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THE SCORESBY SOUND COMMITTEE'S 2ND EAST GREENLAND
EXPEDITION IN 1932 TO KING CHRISTIAN IX.s LAND

LEADER: EJNAR MIKKELSEN

STUDIES ON THE VEGETATION OF THE
EAST COAST OF GREENLAND

BETWEEN SCORESBY SOUND AND ANGMAGSSALIK
(CHRISTIAN IX.s LAND)

BY

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WITH 27 FIGURES IN THE TEXT AND 6 PLATES

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INTRODUCTION

In a former article (T. B. 1933)¹⁾ I have given an account of the floristic results obtained in the course of the Scoresby Sound Committee's 2nd East Greenland Expedition. The present article comprises the ecological results of this expedition, also including a description of the individual localities. It is meant as a connecting link between the investigations from the Scoresby Sound area (HARTZ 1895) and those from the Angmagssalik area (KRUUSE 1911). In my former article I further gave an account of the distribution of the communities of plants on the coast stretch investigated, and it proved that there is a phytogeographical boundary on the coast in the region round Store Glacier 68°48', and that the communities of plants were largely distributed round this boundary, so that on the coast one can speak of a northerly and a southerly group of communities. In my investigations I have, besides the said articles by HARTZ and KRUUSE, chiefly used works by WARMING (1888), RÜBEL (1930) and BRAUN-BLANQUET (1928) (see List of Literature). The figures in black refer to the individual sociological investigations in the following.

¹⁾ Phytogeographical Studies of the Greenland Flora, based upon Investigations of the Coast between Scoresby Sound and Angmagssalik (in the following quoted as T. B. 1933); a preliminary review of the material is found in The Geographical Journal, Vol. LXXXI, No. 5, May 1933, pp. 400—402.

THE LOCALITIES¹⁾

In order to facilitate the general view I will here to indicate the individual areas use the same letters, as were used in the floristic section. I therefore pass over locality A (Scoresby Sound) and locality B (Turner Sound) and begin with locality C (the Cape Dalton region) where the expedition commenced its work.

Loc. C.

C. a. Cape Dalton, 69°25'. Here reference is made to KRUUSE and HARTZ 1911, pp. 345—348. In this locality KRUUSE (1900) observed "that the lowland surrounding the lagoon, as well as the littoral region, was totally devoid of vegetation". This was also very largely the case in 1932; however, on a gravel wall at the outflow of the river, a lichen-moss-heath had formed with a few dominating phanerogams (No. 65). Round the depot house of the Amdrup Expedition there was a fine blow of the ordinary fell-field plants, more particularly *Ranunculus glacialis*, *Saxifraga cæspitosa*, *S. cernua*, *S. oppositifolia*, *Cerastium alpinum*, *Oxyria digyna*, *Salix herbacea* and *S. arctica* × *glauca*.

The rich mountain vegetation on the terraces of the basalt mountain behind the lagoon can be divided into four elements: The heath, consisting of *Cassiope tetragona*, *Vaccinium uliginosum* and *Salix*, here and there interspersed with *Empetrum nigrum* var. *hermaphroditum*, *Cassiope hypnoides* and *Dryas octopetala*; the herb-field, chiefly consisting of *Carex rigida*, *Salix herbacea*, *Polygonum viviparum*, with many different species in the different mountain localities (No. 19); moss-moor with about 10 phanerogams, more particularly *Saxifraga stellaris* var. *comosa*, *S. rivularis*, *Cerastium trigynum*, *Ranunculus sulphureus*, *R. pygmaeus* and *R. hyperboreus*; and, finally, fell-field with *Luzula confusa*, *Oxyria digyna*, *Silene acaulis*, *Minuartia biflora*, *Trisetum spicatum* etc.

Where the basalt is superimposed by a layer of sandstone, there is, at a height of about 300 m above sea-level, a fell-field plateau, where *Papaver radicatum* was almost the only species.

¹⁾ See the map plate 6. Compare also EJNAR MIKKELSEN'S Report on the Expedition.

C. b. From Cape Dalton we made a motor-boat trip to a small fjord north of lat. $69^{\circ}33'$. Within a very short time the following species were registered as growing on the southern slope: *Equisetum arvense*, *Cystopteris fragilis*, *Minuartia biflora*, *Cerastium alpinum*, *Silene acaulis*, *Arabis alpina*, *Draba rupestris*, *Oxyria digyna*, *Polygonum viviparum*, *Sibbaldia procumbens*, *Sedum roseum*, *Saxifraga oppositifolia*, *S. cernua*, *S. nivalis*, *S. caespitosa*, *Salix arctica* $\times$ *arctophila* $\times$ *glauca*, *Salix herbacea*, *Chamænerium latifolium*, *Empetrum nigrum* var., *Vaccinium uliginosum* var., *Veronica alpina*, *Pedicularis hirsuta*, *Euphrasia latifolia*, *Campanula rotundifolia*, *Taraxacum croceum*, *Antennaria alpina*, *Eriogon unalaschkensis*, *Poa alpina* f. *vivipara*, *Poa arctica* and *Peltigera rufescens*.

C. c. Cape Ewart, $69^{\circ}22'$. On the west side of the cape towards the small sea-bay the following plants were recorded, being distributed in the following manner:

1) farthest down at the bay the sloping substratum consisted of moving soil; great masses of stone lay in very long walls, parallel with the direction of the slope, or forming long U-shaped tongues. In the moist clay between the boulders there grew scattered individuals, particularly *Sauteria alpina* (Marchantiaceae), *Phippsia algida*, *Luzula confusa*, *Ranunculus glacialis*, *Oxyria digyna*, *Saxifraga cernua*, *S. nivalis*, *Ranunculus pygmaeus*, *Salix arctica* and secondarily, *Saxifraga oppositifolia*, *Minuartia biflora*, *Cerastium trigynum*, *Trisetum spicatum*, *Poa alpina* and *Arabis alpina*.

