	..	..
— malacea	..	..	..	..	..	..	..	..
— rufescens	..	+	..	..	..	..	..	..
Hb[1] Physcia constipata	..	2	..	..	..	..	..	..
— muscigena	..	+	..	..	+	..	+	+
Rinodina nimbosa	..	1	..	..	..	..	+	+
— roscida	..	+	..	..	..	..	..	..
Stereocaulon alpinum walamoense	..	..	..	..	..	..	..	..
Thamnolia vermicularis	..	..	..	..	..	..	..	..
Toninia sp.	..	..	..	..	..	..	..	..
Lycoperdon molle (umbrinum)	..	..	..	..	..	..	..	..

[1] Widely distributed continental Hb-species associated with loess soil. [2] Widely distributed and continental

sandy soils of the level river plain, all the examples originate from the loess-covered slopes of Hassells Fjeld. M. LANGE (1948, p. 7) found the rare *Geaster minimus* in this community on Hassels Fjeld.

Beside the ice margin as well as in Ørkendalen there was dune vegetation dominated by *Calamagrostis purpurascens*. In Ørkendalen it was rich in lichens, such as *Stereocaulon alpinum*, *Cornicularia*, and *Cetraria nivalis* and was fairly similar to the dense *Calamagrostis purpurascens-Stereocaulon* soc. found on the river plain.

On *Calamagrostis purpurascens* sociations in the interior parts of Scoresby Sund see HARTZ 1895, pp. 145 and 225. HARTZ terms this two or three feet high dry grass vegetation "the scrub floor, but without the shrubs", and often found it associated with dry willow scrubs. *Arabis holboellii* and *Carex supina* show that we have to do with a vegetation closely related to the West Greenland one, even though *Arnica*, *Campa-*

(continued).

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
..	..	+	..	..	..	..	..	..	..	..	..	..	..	..
+	..	..	..	..	+	..	+	..	..	..	..	..	..	..
+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
..	..	1	+	..	..	..	..	..	..	..	..	..	..	..
..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
1	3	1	+	+	1	+	+	1	1	1	..	+	..	..
+	1	+	+	..	+	..	1	2	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	..	..	..	..	..
..	..	..	..	..	+	..	+	..	+	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	1	+	..	..	..	..	..
+	1	..	+	+	+	+	+	+	..	..	..	..	..	..
+	+	..	..	..	..	+	+	..	..	..	..	..	..	..
..	.. ..	+	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	1	..	..	..	..
+	..	..	+	..	..	..	..	..	..	+	1	+	..	..
+	..	..	..	..	..	..	..	..	..	2	1	+	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	1	5	1	..	..	..	..	..	..	..	..	..	..
..	..	+	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	..	..	..	..	..
..	..	..	..	+	..	..	..	..	..	..	..	..	..	..

nula uniflora, *Draba nivalis*, *Chamaenerium latifolium*, and others make it approach to the *Arnica-Campanula uniflora* type.

3. Artemisia borealis, Roegneria violacea, and Potentilla chamissonis Sociations.

Table 20, nos. 19—23 show examples of these three sociations. None of them covers any large areas, and it seems that ecologically they are most closely connected with the *Calamagrostis purpurascens* steppes. The *Artemisia* sociation is probably the most important one. It is pictured on Plate 1, fig. 2 in B. 1949b. The analysis from Itivdlínguaq (no. 23) originates from a place with loose gravelly soil formed by a strongly weathering rock. It contained tall individuals of *Arabis holboellii* var. *tenuis* but because of the nature of the soil, no cryptogams.



Fig. 53. *Calamagrostis purpurascens* steppe on cracked loess soil near the foot of Hassells Fjeld. In the background willow scrubs, which profit by the humidity which now and then appears close to the large free rock surface. In rainy weather the water falling on the rock runs down it and ends in the willow vegetation. T.W.B. phot. Aug. 1946.

A special type of open *Artemisia borealis* soc. was found on minor spots in the dunes at the head of Søndre Strømfjord. Almost only *Festuca rubra* and *Chamaenerium latifolium* occurred in this sociation. Also "white" dunes with *Chamaenerium* sociations were seen, and in these abundant *Artemisia borealis* appeared.

4. Potentilla tridentata Sociations.

Even though *Potentilla tridentata* prefers rocky soil it may also in the continental area occur in small spots on sand and loess and associated with species which without vacillation places the vegetation in the present group of sociations (Table 21). Example no. 1 originates from a southern slope of one of the river terraces near Keglen. The *Potentilla* occurred partly in dry, light willow scrubs, partly outside. The analysis was made in the latter place. The other examples originate from Hassells

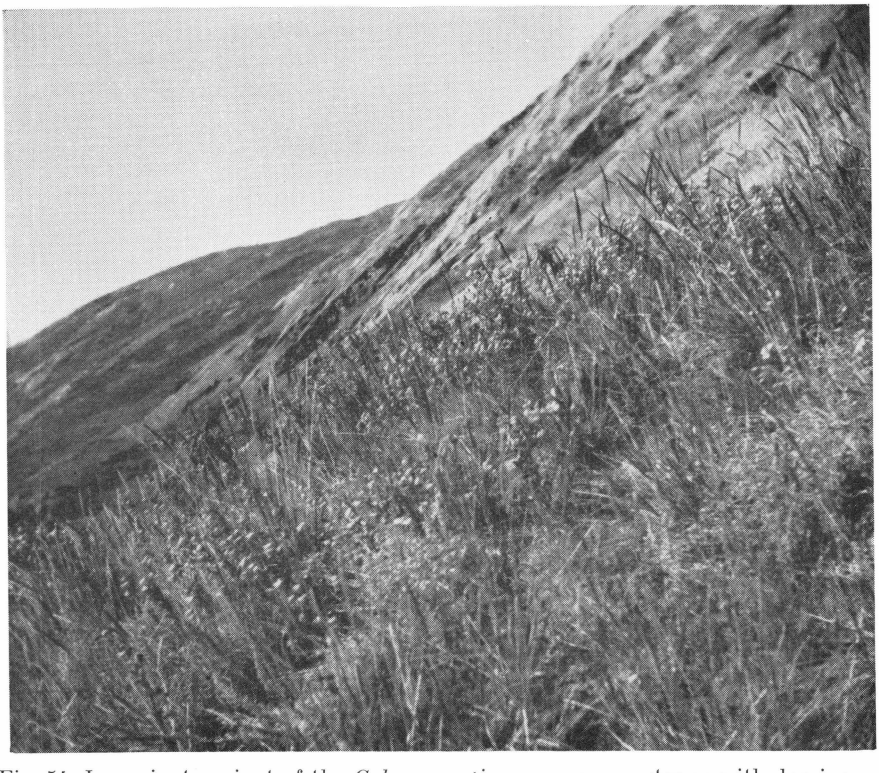


Fig. 54. Luxuriant variant of the *Calamagrostis purpurascens* steppe with dominance of the diploid *Campanula rotundifolia*, *Cerastium alpinum lanatum*, and (especially on the right) *Roegneria violacea*. T.W.B. phot. $^{29}/_{7}$ 1946.

Fjeld, where the vegetation was found on shallow loess soil on rock alternating with *Arctostaphylos* heath. pH varies between 6.1 and 7.0; cf. remark on p. 49.

a_2. The Kobresia myosuroides Sociation Group.

Table 20 gives a good impression of the small part played by *Kobresia myosuroides* in the driest steppe sociations. The greater part is played by it as soon as the degree of humidity becomes slightly higher. This is particularly often the case on nearly level areas, where the largest *Kobresia* steppes are found. *Kobresia myosuroides* is, however, a very versatile species; it is also found, e. g., as a dominant within the following vegetational type and mixes with the dwarf-shrub heaths as a subordinate element. I must completely disregard it as an EG-species, and as a Cl-species it is poor, as its distribution shows it to be a species with a slight continental trend only. It appears in communities which are so heterogeneous that it is regrettable that NORDHAGEN (1936)

Table 21.

Analysis no.	1	2	3	4	5
Locality no.	2	3	3	3	3
Altitude in m	100	80–120			80
Slope	30°	40–50°			45°
Exposure	S	S			S
pH	—	7.0	—	6.1	6.8–6.9
Lt	—	1.1	—		0.5
Total covering per cent	60	70–90			60
EG Carex supina spaniocarpa	1	+	+	1–2	3
— Calamagrostis purpurascens	2	1	1	1	1
— Potentilla chamissonis	..	+	1	1	+
— Artemisia borealis	..	+	..	+	+
— Arabis holboellii	..	..	+	..	2
— Erigeron compositus	..	..	2	..	..
— Arctostaphylos uva-ursi (American races)	..	..	..	..	2
Cl Melandrium triflorum	..	..	+	..	..
— Draba aurea	..	..	..	+	..
Campanula rotundifolia (coll.)	..	1	+	+	+
Empetrum nigrum hermaphroditum	..	..	..	..	+
Festuca rubra var.	..	..	..	+	..
Gentiana aurea	..	1–2	..	..	..
Poa glauca	..	1	..	..	..
Potentilla tridentata	4	5	5	4	4
Viscaria alpina	..	+	..	..	..
Woodsia ilvensis	..	..	..	+	..
Cyanophyceae and Cephaloziella sp. on the surface of the soil (p. 207)	2	..	..	1	1
Encalypta cfr. ciliata	..	..	..	1	..
Tortula ruralis	+	..	+	+	..
Hb[1] Caloplaca citrina	..	+	+	+	+
— elegans	..	..	..	+	..
Cladonia pyxidata	1	1	3	1	1
Hb[1] Diploschistes scruposus	..	..	+	+	..
Lecidea sp. with Stigonema sp. as cephalodia	..	..	..	+	..
Peltigera erumpens	+	..	+	+	1
— rufescens	..	..	+	+	..
Physcia muscigena	..	..	..	+	+
Stereocaulon alpinum walamoense	3	+	..	2	..

[1] Widely described continental Hb-species associated with loess soil.

and GAMS (1936) should attribute so great importance to it at the division of vegetation. Its appearance in the following Icelandic vegetation from a south-facing river bank near Geysir seemed to me to be that differing most from its occurrence on the West Greenland steppes.

Kobresia myosuroides 3, *Rubus saxatilis* 2, *Filipendula ulmaria* 2, *Alchemilla alpina* 2, *Agrostis tenuis* 2, *Prunella vulgaris* 1, *Lathyrus pratensis* 1, *Galium boreale* 1, *G. verum* +, *Festuca rubra* 1, *Anthoxanthum* +, *Thymus drucei* +, *Potentilla tabernaemontani* +, *Geranium silvaticum* +, *Alchemilla vulgaris* +, *Luzula multiflora* 1, *Salix herbacea* 1, *Polygonum viviparum* 1, *Rhinanthus* sp. +, *Euphrasia* sp. +, *Thuidium abietinum* +, *T. philibertii* +, *Hypnum cupressiforme* 1, *Hylocomium squarrosum* 1, *Drepanocladus uncinatus* 1, *Cirriphyllum piliferum* +.

A number of Mølholm Hansen's (1930) and Steindorsson's analyses (e. g. 1936, Table 7A, nos. 5—8) of Icelandic *Kobresia* vegetations are also very deviating from the Greenland *Kobresia* communities.

From the Colorado Rockies Cox (1933) mentions an *Elynetum*, which constitutes the alpine climax there. This is a meso-xerophytic meadow rich in species occurring on moderately acid soil (pH 5.4—6.0), nearly without any similarity to the West Greenland communities mentioned below, but with a few species (*Carex rupestris*, *Campanula uniflora*, *Saxifraga flagellaris*) in common with arctic Greenland *Kobresia* communities. In Colorado *K. myosuroides* is an important element both on fairly dry *Carex rupestris* heaths and on rather moist meadows dominated by *Sieversia*, *Polygonum viviparum*, *Thalictrum alpinum*, and others (thus scattered *Draba crassifolia*, *Sibbaldia*, and *Luzula spicata*, etc.). These Colorado *Elyneta* should no more than the above-mentioned Icelandic vegetation be included in the complex or be considered closely related to it.

The continental West Greenland *Kobresia* sociations are rather poor in species and physiognomically and floristically resemble steppes more than the Norwegian *Kobresia* communities which teem with *Dryas*, *Salix reticulata*, and *Ochrolechia*, and which otherwise floristically differ from the West Greenland ones by including such species as *Oxytropis lapponica* and oceanic elements like *Juncus trifidus*, *Loiseleuria*, *Bartsia*, indeed, even *Salix herbacea* (see Nordhagen 1936, pp. 38–43 II). There is hardly so wide a floristic difference from the Northeast Greenland *Kobresia* vegetations. According to Seidenfaden & Sørensen 1937, p. 117, these vegetations also contain large amounts of *Dryas* and furthermore e. g. *Carex nardina*, *Saxifraga oppositifolia*, and *Papaver radicatum*. Especially the last two species would be unimaginable in the West Greenland lowland vegetation dominated by *Kobresia*, but it is certain that on the mountain plateaux in West Greenland there are communities which approach very closely to the Northeast Greenland ones, and as a transition to such communities we not rarely somewhat up on the mountains find the combination *Kobresia-Dryas integrifolia* or *Kobresia-Arnica* soc., see below.

1. Kobresia myosuroides Sociations.

Pure *Kobresia myosuroides* sociations without dominant cryptogams are important as stages of transition to the preceding group of sociations and are often found on southern slopes, but cover most on



Fig. 55. Vigorous *Kobresia myosuroides* steppe poor in cryptogams between low willow scrubs in the area around Keglen in Sandflugtdalen; cf. Table 22, no. 3. T.W.B. phot. $^{5}/_{8}$ 1946.

slightly sloping terrain. The soil is loess or sand mixed with loess, slightly acid-neutral. Often some rather large areas with a mosaic of low willow scrubs and *Kobresia* steppe are found (fig. 55). There it is possible to observe the Greenland caribou, which easily hides among the bits of scrub.

Kobresia myosuroides-Stereocaulon soc. Table 22, nos. 5—7. Occurring especially on fairly sandy soil on the level river plain in the western part of Sandflugtdalen. In depressions on the plain the sociation might be rich in *Dicranum fuscescens* (no. 6).

Kobresia myosuroides-Cetraria nivalis-cucullata soc. Observed as rather an important variant, particularly in the region around Keglen and in Ørkendalen. Sometimes with some *Cladonia mitis* and *Cornicularia aculeata.*

Table 22.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Locality no.	3	3	2	3	7	2	3	3	2	3	3	3	3
Altitude in m	150	150	125	120	50	90	300	120	300	300	400	80	80
Slope	30°	40°	25°	30°	0°	0°	20°	40°	30°	20°	25°	25°	30°
Exposure	S	SW	S	S	—	—	S	SE	S	S	S	S	W
pH	6.5	6.4	6.6	—	6.6	6.2	—	—	—	—	—	6.5	—
Lt	0.5	—	0.4	—	0.3	0.4	—	—	—	—	—	—	—
EG Carex supina spaniocarpa	1	+	..	+	2	..	+	1	..	..	..	..	..
— Calamagrostis purpurascens	..	1	2	2	+	2	1	+	+	2	+	1	..
— Potentilla chamissonis	+	+	1	+	1	..	1	..	..	..	+	..	..
— Artemisia borealis	+	1	..	1	+	..	+	+	..	..	..	..	1
— Erigeron compositus	..	..	..	..	..	..	1	..	..	..	..	..	..
Cl Draba aurea	..	..	..	..	..	..	..	..	..	+	..	..	..
— Melandrium triflorum	..	+	1	..	1	..	+	..	..	..	..	..	..
— Kobresia myosuroides	5	5	5	4	4	5	5	3+	5	3+	3	..	+
— Arnica alpina angustifolia	+	..	..	..	+	..	..	..	4	..	..	..	..
— Dryas integrifolia	..	..	..	..	..	..	..	..	..	4	5	..	..
— Betula nana	..	..	..	..	..	..	..	..	..	1	1	..	..
— Saxifraga tricuspidata	..	..	..	..	..	..	..	..	..	1	..	..	..
— — aizoon neogaea	..	..	..	..	..	..	..	+	..	..	..	..	..
— Stellaria longipes—monantha	..	..	..	..	..	..	..	..	..	..	..	+	..
— Minuartia rubella	..	..	..	+	..	..	..	..	..	..	..	..	..
Agrostis borealis[1]	..	..	..	..	..	..	..	..	..	..	..	1	..
Gentiana aurea[1]	..	1	..	..	..	..	..	1	..	..	..	1	2
Potentilla crantzii[1]	..	..	..	..	..	..	..	3	..	..	..	4	5
Viscaria alpina[1]	..	..	..	+	..	..	+	..	..	..	..	..	..
Campanula rotundifolia (coll.)	2	1	1	..	..	..	1	1	1	+	..	2	1
Carex bigelowii	..	..	..	..	..	..	..	..	..	..	..	1	..
— scirpoidea	..	..	..	..	..	..	..	2	..	..	..	2	3
Cerastium alpinum lanatum	1	1	1	+	..	..	1	+	+	+	+	..	..
Euphrasia frigida	1	1	..	+	..	..	..	1	1	..	..	..	1
Festuca rubra var.	..	..	..	..	..	+	..	..	..	..	..	..	..
Poa glauca	..	1	..	1	..	..	1	..	..	..	..	..	..
Polygonum viviparum	1	..	..	..	..	..	..	+	..	+	+	2	1
Trisetum spicatum (coll.)	..	..	..	..	..	..	..	..	+	1	..	..	1
Barbula recurvirostris	+	+	..	..	?	..	..	..	..	..	..	..	..
Brachythecium salebrosum turgid.	..	..	..	..	..	..	..	..	..	..	..	2	..
Bryum sp.	+	+	..	+	..	..	..	..	..	..	..	..	..
Campylium stellatum	..	..	..	..	..	..	..	..	+	..	..	+[2]	..
Ceratodon purpureus	+	+	..	..	..	+	..	..	..	+	..	..	..
Dicranum fuscescens	..	..	..	..	..	3	..	..	..	..	..	..	..
— sp.	..	..	+	..	..	..	..	..	..	..	..	..	..
Distichium capillaceum	+	+	..	+	..	..	..	..	+	..	..	..	..
Drepanocladus uncinatus	..	..	..	..	..	+	..	..	+	..	..	..	..
Hypnum revolutum	..	..	..	+	..	..	..	..	..	..	..	..	..
— sp.	+	+	..	..	..	..	..	..	..	..	..	..	..

[1] Species with an oceanic trend or suboceanic. [2] Subsp. protensum.

(To be continued)

Table 22 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Myurella julacea	..	..	..	..	..	..	..	+	..	..	..	..	..
Polytrichum piliferum	..	..	..	..	..	+	..	..	..	..	..	..	..
Tortella fragilis	+	+	..	+	..	..	..	+	+	..	..	..	..
Webera nutans	..	..	..	..	..	+	..	..	..	..	..	..	..
Cetraria crispa	..	..	..	..	..	1	..	..	..	..	..	..	..
— cucullata	1	..	1	..	1	2	..	..	..	..	..	..	..
— nivalis	1	+	2	+	+	..	1	..	..	1	1	..	..
Cladonia gracilis chordalis	..	..	2	..	..	+	+	..	..	..	..	..	..
— lepidota	..	..	1	..	..	+	..	..	..	..	..	..	..
— mitis and rangiferina	..	..	..	..	..	+	..	..	..	..	..	..	..
— pyxidata (coll.)	1	2	+	2	..	..	1	..	1	1	+	..	..
Cornicularia aculeata	1	1	+	+	1	..	2	..	..	+	..	..	..
Peltigera erumpens	+	1	..	..	..	..	..	..	..	..	..	..	..
— malacea	..	..	+	..	..	..	1	..	1	..	..	..	..
Physcia muscigena	+	1	..	..	..	..	..	..	..	1	..	..	..
Stereocaulon alpinum walamoense	..	..	..	..	5	3–4	2–3	..	..	3	2	..	..

Kobresia myosuroides-Aulacomnium turgidum soc. A rarer sociation observed in the same places as the preceding ones, but always on level ground, which especially in spring must be assumed to be more humid. In Ørkendalen the sociation contained *Armeria scabra sibirica* and *Carex norvegica inserrulata* and *C. capitata* (perhaps typical *C. capitata*; unfortunately not collected), thus showing relationship to the continental marsh and fen complex.

Kobresia myosuroides-Potentilla crantzii soc. Table 22, no. 8. A rare type, only found beside medium humid willow scrubs on the southern slope of Hassells Fjeld. The presence of *Carex scirpoidea* and *Gentiana aurea* shows that this is a sociation at a stage of transition to the *Potentilla crantzii* soc. mentioned below. Cf. also profile on pp. 168—169, nos. 2—3.

Kobresia myosuroides-Arnica alpina angustifolia soc. Table 22, no. 9. A montane variant, not quite uncommon on dry soil at altitudes between 200 and 400 m above sea level.

2. Dryas integrifolia Sociations.

Table 22, nos. 10—11 are two examples of *Dryas-Kobresia* sociations from the lower parts of the highlands, where such were seen in a few places. In the lowlands in Loc. 9 there was a *Dryas-Kobresia-Cetraria nivalis* soc. with *Carex supina* and *Fulgensia bracteata*; in other places a *Dryas* soc. containing much *Artemisia*, *Kobresia*, *Carex supina*, *Cetraria nivalis*, and *Cladonia pyxidata*.

Potentilla crantzii Sociation with Affinity to the Kobresią Sociation Group

Where the soil in the lower parts of the southern slope of Hassells Fjeld locally was a little more humid and the ground for some reason was not covered by scrubs (perhaps because of too shallow soil) there was a vegetation which might be characterized as a "dry herb field". It covered very small expanses only. Two examples are included in Table 22 (nos. 12—13). They show the most humid representative of this dry herb field, a *Potentilla crantzii-Carex scirpoidea* soc. with *Gentiana aurea* individuals of a height of about 20 to 30 cm. Such a vegetation must be considered a mixed type, while other forms of this "dry herb field" may be placed within the present group of sociations (Table 22, no. 8). The *Potentilla crantzii-Carex scirpoidea* soc. is probably a parallel to NORDHAGEN's "*Potentilleto-Polygonion vivipari*", which he just associates with "*Elyneto-Seslerietalia*" (1936, p. 37). — As an example of a drier representative we may adduce the following floral list from a strip of scrubless slope close to a large "water-collecting" rock surface (! = dominant or very frequent): *Carex scirpoidea* !, *Campanula rotundifolia* !, *Gentiana aurea* !, *Roegneria violacea* !, *Artemisia borealis* !, *Euphrasia* !, *Polygonum viviparum*, *Festuca rubra* (var.), *Trisetum*, *Carex supina*, *Calamagrostis purpurascens*, *Kobresia*, *Potentilla chamissonis*, *P. crantzii*, *Cerastium alpinum lanatum*, *Erigeron compositus*, *Saxifraga tricuspidata*, *S. aizoon*, *Poa alpina*, *Luzula spicata*, *Cystopteris fragilis dickieana*.

a_3. Elymus mollis and Festuca rubra Sociations with Affinity to the Complex.

On p. 129 the proper shore vegetation in Southwest Greenland is mentioned. The vegetational type in question (the *Honckenya-Mertensia* type) may have *Elymus mollis* as dominant, but such a shore community then will hardly contain EG-species belonging to the present complex. The diploid *Elymus mollis* is itself a widely distributed species (see p. 129) and may occur in large amounts beside the large lakes on the North American continent. In the same way it forms vegetational patches in the inland behind the head of Søndre Strømfjord, — in the large valleys where there is sand-drift. These have no or very few shore plants, for which reason the sociations together with closely related *Festuca rubra* sociations may, if anything, be considered as belonging to a mixed type, as both *Artemisia borealis* and *Calamagrostis purpurascens* mix with *Elymus*.

Table 23.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Locality no.	3										1				
pH	6.9–7.0										6.8				
Lt	0.2										0.3				
EG Calamagrostis purpurascens	.	.	.	.	.	.	.	.	.	1	.	2	1	.	.
— Artemisia borealis	+	.	.	.	+	.	.	.	+	+	+	.	.	+	.
Cl Stellaria longipes (coll.)	.	+	.	+	.	.	.	.	+	.	.	.	.	.	.
— Carex maritima	.	.	.	.	.	2	.	.	+	.	.	.	.	.	.
— Juncus arcticus euarcticus	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Elymus mollis	3	5	5	4	3	3	4	3	2	3	3	4	4	3	5
Honckenya peploides diffusa	+	.	.	.	2	+	.	+	.	.	.	.	.	.	.
Plantago maritima juncoides	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.
Armeria scabra sibirica	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Cerastium alpinum	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Chamaenerium latifolium	.	.	.	.	.	.	.	.	.	.	+	1	1	2	+
Festuca rubra	2	1	+	1	1	1	+	1	2	1	+	+	1	2	.
Rumex acetosella	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.
Salix glauca callicarpaea	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Silene acaulis	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.

1. Elymus mollis Sociations.

The places in which *Elymus* is of greatest importance are the newly formed low sand dunes in the valleys, but it may also occur as a subordinate element in dense *Kobresia myosuroides* sociations. Table 23 contains examples of *Elymus* sociations from dunes in the western and eastern end of Sandflugtdalen. At the head of the fjord (nos. 1—10) *Honckenya* appears scattered and subordinate and reminds of the genuine shore vegetation by the sea. Farther into the valley *Honckenya* soon becomes rarer, and it is completely absent in the *Elymus* sociation closest to the inland ice (nos. 11—15). Nos. 1—10 were found on dry sand in the dune mounds, alternating with willow vegetation or an open *Artemisia borealis* soc. In depressions with a clayey bottom or clay overlain by a thin layer of sand occurred the *Plantago-Puccinellia* soc. mentioned on p. 258. Nos. 11—15 were found on sand deposited on the lower part of the south-facing slope of the valley (fig. 56). The vegetation there was rich in *Chamaenerium latifolium* or *Calamagrostis purpurascens.*

2. Festuca rubra Sociations.

These were observed in a place beside the inner northern branch of the fjord as "white" dune vegetation containing *Elymus mollis*, *Honckenya*, *Artemisia borealis*, *Calamagrostis purpurascens*, *Armeria scabra sibirica*, *Chamaenerium latifolium*, and *Carex maritima.*

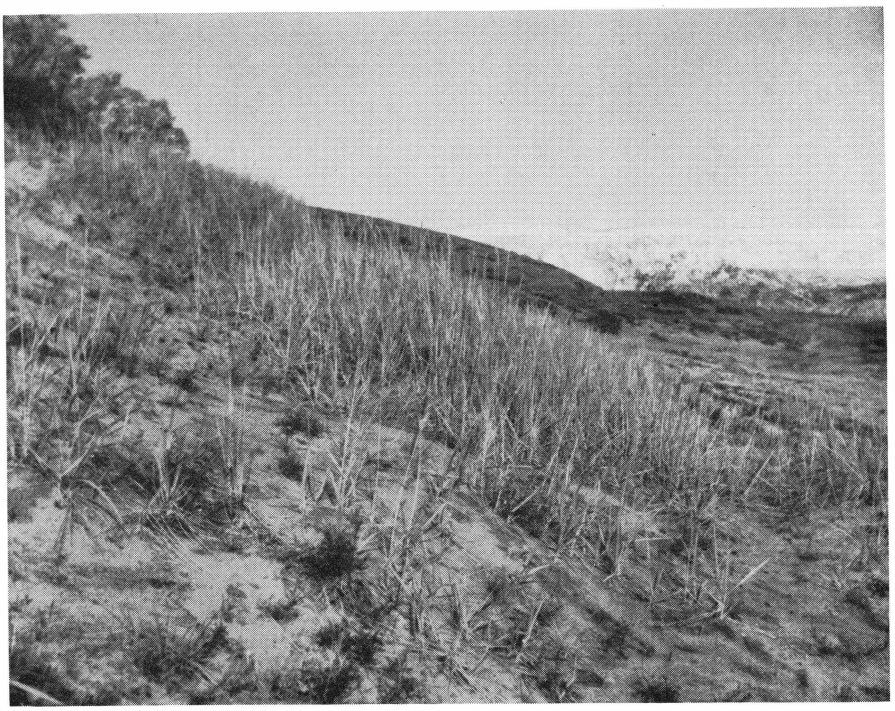


Fig. 56. *Elymus mollis* sociation on drift-sand in the easternmost part of Sandflugtdalen close to the inland ice, which is seen in the background. T.W.B. phot. $^{26}/_{8}$ 1946.

In a few places there might be approaches to the formation of a *Honckenya-Festuca rubra* soc. with a similar list of species besides willow, *Silene acaulis*, *Rumex acetosella*, and *Carex nardina*.

b. The Puccinellia deschampsioides-Gentiana detonsa Type.

(Low arctic-subarctic continental, xero- and mesophytic grassland and Dryas vegetation with halophilous species. "Low arctic salt steppe").

Among the communities analyzed this is perhaps the most interesting one. It is expressive of a soil development which is probably unique to an arctic area (cf. B. 1949b). The chief ecological property is that the soil at its surface is exposed to accumulation of salts. This is due to rising water movement and evaporation from the surface due to the draught. The water movement, however, never becomes so pronounced that the water constantly oozes out. For short periods, presumably especially in spring, the soil is saturated with water right up ot the surface. Because of the evaporation salt crusts will not rarely form above the ground (cf. analyses of such in B. 1949b). This alternation between transitory saturation with water and intense drying up is probably expressed in the flora by the occurrence of a relatively large

number of hapaxanthic species. It is of course a question of different degrees of humidity of the soil and accumulation of salt. The vegetational type correspondingly is rich in sociations. It is found on certain southern slopes and on level areas, dry in summer, near the shores of lakes without or with a transitory outlet. On such salt-lake shores there is every possible transition between the present type and representatives of the continental fen and marsh complex.

EG-species of the vegetational type:

Puccinellia deschampsioides. Cl-Ar: Sub-low arctic-continental, Greenland-American species; cf. further SØRENSEN 1953. — Ecology: Associated with the type as an important dominant, but may also occur in an adjoining closely related lake-shore vegetation (cf. p. 259). Will stand very intense drying-up and has a very well developed root system.

Gentiana detonsa var. *groenlandica*. MARIE-VICTORIN (1932) sets up this variety on the basis of material from Itivdleq and Igaliko. The variety was later criticized by M. P. PORSILD (1935, pp. 43—52), who was of opinion that the lack of plants with three or four pairs of stem-leaves is due to climatic or ecological responses. PORSILD's table (p. 51) of Norwegian, Icelandic, and Greenland material, however, in my opinion suggests that a hereditary basis must be present, which makes the setting-up of the variety perfectly justifiable. My own material from Søndre Strømfjord (10 plants) never had more than two pairs of stem-leaves, which is important, as the plants originate from subarctic climatic conditions. Even richly flowering, branched individuals 27—29 cm in height (Böcher, no. 127, 1946) have only two pairs. — South Greenland individuals (e. g. from Igaliko; Grøntved no. 1570), on the other hand, may have up to four pairs like Icelandic and Norwegian plants. Therefore, I consider it very probable that var. *groenlandica* is a subarctic-continental race occurring isolated in the Strømfjord area and there intimately associated with the present type and not, as far as is known, occurring in salt marshes near the fjord, and not in the continental marsh and fen complex (p. 237), a fact which is worth emphasizing, as the Norwegian population may just occur in meadow-like communities on rather constantly humid soil (*Scirpus pumilus* soc. with *Carex microglochin*, *Pinguicula alpina*, *Thalictrum alpinum*, and *Tofieldia pusilla*; cf. NORDHAGEN 1935, p. 87).

Braya linearis. This, again, is a species with an extremely isolated occurrence near Søndre Strømfjord and there exclusively associated with the present vegetational type. BLYTT (Norges Flora) says about the Norwegian population that it occurs from the pine zone into the willow zone. NORDHAGEN's analysis of an *Arenaria norvegica-Braya linearis* soc. (1935, p. 73) originates from a southwestern slope about 700 m above sea level. It all indicates a low arctic race. Especially its Norwegian occurrence shows that it is also somewhat continental. The West Greenland population avoids the highlands above 300 m above sea level, but this is presumably due to the absence of suitable stations in the higher parts of the mountains. However, it is undoubtedly also low arctic and continental. The Norwegian sociation mentioned with *Braya linearis* as dominant has hardly any species in common with the Greenland one but *Poa glauca*. If, therefore, the Norwegian and West Greenland population are genetically very closely related, it will not

be justifiable to proclaim it an EG-species; but *Braya linearis* is actually a very intricate complex and therefore there is some reason to suppose that the West Greenland and the Norwegian populations should be assigned to different varieties, each with its own ecological requirements.

Torularia humilis (or *Braya humilis* cf. ROLLINS 1953). I join ROLLINS in provisionally treating this species as a collective one and regarding the different chromosome races as subspecies. I am unable to follow SØRENSEN (1954), who refers the East Greenland material to *Torularia*, but thinks that the West Greenland plants belong to *Braya (B. novae-angliae)*. The collective species is almost circumpolar (details in B. 1950). The very isolated West Greenland population may belong to an American-Greenland subspecies with a sub-low arctic and continental distribution. Ecologically it behaves nearly like *Puccinellia deschampsioides* and *Primula stricta*, as it occurs exclusively in the present complex as well as in the continental marsh and fen complex.

Three continental sub-low arctic species, *Primula stricta*, *Draba lanceolata* (map fig. 11 in B. 1952a), and *D. hirta*, are particularly frequent in the present vegetational type, without, however, being bound to it. — The Greenland form of *Sisyrinchium montanum* seems to be important as a Hb-species; this, however, applies to rather a particular series of sociations only, which are collected in a special sociation group below. *Sisyrinchium* was not seen together with *Puccinellia deschampsioides* and *Braya linearis*.

b_1. The Puccinellia deschampsioides-Braya linearis Sociation Group.

1. Puccinellia deschampsioides Sociations.

Puccinellia-Cornicularia soc. rich in *Artemisia borealis*. Table 24, nos. 1—5. This is found on very warm southern and southwestern slopes on loess or clay covered with loess and characterizes rather large parts of the lower sides of Hassells Fjeld, but otherwise is found in small patches about the region, — right up to an altitude of 400—500 m above sea level on sunny sides. The total covering varies between 60 and 80 per cent. in the five analyses, but might go down to 10 to 40 per cent. The bare ground is seen everywhere between the large tussocks and tufts of the grass.[1] Some places looked desert-like. The ground might be covered by crusts and in many places be black-spotted with Cyanophyceae, especially *Gloeocapsa* (probably species like *G. montana*, *dermochroa*, *magma*, and *quaternaria*), *Nostoc* (cf. *N. microscopicum*, *minutum* and *commune*), and a form of *Tolypothrix byssoidea* (abundant in Table 20, no. 13). Rarely a species of *Stigonema*, which served as cephalodia for a *Lecidea*, formed larger dark spots on the soil.

Puccinellia deschampsioides-Plantago maritima juncoides soc. observed as a variant of the preceding soc. in a place where there were $CaCO_3$-crusts on the cracked surface of the soil (see B. 1949b, p. 41); furthermore on the shore of a salt lake beside the harbour road (Table 24,

[1] Some individuals brought home seem to belong to the hybrid *P. deschampsioides* × *groenlandica*; cf. SØRENSEN 1953, p. 32.

Table

Analysis no.	1	2	3	4	5	6
Locality no.	3	3	3	3	3	2
Altitude in m	120	100	150	100	120	75
Slope	30°	30°	30°	30°	35°	10°
Exposure	SSW	SW	SW	SSW	S	E
pH	—	7.3	—	—	—	7.6
Lt	—	0.8	—	—	—	0.8
Total covering percentage	70	80	70	60	70	100
EG Puccinellia deschampsioides	5	5	4	3	3	5
— Gentiana detonsa groenlandica	..	..	..	..	..	..
— Braya linearis	..	..	..	..	..	..
— Torularia humilis	..	..	..	..	..	..
— Carex supina spaniocarpa	..	..	..	..	..	..
— Calamagrostis purpurascens	..	..	1	1	..	..
— Potentilla chamissonis	..	..	..	..	..	..
— Artemisia borealis	+	2	2	2	2	..
— Draba lanceolata	..	..	..	..	..	..
— — hirta	..	..	..	..	..	..
— Melandrium triflorum	+	1	1	1	..	..
Cl Dryas integrifolia	..	..	..	..	..	..
— Kobresia myosuroides	..	..	..	..	..	..
— Betula nana	..	..	..	..	..	..
— Stellaria longipes (coll.)	..	..	..	..	..	..
— Carex rupestris	..	..	..	..	..	..
— Juncus triglumis copelandii	..	..	..	..	..	..
— Carex capillaris robustior[1]	..	..	..	..	..	..
— Primula stricta[1]	..	..	..	..	..	..
— Gentiana tenella[1]	..	..	..	..	..	..
Gentiana aurea[2]	..	..	..	..	..	..
Lomatogonium rotatum[2]	..	..	..	..	..	..
Plantago maritima juncoides[2]	..	..	..	+	..	3
Carex scirpoidea	..	..	..	..	..	..
Cerastium alpinum lanatum	..	..	..	..	..	..
Euphrasia frigida	..	..	..	..	..	..
Festuca brachyphylla	..	..	..	..	..	+
— rubra var.	..	..	..	..	..	..
Poa glauca	..	..	..	2	1	..
Polygonum viviparum	..	..	..	..	..	..
Salix glauca callicarpaea[3]	..	..	..	..	..	..
Triglochin palustre	..	..	..	..	..	..
Cyanophyceae and Cephaloziella on the ground (p. 207)	2	1	3	2	4	..
Amblystegiella sprucei	..	..	..	..	..	..
Barbula recurvirostris	+	..	+	..	..	..

[1] Cf. pp. 228 and 240. [2] Halophilous species. [3] Only as quite low plants, either seedlings or young

24.

7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
7	7	7	7	7	7	5	7	3	3	7	7	10	3	3	3
250	250	250	250	250	250	100	250	120	150	250	250	50	200	200	200
—	—	15°	30°	10°	20°	30°	15°	35°	35°	0°	15°	0°	0°	0°	0°
—	—	S	SSW	S	SSW	S	S	S	S	—	SW	—	—	—	—
—	—	8.6	—	9.1	8.2	7.7	8.7	—	8.9	—	—	9.2	8.4	—	—
—	—	8.7	—	2.6	3.0	6.4	2.3	—	1.8	—	—	5.7	4.3	—	—
80	80	60	60	70	75	75	50	80	80	80	80	60	40	50	30
5	5	5	+	2	..	1	..	..	..	..	..	1	3	2	+
..	2	+	2	4	+	..	1	2	+	+	..	2	..	..	..
2	2	1	3	+	..	..	1	..	..	..	..	+	..	..	..
..	..	..	..	..	..	3	..	..	..	..	..	..	+	3	+
..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..
..	..	..	1	1	2	4	3	4	3	..	+	1	..	..	..
..	..	1	..	..	..	+	..	3	1	..	..	..	..	..	..
..	..	..	1	..	..	..	+	1	1	..	..	2–3	..	..	..
..	..	+	..	..	..	..	..	..	+	..	..	..	..	..	..
..	..	+	..	3	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	+
..	..	..	..	..	..	..	..	..	..	5	5	3	..	..	..
..	..	..	..	..	4	..	..	..	+	3	2	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..
..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	1	..	1–2	..	..	..	..	..	..	+	..	..	..
..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1
1	2	1	1	2	+	..	+	..	..	..	..	..	+	..	+
..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	+	1	..	..	..	..	..	..
..	..	..	2	..	+	2	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	+	..	..	..	..	..	..	2	2	1
..	..	..	..	..	1	..	+	..	..	1	+	..	..	..	..
..	..	+	..	..	..	..	+	+	..	..	..	..	..	..	..
..	..	+	+	..	1	..	..	2	+	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..
..	..	..	1	..	+	..	+	+	2	1	..	..	..	..	1
..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..
..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..
..	..	..	..	..	+	..	+	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

plants, the growth of which has been checked.

