MEDDELELSER OM GRØNLAND
UDGIVNE AF
KOMMISSIONEN FOR VIDENSKABELIGE UNDERSØGELSER I GRØNLAND
Bd. 144 · Nr. 3

DE DANSKE EXPEDITIONER TIL ØSTGRØNLAND 1926–39
Under Ledelse af Lauge Koch

APPENDIX No. 3

SUMMARY OF THE BOTANICAL INVESTIGATIONS IN N. E. GREENLAND

BY

THORVALD SØRENSEN

WITH 29 FIGURES IN THE TEXT AND 1 PLATE

KØBENHAVN
C. A. REITZELS FORLAG
BIANCO LUNOS BOGTRYKKERI A/S
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The subjoined report comprises the results of the botanical work carried out on the Danish expeditions to East Greenland in the years 1926—39 under the leadership of Dr. LAUGE KOCH.

The expeditions were joined by four botanists, viz. GUNNAR SEIDENFADEN, PAUL GELTING, SØREN LUND, and THORVALD SØRENSEN.

SEIDENFADEN joined the two summer expeditions, in 1929 and 1930, as botanist and in these summers carried out the floristic pioneer work, making collections in a great number of localities during short stays, often lasting some few hours only. In this way a general idea of the occurrence and distribution of the commonest species was obtained (SEIDENFADEN 1930, 1931). On the Three-Year Expedition 1931—34 SEIDENFADEN was mostly engaged in organisation work with no relevance to botany, still in 1933 he was offered an opportunity to collect plant specimens in the northernmost part of the area visited by the expedition, i. a. on Norske Ø (SEIDENFADEN & SØRENSEN 1937). During the expedition SEIDENFADEN photographed a large number of the plants of Northeast Greenland. A number of these photographs was published in the aforementioned paper of 1937. The photographs included in the present report is likewise a result of SEIDENFADEN's photographic activity.

GELTING was a member of the expedition in 1931—32, when he passed the winter at Eskimonæs, Clavering Ø, and in the summer of 1933. He made comprehensive floristic, historic-botanical, and Quarternary-geological as well as biological and sociological investigations on Clavering Ø and the adjoining mainlands, in 1932 and 1933 with Eskimonæs as a base, in the autumn of 1931 from the substation in Nordfjord, a northward-extending branch of Franz Josephs Fjord.

SØRENSEN was a member of the expedition in 1931—32, wintering on Ella Ø, in the summer of 1933, and in 1934—35, when he passed the winter at Eskimonæs, Clavering Ø. In 1931—32 he made floristic and sociological investigations in the area around Franz Josephs Fjord, and in 1933 floristic investigations and collections in different places, i. a. in Skærfjord. In the summer of 1934 he made supplementary sociological investigations along the outer coast on the foreland of

Hold with Hope, and in the summer of 1937 in Scoresby Sund. In 1934—35, on Clavering Ø, he investigated the time for the meiosis and pollen formation of the species and at the same time collected cytological material, and during the wintering made investigations and collections for the purpose of elucidating the polygon soil problem. Regular climatic and microclimatic observations were made on Ella Ø 1931—32 and at Eskimonæs 1934—35.

During a two weeks' stay in the area around Scoresby Sund in 1933 GELTING and SØRENSEN made scattered floristic and sociological investigations.

In the summer of 1933 LUND joined the expedition as algologist. He made algological observations and collections from the expedition ship "Godthaab" in connection with the hydrographic and marine-zoological investigations carried out on the expedition.

Floristics and Systematics.

The principal object of botany in a relatively unexplored country like Northeast Greenland is the floristic investigation of the country. Ever since its discovery the collecting of plants has been going on hand in hand with the mapping of the country, so our knowledge of its flora was not quite negligible at the time the expedition started. The German expedition (Zweite Deutsche Nordpolexpedition 1869—70) brought home the first large collections of plants, mainly from the coastal tracts of Wollaston Forland and the surrounding islands (BUCHENAU & FOCKE 1874), while the Swedish expeditions around the beginning of the century contributed great floristic results from the inner ramifications of the Franz Josephs Fjord archipelago (DUSÉN 1901). About the same time the coastal areas south of these regions were investigated by Danish botanists (KRUUSE 1905, HARTZ & KRUUSE 1911). On the Danmark Expedition 1906—08 the northern regions around Dove Bugt were subjected to such careful floristic investigations (LUNDAGER & OSTENFELD 1910) that until the start of the Three-Year Expedition in 1931 this region, notably Germania Land, was the best known floristically of all the tracts of land north of Scoresby Sund.

Simultaneously with the Danish expeditions of 1929 and 1930, Norwegian botanists supplied various new information from "Eirik Raudes Land" (HOEL 1937, VAAGE 1932, LYNGE & SCHOLANDER 1932, LYNGE 1940).

The floristic investigations made on the Three-Year Expedition comprised the area extending from Carlsberg Fjord (c. 71° N. lat.) in the south to Skærfjord (c. 78° N. lat.) in the north. To these must be added the collections from Norske Ø (c. 79° N. lat.) and sporadic investigations in the Scoresby Sund complex. Furthermore collections from some localities on Liverpool Kyst made by one of the geologists of the expedition, A. Noe-Nygaard, are at hand. The surgeon of the expedition, E. Tulinius, likewise collected plants in some localities.

A total of c. 10,000 specimens were collected. The collections are kept at the Botanical Museum of the University of Copenhagen. About 7,000 duplicate specimens have been presented to various foreign museums.

On the map in Pl. 1 all the localities are indicated in which collecting was done or more or less complete plant lists were prepared during the expedition. In a great many localities specimens were collected during short stays on motorboat voyages, some on sledge journeys. The flora lists from such localities will, of course, always be fragmentary to some extent. Fairly complete flora lists can only be expected from such localities in which special investigations rendered prolonged stays or repeated visits necessary. The regions which were really floristically investigated in this way are indicated on the map by special symbols.

Through the floristic investigations the following results have been procured: 1) a revised flora list for the area, 2) an approximate fixation of the northern and southern limits of the species absent north and south of the area respectively, 3) a determination of the east-and-west distribution of the species in response to the change of climate according to the distance from the open sea, 4) a determination of the distribution of the species within the area in relation to the differences of the soil owing to the varying geological structure of the country, and 5) a determination of the altitudinal distribution of the species. In close association with the floristic investigations mention should be made of 6) more special collections of material for the elucidation of the systematics of some difficult species (polymorphic species) and groups of species, and 7) the collecting of cytological material for determination of the chromosome numbers of the species.

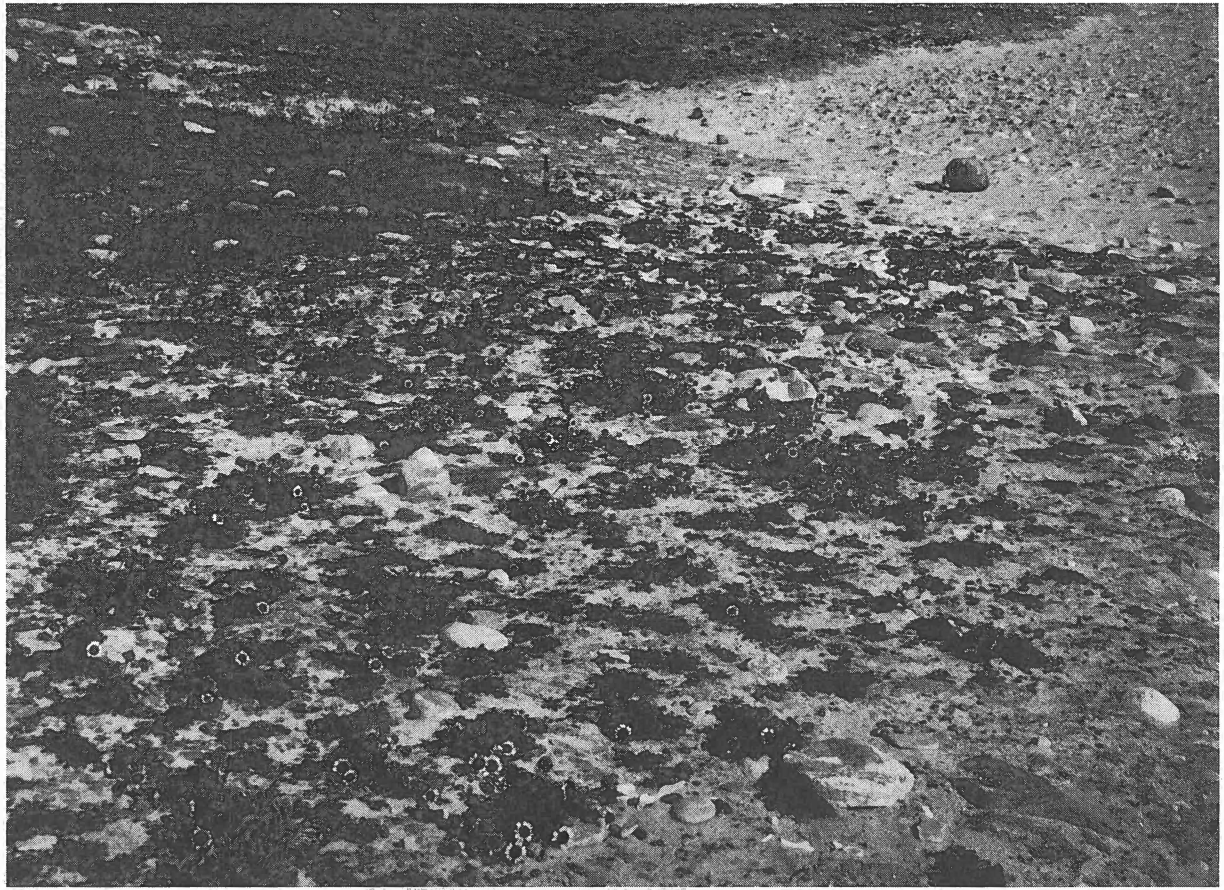
According to the results of the floristic investigations made on the expedition the number of vascular plants represented in Northeast Greenland north of 71° N. lat. amounts to 189. Of these, 47 were not known prior to 1929. However, 27 of the newly discovered species were also collected by the Norwegian botanists in 1929—30 (Vaage 1932). For information on the occurrence of the individual species and a detailed treatment of the systematics and taxonomy of a number of species the reader is referred to earlier papers (Sørensen 1933, Gelting 1934, Seidenfaden & Sørensen 1937). The last-mentioned paper contains a list of all the vascular plants of East Greenland, with systematic and nomenclatural annotations. Some of the most interesting new finds will be dealt with in some detail here.

Phot. G. SEIDENFADEN. No. 3797.

Fig. 1. *Chrysosplenium tetrandrum* (N. LUND) TH. FR., about $^1/_2$ size. Dødemandsbugt, Clavering Ø, 74°08′ N. lat., August 1932.—In wet depressions between Eskimo house ruins, growing among mosses (*Sphagnum* sp.) and grass (*Alopecurus alpinus*).