2) Higher up (about 100 m above sea-level) where the solid rock peeped out of the debris, small patches of heath-like vegetation had formed, being particularly rich in mosses and lichens — *Cassiope tetragona*, *Vaccinium uliginosum* var., *Salix arctica*, *Salix herbacea*, *Cerastium alpinum*, *Luzula confusa*, *Minuartia biflora* and *Poa arctica*. The lichens were: *Cetraria Delisei*, *Cladonia coccifera* var. *stematina*, *Cl. mitis*, *Cl. lepidota* var. *stricta*, *Pertusaria oculata* and *Solorina crocea*; and the mosses: *Rhacomitrium canescens*, *Drepanocladus uncinatus*, *Dicranum scoparium* var. *orthophyllum* and *Scapania mucronata*, which latter according to HARMSSEN (1933) is new to East Greenland.

Loc. D.

D. a. Hot spring in Knighton Bay — about lat. $69^{\circ}20'$ N. From this interesting locality the cartographers of the expedition brought back a quantity of moss cushions and gelatinous lumps of algæ, collected at the outflow of a spring (50 — 60° C.). The species found in the moss were primarily *Epilobium palustre* (see T. B. 1933 p. 16), and secondarily *Epilobium anagallidifolium*, *E. lactiflorum*, *Euphrasia latifolia*, *Salix herbacea*, *Sedum roseum* and *Equisetum arvense*. The moss more

particularly consisted of: *Drepanocladus lycopodioides*, *Calliargon stramineum*, *Aulacomnium palustre* and *Sphagnum quinquefarium*.

D. b. Eastern slope towards Knighton Bay, 69°17'. Heath 120 m above sea-level. Small patches of *Cassiope*-heath, in which more particularly *Salix arctica* × *arctophila* × *glauca* and *Vaccinium*, besides *Empetrum*, *Luzula confusa*, *L. spicata*, *Poa arctica*, *Trisetum spicatum* and, as intermixtures, *Festuca ovina*, *Carex nardina*, *Draba alpina*, *Silene acaulis*, *Cerastium alpinum*, *Saxifraga caespitosa* and a few stunted specimens of *Chamænerium latifolium*.

D. c. Cape Barclay, 69°14'. The vegetation was distributed in the same manner as at Cape Ewart. Very nearly the same species were recorded, and besides these *Cardamine bellidifolia*, *Papaver radiculatum*, *Saxifraga tricuspidata*, *S. caespitosa*, *Carex nardina*, *Cassiope hypnoides*, *Pirola grandiflora*, *Draba alpina*, *D. nivalis*, *D. crassifolia* × *nivalis*? and *D. crassifolia* × *lactea*? (compare E. EKMAN 1933 p. 101). In some localities the rock was dark with *Andreæa Blytii*. The lichens particularly recorded were *Solorina crocea* and *Cladonia coccifera*. On moving soil grew *Sauteria alpina* and *Bryum inclinatum*.

D. d. Rock vegetation of south-western exposure, in front of a steep wall, 200 m above sea-level, at the small sea-bay behind Cape Barclay, 69°16'. Inclination 45—55°. Near a small mountain lake, still frozen over (13. July). *Cerastium alpinum*, *Silene acaulis* f. *albiflora*, *Draba alpina*, *D. nivalis*, *Polygonum*, *Oxyria*, *Sibbaldia procumbens*, *Potentilla Crantzii*, *Sedum roseum*, *Saxifraga nivalis*, *S. tricuspidata*, *Empetrum*, *Vaccinium*, *Pedicularis hirsuta*, *Veronica alpina*, *V. fruticans* (vegetative), *Campanula rotundifolia*, *Taraxacum croceum*, *Erigeron uniflorus*, *Antennaria alpina*, *Carex rigida*, *C. scirpoidea*, *C. nardina*, *Luzula confusa*, *L. spicata*, *Poa alpina*, *P. arctica* and *Trisetum spicatum*. Farther down the mountain there were small heath-patches with *Cassiope tetragona*.

D. e. Rock-vegetation of south-western exposure in front of a steep wall towards Barclay Bay 69°16'. Besides a number of the species mentioned in the preceding localities there were *Euphrasia latifolia*, *Carex capillaris*, *Festuca ovina* and *Juncus trifidus*.

All in all, the region round Cape Barclay and Barclay Bay is more desolate than almost any other part along Blosseville's Coast. There was no continuous cover of vegetation of any extent, only a few square metres of heath or a strip of herbs in front of a wall facing south. Everything bore the impress of a great drought, and this possibly has some connection with two very productive glaciers, which debouch into the head of the bay and, beyond a doubt, always fill it with ice. It was therefore quite surprising to see that there was a great deal of vegetation even on the top of Cape Ryder and the mountains south of 69°05'—08' (observed through a telescope).

Loc. E.

d'Aunay Bay, 69°05'. In the interior part of this sea-bay there was a particularly luxuriant vegetation on the south-eastern slopes of the mountains, 300—400 m above sea-level. The vegetation on the terraces was distributed as at Cape Dalton, there being a constant interchange between dry heath, rich in lichens (*Vaccinium*, *Salix arctophila* × *glauca*, *Cassiope tetragona*) (No. 58) and moist moss-moor, herb-field and heath. The interchange of these communities depends on the terraces and the manner in which the snow has been distributed in winter (see fig. 26 B). The moors were moss-tufts with a dense vegetation of *Salix arctophila* × *glauca*, *Pedicularis lapponica*, *Polygonum* and *Vaccinium* (plate 3, fig. 1). For further particulars see Nos. 20, 36 and 58. In the patches of heath *Arnica alpina* (fig. 7) often occurred, and also *Cassiope tetragona*, whereas *Empetrum* was not frequent. Finally, collections were made of *Arctostaphylos alpina*, *Dryas octopetala*, *Draba cinerea* f. *angustisiliqua*, *Draba lactea* and, of southern species, *Bryanthus coeruleus*, *Hieracium alpinum* and *Juncus trifidus*.