(To be continued)

Table 24

Analysis no.	1	2	3	4	5	6
(Hb) Barbula rufa[2]	..	..	..	..	..	..
Bryum pendulum	..	..	..	..	..	..
— sp.	+	+	+	..	..	..
Desmatodon latifolius	..	..	..	..	..	..
— sp.	..	..	..	..	..	..
Distichium capillaceum	..	..	..	..	..	1
— inclinatum	..	..	..	..	..	..
Ditrichum flexicaule	..	..	..	..	..	..
Encalypta ciliata	?	..	1	..	..	..
Hypnum revolutum	..	..	..	..	..	..
Leptobryum pyriforme	..	..	..	..	..	1
Hb Pottia heimii obtusifolia[2]	..	..	..	..	..	..
Tortella tortuosa	..	..	..	..	..	..
Tortula ruralis	..	..	..	1	..	..
Webera nutans	..	..	..	..	..	..
— sp.	..	..	..	..	..	..
Alectoria ochroleuca	..	..	..	..	..	..
Buellia punctiformis[4]	..	..	..	..	..	..
Hb[1] Caloplaca citrina	1	+	1	1	1	..
— elegans	..	..	..	..	..	..
Hb[1] — stillicidiorum	..	..	..	..	..	..
— subolivacea[4]	..	..	..	..	..	..
Candelariella aurella	..	..	..	..	..	..
— xanthostigma[4]	..	..	..	..	..	..
Cetraria crispa	..	..	..	..	..	1
— cucullata	..	..	..	..	..	4–5
— nivalis	2	..	..	..	..	..
Cladonia cariosa cf. p. 194	+	+	..	..	..	..
— pyxidata	+	2	1	2	2	..
Cornicularia aculeata	3	3	3	2	1	2
Dermatocarpon sp.	+	..	+	..	..	..
Hb[1] Endocarpon pusillum	1	+	1	..	..	..
Hb[1] Fulgensia bracteata	..	..	..	..	..	..
Lecanora castanea[4]	..	..	..	..	..	..
— epibrya	..	..	..	..	..	..
— hageni[4]	..	..	+	..	..	..
Ochrolechia frigida	..	..	..	..	..	..
Peltigera erumpens	+	..	..	+	..	..
Hb[1] Physcia constipata	..	..	..	..	..	..
— muscigena	+	..	1	..	..	..
Rinodina roscida	..	..	+	..	..	..
Hebeloma mesophaeum	..	..	..	..	..	..
Inocybe fastigiata	..	..	..	..	..	..
Marasmius epidryas	..	..	..	..	..	..

[1] See note on p. 194. [2] Halophilous species. [4] Epiphytes on dead branches of dwarf birch and *Dryas*.

(continued).

7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
..	..	..	+	..	+	..	+	..	..	..	..	..	..	..	..
..	..	..	..	2	..	..	+	..	..	..	+	..	..	..	..
..	..	..	+	..	+	+	1	..	..	..	..	+	..	..	..
..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	+	1	+	..	..	..
..	..	..	+	..	1	..	+	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	+
..	..	2	+	2	..	1	1	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	+	1	..	..	..	..
..	..	..	..	+	..	..	+	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	..	+	..	..	..	..
..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..
..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..
..	..	..	..	+	..	..	..	..	..	+	..	..	..	..	..
..	..	..	+	+	+	..	+	..	..	+	..	..	..	..	..
..	..	..	+	+	+	..	+	..	..	+	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	+	..	..	..	..	..
..	..	..	..	+	..	..	..	..	..	+	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..
..	..	..	..	+	..	..	3	..	..	..	2	1	..	..	1
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	+	..	2	..	1	..	1–2	..	..	..	..
..	..	..	..	..	..	..	1	..	..	..	1	..	..	..	+
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	1	..	..	1	..	..	+	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..
..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..
..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..
..	..	..	+	..	+	..	+	..	..	+	+	..	..	..	..
..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..
..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..

nos. 20—21, B. 1949b, Table 8, no. 5), where the vegetation might be rich in *Torularia humilis*. In both cases the total covering was about 50 per cent. and the number of species very low.

Table 24, no. 6 has a lichen as dominant, viz. *Cetraria cucullata*. The vegetation in question was found as a fringe between a *Rhododendron* heath (Table 30, no. 1) and a *Triglochin palustre* soc. dried up in summer and a *Calamagrostis neglecta* soc. with *Gentiana tenella* beside a small strongly basic pond on the river terrace two miles east of the air base. The soil was basic, but not saline, which is due to the fact that the pond at high water level in spring has an outlet through a groove which cuts into the edge of the terrace. The water in the pond had a pH of 7.5 and the pond was full of *Drepanocladus aduncus*, *Potamogeton filiformis*, and *Hippuris*.

Puccinellia deschampsioides-Braya linearis soc. and sociations dominated by *Braya linearis* or *Gentiana detonsa*, Table 24, nos. 7—11, fig. 57. These sociations are treated together, as the two last-mentioned ones only represent less important deviations from the first-mentioned sociation. They were all found around Store Saltsø (Loc. 7). A constant species in these sociations is *Primula stricta*, which reaches a unique size there. The same applies to *Gentiana detonsa* and *Draba hirta*.

The vegetation has developed on saline loess soil and is found partly on fairly small level areas, partly in crevices filled with loess (fig. 57, Plate II, fig. 2) in the deposits of *Drepanocladus aduncus*, dead long ago, daphniae, and loess mentioned in B. 1949b. Because of the reddish colour of the deposits they strike the eye as soon as one approaches to the salt lake. The pH of the soil is nearly 9 and the conductivity value culminates at 8.7. The following halophilous species are found there: *Gentiana detonsa*, *Lomatogonium*, and *Pottia heimii*. A strange feature is the occurrence of *Carex rupestris*, which there, on the border between lowlands and highlands can suddenly assert itself, perhaps because of the special properties of the soil, which weaken some of the species that otherwise expel it from the lower parts of the region.

On the northern shore of the lake there was a gentle slope as the erosion (the beating of the waves) had not been strong enough to form terraces as along the western and the southern side (see Plates in B. 1949b), but only farthest down by the lake slightly broke up the moss-loess deposit. The very dry vegetation on the northern shore had the following zones:

(1) Pure *Puccinellia deschampsioides* soc. (in some places on dried-up, clayey lake bottom cracked in polygons).

(2) *Puccinellia-Braya linearis* soc. with *Leptobryum pyriforme* or with *Primula stricta-Gentiana detonsa*, mostly in crevices; cf. Plate II, fig. 2. Loess soil.



Fig. 57. *Braya linearis* sociation in crevice filled with loess near Store Saltsø. Besides the dominant the following species are seen: *Gentiana detonsa* (centre), *Primula stricta* (especially on the right), and *Puccinellia deschampsioides*. T.W.B. phot. $^{8}/_{8}$ 1946.

(3) *Salix glauca callicarpaea-Calamagrostis purpurascens* soc., often with large open spaces with the following species besides *Calamagrostis purpurascens*: *Braya*, *Primula*, *Gentiana detonsa*, *Plantago maritima juncoides*, *Artemisia borealis*, *Kobresia myosuroides*, *Campanula rotundifolia*, and *Draba hirta*. The vegetation no more than reached the knees. The soil mainly loess. Cf. the background on the left in fig. 2 in Plate II.

(4) *Kobresia myosuroides* soc. (cf. Table 24, no. 12) alternating with dry, low *Betula nana* scrubs and patches of *Betula nana-Vaccinium uliginosum* heath with *Dryas* and *Pedicularis lapponica*. In this zone there are furthermore *Dryas* sociations, partly open "fell-field" vegetations on gravel with *Saxifraga tricuspidata*, *Carex supina*, *Chamaenerium latifolium*, *Alectoria ochroleuca*, *Cetraria nivalis*, partly denser vegetations with *Kobresia* and *Carex scirpoidea* (Table 24, no. 17) on loess.

(5) Dense, dry *Vaccinium uliginosum-Betula nana* heath with *Rhododendron*, *Kobresia*, *Salix glauca callicarpaea*, *Cetraria nivalis*, and *Alectoria ochroleuca* on gravelly soil (see Plate II, fig. 2 in the background, centre).

This transect at any rate in the belts 2 and 3 contains nothing but sociations belonging to the *Puccinellia-Gentiana* type. Belt 1 is doubtful,

as the vegetation may as well be included in the same type as the *Puccinellia-Ranunculus cymbalaria* sociation (p. 259). Belt 5 (and certain heaths in belt 4) belong to the *Arctostaphylos uva ursi-Betula nana* type.

2. Calamagrostis purpurascens Sociations.

These occurred as a variant of the *Calamagrostis* steppe of the southern slopes without halophilous species (p. 191) in places where the soil was particularly basic and saline (Table 24, nos. 15—16, B. 1949b, Table 9, no. 1) and offered conditions of growth for *Gentiana detonsa* and *aurea*. Near the salt lakes this kind of sociations, however, was more frequent. For the area near Store Saltsø reference may be made to the transect above, no. 3, and Table 24, no. 14.

Table 24, no. 13 is a *Calamagrostis-Torularia* soc. on very saline soil (conductivity value 6.4). It was found beside a small pond without outlet close to the boundary between main Loc. 3 and 5. There was an interesting zonation there:

(1) *Potamogeton pusillus* soc. (in the water).
(2) *Triglochin palustre* soc. with *Puccinellia deschampsioides* on the clayey shore of the pond.
(3) Like the preceding zone, but also with *Plantago maritima juncoides* and less *Triglochin*.
(4) *Calamagrostis-Torularia* soc. with such halophilous species as *Lomatogonium* and *Pottia heimii*, and coprophilous species as *Desmatodon latifolius*, and *Desmatodon* sp. *Torularia* very luxuriant.
(5) *Calamagrostis-Carex supina-Potentilla chamissonis* soc. without halophilous species; on drier soil than (4).

It is extremely characteristic that *Carex supina* and *Potentilla chamissonis* should not appear until a level above the saline, ultrabasic soil, and that *Calamagrostis purpurascens* should tolerate this; cf. map fig. 51 and the remarks on pp. 186—187.

3. Kobresia myosuroides Sociations.

Table 24, no. 12 shows an example from the area near Store Saltsø. *Kobresia* dominated small patches there, but seemed to be exposed to invasion of *Rhododendron*, *Dryas*, *Betula nana*, *Vaccinium uliginosum microphyllum*, which might change the vegetation into heath; cf. the transect on p. 213, no. 4.

4. Dryas integrifolia Sociations.

These were observed on dry soil near salt or very basic lakes. Especially the example from Itivdlínguaq (Table 24, no. 19) is good. The soil and the salt crusts formed above it have been mentioned in detail in B. 1949b, pp. 35—37. It is a genuine alkali soil.

b_2. The Sisyrinchium montanum Sociation Group.

This group includes a number of sociations all from the same place on the southern slope of Hassells Fjeld, where *Sisyrinchium montanum* was found together with many other rarities. The place was ecologically well-defined: the rock came close to the surface and the shallow soil was exposed to constant alternation between drying-up and saturation with water. Especially in spring and after showers water oozed over the rocky ground. The water was circumneutral, but no doubt rich in nutrients, as during the percolation it must be supplied with some substances from the loess layers covering the rock. Finally the place faced the south. The combination was extremely rare in the area (see details and photos in B. 1948). An analysis of the diatom flora from the place is found in FOGED (1953). Other analyses from the place (the most humid communities) are mentioned below (pp. 261—264).

Table 25 gives a number of examples of vegetation in which *Sisyrinchium montanum* occurs (nos. 1—10). Only the first seven of these, however, belong to the present vegetational type, while nos. 8 and 11

Table 25.

Analysis no.		1	2	3	4	5	6	7	8	9	10	11
Locality no.		3										
Altitude in m		100–140										
Slope		30–40°										
Exposure		S										
pH		..	..	..	7.6	..	..	..	7.3	..	..	..
Lt		..	..	..	0.8	..	..	..	1.1	..	..	..
EG	Gentiana detonsa groenlandica	+	1	1	+	1	+	+	..	..	..	..
—	Torularia humilis	..	..	..	..	..	+	..	..	..	..	..
—	Carex supina spaniocarpa	4	3	4	3	2	1	+	..	..	..	+
—	Calamagrostis purpurascens	..	+	+	..	3–4	2	2	+	..	..	2
—	Potentilla chamissonis	2–3	2	+	+	1	..	1	+	+	+	+
—	Artemisia borealis	+	+	+	+	+	1	..	..	+	..	+
—	Draba lanceolata	..	+	+	..	..	..	..	..	..	..	+
Cl	Melandrium triflorum	..	..	+	..	..	..	..	..	..	..	..
—	Woodsia glabella	..	..	..	..	..	+	..	..	..	..	1
—	Kobresia myosuroides	..	..	1	1	..	..	..	5	3	3	4
Hb	Sisyrinchium montanum	+	1–2	1	1	+	+	+	+	1	+	..
—	Gentiana aurea	+	+	1	+	1–2	1	1	..	+	..	..
	Campanula rotundifolia (coll.)	..	+	..	..	..	..	..	..	+	..	..
	Carex scirpoidea	..	..	..	1	..	1	..	..	4	4	..
	Cerastium alpinum lanatum	+	+	+	+	+	..	..	..	..	..	+
	Euphrasia frigida	+	+–1	1	1	1	+	+	+	+	+	+

(To be continued)

Table 25 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11
Festuca rubra var.	+	+	..	1	..	3	3	..	..	+	..
Poa glauca	..	..	+	..	..	..	..	..	..	..	1
Salix glauca callicarpaea[1]	+	+	+	+	+	..	1	1	1	+	..
Trisetum spicatum (coll.)	+	..	+	+	..	..	..	+	..	+	..
Luzula spicata[2]	..	..	..	..	..	..	..	..	..	..	+
Poa alpina[2]	..	..	..	..	..	..	..	..	..	..	+
Viscaria alpina[2]	..	..	..	..	..	..	..	..	..	..	+
Mannia fragrans[3]	..	+	..	..	..	..	..	..	..	..	+
Amblystegiella sprucei[3]	..	+	..	..	..	..	+	..	..	..	..
Bryum sp.	..	+	..	..	..	+	+	..	..	..	+
Ceratodon purpureus	+	+	+	+	+	+	+	+	+	..	..
Distichium capillaceum	..	+	+	..	..	..	+	+	..	..	+
Encalypta sp.	..	..	..	..	..	..	+	..	..	..	..
Hypnum revolutum	..	..	+	..	..	+	..	..	..	..	+
Tortella fragilis	..	..	1	3	..	..	..	+	..	1	+
Hb[1] Caloplaca citrina	..	..	..	..	..	..	+	..	..	..	+
Cetraria nivalis	..	..	..	..	..	..	..	..	..	..	+
Cladonia pyxidata	1	1	+	2	+	+	1	+	1	+	3
— cariosa[3]	..	..	..	..	..	..	..	..	..	..	+
Cornicularia aculeata	..	..	+	..	..	..	+	..	..	..	+
Hb[1] Fulgensia bracteata	..	..	..	..	..	..	+	..	..	..	..
Peltigera rufescens	..	..	..	..	..	1	..	..	..	..	1
Physcia muscigena	+	1	1	+	1	..	..	..	..	..	..
Hb[1] Toninia coeruleo-nigricans	..	..	..	..	..	..	+	..	..	..	..
Secultaria arenosa	..	..	..	..	..	..	+	..	..	..	..
Nostoc commune var.	..	..	..	..	..	..	..	..	..	..	+

[1] Only as quite low plants, seedlings or young plants the growth of which has stagnated completely. [2] Oceanic element or (*Poa alpina*) species with a predilection for the oceanically stamped complexes. [3] Widely distributed, more or less continental. Hb[1]; cf. note on p. 194.

are transitional to the *Kobresia* sociation group in the preceding type (cf. Table 22, no. 4), and nos. 9—10 are transitional to *Carex scirpoidea* sociations belonging to the continental marsh-fen complex. The sociation group thus includes *Carex supina*, *Calamagrostis purpurascens*, *Festuca rubra*, and, scarcely, *Kobresia myosuroides* sociations. *Festuca rubra* here denotes a special variety with a coarse, loosely tussocky structure of shoots, its habits reminding of var. *commutata*. It was always associated with places where the soil was somewhat less dry, and both on Hassells Fjeld and near Vandfaldskløften it might be dominant or co-dominant on small patches. These, however, just as often belonged to the *Roegneria-Arabis* sociation group.

The occurrence of *Mannia* (*Grimaldia*) *fragrans* in this community is very interesting. This Marchantiacea will stand being dried up by

rolling up the edges of the thalli. Its distribution is continental in Europe (see map and detailed discussion in PETTERSSON 1946). According to PETTERSSON it is very characteristic in Therophyte-Marchantiales communities on level limestone ground in the island of Gotland and in ecologically corresponding communities in the island of Öland (ALBERTSON 1950). The communities in question are in both cases steppe-like, the thin layer of soil being exposed to great variation as regards humidity. The similarity in an ecological respect to the Greenland community is evident, and there are botanical points of resemblance as well, the Greenland community containing comparatively many hapaxanthic species and cryptogams like *Toninia coeruleo-nigricans*, *Fulgensia bracteata* and *Tortella fragilis*, which are also found in the Baltic communities and on Central European steppe heaths ("*Fulgensio-Psoro-Toninion*"; see GAMS 1938).

c. The Arctostaphylos uva ursi-Betula nana Type.

(Low arctic-subarctic continental xerophytic dwarf shrub vegetation).

Dry heaths are often in the continental parts found associated with the vegetational types mentioned above. As stated above, there is not rarely a development of a patchwork of xerophilous grasslands, dwarf-shrub heaths, and willow scrubs (fig. 50). *Betula nana* is capable of also dominating such dry heaths; therefore it has been included in the name of the type, but it is not an EG-species as it is also abundant in association with *Ledum palustre* ssp. *decumbens*. The chief sociological criterion of the view that the heaths belong to the present dry section is presumably in the cryptogamic vegetation under and between the dwarf shrubs, which in the present type lacks the hygrophilous mosses or contains them in a poorly developed state. Most important for the ranging in the complex is the occurrence of such EG-species as *Calamagrostis purpurascens* and others. Such species are of course greatly held back by the dwarf shrubs, but can nearly always be demonstrated if only the quadrate examined is somewhat larger than that used, viz. one square metre.

EG-species of the vegetational type:

Arctostaphylos uva-ursi. Fig. 58 shows the distribution of this species in America-Greenland. It is evident from the figure that it avoids the large oligotrophic area, and this together with the fact that ST. JOHN 1922, p. 15, considers the main form and its varieties *coactilis* and *adenotricha* to be calcicoles, with great clearness indicates that the American population lacks races which will stand poor, very acid soil. It is, however, just as remarkable that the American type of bear-berry does not range farther north, where there are edaphically favourable areas, and that in West Greenland it is a lowland

plant, which completely avoids the dry heaths in the higher parts of the mountains (B. 1952 a p. 63). This must be supposed to be connected with the fact that the American-Greenland population lacks arctic races. FERNALD (1950) writes that *A. uva-ursi* grows on exposed rock and sands, and ST. JOHN has collected it on limestone sea-cliffs on the Gulf of St. Lawrence. RAUP (1947, p. 221) states that in Southwestern Mackenzie it is common on dry stony fans and warm south-facing slopes up to the timber line. Therefore I think we may safely summarize that the American-Greenland population

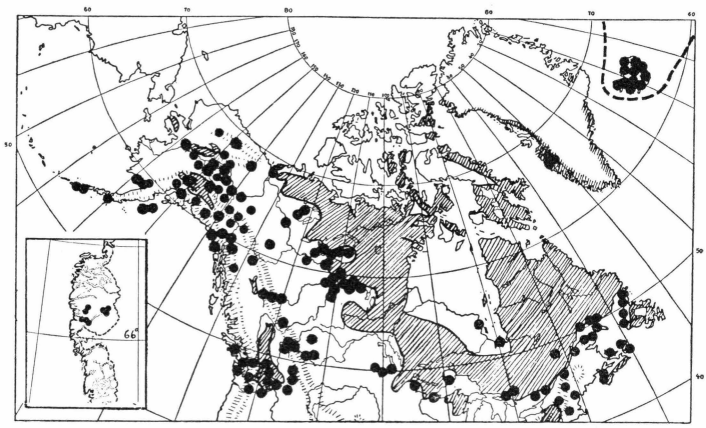


Fig. 58. Distribution of *Arctostaphylos uva-ursi*. The stippled line around Iceland indicates that the Iceland population is associated with the West European one. In America it is conspicuous that the species avoids the oligotrophic areas with Archean rock (the Laurentian shield). The Pre-Cambrian gneiss-(granite) area is indicated by hatching in the figure (from WYNNE-EDWARDS and MARIE-VICTORIN). The small West Greenland area is seen on a larger scale in the corner on the left. The American distribution is mainly based on RAUP 1947.

constitutes a special ecological group of races, which is subarctic and calciphilous and which undoubtedly, like the European population, includes races with a different relation to the degree of continentality of the climate (cf. B. 1943). Among these it must be a continental race which has reached Greenland. HULTÉN (1941—50 VIII, p. 1249) just separates out a special variety (var. *pacifica*) with more elliptical leaves and a red corolla covering a great part of the material from the Pacific coast.

BUSCH (1913—1931) has a map of the Eurasian area of the species. It is remarkable that on this map it should be absent east of Sakhalin and thus in the whole of the part of Asia adjoining Alaska. The American stock therefore in the present time is geographically separated from the Eurasian.

1. Arctostaphylos uva-ursi Sociations.

These were around Søndre Strømfjord associated with south-facing slopes in the lowlands. The vegetation was never rich in lichens, but *Cladonia pyxidata* was rather constant. The chief occurrence was the transitional zone between willow scrub and steppe belonging to the



Fig. 59. Extensive *Carex supina* steppes on loess deposits in the Umivîk branch below Vandfaldskløften (Loc. 9). In the foreground and beside flat depressions on the slope farther away there are patches with heath of *Arctostaphylos uva-ursi*. In the foreground this is characteristically growing on the edge of low willow scrubs. About the carpet of bear-berry straws of *Calamagrostis purpurascens* stick out. T.W.B. phot. $^{21}/_{8}$ 1946.

Carex supina-Potentilla chamissonis type. In Gotland in the Baltic a similar occurrence of the bear-berry heath may be seen between juniper shrubs and dry alvar vegetation on shallow soil overlying calcareous rock, and in the mountains of North Spain an *A. uva-ursi* zone is often seen between *Buxus* or low *Quercus* scrub on the one hand and the Mediterranean steppe on the other.

Besides the type of habitat mentioned (seen in fig. 59) the *Arctostaphylos* heath in Greenland may also occur in flat depressions in the southern slopes (fig. 8 in B. 1949b, fig. 59 in the background) and in the transitional zone between the bare rock and the loess deposit which

has accumulated below the rock. The latter type is seen in Plate II, fig. 2, where *A. uva-ursi* forms a narrow strip between the rock and the *Calamagrostis purpurascens* steppe, which, again, is replaced by willow scrubs where the soil becomes sufficiently deep. In such places the bear-berry vegetation generally contains oreophilous elements like *Saxifraga tricuspidata*, *S. aizoon*, and *Potentilla tridentata*. Instead of *Calamagrostis* sociations there might also be dry *Vaccinium uliginosum microphyllum* heath interposed between willow scrub and bear-berry heath close to the rock.

Table 26 has nine examples of *Arctostaphylos* heaths and one of an *Empetrum* heath, which was found as a variant of the bear-berry

Table 26.

Analysis no.	1	2	3	4	5	6	7	8	9	10
Locality no.	3	3	3	3	3	3	5	5	5	3
Altitude in m	250	75	75	75	75	75	50	50	50	75
Slope	30°	50°	40°	45°	45°	45°	20°	20°	20°	40°
Exposure	S	S	S	S	S	S	S	S	S	S
pH	6.9	5.9	—	6.8	—	—	—	—	—	—
Lt	0.7	0.3	—	0.6	—	—	—	—	—	—
EG Arctostaphylos uva-ursi	5	5	5	5	5	5	5	5	5	3
— Carex supina spaniocarpa	..	+	+	+	..	+	..	..	..	+
— Calamagrostis purpurascens	1	1	2	2	1	2	..	1	..	+
— Potentilla chamissonis	+	..	+	..	..	..	..	..	..	..
— Artemisia borealis	+	1	..	..	..	+	..	..	..	..
— Erigeron compositus	..	+	+	..	..	..	..	..	..	..
Cl Melandrium triflorum	1	..	..	..	..	..	..	..	..	..
— Stellaria longipes-monantha	1	..	..	..	..	..	..	..	..	..
— Kobresia myosuroides	+	..	..	1	..	..	2	..	..	..
— Saxifraga tricuspidata	..	1	..	..	..	..	+	2	..	..
— — aizoon neogaea	..	..	..	..	..	+	..	..	..	+
Viscaria alpina	+	..	+	..	..	..	+	+	..	..
Campanula rotundifolia (coll.)	..	2	+	1	..	..	1	+	..	..
Cerastium alpinum lanatum	1	..	..	..	..	..	..	..	..	..
Empetrum nigrum hermaphrodit.	..	..	..	..	..	..	..	..	2	5
Euphrasia frigida	..	..	..	+	..	+	..	..	..	..
Festuca brachyphylla	..	..	..	..	..	..	+	..	..	..
— rubra var.	3	1	..	..	1	..	..	..	..	..
Juniperus communis montana	..	..	2	..	..	..	..	..	..	..
Poa glauca	1	+	..	..	..	..	..	1	1	..
Potentilla tridentata	..	1	+	+	..	..	..	..	..	+
Salix glauca callicarpaea	..	..	..	..	..	..	..	..	2	1
Trisetum spicatum (coll.)	..	..	..	..	+	..	1	..	..	..
Vaccinium ulig. microphyllum	..	..	..	..	..	..	..	..	2	2
Cephaloziella sp.	..	+	..	+	..	..	..	..	..	..

(To be continued)

Table 26 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10
Bryum sp.	..	+	..	..	..	..	..	..	..	..
Distichium capillaceum	..	..	..	1	..	..	..	..	..	..
Grimmia funalis var.	..	+	..	..	..	..	..	..	..	..
Hypnum revolutum	..	..	..	+	..	..	..	..	..	..
Polytrichum piliferum	..	+	..	..	..	..	..	..	..	..
Tortella fragilis	..	..	..	1	..	..	..	..	..	..
— tortuosa	..	..	..	1	..	..	..	..	..	..
Webera sp.	..	+	..	..	..	..	..	..	..	..
Cetraria nivalis	..	..	..	..	..	..	+	+	+	..
Cladonia cariosa	..	+	..	..	..	..	..	..	..	..
— pyxidata	1	+	1	+	+	+	..	..	..	+
Cornicularia aculeata	+	..	..	..	..	..	..	..	..	..
Peltigera canina	1	..	..	1	..	..	..	..	..	..
— erumpens	..	+	+	..	..	..	..	..	..	+
— malacea	..	..	..	..	..	..	..	+	..	..
— rufescens	..	1	..	..	..	..	..	..	..	..
Stereocaulon alpinum walamoense	..	+	+	+	..	..	..	..	..	..
Hebeloma longicauda	..	..	..	..	..	..	+	..	..	..

heath near willow scrub. Nos. 9—10 contain *Vaccinium uliginosum microphyllum* and form a transition to the following heaths. Such mixed heaths with *Arctostaphylos* and *Vaccinium* were rare.

In connexion with the above-mentioned ecological and distributional difference between European and American-Greenland *A. uva-ursi* I may mention an analysis of an Icelandic *A. uva-ursi* heath. It was found on a south-facing steep rocky slope beside the Thingvalla plain. pH was measured at 5.8 and the conductivity value at 0.6. Apart from the dominant, *Vaccinium uliginosum* and *Empetrum* there were no species common to the Iceland and the Greenland heath. The Iceland vegetation even had an oceanic element including *Calluna*, *Juncus trifidus*, *Thymus drucei*, and *Festuca vivipara*. Furthermore it contained *Dryas octopetala*, *Deschampsia flexuosa*, *Agrostis tenuis*, *Luzula multiflora* ssp. *frigida*, *Carex bigelowii*, *Thalictrum alpinum*, *Galium boreale*, *Rhacomitrium lanuginosum*, *Ptilidium ciliare*, and a little *Drepanocladus uncinatus*.

2. Vaccinium uliginosum microphyllum Sociations.

Dry *Vaccinium* heaths in the lowlands can because of sporadic *Calamagrostis purpurascens* and some continental Cl-species be classed in the *Arctostaphylos-Betula* type. They were found on the southern slope of Hassells Fjeld near willow scrub and dry *Betula nana* heaths or *Kobresia myosuroides* sociations (Table 27, nos. 1—5). In sand-drift terrain near the ice margin (Loc. 1) there was a special sociation of almost pure *Vaccinium* heath with scattered *Kobresia* or *Calamagrostis*

Table 27.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Locality no.	3					3					4	3				
Altitude in m	150–200					150–200					250	150–200				
Slope	10–20°					15–30°					30°	30–35°				
Exposure	S					S–SW					S	S–SE				
pH	—	—	—	—	6.5	—	—	—	—	—	5.8	—	—	—	6.6	—
Lt	—	—	—	—	1.4	—	—	—	—	—	1.0	—	—	—	1.3	—
EG Calamagrostis purpurascens	+	..	..	..	+	1	1	..	..	+	..	+	..	..	..	..
— Roegneria violacea	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..
Cl Betula nana	1	..	2	4	4	5	5	5	5	5	5	1	1	2	1	2
— Rhododendron lapponic.	..	..	..	..	..	..	..	..	..	..	..	5	5	4	5	5
— Vaccinium vitis-idaea min.	..	..	..	..	..	..	..	..	..	..	5	..	..	..	..	..
— Kobresia myosuroides	..	1	+	..	1	1	1	..	..	..	..	1	1	1	..	+
— Saxifraga tricuspidata	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
— Stellaria longipes-monantha	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+
— Pirola grandiflora	..	..	..	..	..	..	..	..	1	..	..	..	..	..	+	..
— Equisetum scirpoides	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..
Campanula rotundifolia	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Carex scirpoidea	..	..	..	1	..	..	..	..	..	..	..	1	..	1	..	..
Equisetum arvense	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	+
Festuca rubra var.	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Poa glauca	..	..	..	1	1	..	+	..	..	+	+	..	..	+	..	..
— pratensis iantha	..	..	..	..	..	..	..	..	..	+	..	..	+	+	..	..
Polygonum viviparum	..	..	..	+	..	..	1	..	..	..	..	+	1	1	..	+
Salix glauca callicarpaea	2	2	1	1	..	1	2	2	1	1	3	3	2	4	2	3
Vaccinium uligin. microphyllum	5	5	5	5	5	..	..	1	..	2	..	2	1	..	..	1
Aulacomnium palustre	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Bryum sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Dicranum sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Drepanocladus uncinatus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Desmatodon latifolius	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
Hypnum callichroum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..
— cupres. vaucheri	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..
Polytrichum strictum	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
Tomenthypnum nitens	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..
Tortula ruralis	..	..	..	..	+	..	..	..	..	..	+	..	..	..	..	..
Webera cruda	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
— nutans	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
Alectoria lanea	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..
Cetraria cucullata	..	1	..	..	..	..	..	..	..	..	..	..	+	..	..	..
— nivalis	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Peltigera erumpens	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+
— malacea	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..

purpurascens. *Vaccinium* might form small pyramidal dunes there, which were apt to die away on the windward side (facing the inland ice).

3. Betula nana Sociations.

These were as much in the character of being low scrubs as being heaths. A characteristic feature besides the scattered occurrence of *Calamagrostis purpurascens* is the very sparse moss vegetation, through which the vegetation is sharply separated from the humid *Betula nana* heaths (p. 274). Table 27, nos. 6—10 show some examples from the southern slope of Hassells Fjeld. No. 11, with cowberry as field stratum, originates from Ringsødal. Dry *Betula* vegetation is not at all bound to southern slopes, but on the contrary is more frequent on level ground and plays a fairly important part there as an element of the vegetational pattern mentioned above (p. 185, fig. 50). In Sandflugtdalen east of Keglen a dune heath was observed which was dominated by *Betula nana* seconded by *Vaccinium uliginosum microphyllum* and *Salix glauca callicarpaea*. On this heath there was much *Calamagrostis purpurascens* and a large number of small tussocks of *Stereocaulon* sp.

4. Rhododendron lapponicum Sociations.

Dry, 20—30 cm high, almost scrub-like vegetation of *Rhododendron* with an extremely scarce cryptogamic flora was found in small areas together with the preceding sociations on the southern slope of Hassells Fjeld (Table 27, nos. 12—16). In spring the soil there might be somewhat more humid, which manifested itself by the greater luxuriance of the willow and the occurrence of stunted individuals of a few hygrophilous mosses. Near Store Saltsø some *Rhododendron* heaths were intermediate between this dry type and the wet type rich in mosses to be mentioned below; see p. 228 and fig. 61.

Scrubs associated with the Artemisia-Calamagrostis-Arctostaphylos Complex.

On the lower parts of the southern slopes of the mountains at the head of Søndre Strømfjord there are 1—2 m high willow scrubs or in a few places willow-juniper scrubs on loess soil (Table 28). The underlying soil is dry, often with many dead willow leaves which are more or less powdered with dust recently conveyed to the place by the wind. A herb stratum may be completely absent or be extremely sparse, undoubtedly because the xerophytes in the immediate surroundings of the scrubs are photophilous. There are two important types of ground flora, one characterized by *Draba aurea* and *Cystopteris fragilis dickieana*, the other by *Pirola grandiflora*. While the former leaves no room for doubt

Table 28.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Locality no.	3	3	3	3	2	2	3	3	3	3	3	3	9
Altitude in m	40–80					200	40	50–100					150
Slope	40°	25°	25°	20°	20°	25°	30°	10°	20°	10°	20°	30°	25°
Exposure	S	S	S	W	SW	SW	S	S	S	S	S	S	S
Salix glauca incl. ssp. callicarpaea	5	5	5	5	5	4	4	5	5	4	5	4	5
Juniperus communis montana	..	..	1	1	..	..	..	..	..	..	..	3	4
Betula nana	..	..	..	..	..	..	..	..	..	3	..	..	..
EG Calamagrostis purpurascens	+	+	..	..	+	..	2	..	..	..	..	+	..
— Roegneria violacea	..	+	..	..	..	..	..	..	..	..	+	..	..
— Potentilla chamissonis	..	+	..	..	..	..	..	..	..	..	..	..	..
— Halimolobos mollis	..	+	..	..	..	..	..	..	..	..	..	..	..
— Draba lanceolata	..	..	..	..	+	1	..	..	..	..	..	..	..
— Arctostaphylos uva-ursi (American race)	..	..	..	..	..	..	..	..	2	..	..	..	..
Cl and Hb Draba aurea	1	1	..	+	1	..	..	..	..	..	..	..	..
— Cystopteris fragilis dickieana	3	1	+	1	..	..	..	..	..	..	2	1	+
Cl Pirola grandiflora	..	..	..	1	1	1	..	4	5	5	4	3	..
— Stellaria longipes-monantha	+	1	..	..	..	..	..	1	..	+	..	..	..
— Arnica alpina angustifolia	..	..	..	..	..	1	..	..	..	..	..	..	..
— Kobresia myosuroides	..	..	..	..	..	1	+	+	..	..	..	..	..
— Saxifraga tricuspidata	..	..	..	..	..	..	..	..	+	..	..	..	..
Campanula rotundifolia (coll.)	..	2	+	..	..	1	1	..	+	..	1	+	..
Carex scirpoidea	..	..	..	..	..	..	..	..	..	..	1	..	+
Cerastium alpinum lanatum	..	1	..	..	..	..	..	..	..	..	..	..	..
Euphrasia frigida	..	..	..	..	+	+	..	..	..	..	..	..	..
Equisetum arvense	..	..	..	..	..	..	..	..	..	1–2	..	..	1–2
Poa glauca	..	1	..	..	..	..	..	+	..	+	+	..	+
— pratensis iantha	..	..	..	..	..	..	..	..	..	+	..	..	..
Polygonum viviparum	..	..	..	..	..	..	..	1	..	..	1	..	..
Potentilla crantzii	..	..	..	..	..	..	..	..	..	..	1	..	..
— tridentata	..	..	..	..	..	..	5	..	..	..	..	..	..
Trisetum spicatum (coll.)	..	..	..	..	1	..	..	..	..	..	..	..	..
Vaccinium ulig. microphyllum	..	..	..	..	..	..	..	2	..	1	..	..	..
Tortula ruralis	..	..	2	..	..	..	+	..	..	..	..	..	..

as to association with the complex, the latter is dubious. The soil there is probably somewhat more humid, the steppe species extremely rare, while widely distributed mesophytes like *Equisetum arvense* or *Carex scirpoidea* may occur. The frequency of *Pirola grandiflora* makes it probable that there is a constant snow-cover in winter; cf. Table 2(5). Scrubs with *Pirola* as a field layer plant are transitional to the scrubs de-

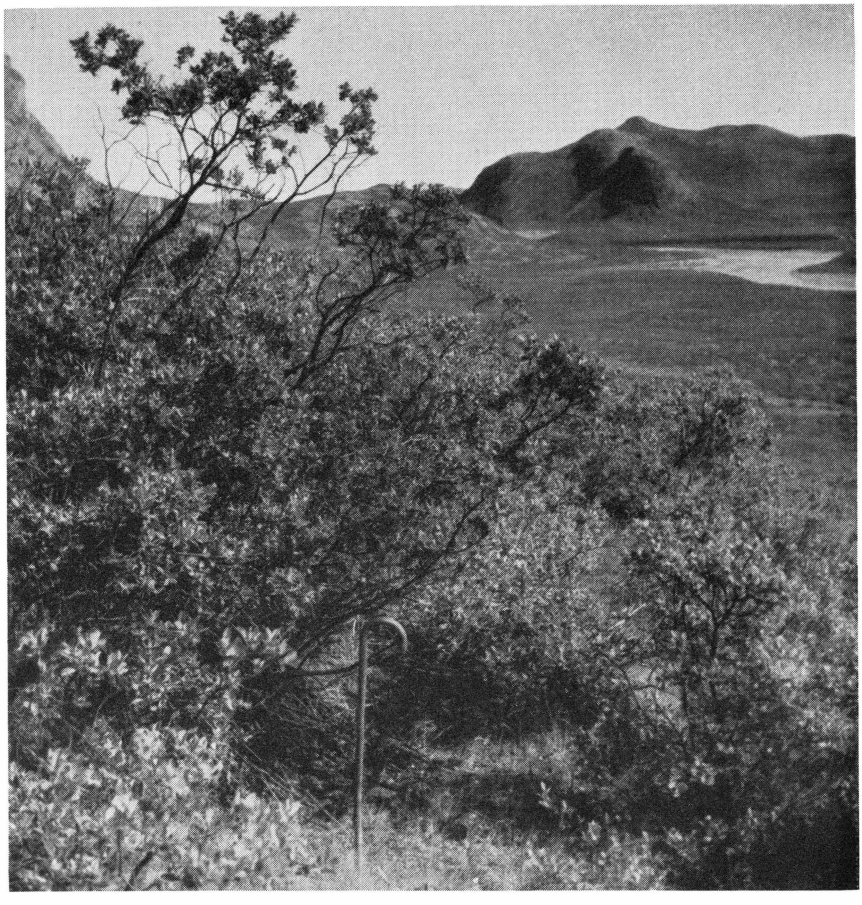


Fig. 60. Nearly 3 m high willow scrub on sunny slope near Keglen. The herb flora is extremely sparse, consisting of scattered *Draba aurea*, *Pirola grandiflora*, *Trisetum spicatum*, *Calamagrostis purpurascens*, and a single *Arnica alpina angustifolia*. T.W.B. phot. $^{19}/_{8}$ 1946.

scribed on p. 282 which are associated with the *Ledum-Calamagrostis groenlandica-Galium* complex. Scrubs of a completely corresponding type have been described by HARTZ (1895) from the interior of Scoresby Sund. Of great importance there are *Calamagrostis purpurascens*, *Poa pratensis iantha*, *P. glauca glaucantha*, and *Festuca rubra*; *Draba aurea* and *Arabis holboellii* are typical accompanying species. A deviation from the Strømfjord scrubs is the occurrence of such pronounced arctic species as *Lesquerella arctica* and *Carex rupestris* (HARTZ *loc. cit.* pp. 146 and 220).