Chrysosplenium tetrandrum (N. LUND) TH. FR. (Fig. 1) was not previously known from Greenland. It is exclusively associated with the former Eskimo habitations, and there is some probability that it may have been introduced with the now extinct Polar Eskimos from Arctic North America on their colonisation migration around the north of Greenland.

Matricaria inodora L. *var. nana* (HOOK.) TORR. (Fig. 2) exhibits a number of isolated occurrences in Northeast Greenland. DUSÉN's record (1901) of the plant has been doubted, accordingly without grounds. Like the preceding species it is chiefly associated with ancient Eskimo settlements, notably with shore localities in the immediate vicinity of the latter. This plant, also, may naturally be assumed to have been introduced into Northeast Greenland by the Eskimos.



Phot. G. Seidenfaden. No. 3832.

Fig. 2. *Matricaria inodora* L. *var. nana* (Hook.) Torr. Dødemandsbugt, Clavering Ø, 74°08′ N. lat., August 1932. Growing along the shore below the large ancient Eskimo settlement. In East Greenland the plant seems to be limited to actual shore areas, mostly to the neighbourhood of ancient Eskimo house ruins where the nitrate content must be assumed to be especially high owing to the excrements of geese, decayed sea-weed, etc.

Phot. G. SEIDENFADEN. No. 3819.

Fig. 3. *Eriophorum callitrix* CHAM., size about $^1/_2$. Behind the station on Ella Ø, 72°51′ N. lat., August 1, 1933. Mossy swamps, drying up during the summer.

Eriophorum callitrix CHAM. (Fig. 3) is likewise new to Greenland. The identity of the East Greenland plant has been disputed, and the systematic position and distribution of the species were therefore subjected to a special investigation (SEIDENFADEN & SØRENSEN 1933).

Another cotton-grass, the hybrid *Eriophorum polystachyum* × *E. Scheuchzeri*, which had not been observed and described previously, seems to be rather common in Northeast Greenland.

Poa Hartzii GDGR., a hitherto entirely unnoticed species, occurs in places in great abundance. Later it has also been found in West Greenland, Arctic North America, and Spitsbergen.

Carex pseudolagopina SOER., a near relative of *C. heleonastes*, which is not found in Greenland, is a character plant of summer-dry mossy bogs within the Franz Josephs Fjord archipelago and the fjord area of

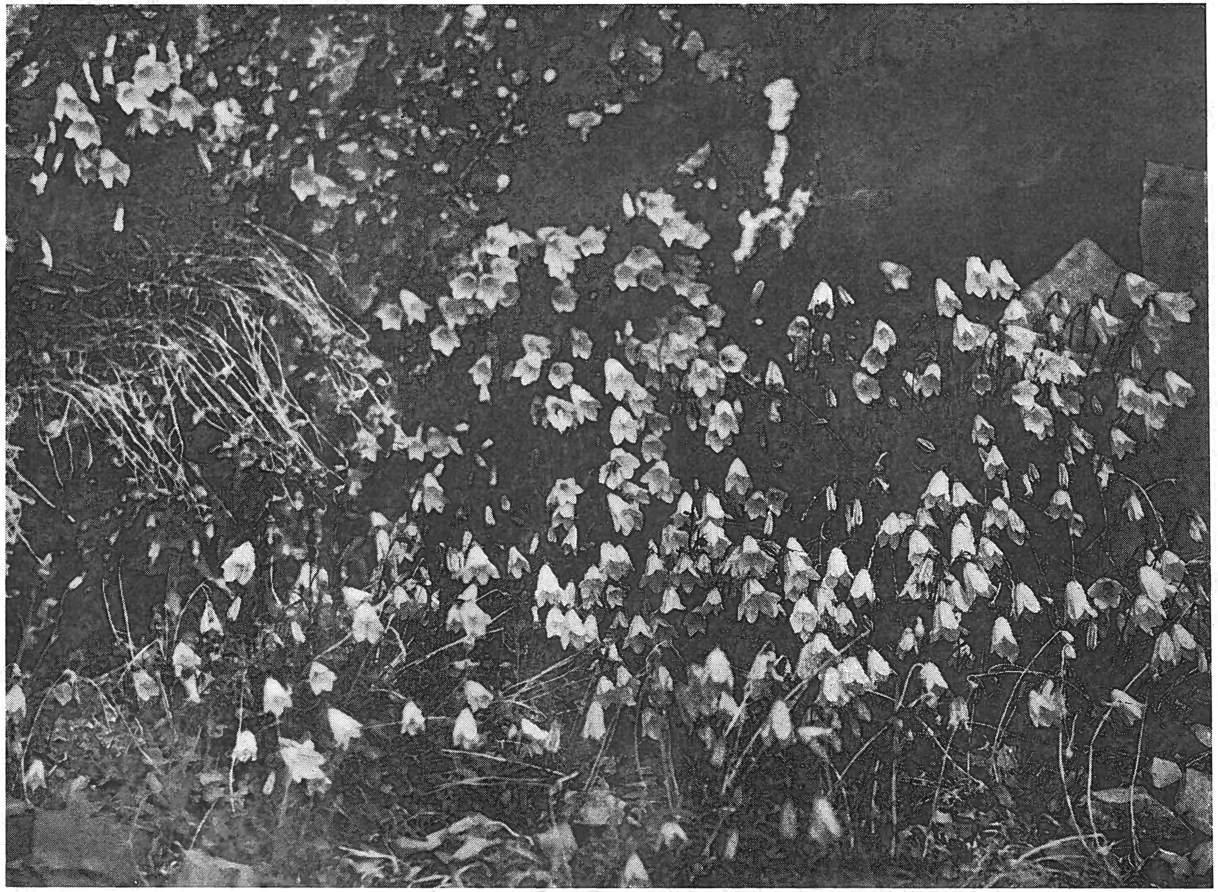
Phot. Th. Sørensen. No. 3877.

Fig. 4. *Sedum roseum* (L.) Scop., about $^{1}/_{5}$ size. North coast of Traill Ø, July 1932, 72°45′ N. lat. Basalt creeks. The species has its northern limit within the area, viz. in Grandjean Fjord, 75°00′ N. lat. The occurrence of the species within the area is nearly always limited to places haunted by birds.

Scoresby Sund. The plant has previously erroneously been referred to *Carex Lachenalii*. Earlier herbarium material has shown that the species occurs in Northwest Greenland and on Spitsbergen also.

Carex sparsiflora (Wbg.) Steud., which was found on Clavering Ø, is new to Greenland. *Carex bicolor* All. is new to East Greenland, since an earlier record from Scoresby Sund has proved to be due to an erroneous determination of *C. rufina* Drej.

Within the Dicotyledons the genus *Potentilla*, in particular, has contributed something new. *Potentilla rubella* Soer. is a systematically rather isolated species, which so far has only been found on Clavering Ø and Kuhn Ø. On Clavering Ø there was in addition found a *Potentilla*



Phot. G. SEIDENFADEN. No. 3779.

Fig. 5. *Campanula rotundifolia* L., about $^1/_4$ size. Kap Broer Ruys, Hold with Hope, 73°30′ N. lat., August 15, 1934. Basalt creeks. The shoots of the previous year with apparently mature capsules are seen to the left. However, the plant belongs to the late-flowering species, and only in the most favourable places is it able to develop ripe seed. It has its northern limit within the area, viz. in 74°30′ N. lat. (inner part of Tyroler Fjord).

Phot. G. SEIDENFADEN. No. 3796.

Fig. 6. *Cerastium alpinum* L., about 1/2 size. Kap Broer Ruys, Hold with Hope, 73°30′ N. lat., August 15, 1934. The species belongs to the polymorphic species within the area. The picture shows a vigorous, caespitose form.

which is very closely related to *P. stipularis* L. of the arctic and alpine East Siberia. It has been described as a *var. groenlandica* of that species.

Primula stricta HORNEM. is new to East Greenland, and *Ranunculus auricomus* L., a species not hitherto recognised as belonging to the Greenlandic flora, was found on Ymer Ø in a special form, *var. glabrata* LYNGE.

The great majority of the other species which are new to the area are such as have hitherto been known from more southerly parts of Greenland. The northern limits of a number of species were thus moved farther northward than might have been expected beforehand.

In some few cases, however, it is the southern limit hitherto known that has been shifted. Thus *Minuartia Rossii* R. BR. was found as far south as Ymer Ø (c. 73° N. lat.), and *Taraxacum pumilum* DAHLST., which, from Greenland, was previously only known from a couple of localities on the north coast, has now been found in Skærfjord.

The study of several groups of polymorphic species whose abundance of forms within the area invites more careful treatment constitutes a special chapter within the floristic-systematical investigation of the country. Of such species mention should in the first place be made of *Potentilla* and *Melandryum*, and furthermore of *Draba*, *Cerastium* (Fig. 6), and *Poa*. A large material for the elucidation of the species content of these genera has been collected, but the working up of this material has not yet been completed; a few of the lines of investigation can, however, be indicated here. *Potentilla nivea* L. (incl. *P. Pedersenii* RYDB.) consists of a series of constant microspecies which are well separated both morphologically and ecologically (but often not geographically). Clavering Ø, in particular, is an eldorado in this respect. There can hardly be any doubt that the individual forms keep sharply separated owing to apomictic reproduction. *Melandryum triflorum* (R. BR.) J. VAHL and *M. affine* J. VAHL each consists of several, systematical units, which are hardly sharply separated morphologically, but are separated geographically in so far as the inner fjord regions often harbour forms that differ from those of the coastal tracts near the icy sea. While these two species are, as a rule, well separated near the outer coast, they converge strongly towards each other farther towards the interior of the fjords.

Furthermore, as coming under the study of the finer species systematics, the collecting of cytological material should be mentioned here. Material of the majority of the species occurring within the area has been preserved to serve the study of the meiosis and the determination of chromosome numbers. The very time for the meiosis was determined on the spot by means of aceto-carmine preparations. The phenological results thus arrived at have been published (SØRENSEN 1941). The determinations of the chromosome numbers of the material are being carried out by Dr. M. WESTERGAARD, but have not yet been completed.

About one-fourth of the species have their northern limit within the area, while only some few have their southern limit there; the great majority of the high-arctic species of East Greenland have their southern limit in the fjord land around Scoresby Sund. A comparatively large number of species in Northeast Greenland are restricted to the fjord complexes, some even to the fjords north of Scoresby Sund.

Besides by the geographical latitude the distribution of the species is to a considerable extent determined by the distance from the ice-filled sea, that is to say, by local climatic factors, and by the conditions of the soil, which depends, roughly, on the age and consistency of the rocks.