Loc. F.

The bay south of Store Glacier, lat. 68°48'. On the Amdrup Expedition in 1900, 25 phanerogams were collected in this locality. HAROLD WAGER brought me a great number of these 25 species, collected on a fertile mountain slope of southern exposure at a height of 500—800 m above sea-level, and besides these the following: *Viscaria alpina*, *Sedum villosum*, *Saxifraga aizoon*, *Veronica fruticans*, *Festuca rubra* f. *vivipara*(?) and *Woodsia ilvensis*. From the outflow of a warm spring at Cape Beaupré (68°52') I further received *Sagina Linnæi*, *Trisetum spicatum* and *Cystopteris fragilis*. The water of the spring was about 38° C.

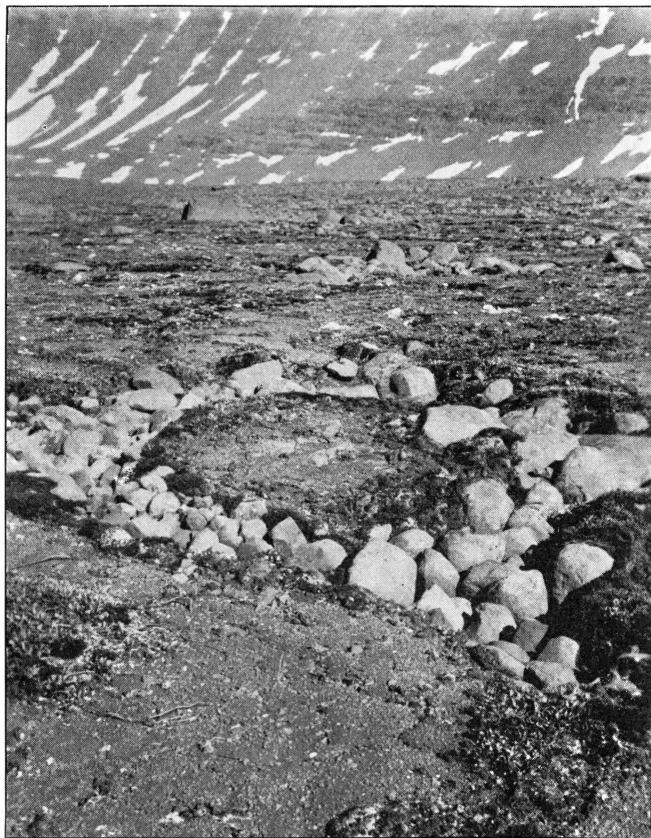
Loc. G.

The bay north of Cape Daussy, 68°43'—44'. This little sea-bay continues towards northeast in a lagoon and an ice-free valley, extending over a distance of several kilometres inland. Although the bay is so close to the open sea, there is a comparatively rich vegetation both in the valley and on the southeastern slope of the mountain.

1) Vegetation in the bed of the valley.

The greater part of the area is occupied by a heath-vegetation, rich in lichens and formed along the stone rings in the particularly well-developed field of moving soil (fig. 1). Where the ground became lower and the movement in the soil greater, the characteristic heath-plants (*Salix arctophila* × *glauca*, *Vaccinium*, *Polygonum*, *Stereocaulon alpinum* and *Cetraria Delisei*) were ousted, and a number of fell-field herbs took their place and increased in frequency, compare table 22.

Here and there the said heath changed into moss-moor and moss-tuft moor. In the latter type of vegetation the moss-tufts were densely covered by *Polygonum*, *Carex rigida* and *Salix herbacea*; further, *Salix arctophila* $\times$ *glauca*, *Vaccinium*, *Empetrum*, *Pedicularis flammea* and *P. hirsuta* were of common occurrence. The tufts were 30 cm high and very elongated; between the tufts in the moss grew *Equisetum arvense* var.



T. B. phot.

Fig. 1. Stone-ring in moving soil, in the valley north of Cape Daussy.

rivulare (see figs. 9, 10, HARMSSEN 1933). Near a small water-hole which had apparently been greater in the spring, a small community had formed in the now dried-up clay surface beside it; the earth was split up into fine polygons, 40—60 cm in diagonal. In the moistest places the polygons were covered with moss, in which *Equisetum arvense* var. *rivulare*, *Salix herbacea* and *Phippisia algida*; in the cracks between the polygons there was a luxuriant growth of *Koenigia islandica* (see table 31 and plate 4, fig. 1). The lagoon and the little water-hole were entirely devoid of vegetation (with the exception of a few green algæ).

2) The southeastern slope of the mountains.

Everywhere the heath-vegetation dominated, and herb-field only occurred as an association fragment. The heath consisted of *Vaccinium* and *Empetrum* and was very dry (No. 59), and *Cassiope tetragona* was lacking everywhere. In a few rather moist places in the heath *Carex rigida*, *Salix herbacea* and *Polygonum* were added as dominants, being intermixed with *Cassiope hypnoides*, *Bryanthus coeruleus*, *Lycopodium selago* and *Bartschia alpina*. In a moor 300 m above sea-level there were great quantities of *Ranunculus affinis*. On the slope of the mountain there were finally a few rarer species viz. *Viscaria alpina* (plate 3, fig. 2), *Arctostophylos alpina* and *Carex alpina*.