Besides the types of ground flora mentioned there are higher on the mountains low willow scrubs with *Arnica alpina angustifolia* as the chief ground plant (observed in Loc. 2 and 3). Table 28, no. 6 is transitional to this *Arnica* sociation.

Table 28, no. 7 is a *Potentilla tridentata* sociation. It occurred in several places in small patches in scrubs on south-facing slopes of river terraces in Sandflugtdalen.

In many places the pattern formed by steppe communities and scrubs (fig. 4 in B. 1949a, fig. 16 in B. 1949b) were probably dependent on small differences in the terrain which caused somewhat larger accumulations of snow in some places. The snow coverage, however, is hardly so important as the drying-up in summer, which in many places seemed to be able to kill the willows where the scrubs bordered on open expanses covered by steppe (see B. 1949b, Plate 1, fig. 2). The scrubs were found most typically distributed at the foot of southern slopes (B. 1949a, fig. 15) or in furrows on southern slopes, often surrounded there by *Arctostaphylos* heath (see p. 219). In other places the factors causing the distribution were not evident, but the boundaries between scrub and steppe then might be considered to be conditioned by differences in the rocky ground below the loess deposit. Where this was particularly deep, the deep-striking roots of the willow shrubs might be supposed to reach down to constantly water-bearing layers. A vegetation pattern of *Kobresia* soc. and scrub like the one in fig. 55 or 50, however, may also be due to competition for the accessible water in the soil. It is probable that the various bits of scrub draw water from the surrounding steppe-covered area, and that this supply from the surroundings is a condition of their existence. Often some very low willows are seen which fight desperately for life in the steppe-covered areas. Their worst enemies, however, are hardly *Kobresia* or *Carex supina*, but rather the nearest bits of scrub. Such an explanation of the patchwork vegetation is in good agreement with the otherwise rather unintelligible fairly regular distance between bits of scrub or successful single willow shrubs.

Table 29.

Vegetation			pH	Lt	Tk	Ft
Arctostaphylos-Betula nana type.....		Table 26 no. 1	6.9	0.7	9.1	21.0
Carex supina-Potentilla chamissonis type	*Kobresia* sociation group	Table 22 no. 6	6.2	0.4	7.4	22.0
		– 22 – 5	6.6	0.3	7.6	16.0
	Roegneria-Arabis holb. sociation group	– 20 – 10	6.7	0.6	4.9	21.0
		– 20 – 3	6.8	0.7	17.0	14.0
		– 20 – 1	7.6	0.8	24.0	15.0
		– 20 – 23	7.6	0.9	32.0	15.0
Puccinellia-Gentiana detonsa type	*Sisyrinchium* sociation group	Table 25 no. 8	7.3	1.1	10.0	14.0
		– 25 – 4	7.6	0.8	20.0	10.0
	Puccinellia-Braya linearis sociation group	– 24 – 13	7.7	6.4	13.0	—
		– 24 – 16	8.9	1.8	15.0	14.0
		– 24 – 11	9.1	2.6	54.0	4.0
		– 24 – 19	9.2	5.7	43.0	—

From the *Artemisia-Calamagrostis-Arctostaphylos* complex investigations are available of potassium (Tk) and phosphoric acid (Ft) values from some soil samples (Table 29). With reference to the mention in B. 1949b we may sum up that the phosphoric acid value is generally highest in the slightly acid soils and that the potassium value rises to very considerable heights when pH exceeds 9. Otherwise there is some variation as regards Tk and Ft, both within the *Roegneria-Arabis holboellii* sociation group (Table 20), the *Sisyrinchium* sociation group (Table 25), and the *Puccinellia-Braya* sociation group (Table 24).

HAMMER 1952 (nos. 1—3) has analyzed the oribatid-collembola fauna of the soil under a *Carex supina* soc., a *Kobresia myosuroides* soc. and a willow scrub with *Cystopteris fragilis dickieana*, all belonging to the complex. The number of species in the three samples was 2, 10, and 18, while the number of individuals was 2, 230, and 921, which indicates that the very dry *Carex supina* steppe is an extremely poor vegetation as a basis of these groups of animals. The slightly greater humidity of the *Kobresia* steppe considerably increases the possibilities of existence.

V. The Carex inserrulata-Juncus arcticus Complex.

Sub-low arctic continental meso-hygrophytic or telmatophytic, more or less calcicolous communities.

This complex includes partly humid heaths and willow vegetations and meadow-like communities on soil mostly rich in humus and nutrients, partly communities on drying-up lake shores and humid clayey or sandy flats. Often dwarf-shrub communities and herbaceous communities form a pattern, in which the meadow-like spots are found in lower, slightly more humid places between tussocks overgrown with dwarf-shrubs. The vegetation may physiognomically remind of bogs, but can never be designated as such because of the soil water rich in nutrients, the absence of *Sphagnum* and the other character of the flora without typical oxylophytes and with such a species as *Tomenthypnum nitens* as one of the leading mosses. The complex is related to the alpine vegetation mentioned by G. and J. BRAUN-BLANQUET (1931, pp. 27—28) and GUINOCHET 1938 Table 18 and to Scandinavian vegetation described as *Salicion myrsinitis* (KALLIOLA 1939, p. 93) and *Caricion atrofuscae-saxatilis* (NORDHAGEN 1943). Related vegetation is also found in Northern Asia (lower Lena valley; cf. CAJANDER 1903, p. 102, no. 3) and in Canada (cf. e. g. A. E. PORSILD 1945, p. 6).

Among the vegetational types of the complex especially the *Rhododendron* moor plays an important part in the Strømfjord area. In many places its units border on units belonging to the preceding complex, as it is first of all the greater humidity that conditions the transition to the present complex. On a slope like the one pictured in fig. 61 there

were partly dry *Rhododendron-(Dryas-)*heaths belonging to the preceding complex, partly more humid *Rhododendron* moors with *Tofieldia pusilla* and *Carex capillaris* belonging to the present complex.

EG-species (continental, sub-low arctic, meso-hygrophilous, calcicolous (oxyphobous) species): *Carex norvegica inserrulata*, *C. microglochin*, *C. amblyorhyncha*, *C. capillaris robustior*, *Kobresia simpliciuscula*, *Juncus arcticus euarcticus*, *Luzula groenlandica*, *Ranunculus pedatifidus leiocarpus*, *Primula stricta*, *Gentiana tenella*.

EG-species with a medium arctic-continental distribution: *Carex holostoma*.

EG-species in common with the *Puccinellia-Braya* type: *Torularia humilis*, *Puccinellia deschampsioides*.

Cl-species approaching to the EG-species: *Equisetum variegatum* and *scirpoides*.

Cl-species, otherwise especially: *Rhododendron lapponicum*, *Betula nana*, *Dryas integrifolia*, *Pedicularis lapponica*, *Stellaria longipes* coll., *Ranunculus lapponicus*, *Pirola grandiflora*.

Hb-species with subarctic-temperate continental distribution: *Orchis rotundifolia*.

Hb-species: *Juncus castaneus*, *J. triglumis*, *Carex gynocrates*, *Tofieldia pusilla*, *Campylium stellatum*, *Tomenthypnum nitens*.

Hb-species with a wide temperate-subarctic distribution and according to IVERSEN (1936) oligohalobous: *Scirpus pauciflorus* and *Triglochin palustre* (both telmatophytes) and *Lomatogonium rotatum* and *Juncus ranarius*, which may be considered mesohalobous.

a. The Rhododendron-Carex amblyorhyncha Type.

(Low arctic continental moist heath or moor on circumneutral soil).

It may be practical to begin with the dwarf-shrub type, as it covers the largest area. On the other hand its contents of EG-species are very scarce, presumably because *Rhododendron* and other dwarf shrubs do not leave much room for the herbaceaous plants. On larger expanses than a square metre we shall very often find at any rate *Carex norvegica inserrulata* or *C. capillaris robustior*. NORDHAGEN (1936) has *Rhododendron lapponicum* as character species of his xerophilous *Elynion*; so it seems that this shrub in Norway is associated with dry soil. In continental West Greenland this is not so. On the contrary it seems that wet soil gives the species optimum conditions. The communities mentioned in the present type all occur in places with slowly percolating soil water, mostly at the foot of inclines sloping down towards lakes or streams. The infiltration of fen communities and *Rhododendron* moor which is so often observed necessitates a combination of the vegetational types in question in the same complex.

EG-species of the vegetational type:

Carex amblyorhyncha. Cl-Ar: The southern subspecies (ssp. *amblyorhyncha*) has a low arctic-continental distribution and is nearly circumpolar



Fig. 61. North-facing slopes towards Store Saltsø. On the dry terrace *Kobresia myosuroides* is seen in the *Rhododendron* heath. Below, there is more humid *Rhododendron* moor with occasional *Betula nana*, *Salix glauca callicarpaea*, and *Tofieldia pusilla*. *Caloplaca elegans* is abundant on the projecting stones. T.W.B. phot. $^{8}/_{8}$ 1946.

(gap at the Bering Sea). — Ecology: Connected with meso-eutrophic moors. Details in B. 1952b.

For other EG-species see pp. 237—240.

Among the Hb-species there is reason to mention *Orchis rotundifolia*, which at its only station at Umîvik (Loc. 9) was associated with *Rhododendron-Dryas* moors. This species is widely distributed in North America and a good indicator of soil rich in lime, but otherwise it is associated with damp, mossy woods, damp rocks, and fens. It constitutes a subarctic element of the vegetation and as such contributes to distinguishing this type of *Rhododendron* vegetation from that previously mentioned (p. 149) with a more arctic flora. HULTÉN's map of its distribution in Alaska indicates a species associated with a continental climate.

1. Rhododendron-Vaccinium uliginosum microphyllum Sociations.

Table 30, nos. 1—5 shows examples with *Aulacomnium turgidum*, *Drepanocladus uncinatus*, or sometimes *Dicranum elongatum* and *Toment-*

hypnum as dominants in the ground layer. pH is typically below 7 and the conductivity value (Lt) above 1. The vegetation was found in the lowlands and its richness in mosses was obviously connected with the fact that *Dryas* was somewhat unobtrusive. In the sixth and seventh example of the table *Dryas* on the other hand is more abundant and appears as ground layer under the other dwarf shrubs, at the same time supplanting the mosses.

The example Table 30, no. 8 originates from the highlands, on the bank of the *Menyanthes* lake (p. 287). There the calciphilous *Campylium stellatum* appears rather abundantly, and moor plants like *Salix arctophila*, *Carex rariflora*, *C. saxatilis* also occur there, besides the rare *C. amblyorhyncha* (var. *fusca*). The vegetation is found immediately below the type rich in *Dryas* (Table 30, no. 9), which occurs on basic soil.

Fig. 62 shows one of the lowland vegetations and Plate III, fig. 2 is an example of the appearance of a mosaic of tussocks with dwarf-shrub communities and interjacent fen-like patches.

2. Dryas-Rhododendron Sociations.

Table 30, nos. 9—10. The situation of no. 9 with *Distichium capillaceum* as dominant has just been mentioned. It was found on shallow soil rich in electrolytes. No. 10 was found on deeper soil and originates from the surroundings of a small brook below the waterfall at Loc. 9. There, too, there is a high content of electrolytes in the soil. The layer of moss had disappeared completely and *Dryas* forms a dense mat, where, however, *Orchis rotundifolia* is capable of sticking up here and there. M. P. PORSILD (1930, p. 14) at Qagssiarssuk in South Greenland also found this orchid in a *Dryas* vegetation as well as in swampy depressions among mosses under willows. He characterizes the *Dryas* vegetation as "very dry", a statement which perhaps requires some checking. Besides, the ecological contrast between *Rhododendron-Vaccinium* soc. and *Dryas-Rhododendron* soc. undoubtedly also appears in the fact that such species as *Pedicularis lapponica*, *Aulacomnium turgidum*, and *Drepanocladus uncinatus* are absent where *Dryas* is dominant.

3. Dryas integrifolia-Aulacomnium palustre Sociation.

This peculiar combination was found a few times in small not very wet patches on Hassells Fjeld. In the example analyzed (Table 30, no. 11) *Rhododendron* was absent, whereas it was found in some of the other patches. Therefore it is probable that this humid *Dryas* vegetation should be placed in the present vegetational type. Only more analyses can decide where it belongs. *Ranunculus lapponicus* and the moss domi-

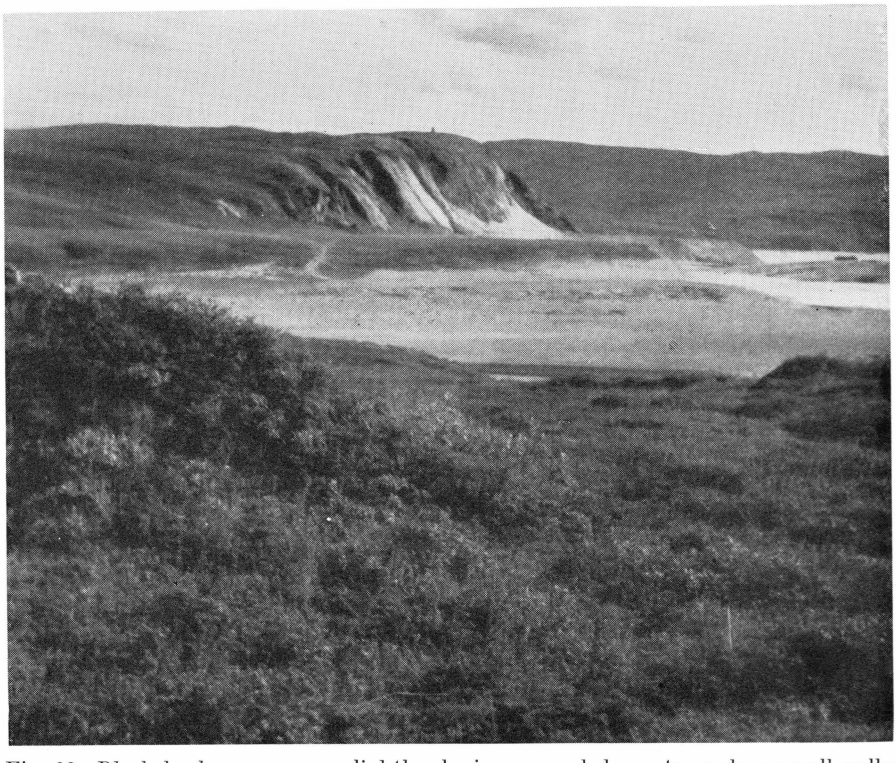


Fig. 62. *Rhododendron* moor on slightly sloping ground down towards a small gully which cuts into the older river terrace on the north side of the western part of Sandflugtdalen. The margin of the terrace is seen and behind it the river plain, the corresponding terrace on the southern side of the valley, and Ravneklippen. For an analysis of the vegetation in the foreground see Table 30, no. 1. T.W. B. phot. $^{31}/_{7}$ 1946.

nant also indicate relationship with the *Salix arctophila* sociations (see 5, below).

4. Betula nana Sociations.

As appears from Table 30, *Betula nana* is often dominant together with *Rhododendron* (cf. also fig. 65). My notes also contain information about pure *B. nana* sociations with *Helodium*; see p. 262. By the river between Ringsødal and Strømfjordshavn the bank was overgrown with a mossy *B. nana* soc. with, amongst others, *Triglochin palustre* and *Carex saxatilis*, while stones and rocks in the riverbed itself especially was abundantly covered with *Schistidium alpicola.* At the northern creek of the fjord we observed — besides the *Rhododendron* soc. Table 30, no. 2 — a luxuriant humid *B. nana* soc. with *Carex norvegica inserrulata* as subdominant. On the bank of a mountain lake on Hassells Fjeld and a basic lake east of Store Saltsø a *B. nana-Equisetum scirpoides* sociation was of some importance.

Table 30.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11
Locality no.	2	7	3	3	9	9	3	3	3	9	3
Altitude in m	75	50	150	50	30	30	50	400	400	30	375
Slope	10°	15°	10°	0°	10°	10°	0°	15°	15°	0°	20°
Exposure	SW	N	SE	—	SW	SW	—	S	S	—	SW
pH	—	5.8	6.5	6.9	6.8	—	—	ca. 6	7.3	7.2	—
Lt	—	1.0	0.7	1.1	1.3	—	—	—	2.8	2.7	—
EG Carex amblyorhyncha	..	..	..	..	..	..	..	1–2	..		..
— — norvegica inserrulata	..	1	..	..	..	..	..	..	..	..	..
— — capitata capitata	..	..	..	+	..	..	..	..	..	..	..
— — capillaris robustior	..	..	..	+	..	+	..	..	..	+	..
— Luzula groenlandica	..	..	..	..	..	..	..	+	..	..	..
Cl Rhododendron lapponicum	4–5	3	4–5	4	2–3	2	3	3	2	2	..
— Dryas integrifolia	1	1–2	+	2	..	2	3	..	5	5	4
— Betula nana	2	..	2	3	3	2	1	+	2	..	2
— Equisetum variegatum	..	..	..	+	..	..	..	..	..	..	..
— — scirpoides	..	..	..	..	..	..	..	..	..	+	..
— Calamagrostis lapponica groenlandica	..	..	..	..	..	..	..	..	+?	..	..
— Kobresia myosuroides	1	..	+	..	..	..	..	..	..	..	..
— Stellaria longipes-monantha	+	..	+	..	..	..	..	..	..	..	+
— Ranunculus lapponicus	..	..	..	..	..	..	..	..	..	..	+
— Pedicularis labradorica	..	..	+	+	..	..	..	..	..	..	..
— — lapponica	+	1	..	+	+	+	+	..	..	..	..
— Pirola grandiflora	+	1	..	..	..	..	..	..	+	..	..
— Poa arctica[1]	..	+	..	..	..	..	..	..	..	..	..
— Luzula arctica[1]	..	+	..	..	..	..	..	..	..	..	..
Hb Orchis rotundifolia	..	..	..	..	1	1	..	..	..	+	..
— Tofieldia pusilla	+	1–2	1	1	+	+	1	..	+	+	..
— Carex maritima	..	..	..	+	..	..	..	..	..	..	..
Carex bigelowii hyperborea	+	1	..	..	+	1	..	..	..	1	..
— rariflora	..	..	..	..	..	..	..	2	1	..	..
— saxatilis	..	..	..	..	..	..	..	+	..	..	..
— scirpoidea	1	..	..	..	..	..	+	..	..	..	..
Chamaenerium latifolium	..	1	..	..	..	..	..	..	..	..	..
Empetrum nigrum hermaphr.	1	1	..	+	..	..	+	+	..	..	1
Euphrasia frigida	..	..	..	1	+	..	+	..	..	..	..
Equisetum arvense	..	+	..	3	+	..	2	..	..	..	2
Luzula confusa	..	+	+	..	..	..	+	..	..	..	..
Pedicularis flammea	..	..	..	..	..	..	..	..	+	..	..
Poa pratensis iantha	..	..	+	..	..	..	+	..	..	..	1
Polygonum viviparum	+	1	+	+	+	+	+	+	..	+	+
Salix arctophila	..	..	..	..	..	..	..	1	..	..	..
— glauca callicarpaea	2	..	1	..	+	..	..	..	+	..	1
Vaccin. ulig. microphyllum	3	4	4–5	3	2	3	3	4	1	3	3
Lophozia alpestris major	..	..	..	+	..	..	..	..	..	..	..
Plagiochila asplenioides	..	..	..	+	..	..	..	..	..	..	..

[1] High arctic continental.

(To be continued)

Table 30 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11
Barbilophozia barbata	..	..	..	..	+	..	..	..	..	..	..
Amblystegium varium	..	..	..	..	..	..	..	..	+	..	..
Aulacomnium palustre	..	..	1	1	..	..	..	..	..	..	5
— turgidum	4	3–4	2	1	..	..	..	..	..	..	1
Brachythecium salebrosum	..	..	+	..	..	..	..	1	..	..	..
Bryum pendulum	..	..	..	..	..	..	..	..	+	..	..
— sp.	..	..	..	..	..	..	..	+	..	..	..
Campylium polygamum	..	..	..	..	..	..	..	..	+	..	
Hb — stellatum	..	+	..	..	+	+	..	2	+	..	..
Dicranum elongatum	..	3	3	..	1	..	..	..	..	..	..
— fuscescens(?)	1	..	..	..	..	..	..	..	..	..	..
Distichum capillaceum	..	..	..	..	..	..	..	..	3	..	..
Drepanocladus uncinatus	+	2	3	4	5	+	+	..	..	..	..
Hylocomium splendens	1	1	..	1	..	..	..	..	..	..	..
Hypnum callichroum	..	..	..	1	..	..	..	..	..	..	..
— cupressiforme vaucheri	..	..	..	..	..	..	+	..	..	..	..
— revolutum	..	..	+	..	..	..	..	..	..	..	..
Meesia uliginosa	..	..	..	..	..	..	..	1	+	..	..
Oncophorus wahlenbergii	..	1	..	..	1	2	..	..	..	..	..
Hb Tomenthypnum nitens	2	2	1	3	1	1	..	2	1	..	1
Webera nutans	..	..	..	..	..	..	..	1	+	..	..
Alectoria lanea	..	..	+	..	..	..	..	..	..	..	..
— ochroleuca	..	..	1	..	..	..	+	..	1	..	..
Cetraria crispa	..	1	..	..	..	..	..	..	..	..	..
— cucullata	+	..	1	+	..	..	+	..	2	..	..
— delisei	..	..	..	..	1	..	..	..	..	..	..
— islandica	1	..	..	..	..	..	..	..	..	..	..
— nivalis	..	..	..	..	..	..	1	..	+	+	..
Cladonia cfr. amaurocraea	..	..	1	..	..	..	..	..	..	..	..
— gracilis chordalis	..	..	..	+	+	..	..	..	..	..	..
— pyxidata	..	..	..	..	..	..	..	..	..	+	..
Cornicularia aculeata	..	..	+	..	..	..	+	..	+	..	..
Nephroma expallidum	..	..	1	..	..	..	..	..	1	..	..
Peltigera aphthosa	1	..	+	..	..	..	..	..	..	..	..
— leucophlebia	..	1	..	..	..	..	..	..	..	..	1
— malacea	..	..	1	+	..	..	1	..	..	..	..
Psoroma hypnorum	+	..	..	..	..	..	..	..	..	..	..
Thamnolia vermicularis	..	..	..	..	..	..	..	..	+	..	..
Boletus scaber	+	..	..	..	..	..	..	..	..	..	..
Hebeloma crustuliniforme	..	..	..	..	..	..	..	..	..	+	..
Xeromphalina cauticinalis	..	..	..	..	..	..	..	..	..	+	..

5. Salix arctophila Sociations.

A fair number of the many *Salix arctophila* sociations contain EG-species which refer them to the present complex. They occur on banks of lakes and e. g. in the ravine rising from west to east in the south-

facing slope of Hassells Fjeld (fig. 63), where the ground is often covered by a fen-like vegetation with *Salix arctophila* as the most important of the higher plants. North of the Strømfjord area they seem to be frequent in the Egedesminde District (cf. KRUUSE 1898, pp. 385 and 391). As compared with the preceding sociations, the *Salix arctophila* sociations very much seem to require a peat which is more saturated with water. On the other hand, there is no difference respecting the pH of the water, which in three cases (among them nos. 1—2 in Table 31) was about 7. In several cases a zonation was noted in which *Rhododendron* moor was found immediately above a *Salix arctophila* soc. Table 31, no. 1 shows an example in which *Rhododendron* occurs together with dominant *S. arctophila.*

The most important EG-species is *Carex norvegica inserrulata* (see p. 238). *C. amblyorhyncha* may also be found. It was observed both in Ørkendalen and near the vegetation Table 30, no. 8, where it was growing together with the southern species *Galium brandegei.*

The occurrence of *Salix arctophila* sociations may further be illustrated by the following notes:

A profile laid across the ravine on Hassells Fjeld (fig. 63) first cuts across a fen-like vegetation with a composition as shown in Table 31, no. 2. It is followed by a small north-facing slope with heath dominated by *Salix glauca callicarpaea*, *Betula nana*, *Vaccinium uliginosum microphyllum*, and *Aulacomnium turgidum* (fig. 63) or *Betula-Ledum decumbens* heath with *Pirola grandiflora*, *Equisetum arvense*, and *Poa pratensis iantha.* Next, on the surface of the ridge demarcating the ravine, either plane or sloping slightly towards the west, there are either a dry *Vaccinium uliginosum* heath with *Kobresia myosuroides* or dry *Salix glauca* scrub, and then the *Carex supina* vegetation of the southern slope.

In continuation of the part of the ravine seen in the photo, we find farther east the long and narrow lakes Kløftsøerne. These lakes have slightly acid water and their banks in several places have a bog-like vegetation (p. 284), in other places *Salix arctophila* with *Aulacomnium palustre* dominates, and there are scattered occurrences of *Carex norvegica inserrulata*, *Equisetum variegatum*, and *Climacium.* Near Keglen there is often a bank vegetation with the same mosses and *Mnium rugicum*, and the willow species is accompanied by such species as *Pedicularis labradorica*, *P. lapponica*, *Cardamine pratensis*, and *Equisetum variegatum.* These are transitional to the more oligotrophic communities, while other banks near Keglen contained *Luzula groenlandica*, *Gentiana tenella*, and *Carex norvegica inserrulata* in *Salix arctophila-Aulacomnium* sociations. The last-mentioned sociations generally occurred below *Rhododendron* moors.



Fig. 63. *Salix arctophila-Tomenthypnum nitens* soc. in the ravine on Hassells Fjeld. In front *Vaccinium uliginosum* heath with occasional *Salix glauca callicarpaea*. M. Skytte Christiansen phot. August 1946.

Near the large lake Taserssuatsiaq and the river which drains it, there are in several places a *Salix arctophila* soc. belonging to the complex. The whole of the strange vegetational pattern deserves special mention:

The low bank of the lake has a number of small prominences between which there is an interesting flora of dwarf-like plants such as *Ranunculus reptans*, *Juncus alpinus nodulosus*, *Heleocharis acicularis*, and dwarfish specimens of *Equisetum scirpoides* and *variegatum*. The *Ranunculus* is weakened and *Heleocharis acicularis* disappears if mosses immigrate and get the upper hand. At the same time *Salix arctophila* makes its appearance and forms a vegetation like the one in Table 31, no. 4, raised only a little above the surface of the lake. Away from the lake, on their highest part, the prominences were covered by a low scrub of willow and dwarf birch, but on the part sloping down towards the lake, there was a flora rich in herbs, which evidently belonged to the present complex. Frequent species there were *Luzula groenlandica*, *Kobresia simpliciuscula*, *Juncus castaneus*, and *Carex saxatilis*. The vegetation, however, also had traces of the herb fields of the coastal regions with

Table 31.

Analysis no.	1	2	3	4	5
Locality no.	3	3	5	7	3
Altitude in m	200	200	200	50	300
EG Carex norvegica inserrulata	+	+	..	..	+
Cl Equisetum variegatum	..	..	+	1–2	..
— — scirpoides	..	..	..	2	..
— Rhododendron lapponicum	1–2	..	..	..	..
— Betula nana	2	..	+	..	1
— Pedicularis lapponica	+	+	..	..	..
— Ranunculus lapponicus	+	+	..	..	..
— Stellaria longipes-monantha	..	..	+	..	+
— Calamagrostis lapponica groenlandica	..	..	+	+	..
Hb Carex gynocrates	..	+	..	..	..
— Juncus castaneus	..	+	..	..	..
— Tofieldia pusilla	..	+	..	..	..
Carex rariflora	1–2	1	3	..	..
— saxatilis	..	..	..	+	..
— scirpoidea	..	+	..	..	..
Chamaenerium latifolium	..	+	..	..	..
Equisetum arvense	4	3	..	..	..
Eriophorum angustifolium	..	2	2	..	2
Pedicularis flammea	..	+	..	..	..
— hirsuta	..	..	..	..	+
Poa pratensis iantha	+	1	..	..	..
Polygonum viviparum	..	+	+	..	+
Ranunculus reptans	..	..	..	+	..
Salix arctophila	4	4	2	5	5
Vaccinium uliginosum microphyllum	2	..	..	..	+
Aulacomnium palustre	..	..	5	1–2	5
Calliergon stramineum	..	..	..	1	..
Climacium dendroides	..	..	..	5	1
Drepanocladus revolvens	..	..	..	1	..
Helodium blandowii	..	3	..	..	..
Hypnum pratense	..	1	..	..	..
Mnium rugicum	1	+	..	..	..
Philonotis fontana	..	..	..	+	..
Tomenthypnum nitens	3	4	3	1	..
Peltigera leucophlebia	..	..	1	..	..

occasional abundance of *Thalictrum alpinum* and *Bartsia alpina*, two species which are very rare in the continental area. Other species in this vegetation were *Carex bigelowii hyperborea*, *C. rariflora*, *C. scirpoidea*, *Poa pratensis iantha*, *Calamagrostis lapponica groenlandica*, *Tofieldia pusilla*, and *Stellaria longipes* coll. In Ringsødal *Bartsia* was found under identical conditions exposed to spray of waves on

a mossy bank of a lake together with *Juncus castaneus* and *Solorina bispora.*

Most sociations dominated by *Carex rariflora* have an oligotrophic flora; *C. rariflora* itself is, however, very tolerant as regards pH and the contents of nutrients of the soil; cf. NORDHAGEN (1943, p. 448). Therefore there is nothing strange in the fact that it also, although rarely, may form mesotrophic sociations which owing to high frequency of *Salix arctophila*, if anything, belong in the present complex.

By a lake in the eastern part of Sandflugtdalen, in part surrounded by flats of driftsand, there was on the sheltered side (the east end) a mossy *C. rariflora* marsh, which owing to the other vascular plants may be grouped with the *Salix arctophila* sociations; for *S. arctophila* was very frequent, and furthermore there were some *Ranunculus lapponicus*, *Luzula groenlandica*, *Juncus arcticus*, *Carex saxatilis*, *C. bigelowii*, *Pedicularis flammea* and *hirsuta*, both *Eriophorum* species, and *Betula nana.*

In continuation of Ringsødal towards Strømfjordshavn there was a similar bank vegetation, a *C. rariflora-Aulacomnium palustre-Tomenthypnum* soc. (Table 31, no. 3) sometimes containing abundant *Equisetum variegatum* and *Salix arctophila* or occasional *Carex capitata* ssp. *arctogena*, and *Epilobium palustre.*

b. The Ranunculus pedatifidus-Kobresia simpliciuscula Type.

(Low arctic-continental fens and marshes on neutral-basic soils).

I have made several attempts at dividing this type into a telematophytic type on humid, mainly mineral soil (lake shores and the like) and a non-telematophytic type, which is rich in mosses and makes its appearance on soil more or less peaty. In spite of some difference as regards the placing in the terrain and the degree of humidity in the soil, the communities naturally belong together floristically as well as ecologically. Common to all of them is the neutral-basic soil, which in many cases dries up superficially in summer. The vegetational type is found partly together with communities belonging to the preceding type, partly bordering on communities from the *Puccinellia-Gentiana detonsa* type.

EG-species of the vegetational type:

Ranunculus pedatifidus var. *leiocarpus* (*R. affinis* var.). This variety may cover the East American-West Greenland form cycle. It has a low arctic-continental distribution and has a southern range in the Canadian Eastern Arctic (POLUNIN 1940, p. 221). FERNALD (1950, p. 650) mentions it in the south from calcareous or basic cliffs or turfy slopes. In continental West Greenland it was found on slightly acid-neutral soil. It is very frequent in mossy depressions which dry up in late summer. The Northeast Greenland plant has another chromosome number (HOLMEN 1952) and a deviating ecological behaviour.

Kobresia simpliciuscula. The Greenland material probably belongs to a more arctic race than the European material (map and discussion in B. 1951c). The southern limit in East America has been mapped by RAYMOND (1950). It is absent on the Atlantic part of the Labrador coast, but is found in calcareous areas in West Newfoundland and on and near Anticosti Island. In the south it seems more exclusive to lime than farther north, where, e. g. by the Strømfjord, it may be found on neutral soil. There it is most frequent beside running water (luxuriant in the waterfall at Loc. 9!).

Carex norvegica ssp. *inserrulata.* Cl-Ar: The subspecies is low arctic-subcontinental, East American-Greenlandic; see details in KALELA (1944); RAYMOND 1950, map 4; B. 1952, p. 72. — Ecology: An important plant in the continental area with occurrence in a large number of the sociations of the complex, mostly in places which in summer are exposed to some drying-up. If anything, mesotrophic.

Carex holostoma. Cl-Ar: Medium arctic-continental, absent in most of Asia. For maps see especially RAYMOND 1950a, fig. 11; B. 1952, fig. 32. — In the Strømfjord area it is a montane species, which is missing in the lowlands. Its total distribution and local occurrence justify a reference of the *C. holostoma* sociations to a special group or subtype — Ecology: According to NYGREN (1936) presumably indifferent as regards pH. Several of its accompanying plants in Northern Sweden are typical of the present complex, e. g. *Carex atrofusca, C. microglochin, Primula stricta.*

Carex capitata ssp. *capitata.* Subarctic-subcontinental; see details in H. SMITH (1940) and B. (1950, pp. 8—10; 1952a, p. 54).

Carex capillaris ssp. *robustior.* This subspecies seems to have a low arctic-continental distribution (B. 1952a, pp. 51—54). The collective species is not continental; see maps in RAUP (1947) and HULTÉN (1950, map 408). Ssp. *robustior* is probably markedly calciphilous.

Carex microglochin. Cl-Ar: Low arctic-subcontinental, like *C. capitata, Gentiana tenella,* and others penetrating to oceanic areas, where the soil is rich in lime (e. g. Iceland, where it is frequent). The continental trend is supported by its absence in South Alaska and Western Norway; maps in RAUP (1947, North America), B. 1938 (Greenland), HULTÉN 1950 (Scandinavia). — Ecology: The species is a soil-specialist, which explains its often very sporadic occurrence; cf. the remarks in B. 1949b, 1950.

Carex atrofusca. This character species of the related *Caricion atrofuscae-saxatilis* described by NORDHAGEN also ought to be mentioned here, although the species is absent in the area investigated by me. This absence is probably due to the fact that the Greenland material belongs to a more arctic race. I have not seen the species in Greenland myself, but there is much to indicate that the communities in which it is dominant or occurs are very closely related to the sociations described below and should be included in the complex. Its distribution seems to be continental (absent in Atlantic East America (RAYMOND 1951, map 1) and Iceland, rare occurrence in Western Norway).

Luzula groenlandica. Cl-Ar: Low arctic-continental, East American-West Greenland species; see details in B. 1950, 1952. — Ecology: Very characteristic of the complex, mostly on soil which dries up somewhat in summer. On the occurrence of the species in Canada the following information kindly given by Dr. I. A. CALDER, Ottawa, may be quoted: "During the summer of 1948

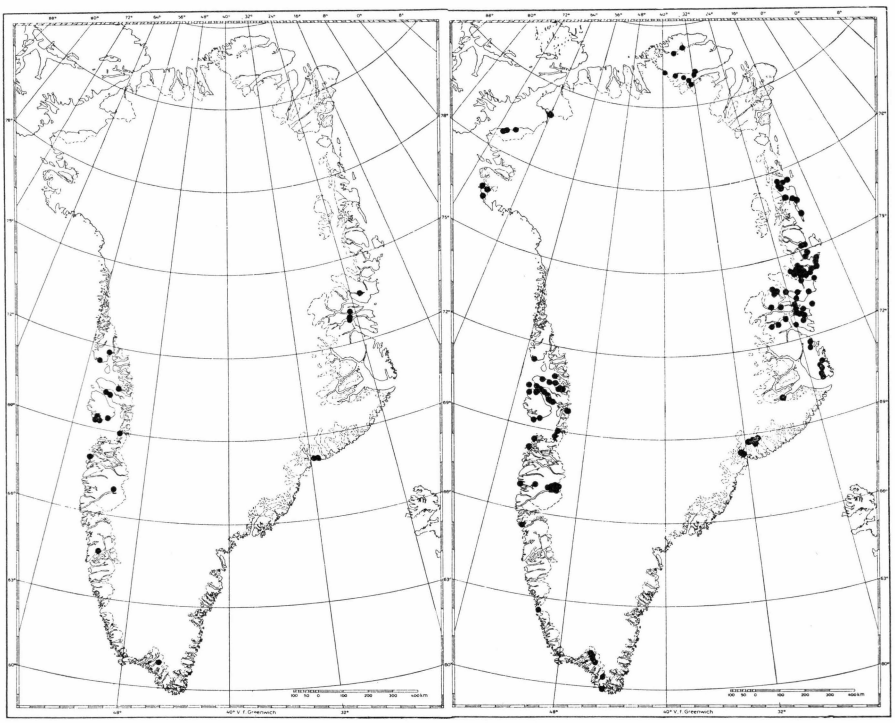


Fig. 64. Greenland distribution of *Carex bicolor* (left) and *C. maritima* (*incurva*) (right).