The climate increases in continentality from the coast towards the inland ice. Compared with the coast land, the interior is characterised by a low precipitation, early melting of the snow in the spring, and a summer temperature which exceeds that of the coastland by several degrees, slight humidity of the air and not many clouds, and consequently intense desiccation of the soil towards the end of the summer.

The floristic difference between the coast land and the inland manifests itself by the fact that the inner fjords harbour the northernmost outposts of the southern species, while the northern high-arctic species extend rather far southward along the coast. However, there are exceptions (cf. GELTING 1934 p. 280). According to GELTING's record from Clavering Ø (c. 74° N. lat.) the snow-line rises from c. 900 m altitude at the outer coast to c. 1500 m near the edge of the inland ice. The high-arctic outer coast species follow this line to a certain extent, since they move to higher levels towards the inland ice, where together with a stock of widely distributed ubiquists they form the high-alpine vegetation. Or conversely: in the coastal tracts the alpine hygro- and psychrophilous flora moves down to the level of the sea, whereas the lower parts of the inland harbour a number of relatively thermophilous species which are entirely absent from the outer coast.

As examples of species which are characteristic of the coastland and farther inland are chiefly restricted to altitudes above c. 700 m, the following may be mentioned: *Cardamine bellidifolia*, *Draba subcapitata*, *Minuartia Rossii*, *Sagina intermedia*, *Poa abbreviata*, *Puccinellia Vahliana*, *Phippsia algida*, *Potentilla emarginata*, *Ranunculus glacialis* (Fig. 7), and *Ranunculus affinis*.

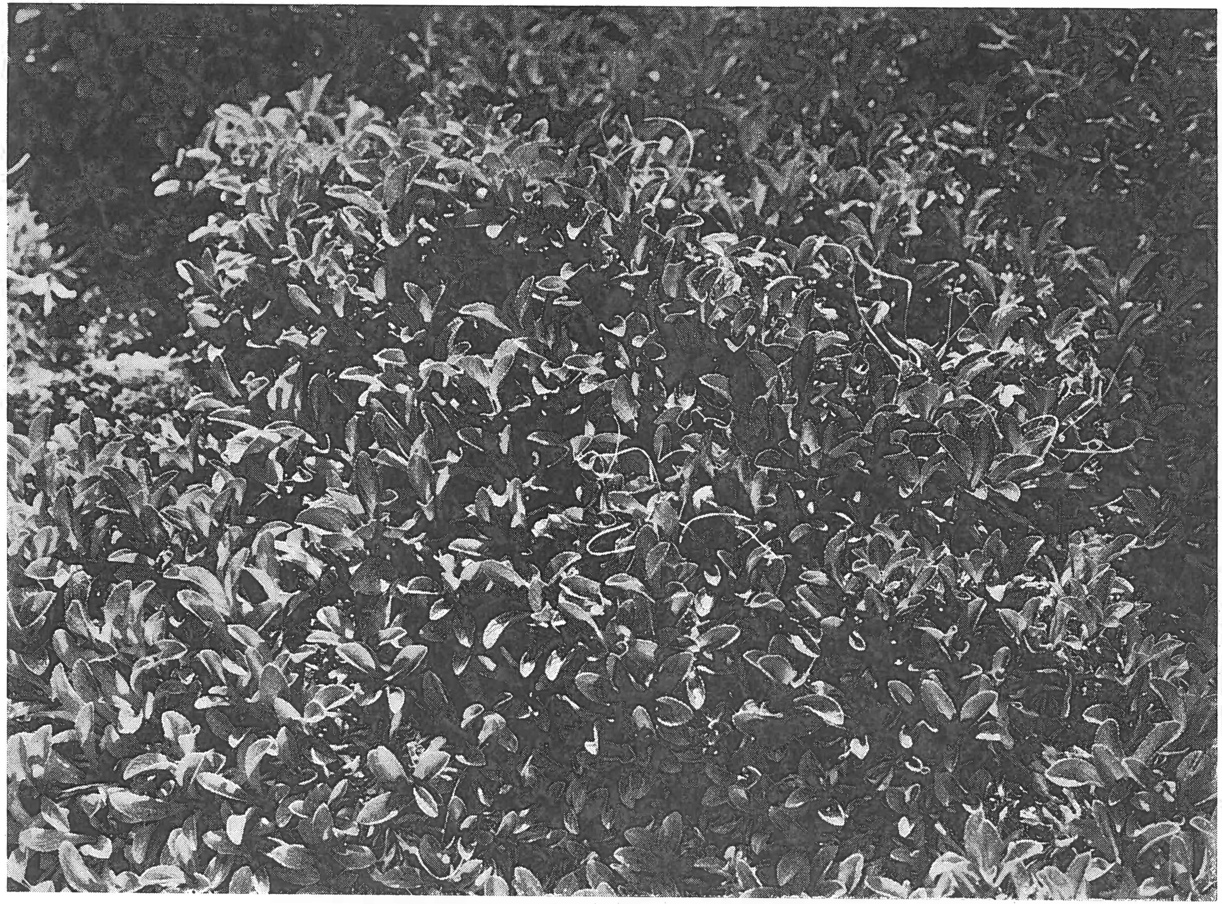
Species which are limited to the outer coast alone and which seem to be absent from the inner fjords even in the alpine regions are: *Cerastium Regelii*, *Deschampsia arctica*, *Draba alpina*, *D. micropetala*, *D. Gredinii*, *Polemonium boreale*, *Saxifraga Hirculus*, and *S. flagellaris*.

Phot. G. SEIDENFADEN. No. 1449.

Fig. 7. *Ranunculus glacialis* L., about $^1/_1$ size. Grønnedal, Clavering Ø, July 20, 1930. Found among algæ (Cyanophyceae) in a water-saturated moraine along the front margin of a firn. Often it is the only flowering plant in such localities.

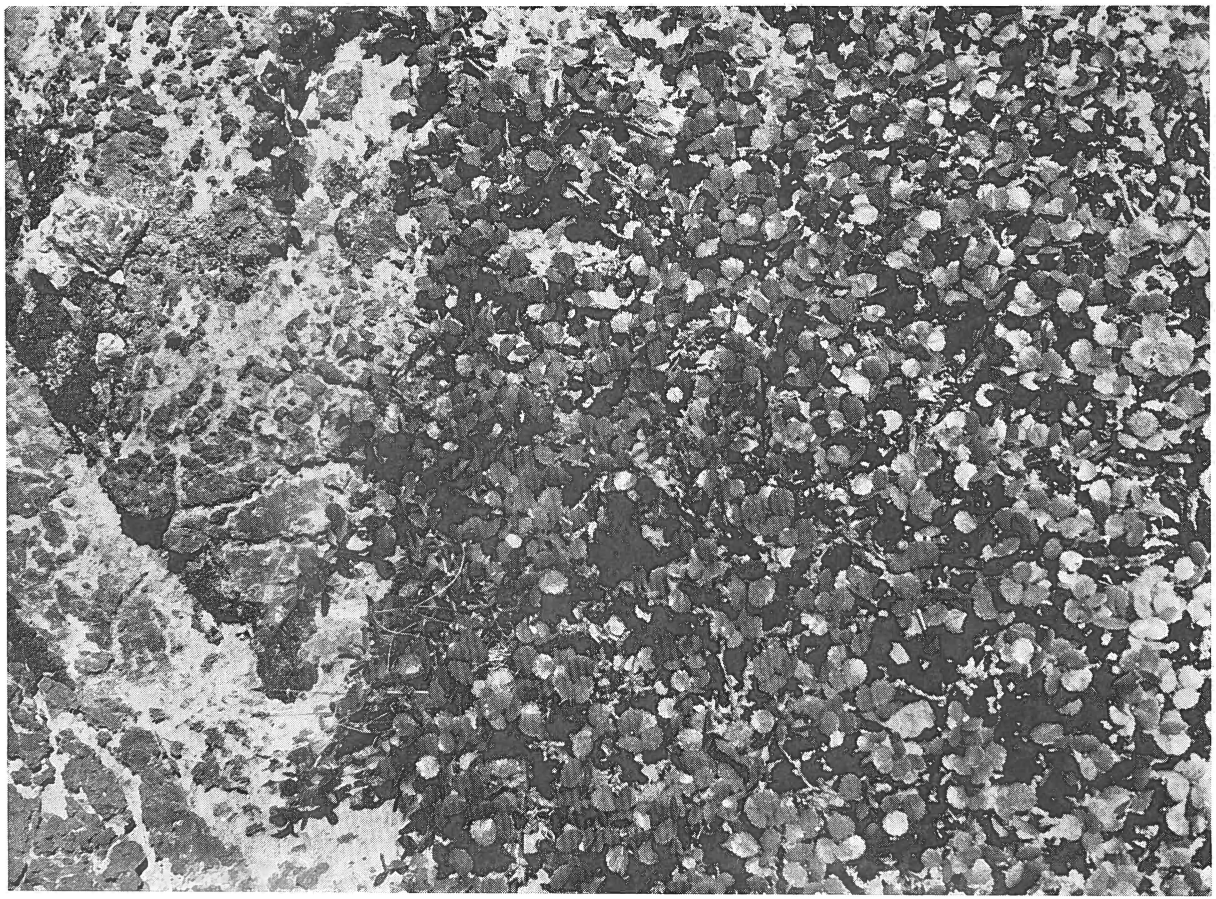
As examples of fairly common species of the relatively large group of species which are mainly limited to the inner fjord land, and which do not, as a rule, extend above c. 500 m, the following may be mentioned: *Arctostaphylos alpina* (Fig. 8), *Betula nana* (Fig. 9), *Empetrum hermaphroditum* (Fig. 10), *Carex supina*, *C. pseudolagopina*, *C. parallela*, *Calamagrostis purpurascens*, *Agropyrum latiglume*, *Juncus arcticus* (Fig. 12), *Luzula spicata*, *Tofieldia palustris*, *Rumex Acetosella*, *Braya humilis*, *Saxifraga aizoides*, *Pedicularis lapponica*, and *Antennaria alpina*. Besides a number of the rare southern species of the area belong to this group.

On the basis of the aforementioned distribution of the species GELTING (1934) divides the land areas (i. e. the lowlands) into three floristic zones, a narrow outer coast belt with a fairly oceanic climate,



Phot. G. SEIDENFADEN. No. 3771.

Fig. 8. *Arctostaphylos alpina* (L.) SPRENG., about 1/2 size. Kap Oswald, Ella Ø, 72°51′ N. lat., August 20, 1934.— Section of an *Arctostaphylos* heath in the late summer aspect. Here and there ripe black-berries are seen among the foliage, which at this season of the year is of a deep red colour. A small tuft of *Stereocaulon* is seen to the left in the picture, but otherwise the vegetation is entirely unmixed, apart from a few individuals of *Carex rupestris*.



Phot. G. Seidenfaden. No. 3775.