Loc. H.

H.a. The fjord between Cape Ravn and Cape Johnstrup, about 68°31'¹). Already at a distance it was observed that there were extensive areas covered with vegetation on the southern slopes of this fjord. On the terraces of the basalt mountains large continuous patches were visible at a height of 150—350 m above sea-level. A succulent light-green colour suggested a rich herb-field vegetation and, when examined, it proved to consist of *Alchemilla glomerulans* and *A. alpina* covering extensive areas. The herb-field here attained a development and a wealth of species as nowhere else on the coast, and comprised a very large contingent of southern species (compare: T. B. 1933). Its composition and various sociations (= Facies, DU RIETZ 1930) will be mentioned on a later occasion (p. 37). The mountains at the head of the fjord, behind the glaciers, were covered with a similar vegetation, as appears from the list of species from a pronounced Sydberg in this place (pp. 32—33 in my afore mentioned article). A development which was at least as powerful as that of the herb-field was attained by the *Vaccinium-Empetrum*-heath, which consisted of a quantity of various sociations, compare Nos. 42 and 43. Worthy of notice was in particular a heath-association with *Scirpus caespitosus*, *Vaccinium* and *Empetrum* dominating, in which very frequently also *Pinguicula vulgaris*, Nos. 44 and 52. Owing to the character of the enormous quantity of debris, there was no vegetation at less than 150 m above sea-level, where only here and there between the blocks there was a possibility of a little soil gathering. The only place where there was vegetation below the height mentioned was near a spring 75 m above sea-level. In the thick layer of moss, more particularly consisting of *Aulacomnium palustre*, *Dicranum fuscescens*, *Drepanocladus lycopodioides*, *Philonotis calcarea*, *Pohlia nutans*, *Polytrichum alpinum* and *Sphagnum plumulosum*, there grew specimens of *Taraxacum croceum*, *Alchemilla filicaulis*, *Phleum alpinum*,

¹) = Wiedemann's Fjord, see fig. 12 in E. MIKKELSEN 1933 (b).

Polygonum, *Epilobium anagallidifolium*, *E. lactiflorum* and secondarily *Equisetum arvense*, *Salix herbacea*, *S. arctophila* × *glauc*a, *Sibbaldia procumbens*, *Cardamine pratensis* (flowering), *Veronica alpina*, *Saxifraga rivularis*, *Cerastium trigynum*, *Juncus biglumis*, *Carex Lachenalii* and *Poa alpina* var. *vivipara*. The water of the spring was 5—6° (C.) (see fig. 11 HARMSSEN 1933). As to the débris vegetation see p. 48.

H. b. Cape Johnstrup. No vegetation worth mentioning until at a height of 420 m above sea-level, where the following species were recorded in a moist heath-slope: *Cassiope hypnoides*, *Vaccinium*, *Empetrum*, *Salix arctica* × *arctophila* × *glauc*a, *Polygonum* and, secondarily, also *Cerastium alpinum*, *C. trigynum*, *Viscaria alpina*, *Saxifraga cernua*, *Chamænerium latifolium*, *Epilobium lactiflorum* (in clay between the blocks), *Veronica alpina*, *Bartschia alpina*, *Bryanthus coeruleus*, *Antennaria alpina*, *Taraxacum croceum*, *Luzula spicata*, *L. confusa* and *Trisetum spicatum*. Also *Minuartia biflora*, *Sagina intermedia*, *Ranunculus pygmæus*, *Carex Lachenalii*, *C. capillaris* and *Poa glauca* were recorded elsewhere.

H. c. Cape Ravn. Débris of basalt boulders, scattered fell-field herbs: *Oxyria*, *Trisetum*, *Saxifraga cæspitosa*, *S. oppositifolia*, *S. nivalis*, *S. cernua*, *Arabis alpina*, *Cerastium alpinum*, *C. trigynum*, *Minuartia biflora*, *Salix arctica* × *arctophila* × *glauc*a, *S. herbacea*, *Agrostis borealis* and *Poa alpina*. Besides a number of the plants mentioned above, HAROLD WAGER collected *Cystopteris fragilis*, *Woodsia ilvensis*, *Carex nardina* and *Poa glauca* at a height of 650 m above sea-level.

H. d. Wiedemann's Mountains. Nunatak region behind Cape Ravn. From the very desert fell-field vegetation in that place HAROLD WAGER brought back *Papaver radicum*, taken at a height of 460 m above sea-level.

The Kangerdlugssuak area.

Loc. I, J and K.

See the map fig 2, p. 25 in T. B. 1933. Kangerdlugssuak is the only fairly large incision in the coast between Scoresby Sound and Angmagssalik. It extends from 68° to 68°40' and has two arms, a westerly, Am-drup's Fjord, and an easterly, Watkins Fjord. Farther out lies Kraemer's Island, and between this and the continent the narrow Uttental Sound. At the outer mouth of this sound lies Skærgaard Peninsula. From the hinterland east of Watkins Fjord a valley extends in a southerly direction, this valley being a natural continuation of Miki's Fjord. It seems natural first to mention the vegetation in this valley and Miki's Fjord.

Miki's Fjord — the valley between Miki's Fjord and Watkins Fjord.

(I and II in fig. 2, T. B. 1933.)