I collected *Luzula groenlandica* at Fort Chimo in northern Quebec; it was quite common in open sandy areas (alluvial deposits) along the banks of the Koksoak River and apparently it is one of the first invaders of disturbed or broken ground. This past summer one of our staff collected *L. groenlandica* var. *fuscoatra* at Chesterfield Inlet on the west coast of Hudson Bay. Two collections were made, one on a muddy gravel flat beside a brackish pond, and the other on moist but apparently fresh grassland. It was noted as rare in the Chesterfield area". Cf. further SAVILE & CALDER 1952, p. 104.

Juncus arcticus ssp. *euarcticus*, cf. HYLANDER 1953. Cl: Low arctic-continental (see B. 1938, p. 242, supported by map of the Scandinavian distribution, HULTÉN 1950, map 437, and remarks in GAMS 1931—53, p. 191, which show that this species very rare in the Alps is just found in the climatically most continental places). Ar: A. E. PORSILD 1951, p. 126, writes that the species in America is eastern and has not penetrated far west of Hudson Bay. Its relation to ssp. *balticus*, as just appears from PORSILD's description, is, however, particularly complicated in America. — Ecology: With clear concentration in the present complex, but may occur outside it, e. g. at the colony Godthaab, where it grows in a ditch beside the road, undoubtedly on somewhat manured soil.

On the bank of a slightly salt lake near Strømfjordshavn I found both *Carex bicolor* and the hybrid *Epilobium palustre* × *davuricum* (var. *arcticum*). The latter *Epilobium* species and the sedge both enter as elements in NORDHAGEN's *Caricion atrofuscae-saxatilis* and may also be considered as EG-species

in the Greenland complex. RAUP's map (1947, Plate 31) and HULTÉN's map (1950, no. 1279) strongly indicate that *E. davuricum* is continental. As to *C. bicolor* its distribution both in Greenland (fig. 64) and Scandinavia (GJÆREVOLL 1950a, fig. 1) seems to point in the same direction. This species occurs in Iceland, but is rare there and mostly found in the northeast (map in OSKARSSON 1951). *Carex saxatilis*, too, is by NORDHAGEN considered a guiding species and is even used to name the alliance. In the case of Greenland I dare not use this species as its environmetal requirements there are not sufficiently clear. It seems to occur in many rather oligotrophic communities around Søndre Strømfjord. This may be connected with the fact that in Greenland it may not be very well demarcated from "*C. rotundata*", or it may have another racial structure than in Scandinavia (cf. B. 1952 a), but after a study of KNABEN's *Eriophorum-Carex saxatilis* fen from W. Norway (1950, Table 11, especially I) I am no longer, for that matter, quite sure of the value of this species as an indicator even in Scandinavia.

Primula stricta. Continental, sub-low arctic species with disrupted range (B. 1950, p. 36 and map fig. 15). — Occurs mainly in the present complex as well as in the steppe communities on ultrabasic soil (Table 24). A. E. PORSILD 1951 found it confined to marl bogs in Yukon.

Gentiana tenella. This species is in West Greenland closely connected with the complex. NORDHAGEN (1943, pp. 456 and 461) mentions it from a *Carex microglochin* soc. and a *C. atrofusca* soc. in the Dovre, but does not include it among his guiding species. This is presumably due to the fact that in Scandinavia it may also occur on gravelly soil. The continental trend of the species, for that matter, is reflected both in its total distribution and its distribution within Scandinavia and Greenland. Its frequent occurrence in Iceland may perhaps be considered the result of the edaphic conditions which are favourable to so many more or less continental species in this island. According to ROUSSEAU & RAYMOND 1952 the species is polymorphous and there may be some constant genetic differences between the European and the American populations.

Equisetum variegatum and *scirpoides* are both frequent in the communities of the complex and have a sub-low arctic, more or less continental distribution (the latter is absent in West Norway, in Iceland, and in South Alaska, the former is more problematic as it is frequent in Iceland and in parts of the oceanic coast of West America; RAUP 1947, Plate XIV). NORDHAGEN mentions *E. variegatum* as a regional guiding species for his *Caricion atrofuscae-saxatilis.* In Greenland, too, it is one of the two species most intimately connected with the complex, while *E. scirpoides* is more frequently found outside it and in America (e. g. Yukon) is important in so-called pre-climax flood-plain forests (A. E. PORSILD 1951b). In N. Finland it grows in damp forest on calcareous soil (KOTILAINEN 1951, p. 87). An example of deviating occurrence of *E. variegatum* in Greenland is mentioned in B. 1933b from Mikis Fjord in East Greenland, where the species occurred on loose scree of basaltic gravel. — The halophilous *Lomatogonium rotatum* approaches to the EG-species. It has a considerable distribution in the central parts of the large continents, but is completely absent in Western Europe (with the exception of Iceland) and is rare in oceanic climatic areas along the northern Pacific. Its Greenland distribution is sub-low arctic with its highest frequency in the Strømfjord area (B. 1952a, map fig. 17).

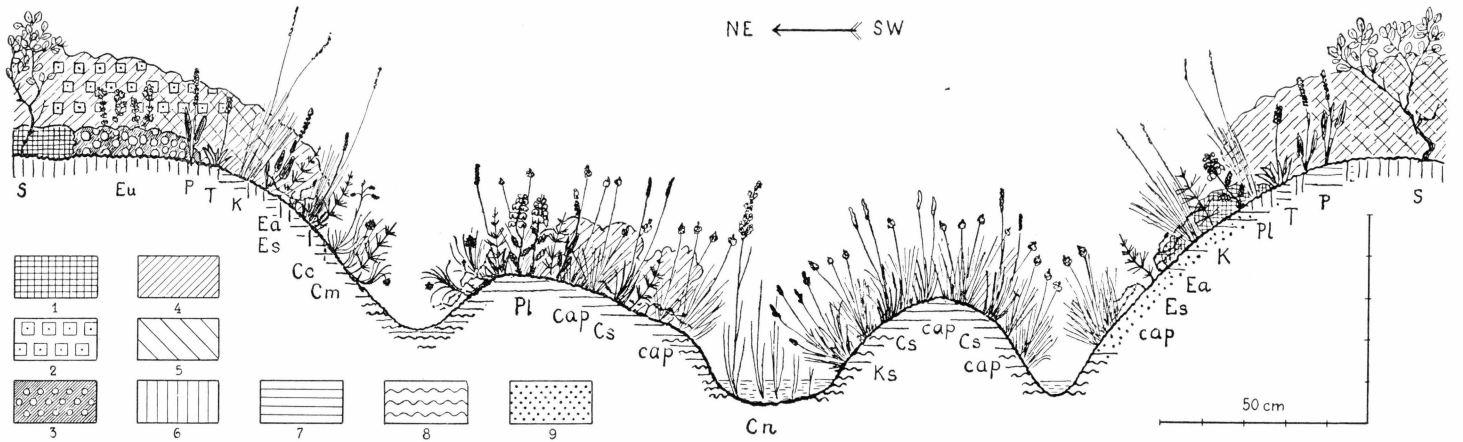


Fig. 65. Profile transect through depression in *Rhododendron*-moor at the foot of Hassells Fjeld, Loc. 3. Explanation of signs and hatchings:

1. *Empetrum nigrum hermaphroditum*
2. *Rhododendron lapponicum*
3. *Dryas integrifolia*
4. *Betula nana*
5. *Vaccinium ulig. microphyllum*
6. *Cetraria cucullata-Cladonia gracilis-Drepanocladus uncinatus*, and a little *Hypnum callichroum*; on the south-facing slope on the left, *Cladonia pyxidata pocillum* and the rare *C. acuminata* var. *norrlinii*
7. *Tomenthypnum nitens*
8. *Tomenthypnum nitens* and *Calliergon turgescens*, *Cosmarium holmiense integrum*, *Pinnularia gracillima* and 21 other species of diatoms
9. *Drepanocladus* sp., *Distichium capillaceum*, *Campylium stellatum*, *Nardia scalaris*

cap. *Carex capitata capitata*
Cc — *capillaris*
Cm. — *maritima*
Cn. *Calamagrostis neglecta*
Cs. *Carex scirpoidea*
Ea. *Equisetum arvense*
Es. — *scirpoides*
Eu. *Euphrasia frigida*
K. *Kobresia myosuroides*
Ks. — *simpliciuscula*
P. *Polygonum viviparum*
Pl. *Pedicularis lapponica*
S. *Salix glauca callicarpaea*
T. *Tofieldia pusilla*

pH 6.9 Lt 1.1

On microclimatic measurements in the place see B. 1949b, Table 4 (3)

On microfauna in the soil see M. Hammer 1952, no. 4. In all 23 species (600 individuals).

1. Carex capitata Sociations.

These sociations were observed only in small patches between tussocks in *Rhododendron* moor or in holes on level areas covered by *Kobresia myosuroides* sociations. In the latter case the most important accompanying plants were *Carex norvegica inserrulata* and *Armeria scabra sibirica*, in the former case, *Kobresia simpliciuscula*, *Carex maritima*, *Equisetum variegatum* and *scirpoides*; cf. the transect described below, which shows the vegetational pattern in the valley below Hassells Fjeld, and Plate III, fig. 2, which shows a photo of a tussocky *Carex capitata* (ssp. *capitata*) sociation from the same place.

Transect fig. 65. This transect cuts through an upper dwarf-shrub zone dominated by *Betula nana* or *Rhododendron-Dryas*, a very narrow zone with *Kobresia myosuroides-Carex scirpoidea-Equisetum arvense*, a zone with *Carex capitata-C. maritima-Equisetum scirpoides-Kobresia simpliuscula*, and a lower zone with mostly sterile *Calamagrostis neglecta* (see also in Plate III, fig. 2).

2. Equisetum scirpoides Sociations.

Equisetum scirpoides occurs as dominant in the continental area in small patches on the steep banks of beds of brooks which dry up in summer and where it must be supposed that there is slight seepage of ground water. This kind of patches was seen both at Itivdlínguaq and on Hassells Fjeld, from where the following example originates: 300 m above sea level, 50° towards the east: *E. scirpoides* (5), *Salix glauca callicarpaea* (2), *Betula nana* (1), *Poa pratensis iantha* (1), *Equisetum arvense*, *Polygonum viviparum*, and *Stellaria longipes-monantha* (+), no mosses.

Ecologically related was another patch of vegetation on the slope below Lille Saltsø, where, perhaps, also some soil water might force its way towards the surface. This patch was found on a north-facing steep slope with an inclination of about 35° and about 60 m above sea level and had the following flora: *E. scirpoides* (4), *Betula nana* and *Vaccinium uliginosum* (2), *Rhododendron*, *Empetrum*, *Pirola grandiflora*, *Poa pratensis iantha*, and *Polygonum viviparum* (+). Mosses: *Hylocomium splendens* (5), *Drepanocladus uncinatus*, and *Tomenthypnum nitens* (1), *Aulacomnium turgidum* (+), *Peltigera aphthosa* (+). The frequency of the acidophilous *Hylocomium splendens* is presumably due to the fact that the surface layer of humus is acid enough for this species, while the *Equisetum* species benefits by the substances supplied by the rising ground water.

Beside an alkaline lake east of Store Saltsø *E. scirpoides* was observed, partly as a subordinate element on a *Betula nana* heath, partly as dominant in a strip of moss on the steep bank immediately above the surface of the lake.

3. Carex maritima Sociations.

Fig. 64 shows the distribution of *Carex maritima* in Greenland. It is a very widely distributed species, but it has a distinct concentration in the continental areas. In Scandinavia, on the other hand, it is found both along the sea coast and in the mountains in the interior (e. g. in the Dovre); see HULTÉN 1950. So in Greenland it perhaps belongs to a special arctic-continental race, which can even grow on nunataks (Knud Rasmussens Land), while southern seashore races may be absent in Greenland. NORDHAGEN (1943) mentions *C. maritima* as a guiding species for his *Caricion atrofuscae-saxatilis*. In accordance with this, it is in the Strømfjord area concentrated in communities belonging to the present complex. Still, it is not always easy to decide to what complex it belongs, because the species so frequently appears as sole dominant nearly without companions. This especially applies where it grows on the sandy plains of the river valleys. There it may form pure *C. maritima* sociations, e. g. on moist driftsand between dunes. These do not, however, occur on the moistest sand, as appears from the following zonation from Sandflugtdalen west of Keglen:

(1) *Juncus arcticus-Distichium inclinatum* soc. on moist sand in depression (old river-bed) in the plain. Table 33, no. 2.

(2) *Plantago maritima juncoides* soc. with scattered *Puccinellia deschampsioides* and *Carex maritima*. Table 34, no. 1.

(3) *Carex maritima* soc. or *Plantago maritima-Festuca rubra* soc.

(4) Low, lengthy dunes overgrown with *Salix glauca callicarpaea*.

Mossy *C. maritima* sociations occur in many places in the vegetation of the river valleys and on the shores of the salt lakes. In the river valleys there are two types, one of which occurs in holes in *Rhododendron* moors, the other in depressions drying up in summer. A profile laid through one of the holes in the *Rhododendron* moor at the foot of Hassells Fjeld (cf. fig. 65) had a *Carex maritima* soc. (with *Equisetum arvense* and *Kobresia simpliuscula*) inserted between the dwarf-shrub vegetation on top of the tussocks and the *Calamagrostis neglecta* soc. between the tussocks.

Table

	Analysis no.	1	2	3	4	5	6	7	8
	Locality no.	7	7	5	7	2	2	1	3
	Approx. altitude in m	250		200	100	100	250	100	50
	pH	7.1	7.2	—	7.5	—	ca. 8	—	6.8
	Lt	—	1.2	—	0.6	—	—	—	1.9
EG	Carex capillaris robustior	4	4	3	2	2	..	+	..
—	— norvegica inserrulata	..	..	..	..	..	..	..	..
—	— capitata capitata	..	..	..	..	+	..	..	+
—	Luzula groenlandica	..	..	..	..	..	1	..	..
—	Juncus arcticus	..	+	..	..	..	1	..	+
—	Ranunculus pedatifidus	..	..	..	..	..	..	..	..
—	Kobresia simpliciuscula	..	..	..	..	+	..	..	+
—	Gentiana tenella	2	..	..	1	..	..	..	..
—	Primula stricta	..	..	1	..	+	2	..	..
Cl	Calamagrostis neg cta	..	..	..	+	..	+	..	+
—	— lapponica groenl.	..	..	..	..	..	..	..	..
—	Equisetum scirpoides	..	..	..	..	..	..	..	1
—	Kobresia myosuroides	..	..	..	..	..	..	+	+
—	Poa arctica	..	..	..	..	..	..	..	..
—	Braya linearis	..	..	..	1	..	..	..	..
—	Torularia humilis	..	..	+	..	..	..	..	..
—	Draba hirta	..	..	..	..	..	..	..	..
—	— lanceolata	..	..	..	..	..	..	..	..
—	Melandrium triflorum	..	..	..	..	..	..	..	..
—	Stellaria longipes-monantha	..	..	..	..	..	..	..	..
—	Armeria scabra sibirica	..	..	..	..	..	..	..	..
—	Betula nana	..	..	..	..	..	..	2	2
Hb	Carex maritima[1]	..	1	..	..	5	5	5	5
—	Lomatogonium rotatum[1]	..	..	+	..	..	..	+	..
—	Juncus ranarius[1]	..	..	..	+	..	..	..	..
—	Tofieldia pusilla	..	..	1	..	..	..	..	..
—	Juncus alpinus nodulosus	..	..	..	1	..	..	..	..
—	— triglumis copelandii	..	..	..	+	..	..	..	..
—	Cardamine pratensis	..	1	..	..	..	+	..	..
—	Saxifraga aizoides	1	5	..	..	..	..	..	..
	Carex saxatilis	..	..	1	..	..	+	..	..
	— scirpoidea	..	..	1	..	..	..	..	..
	Cerastium alpinum lanatum	..	..	..	..	..	..	..	..
	Equisetum arvense	..	..	..	..	..	..	..	+
	Eriophorum angustifolium	..	..	..	..	..	..	..	..
	— scheuchzeri	..	..	1	..	..	..	..	..
	Euphrasia frigida	..	1	..	2	..	..	..	..
	Festuca brachyphylla	..	..	..	..	..	..	..	..
	— rubra	..	..	..	..	+	..	..	..
	Pedicularis flammea	..	..	+	..	..	..	+	..

[1] Oligohalobous Hb-species.

32.

9	10	11	12	13	14	15	16	17	18	19	20	21
5	2	2	2	5	6	2	2	7	2	2	7	3
70	100	100	250	200	100	100		250	250	100	250	300
—	—	—	—	—	—	6.8		6.0	5.2	—	—	5.3
—	—	—	—	—	—	—		0.6	0.6	—	—	—
..	1	1	..	..	1	..	..	..	..	..	..	..
..	..	..	1	1	..	+	1	1	..	..	..	1
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	1	1	..	..	..	..	..	+	..	..
..	..	..	1	..	..	..	..	..	..	..	..	..
..	..	..	..	..	+	+	2	1	+	1	2	+
..	..	..	..	..	..	..	..	..	..	..	..	..
..	2	..	..	..	1	..	+	..	..	..	..	..
..	+	..	1	..	..	..	..	..	..	..	..	..
5	3	4	4	5	4	3	3	..	..	..	..	..
..	..	..	..	..	..	..	..	..	3	2	..	1
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	2
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	1	1	..	..	..	..	..	+	..	..
..	..	..	+	..	..	..	..	..	..	..	..	..
..	..	..	..	+	..	..	..	..	..	..	..	..
..	..	..	+	..	..	..	1	..	+	1	2	2
..	..	..	..	..	..	..	..	+	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
2	..	1	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	+	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	1	1	..	..	..	..	..	..	..	..	..
..	..	..	..	..	1	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	..	+	+	..
..	..	..	..	..	..	..	..	..	..	..	..	..
1	..	..	..	..	..	..	..	+	..	..	1	..
..	..	1	1	1	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	1?	..	..
..	..	..	..	..	..	2	1	..	1	1?	+	1
..	..	..	..	..	..	..	..	..	..	..	..	..

(To be continued)

Table 32

Analysis no.	1	2	3	4	5	6	7	8
Pedicularis hirsuta	..	..	..	..	..	..	+	..
Poa pratensis iantha	..	..	..	..	..	..	..	..
— glauca	..	..	..	..	..	1	..	..
Polygonum viviparum	..	..	..	..	..	+	+	+
Rumex acetosella	..	..	..	..	..	..	..	..
Salix arctophila	1	2	..	..	..	..	..	..
— glauca callicarpaea	1	..	..	..	+	+	..	..
Saxifraga caespitosa	..	..	..	..	..	..	..	..
Vaccinium ulig. microphyllum	..	..	..	..	..	..	..	1
Plagiochila asplenioides	..	..	..	..	..	..	..	+
Scapania sp.	..	..	..	..	..	..	..	+
Tritomaria quinquedentata	..	..	..	..	..	..	..	+
Amblystegium compactum	..	..	..	..	3	..	..	..
— cf. serpens	..	1	..	..	..	..	..	..
Aulacomnium turgidum	..	..	..	..	..	..	..	+
Barbula recurvirostris	..	?+	..	..	..	..	2	..
Bryum sp.	1	3	..	..	1	..	1	1
Calliergon turgescens	..	..	..	1	..	..	..	1
Campylium polygamum	..	..	..	1	..	..	..	..
— stellatum	..	..	..	..	..	..	..	1
Ceratodon purpureus	..	..	..	+	..	..	..	..
Distichium capillaceum	..	..	..	..	..	..	3	..
— inclinatum	1	2	1	3	2	1	..	..
Drepanocladus aduncus polycarpus	..	..	..	..	..	..	..	..
— revolvens	..	..	..	1	..	..	..	..
— uncinatus	..	..	..	..	..	..	..	..
Hypnum callichroum	..	..	..	..	..	..	..	..
Leptobryum pyriforme	..	..	1	..	..	1	..	..
Mnium rugicum	..	..	..	..	..	..	..	..
Tomenthypnum nitens	..	..	..	..	..	..	..	1
Polytrichum strictum	..	..	..	..	..	..	..	..
Peltigera erumpens	..	..	..	..	..	..	..	..
— leucophlebia	..	..	..	..	..	..	..	..
— sp.	..	..	..	..	..	..	..	..
Hebeloma mesophaeum	..	..	..	..	..	..	..	..
Nostoc commune	..	..	..	..	..	1	..	..
— cf. fuscescens	..	..	..	..	..		..	..
Gloeothece cf. goeppertiana	..	..	..	..	..		..	..
— cf. membranacea	..	..	..	..	..	+	..	..
Aphanothece castagnei	..	..	..	..	..	+	..	..

Summer-dry depressions with *Carex maritima* were rather frequent near the ice margin (Loc. 1). An example from this area with abundant *Distichium capillaceum* and *Barbula recurvirostris* is included in Table

(continued).

9	10	11	12	13	14	15	16	17	18	19	20	21
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	1	..	..	..	3	4	3	3	1	+	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	+	+	..	..
..	1	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	+	..	..
..	..	..	..	..	..	..	..	+	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	4	..	..	5	5	5	5	5
..	..	..	..	..	..	..	..	..	..	..	..	..
1	1	..	..	..	..	1	1	..	..	..	..	1
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	+	2	+	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	5	4	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	1	..	+	..	1	+	2
..	..	..	..	..	..	..	..	..	+	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	+	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	1
..	..	..	..	..	..	..	..	..	+	..	..	..
..	..	..	..	..	..	..	..	..	..	1	..	2
..	..	..	..	..	..	..	..	..	+	..	..	1
..	+	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..

32, no. 7. In some places such sociations might contain scattered *Ranunculus pedatifidus* or *Luzula groenlandica*, *Carex capitata* (? ssp. *capitata*), *C. norvegica inserrulata*, *Poa pratensis iantha*, and *Primula stricta*.

In the depressions there might be moister holes dominated by *Calamagrostis neglecta* or *Juncus arcticus*.

The examples Table 32, nos. 5—6 show *C. maritima* sociations from the shores of two lakes with slightly salt water (pH 8.0). One of them, east of Keglen, with *Amblystegium compactum* as ground layer, was found in a zone slightly above a *Calamagrostis neglecta* soc., with *Carex saxatilis* and *Eriophorum angustifolium* close to the water. The other was found beside a lake at an altitude of 250 m alternating with a *Carex capillaris* or *Primula stricta-Leptobryum* soc. and on a level immediately above a *Juncus arcticus* soc. occurring in very shallow water. By Store Saltsø, too, small patches of *C. maritima* and *Kobresia simpliuscula* were seen in some of the depressions in front of the brinks of the terraces.

From Gross Glockner in the Alps there is an analysis of a vegetation closely related to the arctic one; see G. and J. BRAUN-BLANQUET (1931), "Association à *Carex incurva* et *Equisetum variegatum*", in which amongst others the following species were observed: *Carex bicolor*, *C. microglochin*, *Juncus arcticus* and *biglumis*, and *Saxifraga aizoides*. A deviating soc. is the nitrophilous *Carex maritima* soc. very poor in species, which SCHOLANDER 1934, pp. 125—126, mentions from bird-cliffs in Spitzbergen.

Poa pratensis iantha Sociations.

Poa pratensis iantha is significant in many medium humid heaths (Table 36) and willow scrubs, but it may also be very abundant in meadow-like communities or on lake-banks (cf. fig. 72). By the large lake at Itivdlínguaq it was dominant above a zone with *Eriophorum angustifolium* and *Juncus arcticus*, which there, if anything, constituted a limnetic community. The *Poa* fen included *Calamagrostis neglecta*, *Equisetum arvense* and *variegatum*. By the small salt lake northeast of Keglen almost the same combination was found in a zone above the *Calamagrostis neglecta* sociation.

The most important type of *Poa pratensis* fenland which my be classed in the complex, occurs in summer-dry depressions under similar conditions as the mossy *Carex maritima* sociations, especially small depressions without any draining in the form of outlets, too small to give a possibility of the formation of salt lakes. In spring time the soil in such depressions must be assumed to be saturated with water, but in summer its surface dries up. Where the soil is driest and slightly acid, the vegetation approaches to the *Ledum-Calamagrostis-Galium* complex (cf. p. 265) and gets *Aulacomnium turgidum* as ground dominant. *Carex norvegica inserrulata* and *Ranunculus pedatifidus* may be the only representatives of the EG-species (Table 32, no. 17, from the region around Store Saltsø). *Calamagrostis lapponica groenlandica* may occur in this mesotrophic type (Table 32, no. 18—19), but it does not



Fig. 66. Summer-dry fenland east of Keglen dominated by *Poa pratensis* var. *iantha* and *Calamagrostis neglecta* with frequent occurrence of *Ranunculus pedatifidus*. The transition to the *Kobresia myosuroides* soc. and scattered low willow scrubs is just where M. Skytte Christiansen, the lichenologist, and Morten Lange, the mycologist, stay. T.W.B. phot. $^{26}/_{8}$ 1946.

thrive very well there. In the example Table 32, no. 21 *Poa pratensis* is replaced by *P. arctica*; it originates from the highlands behind Hassells Fjeld. Where the soil is moister and neutral, other combinations occur, among which especially the *Poa pratensis iantha-Calamagrostis neglecta-Drepanocladus aduncus* soc. should be mentioned. Table 32, nos. 15—16, shows two examples from rather a large depression east of Keglen in Sandflugtdalen (fig. 66). *Drepanocladus aduncus* according to HOLMEN's determination appeared in the variety *polycarpus* f. *gracilescens*. In no other place did I see so great a density and luxuriance of *Ranunculus pedatifidus*, which flowered richly even as late as the end of August. The grasses, on the other hand, were not particularly willing to flower.

5. Calamagrostis neglecta Sociations.

As appears from the mention of the preceding sociations, *C. neglecta* generally occurs on a slightly lower level than these. It may in part

dominate communities, which are often mossy and which dry up in late summer, partly occur on constantly moist soil on lake-shores. While the former group is ecologically associated with the preceding sociations, the latter is, if anything, ecologically related to the *Juncus arcticus* and *Carex saxatilis* sociations.

Summer-dry sociations: *C. neglecta-Aulacomnium turgidum* sociation, Table 32, no. 14, observed in Ørkendalen. In some places the sociation also contained *Carex norvegica inserrulata* and *C. capitata*. Near the salt lake northwest of Strømfjordshavn there were patches where *Tofieldia pusilla* and *Luzula groenlandica* entered abundantly in the *Calamagrostis neglecta*, and similar vegetation repeated itself more or less pronouncedly near other salt or brackish lakes. In many places there were in such localities no or very few mosses (cf. Table 32, nos. 11—13), and the drying-up in summer might create a possibility of the occurrence of species like *Draba hirta*, *D. lanceolata*, indeed even *Artemisia borealis* and *Melandrium triflorum* as small, cowed specimens.

Calamagrostis neglecta-Drepanocladus aduncus soc. This vegetation was seen near one of the salt lakes north of the harbour road. Scattered *Draba hirta* and *Stellaria longipes* were seen there in the moss carpet drying up in August. In other places the *Calamagrostis* species was absent and the moss only contained scattered *Carex maritima* and *Puccinellia deschampsioides*. As a result of the drying-up the moss carpet cracked; it was particularly in these cracks that the higher plants occurred. Along the southern bank of Lille Saltsø there was much *Gentiana tenella* in dense *Drepanocladus aduncus* under scattered *Calamagrostis neglecta*. Both there and north of the harbour road the moss carpet was exposed to a rain of loess particles, so that a dust was raised when a person walked there. This is of great interest for our understanding of the formation of the large loess-*Drepanocladus aduncus* deposits on the banks of Store Saltsø. It must be assumed that a similar, almost pure *D. aduncus* vegetation was growing on the banks of this lake when these deposits developed (cf. further B. 1949b, pp. 53—56 and Plates 2—3).

Sociations on constantly moist soil: These may contain mosses, but most frequently the grass is growing on the clayey lake-shore together with such species as *Carex saxatilis*, *Juncus arcticus*, *Triglochin palustre*, or the *Eriophorum* species. Where *Calamagrostis neglecta* grows in dense moss of *Drepanocladus fluitans* or stands alone in pure populations beside lakes that are not basic, as e. g. in the profile mentioned on p. 288, there is no reason to include the vegetation in the present complex. The same applies to the *Calamagrostis neglecta* sociation mentioned from Angmagssalik (B. 1933b, p. 104). There is no



Fig. 67. Tall, tussocky vegetation of *Calamagrostis canadensis* var. *langsdorfii* in a small flat depression in Sandflugtdalen dried up in summer. The margin of the depression overgrown with low willow scrubs. T.W.B. phot. $^{5}/_{8}$ 1946.

doubt that *C. neglecta* can be dominant in mesotrophic communities. Therefore it cannot be classed among the EG-species even though it has a distinct continental distributional trend and is most frequent in communities of the type mentioned here.

6. Calamagrostis canadensis langsdorfii Sociations.

The widely distributed *Calamagrostis canadensis langsdorfii* (cf. map in RAUP 1947, Plate XVI) is most frequent in the herbaceous communities and scrubs of the coastal regions (see p. 74), and is probably more selective in the continental area, although not rare there. Besides, it is found together with *Angelica* (see fig. 25) in a number of communities which it is very difficult to place because they are poor in species and do not — or only exceptionally — contain EG-species which clearly place them. I am thinking of the moist willow scrubs mentioned above (pp. 92—93) and of *Calamagrostis canadensis langs-*

dorfii-Equisetum arvense sociations which are not shaded and are found beside outlets from lakes, e. g. beside Kløftsøerne and the Menyanthes lake (p. 287). Furthermore, I am thinking of the following two sociations both seen in the eastern part of Sandflugtdalen.

Close to the inland ice there is a small valley (B. 1949a, fig. 15). Ground water from this valley percolates into the more level ground below the valley and forms a fen, the middle of which is so moist that water can be observed in several places. Here there is a lengthy area dominated by knee-deep *Calamagrostis canadensis langsdorfii* practically without any companions. Ecologically this type corresponds to the sociations poor in species which are found at the outlets from the lakes, and its placing in the present complex is extremely doubtful.

The other vegetation was observed in a flat depression near Keglen. The place was surrounded by willow scrubs and the vegetation was again very poor in species, consisting of more than knee-high *Calamagrostis* tussocks, in which, however, it was always possible to find occasional straws of *Poa pratensis iantha*. A few individuals of *Luzula groenlandica* might be used there to make it probable that there was a relationship with the above-mentioned sociations of the present complex. Fig. 67 shows the appearance of this vegetation, which possibly resembles certain forms of Canadian prairies on heavier soils, where the dominants according to RAUP (1935, pp. 45—46) may just be *Calamagrostis canadensis* (var. *robustior*, it is true) and *Poa pratensis*. The soil between the large grass tussocks was completely dried up already on 5 August, for which reason the ecological similarity to e. g. the *Poa pratensis iantha* sociations was indisputable. I cannot pronounce with certainty on the cause of the difference between these and vegetation mentioned here. It will only be possible to solve the problem by observations in spring. Perhaps the depression is drifted with snow and is very moist for a short period in spring, then to dry up very fast because the soil is easily penetrable. A better draining of the *Calamagrostis canadensis* depression would be in good agreement with the occurrence of this species of grass at the outlets from lakes mentioned and with a vegetation mentioned by POLUNIN (1948, p. 227) from a river valley in Northern Quebec, where there is good drainage and aeration and where *Calamagrostis canadensis langsdorfii* is dominant together with *Carex bigelowii*.

7. Carex capillaris robustior Sociations.

These sociations never play a great part, but are found as small patches on the shores of salt or brackish lakes, mostly on wet soil. Table 32, nos. 1—4, shows a few examples. The first two originate from the surroundings of Store Saltsø and no. 2 is a *Saxifraga aizoides-Carex capillaris* soc. with abundant *Bryum* and *Distichium*. No. 4 from the shore of Lille Saltsø contains three *Juncus* species, among them two southern ones, viz. *J. ranarius* and *alpinus* in dwarf-like specimens.

8. Primula stricta-Leptobryum Sociation.

This sociation was often found together with the preceding ones, e. g. near Store Saltsø (Table 33, no. 1) and near a small brackish-water

lake north of Keglen. In the latter place the vegetation contained much *Lomatogonium* and scattered *Tofieldia pusilla*, *Triglochin palustre*, and *Pinguicula vulgaris*. Near a small lake east of Store Saltsø *Saxifraga aizoides* and *Puccinellia deschampsioides* were seen in a similar sociation.

9. Carex migroglochin Sociations.

This sociation was observed in two places at the fjord, in both cases on clay, where freshwater flows into it. Near Vandfaldskløften the species either grew alone in the percolated clay or together with *Juncus arcticus*, *J. castaneus*, *Saxifraga aizoides* and a few very big individuals of *Torularia humilis*. Near the northern creek of the fjord the sociation covered rather wide areas on clay-flats outside the place where the river debouches which drains Lake Taserssuatsiaq. The following belt formation was observed:

(1) Outermost, pioneer plants towards an open very wet vegetationless clayey flat which is covered by the fjord at high water: *Juncus arcticus*, *Calamagrostis neglecta*, *Equisetum arvense*, *Triglochin palustre*, *Eriophorum scheuchzeri*, *E. angustifolium*.

(2) *Eriophorum scheuchzeri* soc. with *Calamagrostis neglecta* and *Triglochin*.

(3) *Calamagrostis neglecta-Carex saxatilis* soc.

(4) A belt with one of the following three sociations:
(a) *Carex microglochin* soc.; see Table 33, nos. 3—7 and mention in B. 1949b, p. 43, of the very high phosphoric acid value.
(b) *Carex maritima* soc. (only small patches).
(c) *Eriophorum angustifolium* soc. (poor in species).

(5) A belt in which *Salix glauca callicarpaea* and *arctophila* and *Equisetum arvense* are very important, while *Carex microglochin* and *Eriophorum* disappear.

(6) Fringe along steep clayey cliff closest to the land: *Elymus mollis* soc. with *Festuca rubra*, *Puccinellia groenlandica* and *deschampsioides*, *Plantago maritima*, and *Salix glauca callicarpaea*.

(7) Dry clayey cliff and clayey expanse above the crest of the cliff: Scattered *Artemisia borealis*, *Poa glauca*, *Melandrium triflorum*, and *Taraxacum lacerum*; the last mentioned species frequent in places.

From Lerbugten at Christianshaab Hartz (1894, p. 43) mentions a *Carex microglochin* soc. from depressions in the clay flats. It contained *Juncus arcticus*, *castaneus*, and *biglumis*, *Pinguicula*, *Tofieldia pusilla*, *Pedicularis hirsuta*, and *Bartsia*.

Table 33, nos. 3—7 shows that *Juncus castaneus* and *arcticus* are very frequent, the latter quite constant. There is a fairly good agreement with Norwegian *C. microglochin* sociations described by Nordhagen

Table 33.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13
Locality no.	7	2	7–8					5	7	5			5
Altitude in m	250	40	0					250	100	200			200
pH	7.8	8.8	7.6					7.9	7.2	6.7			—
Lt	2.9	1.2	0.8					3.5	1.5	1.0			—
EG Carex microglochin	..	..	5	5	5	5	5	..	..	..	..	..	..
— — bicolor	..	..	..	..	..	..	..	+	..	..	..	..	..
— — capillaris robustior	+	2	..	..	2	..	..	2	..	+	+	+	2
— Juncus arcticus	..	5	1	2	1	1	2	+	+	+	+	..	..
— Gentiana tenella	..	..	..	..	..	..	..	..	..	..	..	+	+
— Primula stricta	3–4	+	..	+	..	..	..	2	+	..	..	+	1
Cl Calamagrostis neglecta	..	..	+	1	..	1	..	..	1	..	..	+	+
— Puccinellia deschampsioides	..	..	..	..	..	..	..	1–2	..	..	..	..	+
— Torularia humilis	..	..	..	..	..	..	..	..	..	..	..	..	3
Hb Equisetum variegatum	..	..	2	1	..	..	..	..	..	..	..	..	..
— Carex maritima	..	..	+	..	..	..	..	..	+	..	..	..	..
— Scirpus pauciflorus	..	..	..	..	..	..	..	4–5	5	5	5	4–5	1
— Juncus castaneus	..	..	1	1	..	1	2	+	+	+	+	..	..
— — alpinus nodulosus	..	..	..	..	..	..	..	..	..	+	+	..	..
— Tofieldia pusilla	..	..	..	..	..	..	..	..	..	..	+	+	+
— Lomatogonium rotatum	3	2	..	..	..	..	..	..	..	..	..	..	..
— Triglochin palustre	1	..	..	+	1	1	+	+	..	..	1–2	..	..
Carex saxatilis	..	..	..	..	..	..	+	..	..	..	..	..	..
— scirpoidea	..	..	..	..	..	..	..	..	..	1	..	1	..
Equisetum arvense	..	..	..	+	..	1	1	..	..	..	..	..	..
Eriophorum angustifol.	..	..	1	2	..	2	..	..	..	..	..	..	..
— scheuchzeri	..	..	..	..	..	..	..	..	..	+	+	..	..
Euphrasia frigida	1	..	..	..	..	..	..	..	+	..	..	..	..
Pedicularis flammea	..	..	..	..	..	..	..	..	..	+	..	..	..
Plantago marit. juncoides	..	1	..	..	..	..	..	..	..	..	..	..	..
Salix glauca callicarpaea (very low)	..	2	2	1	1	1	1	..	..	..	..	+	..
Bryum sp.	+	..	..	..	..	..	..	..	..	..	..	..	..
Campylium polygamum	..	..	..	+	..	..	..	..	..	..	..	..	..
Distichium inclinatum	..	3	..	+	..	..	..	..	..	..	..	..	..
Leptobryum pyriforme	5	1	..	..	..	..	..	..	..	..	..	1	+
Pottia sp.	..	..	..	..	..	..	..	..	1	..	..	..	..
Undetermined species	..	..	..	..	..	..	..	..	..	..	..	+	..
Lachnea scutellata	..	..	..	..	1	..	..	..	..	..	..	..	..
Cyanophyceae	..	..	..	..	..	..	..	..	+	1	+	..	..