Fig. 9. *Betula nana* L., about 1/2 size. Kap Oswald, Ella Ø, 72°51′ N. lat., August 20, 1934. The plant is entirely prostrate like an espalier on the characteristic weathered calcareous rocks (Eleonore Bay Formation). At this season of the year the plant bears mature catkins, which can be distinguished in the left part of the picture.

Phot. G. Seidenfaden. No. 3808.

Fig. 10. *Empetrum nigrum* L. *var. hermaphroditum* (Lge.), about $^1/_1$ size. Kap Oswald, Ella Ø, 72°51′ N. lat., August 20, 1934. Note the erect growth and short shoots of the plant, by which characters it differs from the main species in the temperate regions. Although the photograph was taken late in August, the fruits are not fully developed; indeed, the plant rarely develops mature fruits in these latitudes.

Phot. G. SEIDENFADEN. No. 3888.

Fig. 11. *Vaccinium uliginosum* L. *var. microphylla* LGE., about $^{1}/_{1}$ size. Kap Oswald, Ella Ø, 72°51′ N. lat., August 20, 1934. The plant grows in dry heaths, which is especially characteristic of *v. microphylla.* The fruits ripen within the area, unlike those of *Empetrum.* The other plants seen in the picture are: *Dryas octopetala*, *Carex rupestris*, and, to the right, *Stereocaulon.*

a transitional belt, and, nearest the inland ice, a comparatively broad inner fjord belt with a marked continental climate. Although at any rate the first-named and the last-named belt have their characteristic species, the greater number of the species of the area are to be found

Phot. G. Seidenfaden. No. 3823.

Fig. 12. *Juncus arcticus* Willd., about 1/3 size. Kap Elisabeth, Ella Ø, 72°54′ N. lat., August 1, 1933. This species is the only representative of *Junci genuini* within the area. The white spots in the background are the mature spikes of *Eriophorum Scheuchzeri*.

in all three zones. If, however, not only the mere presence of the species but also their mass occurrence in the different zones are taken into consideration, the differences between the coastland and the inland are much more conspicuous.

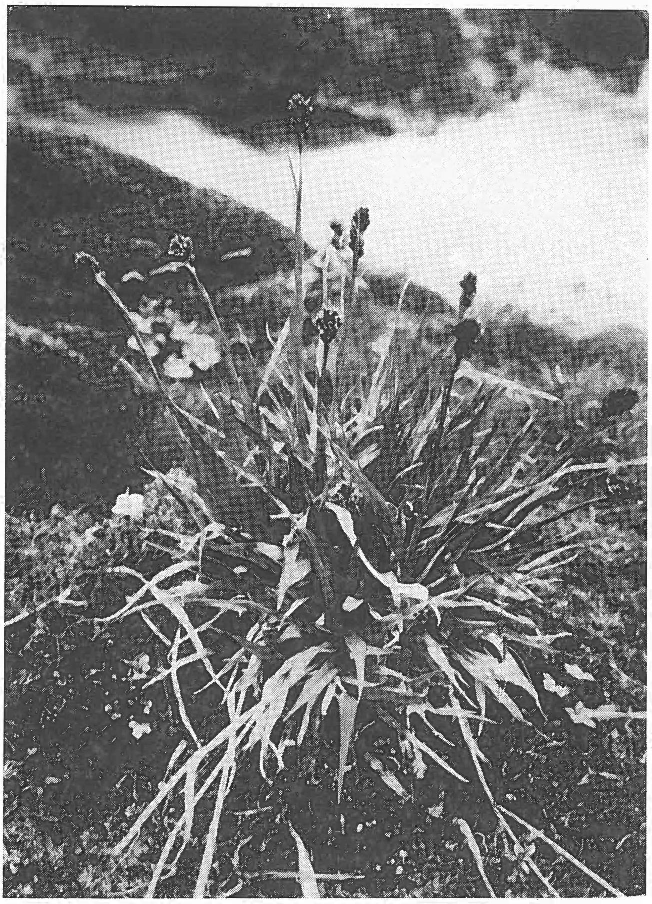
As mentioned above, the geological structure of the country shows strong floristic manifestations. The lime content of the soil is a very

Phot. G. SEIDENFADEN. No. 1483.

Fig. 13. *Woodsia glabella* R. BR., about 5/4 size. South side of Jordanhill, 74°07′ N. lat., July 27, 1930. Growing at the margin of a tuft of the highly pulvinate form of *Saxifraga oppositifolia*.

significant species-distributing factor. On the pre-Cambrian sediments (Eleonore Bay Formation) there occurs a distinctly calciphilous flora comprising a number of species which are absent from places where the substratum is made up of gneiss and granite. These last-mentioned rocks represent the second extreme point as to lime content. According to a series of non-published measurements of the acidity, the pH of samples of mineral soil from the Eleonore Bay Formation (Ella Ø) is about 7—8, of gneiss (Kap Hedlund) 5—6. Between these extremes there occur for instance Devonian sandstones and basalt. On account of the arid climate of the area really acid soils do not occur, and the peat formation, even where conditions for this would seem favourable, is limited to a very thin layer of raw humus, the pH of which is only inconsiderably lower than that of the mineral soil. Podsol profiles were not observed.

Species which distinctly prefer calcareous soil and are absent from the areas of gneiss and granite unless these areas contain morainic material

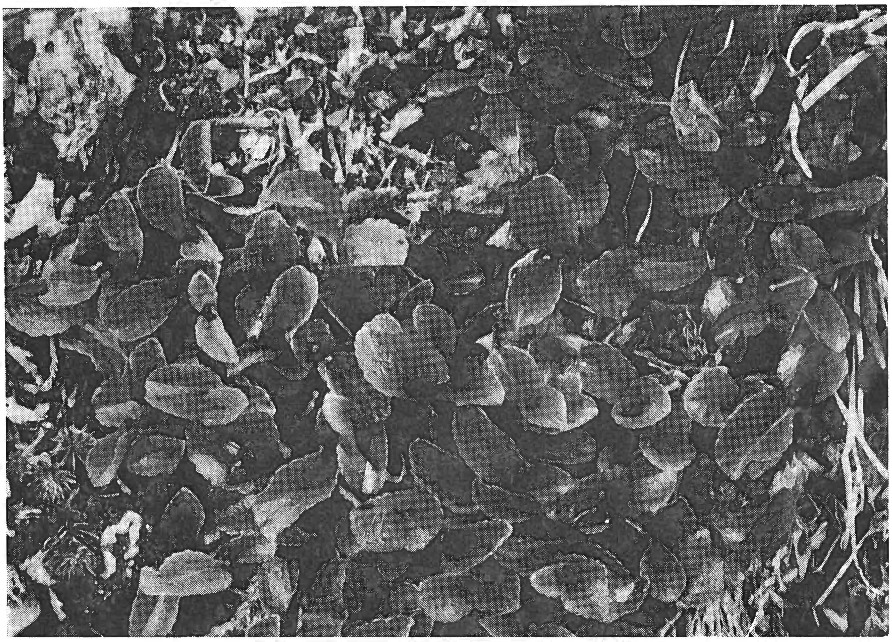


Phot. G. SEIDENFADEN. No. 3832.

Fig. 14. *Luzula nivalis* (LAEST.) BEURL., about $^1/_2$ size. Kuhn Ø, 74°56′ N. lat., August 8, 1933. The plant is of common occurrence on damp calcareous soil, where it replaces *Luzula confusa* to some extent, which is not, or rarely, found on decidedly calcareous soil.

derived from the sedimentary rocks, are: *Woodsia glabella* (Fig. 13), *Carex atrofusca*, *C. pedata*, *Cobresia bipartita*, *Eriophorum callitrix*, *Draba Bellii*, *Juncus triglumis*, *J. castaneus*, *Luzula nivalis* (Fig. 14), *Saxifraga aizoides*, *Braya linearis*, *B. purpurascens*, and *Eutrema Edwardsii*.

Commonly distributed species which are entirely absent from the calcareous rocks are: *Carex rigida*, *C. supina*, *Hierochloe alpina*, *Luzula*



Phot. G. SEIDENFADEN. No. 3862.

Fig. 15. *Salix herbacea* L., about $^1/_1$ size. Kap Broer Ruys, Hold with Hope, 73°30′ N. lat., August 15, 1934. The species is exceptionally frequent in this locality, probably on account of the abundant moisture and the acid soil.

confusa, *Lycopodium Selago*, *Poa arctica*, *Ranunculus pygmaeus*, *Salix herbacea* (Fig. 15), *Stellaria longipes*, *Campanula uniflora*, *C. rotundifolia*, *Taraxacum arcticum*, *Cardamine bellidifolia*, and *Rumex Acetosella*.

The nature of the weathering rock is also of great importance for the physical nature of the soil. The limestone produces very fine-grained weathering products, which give rise to strong solifluction phenomena, while the basalt on weathering is decomposed into coarse-grained soils, which form a more stable substratum for the vegetation. However, these physical differences evidently exert less influence on the floristic composition of the vegetation than on the mass occurrence of the vegetation types represented and their distribution.

The History of the Flora.

GELTING (1934, Chapt. III) has tried to gain an idea of the history of the country and accordingly of that of the vegetation. He takes the physiographic conditions of the country as his point of departure, paying special attention to the position of ancient raised beaches and of ice-worn (moutonnée) mountains as well as such not eroded by ice (alpine peaks).

The occurrence of submarine moraines on the one hand and raised beaches on the other shows that the country has been subjected to upheavals and subsidences in Pleistocene times. The inland ice, too, has been subject to various advances and retreats after its maximum distribution. From this it must be evident that the lower regions of the inner fjord tracts, which harbour the thermophilous flora of a southern character, must have been the last to be colonised by the vegetation. The flora of the outer coast and the nival flora of the inland, which, as mentioned above, show no small agreement and comprise the northern element of the flora, in all probability include the earliest colonisers of the country. However, GELTING's suggestion that the nival flora of the inland should possibly be regarded as a direct continuation of an ancient lowland flora which was elevated from its original position near the coast during the last upheaval of the country, probably goes too far (GELTING 1934, p. 240). The elevation does not amount to sufficiently great heights (GELTING 1941, p. 80), and the occurrence of doubtful "halophilous" species at great altitudes (e. g. *Armeria labradorica* 700 m, *Carex incurva* 1000 m) can hardly be considered to support the hypothesis. The *Carex subspathacea — Dupontia Fisheri* swamps found at a height of 200 m may, however, possibly be epeirogenically conditioned.

However, the historical way of considering the flora of the country advocated by GELTING has in other respects led to exceedingly interesting results, which at any rate as a working hypothesis mean an undoubted step forward (GELTING 1934, 1936, 1941).

In a floristic respect Northeast Greenland is characterised by a more or less local accumulation of "centric" species, that is to say, species which are endemic to the area or such whose area in East Greenland forms a marked enclave in relation to their total area. A number of species have a "bi- or tricentric" distribution in Greenland, being found besides in Northeast Greenland in one or two minor limited areas in West Greenland. Some species are even absent from West Greenland, but are present in arctic Scandinavia or Siberia.