Miki's Fjord, 68°10', first bends in an easterly and then in a northerly direction and is being continued in the valley mentioned above. The

parts which bore vegetation were partly a very extensive area on the southern slope of the fjord, and then the valley with its western and eastern slopes. Conditions were greatly reminiscent of what has been mentioned for locality H.; only, the areas were greater and the southern communities of plants, viz. the *Alchemilla glomerulans*-association and the willow-copse more pronounced. Whereas in locality H. the vegetation was chiefly to be found immediately in front of the steep wall of a terrace, the whole terrace in this place was covered, more especially



T. B. phot.

Fig. 2. View from the interior of Miki's Fjord. Walls of marginal moraine. Size indicated by the vessel of the expedition, the "Søkongen", lying out in the fjord.

with luxuriant *Vaccinium-Empetrum*-heaths, and the vegetation here extended all the way down to the fjord (see fig. 5 in T. B. 1933).

On a headland with low, rounded rocks round Eskimo house-ruins there was a vegetation distinctly characterized by manure and kitchen midden, particularly with *Oxyria* and *Sibbaldia*, *Cerastium trigynum*, *C. alpinum* and *Trisetum*. Across the ruins spread a thick carpet of vegetation, where the roots and the many seal bones were hardly to separated from one another. The *Salix* shrubs which grew on the ruins were 25—35 years old, which signifies that it is at any rate so long since human beings had been living here. About 50 per cent of the *Oxyria* individuals were attacked by *Ustilago vinosa* (LIND 1933); in the course of the excavations we found a sealskin bag containing the purplish

spore-powder of *Ustilago* which may have been used by the Eskimos, for instance as a dye-stuff. The plants affected by this disease had undergone a change, the stems being drier and hollow.

At the head of the fjord, near the innermost sharp bend, there are two glaciers on the western slope of the mountains which in former times projected themselves into the fjords, as is shown by some very pronounced marginal moraine walls left there (fig. 2). Only the moraine to the north has left a complete semicircle of walls, while the southern one is contiguous with the other semicircle by a small section of the circle in the interior of the fjord, and in the exterior part it has, as it does now, calved in the fjord. Three stages of stagnation in the northern glacier are visible. The walls were 2—4 m above sea-level. Only here and there, on the uppermost dry part with no moving soil, there were patches with a scattered heath vegetation rich in lichens, more particularly with *Salix arctophila* $\times$ *glauca*. The walls of the moraine were, at the end of August, teeming with passing waders; therefore, there were many birds' excrements, and this undoubtedly conditioned the luxuriant growth of a *Draba* species (*D. cinerea* $\times$ *rupestris*?), *Oxyria* and *Trisetum spicatum*, which are also of common occurrence in kitchen middens. The total number of phanerogams recorded amounted to 24, the following being of very common occurrence: *Salix arctophila* $\times$ *glauca*, *Oxyria*, *Trisetum*, *Sagina intermedia*, and of lichens *Cladonia coccifera*, *Cl. pyxidata*, *Stereocaulon*, *Peltigera rufescens*. Common were: *Saxifraga oppositifolia*, *S. caespitosa*, *S. rivularis*, the *Draba* species, *Phippsia algida*, *Chamænerium latifolium* (without flowers), *Salix herbacea*, *Empetrum*, *Vaccinium*, *Antennaria alpina*, *Erigeron* sp. (without flowers), *Poa glauca*, *P. alpina*, *Luzula confusa*. Rare were finally: *Cerastium trigynum*, *Arabis alpina*, *Taraxacum croceum* (without flowers), *Sibbaldia*, *Carex nardina*, *Juncus trifidus* and *Peltigera leucophlebia*. The mosses found were: *Drepanocladus revolvens* and *Polytrichum* sp.

Many of these species were only vegetative; the greater part favoured the most elevated parts, and only *Phippsia* and *Sagina intermedia* occurred by preference in the low, moist parts. One might here form an estimate of the manner in which the immigration of the species to these walls had taken place. The distance to the nearest continuous patch of vegetation was 800—1000 m. The two *Salix*-species, *Chamænerium*, *Erigeron*, *Antennaria*, *Taraxacum* and *Stereocaulon* may have been carried from there by the wind; *Cerastium trigynum* may have been brought by the birds, more particularly siskins, seeing that these birds lived on the seeds of *Cerastium* species (examinations of the contents of their intestines, by MÖHL HANSEN), for which reason they were always found in great quantities in moss-moor and snow-patch vegetation with *C. trigynum* or at kitchen middens with *C. alpinum* and

C. trigynum. *Empetrum* and *Vaccinium* I saw washed ashore in great quantities, carried out by the many rivers which flow through the vegetation on the mountain slopes farther inland. The water was almost fresh behind the semi circle, and it is therefore possible to imagine a transport taking place in this manner with the current. When counting the yearly rings on the thickest willow-trunk growing on the walls, the result attained was about fifty-three years, the trunk being $2-3\frac{1}{2}$ cm in diameter. Thus it is at least fifty years since the immigration to these moraine walls commenced. There is a great possibility of botanists visiting this place in future years, and it would then be a fitting task to compare conditions now with conditions later on.