1935, p. 90, from the mouth of a river in Porsangerfjord and 1943 from alpine areas in the Dovre (there amongst others containing the two *Juncus* species, *Carex maritima* and *Gentiana tenella*).

10. Scirpus pauciflorus Sociations.

These sociations in some places played not quite a small role on the flat shores of brackish and slightly salt lakes on loamy soil with many blue-green algae. This is in good agreement with the fact that the dominant by IVERSEN 1936 is characterized as oligohalobous and that KOTILAINEN terms it "im eigentlichen Sinne eine Meeresstrandpflanze". The example from the lake northwest of Strømfjordshavn, Table 33, no. 8, is interesting by containing the rare *Carex bicolor*. In other places by the same lake the vegetation contained *Juncus alpinus nodulosus*, *Pinguicula*, and *Leptobryum*. Two of the other examples from the salt lake north of the harbour road, Table 33, nos. 10—11, also contain *Juncus alpinus*, which is thus associated with *Scirpus pauciflorus* in the present vegetation as well as in Greenland in general (cf. the distribution of the two species in B. 1950, fig. 11b; 1952a, p. 57). The position of the quadrates mentioned in Table 33, nos. 10—12 appears from the following transect, which at the same time tells much about the types of lakes found in the area.

West-north-west of the salt lakes north of the harbour road ("salt" between 3 and 5 in fig. 2) there is a large nearly circular lake drained towards Strømfjordshavn. Immediately east of this lake there is quite a small lake (not drawn in in fig. 2) without any outlet and with a surface which in the height of summer is lower than that of the large lake. The two lakes are separated by an isthmus, which mostly is 3—5 m high, but which has a low part which may be 0.5—1 m above the surface of the large lake. The isthmus in this low part is overgrown with a tussocky *Carex maritima* soc. and it seems that the two lakes at high water can give off water to one another. Mostly it is probably from the large lake that a little water percolates to the small one, where it then evaporates. The large lake with its outlet to the harbour, like other lakes of this type had banks completely covered with vegetation, while the small one from the distance seemed to have completely naked shores because the vegetation there was extremely scarce or consisted of sociations of small plants such as *Scirpus pauciflorus* and poor in mosses. The profile cuts through the following belts from west-north-west to east-south-east.

Large lake (pH about 6)

(1) The bank: *Menyanthes trifoliata* soc.

(2) – – : *Carex saxatilis* soc. (rich in mosses) with *Eriophorum angustifolium* and above, towards (3), a little *Calamagrostis lapponica groenlandica.*

(3) West-north-west slope: *Betula nana-Ledum decumbens-Aulacomnium turgidum* soc. with the above-mentioned *Calamagrostis*, *Salix glauca callicarpaea*, and *Vaccinium vitis-idaea minus.*

(4) The top of the isthmus:
  (a) *Carex supina-Cetraria cucullata* soc., Table 20, no. 11.
  (b) *Calamagrostis purpurascens* soc. with *Potentilla chamissonis*.
  (c) *Betula nana-Cetraria cucullata* soc.
  (d) *Vaccinium uliginosum microphyllum* soc., dense, rich in lichens.

(5) Upper part of ESE slope (sloping slightly): *Betula nana-Empetrum-Salix glauca callicarpaea* soc.

(6) Upper shore of small lake: *Carex capillaris* soc., Table 32, no. 3.

(7) Middle part of shore of small lake: *Scirpus pauciflorus* soc., Table 33, nos. 10—12, or small patches with much *Torularia humilis*, Table 33, no. 13.

(8) Lower part of shore of small lake: *Triglochin palustre* and *Puccinellia deschampsioides*, in patches forming sociations.

(9) Lake-bottom cracked in polygons, dried up: Occasional specimens of the two preceding species and of *Juncus arcticus*.

Small lake (pH about 7—8): *Potamogeton filiformis*.

Besides the species noted in Table 33, nos. 10—12, and in the transect, the following species were observed on the flat clayey shores of the small lake: *Calamagrostis neglecta*, *Primula stricta*, *Rumex acetosella*, *Luzula groenlandica*, *Draba hirta*, and *Pedicularis labradorica*. In the lake also a little *Hippuris vulgaris* was seen.

11. Juncus arcticus Sociations.

These sociations play a fairly great role as an outer vegetational zone towards the open water in lakes the surfaces of which are lowered in the course of the summer and which are without any effective outlet and therefore frequently become more or less salt. Beside Lille Saltsø and the salt lake north of Keglen *J. arcticus* was almost sole dominant on loamy soil, often full of puddles the water of which was red with daphniae (see fig. 68). Beside Store Saltsø *J. arcticus* sociations were found on humid soil in front of the brink of the outermost terrace edge but one, alternating with *Triglochin palustre* sociations, both sociations mostly with much *Lomatogonium* and surrounded with *Carex saxatilis* sociations or low willow vegetation.

On the sandy river plains as well *J. arcticus* plays a part. It is found there as a border growth beside lakes on the plain or form more extensive meadow-like communities in old small gullies on the plain. In such places a moss layer of *Distichium inclinatum* (Table 33, no. 2) or *Leptobryum pyriforme* develops and pH almost reaches 9; cf. otherwise the transect mentioned on p. 243. According to M. LANGE's determinations the following fungi were found there: *Lachnea scutellata*, *Hebeloma mesophaeum*, *Inocybe dulcamara* and cfr. *fastigiata*. On the river plain close to the inland ice (Loc. 1) we saw a related vegetation dominated by *Psilopilum laevigatum*; besides *Juncus arcticus* and *castaneus*



Fig. 68. Lille Saltsø photographed in August 1946. On the left *Juncus arcticus* is seen as almost the only plant on the shore.

we found there some *Poa alpina*, *P. pratensis iantha*, *Equisetum arvense*, and *Eriophorum scheuchzeri*.

HARTZ (1894, p. 41; 1895, p. 232) mentions a corresponding *Juncus arcticus* sociation from Sydostbugten immediately north of the Strømfjord area and from Ispynt in Scoresby Sund. In Sydostbugten it occurred on wide humid clayey flats beside a large river and contained *Carex microglochin* (often dominant), *Juncus triglumis*, *Carex bigelowii* ssp. *hyperborea*, both *Eriophorum* species, and *Plantago maritima juncoides*.

12. Carex saxatilis Sociations.

In the profile described on p. 255, which passes from a basic lake to an acid one, *C. saxatilis* forms sociations beside the acid lake, while beside the basic lake it was seen occasionally in belt (6). While mossy *C. saxatilis* sociations without EG-species from the present complex are rather frequent, *C. saxatilis* sociations which may be classed here are rare, a fact which, as viewed in connexion with the behaviour of *C. saxatilis* in Norway and Finland (NORDHAGEN's and KALLIOLA's works), is rather peculiar; cf. p. 240.

The *Calamagrostis neglecta-C. saxatilis* soc. mentioned on p. 253 and the vegetation seen on the left in Plate III, fig. 1 belong to the present complex. In the latter case a dense *C. saxatilis* meadow was found along a slightly salt lake near Strømfjordshavn. Unfortunately it was not thoroughly analyzed, but the records emphasize that it was poor in species with *Stellaria longipes* coll. as its most important species and with such species as *Poa pratensis iantha* and *Luzula groenlandica* as quite subordinate elements.

13. Eriophorum scheuchzeri Sociations.

Observed on the bank of Lille Saltsø and by the northern creek of the fjord; cf. transect on p. 253. In both places the sociation was poor in species, mainly containing *Juncus arcticus*, *Triglochin palustre*, or *Calamagrostis neglecta*. Mossy sociations were observed by the salt lake at Strømfjordshavn. Particularly important there was an *E. scheuchzeri-Calamagrostis neglecta-Drepanocladus exannulatus* soc. rich in *Poa pratensis iantha*, *Bryum* sp., and *Campylium polygamum*, and with scattered occurrence of *Cardamine pratensis*, *Eriophorum angustifolium*, *Carex saxatilis*, *Stellaria longipes*, and a little *Hippuris*, which itself formed a sociation together with *Calliergon turgescens* immediately outside the *Eriophorum* zone; see Plate III, fig. 1.

The flood plain community mentioned from the Brintnell Lake area in Canada (RAUP 1547, p. 58 and Plate XI) is evidently related especially to the sociation found near the northern creek of the fjord, where *Carex microglochin* may occur. As a transitional stage in the succession from this sociation further on to scrubs and forests an *Equisetum variegatum* soc. rich in mosses is mentioned, with *Tofieldia*, *Carex microglochin*, and a great many species which appear as differential Ar-species, e. g. *Anemone parviflora*.

14. Plantago maritima juncoides Sociations.

These are communities typical of the shores of salt lakes and fjords and contain few EG-species. They might perhaps be classed in an extra-regional complex, but such species as *Puccinellia deschampsioides* and others make it most natural to include them in the continental complex. It is often an open *Plantago-Puccinellia* soc., where now one, now the other dominant has the upper hand, thus close to the northern branch of the fjord (Table 34, nos. 12—16), where the sociation was found in level depressions on sticky slimy sand mixed with clay surrounded by low dunes with *Elymus-Festuca rubra* sociations (see Table 23, nos. 1—10). The community Table 34, nos. 2—6, was found on the eastern shore of Lille Saltsø, nearest to the close vegetation (heath and the like) above the shore proper, while a somewhat moister part of the shore had a

Table 34.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Locality no.	2	7	7	7	7	7	7	7	7	7	7	3	3	3	3	3
Altitude in m	50			100					100					1		
pH	—			—					7.8					ca. 7.0		
Lt	—			—					1.1					—		
EG Carex capillaris robustior.	..	..	..	..	+	+	1	..	..	..	..	..	..	..	..	..
— Juncus arcticus	..	..	..	..	..	+	..	+	+	..	+	..	..	+	..	+
— Primula stricta	..	..	..	+	1	2	..	+	+	..	..	..	..	..	....	
Cl Puccinellia deschampsioid.	2	2	1	1	+	+	1	2	1	2	1	2	1	1	2	1
— Calamagrostis neglecta	..	..	..	..	..	..	..	..	+	1	..	..	..	..	..	..
Hb Ranunculus cymbal. alpina	..	..	..	..	..	..	1	2	1	2	1	..	..	..	..	..
— Plantago marit. juncoides	5	4	5	4	5	4	+	+	..	+	..	1	3	3	3	2
— Carex maritima	1	..	..	..	..	..	..	..	1	..	..	..	..	..	..	2
— Lomatogonium rotatum	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— Triglochin palustre	1	..	..	..	..	..	..	..	..	..	+	2	+	..	..	+
Equisetum arvense	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+
Festuca rubra	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+
Elymus mollis	..	..	..	..	..	..	..	..	..	..	..	+	1	..	..	..
Salix glauca callicarpaea	..	..	..	1	+	1	1	..	+	..	..	..	..	..	..	..
Secultaria arenosa	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Glocothece membranacea[1]	..	..	..	..	..	..	1	+	1	+	1	..	..	..	..	..

[1] Forms a mucilage in which occurred a species of the *Oscillatoriaceae* with long, 1 μ broad cells and further a species of *Spirulina* as well as *Nostoc sphaericum*.

purer *Puccinellia* vegetation (Table 34, nos. 7—11); see below. An example of *Plantago maritima* sociations from the river-valley in Sandflugtdalen is described in Table 34, no. 1 (cf. transect on p. 243).

15. Puccinellia deschampsioides Sociations.

Puccinellia deschampsioides, which occurs as a dominant on dry, saline soil (p. 207), may also occur abundantly on the shores of salt lakes. These shores dry up late in summer and often crack up in polygons. On such a soil this grass species becomes a kind of dominant, this meaning the most frequent species; for the individuals may very well be greatly scattered (fig. 69). A particularly interesting combination was found by Lille Saltsø, where *Ranunculus cymbalaria* var. *alpina* entered into the vegetation (Table 34, nos. 7—11). It especially grew beside the many stones of various sizes found about the clayey shore (fig. 68, the background). Perhaps the soil keeps moist for a prolonged time beside the stones.

On the shore of one of the salt lakes north of the harbour road there was a *Puccinellia-Primula stricta-Lomatogonium* soc. with *Carex*

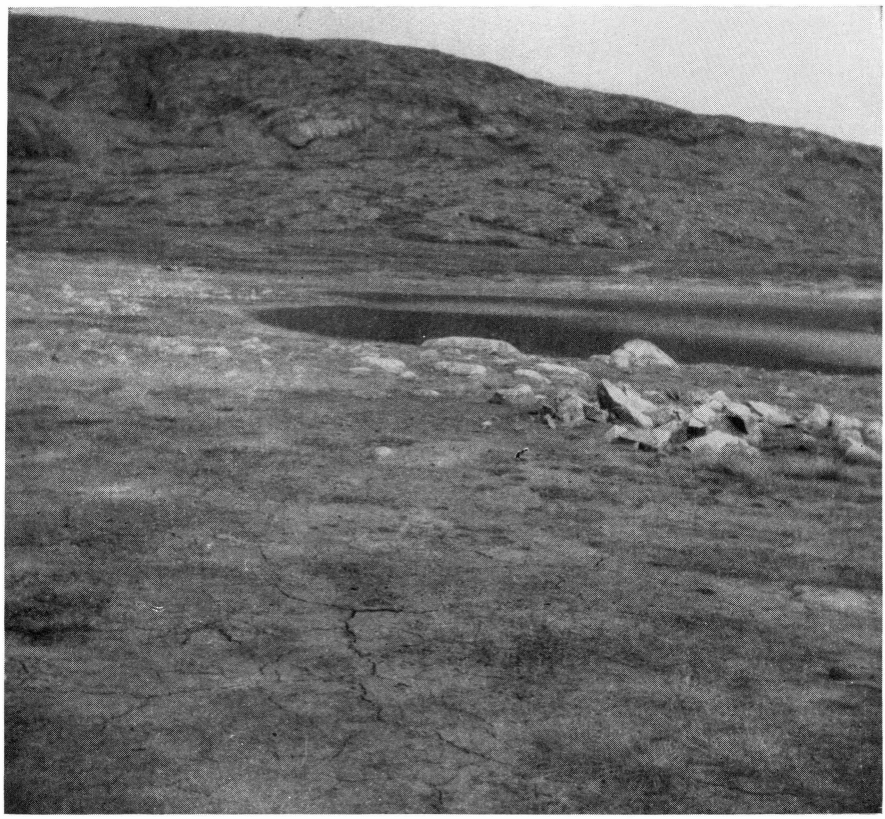


Fig. 69. Typical shore of salt lake (the salt lake north of the harbour road). Scattered individuals of *Puccinellia deschampsioides* are seen on the clayey flat cracked in polygons. T.W.B. phot. $^{28}/_{8}$ 1946.

maritima. It was inserted as a belt between a *Calamagrostis neglecta* soc. situated above and a lower belt on the completely dried-up lake bottom, where there were scattered *Puccinellia*, *Triglochin*, *Torularia*, and *Draba hirta* on the clayey flat cracked in polygons. The following zonation was observed by a larger salt lake in the same place:

(1) *Betula nana-Dryas* soc. or *Rhododendron* soc.
(2) *Plantago maritima-Puccinellia deschampsioides* soc.
(3) *Puccinellia deschampsioides-Triglochin palustre* soc.
(4) *Potamogeton filiformis* soc. in water with pH 8.5—9.0.

By a circular pond without any outlet on the river plain near Keglen there was a similar belt formation:

(1) *Festuca rubra-Plantago maritima juncoides* soc.
(2) *Puccinellia deschampsioides* soc.
(3) *Triglochin palustre* soc. with *Juncus arcticus*.
(4) *Potamogeton filiformis* soc. with a little *Hippuris*.

In the belts (1)—(2) there were much *Leptobryum*, some *Equisetum arvense*, *Eriophorum scheuchzeri*, *Juncus arcticus*, *Carex capillaris robustior*, *Primula stricta*, *Lomatogonium*, *Draba hirta*, *D. lanceolata*, *Calamagrostis neglecta*, and scattered *Melandrium triflorum*.

Belt (3) is a *Triglochin* soc. Such a sociation with *Puccinellia* and *Drepanocladus aduncus* forming a carpet was also observed on the western shore of Lille Saltsø.

16. Kobresia simpliciuscula Sociations.

This and the following two sociation groups (nos. 17—18) are mainly found beside running or percolating freshwater which is rich in nutrients and neutral (slightly acid-slightly basic). *Kobresia simpliciuscula*, however, may very well be found on other kinds of soil. At Itivdlínguaq it appeared as dominant in a meadow-like vegetation in which *Pinguicula vulgaris* was the most important accompanying species. In the highlands it grew together with *Carex holostoma* on the banks of lakes (see p. 264).

Table 35.

Analysis no.		1	2	3	4	5	6
Locality no.		3					
Altitude in m, slope and exposure		100–140°, 30–40° towards S					
pH		6.1	—	—	—	—	6.3
Lt		—	—	—	—	—	0.4
EG	Kobresia simpliciuscula	..	..	..	..	4	..
—	Juncus arcticus euarcticus	+	..	..	..	..	..
—	Gentiana tenella	..	..	..	..	..	+
Hb	Juncus castaneus	2	1	2–3	+	..	+
—	— triglumis copelandii	1	2	1–2	..	1–2	+
—	— ranarius	..	..	..	1	..	+
—	Triglochin palustre	..	..	..	..	+	..
—	Sedum villosum	..	..	..	+	..	1
Cl	Kobresia myosuroides	+	1	..	+	+	1
—	Carex supina spaniocarpa	..	+	..	+	..	..
—	Minuartia rubella	..	..	..	+	..	..
—	Torularia humilis	..	..	..	..	..	+
—	Saxifraga aizoon neogaea	1	..	..	..	..	1
—	Rhododendron lapponicum	..	..	1–2	..	..	..
—	Artemisia borealis	..	..	..	+	..	+
—	Woodsia glabella	..	..	..	..	..	+
	Agrostis borealis[1]	+	..	..	..	+	2
	Poa alpina[1]	..	..	..	..	..	1
	Luzula spicata[1]	..	..	..	..	..	+
	Viscaria alpina[1]	..	..	..	+	..	..

[1] Oceanic species or species with the greatest frequency in the outer coastal regions of West Greenland.

(To be continued)

Table 35 (continued).

Analysis no.	1	2	3	4	5	6
Agrostis canina	+	..	..	..	..	1
Carex bigelowii	..	..	2	..	..	..
— scirpoidea	3	3–4	1	..	+	1
Campanula rotundifolia	..	..	..	..	..	+
Cerastium alpinum	..	..	..	+	..	+
Equisetum arvense	1	..	..	..	..	..
Euphrasia frigida	+	+	..	1	..	+
Pedicularis flammea	+	+	+	..	+	+
Poa glauca	..	..	..	+	..	+
Polygonum viviparum	1	2	..	..	+	..
Salix arctophila	..	..	..	+	+	+
— glauca callicarpaea	..	+	+	..	..	..
Vaccinium ulig. microphyllum	..	..	..	..	+	..
Cephaloziella sp.	..	+	..	+	+	..
Riccia sorocarpa	..	..	..	+	+	..
Scapania gymnostomophila	..	+	..	..	..	..
Barbula recurvirostris	..	..	..	+	+	..
Bryum sp.	..	+	+	+	..	+
Ceratodon purpureus	+	..	..	+	+	..
Dicranum fuscescens	..	..	..	..	..	+
Distichium capillaceum	..	..	..	..	..	5
Ditrichum flexicaule	..	+	..	..	+	+
Encalypta rhabdocarpa	..	..	..	1	+	..
Hypnum revolutum	..	..	..	..	..	+
Myurella julacea	..	+	+	..	..	..
Schistidium apocarpum	3	1	1	3	3–4	..
Tortella fragilis	1	1	1	..	1	..
Cetraria cucullata	..	..	1	..	..	..
— nivalis	..	..	+	..	..	..
Cladonia pyxidata	1	+	1	3	..	1
Cornicularia aculeata	..	..	+	..	..	+
Solorina saccata	..	+	+	..	..	..
Laccaria laccata	..	..	..	+	..	..
Nostoc microscopicum	..	..	..	..	..	+
— commune	..	..	..	..	..	1

As a dominant beside waterfalls or seepage streams *Kobresia* was observed e. g. beside the river which drains Lake Taserssuatsiaq in a mossy vegetation together with *Carex scirpoidea* and alternating with mossy *Carex bigelowii hyperborea* or *Betula nana-Helodium-Aulacomnium palustre* sociations. A *Kobresia-Saxifraga aizoides* soc. with *Carex scirpoidea* and *Chamaenerium latifolium* was found close to a waterfall in the same river. On the southern slope of Hassells Fjeld, where water seeps out near the *Sisyrinchium* place, the vegetation was of a different

character, with *Schistidium apocarpum* as ground dominant and *Juncus triglumis* as the most important accompanying species; see Table 35, no. 5.

There as well as in Vandfaldskløften *Carex rupestris* was frequent on some moss cushions beside the running or seeping water. The same applied to *Woodsia glabella*. In Vandfaldskløften there were among other species *Saxifraga oppositifolia*, *S. cernua*, *Luzula arctica*, and *Chamaenerium latifolium*, a remarkable arctic element. Among the mosses *Tortella tortuosa* and *fragilis* were frequent. The diatom flora included 51 species (Foged 1953).

17—18. Juncus castaneus, Carex scirpoidea, and Related Sociations.

In the above-mentioned place on the southern slope of Hassells Fjeld, where water seeps out below the west end of Kløftsøerne, there is an interesting vegetational pattern, the drier units of which have been described on p. 215 (the *Sisyrinchium* sociation group). Besides the *Kobresia simpliuscula* soc. mentioned the moistest soil is also overgrown with *Carex scirpoidea* and *Juncus castaneus* sociations (see Table 35, nos. 1—2 and 3), and mostly there were small patches where *Agrostis borealis*, *A. canina*, *Carex maritima*, *Sedum villosum*, *Juncus triglumis* (*copelandii*), *J. ranarius*, *Torularia humilis*, or *Woodsia glabella* grew very densely in moss cushions. Among the mosses especially *Ditrichum flexicaule*, *Ceratodon purpureus*, *Distichium capillaceum*, *Tortella fragilis* played a great part. An *Agrostis-Distichium* soc. has been included in Table 35, no. 6. More subordinate or scattered species were *Carex capillaris*, *C. norvegica inserrulata*, *C. rupestris* (tender and untypical), *Saxifraga oppositifolia*, and others; cf. Table 35. Among the cryptogams there were a moss species like *Fissidens osmundoides*, an indeterminable *Cephaloziella* species, and according to M. Lange such fungi as *Laccaria laccata* var. *rosella*, *Rhodophyllus radiatus*, *Cortinarius glandicolor*, and *Inocybe microspora*. The diatom flora included 27 species with *Nitzschia perminuta* as dominant and several other aerophilous forms (Foged 1953).

The following transect indicates the distribution of some of the sociations:

(1) South-facing, relatively deep soil (8—15 cm) over rock, over which water is percolating now and then: *Kobresia myosuroides* soc. rich in *Carex scirpoidea*, *Euphrasia*, *Campanula rotundifolia*, and *Polygonum viviparum*.

(2) Shallow soil rich in humus over mostly wet south-facing rock below (1). Black and dark-brown mosses together with *Cladonia pyxidata* form a dense mat in which there are scattered specimens of *Euphrasia* (frequent), *Viscaria*, *Saxifraga aizoon* and *Luzula spicata*.

(3) Like the preceding belt, but in a narrow, outer strip towards the completely bare rock surface. Almost no soil, but black and dark-brown cakes of moss sticking close to the rock. The only phanerogam: *Juncus ranarius*; a little *Cladonia pyxidata.*

The mosses in (2)—(3) are especially *Schistidium apocarpum*, *Ceratodon*, *Encalypta rhabdocarpa*, *Barbula recurvirostris*, in spots *Riccia sorocarpa*, and in a few places *Mannia fragrans.*

Especially the vegetation of the outer strip has a strange ecology. The exposure conditions a relatively high heat and a chance of temporary drying-up, and the percolating water supplies nutrients and sufficient water to the cakes of moss. In other similar places outside the transect *Juncus ranarius* occurred together with some other species (see e. g. Table 35, no. 4), of which particularly *Torularia* and *Sedum villosum* might be of appreciable importance, some times also *Euphrasia*, *Gentiana tenella*, *Primula stricta* (small individuals), and *Minuartia rubella.*

In connexion with this sociation group a mossy marsh described by KRUUSE (1898, p. 391) may be mentioned. *Carex scirpoidea* and *Juncus biglumis* were dominants accompanied by *Juncus castaneus*, *Carex norvegica inserrulata*, *Equisetum variegatum*, and *Ranunculus lapponicus.* The sociation may, however, belong to a mixed type, into which *Scirpus caespitosus austriacus* enters as a reminiscence of southern coastal regions and *Saxifraga rivularis* reminds of purely arctic marshes rich in mosses.

19. Carex holostoma Sociations.

Since *Carex holostoma*, as mentioned above (p. 238), is medium arctic-continental, the vegetation dominated by it might well be considered a special subtype (cf. the *Erigeron-Draba crassifolia* subtype).

C. holostoma sociations were observed only in the highlands on Nákajanga and at Itivdlínguaq at an altitude of about 200 m. Unfortunately no thorough analyses were made. At Itivdlínguaq the sedge was sole dominant on the mossy bank of a pool. The only other species noted was *Eriophorum angustifolium.* On Nákajanga ridge, at an altitude of 450 m, there was a small pool with abundant *Hippuris* and *Nostoc* sp. The water was rich in humus, with pH between 5 and 6. Round the pool *C. holostoma* was abundant in the moss together with *Eriophorum* and *Salix arctophila.* Higher up there were a number of small lakes surrounded by a similar vegetation. Thus in a *C. holostoma*(*-Eriophorum angustifolium*) soc. at an altitude of 600 m the following species were observed: *Carex capitata arctogena*, *C. rariflora*, *Eriophorum scheuchzeri*, *Ranunculus lapponicus*, and *Omphalia umbellifera.* In other places *C. holostoma* occurred together with *Kobresia simpliciuscula* or together with the latter and *Carex norvegica inserrulata* on moist soil between tussocks overgrown with dwarf-shrubs.

Scrubs Associated with the Carex norvegica inserrulata-Juncus arcticus Complex.

No scrubs were found which without vacillation could be referred to the complex. They may exist, but in order to ascertain their existence many analyses are needed. The difficulty is connected with the fact that the EG-species of the complex are photophilous and therefore avoid scrubs. Still certain scrubs occur under ecological conditions resembling those prevalent in the communities of the present complex, thus as a kind of a fen scrub or "carr". This is especially true of such scrubs as occur on percolated soil or beside running water rich in nutrients.

A three m. high willow scrub with a ground layer dominated by *Equisetum arvense-Mnium rugicum* was observed in connexion with fen-like communities with *Salix arctophila-Tomenthypnum* in a small ravine west of the air base (Loc. 3). It further contained a little *Polygonum viviparum*, *Campanula rotundifolia*, *Pirola grandiflora*, *Vaccinium uliginosum*, *Rhododendron lapponicum*, and *Cortinarius glandicolor*. Especially the slightly etiolated specimens of *Rhododendron* suggests association with the complex. A similar scrub within Loc. 7 had the same dominants and *Polygonum viviparum* as subdominant. An *Equisetum arvense* soc. extremely poor in phanerogams was observed in a scrub beside the outlet from a mesotrophic lake in the same main locality. Thus, where the ground layer exclusively exists of widely distributed species, the community may as well be associated with other complexes.

A willow scrub beside the river below the waterfall at Loc. 9 had in the ground layer *Equisetum scirpoides* with the coverage 3 and *Pirola grandiflora* with 3, besides *Carex scirpoidea*, *Equisetum arvense*, and *Polygonum viviparum* (+). There were also *Betula nana* scrubs with a similar composition or with predominance of vigorous specimens of *Carex scirpoidea*. Both *Equisetum scirpoides* and this sedge have a certain connexion with the complex through the above-mentioned fen sociations in which they are dominants. Therefore it is most natural to mention such scrubs here. The scrub described in Table 37, no. 11 is of a similar character. Like the scrubs in Table 37, nos. 6—10, it originates from the bottom of the valley at Loc. 3, but from a different place, where the scrubs occurred on some low heaps of sand-loess that had accumulated on a clayey flat. The flat was overgrown with *Puccinellia deschampsioides* accompanied by *Triglochin* and *Plantago maritima*, and there was a strip of *Festuca rubra-Carex maritima* between the *Puccinellia* sociation and the scrub. In a few places in the scrub *Carex scirpoidea* was approaching to being the most frequent species.

VI. The Ledum decumbens-Calamagrostis lapponica-Galium brandegei Complex.

Sub-low arctic continental meso-hygrophytic or telmatophytic acidophilous communities.

This large complex covers vast tracts of country on the shady sides of the mountains and on moist level ground, where the soil is medium acid (pH about 5—6) and rich in humus. For the traveller most of the

communities of the complex are a constant source of exhaustion. The dwarf shrubs force him to raise his legs high and at every step his foot sinks into deep, soft cushions especially of *Aulacomnium turgidum*.

The complex can be divided into three vegetational types, one characterized by dwarf shrubs, one by mesophytic grasses, and one by marsh plants. As was the case of the preceding complexes there are also willow scrubs associated with this complex.

Particularly the *Ledum-Betula* type is of great plant-geographical interest. Ecologically it corresponds to heaths belonging to the *Phyllodoce-Lycopodium alpinum* type in the coastal regions (p. 94) and the *Cassiope tetragona* heaths in more arctic-alpine and at the same time continental regions. In the interior of the Strømfjord area there is an even transition to *Cassiope tetragona* heaths on the upper parts of the northern slopes of the mountains (p. 174), and a corresponding transition to the type of the coastal heaths is observed on travels across the ice-free country. North of the Strømfjord area the communities of the *Ledum-Betula* type reach Sydostbugten and Jakobshavn, perhaps even a little farther north, until *Cassiope* gets the upper hand. In the south, on the other hand, they do not reach so far; already in the interior of the Godthaabsfjord *Ledum groenlandicum* is extremely common while *L. palustre decumbens* is retreating, and the relatively continental *Betula nana* heath there will generally contain fewer continental species. Soon the species of the *Phyllodoce-Lycopodium* type will make their appearance and form mixed types, until these species south of the Godthaab region completely take the lead also in the interior of the country, while *Betula nana* is supplanted by *B. glandulosa rotundifolia*.

Relatives of the present complex are north Scandinavian mossy *Betula nana* "scrubs" with *Calamagrostis lapponica* or mossy *Calamagrostis lapponica* sociations; see TH. FRIES 1913, pp. 88 and 93, furthermore West Siberian "*Nanobetuleta muscosa*", wich according to GREENJ (1940, p. 53) are characterized by *Carex globularis*, a boreal-continental species (see HULTÉN 1950, map 373), which is acidophilous and in Northern Sweden as regards distribution is associated with *Ledum palustre* (SELANDER 1950, fig. 24). In Canada huge areas are covered with related vegetation, cf. A. E. PORSILD (1951, p. 16), who writes that "the dwarf-shrub heath tundra attains its greatest luxuriance in a continental climate and is best developed on the interior coastal plains of Northern Alaska at some distance from the sea, on the main land north of Great Bear Lake, in Central Keewatin and the Greenland fiord districts. It is essentially a lowland plant community and has its counterpart in the muskeg of the boreal forest." Its chief components are *Betula glandulosa*, *Ledum decumbens*, *Vaccinium uliginosum*, *Pedicularis labradorica*, and others. The ground under the shrubs "is covered by a thick

carpet of mesophytic lichens and mosses into which the foot sinks ankle deep at every step."

EG-species (continental, sub-low arctic, meso-hygrophilous, acid-tolerant species): *Ledum palustre decumbens*, *Calamagrostis lapponica groenlandica*, *Pedicularis labradorica*, *Galium brandegei*. Approaching to the EG-species: *Ranunculus lapponicus*.

Cl-species particularly: *Betula nana*, *Vaccinium vitis-idaea minus*, *Stellaria longipes-monantha*, *Pirola grandiflora*, *Pedicularis lapponica*.

Hb-species: *Comarum palustre*, *Menyanthes trifoliata*, *Carex canescens*, species of *Sphagnum*.

a. The Ledum decumbens-Betula nana Type.

(Low arctic, continental, moist heath and dwarf-shrub bog-vegetation on moderately acid soil).

This type especially occurs as heath on northern slopes in the interior and on soil which is characteristic by mainly consisting of raw humus, to which is admixed loess particles or mineral particles from the underlying mineral soil, which, therefore, is never very acid (cf. B. 1949 b), which is constantly moist and during the winter constantly covered by deep snow (Table 2, 1), and which at a small depth is frozen even at the end of summer. While the steppe-like communities grow on soil thawing to a great depth, there is permafrost under the heath, not rarely already at a depth of 20—30 cm.

We know too little of the distribution of permafrost in Greenland. It is probable that great parts of southern Greenland may be characterized as areas with discontinuous or sporadic permafrost and that, where it occurs, this is of decisive importance for the distribution of the vegetation. No doubt the thick, isolating moss cover of the heath and its greater, more constant and prolonged snow cover are conclusive of the soil frost occurring there (cf. Russian investigations by Sumgin 1937, Sumgin, Kachurin, Tolstichin & Tumel 1940). The distribution of permafrost in Asia (map in Berg 1950, p. 27) and America (Jenness 1949, Benninghoff 1952) shows that this is favoured by climatic continentality. Therefore, there is nothing strange in the fact that permafrost occurs in the inland of West Greenland; but in the lowlands there it is limited to the north sides and certain level bogs, as the sunny sides have no moss carpet, but often bare ground between the plants (fig. 53) and great drying-up of the soil with occurrence of numerous air-bearing cavities and cracks with connexion to the air above the ground.

EG-species of the vegetational type:

Ledum palustre ssp. *decumbens*. Cl-Ar: Low arctic-continental. According to Hultén the Alaska material is critical; the species there reaches maritime stations, which indicates another content of genes than that which characterizes the populations in East America-Greenland, where the species keeps

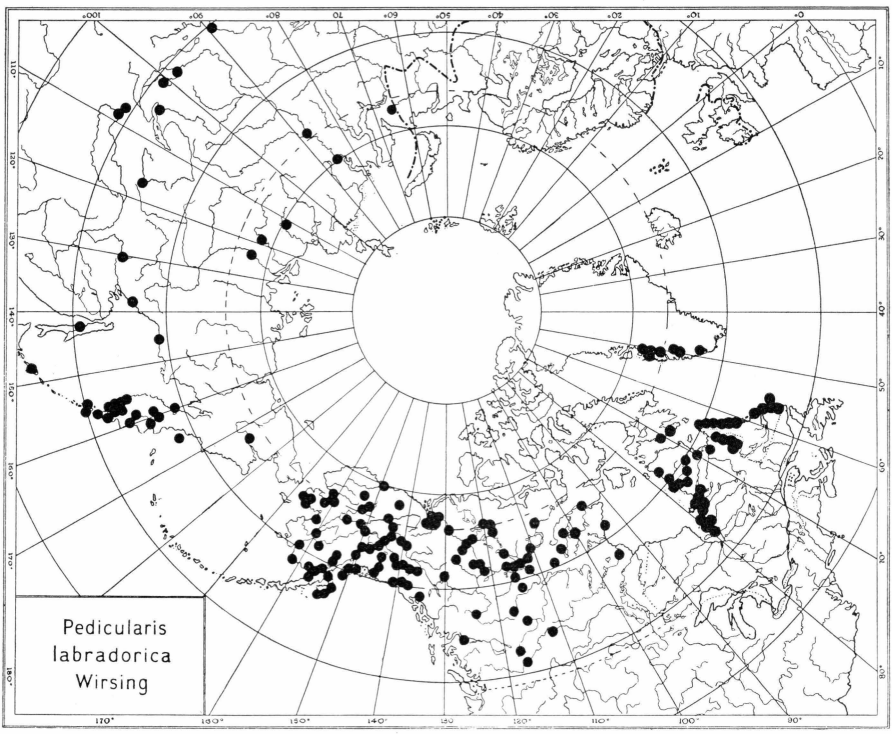


Fig. 70. Total area of *Pedicularis labradorica*. Stations indicated by Dr. M. RAYMOND. —·—·—·—: limit of the last Glacial Period in Northwest Eurasia. Details concerning the range of the species in West Greenland may be seen on map fig. 19 in B. 1952 a.

away from regions greatly influenced by the Atlantic (see for Greenland map fig. 14 in B. 1952 a). The southern limit in East America is in Ungava, Labrador (cf. stations in HUSTICH & PETTERSSON 1943). — Ecology: Heaths and bogs always on peaty, acid soil; hardly ever together with *Rhododendron lapponicum*.

Calamagrostis lapponica. Cl-Ar: Circumpolar, low arctic-continental. In Scandinavia markedly continental; see map 164 in HULTÉN 1950; the same is the case in North America (map Plate XVI in RAUP 1947) and Greenland (B. 1952 a, TH. SØRENSEN unpublished). Much American material has been referred to var. *nearctica* A. E. Porsild. The Greenland material forms a special variety (*groenlandica* Lge = *C. hyperborea* Lge). — Ecology: The association with the complex is strong, but not absolute, as it may also occur as a subordinate element in the preceding complex. A. E. PORSILD (1943, p. 11) mentions var. *nearctica* from old sand dunes as well as peaty soil in open heath and muskegs.

Pedicularis labradorica. Cl: Sub-low arctic-continental, but like *Ledum palustre decumbens* with oceanic areas of occurrence on the northern Pacific. It is probably a further exemple of a Beringia radiant, which on its migration towards the east and west through the continents has lost all oceanic biotypes (cf. B. 1951 c, p. 387). Ar: Almost circumpolar, only not found in East Greenland, Iceland, and the parts of Northwest Eurasia glaciated during the last



Fig. 71. Characteristic picture of a variant of the *Ledum decumbens-Betula nana-Aulacomnium turgidum* heath rich in *Calamagrostis lapponica* on the northern slope of Keglen. The cloddy or low-tussocky surface of the vegetation is conspicuous. — In the background a south-facing steep slope, on which the *Carex supina* steppes are seen as light flats surrounded by dark spots, which are dry willow or birch scrubs. T.W.B. phot. August 1946.

Glacial Period; cf. map fig. 70. — Ecology: Association with the complex not absolute; cf. thus its occurrence on the shore of an alkaline lake, p. 256. In North America especially in muskegs, heaths and mossy, subalpine woods, occasionally also on mineral soil. Thus it is no reliable EG-species.