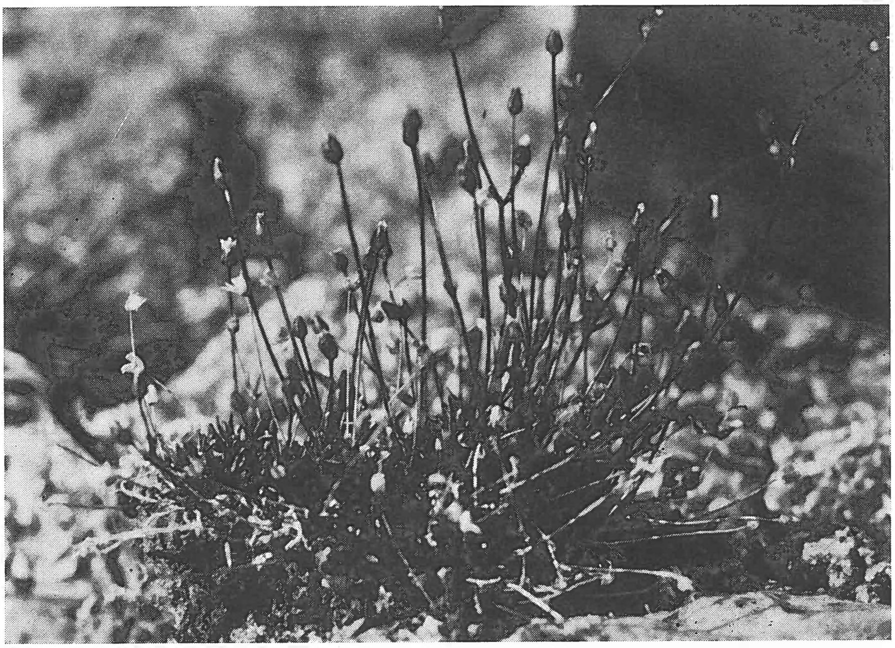
As stated above, geological evidence is at hand, showing that some areas in Northeast Greenland have never been glaciated, and the aforementioned floristic peculiarities likewise bear evidence of these areas having served as plant refuges in Pleistocene times. The geological as well as the botanical evidence seems to assign the position of such refuges to the regions around Scoresby Sund and Clavering Ø. Thus in the Scoresby Sund area we find the following species: *Arabis arenicola*, *A. Holboellii*, *Ranunculus pygmaeus var. Langeana*, *Saxifraga tricuspidata*, *Dryopteris fragrans*, *Draba sibirica* (otherwise not known outside Eurasia); and in the Clavering Ø area: *Carex sparsiflora*, *Saxifraga Hirculus*, *Polemonium boreale*, *Potentilla rubella* (endemic), *Potentilla*

Phot. G. SEIDENFADEN. No. 3870.

Fig. 16. *Saxifraga Nathorsti* (DUSÉN) HAYEK, about 4/5 size. Northwest coast of Loch Fyne, 73°57′ N. lat., July 23, 1933. The species is one of the few endemic species of the area, being limited to the area between 70°50′ and 75°18′ N. lat.

stipularis; distributed over the area Scoresby Sund-Clavering Ø or even farther northward: *Saxifraga Nathorsti* (Fig. 16) (endemic) and the following species not found in other parts of Greenland or at any rate not on the east coast: *Arenaria pseudofrigida*, *Arctostaphylos alpina*, *Braya humilis*, *B. linearis*, *Carex parallela*, *C. pseudolagopina*, *C. ursina*, *Draba altaica*, *Eriophorum callitrix*, *Epilobium arcticum*, *Gentiana tenella*, *Minuartia stricta* (Fig. 17), *M. Rossii*, *Primula stricta*, and *Saxifraga hieraciifolia*.

The idea that the hardiest of the Greenland plants, which at the present day occur up to the greatest altitudes, and may even thrive on the nunataks, might have survived the Ice Age in Greenland, is of early date. However, a characteristic of a large number of the above-mentioned species is that they are restricted to the lowland, and to most of them it even applies that they do not correspond to the notion of high-arctic plants one involuntarily forms during the work in the field. The occurrence of such species has led to the following assumption: "Es gab eisfreie Tieflandsgebiete, die durch Hochland gegen das Inlandeis im Westen geschützt waren" (GELTING 1941, p. 81). The reason why the species in question have not been able to spread over large areas in the course of the thousands of years which must have elapsed since the



Phot. G. Seidenfaden. No. 3836.

Fig. 17. *Minuartia stricta* (Sw.) Hiern, about $^1/_1$ size. Behind the station of Ella Ø, 72°51′ N. lat., August 1, 1933. By its long glabrous stalks the species is markedly distinguished from *Minuartia rubella.* In the photograph the stalks from the previous year are readily distinguishable from those of 1933.

maximum glaciation, seems to be that we are here confronted with species which have become highly specialised in their demands on the soil. They are largely calcicolous plants which are not at all capable of colonising areas of granite or gneiss. And it is precisely this property in these species which enables us to recognise them as relicts. The great majority of the less specialised and accordingly commoner species of the country had, of course, just as great chances of surviving during the maximum extension of the ice.

But when did the maximum extension of the Greenland ice shield occur? On the analogy of our knowledge of the European ice ages, namely that the last but one, the Riss ice age, covered much larger areas than the last one, the Wurm ice age, we have been inclined to assume that the last advance of the ice was not of the same dimensions in Greenland, either, as the preceding one or ones. Drawing support from Wegener's hypothesis of continental drift, Gelting assumes, however, that during the last ice age in North Greenland much larger areas were covered with ice than during the preceding one, since the latter must have occurred at a time when the North Atlantic was merely a relatively narrow belt between Scandinavia and Greenland. For an illustration of the conditions prevalent at that time the reader may be referred to the Red Sea of the present day. The centre of glaciation would then have been the mountains of East Greenland south of Scoresby Sund, the highest mountain massif in Greenland, whence the ice masses must have advanced northward and westward, though not farther than that the whole of northern Greenland north of a line extending almost from Scoresby Sund in the east to Sukkertoppen in the west was, roughly, free of ice. In a phytogeographical respect GELTING's hypothesis is of the greatest interest. The ice shield has divided the early Pleistocene flora into a northern division, isolated north of the ice barrier, and a southern division, whose place of survival is less essential in this connection. The former, in particular, is of interest for our understanding of the present day flora of northern Greenland. Thus a number of arctic-continental species may have had or have acquired a continuous distribution from North America via N. Greenland to Siberia, and as to the more hygrophytic species GELTING postulates a regular zone of crossing immediately north of the ice shield where they have profited by the nival climate prevalent there.

The advance of the ice across northern Greenland during the last and greatest ice age extinguished large parts of the early Pleistocene flora, but the present peculiarly discontinuous distribution of many species shows that, as stated above, refuges for the plants were left in certain places.

GELTING's hypothesis gives a satisfactory explanation of different types of plant distribution in Greenland, which at the outset anticipates the idea of a colonisation both from the north and the south. Thus, for instance, it has previously been shown (SØRENSEN 1933) that in Greenland *Eriophorum polystachyum* consists of two separate types, *var. tristis* TH. FR. in the north and the main species in the south. On the west coast the two types meet in about 70° N. lat., while on the east coast they have not yet met, a long stretch south of Scoresby Sund, where the species is entirely absent, separates the areas of the two forms.

However, in addition to the Pleistocene relicts we must no doubt also assume the presence of post-glacial relicts in Greenland. Post-glacial oscillations of the climate have been ascertained (JENSEN & HARDER 1910, JENSEN 1942), and it would seem that a number of relict-like occurrences of heat-demanding species in the interior of Scoresby Sund and in the archipelago of Franz Josephs Fjord may be accounted for on the assumption of an earlier warmer climate, under which the species in question were able to spread over larger areas than is the case at present. In accordance with this SEIDENFADEN & SØRENSEN (1937) advanced a hypothesis of a chiefly post-glacial immigration of large parts of the Greenland flora during alternating warmer and colder, humid and drier climatic periods. If here, however, the most probable route and time of immigration are taken into consideration, one group will be left, viz. "Ancient Cold Plants", whose immigration into the country can hardly be assumed to be post-glacial. GELTING's assumption of a direct continuation of Tertiary—early Pleistocene arctic elements will then give the key to the history of these species in Greenland.

On the basis of our present knowledge of the origin of the Greenlandic flora we must no doubt assume two elements separated in a historical as well as an ecological respect: a northern indigenous element and a younger southern element. It is probable that the distribution of the latter has not yet reacted in full accordance with the climatic and edaphic conditions prevalent at the present day. Certain Southeast Greenland species convey the impression of being still migrating northward. (Cfr. also JENSEN 1939).

Biology and Ecology.

The circumstance that the botanists of the expedition had the opportunity to pass the winter within the area of the expedition, enabled them to make biological and phenological observations on the vegetation to a greater extent than had been possible before. GELTING (1934, Chapt. V) tried to give an all-round biological characterisation of the flora, taking into account the life-form in which the plants pass the winter, the type of growth, the size of the leaf, the succulence, type of root, etc. In addition, the flowering periods of the species are correlated with their life-form and with the date for the melting of the snow in their habitat. Later on SØRENSEN (1941) subjected the same questions to a special investigation on a somewhat broader basis; here the periodical manifestations of plant life viewed in relation to the extreme temperature climate of the country are considered as the central problem.

The flora of Northeast Greenland is distributed over the life-forms of RAUNKIÆR in the following way: chamaephytes 27 $^0/_0$, hemicryptophytes 52 $^0/_0$, geophytes 16 $^0/_0$, helo- and hydrophytes 3 $^0/_0$, and therophytes 2 $^0/_0$. The high Ch-percentage shows that we are beyond the limit of the arctic chamaephyte belt. According to GELTING's investigations on the south coast of Clavering Ø, the chamaephyte percentage increases with the height from c. 30 at sea-level to c. 40 at the snow-line, which here occurs at a height of c. 1200 m. A relatively large number of species pass the winter with green leaves: c. 5 $^0/_0$ are ever-green, 26 $^0/_0$ winter-green, while 69 $^0/_0$ are summer-green. During the winter the buds are less protected than might be expected at the outset. Thus c. 38 $^0/_0$ of the species pass the winter without the slightest protection of the buds, that is to say, the vegetative shoot apices have about the same appearance all the year round, and only c. 18 % have an actual protection of the buds. If in this connection we consider the distributional type of the species, we shall find that it is chiefly the northern types which are winter-green and without protection of the buds, while the southern types are more frequently summer-green and have protection of the buds.