The valley between Miki's Fjord and Watkins Fjord bears a rich vegetation, more particularly the west-southwestern slopes of the mountains, where the terraces are characterized by luxuriant herb-field, heath and small willow-copses; farther down the cover of plants consists of débris-vegetation with *Equisetum variegatum* (No. 27) and river-bank vegetation with *Chamænerium latifolium*. The bed of the valley mostly consisted of a very large river plain with snow-patch communities, consisting of mosses in which scattered, but very frequent *Carex Lachenalii*, *Cerastium trigynum* and *Oxyria*, besides *Saxifraga oppositifolia*, *S. caespitosa*, *S. nivalis* and *S. rivularis*. Other snow-patch associations with *Salix herbacea* and *Carex rigida* were also frequent; similar associations occurred in the river-deposits and in level, fairly moist soil with *Salix herbacea* and *Equisetum variegatum* dominating or with *Carex rigida* and *Chamænerium*. Towards the west the valley was intersected by many narrow ravines across the direction of the valley; in such ravines there was frequently a small river with a wealth of *Chamænerium*, *Salix herbacea*- and *Cassiope hypnoides*-associations and herb-field as an association fragment right up to the south wall of the ravine. The vegetation on the slopes facing east consisted farthest out towards Miki's Fjord of *Vaccinium-Empetrum*-heath; farther in, the mountains were too steep to carry vegetation. Many waterfalls plunged downwards from the great heights, on whose peaks the masses of snow were melting. About midway of the valley a glacier begins, which in front of it has some melting lakes and some large moraine areas. Here, for the first time, we saw a small lump of *Cassiope tetragona* (about 180 m above sea-level) and a specimen of *Saxifraga aizoides*. The glacier was easily traversed, but in one place there was a rather broad hole, about 80 m deep, which was not visible, until we were quite near it. We left the glacier in the place where it curves towards northeast, crossed a small Gabbro ridge and, standing on the latter, we looked across the hinterland at Watkins Fjord.

Hinterland east of Watkins Fjord.

(III and IV in fig. 2, T. B. 1933.)

Just as the geological conditions were now changing from basalt to gneiss, in the same manner there was a sudden change in the vegetation, though chiefly on account of the desert-like drought, which left its impress on this inland. We walked in a sea of boulders, where only *Luzula confusa* and a few *Saxifraga*-species were able to live. The sun warmed the polished, rounded rocks (12° C. at 2 p. m. on 22. August). There were here two lakes of rather large dimensions (about 1 km in diameter), both entirely without vegetation and very cold, as glaciers were calving into them¹). Besides these greater lakes there were some which were quite small, and where no glaciers calved. Here there was life, although consisting of very few and simple elements: the lowest grade was represented by some freshwater algæ, Diatomaceae, and particularly one moss-species *Drepanocladus aduncus* f. *aqvatica*, which grew on the stones and filled the water with detritus. The water swarmed with a small red Daphnie-species, which undoubtedly provided food for a small fish of a salmon species, and this in its turn was pursued by a diver's family. Everywhere there were many fresh bear tracks; the polar bear evidently uses this region as a convenient short cut between Miki's Fjord and Kangerdlugssuak. At the camping site near the eastern lake there was on the southern slope a little heath-vegetation, in which *Loiseleuria procumbens* frequently occurred. On the top of the small ridge there grew in particular *Cassiope tetragona* and *Diapensia lapponica*.

North of this ridge lies a desert valley with a river, which drains a couple of glaciers towards the east. On the southern slope of this valley there was, in one locality, a luxuriant vegetation, which is mentioned in T. B. 1933 p. 37. The vegetation extended from the bed of the valley (300 m above sea-level) to the top of the ridge (500 m) and chiefly consisted of luxuriant, varying heath, of herb-field and small willow-copses²). Besides the ordinary species, which everywhere form

¹) The eastern of these lakes lay at a height of 300 m above sealevel, and was connected with the lower lying western one by a river with a water-fall. The only possibility of an outlet from these lakes must be into Watkins Fjord; however, we could see no outlet from the western lake; but there is reason to suppose that the water finds its way below the glacier to the west of this lake, between it and the fjord.

²) From the top of the mountain there was a view across a very large area of Kangerdlugssuak; in particular it was interesting to observe the glaciers, which here joined one another and united into the very productive glacier draining into the northeastern corner of Watkins Fjord. The greater of these passes through a very large valley trending north, and is surely in direct communication with the Inland Ice, where at the last it trends towards northeast; in the horizon the Inland Ice wa

the staple elements of the vegetation, the following were recorded from this locality: *Lycopodium alpinum*, *L. annotinum*, *L. selago*, *Woodsia ilvensis*, *Draba rupestris*, *Bryanthus coeruleus*, *Rhododendron lapponicum*, *Cassiope tetragona*, *C. hypnoides*, *Loiseleuria procumbens*, *Diapensia lapponica*, *Campanula rotundifolia*, *Bartschia alpina*, *Gnaphalium supinum*, *Pinguicula vulgaris*, *Scirpus cæspitosus* var. *austriaca*, *Carex pedata*, *Phleum alpinum* and *Tofieldia palustris*. It is worth noticing that all the *Alchemilla*-species were lacking. Of lichens and mosses I collected *Cetraria nivalis*, *Cladonia uncialis*, *Cl. mitis*, *Aulacomnium palustre*, *A. turgidum*, *Polytrichum juniperinum* and *Sphagnum plumulosum*.

Skærgaard Peninsula and southern part of Kraemer's Island.

(V and VI in fig. 2, T. B. 1933.)

The area consists of Gabbro, which seems to be very unfavourable to the vegetation, as the weathering process of the mountains consists in a strong scaling off and subsequent communitation, the rounded cliffs being often largely covered by sharp-edged gravel. The vegetation principally consisted of extensive snow-patches, patches of heath and, on protected slopes of southern exposure, herb-field. Of species worthy of notice the following must be mentioned *Alchemilla alpina*, *A. filicaulis*, *Potentilla tridentata*, *Saxifraga aizoon*, *Viscaria alpina*, *Draba crassifolia*, *D. rupestris*, *Chamænerium latifolium*, *Bartschia alpina*, *Veronica alpina*, *V. fruticans*, *Gnaphalium supinum*, *Taraxacum croceum*, *Bryanthus coeruleus*, *Gentiana nivalis*, *Agrostis borealis*, *Carex glareosa*, *C. Lachenalii*, *C. scirpoidea* and *Juncus trifidus*.