1. Ledum decumbens-Betula nana Sociations.

The first eight analyses in Table 36 belong to this category. The first, from the area of coastal mountains at Pâ, are deviating, an interesting precursor of the continental heath type. All EG-species except *Ledum* are absent and dominants in the moss carpet are *Dicranum fuscescens* and *Ptilidium ciliare*, which are both of them subordinate in

Table

Analysis no.	1	2	3	4	5	6	7	8
Locality no.	12	2	3	7	2	7	6	6
Altitude in m	40	150	400	100	200	200	100	100
Slope	10°	30°	25°	30°	25°	30°	25°	25°
Exposure	NW	N	NN-W	N	N	N	N	N
pH	—	5.1	—	4.8	—	—	—	—
Lt	—	1.1	—	0.8	—	—	—	—
EG Ledum palustre decumbens	3	3	4	5	4	5	3	3
— Calamagrostis lapponica groenlandica	..	1–2	..	2	+	1	+	..
— Pedicularis labradorica	..	1	..	..	..	..	..	+
Cl Betula nana	3	4	2	2	3	4	3	3
— Vaccinium vitis-idaea minus	..	..	1	+	..	1	..	..
— Ranunculus lapponicus	..	..	..	..	..	..	..	..
— Pirola grandiflora	..	..	2	..	+	..	..	..
— Stellaria longipes-monantha	..	1	1	+	+	+	1	+
— Pedicularis lapponica	1–2	..	..	..	..	..	..	..
— Equisetum scirpoides	..	..	..	..	..	..	..	..
— Poa arctica	..	..	..	..	..	..	..	1
Carex bigelowii	2	..	..	..	..	..	..	..
Diapensia lapponica	1	..	..	..	..	..	..	..
Empetrum nigrum hermaphroditum	4	+	+	..	..	1	..	1–2
Equisetum arvense	..	2	1	..	1	1	1	1
Festuca rubra var.	..	..	..	..	..	..	..	+
Ledum groenlandicum	..	..	..	..	..	..	..	..
Luzula confusa	..	..	..	..	+	..	..	..
Poa pratensis iantha	..	+	1	..	..	+	+	..
Salix arctophila	1–2	..	..	..	..	..	..	..
— glauca callicarpaea	..	..	..	..	..	..	..	..
Tofieldia pusilla	..	..	..	..	..	..	..	..
Vaccinium uliginosum microphyllum	3	1	2	+	1	+	1	..
Calypogeia trichomanis	..	..	..	..	..	..	..	..
Cephalozia bicuspidata	..	..	..	..	..	..	..	..
Cephaloziella papillosa	..	..	..	..	..	..	..	..
— sp.	..	..	+	..	..	..	..	..
Lophozia alpestris major	....	..	..	..	..	..	..	..
— excisa	..	..	1	..	..	..	..	..
— ventricosa	..	..	..	..	..	..	..	..
Orthocaulis kunzeanus	1	..	..	..	..	..	..	..
Ptilidium ciliare	4	..	..	..	..	..	..	..
Sphenolobus minutus	1	..	..	..	..	..	..	..
Amblystegiella sprucei	..	..	1	..	..	..	..	..
Aulacomnium palustre	..	..	..	..	..	..	..	..
— turgidum	2	5	5	3	5	5	2	5

36.

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
7	3	3	1	2	2	7	7	7	7	7	8	3	6	7	3	3
70	350	350	150	200	200	70	70	70	70	70	50	400	100	300	300	350
10°	10°	10°	5°	15°	20°	10°	10°	10°	10°	10°	40°	15°	20°	25°	0°	0°
N	N	N	N	N	N	N	N	N	N	N	N-E	N-E	N	NN-E	—	—
5.4	—	5.5	—	—	—	5.4	—	—	—	—	5.0	—	—	—	5.5	—
0.7	—	0.8	—	—	—	0.7	—	—	—	—	0.9	—	—	—	—	—
..	..	..	..	..	+	2	..	..	..	+	2	..	..	3	3	+
+	..	..	2	2	+	1	+	1	+	+	1	..	1	..	..	1
..	+	..	..	+	..	..	+	..	..	..	..	..	..	..	+	..
5	5	3	5	5	5	1	1	1	1	3	+	3	3	2	2	1
..	..	..	..	..	..	..	..	..	..	..	1	+	..	..	1	..
..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	+	..
+	..	..	4	+	1	..	..	..	+	..	+	+	+	+	..	..
+	2	1	..	1–2	1	+	1	..	+	+	..	..	..	+	..	+
..	..	+	..	..	..	..	..	..	..	..	+	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..
..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	2	..	..	..	+	..	+	+	1	+	5	5	3	5	4
2	..	..	+	..	..	+	1	+	2	+	..	..	+	..	..	..
+	+	+	..	..	..	..	+	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
+	1	+	+	..	+	..	+	+	+	..	..	+	..	+	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	1	..	..	1	+	1	+	..	2	.. 1–2		2	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..
..	..	..	1	..	..	5	5	5	5	5	3	..	2	1	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	+	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..
..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
+	+	+	..	1	+	..	..	..	+	+	..	+	..	1	+	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	+	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	+	..	..	+	..	..	..	..	..	+	..
5	5	5	5	4	2	4	5	5	3	5	1	5	1	1	3	..

(To be continued)

Table 36

Analysis no.	1	2	3	4	5	6	7	8
Brachythecium salebrosum	..	..	..	..	..	..	..	..
Calliergon stramineum	..	..	..	..	..	..	..	..
Ceratodon purpureus	..	..	..	..	..	..	..	..
Distichium capillaceum	+	..	..	..	..	..	..	..
Ditrichum flexicaule	+	..	..	..	..	..	..	..
Dicranum angustum	..	..	..	..	..	..	..	..
— elongatum	..	..	..	1	..	..	..	..
— fragilifolium	..	1	..	..	..	..	..	..
— fuscescens	3	+	..	..	..	..	..	..
— scoparium	..	..	..	..	..	..	..	..
Drepanocladus uncinatus	+	1	1	..	+	..	1	+
Hylocomium schreberi	+	..	..	1	..	..	..	..
— splendens	..	3	+	5	3	1	5	3
Hypnum callichroum	..	+	..	..	..	..	..	..
— cfr. cupressiforme	..	..	..	..	..	..	..	..
Polytrichum alpinum	+	1	..	..	+	..	..	..
— hyperboreum	..	..	..	+	..	..	..	..
— juniperinum alpinum	+	..	..	..	..	..	..	1
— strictum	..	..	..	+	..	..	..	..
Rhacomitrium lanuginosum	1	..	..	..	..	..	..	..
Rhytidium rugosum	..	..	..	1	..	..	..	..
Sphagnum girgensohnii	..	..	..	..	..	..	..	..
Tomenthypnum nitens	..	..	..	..	..	..	..	..
Tortula ruralis	..	1	1	..	..	..	..	..
Webera nutans	..	+	..	..	..	..	..	..
Cetraria cucullata	..	..	+	..	..	..	..	..
— islandica	2	..	..	+	..	..	..	..
— nivalis	1	..	+	..	..	..	..	..
Cladonia chlorophaea	+	+	..	..	..	..	..	..
— gracilis chordalis	+	..	..	..	..	..	..	..
— mitis	1	..	..	..	..	..	..	..
— rangiferina	1	..	..	..	..	..	..	..
— uncialis	+	..	..	..	..	..	..	..
Nephroma expallidum	..	..	3	..	..	..	..	..
Peltigera aphthosa	..	2	..	1	4	1	2	1
— canina	..	..	..	..	..	..	..	..
— erumpens	..	..	..	..	..	..	..	..
— malacea	..	..	..	1	..	..	..	..
Boletus scaber	..	..	..	..	..	..	..	..
Galera hypnorum	..	+	..	..	..	..	..	..
Laccaria laccata	..	..	..	..	..	..	..	..
Lactarius glyciosmus	..	..	+	..	..	..	..	..
Omphalia leucophylla	..	..	+	..	..	..	..	..
Russula emetica	..	+	..	..	..	..	..	..
— vinosa	..	..	..	..	..	..	..	..

(continued).

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..
..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..
..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	+	1	..	+	..	1	..	..	2	..	+	+	1	1	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	1	5	..	..	..	..	..	3	1	..	+	..	..
..	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..	..
..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..
..	..	+?	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	1	3	..	..	..	..	..	..	..	..	..	..	..	..	+	1
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	5
..	..	..	..	..	..	1	..	..	2	..	..	..	..	..	..	..
1	..	..	1	..	..	..	1	..	..	..	..	..	..	+	..	..
+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..
..	2	2	..	4	3	1	..	..	+	+	1	2	..	+	+	..
+	..	..	+	..	..	+	1	1	..	1	..	..	+	1	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..

the lowlands in the continental area, but which are very frequent in the communities of the coastal regions. The vegetation was found in small patches on slightly sloping ground, which was estimated to be exposed to a very slow percolation (near the quadrate there was a little *Scirpus caespitosus austriacus*).

In the inland heaths *Aulacomnium turgidum*, *Hylocomium splendens*, or both are predominant in the ground layer, and *Stellaria longipes-monantha* is constantly present in the moss under the shrubs. *Vaccinium vitis-idaea minus* is sometimes frequent together with *Ledum*, a circumstance which is no doubt connected with the fact that both are rather exclusive acidophilous plants.

Ledum palustre decumbens is as a dominant in the continental area associated with comparatively moist soil; so it is found on the steeper northern slopes and in bogs. The frequent occurrence of low tussocks (see fig. 71) should no doubt be connected with soil frost action. It was characteristic that there were hardly ever any patches of bare soil (frost scars), and in several places it was evident that the peat layer was thicker than the depth of annual thaw. If so, there will just not be any frost scars (according to HOPKINS & SIGAFOOS 1950), but the frost heaving occurs entirely within the peat and results in the formation of peat mounds of irregular shape.

On several heath-covered northern slopes in Ørkendalen it was evident that the formation of tussocks ceased on steeply sloping flats, but was pronounced where the sloping decreased at the foot of the slope. There the tussocks increased in size, often finally being sinuous-lengthy with interjacent grooves, where mineral soil could be seen in small spots.

An analysis of the oribatid-collembola fauna in the soil showed that this was rich (19 species in 1045 individuals) and not a little different from that under the *Rhododendron* moor with similar conditions of humidity (cf. HAMMER 1952, nos. 4—5).

2. Betula nana Sociations.

This heath is illustrated by examples 9—14 in Table 36, all with *Aulacomnium turgidum* as dominant. It was found on somewhat drier soil than the preceding heath, which is connected with the smaller sloping. *Hylocomium splendens* obviously does not thrive well and is not dominant when we approach to a 10—15° slope on the shady side of the mountains. In many places the *Betula nana-Aulacomnium* heath is observed as a zone between dry *Betula nana* heath (cf. p. 223) and the heath rich in *Ledum*.

Close to the ice cap north of Sandflugtdalen there is a plateau at an altitude of only 100—200 m above sea level. This is to a great extent

covered by a scrub-like *Betula nana-Aulacomnium* vegetation, in which *Pirola grandiflora* may form the ground layer (Table 36, no. 12), but where also *Salix glauca callicarpaea*, *Vaccinium uliginosum*, and *Calamagrostis lapponica* may appear as important elements. The rather large, fairly plane country round a circular lake between Loc. 5 and Loc. 3 was also covered by *Betula nana-Aulacomnium* heath with abundant *Calamagrostis lapponica* and *Poa pratensis iantha*. Especially the level heaths sometimes had sporadic representatives of other communities, thus *Rhododendron lapponicum* might enter into the vegetation, nearly always accompanied by *Salix glauca callicarpaea*, which is expressive of a less moist and less oligotrophic soil; cf. Table 36, where the willow is absent in nos. 1—8, and Plate IV, fig. 1.

Near Vandfaldskløften high up on a northern slope there was a *Betula nana-Empetrum-Hylocomium splendens* soc. with occasional *Ledum decumbens* and *Ranunculus lapponicus*.

3. Vaccinium uliginosum microphyllum Sociations.

These sociations play a more subordinate part than the preceding ones and occur on less moist and perhaps especially on less snow-protected soil. Examples 15—19 in Table 36 all originate from the foot of Ravneklippen on slightly sloping ground and somewhat exposed to wind which sweeps past the rock. *Hylocomium splendens* is completely absent and *Peltigera aphthosa* is less frequent, whereas *P. canina* seems to be more frequent. It is also characteristic that *Salix glauca callicarpaea* enters the vegetation.

In other places along the foot of Ravneklippen a "dune heath" has formed by driftsand having drifted over a heath of the above-mentioned type. There is no moss there, but sand between the shoots of the vascular plants. *Vaccinium uliginosum*, *Empetrum*, *Betula nana*, *Salix glauca callicarpaea*, and *Rhododendron lapponicum* form the dwarf-shrub layer, with *Ledum decumbens* as a subordinate species. Important species are *Calamagrostis lapponica* and *Stellaria longipes-monantha*, but also representatives of the steppe communities, thus *Kobresia myosuroides*, *Calamagrostis purpurascens*, and *Melandrium triflorum*. Occasional species are *Carex bigelowii*, *Poa pratensis iantha*, *P. glauca*, *Polygonum viviparum*, *Cerastium alpinum*, *Campanula rotundifolia*, and *Equisetum arvense*.

Vaccinium-Ledum groenlandicum sociation, Table 36, no. 20. This combination was very rare, at any rate in the interior. It was seen on the bank of Lake Taserssuatsiaq as small patches surrounded by heath belonging to the *Ledum decumbens-Betula nana* type. A little *L. groenlandicum*, although as subdominant in heath rich in *L. decumbens*, was also observed on a steep slope at the western end of Ørkendalen. Besides these two stations *L. groenlandicum* was not seen in the lowlands at the head of Søndre Strømfjord; but it was seen in the highlands on Nákajanga at an altitude of 600 m in a wet bog near a lake together with *Carex bigelowii*, *C. rariflora*, and *Salix arctophila*.

According to TRAPNELL (1933) the combination *Betula nana-Ledum groenlandicum* covers large areas in the middle part of the Godthaabsfjord. It was not seen at the head of Søndre Strømfjord, but certainly occurs at the entrance to the fjord. Already at Itivdlínguaq *L. groenlandicum* was fairly rare, but *L. palustre decumbens* was frequent in *Betula nana*, *Cassiope tetragona*, or *Vaccinium uliginosum* heath. In a variant of the last-mentioned type of heath, obviously on somewhat richer soil there were *Rhododendron*, *Pedicularis lapponica*, and *Bartsia alpina* f. *rosea*.

4. Empetrum nigrum hermaphroditum Sociations.

Because of the procumbent growth of the crowberry the moss in the heath where it is dominant, is often forced back. This applies to the examples nos. 22—23 in Table 36, which originate from slopes right down to freshwater. No. 21, on the other hand, is an example of an *Empetrum-Aulacomnium* heath. It originates from the highlands of Hassells Fjeld where it appeared as small patches near a vertical north-facing rock, in a place where the snow cover in winter must be estimated to be constant and protracted. On Nákajanga, too, mossy crowberry heaths were observed under similar circumstances and at altitudes between 400 and 500 m above sea level. One of these sociations had *Betula nana* as subdominant and, besides, *Ledum decumbens* and *Ranunculus lapponicus*, another contained *Lycopodium annotinum*, *Vaccinium vitis-idaea minus*, *Poa pratensis* (? var. *rigens*), dominant *Hylocomium splendens*, *Tritomaria quinquedentata*, besides a little *Sphagnum girgensohnii* and *Polytrichum juniperinum*. These examples show in how high a degree dominance of *Empetrum* in the continental area depends on special conditions of humidity. This is in good agreement with the fact that on the banks of acid lakes there are not rarely bogs dominated by *Empetrum* together with *Sphagnum*. Two examples of *Empetrum-Sphagnum girgensohnii* soc. are described in Table 36, nos. 24—25. The vegetation no. 24 is seen on the left in fig. 73 and its neighbouring vegetation closest to the water is mentioned on p. 285.

b. The Calamagrostis lapponica groenlandica Type.

(Low arctic continental grassland and herb-moss vegetation on moderately moist and acid soil).

This vegetational type is associated with the preceding one, its sociations not rarely being found together with the heaths or bordering on them. It was not possible for me during our stay in Greenland in all cases to find out the cause of this alternation between heath and grass or herbaceous vegetation. From the following profile transects, however, it appears that there is often a greater humidity where the

heath gives way. Still, it is hardly the humidity itself, but the greater amount of nutrients, better access of oxygen, and less frost in the soil that may be decisive. This agrees with the fact that exactly the *Calamagrostis lapponica* type is often transitional to the *Ranunculus pedatifidus-Kobresia* type; see p. 248. The EG-species of the type, *Calamagrostis lapponica groenlandica* was mentioned on p. 268.

1. Calamagrostis lapponica groenlandica Sociations.

On north-facing slopes in Ørkendalen *Calamagrostis lapponica groenlandica* may be dominant in a dense moss carpet of *Aulacomnium turgidum* and with *Stellaria longipes-monantha* as an important component. But mostly it is in such cases ousted from its leading position by the heath shrubs. On the other hand, it attains to sole dominance together with certain mosses in certain depressions in the ground or in the vicinity of lakes. On Hassells Fjeld in a ravine at an altitude of about 200 metres above the sea a *Ledum decumbens-Betula nana-Aulacomnium* heath was observed on a north-facing slope, while the bottom of the ravine was covered by a *Calamagrostis lapponica groenlandica-Poa pratensis iantha-Aulacomnium turgidum* soc., in which *Equisetum arvense*, *Ranunculus lapp.*, and *Ledum palustre decumbens* were noted. The soil was constantly moist there. In depressions which dry up in summer and which have no outlets, *Calamagrostis lapp. groenlandica* may very well be frequent, but as soon as *Carex norvegica inserrulata* and its companions appear in abundance, it disappears.

The occurrence of the sociation in belt transects round lakes may be illustrated by the following examples:

A. The river plain in front of Ravneklippen, Loc. 7.

(1) *Kobresia myosuroides-Stereocaulon alpinum* soc. alternating with bits of low willow scrubs.

(2) Low *Betula nana-Salix glauca* scrub with a little *Kobresia* and gradually some moss in the ground layer.

(3) Mossy *Calamagrostis lapponica groenlandica* soc. with *Poa pratensis iantha* and *Stellaria longipes monantha* as subdominants.

(4) *Calamagrostis neglecta soc.* with *Carex saxatilis.*

(5) Open water in small lake.

B. The area west of Ravneklippen, Loc. 7.

(1) Upper part of southern slope: *Artemisia borealis*, *Calamagrostis purpurascens*, *Carex supina*, *Potentilla chamissonis*, *Draba hirta.*

(2) Rather dry *Betula nana* scrub with occasional one metre high willows and much *Pirola grandiflora*, *Stellaria longipes-monantha*, and *Campanula rotundifolia.*

(3) Almost level ground with moister mossy *Betula nana* heath with low-growing willows, *Vaccinium vitis-idaea minus*, *Pedicularis labradorica*, *Ranunculus lapponicus*, and *Calamagrostis lapponica groenlandica*.

(4) Narrow strip with mossy *Calamagrostis lapponica groenlandica* soc.

(5) *Calamagrostis neglecta* soc. with *Carex saxatilis*, *Eriophorum angustifolium*, and *E. scheuchzeri*.

(6) Open water with *Hippuris* soc.

C. Ringsødal, Loc. 4.

(1) Steep north-facing rocky slope, i. a. with *Pirola grandiflora-Hylocomium* soc. or patches of mossy *Cassiope tetragona* heath.

(2) Near the foot of the slope, on less sloping incline: *Betula nana-Ledum-Aulacomnium* heath. The ground rough with peat mounds.

(3) Slightly sloping ground below the steep slope: *Betula nana-Aulacomnium* soc. with *Calamagrostis lapponica groenlandica* as subdominant, much *Peltigera aphthosa*, and scattered *Pedicularis labradorica*.

(4) *Calamagrostis lapponica groenlandica-Aulacomnium* soc.; besides *A. turgidum* also *A. palustre*. *Poa pratensis iantha* frequent.

(5) The *Eriophorum* species, *Calamagrostis neglecta*, and *Carex saxatilis*, and various greatly hydrophilous mosses. Between (4) and (5) sometimes mossy *Salix arctophila* soc.

Especially in Ringsødal the mossy *Calamagrostis lapponica groenlandica* soc. was very important, as besides occurring at the foot of the slopes as in C(4) it occurred on large areas on the flat isthmuses between the many smaller and larger lakes (cf. fig. 72).

2. Stellaria longipes-monantha Sociations.

Stellaria longipes (including forms corresponding to *S. monantha* Hult.) is very constant on the heaths, but besides, it may be completely or almost dominant in independent sociations rich in grass. This was observed on north-facing slopes at the east end of Ørkendalen (Table 37, no. 1), where such patches of vegetation alternated with patches dominated by *Calamagrostis lapponica groenlandica* or *Betula-Ledum*. The cause of the occurrence of the grass- or *Stellaria*-dominated "glades" in the heath may perhaps be a greater drying-up as a consequence of the strong easterly gales and foehns characteristic of the vegetation closest to the ice margin. The example Table 37, no. 2 from Ringsødal differs by great frequency of *Poa glauca*; cf. below. The vegetation was found as small patches there and seems ecologically to hold an intermediate position between the *Betula-Ledum* heath and the *Kobresia myosuroides* sociations.

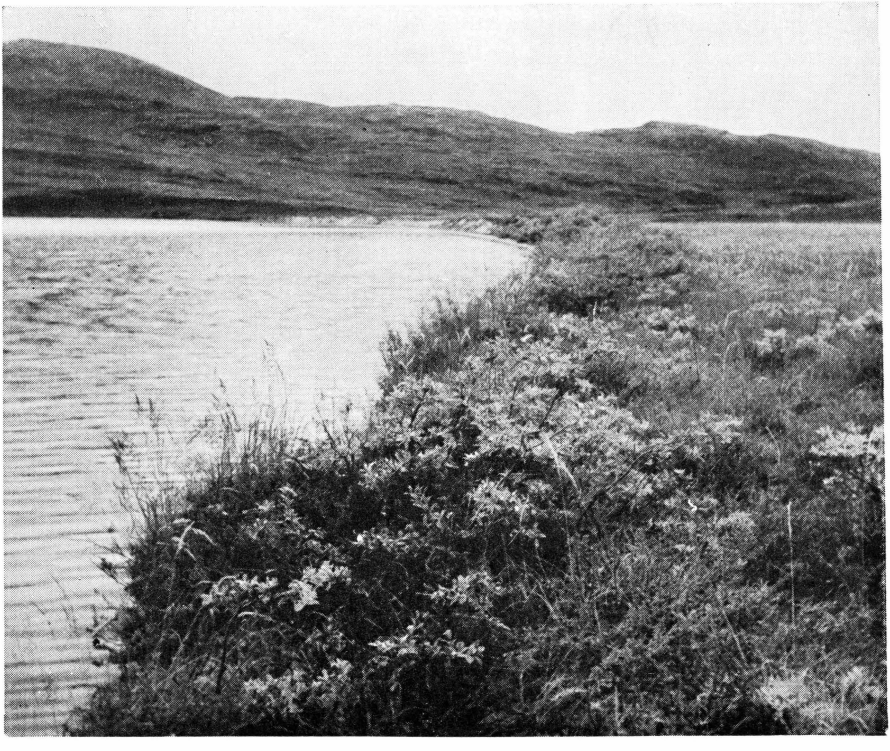


Fig. 72. Ringsødal. Low natural sandy rampart along the lake shore covered with *Salix glauca* ssp. *callicarpaea*, *Betula nana*, *Calamagrostis lapponica* var. *groenlandica*, and *Poa pratensis* var. *iantha*. Right of the bank, a meadow mainly with *Calamagrostis-Poa pratensis*. T.W.B. phot. $^{24}/_{8}$ 1946.

3. Poa glauca Sociations.

These sociations are mentioned here because ecologically and floristically they are most naturally associated with the complex. In Norway *Poa glauca* is a very important species on "rasmark" (talus slide); cf. NORDHAGEN's "*Veronico-Poion glaucae*". The Norwegian vegetation is, however, floristically completely different from the *Poa glauca* vegetation that was observed in the interior of West Greenland, but resembles several talus slide vegetations which I have seen in the coastal regions. On the steep north-facing slopes in Ørkendalen there were slides in several places, presumably in connexion with great water saturation of the soil in spring. In such slides the soil is mainly mineral and is thawing to a great depth during the summer period, while the humus soils, with their cover of moss and dwarf shrubs have a constant soil frost not far below the surface. Because of this contrast the succession is made difficult or hampered, and often such slides will therefore get a social, rather stable vegetation dominated by *Poa glauca* together with a few other species, among which especially *Equisetum arvense* is important. In a certain place practically only *Poa pratensis iantha* was found besides the two species just mentioned, but behind clods of earth or stones there might be some other species, particularly *Luzula confusa*, *Papaver radi-*

Table 37.

Analysis no.	1	2	3	4	5	6	7	8	9	10	11
Locality no.	6	4	4	8	6	3	3	3	3	3	3
Altitude in m	150	300	350	150	80			40			40
Slope	30°	15°	40°	45°	30°			0°			0°
Exposure	N	W	N	N	N			—			—
pH	4.8	—	—	6.4	—			6.0–6.1			—
Lt	—	—	—	—	—			0.9			—
EG Ledum palustre decumbens	..	..	..	..	+	..	..	..	..	..	..
— Calamagrostis lapponica groenlandica	+	..	..	..	2	1	..	2	3	2	..
Cl Stellaria longipes-monantha	3	4	+	..	+	+	1	+	+	1	..
— Pirola grandiflora	+	..	5	3	..	3	1	4	3	3	..
— Equisetum scirpoides	..	..	..	..	..	..	..	..	1–2	..	..
— Betula nana	..	..	..	..	..	3	1	+	..	3	..
— Vaccinium vitis-idaea minus	..	..	+	..	..	..	..	..	..	..	..
— Pedicularis lapponica	..	..	..	..	..	..	..	..	+	..	..
— Saxifraga tricuspidata	..	..	..	+	..	..	..	..	..	..	..
— Hierochloë alpina	..	..	1	..	..	..	..	..	..	..	..
Campanula rotundifolia (coll.)	..	+	..	+	..	1	..	..	..	..	..
Carex bigelowii	..	..	..	..	..	..	..	..	..	..	2
— scirpoidea	..	..	..	..	..	..	..	..	..	..	1
Cerastium alpinum lanatum	1	+	..	+	..	..	..	..	..	..	..
Chamaenerium latifolium	..	..	..	..	..	..	..	..	..	..	1
Empetrum nigrum hermaphr.	..	..	..	..	..	4	1	..	..	..	..
Equisetum arvense	..	+	..	..	2	1	..	+	..	2	+
Festuca rubra var.	2	..	..	..	..	..	..	..	..	..	..
Luzula confusa	..	..	+	..	..	..	..	..	..	..	..
Poa glauca	..	3	..	..	..	..	..	..	..	..	..
— pratensis iantha	2	2	+	..	..	..	+	..	..	..	+
Polygonum viviparum	..	..	..	..	..	1	..	..	..	..	1
Salix glauca callicarpaea[1]	1	..	..	..	5	4	5	5	5	5	5
Vaccinium ulig. microphyll.	..	..	..	+	3	2	4	..	..	..	5
Lophozia alpestris major	+	..	..	..	..	..	..	..	..	..	..
Amblystegium serpens	..	..	..	..	..	..	..	..	..	+	..
Aulacomnium turgidum	1	5	1	1	+	1	+	..	2	1	..
Brachythecium salebrosum	..	..	..	..	..	..	1	+	1	..	1
Bryum sp.	..	..	..	..	..	..	..	..	..	+	..
Desmatodon latifolius	..	..	..	..	..	..	..	..	..	+	..
Dicranum fuscescens	..	..	1	..	..	..	..	..	..	..	..
— scoparium	..	..	..	3	..	..	..	..	..	..	..
Drepanocladus uncinatus	..	..	+	..	1	2	+	1	2	2	3
Grimmia funalis	..	..	..	1	..	..	..	..	..	..	..
Hylocomium splendens	5	..	5	..	..	..	..	..	..	..	..

[1] In nos. 5—11 forming scrubs, 1—1.5 m high.

(To be continued)

Table 37 (continued).

Analysis no.	1	2	3	4	5	6	7	8	9	10	11
Hypnum cfr. cupressiforme	..	..	..	2	..	..	..	..	..	..	..
Mnium affine	..	..	..	..	..	..	..	..	..	..	1
Polytrichum junip. alpin.	1	..	..	..	..	..	..	..	..	..	..
Rhacomitrium canescens	..	..	..	3	..	..	..	..	..	..	..
Tortula ruralis	2	..	..	..	..	2	1	1	2	3	..
Cladonia sp. (chlorophaea)	..	..	..	+	..	..	..	..	..	..	..
Ochrolechia frigida	..	..	..	+	..	..	..	..	..	..	..
Peltigera aphthosa	1	+	1	+	..	..	..	..	..	..	..
— canina	1	..	..	..	..	..	..	..	..	..	..
— rufescens	..	..	..	..	..	1	..	..	1	1	..
Stereocaulon alpinum	..	..	..	2	..	..	..	..	..	..	..
Galera hypnorum	+	..	..	..	..	..	..	..	..	..	..
Laccaria laccata	+	..	..	..	..	..	..	..	..	..	..
Lycoperdon sp.	..	..	..	..	..	..	..	..	..	1	..
Typhula sp.	..	..	..	..	..	..	..	..	..	..	+

catum, *Cerastium alpinum*, *Saxifraga tricuspidata*, and *Stellaria longipes-monantha*. Particularly instructive was the vegetation of the steep slope towards the fjord below Lille Saltsø, which is situated about 100 m above sea level. There the combination *Poa glauca-Equisetum arvense* was found again, nearly without any other species, on a slide on the middle of the steep slope. The place was surrounded by mossy heaths besides a peculiar *Equisetum scirpoides-Hylocomium splendens* soc. (see p. 242), which like the *Poa* soc. perhaps benefited by ground water seeping out slowly. The seepage might contribute to a saturation with water in the soil, which in spring might give rise to a movement of the soil, but there was no indication that there was ever any trickling of water.

4. Pirola grandiflora Sociations.

Such sociations are found on steep north-facing walls of rock, where there is very shallow soil over the rock; cf. the profile mentioned on p. 169 (7). In Table 37 there are two examples. In no. 4 the rock approaches very closely to the surface; there *Rhacomitrium canescens* and *Grimmia funalis* are characteristic, and the richness in lichens relatively great. The vegetation was surrounded by an *Empetrum-Vaccinium-Hylocomium splendens* soc. with abundance of *Ledum pal. decumbens* and *Pirola grandiflora*. The vegetation mentioned as no. 3 from Ringsødal grew on somewhat deeper humus soil and had *Hylocomium splendens* as moss dominant. Both there and in a corresponding patch of vegetation west of Store Saltsø *Hierochloë alpina* occurred, a clear effect of the reduced competition on the shallow soil over the rock. In the latter

place there were also, as in no. 4, *Rhacomitrium canescens*, *Saxifraga tricuspidata*, and *Stereocaulon alpinum*. The vegetation was surrounded by *Ledum decumbens-Vaccinium vitis-idaea minus-Hylocomium splendens* heath, again with abundant *Pirola grandiflora*.

In certain places the vascular plants might be scattered so much that it was a question of an almost pure *Hylocomium splendens* sociation. The soil there seems to be more constantly moist. In Ørkendalen such a moss vegetation was found below places where snow must be estimated to accumulate in winter, and the humidity conditioned that the moss carpet also came to include such species as *Sphagnum squarrosum* and *Mnium longirostre*. Scattered in the moss there were *Peltigera aphthosa*, *Equisetum arvense*, *Pirola grandiflora*, *Stellaria longipes-monantha*, and *Festuca rubra*.

Scrubs Associated with the Vegetational Types a and b in the Complex.

Salix glauca callicarpaea is ecologically a wide-ranging species, but it has no doubt the best conditions on meso-eutrophic soil. Therefore it is mostly absent where *Ledum palustre decumbens* becomes dominant (Table 36). The willow scrubs on the low ramparts by the lakes in Ringsødal (fig. 72) clearly belong to the complex and besides *Calamagrostis lapponica groenlandica* and *Betula nana* may in places contain such acidophilous species as *Ledum* and *Vaccinium vitis-idaea minus*. The scrubs in Table 37, no. 5—10 may also be connected with the complex. No. 5 originates from the northern slopes in Ørkendalen, from a place where the scree consisted of large blocks overgrown with moss (e. g. *Pirola grandiflora-Hylocomium splendens* soc. or *Carex supina-Drepanocladus uncinatus-Tortula ruralis* soc. with *Rhacomitrium canescens*, *Saxifraga tricuspidata*, *Stereocaulon alpinum*, and *Peltigera malacea*). In the vicinity there were *Poa glauca* sociations (cf. above 279).

Nos. 6—10 originate from the bottom of the valley at the air base (Loc. 3). There *Calamagrostis lapponica groenlandica* was almost constant and often abundant. In some places *Empetrum*, in other places *Vaccinium uliginosum* was very important under the willows. At intervals between various parts of the willow scrub there were lower *Betula nana* scrubs with the same species, but often with more *Aulacomnium turgidum*, *Poa pratensis*, and *Pedicularis lapponica*.

The willow scrubs described by M. P. PORSILD 1912 from the head of Laksefjord seem to be related to the above-mentioned scrub vegetation.

c. The Comarum-Galium brandegei Type.

(Sub-low arctic bog vegetation with widely distributed and continental species; water moderately acid and meso-oligotrophic).

This type has some widely distributed subarctic Hb-species, among which *Comarum palustre* and *Menyanthes trifoliata* play an important part, while *Carex canescens* is very rare. One might have imagined a union of all Greenland sociations rich in *Comarum* within an extra-regional subarctic-temperate bog type, but it was felt that such a union would be too heterogeneous and large. The widely distributed species must content themselves by serving as local guiding species and we must try to make the classification on the basis of species with distributions associated with a narrower climatic range. From Angmagssalik there is an analysis (B. 1933 b, no. 91) of a *Sphagnum* bog with *Carex rariflora-Comarum* as dominants. This is differentiated from similar sociations in the Strømfjord area by the occurrence of such species as *Salix herbacea* and *Carex lachenalii*, the occurrence of which is unimaginable in the most continental West Greenland, while such species as *Ranunculus lapponicus* and *Galium brandegei* may be rather frequent there. As, furthermore, the continental bog sociations may contain EG-species of the present complex besides continental Cl-species, a ranging of them in the complex seems the most natural solution.

The type is related to the Scandinavian moderately acidophilous alliance which by Nordhagen (1943, p. 482) has been termed "*Caricion canescentis goodenowii*" and which is characterized by such species as *Eriophorum scheuchzeri*, *Epilobium palustre*, and *Carex canescens* and is preferred by such a species as *Comarum palustre*. Nordhagen inserts this alliance between the alkaliphilous "*Caricion atrofuscae-saxatilis*" and the strongly acidophilous "*Stygio-Caricion limosae*", which has no parallel in continental West Greenland and hardly is typically developed anywhere in Greenland as most of its guiding species are absent.

EG-species of the vegetational type:

Galium brandegei Gray. Cl-Ar: The species is presumably only to be considered as a subspecies of *G. trifidum* L. The distribution comprises North America, Greenland, and, according to Fernald and Löve, Iceland. In the place mentioned last it especially occurs in the northern parts of the country (Grøntved 1942, fig. 162), which is in good agreement with the fact that in Greenland it has a continental trend of distribution (map in B. 1952 a). Löve (1950) has an approximative map of the total distribution of the species. This is in very poor agreement with the statements in Fernald (1950), who still, like Hultén, maintains Alaska as belonging to its range, and only mentions it from Northern Newfoundland. The map records it from almost the whole of the coast of Labrador although Hustich & Pettersson (1945) and Raymond (1950) do not mention it at all from there, but they record

G. trifidum. To all appearance the species has a disrupted range with an area in Utah-California, scattered occurrences in West Alaska and East America (e. g. the Schickshock Mountains), Greenland, and Iceland. — The closely related *G. trifidum* has in Scandinavia a clearly continental range (map 1630 in HULTÉN 1950). — Ecology: Little known. In Greenland nearly always together with *Sphagna* on the shore of oligotrophic lakes. According to TIDESTROM (1925) it is in Utah subalpine, associated with the coniferous zones of the mountains in moist places.

Approaching to EG-species:

Ranunculus lapponicus. Cl-Ar: Sub-low arctic-continental; cf. maps of North America (RAUP 1947), Greenland (B. 1951 c), Scandinavia (HULTÉN 1950). — Ecology: Associated with the whole complex, but often particularly frequent in communities which may be characterized as bogs. It may also enter into mossy moist communities of the preceding complex (see Table 30, no. 11; Table 31, nos. 1—2), but furthermore grows high on the mountains, occurring there together with *Cassiope tetragona* (Table 16, no. 5). — In Scandinavia it occurs in boggy woods in dense moss of *Calliergon stramineum* or *Sphagnum* (SELANDER 1950, p. 85). From North America RAUP (1935) mentions it from mossy muskeg thickets and A. E. PORSILD (1951) says that it is common in *Sphagnum* bogs, particularly in black spruce muskegs.

The discussion of this vegetational type must mainly be based on a description of belt transects. As will be seen, the vegetational type only appears as small fragments, often even little typical, a fact that may be ascribed to the climatic-edaphic conditions in the continental area, which must be considered unfavourable for the development of bogs not dominated by dwarf shrubs.

Banks of the lakes Kløftsøerne (see map fig. 2).

The ravine seen in fig. 63 continues towards the east and there contains a number of long and narrow lakes, the banks of which are characterized by rather oligotrophic communities particularly belonging to types a–b within the complex. The lakes are situated about 300 m above sea level and the pH of the water is about 6 (see also Table 38). The following zonations illustrated by the two examples A and B are found there.

A (1) *Betula nana-Ledum palustre decumbens-Sphagnum girgensohnii* soc.
(2) *Comarum-Carex rariflora-Eriophorum angustifolium-Sphagnum squarrosum* soc.
(3) *Comarum-Drepanocladus* sp. soc. (? *D. aduncus*).
(4) *Menyanthes* soc. in open water close to the bank (narrow strip).
(5) *Sparganium hyperboreum-Hippuris* soc.

B (cf. fig. 73).
(1) *Empetrum-Sphagnum girgensohnii* soc. (Table 36, no. 24).



Fig. 73. Mossy bank vegetation at the western end of Kløftsøerne. The *Empetrum-Sphagnum girgensohnii* sociation is seen on the left; this is followed, nearly in the middle, by a strip of *Comarum-Sphagnum squarrosum* soc., and next follows, beside the bank, the narrow marginal vegetation of *Menyanthes*; in the water *Hippuris* is seen. T.W.B. phot. $^{6}/_{8}$ 1946.

(2) *Comarum-Sphagnum squarrosum* soc. with the following subordinate species:

Carex rariflora	*Aulacomnium palustre*
Poa pratensis iantha	*Calliergon giganteum*
Galium brandegei	*Philonotis fontana*
Betula nana	*Webera nutans*
Cardamine pratensis	*Tomenthypnum nitens*
Equisetum variegatum	*Campylium stellatum*
Montia lamprosperma	*Brachythecium salebrosum.*

(3) *Menyanthes* soc. near the open water.