A characteristic of the arctic vegetation is its exceedingly rapid development in the spring after the melting of the snow. GELTING has determined the prefloration time for a number of species, that is to say, the time that elapses from the date the plant appears above the snow till the flowering begins. As regards a number of snow-patch plants the prefloration period amounts to 8—12 days only, while 2—4 weeks are common for a great many species. The short summer renders it necessary for the plants to complete their flowering and fructification very rapidly. The relatively early flowering can only be accomplished because it is well prepared. The developmental state of the flower buds during the wintering has been examined for all species of the area. The great majority pass the winter with highly developed buds. However, only c. 5 % of the species have pollen in the anthers, but these species are not, as a rule, among those that flower earliest. Thus, for instance, the first flower of the spring, *Saxifraga oppositifolia* (Fig. 18), must complete the meiosis and the development of pollen in the spring before flowering. On the whole it holds good that the northern species, which often grow on snow-free hills exposed to the wind and in places which become free of snow very late in the spring or in the summer, pass the winter with highly developed flower buds, and they have a short prefloration period, while species with a comparatively southern area may sometimes pass the winter entirely without flower buds or in most cases with the buds in a very young initial stage. Such species have a long prefloration period, and they grow, indeed, in places where the snow disappears early in the spring.—The greater number of species exhibit a marked periodicity in the inception of the flower buds in accordance with the seasonal climatic changes. The first initial stages often appear in the spring the year before the flowering takes place. All buds of each species thus come to pass the winter in approximately the same stage of development. However, no small number of species, altogether c. 12 per cent., deviate from this rule, their buds being initiated casually, at different times, and they will then pass the winter in highly different stages of development. It will then likewise depend on chance at what time the individual buds will reach the flowering stage. Such species do not, like the others, flower at a definite time in relation to the melting of the snow, but at different times, from shortly after the disappearance

Phot. G. SEIDENFADEN. No. 1347.

Fig. 18. *Saxifraga oppositifolia* L., about 1/2 size. Grønnedal, Clavering Ø, 74°17′ N. lat., July 20, 1930. One of the commonest species within the area; it occurs in several forms in the different plant communities (cf. Fig. 13).

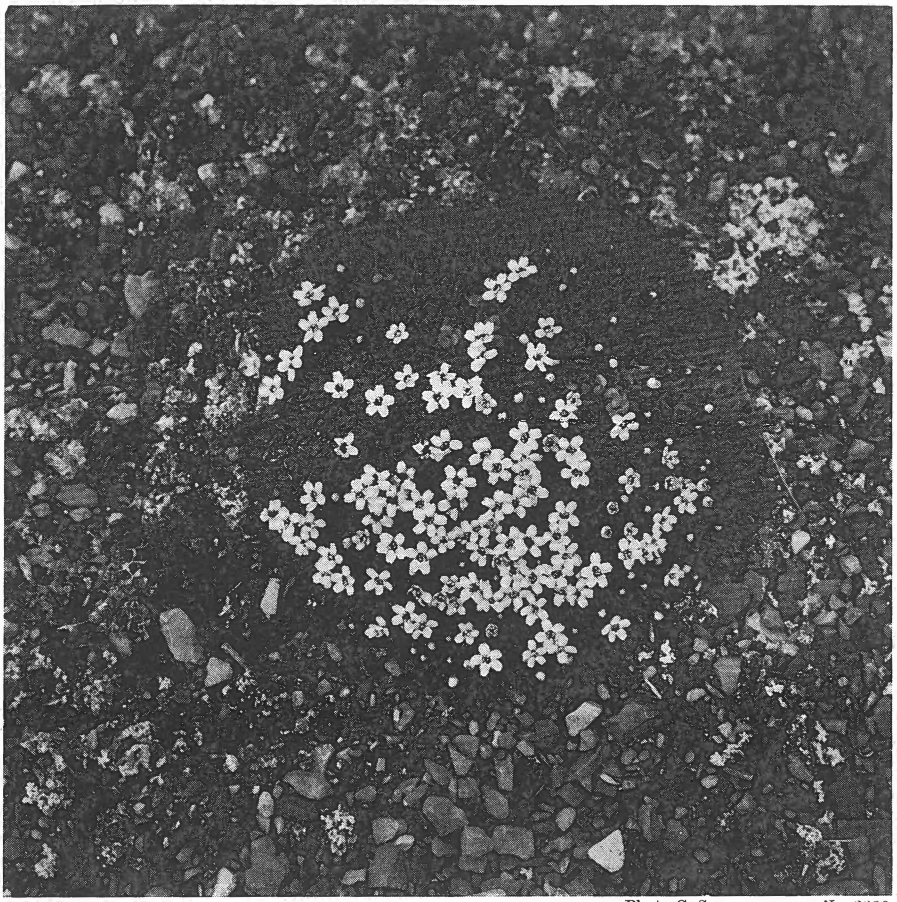
of the snow, to immediately before the winter frost sets in. The flowers which are not unfolded "in time", will then, as a rule, be destroyed by the frost before they are able to fructify. Plants of this type of development may with some right be called aperiodical. Only one of the aperiodical species of the country, a Crucifer, *Braya humilis*, is capable of continuing its development after a wintering regardless of the stage of development, for instance with buds, unfolded flowers, or immature siliques. After a winter of about nine months it will continue its flowering and ripen its siliques initiated the previous summer. The aperiodical species, which have to some extent freed themselves from their dependency on the short summer, belong to the markedly northern element of the flora and often occur in places with a protracted snow-covering. Their flower buds are often initiated even two years before they unfold.

Not only the flower buds, but also the vegetative innovation shoots are initiated especially early in the northern species. This brings about that several shoot generations of the sympode bear leaves at the same time. In this way the compact, somewhat pulvinate growth forms arise in many arctic plants. This is of practical importance for the plant in that the whole foliage of the sympode, which consists of very few leaves on each shoot, may unfold at the same time. In the plants of more southerly regions as a rule only one joint of the sympode develops at a time, in that case the leaves of each growth season will form successively on a single joint. Thus the compact pulvinate growth of many arctic plants seems in the last instance to indicate an adaptation to a short vegetation period (Fig. 19).

As regards the temperature, which in these northern tracts plays such a decisive part as a plant-limiting factor, there is actually a much greater difference between early snow-free and late snow-free soil than might be immediately expected. This is evident from the series of temperature registrations of the air, the surface of the ground, and the soil made for botanical purposes during the expedition (SØRENSEN 1941).

On terrain with a slight southern exposure the surface of the ground, during great parts of the season with favourable temperatures, is exposed to temperatures which are 5°—7° above the meteorological air temperature. As the arctic plants are very low and often creep across the surface of the ground, there can be no doubt that they are capable of utilising these relatively high temperatures. This is moreover evident from the fact that the growth of the plants begins almost at the time when the diurnal mean temperature of the surface of the ground passes the 0-line. This takes place 3—4 weeks before the diurnal mean temperature of the air reaches zero. At this time the soil has already thawed to a depth of c. $^1/_2$ m. Thus owing to the insolation the microclimate in early snow-free biotopes with a moderately favourable exposure is more favourable to plants, and their plants are less modest in regard to the temperature factor than generally assumed. However, where the soil is exposed to a more extensive or more prolonged snow-covering, the plants will not be able to benefit from the insolation until the snow has completely melted.

On account of the very rugged terrain of the country and the violent winter gales the snow-covering will be very unequally distributed. If we imagine two biotopes, one of which becomes free of snow one month later than the other—the difference may often be much greater—the difference in the duration of the "summer" of the plants in the two



Phot. G. SEIDENFADEN. No. 3880.

Fig. 19. *Silene acaulis* L., about 1/2 size. Kap Broer Ruys, Hold with Hope, 73°30′ N. lat., August 15, 1934. The most marked cushion plant. The south-facing side of the semiglobular cushion bears the first developed flowers.

biotopes will not only amount to one month, but rather to two months. What two months mean to the plants in a climatic area in which the positive temperatures of the summer only lasts for about three months, goes without saying. From this the significance of the unequal snow-covering as a species-distributing factor will be immediately evident. If there is any sense at all in speaking of the adaptation of plants to the environment, it is evident that the developmental-biological characteristics which—as demonstrated above—distinguish the (northern) species of the snow-patches from the (southern) species of the early snow-free slopes with a southern exposure, point very strongly towards a safeguarding against the unfortunate effects of an extremely short vegetation period. Along with—but evidently quite independently of—

this adaptation the species in question have developed a peculiar insensibility to extremely low temperatures, which is visibly manifested in their ability to survive the winter in the most different stages of development or at any rate without external protection of the shoot apices. The protective influence of the snow-covering cannot, probably, be entirely disregarded in this connection. However, temperature registrations beneath the snow-covering on the one hand, and the frequent local occurrence of the snow-patch species on soil free of snow in the winter on the other hand, strongly suggest that the snow-covering in high-arctic regions is of no great importance as a protection against low temperatures.

In spite of the short duration of the arctic summer a regular succession of aspects as an expression of the sequence of the phenological seasons can be demonstrated for the Northeast Greenland landscape. While in the temperate regions it is a rule that the flowering of each plant community is distributed over different aspects, in Northeast Greenland each community contributes by its flowering to one single aspect. The flowers of spring in the temperate deciduous woods convey an idea of the arctic conditions, though the comparison halts.

Through June, July, and August, the three months with positive temperatures, we may distinguish between the vernal, the æstival, the serotinal, and the autumnal aspect representing the phenological seasons spring, summer, late summer, and autumn.

The vernal aspect is dominated by the vegetation of the dry, snow-free hill-tops and terraces exposed to the wind, composed, in particular, of northern species with a short prefloration time. The summer aspect is principally dominated by the flowering heaths of heather (*Cassiope tetragona* (Fig. 20)) and *Dryas* (Fig. 21). The plant communities which lend colour to the serotinal aspect are on the one hand the luxuriant, damp, south-facing slopes with southern species with a long prefloration time, and on the other hand the newly thawed snow-patches with decidedly northern species with an extremely short prefloration time. The autumnal aspect has no wealth of flowers—only the snow-patches, thawing late and poor in species, still exhibit some flowering plants but it receives its colours from the autumnal hues of the dwarf shrub heaths.

The phenological spring, characterised by the flowering of *Saxifraga oppositifolia*, sets in with only a slight calendar delay from the south towards the north and from the inland towards the outer coast. The flowering of the first *Saxifraga*, stationed as they are on the snow-free hill-tops, depends principally on the insolation. The summer and late summer aspects, however, which in addition depend on the progress of the thawing, are the more delayed in relation to the vernal aspect the farther we proceed northward and the farther we get from the

Phot. G. SEIDENFADEN. No. 1443.

Fig. 20. *Cassiope tetragona* (L.) DON, about 1/2 size. Grønnedal, Clavering Ø, 74°17′ N. lat., July 20, 1930. The chief heath-forming dwarf-shrub, which by its abundance of flowers is of decisive importance for the summer aspect over vast areas.

Phot. G. SEIDENFADEN. No. 1481.