In the bend of Uttental Sound on a southern slope were further found *Alchemilla pseudomicans*, *Epilobium anagallidifolium* and *Lycopodium alpinum*.

Northern Part of Uttental Sound and Kraemer's Island.

(VII and VIII in fig. 2, T. B. 1933.)

The area consists of gneiss mountains worn smooth. The vegetation was chiefly heath-vegetation in which *Cassiope tetragona* played a part, but only at a height of 160 m; then snow-patches and river-bed vegetation. Besides the species common everywhere the following were collected in this locality: *Potentilla Crantzii*, *Pedicularis hirsuta*, *P. flammea*, *Euphrasia latifolia*, *Campanula rotundifolia*, *Taraxacum brachyceras*, *Hieracium alpinum*, *Diapensia lapponica*, *Carex cappilaris*, *C. pedata*, *Elyna Bellardi*, *Festuca ovina* and *Tofieldia palustris*.

just visible in an indentation (a valley) in the very high alpine mass which forms the termination of this valley, and which undoubtedly extends as far towards the north as the principal fjord of Kangerdlugssuak. This glacier was joined by four smaller ones, coming from the east; cf. figs. 27—28 in E. MIKKELSEN 1933 (b).

The interior of Kraemer's Island is very desert and dry and almost entirely devoid of vegetation.

Amdrup's Fjord.

(IX in fig. 2, T. B. 1933.)

In some patches of heath on the south coast of this very desert fjord I identified the following species: *Woodsia ilvensis*, *Minuartia biflora*, *Cerastium alpinum*, *C. trigynum*, *Silene acaulis*, *Oxyria*, *Polygonum*, *Ranunculus glacialis*, *R. pygmæus*, *Sibbaldia procumbens*, *Sedum roseum*, *Saxifraga cernua*, *S. cæspitosa*, *S. nivalis*, *Salix arctophila* × *glauca*, *S. herbacea*, *Empetrum*, *Vaccinium*, *Veronica alpina*, *Antennaria alpina*, *Erigeron unalaschkensis*, *Gnaphalium supinum*, *Hieracium alpinum*, *Taraxacum croceum*, *Carex Lachenalii*, *C. rigida*, *Trisetum spicatum*, *Festuca ovina*, *Agrostis borealis*, *Luzula confusa*, *L. spicata* and *Juncus trifidus*. In a small bay on the north coast HAROLD WAGER found *Lycopodium alpinum*, *L. selago* and *Saxifraga aizoides* on a fertile slope of south-eastern exposure. On a small skerry in the fjord, the extent of which was about 25 m², 12 of the afore-mentioned species were found.

East coast of the principal fjord¹⁾.

(X in fig. 2, T. B. 1933.)

Somewhat north of the mouth of Amdrup's Fjord in Kangerdlugssuak there is an area supporting a comparatively luxuriant vegetation of heaths and snow-patches. This area, the substratum of which consists of gneiss is the only fairly large area of vegetation in the fjord. The heath was a perfect mosaic of associations and sociations, and was itself to be found on the northeastern slope of the mountain. On this north-eastern slope there was in one locality *Carex misandra*. The contingent of high-arctic species was great, and *Cassiope tetragona* was particularly common on the plateau on top. Of species, the distribution of which offers points of interest, particular mention should be made of *Arnica alpina*, *Elyna Bellardi* and *Hierochloë alpina*; further, the following must be mentioned: *Sagina intermedia*, *Minuartia biflora*, *M. rubella*, *Draba crassifolia*, *D. nivalis*, *D. rupestris*, *Potentilla Crantzii*, *Saxifraga aizoon*, *Campanula rotundifolia*, *Diapensia lapponica*, *Taraxacum brachyceras*, *Carex cappilaris*, *Eriophorum Scheuchzeri* (at a small water-basin in the rock), *Agrostis borealis*, *Tofieldia palustris* and *Woodsia ilvensis*.

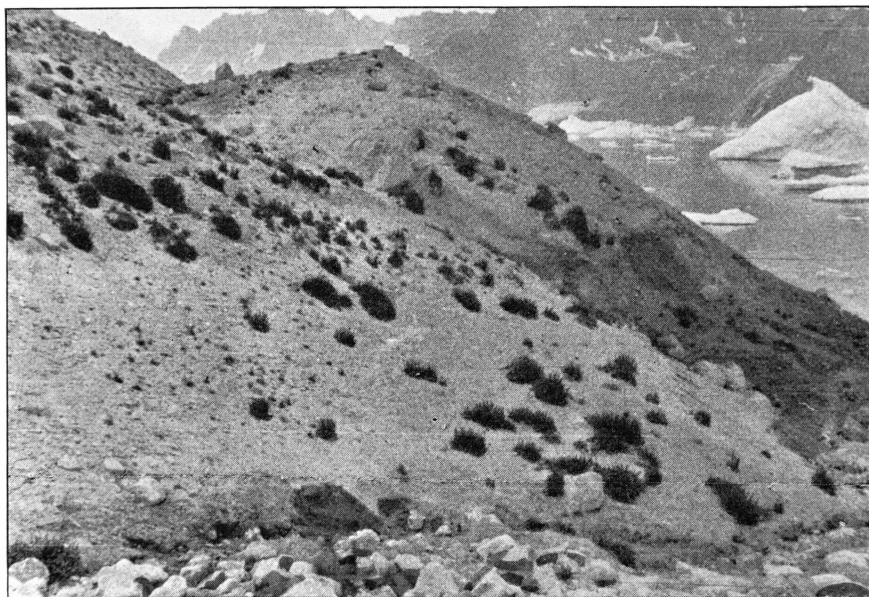
South of this area there is a glacier, which has exposed a large moraine landscape lying in front of it; in the large sand-hills of this locality (fig. 3) the most frequently occurring plants were *Oxyria*, *Poa glauca*, *Trisetum spicatum*, *Salix arctophila* × *glauca*, and then *Antennaria alpina*, *Erigeron* sp., *Draba rupestris* and *Taraxacum croceum*. An

¹⁾ Compare DEVOLD and SCHOLANDER 1933.

entirely similar vegetation was found by KRUUSE (1911) on moraines in the Angmagsalik region.