(4) *Hippuris-Potamogeton alpinus tenuifolius* soc.

In these transects A(1) and B(1) belong to the *Ledum decumbens-Betula nana* type, while A(2)—(4) and B(2)—(3) belong to the *Comarum-Galium brandegei* type. It is, however, worth while calling attention to

the fact that B(2) contains several species with a eutrophic trend (*Equisetum variegatum*, *Campylium stellatum*). Both profiles range between communities on acid humus soil and communities benefiting by the water of the lake, which is slightly acid and not extremely oligotrophic. Therefore the marginal zone is a community which comes to contain a mixture of meso-oligotrophic and meso-eutrophic species. The belt formation reminds not a little of that mentioned by GREENJ 1940, fig. 4, from West Siberia.

Between two sections of Kløftsøerne there is a meadow which time and again is percolated by water. There the moss mainly consisted of *Calliergon giganteum*, which according to NORDHAGEN also occurs as dominant in Norwegian sociations belonging to the "*Caricion cenescentis-goodenowii*", and in the moss there was abundance of *Carex canescens*, *Epilobium palustre*, *Galium brandegei*, and some *Montia*, occasional *Carex saxatilis*, and *Pinguicula*, the last-mentioned species clearly being a eutrophic element.

The Lake Terrain Northwest of Strømfjordshavn (Loc. 5).

Five small lakes there, all of them with an outlet and vegetation-covered banks and brown water rich in humus, and with pH 5—6 were examined perfunctorily. Closely outside the bank the following sociations were predominant: Outermost, *Menyanthes* soc. and *Comarum* soc.; on the mossy bank itself: *Carex rariflora* soc., *Eriophorum angustifolium* soc., and *Calamagrostis lapponica groenlandica* soc. Scattered in the communities of the mossy bank were found such species as *Carex saxatilis*, *Ranunculus lapponicus*, *Pedicularis labradorica*, and *Salix arctophila*. In the lake pictured in B. 1949b, fig. 15, there are outermost *Menyanthes* together with *Hippuris*, this zone is followed by a *Comarum* zone and then by the communities of the bank proper, a *Calamagrostis lapponica groenlandica-Aulacomnium palustre-Sphagnum squarrosum* soc. with scattered *Eriophorum angustifolium*, *Polytrichum*, and *Aneura* sp., then a clodded, tussocky *Betula nana-Salix arctophila-Aulacomnium-Sphagnum acutifolium-fimbriatum* soc. containing *Ledum palustre decumbens*, *Vaccinium vitis-idaea minus*, and, particularly between the tussocks, *Carex rariflora*. While the last-mentioned sociations are placed in the types a–b, the *Carex rariflora*, *Comarum*, and *Eriophorum angustifolium* sociations rich in *Sphagnum* may best be associated with the type c, although *Galium brandegei* was not present, but scattered *Calamagrostis lapponica*, *Ranunculus lapponicus*, and several other continental Cl-species were found.

The Menyanthes Lake on Hassells Fjeld (Loc. 3).

This small lake, which in several respects was of special interest, was investigated more thoroughly. It is situated 400 m above sea level

close behind the steep southern slope of the mountain. A picture of the lake is found in Plate IV, fig. 2. In B. 1949, Table 12, there is a water analysis which shows that the water is less oligotrophic than in the two other small lakes examined, which have water rich in humus. At high water the lake may in spring give off water in an easterly direction. At its east end there is a moist *Carex rariflora* meadow which is percolated by water. At the outlet, which is dry in summer, there is a *Calamagrostis canadensis langsdorfii* soc. poor in species (seen in Plate IV, fig. 2). Close to this drainage area the northern low bank is sloping evenly upwards. There the belt formation was examined in two places (A and B), a third place being mentioned in detail in B. 1952b, pp. 29—30.

A (close to the drainage area).

(1) *Vaccinium uliginosum microphyllum-Cetraria cucullata-Alectoria lanea-ochroleuca* soc. with *Betula nana*, *Rhododendron*, *Vaccinium vitis-idaea minus*, *Kobresia myosuroides*, *Poa pratensis iantha*, *Luzula confusa*, *Polygonum viviparum*, *Stellaria longipes-monantha*, *Pedicularis lapponica*, *Aulacomnium turgidum*, *Peltigera*, and *Cladonia gracilis*.

(2) *Vaccinium uliginosum microphyllum-Aulacomnium turgidum* soc. with most of the species mentioned above, besides *Ledum palustre decumbens* and *Salix glauca callicarpaea*; no dominant lichens as in (1), but some *Nephroma expallidum*, a little *Stereocaulon alpinum*, and *Tomenthypnum nitens*. No *Kobresia*.

(3) *Betula nana-Vaccinium uliginosum microphyllum-Aulacomnium palustre* soc. with *Carex rariflora* as subdominant, and occasional *Empetrum*, *Ranunculus lapponicus*, and *Calamagrostis lapponica groenlandica*.

(4) *Carex rariflora-Salix arctophila-Sphagnum squarrosum* soc. on low sinuous tussocks. Scattered *Eriophorum angustifolium*, *Vaccinium uliginosum microphyllum*, *Aulacomnium palustre*, perhaps *Calamagrostis canadensis langsdorfii* (not collected, but noted).

(5) *Menyanthes-Drepanocladus aduncus-Calliergon giganteum* soc.

(6) *Menyanthes* without dominant mosses.

(7) *Hippuris* soc. in the lake.

B (farther west on the northern bank; the mosses not examined).

(1) *Empetrum-Vaccinium vitis-idaea minus-Aulacomnium turgidum* soc. with *Ledum palustre decumbens* and *Ranunculus lapponicus*.

(2) Mossy *Calamagrostis lapponica groenlandica* soc.

(3) Mossy *Carex rariflora* soc. with *Galium brandegei*, *Salix arctophila*, a single tussock of *Carex amblyorhyncha*.

(4) Mossy *Carex saxatilis-Eriophorum angustifolium* soc.

(5) *Menyanthes* soc.

(6) *Hippuris* soc.

(7) *Potamogeton* soc. with *Myriophyllum spic. exalb.*: see p. 294.

The west end of the lake is surrounded by a large boggy area. There the zones are broad and the ground does not rise until the sur-

rounding morainic and rocky ground begins rising. The zonation there was as follows:

C (the west end of the lake, direction towards the northeast).

(1) *Betula nana-Aulacomnium turgidum* soc. with *Ledum palustre decumbens* and *Poa pratensis iantha.*

(2) *Betula nana-Vaccinium uliginosum microphyllum-Ledum decumbens-Aulacomnium palustre* soc. with *Empetrum*, *Calamagrostis lapp. groenl.*, occasional *Sphagnum* and *Aulacomnium turgidum.*

(3) *Carex rariflora-Sphagnum fimbriatum* soc. with *Sphagnum acutifolium*, *Aulacomnium palustre*, *Polytrichum swartzii*, and *Calliergon stramineum.*

(4) *Calamagrostis neglecta* or *Carex saxatilis-Calliergon giganteum* soc. with *Sphagnum squarrosum.* Patches of *Comarum-Sphagnum squarrosum* soc. with *Polytrichum swartzii.*

(5) *Eriophorum scheuchzeri-Calliergon giganteum* soc. with *Drepanocladus aduncus*, *Calamagrostis neglecta*, *Ranunculus hyperboreus*, and *Montia.*

(6) *Menyanthes-Drepanocladus aduncus* soc., a little *Hippuris* and *Myriophyllum spicatum exalbescens.*

(7) *Hippuris* soc. with a little *Myriophyllum* and *Potamogeton alp. tenuifol.*

Water squeezed from mosses from the middle of the bog (3) had a pH of about 4.5, while the water of the lake had pH between 5 and 6. This is in good agreement with the vegetation which has a more oligotrophic character closest to the heaths and a mesotrophic character beside the open water. It was characteristic that *Comarum* occurred in the bog and not beside the open water as in the case of the more oligotrophic lakes. It seems to be a clear indicator of relative poverty in nutrients and therefore a better Hb-species than *Menyanthes* (cf. also B. 1949b, pp. 44—49).

In the above-mentioned belt-transects the communities A(4)—(5), B(3)—(5), and C(3)—(6) may be placed in the present type, although it must be emphasized that several of them are extremely poor in species as far as phanerogams are concerned and do not contain EG- or Cl-species. I suppose, however, that a closer examination of greater expanses will show that such species occur; perhaps they may be found among the mosses (e. g. the rare *Polytrichum swartzii*) or the microalgae, on which a few remarks will be found below.

Of special importance are the communities rich in mosses (in part *Sphagnum*) with *Carex rariflora*, *C. saxatilis*, and *Eriophorum* as the most important phanerogams. They also occur in the Egedesminde district farther north, where they often contain *Ledum palustre decumbens* and *Ranunculus lapponicus* (KRUUSE 1898, p. 386).

It should be pointed out that both *Carex saxatilis* and *Calamagrostis neglecta* occur there under rather oligotrophic conditions. Both are more closely associated with the preceding complex, but may occur

together with species with oligotrophic tendencies, even together with oceanic species, as appears from investigations at Angmagssalik, from where KRUUSE (1912) mentioned *Carex saxatilis* from Amakâ (Âmagâ) in a mossy quaking-bog together with *C. rariflora*, *Comarum*, and *Juncus subtilis*. Near the interesting *Subularia* pond he found it in a sedge fen together with *Carex bigelowii*, *C. rariflora*, *C. macloviana*, *Phleum commutatum*, *Deschampsia alpina*, *Viola palustris*, *Galium brandegei*, and *Cardamine pratensis*, a very strange mixture of species. *Calamagrostis neglecta*, too, meets with oceanic species, especially *Deschampsia alpina*, in the Angmagssalik region (B. 1933 b, Table 32 and pp. 103—104).

Some collections of algae were also made in the Menyanthes lake and on its banks. These have been treated in works by GRÖNBLAD (1952) and FOGED (1953). The algae of Kløftsøerne and a few other oligotrophic lakes are also mentioned there. The Menyanthes lake is very rich in desmids (see Samples 10—11 in GRÖNBLAD, *loc. cit.*). The change of the algal flora in relation to the contents of nutrients in the water is of special interest. In three oligotrophic lakes a sample of *Sphagnum* was taken from the bank, and water from the moss was squeezed into a glass with a preservative fluid. The result indicates that the desmid flora decreases in number of species with decreasing contents of nutrients and that astonishingly few species may be constant in such *Sphagnum* samples (see Table 38). There is also a considerable difference between the three samples in respect of the diatom flora.

Table 38. The algal flora in three *Sphagnum* samples from three lakes with acid water rich in humus (see B. 1949 b, Table 12). The material determined by R. GRÖNBLAD and N. FOGED. The figures indicate percentage occurrence.

	The Menyanthes lake	Kløftsøerne	Small lake with Sphagnum margin
Millival./l	1.43	0.84	0.59
Nostoc sp. (large quantities)	+	..	..
Bulbochaete rectangularis	..	..	+
Oedogonium sociale	..	..	+
Spirogyra sp.	..	..	+
Tribonema sp.	..	..	+
Zygnema sp.	..	..	+
Mesotaenium macrococcum[1]	+	..	..
Penium sp.	+	..	..
Closterium angustatum	..	+	..
— dianae	..	..	+

[1] Species found only in the sample in question (in all 32 samples examined for desmids and 36 for diatoms).

(To be continued)

Table 38 (continued).

	The Menyanthes lake	Kløftsøerne	Small lake with Sphagnum margin
Closterium moniliferum	..	..	+
— parvulum	..	+	..
— striolatum	..	+	..
Euastrum ansatum concavum	..	+	..
Micrasterias angulosa[1]	..	+	..
Cosmarium arctoum[1]	..	+	..
— conspersum latum	+	..	..
— crenatum	+	..	..
— cyclicum arcticum[1]	+	..	..
— latifrons	+	..	..
— microsphinctum[1]	+	..	..
— orthodes	+	+	..
— quadratum willei	+	..	..
— saxicolum	+	..	..
— simplicius[1]	..	+	..
— subcrenatum	+	..	..
Staurastrum brebissonii laticeps	..	+	..
— groenbladii[1]	+	..	..
— lunatum	..	+	..
— pseudosebaldi simplicius	..	+	..
Desmidium swartzii	+	..	..
Amphora veneta	..	3.0	..
Cymbella spuria	5.4	4.0	..
— ventricosa groenlandica	..	3.4	..
Eunotia alpina	2.0	3.2	0.4
— exigua	3.8	2.2	2.0
— lunaris	+	5.8	1.8
— rhomboidea	..	..	2.6
— tenella	0.2	20.8	..
Fragilaria capucina desmazieres	3.2	0.4	..
Gomphonema lagerheimii	..	4.8	..
Hantzschia amphioxys maior	4.0	0.6	..
Melosira distans lirata[1]	..	..	3.4
Neidium affine capitata	7.2	..	..
Nitzschia perminuta	26.0	..	1.6
Pinnularia sp. 1	12.4	..	1.6
— sp. 2	..	18.6	..
— microstauron brebissonii f. diminuata	7.6	..	..
— stomatophora	5.8	..	1.0
Stauroneis phoenicenteron	2.2	10.4	+
Tabellaria fenestrata intermedia	1.2	+	23.6
— floccolosa	2.2	0.2	47.2
Number of other diatom species	28	40	39
Total number of species	57	65	47

[1] See note p. 289.

VII. Extraregional Types Occurring in the Arctic-Subarctic Continental Vegetational Region.

Several lake-shore or bog vegetations belonging to the two last-mentioned complexes were poor in EG-species and therefore not easy to refer to a regional type. The dry-medium humid soil harbours most species clearly dependent on the climate. The other extreme is reached in the lakes. There, as mentioned on p. 128, widely distributed species reign which form extraregional types. Mainly oligotrophic communities occur in the oceanic vegetational region. It has been proposed to refer these to the *Myriophyllum alterniflorum-Subularia* type. The hydrophyte communities appearing in the continental vegetational region cannot be classed in this type, but are best grouped in two types, a mesotrophic type, the *Potamogeton tenuifolius-Myriophyllum exalbescens* type, and a eutrophic-halobous type, the *Potamogeton filiformis* type. As to life-form the three types differ in the way that the first has isoetids (and elodeids), the second nymphaeids (and elodeids), and the third only elodeids. In Greenland all the three types may be supposed to be represented by a special northern sociation group and to be elements in a large extraregional temperate-subarctic hydrophyte complex.

a. The Potamogeton tenuifolius-Myriophyllum exalbescens Type.

(Subarctic-temperate, mesotrophic vegetation of hydrophytes, some of which have floating leaves; isoetids generally absent).

As to the phanerogamic vegetation there is no doubt that this type is the richest. Especially small, not too deep lakes or ponds with moderately acid-circumneutral water rich in humus in the continental area around the Strømfjords harbour not only many species, but real communities of hydrophytes as well. Similar conditions are found in the interior of South Greenland, where Polunin (1943) has demonstrated the occurrence of *Potamogeton natans*.

Tables 12—13 in B. 1949b show chemical analyses of water from lakes the vegetation of which belongs to the present type. As especially emphasized by Lundh (1951) the content of bicarbonate of the water must be a limiting factor for a great many aquatic plants. It is therefore of interest to remind of the fact that the lakes in question have between 0.6 and 1.1 millival/l HCO_3^- (0.35—0.65 millival/l Ca^{++}), while lakes belonging to the *Potamogeton filiformis* type have more than 5.0 millival/l HCO_3^- (more than 1.25 Ca^{++}); cf. data in B. 1949b.

The great luxuriance of the vegetation of hydrophytes is an interesting fact when compared with Nordhagen's statements (1936, p. 14; 1943, p. 441), from which it appears that higher plant life in the lakes

in the subalpine zone in Norway is extremely limited and the vegetation mostly sporadic and fragmentarily developed. The reason for the frequent occurrence of a real vegetation of hydrophytes around the interior of the Strømfjord is undoubtedly climatic. As previously mentioned (B. 1949b, p. 21) the lowlands are subarctic, and the absence of forests in the big valleys is, if anything, due to the draught. But it is still something of a riddle why e. g. in Loc. 3 we have a richly developed flora of hydrophytes in lakes up to an altitude of 400 metres above sea level, while a corresponding flora in the subalpine regions of Norway is so scarce. The temperature in the months of summer can hardly be very different, but it seems possible that the growing season in continental West Greenland is protracted because the ice on the lakes has only a thin, inconstant snow cover.

Table 39 is a survey of the flora in a number of lakes the pH of which was measured by means of a universal indicator to which was added a small water sample. In eight of these lakes, furthermore, a larger sample was taken for chemical analysis, so it is possible in these cases to state the content of salt expressed in millival per litre (see B. 1949b). While vascular plants are absent in the lakes with the highest content of salts, such are found in the slightly salt alkaline lakes and in the acid or neutral lakes relatively poor in salts. The two types of lakes mentioned last, however, differ greatly from each other as regards the number of species. The flora is thinned more and more as the amount of salts and pH increase. The moderately acid-neutral lakes are characterized by *Potamogeton alpinus tenuifolius*, *gramineus* and *Sparganium hyperboreum*, besides *Menyanthes*. Within this type of lake *Comarum palustre*, however, is found only in the most acid waters (cf. p. 288).

A comparison with IVERSEN's similar table from Denmark (1929, p. 330) shows fairly good agreement as regards the species common to both tables. Furthermore, it is evident that as regards lake types the concept "dauernd sauere Gewässer" is missing in continental West Greenland. The distribution of *Comarum* and *Menyanthes* corresponds to the occurrence of these species in German bog communities (PAUL & LUTZ 1941, Table 1).

EG-species of the vegetational type:

Myriophyllum spicatum ssp. *exalbescens*. Ar-Cl: American-Greenland subspecies with a temperate-subarctic distribution. In America only to southern Labrador; frem there a wide gap to West Greenland, where it is only found north of about 67° lat. N. and only abundantly at the head of Søndre Strømfjord; see map fig. 32 in B. 1952a. The main species is almost completely absent in West Norway (HULTÉN 1950, map 1297) and is rare in Iceland. Perhaps it may be considered a slightly continental species. — Ecology: According to IVERSEN 1929 and 1936 occurring in neutral-alkaline waters, oligohalobous.

Table 39.

Lake no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Locality no.	3	3	5	5	7	3	6	2	2	7	2	2	5	7	3-5	7
Altitude in m	400	300	200	200	50	400	100	80	80	300	80	250	200	100	150	250
pH (approximatively)	5–5.5	ca. 6	5–6	6	7	5–6	5–6	7	7–7.5	7.5	7.5	8.0	8.0	8–9	8-9	8-10
Millival/l. (cp. B. 1949b)	0.5	0.8	—	—	0.9	1.4	—	1.5	—	—	—	—	9.6	11.0	—	49.0
EG_1 Myriophyllum spicat. exalbescens	..	+	+	..	..	+	+	+	+	..	..	..	+	+	..	..
— Potamogeton alpinus tenuifolius	..	+	..	+	..	+	+	+	..	..	..	..	..	..	..	..
— — gramineus	..	..	+	..	..	..	..	..	+	..	..	..	..	..	..	..
— — pusillus groenlandicus	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..
— Ranuncul. confervoid.	..	+	..	+	+	+	+	..	..	+	..	..	..	+	..	..
— Spargan. hyperboreum	..	+	..	+	..	..	+	+	+	..	..	..	..	..	..	..
EG_2 Potamogeton filiformis	..	..	+	..	+	+	+	..	+	+	+	+	+	+	+	..
Heleocharis acicularis	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
Ranunculus reptans	..	..	+	..	+	+	+	..	..	..	..	..	..	..	..	..
— hyperboreus	..	..	+	..	..	..	+	+	..	+	..	..	..	..	..	..
Hippuris vulgaris	+	+	+	+	+	+	..	+	+	+	+	+	+	+	..	..
Menyanthes trifoliata	+	+	+	+	..	+	..	+	+	..	..	..	..	..	..	..
Comarum palustre	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..
EG_1: The *Pot. tenuifol.-Myriophyll. exalb.* type		Moderately acid-neutral waters poor in salts								Alkaline, slightly saline waters					Highly alkaline, saline waters	
EG_2: The *Pot. filiformis* type																
		Pot. tenuifolius-Myriophyll. exalbescens type								Pot. filiformis type						

This statement, which refers to the main species, also seems to agree with ssp. *exalbescens*, which also occurred in some of the slightly salt lakes. Widely distributed in lakes in Wood Buffalo Park together with *Chara* sp.; see Raup 1935.

Potamogeton alpinus ssp. *tenuifolius*. Ar-Cl: The subspecies is American-Greenlandic. The distribution in America mapped by Ogden (1943, p. 91). It appears that the species on the whole avoids the Laurentian shield. It has a very wide distribution in temperate regions and reaches the subarctic area in Alaska and Newfoundland-Labrador; in the latter area, however, only one station is recorded. In Greenland (map fig. 22 in B. 1952a) it occurs in the subarctic interior between about 61° and 67° lat. N. — According to Hultén's map the main species is rare in West and North Scandinavia. — Ecology: The main species is said to be mesotrophic (see Samuelsson 1934, p. 51). This is in complete agreement with my impression of ssp. *tenuifolius*, which is just missing in the greatly alkaline lakes rich in salts.

Potamogeton gramineus. Ar-Cl: Circumpolar, temperate-subarctic. Maps: America (distribution nearly like the preceding species; see OGDEN 1943, p. 147), Greenland (South Greenland, Søndre Strømfjord; see B. 1952 a, fig. 22), Scandinavia (almost completely like the preceding species, fairly rare in the west); see HULTÉN (1950, map 90). — Ecology: Mesotrophic-eutrophic, but not found in slightly salt waters.

Potamogeton pusillus ssp. *groenlandicus.* The subspecies Greenlandic with its main distribution on Disko Bugt (B. 1952 a, fig. 31). The main species rather southerly (decreasing greatly in North Scandinavia, in East America as far as Gaspé Co.). — Ecology: FERNALD (1950) states that it grows in alkaline waters, and IVERSEN (1929) also found it in lakes with changing acidic-alkaline water.

Ranunculus confervoides. Distribution incompletely known; according to HULTÉN's statements (Flora Alaska-Yukon) if anything circumpolar, subarctic-low arctic. SAMUELSSON (1934, p. 62) says that the species in Scandinavia has its main distribution in mountain waters rich in lime and in brackish water along the Gulf of Bothnia and the Gulf of Finland. This is in agreement with the fact that in Greenland it was found in mesotrophic lakes as in the slightly salt lakes. Together with *Sparganium hyperboreum* and *Ranunculus hyperboreus*, which are both absent in the temperate areas, it is suitable as a differential species for the northernmost sociation groups within the vegetational type.

Utricularia intermedia. Wide temperate-subarctic distribution with wide gaps. Like other species of the genus it is concentrated in the interior north of 66° lat. N. in West Greenland (B. 1952 a, fig. 33). HULTÉN's map of the Scandinavian distribution indicates increasing frequency eastwards. It is also absent in Iceland. Data in IVERSEN (1929) and LUTHER (1951, p. 272) indicate that the species is meso-oligotrophic; my observations point somewhat in a meso-eutrophic direction; see p. 297.

Besides these there are without doubt many algae which may be apprehended as Hb-species; cf. below.

For practical reasons the vegetation is divided into vegetation of cormophytes, algal vegetation which is sessile or found on the bottom, and plankton vegetation.

a_1. Sociations of Cormophytes.

1. Potamogeton alpinus tenuifolius Sociations.

Frequent and important in many moderately acid lakes rich in humus; cf. profile on p. 287. In the Menyanthes lake (400 m above sea level; Plate IV, fig. 2) especially along the northern bank in water of a depth of more than 50 cm. In the continuation of Ringsødal towards Strømfjordshavn containing amongst others *Potamogeton pusillus groenlandicus*, *Ranunculus confervoides*, some green algae, and, loose on the bottom, *Nostoc pruniforme*; see below.

2. Potamogeton gramineus Sociations.

Observed in a moderately acid humus lake near Strømfjordshavn with *P. filiformis*, *Myriophyllum spicatum exalbescens*, and *Ranunculus confervoides* as subordinate species. In a lake beside Keglen the same species and *Sparganium hyperboreum*. In Ringsødal and at Itivdlínguaq a *P. gramineus-Hippuris* soc., in the latter place with abundance of *Utricularia intermedia* in a small pond with water rich in humus (see p. 297).

3. Ranunculus confervoides-Myriophyllum spicatum exalbescens Sociations.

In the Menyanthes lake along the southern bank in water about half a metre deep, containing *Potamogeton filiformis*. The *Ranunculus* was flowering below the surface of the water, if anything cleistogamically, as the flowers did not open. The same was seen in another small lake.

4. Sparganium hyperboreum Sociations.

Seen in a sheltered creek in one of the lakes northwest of Strømfjordshavn, in Kløftsøerne (see p. 284), and in small pools beside the road between the air base and the harbour, in the last-mentioned places together with *Ranunculus hyperboreus*, which was dominant in one of the pools.

5. Myriophyllum spicatum exalbescens and Hippuris Sociations.

These sociations were not infrequently seen to alternate with one another in some of the small lakes in Sandflugtdalen around Keglen. Accompanying plants were especially *Sparganium hyperboreum*, *Potamogeton alpinus tenuifolius*, and *Ranunculus hyperboreus*. Pure *Hippuris* sociations were not rare in any of the more alpine lakes and in some of the small lakes in the sand-drift terrain near Keglen. It is uncertain where these *Hippuris* sociations belong.

6. Drepanocladus fluitans Sociation.

Observed on narrow stripe with shallow water in a neutral mesotrophic lake in the vicinity of Keglen. On August the 5th this narrow stripe had become an isthmus, perhaps as a consequence of drainage in connexion with a road built near by. The moss plants covered the whole area.

a_2. Algal Vegetation on the Bottom or Epiphytic.

1. Nostoc pruniforme Sociation.

This vegetation plays a great part in certain lakes in the Itivneq valley in the inland behind Holsteinsborg, from where already J. VAHL mentions it in his travelling diary from 1832.[1] On August the 26th it says about the Itivneq valley south of the river, where several larger and smaller lakes are found: "In one of the lakes there was a round species of *Nostoc*, which resembled *N. pruniformis*, and with which the whole bottom near the bank of the lake was filled; among these there were others which were of different formation and among them some hollow ones and big like an egg, but still of the same substance; by the bank, on the other hand, some were swimming which both had a different figure (i. e. shape) and consistency and had a kind of membrane with something foam-like in it. Otherwise the valley like the other part was well overgrown and among other plants found there was also *Carex incurva*, which I had not found since I left the Julianæhaab district; likewise *Menyanthes trifoliata* was found there."[2]

Later the vegetation in the same place has been mentioned by WARMING (1886, p. 185). According to NAUMANN (1925, pp. 19—20) this algal sociation only occurs on a muddy bottom and seems to have its main distribution in eutrophic-mesotrophic lakes. In a lake in Uppland it was found on gyttja at a depth of about one metre.

My observations originate from a rather large lake northeast of Strømfjordshavn. The vascular plants of the lake have been mentioned on p. 294 and in Table 39, no. 4. On the mostly mossy bank there was a *Carex rariflora* sociation, sometimes scattered *C. capitata arctogena* and *Epilobium palustre*. On the bottom, which was soft and consisted of mud, there was at a depth of about 80—150 cm abundance of *Nostoc pruniforme*, the size of small apples. Some specimens had also been washed ashore and lay there drying up into parchment-like membranes which the wind could take hold of. Some of the membranes had still living cells in certain parts and carried by the wind to other lakes might perhaps disperse the species.

[1] J. VAHL, Notes from his Travels in Greenland 1832, Ms. in Bot. Centralbibliotek, Copenhagen.

[2] "i een af Søerne fandtes en rund Art af *Nostoc*, hvilken lignede *N. pruniformis*, og hvormed heele bunden i Nærheden af Søens Bredde var opfyldt; imellem disse laae andre som vare af forskiellige Dannelse og deriblant nogle huule og store ligesom en Æg, men dog af samme Substancia, ved bredden derimod svømmede nogle, der baade havde forskiellige Figur og Consistencia og lignede med en Hinde en liden smul skumagtig i sig. Dahlen var iøvrigt ligesom den anden deel ret godt bevoxen og iblandt andre Planter, som der fandtes, vare ogsaa *Carex incurva*, som jeg siden jeg havde forladt Julianæhaabs District ikke havde fundet, illigemaade fandtes her *Menyanthes trifoliata*."

The algae of the lake have been studied by FOGED (1953) and GRÖNBLAD (1952, samples 20—21). In two samples there were respectively 17 and 42 species of desmids and 95 and 87 species of diatoms. *Stigeoclonium fasciculare*, *Chaetophora* cf. *tuberculosa*, and a *Rivularia* species appeared as important epiphytes on moss and *Potamogeton* stems. According to FOGED the flora of diatoms indicates that the lake is slightly oligotrophic, which is in agreement with a pH value of about 6 and with the occurrence of *Menyanthes*.

The sociations mentioned under a and b contain large amounts of desmids and diatoms. The number of species of desmids ranges between 17 and 94 per sample (on an average 42); see samples 8, 10, 11, 14, 20, 21, 24, 25 in GRÖNBLAD 1952. The number of species of diatoms in the same samples ranges between 53 and 101 with an average of 78. According to FOGED the dominants are especially *Achnanthes linearis*, *Tabellaria floccolosa* and *fenestrata intermedia*. Among larger green algae many species have been found of the genera *Bulbochaete*, *Oedogonium*, *Scenedesmus*, *Pediatrum*, *Coelastrum*, and *Coleochaete* (only the species *scutata*).

A community found in a small pond at Itivdlínguaq should no doubt be classed in the mesotrophic lake vegetation. The pond was full of *Utricularia intermedia*, and this species and *Potamogeton gramineus* indicated that the pond was mesotrophic. The flora of diatoms, with 35 per cent. *Diatoma elongatum* and abundant *Achnanthes petersenii*, is not suggestive of water poor in nutrients (FOGED 1953). The same applies to *Equisetum variegatum*, which grew on the bank and in the water, and *Pinguicula*, which also grew on the bank. Furthermore, the flora of desmids is poor, while the flora of blue-green algae is rich, with such species as *Dichothrix gypsophila*, *Stigonema clavigerum*, *Nostoc* cf. *commune*, and *N. paludosum*.

a_3. Phytoplankton.

Three analyses of the phytoplankton were kindly made by Dr. G. NYGAARD.

The two small lakes rich in humus, Kløftsøerne and the *Menyanthes* lake, the hydrochemistry of which is described in B. 1949b, Table 12, have a very scarce phytoplankton, a fact which is remarkable as the non-planktonic flora is very rich (see above Table 39, nos. 2 and 6, and see GRÖNBLAD nos. 8—14, FOGED nos. 2, 22, 3, 18, 20). In Kløftsøerne it is dominated by *Tabellaria flocculosa*, which is also abundant in FOGED's sample 2, while the Menyanthes lake, which is somewhat richer in nutrients, is particularly characterized by *Botryococcus braunii*.

The large Lake Taserssuatsiaq (between 7 and 8 in fig. 2), which has clear water and the chemical properties of which appear from Table 13 in B. 1949b, has a very scarce vegetation of phanerogams (cf. Table 39, no. 5, and the remarks on p. 235); but its phytoplankton is rich. According to NYGAARD the dominant forms are *Dinobryon bavaricum*, *Botryococcus braunii*, and *Gloeococcus schroeteri*. Among the 32

organisms found may be mentioned such interesting forms as *Pediastrum pearsonii* var. *orientale*, a special form of *Cyclotella bodanica*, and a form of *Cyclotella stelligera* var. *tenuis*, only 3—5 μ in size, which has hitherto been reported only from Indonesia. Among the 10 desmids found is to be mentioned *Staurastrum petsamoense* var. *biverticillatum* nov. var.[1] The diatoms in the plankton sample are also represented by bottom forms, the most remarkable of which are *Synedra subrhombica* n. sp.,[1] *Amphora delicatissima* var. *protracta* nov. var.,[1] and *Eunotia elegans*.

b. The Potamogeton filiformis Type.

(Subarctic-temperate, eutrophic, oligohalobous vegetation of hydrophytes; nymphaeids and isoetids absent).

As regards phanerogams this type is poor in species. In return the vegetation, particularly when *Potamogeton filiformis* is dominant, may be extremely dense. Besides this species there are in my analyses only a modification of *Myriophyllum spicatum exalbescens*, *Ranunculus confervoides* and *hyperboreus*, and the ubiquitous *Hippuris vulgaris*; cf. Table 39, nos. 10—16. M. P. PORSILD (1935, p. 78) from Sydostbugten north of the Strømfjords mentions a lake vegetation which undoubtedly must be considered as belonging to this type. The lake is situated a couple of miles from the shore and had extensive floating masses of *Potamogeton filiformis*, *P. pusillus groenlandicus*, and *Hippuris*. The lake shore was full of halophilous species: *Puccinellia phryganodes*, *Stellaria humifusa*, *Cochlearia groenlandica*, *Carex ursina*, *C. glareosa*, and *Plantago maritima juncoides*; other species were *Triglochin palustre*, *Juncus arcticus*, *J. subtilis*, and, presumably on drier soil, *Potentilla pulchella* and *nivea*.

Hydrochemically the *Potamogeton filiformis* type is characterized by a high pH value, which in certain cases approaches to 10. As stated above, the amount of HCO_3^- is 5.2—13.6 millival/l. In such waters presumably only plants capable of utilizing bicarbonate as the source of carbon will be able to live, since free carbon dioxide is practically absent (cf. LUNDH 1951, p. 96). Otherwise reference is made to Tables 14 and 16 in B. 1949b.

Whereas the *Potamogeton tenuifolius-Myriophyllum exalbescens* type occurs in lakes surrounded by vegetation belonging to the *Ledum-Calamagrostis-Galium* complex, the *Potamogeton filiformis* type will occur in places where the shores are dominated by the *Carex norvegica inserrulata-Juncus arcticus* complex. This appears from the belt transects mentioned on pp. 256 and 260.

[1] As to these new varieties and species reference is made to the Appendix on p. 311 ff. by G. NYGAARD.

EG-species of the vegetational type:

Potamogeton filiformis. Circumpolar, very widely distributed species, which is alkaliphilous-oligohalobous (IVERSEN 1936). It is extremely common along the northern part of the Baltic (map fig. 11 in SAMUELSSON 1934), and in the Ekenäs region in Finland reaches a limit where the brackish water becomes fresh by admixture of water poor in nutrients from a terrain of Archean rock (LUTHER 1951, pp. 96—98 and map 37). In Greenland it grows with reduced frequency and density in mesotrophic lakes and is absent in oligotrophic lakes.

Chara fragilis. Found by A. E. Porsild ($^{9-12}/_{7}$ 1942) in a lake at the head of Søndre Strømfjord, probably near Strømfjordshavn. The material has been determined by SIGURD OLSEN, according to whom (1944, pp. 152—56) the species is widely distributed, ecologically, in spite of occurrence in a single oligotrophic lake, clearly most frequent in meso-eutrophic, neutral-alkaline waters; it may also occur in brackish water. It is hardly a good Hb-species. The mesohalobous *Chara baltica* seems a better Hb-species. According to information from SIGURD OLSEN it has been collected in Greenland by Raben (BRAUN & NORDSTEDT, Fragmente einer Monographie der Characeen 1882), but it may have been collected in a fjord. Besides the species mentioned the Greenland flora of Characeae only includes two *Nitella* species (*N. opaca* found by Berlin at Sofias Havn in the interior of Nordre Strømfjord, and *N. translucens* found by Hartz near Christianshaab; see M. P. PORSILD 1935, p. 81). Both are associated with neutral-alkaline waters, but will not stand brackish water and are hardly any good as Hb-species.

It is most probable that other algae will be fit for being used as Hb-species; among the diatoms there are evidently *Synedra pulchella*, *Navicula halophila*, *Diatoma elongatum*, and others more or less halophilous species; cf. FOGED 1943.

The vegetational type is best illustrated by a summary survey of plant life in some selected lakes.

(a) Small alkaline, fairly saline lake northwest of Strømfjordshavn.

Situation and hydrochemistry see B. 1949b, pp. 49—50. pH 8.5.2 millival/l HCO_3^-, 4.3 Cl^-.

Shore vegetation mentioned in Table 33 no. 8; see also Plate III, fig. 1 and photo in B. 1949b fig. 17.

Sociations close to the shore: *Hippuris-Calliergon turgescens* soc. off the *Eriophorum scheuchzeri* soc. mentioned on p. 258. Off clayey shores with *Scirpus pauciflorus*, *Juncus alpinus subnodulosus*, *Carex maritima*, *C. bicolor*, *Leptobryum pyriforme*, and others, there is hardly any vegetation, but drifting in the water and scattered on the bottom there is a *Nostoc* which must be considered a variety of *N. zetterstedtii*, a species which, however, according to NAUMANN (1925, p. 17) in its typical form occurs in oligotrophic lakes.

Bottom vegetation at a depth of $\frac{1}{2}$—1 metre: Scattered *Potamogeton filiformis* and *Myriophyllum spicatum exalbescens*; near the *Hippuris* sociation also scattered vegetation of *Scorpidium scorpioides.*

Flora of green algae: Only one species of desmids: *Cosmarium regnellii* var. *minimum*. Much *Zygnema* sp. and *Oedogonium* sp.

Flora of diatoms: 58 species, especially indifferent, but with a distinct element of haline forms, FOGED 1953.

(b) Lille Saltsø (Loc. 7).

Situation, hydrochemistry: Fig. 2, B. 1949b, pp. 49—52, pH 8—9, 6.5 millival/l HCO_3^-, and 4.8 millival/l Cl^-.

Shore vegetation described in Table 34 and p. 259; see especially fig. 68. Flora of diatoms on the shore, 35 species, particularly *Denticula tenuis* var. *frigida*.

Sociations close to the shore:

Outside the more or less vegetation-covered southern shore at a depth of a few cm: *Triglochin palustre-Drepanocladus aduncus* soc. (or the same almost only consisting of the moss).

Outside the clayey northern shore, where *Ranunculus cymbalaria* occurs: *Potamogeton filiformis*.

Bottom vegetation at a depth of 0.5—1 m: *Hippuris* soc. here and there with a little *Myriophyllum spicatum exalbescens*, and scattered *Potamogeton filiformis* together with *Ranunculus confervoides*.

Phytoplankton: According to G. NYGAARD this is dominated by *Botryococcus braunii* and in a less degree by *Asterococcus superbus*. It is of special interest that this slightly haline lake contains no less than 10 species of desmids, nearly exclusively of the genus *Cosmarium*. The most frequent desmid in Lille Saltsø is the taxonomically somewhat disputed *Cosmarium tetraophthalmum* var. *scrobiculatum* Messikommer.