Fig. 21. *Dryas octopetala* L., about 3/4 size. South side of Jordanhill, 74°07′ N. lat., July 27, 1930. Character plant in dry places. The individuals figured, which occurred in a luxuriant mixed heath (*Vaccinium uliginosum*, *Cassiope tetragona*, *Salix arctica*), have larger, less revolute leaves than is normal for the plant in drier wind-swept places.

summer-warm interior of the fjords towards the bleak and damp outer coast.

As already stated, the greater number of the southern species have their northern limit in the inner fjord areas. In the north and towards the coasts of the Arctic Sea the phenological summer sets in so late that flowering or at any rate a regular fructification is no longer possible, and thus a limit will be put to the possibilities of existence of such species.

Sociology.

Vegetation analyses according to RAUNKIÆR's method were made on the expedition, in 1931—32 and 1933 by GELTING on Clavering Ø

Phot. TH. SØRENSEN. No. 3773.

Fig. 22. *Arnica alpina* (L.) OLIN, about $^1/_4$ size. North coast of Traill Ø, 72°45′ N. lat., July 1932. Luxuriant growth on basalt ledges.

and the adjoining mainlands, in 1931—32 and 1934 by SØRENSEN in the Franz Josephs Fjord area, and, finally, in 1933 scattered analyses were made in the Scoresby Sund area. In most of the vegetation analyses at hand, amounting to 600—700 separate analyses, the cryptogamous flora has been taken into account besides the vegetation of vascular plants, mosses and lichens having been collected for later determination. This material has not yet been fully worked up, so the present report can give no satisfactory summary of the plant-sociological results of the expedition.

A loosely sketched treatment of some Northeast Greenland types of vegetation has, however, been given by GELTING (1937, pp. 23—45) in so far as they are of any great importance as food for the East Greenland ptarmigan (see below).

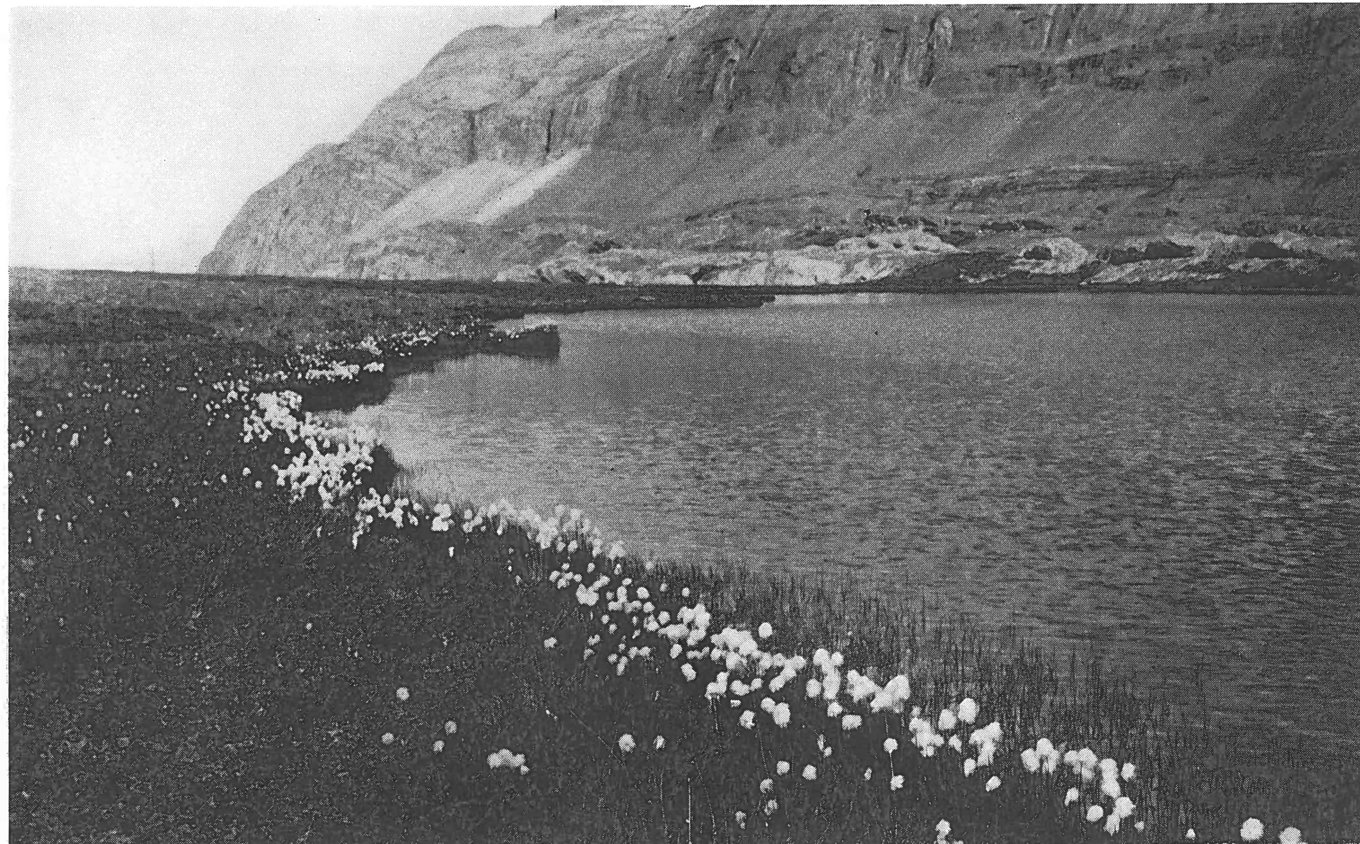
SØRENSEN has given a preliminary synopsis of the types of vegetation found within the northernmost part of the area investigated. The same division was later in a somewhat extended form made the basis of a description of the phenology of the Northeast Greenland vegetation. Here 22 different types of vegetation (ecosystems) are separated, of which some only are represented within the whole area investigated, while others are restricted either to the inner fjord lands or to the coastal areas only. Certain differences may also be observed from south to north, some types disappearing towards the north, while the typically northern types extend relatively far southward, following the outermost coastal tracts.

As a consequence of the preliminary character of the aforementioned vegetation systematics, they will not be treated in more detail here. Until the final treatment of the sociological investigation material of the expedition is available, the reader is referred to the preliminary publications (SEIDENFADEN & SØRENSEN 1937, Chapt. III, SØRENSEN 1941, Chapt. IV).

Other Investigations.

In addition to the purely botanical investigations, the botanists of the expedition have been engaged in various kinds of work which actually fall outside botany in the strict sense, but which indirectly are closely associated with the investigation of the vegetation of the country. Such works are 1) investigations of the solifluction and the problem of polygon soil (SØRENSEN 1935), and 2) investigations of the food of the East Greenland ptarmigan viewed in relation to snow-covering and vegetation (GELTING 1937).

1) The arctic solifluction phenomena are of exceedingly great importance for the vegetation and the distribution of the different types of vegetation. Already SEIDENFADEN (1931), during his pioneer investigations, paid attention to the dependence of the vegetation on moving soil. Not only the recent solifluction plays a part in this respect, but even soil structures produced by solifluction phenomena that have long since ceased still to-day set their mark on the vegetation. The cause of this is that in the long run changes in the water-carrying capacity of the upper layers of the soil will take place during the formation of the earth polygons. By the slow action of solifluction the soil is divided into fields, which consist of very fine-grained and accordingly highly water-binding material in the middle, but towards the margins are chiefly made up of sand and gravel, which permit an effective aeration. The network of grooves separating the fields is as a rule stabilised by a framework of larger or smaller stones, a veritable drainage system being



Phot. G. SEIDENFADEN. No. 3896.

Fig. 23. Lake behind the station on Ella Ø, 72°51′ N. lat., August 1, 1933. The lake is brimmed with *Eriophorum Scheuchzeri*, which is the most conspicuous plant. Stalks of *Carex atrofusca* are seen in the outermost part of the plant belt along the bank, while those visible farther left are mostly of *Eriophorum callitrix*. Otherwise the vegetation consists mainly of *Carices* (*C. pseudolagopina*, *incurva*, *parallela*, *rariflora*, *rupestris*, *subspathacea*), *Juncus triglumis*, *J. biglumis*, and *Eriophorum polystachyum*. In addition *Equisetum arvense*, *E. variegatum*, *Polygonum viviparum*, *Tofieldia palustris*, *Dryas octopetala*, and *Salix arctica* s. l. are of common occurrence.

Phot. G. SEIDENFADEN. No. 3839.

Fig. 24. *Pedicularis hirsuta* L., about $^2/_1$ size. Eastern side of Hurry Fjord, Scoresby Sund, 70°40′ N. lat., July 1, 1933. The plant occurs in localities which become free of snow at highly varying times, so it may be met with in flower all the summer. One of the commonest species within the area.

Phot. G. Seidenfaden. No. 3838.

Fig. 25. *Papaver radicatum* Rottb., about 1/2 size. Granatdal, Clavering Ø, 74°10′ N. lat., July 19, 1933. In the foreground, right, *Chamaenerium latifolium.*

Phot. G. SEIDENFADEN. No. 3837.

Fig. 26. *Oxyria digyna* (L.) HILL, about $^3/_4$ size. Hird Bay, Clavering Ø, 74°10′ N. lat., July 22, 1933. The plant forms vigorous tufts of fresh green (edible) leaves among stones along river banks.

formed for the removal of the thaw-water, which is thus prevented from stagnating. The water is not drained into the depths on account of the permanently frozen soil. It is obvious that the centre of the fields and their marginal zones offer widely different growth conditions for the

Phot. G. SEIDENFADEN. No. 3861.

Fig. 27. *Ranunculus sulphureus* SOLAND., about $^5/_4$ size. Hird Bay, Clavering Ø, 74°10′ N. lat., July 22, 1933. The most well developed individuals occur on highly water-saturated soil affected by solifluction.

vegetation, which, again, is manifested in the peculiarly mosaic-like arrangement so characteristic of the arctic landscape (the pjatnistaja tundra of the Russians).

Through GRIPP's fundamental investigations in Spitsbergen it has been demonstrated that the sorting according to grain-size in the upper layer of the soil and the division of the soil into fields are produced by convection currents in the newly thawed water-saturated mud. The motive power is stated by GRIPP to be a difference in the specific gravity of the various layers owing to a fall of the temperature from the surface, which is assumed to lie at the greatest specific gravity of the water, 4°, to the frozen bottom, which will be approximately 0°.—However, by the investigations in East Greenland during the expedition it was rendered probable that the motive power of the convection currents is not to be found in differences in specific gravity resulting from a fall of temperature towards the constantly frozen layer, but in an increasing content of water in the mud towards the frozen bottom. At any rate during certain stages of the thawing, the layers nearest the frozen substratum are, so to speak, over-saturated with water and accordingly have a much lower specific gravity than the higher-lying layers, which are, indeed, saturated, but not over-saturated. This phenomenon can be traced back to the stratified segregation of ice when the frost penetrates into the soil in the autumn. Thus it is evident that only a detailed investigation of the mode of deposition in the frozen soil can in the last instance provide a clue to the final solution of the problem of the arctic soil structures.

During the wintering on Clavering Ø in 1934—35 the present author continued the investigation of frozen soil profiles combined with collection of series of soil samples and determinations of the water content and the size of the grains. The partial working up of the material carried out so far seems fully to confirm the above-mentioned explanation of the convection movement and the formation of polygons. The size of the polygons depends on the water content and the depth to which the thaw has penetrated. Furthermore it appears from the investigation that the greater number of the Northeast Greenland earth structures are no longer "alive", but must be regarded as subfossil. This is an incontestable proof that the precipitation of the country was much more abundant in earlier post-glacial time than it is at present.

2) From GELTING's investigations of the crop contents of the East Greenland ptarmigan (*Lagopus mutus*) it appears that the most important fodder plants of this bird in the winter are *Salix arctica* (Fig. 28) (buds), *Dryas octopetala* (young leaves), and *Saxifraga oppositifolia* (apices of shoots), in the summer, however, *Polygonum viviparum* (Fig. 29) (bulbils). The absolutely most important winter food of the bird seems to be *Salix arctica.* In the interior fjord regions the area of dominance of this species is associated with ground covered with snow in the winter, while along the outer coast it is common on snow-free soil. *Dryas* and especially *Saxifraga* occur in places exposed to the wind, and after snowfalls not combined with strong winds only these two species, or even only *Saxifraga*, will as a rule be so free from snow that they are accessible to the ptarmigan. The *Salix* areas will then be covered with

Phot. G. SEIDENFADEN. No. 1442.

Fig. 28. *Salix arctica* PALL., about 1/2 size. Grønnedal, Clavering Ø, 74°17′ N. lat. One of the commonest, very polymorphic species of the area, which occurs in widely different plant communities.

Phot. G. SEIDENFADEN. No. 3847.

Fig. 29. *Polygonum viviparum* L., about $^1/_1$ size. Kap Broer Ruys, Hold with Hope, 73°30′ N. lat., August 15, 1934. The stalk to the left bears mainly bulbils, while that to the right shows a greater abundance of flowers. Only vigorous individuals develop flowers.

snow, but will be accessible again after the first gale. *Saxifraga*, therefore, is of essential importance for the diet of the ptarmigan as food in emergencies when the snow-covering prevents its access to the food plants preferred.

Polygonum, which to a certain extent is a snow-patch plant, will not be accessible till the actual melting of the snow has commenced in the spring. Once it has appeared, it is so absolutely preferred by the ptarmigan above all the other plant species of the country that it is the only one which plays any great role in the summer diet of the bird.

An analysis of the nutritive value of the crop contents shows that the summer diet (*Polygonum* bulbils) is especially rich in proteins, while the winter diet (*Salix*, *Dryas*, *Saxifraga*) is relatively rich in fat. Moreover the analyses have rendered probable the physiologically surprising phenomenon that by means of the only half-unfolded leaves persisting during the winter *Dryas* begins to assimilate as early as March, that is to say, even before the insolation temperatures at the surface of the soil become positive.

According to the seasonally changing accessibility of these most important fodder plants the ptarmigan undertakes yearly migrations.

Thus in the winter it migrates towards the snow-free *Salix* areas of the coastland. In the spring it goes back to the interior of the fjords again, where the earlier melting of the snow first affords access to the *Polygonum* growths which provide the ptarmigan with its favourite diet. In the course of the summer the ptarmigan migrates into the mountains, following the melting of the snow, which constantly bring to light fresh growths of *Polygonum*. However, at the first snowfall in the autumn, which at once covers the snow-patch communities in the depressions, the bird must again migrate to the coast and be content with the resources of that part of the country.

Algology.

The algological collections were made in the period June 27th to August 28th, 1933, by the algologist S. Lund from the expedition ship "Godthaab", which had been placed at the disposal of the expedition for marine investigations. As the main stress was laid upon the marine zoology, the position of the stations was determined from faunistic considerations. This, of course, in some cases resulted in a disregard of botanical interests, but did not prevent the fulfilment of the algological programme: to gain an idea of the marine flora of the fjords viewed in relation to the depths and the character of the bottom, as well as the distance of the localities from the open sea.

In the Scoresby Sund area (70°—71° N. lat.) the algological collections comprise seven localities in which series of samples from different depths were taken; they were situated between the mouth of Scoresby Sund near Kap Tobin and the head of the fjord complex near Røde Ø about 250 km from the mouth of the sound. Smaller collections are at hand from some few additional localities.

Within the Franz Josephs Fjord area (73°—74° N. lat.) serial collections were made at the mouth of Dusén Fjord and at its head, and near Ella Ø. A few scattered samples from other localities within this area are likewise at hand (cf. the map Pl. 1).

In addition to the systematic collections made by S. Lund, some few more casual collections were made by G. Seidenfaden, the northernmost one in Grandjean Fjord in 75° N. lat.

The material collected is preserved partly in alcohol or formol partly in a herbarium state, and comprises c. 500 glass vessels with a number of species (c. 10) in each and c. 350 herbarium specimens. To these must be added c. 200 (estimated) samples of dried crustaceous algæ on stones.

The material is being worked up by the collector, and though it is not yet finished, the greater part of the floristic results are fairly clear. According to information kindly placed at my disposal by S. Lund the results may be briefly summarised as follows: The number of specifically determined sea algæ from East Greenland was computed by ROSENVINGE (1910) to be 124. By the investigations of the expedition this figure was increased by 19, viz. 3 Rhodophyceae, 15 Phaeophyceae, and 1 Chlorophycea. Of these 19 species, only six were previously known from West Greenland, while thirteen are new to Greenland and four of these new to science.

As regards the species hitherto known from East Greenland, the examination of the material, in so far as it has been completed, has resulted in 18 new northern limits and one new southern limit.

Of the more special systematic problems studied on the basis of the collections, an investigation of the identity of *Lithoderma fatiscens* ARESCH. and *L. fatiscens* KUCK. has been published (LUND 1938). From this investigation it appears that *L. fatiscens* KUCK c. spor. pluriloc. and *L. fatiscens* c. spor. uniloc. belong to the same species, while *L. fatiscens* ARESCH. c. spor. pluriloc., in spite of its vegetative agreement in the structure of the crust with the aforementioned species, is supposed to differ specifically from the latter on account of the lateral position of the plurilocular sporangia on the free cell filaments, and is probably synonymous with *Ralfsia ovata.*

For the total results of the algological investigations carried out on the expedition, the detailed floristic as well as the phytogeographical results, the reader is referred to the forthcoming paper by S. LUND, for which the manuscript is in preparation.

C. 15 samples of plankton are at hand from the different localities visited. These samples have been handed over to Professor O. PAULSEN for examination and description, but have not yet been worked up.

Six water samples taken between N. Iceland and Greenland in the days June 23rd—25th, 1933, have been examined for phytoplankton by E. STEEMANN NIELSEN (1935, p. 41, and map No. 4).

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FROM THE EXPEDITIONS

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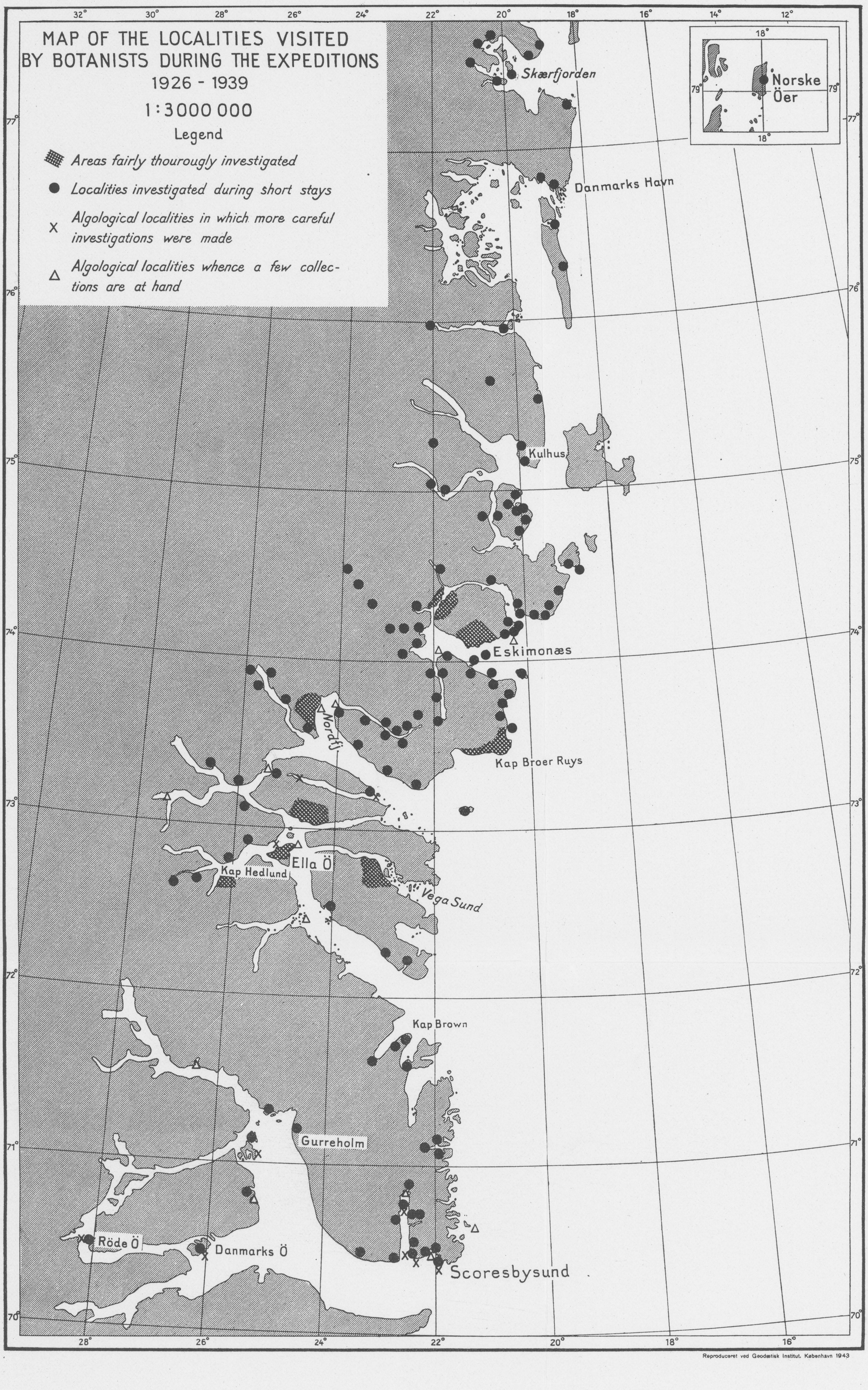

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