(c) The Lakes North of the Harbour Road (Loc. 3).

For situation see B. 1949b, pp. 52—53.

1. Alkaline, presumably slightly salt lake with pH about 7.5 (B. 1949b, p. 52 below).
   Shore vegetation: Especially *Calamagrostis neglecta* soc. with *Luzula groenlandica*, *Carex norvegica inserrulata*, *Juncus arcticus*.
   In the shallow lake: *Potamogeton filiformis* soc. with *Triglochin palustre*, *Hippuris*, and green algae.
2. Salt lake, pH nearly 9. B. 1949b, p. 53. Fig. 69.
   Shore vegetation: *Plantago maritima juncoides-Puccinellia* soc. Often salt crusts; on the contents of diatoms of these see FOGED 1953. Close to the water *Puccinellia deschampsioides-Triglochin* soc.
   In the lake only: *Potamogeton filiformis* and green algae; furthermore a flora of diatoms including 21 species with *Synedra pulchella* as dominant (FOGED 1953). No desmids.
3. Small pond beside the salt lake mentioned above, undoubtedly highly alkaline and slightly salt.
   Shore vegetation: *Calamagrostis neglecta-Drepanocladus aduncus* soc. with *Draba hirta* and *Gentiana tenella*.
   In the pond: Densely tangled vegetation of filamentous algae dominated

by *Cladophora* sp.; furthermore, frequent *Spirogyra* sp., *Oedogonium* sp., and a little *Zygnema* sp.

Two samples were examined for microscopical algae; in one there were five species of *Cosmarium*, *Ophiocytium cochleare*, *Pediastrum boryanum*, and 52 species of diatoms, among which *Synedra pulchella* and *Nitzschia denticula* were dominant. The other sample was without desmids and had 36 species of diatoms, especially *Synedra pulchella* accompanied by seven other halophilous-mesohalobous forms (see details in FOGED 1953 and GRÖNBLAD 1952).

(d) Small Pond on the River Terrace (Loc. 2), pH about 7.5.

For situation and mention of shore vegetation see above p. 260.

In the pond: *Potamogeton filiformis*, *Hippuris* in dense *Drepanocladus aduncus*. 4 species of *Cosmarium* (GRÖNBLAD 1952, no. 6) and 38 species of diatoms; 13.8 per cent. haline species (FOGED 1953, no. 30).

(e) Store Saltsø (Loc. 7).

Situation and hydrochemistry: B. 1949b, pp. 53—57. pH 9—10; 13.6 millival/l CO_3^{--}, 14.4 HCO_3^{-}, 0.9 SO_4^{--}, and 20 Cl^{-}. Among the cations especially much Mg and Na.

Shore vegetation: See Table 32, no. 1—2; 33, no. 1, and 24, nos. 7—12, 17—18. Close to the water *Puccinellia deschampsioides* soc., *Gentiana detonsa* soc. (*Pottia heimii*), *Leptobryum pyriforme* soc.

Pool in depression in front of one of the old erosion slopes in the moss-loess terraces beside the lake: Dominants, two species of *Spirogyra*; frequent, two species of *Oedogonium*, scattered *Tribonema* sp. and *Aphanochaete* sp.; 49 species of diatoms, especially indifferent species, FOGED no. 11. The pool surrounded by *Carex saxatilis*; no halophilous species.

Puddle in similar depression closer to the lake. In the depression *Juncus arcticus* soc. with *Lomatogonium*, *Triglochin palustre* soc., *Carex maritima* soc., *Kobresia simpliuscula* soc., and *Calamagrostis neglecta* soc. The puddle dried up; under a layer of dead or dying daphniae the loess soil is dark above and stinks somewhat; there are 40 species of diatoms and a markedly haline spectrum there (FOGED no. 35).

In the lake: No macroscopical vegetation.

1. Epiphytic on long dead stems of *Drepanocladus aduncus*, which from the moss-loess deposit hang as small shreds into the lake: Dominant *Lyngbya pusilla*, often abundance of a species belonging to the *Chamaesiphonales*, scattered *Oedogonium* sp.; 39 species of diatoms with *Diatoma elongatum* as dominant and seven clearly haline species (FOGED 1953, no. 38).
2. Phytoplankton: According to G. NYGAARD the dominant organism is identical with or at any rate closely related to *Binuclearia tatrana*. *Botryococcus braunii* and an *Oocystis* species are poorly represented.

CONCLUDING REMARKS ON THE TWO VEGETATIONAL REGIONS

The main classification used at the grouping of the vegetational types within a continental and an oceanic vegetational region invites seeing matters in a wider plant geographical perspective. Related vegetation has already been pointed out during the treatment of the various types. Thus it all tends towards a bipartition of all arctic vegetation. Let us try to evaluate the importance of such a bipartition.

On the map fig. 74 certain important curves of temperature and precipitation have been drawn in which are suitable to give some idea of the distribution of the arctic-continental and oceanic areas. To be characterized as arctic, the climate must, as established by custom, be so cold that no wood will grow there, i. e. below a mean temperature of 10° C. for the warmest month. The distinction between continental and oceanic must of course in some degree be made on an estimate. I have chosen two climatic curves as the boundary, the 250 mm annual isohyet and the 25° C. annual mean range of temperature. In order to define the situation of the most oceanic areas I have finally had the 15° C. annual mean range of temperature drawn in. An 800 mm annual isohyet would in many places follow this line or be very close to it.

The areas situated north of the timber-line isotherm and of the two determinative curves of continentality have been shaded; areas which are both poor in precipitation and have a wide annual range of temperature are dotted.

The selection of the two curves which demarcate the continental-arctic area from the oceanic-arctic one has been made on the following background. The work at the flora in Southwest Greenland, in particular the floral contrast around an oblique line from the interior of the Godthaabsfjord to the outer parts of the fjords at Holsteinsborg (B. 1952 a), made me follow the climatic lines determinative of the West Greenland floral contrast, outside West Greenland. It then appeared that the lines on the large continents soon diverged, while they approached to one another near the oceans. In Søndre Strømfjord they coincide because

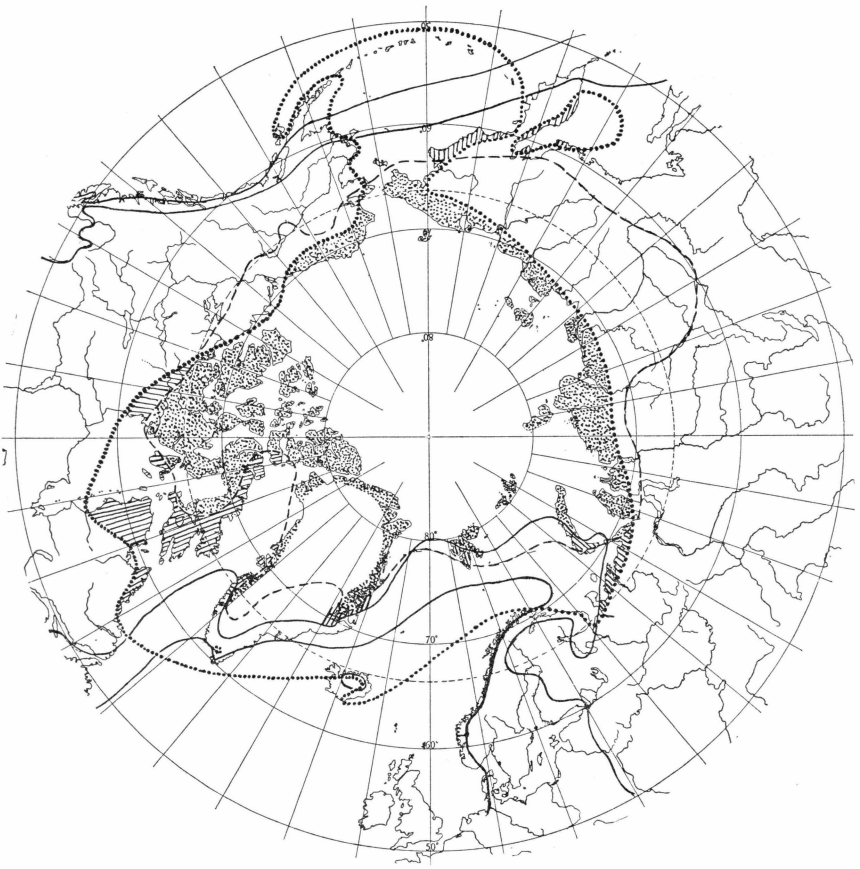


Fig. 74. Circumpolar map on which are drawn in the July isotherm 10° C. (dotted line), the annual isohyet 250 mm (broken line), lines for the mean annual temperature range of 15° C. (southernmost full lines) and 25° C. (northernmost full lines). — Continental arctic areas are indicated by hatching and dotting.

of the comparatively high winter temperature conditioned by foehns (cf. p. 136). A similar coincidence is imaginable in the interior of Scoresby Sund.

Botanically it appears that the mean annual range of or near 25° C. in the great majority of places is accompanied by considerable floristic declines in both directions across this line. This applies to South Alaska and Kamchatka (see HULTÉN's map of plant distributions in the two areas), it applies to the area at the Gulf of St. Lawrence-West Newfoundland, and it applies to Northern Europe, where HULTÉN's groups 23—24 (1950, p. 65) are contrasted with groups 19—20 and 11. Taking North America as a whole, a group like RAUP's arctic alpine group, which avoids coastal mountains (1947b, p. 67), and his forest species,

which avoid the wet slope forests of southern Alaska (*loc. cit.* p. 65) form contrasts to a number of amphi-Atlantic species in the east (HULTÉN 1950, groups 10—11) and oceanic north Pacific species in the west (HULTÉN 1937, Pl. 9 and 16).

There are some, but not many species which have a distribution associated with the shaded area in fig. 74. Reference may especially be made to the material of maps in TOLMATCHEV 1932 and a great number of the species which HULTÉN (1937, Pl. 13) terms bilateral radiants of Northern Beringia. Thus few species only stick to the areas north of the timber line, which may be due to historical conditions, as TOLMATCHEV, like other authors later, assumes that there were Ice-Age refugia in arctic East Asia, Alaska, and the Arctic American Archipelago. He seems also, however, to count on a climatic demarcation of the plant areas in question, at any rate in the regions near the oceans, where he shows that the area of *Cornus suecica* fills the gap in the distribution of the other species. The reason why the majority of arctic species are not associated with the areas situated north of the timber line, is of course that mountains farther south give them good chances above the local timber line there. Add to this that also lake-shores, river-banks, rocks and similar forest-free areas in the lowlands may give some of them good chances some distance south of the timber line until the competition from more thermophilous species gets too great.

If we keep to the classical definition of the Arctics as the regions north of the timber line or the 10° C. July isotherm, few species will be purely arctic, and perhaps these will all be relics, occurring in areas which are mainly determined by the situation of their previous refugia. The timber line may be an important physiognomic boundary, but its plant geographical importance seems to be small. In Greenland there are practically no specific birch-wood species, as the ground flora of these woods may as well occur in willow scrubs and on mossy heath on shady hill-sides or even grows in sunny herb fields if only the air humidity is high enough. The great boundary in the vegetation of Greenland is found where the moist willow scrubs, the moist meadows (herb fields and snow-patches) and heaths with *Phyllodoce* or *Cassiope hypnoides* cease. And it seems as if similar ecological boundaries accompany the floristic ones, e. g. in Alaska, Kamchatka, and Northern Russia as well. The vegetational contrast which may be observed in West Greenland in the Holsteinsborg area and in East Greenland near Scoresby Sund and South of this fjord system (cf. B. 1933a), gives us the clue to an ecological plant geographical bipartition of the whole of the arctic-boreal area, a division which makes the established one with the timber line as main boundary recede into the background. Besides

an indifferent type we get two main types of biological (ecological) distributions, a macro- and microclimatic, oceanic, boreal-arctic, montane-alpine type and a corresponding macro- and microclimatic continental type. In the former, species are associated which grow in the oceanic areas somewhat south and north of the timber line with species which, besides growing there, are also capable of forcing their way to snow-patches, damp woods, moist ravines, and beds of brooks in the inland. The other includes continental species both north and south of the timber line and species with their main distribution in the continental regions, which force their way to the oceanic regions on spots where it is particularly dry or where the relief conditions wide local temperature ranges. Within both types there are edaphic specialists, generally acidophilous plants in the former and neutro-basiphilous species in the latter. These species, besides microclimatically favourable conditions, will also, if occurring outside the area in which the macroclimate is optimal for them, require very special conditions of the soil. Often they appear most fastidious about the soil in the areas which are least suitable for them in a climatic respect. In West Eire there are large karst areas in which ecological conditions in many respects remind of the "alvar" in Baltic areas. Several Eurasian continental species, among them some which are also found on the alvar, are there growing together with West European species and differentiate the vegetation in question from the purely Atlantic communities. A mixed type arises in which edaphic and microclimatic factors carry widely different floral elements into the same communities.

In the arctic-boreal, circumpolar area mixed types of a similar type will especially occur in Scandinavia, Northern Russia, Northeast Iceland, Southern Labrador, South Alaska, Kamchatka, and many mountainous regions. It cannot be too strongly emphasized that mixed types are of very great importance ecologically, as they contain some species under conditions under which they are forced by the macroclimate to seek out a definite, narrowly limited combination of environmental conditions. In this way these species become good local character species, but not suitable for a classification which concerns larger areas.

An important problem at a possible future classification of the circumpolar vegetation on the lines suggested in the present work will be the distinction between several ecological-physiognomically related vegetational types within the same complex. There the Ar-species will become of great importance. At the mention of the *Carex nardina-Lesquerella-Saxifraga tricuspidata* complex it was proposed to set up an *Oxytropis arctobia* type, which were to cover North American communities belonging to this complex. By means of a large number of

Ar-species it will be possible to separate this type from the ecologically related West Greenland *Carex nardina-Hierochloë* type. The work at dividing the circumpolar area into natural floristic provinces will be of great importance for the pointing out of the Ar-species. Such species the area-limits of which may be used as the basis of a fixing of the boundaries of the provinces will also be Ar-species provided that the boundaries of their areas are conditioned by historical conditions (centre of development or refugium in a certain region and a limited power of migration).

SYNOPSIS OF PLANT COMMUNITIES

The list of contents at the beginning of this paper makes a survey of the plant communities grouped according to the plant geographical system used. Immediately below, a survey will be made which considers the physiognomy and life-forms of the vegetation. It will include all communities mentioned in detail, while the final survey on p. 309, which is based on the occurrence or ecology of the communities, will be incomplete and refer to the survey based on physiognomy.

A. Low wood or copse of deciduous trees and shrubs
   1. Betula pubescens 64, 71
   2. Sorbus decora groenlandica 72
   3. Alnus crispa 75
   4. Salix glauca callicarpaea 64, 72, 84, 89, 103, 223, 265, 282

B. Dwarf-shrub vegetation (heath, low scrub)
   a. Deciduous dwarf-shrubs
      1. Betula glandulosa rotundifolia 44, 101
      2. — nana 223, 231, 274
      3. Salix arctophila 89, 233
      4. — herbacea 119, 124
      5. — uva-ursi 43
      6. Vaccinium uliginosum microphyllum 102, 150, 221, 229, 275
   b. Evergreen dwarf-shrubs belonging to Bicornes
      1. Empetrum nigrum hermaphroditum 42, 99, 100, 276
      2. Diapensia lapponica 42, 150
      3. Arctostaphylos uva-ursi 218
      4. Cassiope hypnoides 123
      5. — tetragona 167
      6. Loiseleuria procumbens 38
      7. Phyllodoce coerulea 99
      8. Rhododendron lapponicum 151, 223, 229, 230
      9. Ledum groenlandicum 101, 275
      10. — palustre decumbens 269
      11. Vaccinium vitis-idaea min. 160
   c. Dwarf-shrubs or half-shrubs belonging to other orders
      1. Dryas integrifolia 139, 151, 174, 202, 214, 230
      2. Potentilla tridentata 35, 53, 196
      3. Thymus drucei 52
      4. Juniperus communis nana 53
      5. Lycopodium alpinum 99
      6. — annotinum 103, 181

C. Herbaceous vegetation (apart from vegetation of marsh- and aquatic plants)
   a. Vascular cryptogams
      1. Dryopteris filix mas 68
      2. — fragrans 157
      3. Woodsia ilvensis 53, 159
      4. Species of Lastraea 69, 70
      5. Equisetum arvense 93, 265
      6. — scirpoides 242
      7. Selaginella rupestris 53
   b. Tall-growing, not graminoid plants
      1. Streptopus amplexifolius 68
      2. Angelica archangelica 87, 91

3. Chamaenerium angustifol. 70
4. — latifolium 164

c. Medium-sized non-graminoid plants

1. Alchemilla vulgaris 82
2. — alpina 60, 83
3. Sibbaldia procumbens 84, 114, 116
4. Potentilla crantzii 115, 203
5. — chamissonis 195
6. — tridentata (see B c 2)
7. Saxifraga foliolosa 180 f.
8. — tricuspidata 156
9. Species of Epilobium 87, 88
10. Cornus suecica 96
11. Stellaria longipes 278
12. — humifusa 129
13. Silene acaulis 148
14. Cerastium cerastioides 112
15. Oxyria digyna 182
16. Pirola grandiflora 281
17. Primula stricta 252
18. Plantago maritima juncoides 258
19. Arnica alpina 163
20. Artemisia borealis 195
21. Taraxacum croceum 83
22. — lacerum 164

d. Dwarfish succulents

1. Sedum annuum 52
2. — villosum 127, 264

e. Other dwarfish, non-graminoid plants

1. Koenigia islandica 109
2. Minuartia groenlandica 35
3. Gnaphalium supinum 113

f. Grasses

1. Agrostis borealis 62
2. Anthoxanthum odoratum alpinum 59
3. Calamagrostis canadensis langsdorfii 60, 93, 251
4. — lapponica groenland. 277
5. — neglecta 249
6. — purpurascens 191, 214
7. Deschampsia alpina 127
8. — flexuosa 58
9. Elymus mollis 129, 204
10. Festuca rubra 204
11. — vivipara 34
12. Hierochloë alpina 148
13. Nardus stricta 60
14. Phleum commutatum 89
15. Phippsia algida 128
16. Poa glauca 279
17. — pratensis 63, 248
18. Puccinellia deschampsioides 207, 259
19. — phryganodes 129
20. Roegneria violacea 195

g. Cyperaceae or Juncaceae

1. Carex bigelowii 60, 123, 124
2. — capillaris robustior 202
3. — capitata 242
4. — holostoma 264
5. — maritima 243
6. — nardina 139
7. — rupestris 147
8. — scirpoidea 263
9. — supina spaniocarpa 190
10. Kobresia myosuroides 199, 214
11. — simpliciuscula 261
12. Scirpus caespitosus austriacus 104
13. Juncus trifidus 30
14. Luzula spicata 34

D. Telmatophytic vegetation (cf. IVERSEN 1936)

1. Eriophorum angustifolium 91, 253
2. — scheuchzeri 258
3. Carex microglochin 253
4. — rariflora 237, 283 f.
5. — saxatilis 257
6. Scirpus pauciflorus 255
7. Juncus arcticus 256
8. — castaneus 263
9. Comarum palustre 284 f.
10. Menyanthes trifoliata 284 f.
11. Hippuris vulgaris 295 f.

E. Hydrophytic vegetation

a. Elodeids and nymphaeids (cf. DR RIETZ 1931, p. 31)

1. Sparganium species 295
2. Potamogeton alpinus tenuifolius 294
3. — gramineus 295

4. Potamogeton filiformis 299 f.
5. Ranunculus confervoides 295
6. Myriophyllum alterniflorum 130
7. — spicatum exalbescens 295

b. Isoëtids (cf. DU RIETZ, *loc. cit.*)

1. Isoëtes echinospora 130
2. Subularia aquatica 130

c. Sessile algae or algae lying loose on the bottom 296

d. Plankton algae 297, 300, 301

F. Vegetation with predominance of lichens

a. Stone lichens

1. Species of Rhizocarpon 31
2. Species of Umbilicaria 31

b. Earth lichens

1. Species of Alectoria 44, 148
2. Species of Cetraria 44, 148, 190, 200
3. Species of Cladonia 31, 46, 58, 147
4. Ochrolechia frigida 117
5. Species of Stereocaulon 44, 58, 60, 147, 190, 200

G. Vegetation with predominance of musci

1. Aulocomnium palustre 236
2. Aulacomnium turgidum 202, 248, 250, 274
3. Bryum species 182
4. Species of Calliergon 180, 184, 286—288, 299
5. Species of Dicranum 100, 118.
6. Drepanocladus aduncus 249, 250, 300, 301
7. — , other species 106, 295
8. Species of Hylocomium 58, 63, 64, 72, 82, 100, 173, 274, 282
9. Leptobryum 109, 212, 252, 256, 301
10. Mniobryum albicans 87
11. Mnium rugicum 90, 265
12. Species of Polytrichum 118, 124, 170, 173, 180
13. Philonotis fontana 87
14. Species of Rhacomitrium 35, 37, 43, 46, 174
15. Species of Sphagnum 88, 102, 106, 284
16. Timmia austriaca 181 f.
17. Tomenthypnum 236

H. Vegetation with dominance of Hepaticae

1. Gymnomitrium species 120, 125, 180
2. Lophozia species 113
3. Anthelia species 118, 120, 180

Survey of Certain Plant Communities Which are Often Defined Through Occurrence or Substratum.

Fell field (apart from talus slide vegetation); see Ba 5, Bb 1, 2, and 6, Ce 2, Cf 12, Cg 6 and 14.

Talus slide vegetation and rock vegetation Bc 3 and 4, Ca 2—4, and 7, Cc 6 and 8, Cd 1 and 2.

Dune vegetation Cf 9 and 10.

Shore and salt marsh vegetation Cc 12, Cf 19 and p. 129.

Snow-patch vegetation Ba 4, Cc 3, 7, 14, and 15, Ce 3, Cf 15, H.

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The working up of the material collected by myself during the expedition in 1946 is finished in the present work. Therefore I want once more to offer my best thanks to the Carlsberg Foundation, the Royal Danish Navy, and the Greenland Department for making it possible to undertake the expedition and for assistance of different kinds during the work. Besides I am glad to offer my cordial thanks to the persons who have assisted me, partly in the determination of the cryptogams occurring in the vegetational analyses, partly in preparing the maps of the distribution of the plants, viz. Miss Eva Clausen, M.Sc., Mrs. Bodil Lange, M.Sc., Mr. M. Skytte Christiansen, M.Sc., Lektor Niels Foged, Dr. Rolf Grönblad, Mr. K. Holmen, M.Sc., Dr. Morten Lange, Dr. G. Nygaard, Dr. M. Raymond, Montreal, and several others who have assisted me in various ways, particularly Captain Erik Borreby and Major W. E. Zimmermann, who were so kind as to make the climatological measurements and observations mentioned on p. 23.

APPENDIX

A NEW DIATOM SPECIES AND TWO NEW VARIETIES FROM PLANKTON IN LAKE TASERSSUATSIAQ

By GUNNAR NYGAARD.

Synedra subrhombica Nygaard n. sp.
Fig. 1.

Diagnosis: Cellulae solitariae, non colonias formantes, rectae, subrhombicae, apicibus capitellatis et area centrali ovali instructae; longitudo cellularum 67—72 μ, latitudo 1.9—2.1 μ; latitudo capituum 0.8—1 μ, sub apicibus 0.5—0.7 μ; 24—27 striae pro 10 μ.

Hab. Lacus Taserssuatsiaq, Groenlandia occidentalis, libere natans.

The species is closely related to *Synedra nana* Meister, the cells of which measure 50—90 μ in length, while the breadth of the medium portion is 1.5—2 μ, but near the more or less capitate cell-ends only 0.5 μ; the cells are likewise densely striated, 25—30 striae per 10 μ.

The cells of *Synedra nana* are, however, linearly lanceolate, the walls midway between the poles being parallel. The pseudoraphe is very narrow and does not normally expand into a central smooth area.

Synedra subrhombica n. sp. thus differs from the preceding species in having subrhombical cells with a conspicuous smooth central area and a rather broad pseudoraphe, occupying about one third of the cell-breadth. Of the 6 individuals observed only one had central striae continuing as exceedingly delicate lines into the central area (see fig. 1 c_1).

According to HANS BACHMANN (Beiträge zur Algenflora des Süsswassers von Westgrönland, 1921, p. 116 und 160) *Synedra nana* occurs in Greenland.

Amphora delicatissima Krasske var. *protracta* Nygaard nov. var.
Fig. 2.

Diagnosis: A typo apicibus valde prolongatis et subcapitellatis differt. Dimensiones valvarum 17 μ × 2.5 μ, 28—31 striae dorsales pro 10 μ, 35—40 striae ventrales pro 10 μ.

Hab. Lacus Taserssuatsiaq, Groenlandia occidentalis, libere natans.

This variety may be a tychoplanktic form; only the individual pictured was observed. The type is only recorded from brackish water (Bad Salzungen; see HUSTEDT in Die Süsswasserflora Mitteleuropas, Heft 10, 1930, p. 346, fig. 635). Its dimensions are 5—20 μ × 3—7 μ; the type is consequently broader than the variety and according to HUSTEDT, to whom I am indebted for advice and criticism, its apices are rather obtusely rounded or sometimes slightly protracted.

Ecological differences between type and variety need not exist, as the presence of the variety in pure freshwater of an oligotrophic nature may be occasional.

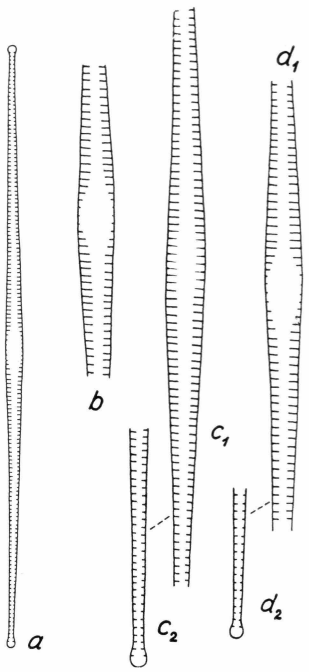


Fig. 1. *Synedra subrhombica* n. sp.; *a* 1200 ×, the other figures 2400 ×.

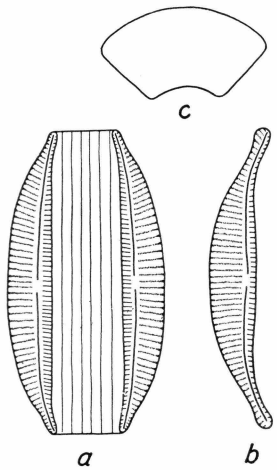


Fig. 2. *Amphora delicatissima* Krasske var. *protracta* nov. var.; *a*, girdle view; *b*, valve view; *c*, top view; all figures 2400 ×.

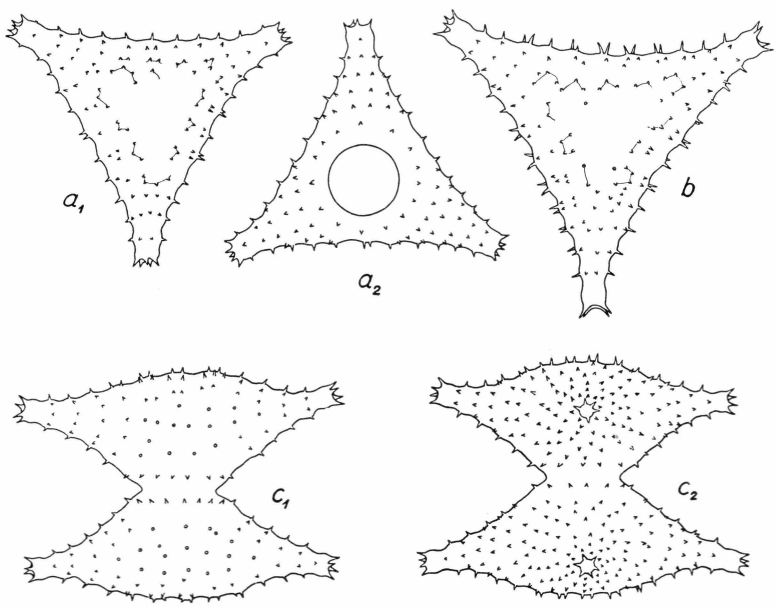


Fig. 3. *Staurastrum petsamoense* Järnefelt var. *biverticillatum* nov. var.; 3 individuals (*a*, *b*, *c*) figured. a_1 and *b* vertical views, a_2 basal view, c_1 and c_2 lateral views. 800 ×.

Staurastrum petsamoense Järnefelt var. *biverticillatum* Nygaard nov. var.
Fig. 3.

Diagnosis: A typo in hoc modo differt: corpus semicellulae verticillo isthmali spinarum instructum; cellulae valde minores quam typus. Longitudo cum spinis 39—41 *μ, latitudo cum spinis 46—57 μ, latitudo isthmi 11.5—12 μ, spinae 0.5—2 μ longae.*

Hab. Lacus Taserssuatsiaq, Groenlandia occidentalis, libere natans.

I am indebted to Dr. ROLF GRÖNBLAD for advice concerning this new variety. Each lateral part has 11—13 spiniferous undulations and the ends of processes are provided with 4—6 spines, just as in the type (see ROLF GRÖNBLAD: Desmids from West Greenland, 1952, p. 22, t. 2, figs. 36—37). GRÖNBLAD gives the dimensions of the type: longitudo 84 *μ*, latitudo 114 *μ*. The variety thus differs from the type on two essential points: it scarcely reaches half size of the type and it possesses an isthmal circle of minute spines.

Dr. GRÖNBLAD remarks in a letter to me that he has not observed the alga in question in Dr. BÖCHER's non-planktic samples from Lake Taserssuatsiaq. The alga thus seems to be either euplanktic or facultatively planktic.

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Xeromphalina cauticinalis 233.

Zygnema sp. 289, 300, 301.

Færdig fra trykkeriet den 4. oktober 1954.

PLATES

Plate I.

Aerial view of the region around Sandflugtdalen, which is seen down through the middle of the picture. In the background on the left the inland ice sends a large glacier down through the valley which continues in Nordre Isortoq; the Isordlerssuaq nunataks and the eastern part of Ørkendalen are seen on the right. Nearly in the centre the mountain Keglen is situated (left of the river). In the foreground on the left, one of Kløftsøerne, in the middle the southern slope in continuation of Hassells Fjeld, which is situated out of the picture. We can see the grey steppe areas broken by dark heath and streaks of scrub. On the right the western end of Ørkendalen. — Phot. 1.505. HØ III. Start. $^{19}/_{8}$ 1948. Geodætisk Institut copyright.

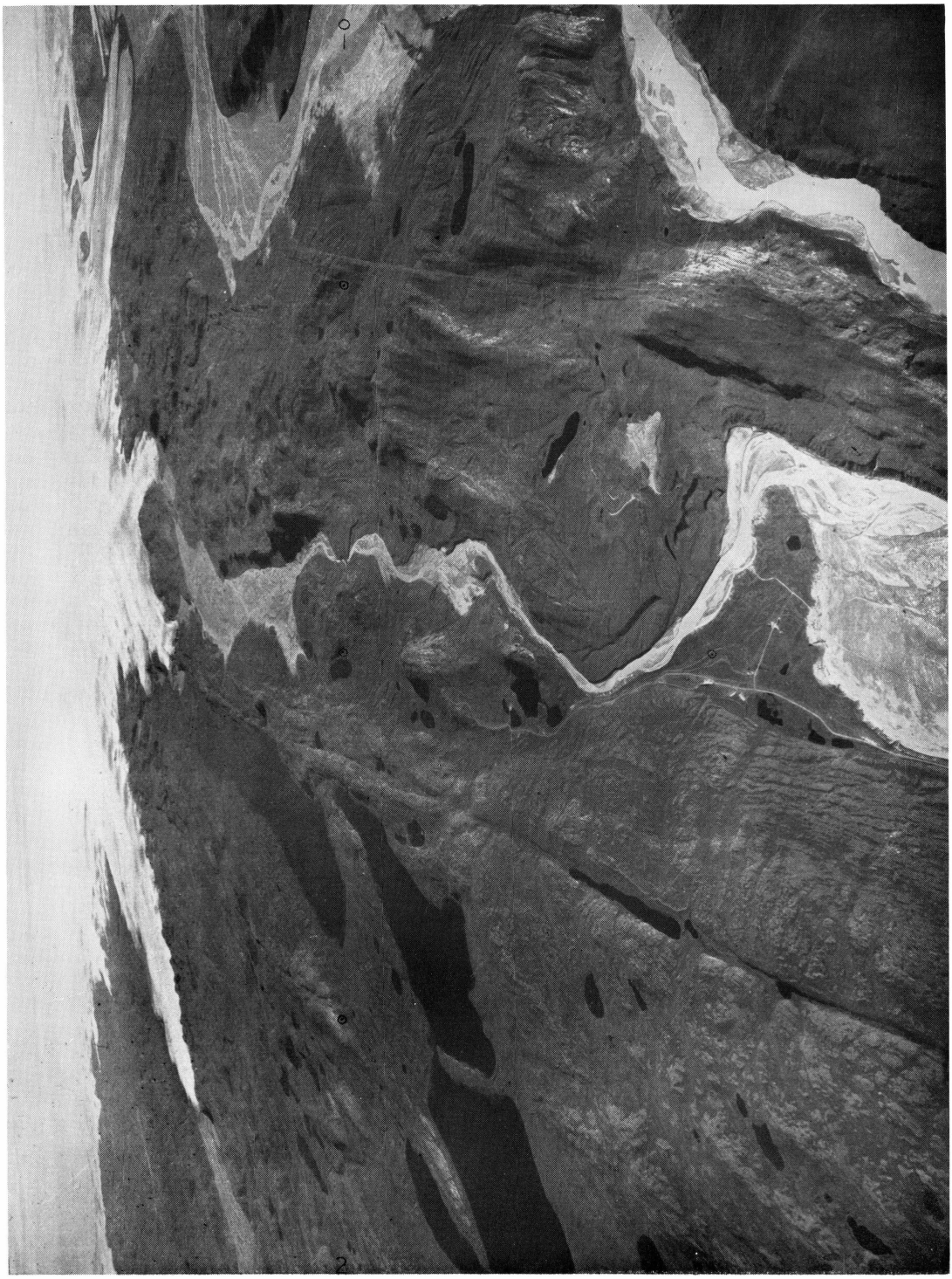


Plate II.

Fig. 1. *Puccinellia deschampsioides-Braya linearis* sociation in crevices in deposit of moss, loess, and daphniae beside Store Saltsø. In the background dry low willow scrubs and "glades" with *Calamagrostis purpurascens*. — TWB. phot. $^{8}/_{8}$ 1946.

Fig. 2. South slope of Hassells Fjeld in a place where the bare rock borders on the loess deposit at the foot of the mountain. Close to the rock a zone of *Arctostaphylos uva-ursi*. Between this and the willow scrub abundant *Calamagrostis purpurascens*. — TWB. phot. $^{9}/_{8}$ 1946.



Fig. 1.



Fig. 2.

Plate III.

Fig. 1. Belt formation beside the slightly salt lake northwest of Strømfjordshavn. On the left *Carex saxatilis* soc., in the centre *Eriophorum scheuchzeri-Calamagrostis neglecta-Drepanocladus exannulatus* soc., and on the right *Hippuris-Calliergon turgescens* soc. In the open water (pH about 8) occasional *Myriophyllum spicatum exalbescens*. — TWB. phot. $^{3}/_{8}$ 1946.

Fig. 2. *Carex capitata* ssp. *capitata* forms large tussocks on moist soil surrounded by *Rhododendron-Betula nana* moor. Sandflugtdalen at the foot of Hassells Fjeld. — TWB. phot. $^{11}/_{8}$ 1946.



Fig. 1.



Fig. 2.

Plate IV.

Fig. 1. The margin of the inland ice af Loc. 1 (the head of Sandflugtdalen). In the foreground mossy *Betula nana-Vaccinium uliginosum microphyllum* on a slightly north-sloping expanse. *Salix glauca callicarpaea* is scattered over the area as very low shrubs. Subordinate elements of the heath: *Rhododendron lapponicum*, *Pirola grandiflora*, *Luzula confusa*, and *Hierochloë alpina*. — TWB. phot. $^{26}/_{8}$ 1946.

Fig. 2. The Menyanthes lake 400 m above sea level near Hassells Fjeld (Loc. 3). View of the inland ice and in the distance the nunataks (cf. Plate I). *Hippuris* is seen farthest out in the lake; then there is a zone of *Menyanthes* slightly off the bank. On the bank, *Rhododendron* or *Salix arctophila* with Cyperaceae, amongst others *Carex amblyorhyncha*; in the background on the left, *Eriophorum angustifolium*, and at the outlet from the lake in the background, a little left of the centre, *Calamagrostis canadensis langsdorfii*. — TWB. phot. $^{29}/_{7}$ 1946.

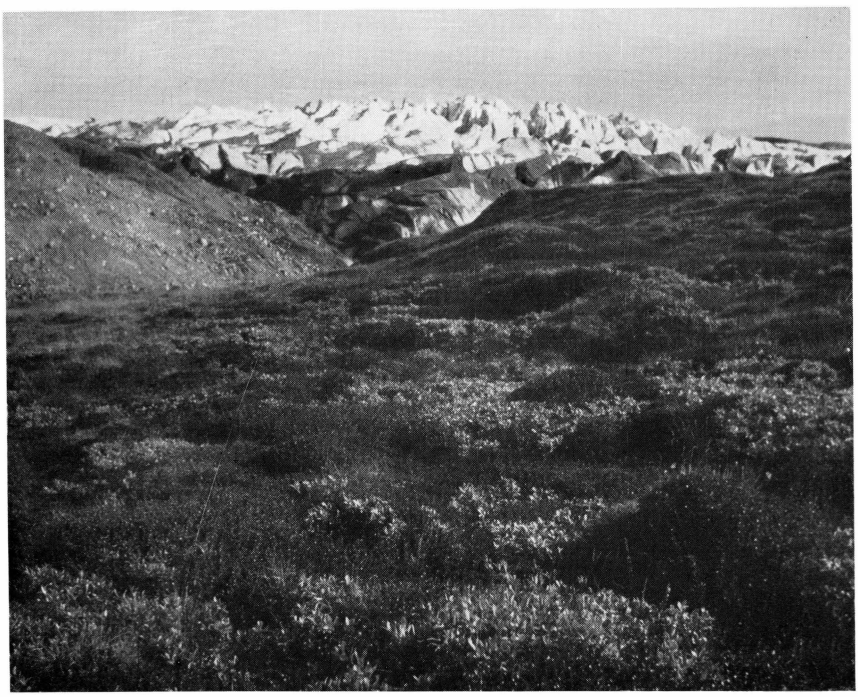


Fig. 1.



Fig. 2.