In one locality along this coast there was a protected beach, but the species growing there were not halophile; 2 meters from the water there grew in moist shingle: *Oxyria*, *Ranunculus glacialis*, *Luzula confusa* and, further, *Salix arctophila* $\times$ *glauca*, *S. herbacea*, *Silene acaulis*, *Draba rupestris* and *Saxifraga oppositifolia*.

As to the "List of Plants" from Locality XI "Notched Mt", a



T. B. phot.

Fig. 3. Moraine walls along the east coast of Kangerdlugssuak.
Tufts of *Oxyria digyna*.

mountain mass of northern exposure in the inner basin of Kangerdlugssuak, see T. B. 1933 p. 30.

South-western coast in the interior fjord-basin.

(XII in fig. 2, T. B. 1933.)

In a rather large heath-slope (*Empetrum-Vaccinium*-heath) the following species were identified: *Carex nardina*, *C. rupestris*, *C. rigida*, *C. scirpoidea*, *C. cappilaris*, *Luzula spicata*, *Juncus trifidus*, *Tofieldia palustris*, *Diapensia lapponica*, *Cassiope tetragona*, *Bartschia alpina*, *Pedicularis flammea*, *P. hirsuta*; of rarer occurrence were: *Saxifraga aizoon*, *Rhododendron lapponicum*, *Taraxacum brachyceras* and *Eriophorum Scheuchzeri*. The vegetation particularly favoured the basalt-dikes in the gneiss (more advanced weathering, shelter from the wind,

better soil). In the fjord the bottom was covered by large submarine "forests" of *Alaria* (see ROSENVINGE 1933).

Nunatak localities.

Locality XIII, in fig. 2, T. B. 1933: Nunatak in the nepheline-syenite area west of Kangerdlugssuak. Only plant occurring: *Papaver radiculatum* (HAROLD WAGER).

Locality XIV: Nunatak at the mouth of the fjord, north of Cape Deichmann. Here WAGER collected *Salix arctophila* $\times$ *glauca*, *S. herbacea*, *Empetrum*, *Vaccinium*, *Oxyria*, *Polygonum*, *Cerastium alpinum*, *Silene acaulis*, *Ranunculus glacialis*, *Saxifraga oppositifolia*, *Poa glauca* and *Luzula confusa*. From Cape Deichman proper (substratum: olivine-syenite) only *Potentilla Crantzii* was collected, but I was told that there was a very luxuriant vegetation in this locality.

Everything considered, Kangerdlugssuak cannot be said to be a particularly rich fjord from the point of view of land-vegetation, and one must often use ones eyes well in order to find the small green patches which are scattered about, compare MIKKELSEN 1933(a) p. 395. A contrast is offered by the marine algal vegetation. In the course of the dredgings undertaken by M. DEGERBØL and myself, it became clear that the very rich algal life was a natural condition for the great fjord mammals, which here occurred in great quantities. In the upper layers it was possible to identify a zone with *Fucus* and *Pylayella*; then, at a depth of 8—15 m a *Laminaria-Alaria*-zone, which was in its turn succeeded by a red algæ zone.

It was more particularly in the narrow ice-free Uttental Sound that the algal life was so richly developed, whereas farther in it seemed more homogeneous. The material is too slight to say anything about the marine algal associations, but besides the *Fucus-Pylayella*- and *Laminaria*- and *Alaria*-associations, I should like to mention that for instance *Halosaccion ramentacion* formed dense growths on low reefs between the skerries at the houses of the expedition, and that *Monostroma* here covered the bottom at one locality in a small bay between the skerries (see further ROSENVINGE 1933).

Tuġtilik (Lake Fjord) 66°20'.

The expedition spent twenty-four hours in this fjord. On the south side of the fjord there is a very rich vegetation of heath, small willow-copses and patches with herb-field. *Empetrum* often dominated entirely and even forced the *Vaccinium* somewhat back. In this heath with all its different sociations the following species in particular played a part: *Lycopodium alpinum*, *L. annotinum*, *L. Selago*, *Juniperus communis*, *Chamænerium latifolium*, *Alchemilla alpina*, *Salix herbacea*, *S. arctophila*

× *glauca*, *Saxifraga aizoon*, *S. oppositifolia*, *Campanula rotundifolia*, *Hieracium alpinum*, *Gnaphalium supinum*, *Diapensia lapponica*, *Bryanthus coeruleus*, *Cassiope hypnoides*, *Loiseleuria procumbens*, *Rhododendron lapponicum*, *Thymus arcticus*, *Pinguicula vulgaris*, *Bartschia alpina*, *Pedicularis flammea*, *P. hirsuta*, *Veronica fruticans*, *Carex nardina*, *C. rigida*, *C. scirpoidea*, *C. microglochin*, *C. atrata*, *Scirpus caespitosus*, *Agrostis borealis*, *Festuca ovina*, *Deschampsia alpina*, *Poa glauca*, *Trisetum spicatum*, *Luzula confusa*, *L. spicata*, *Juncus trifidus* and *Tofieldia palustris*.

As to the willow copses in this locality see table 4. Along the water courses *Saxifraga aizoides* and *S. stellaris* were identified, besides in great numbers *Deschampsia alpina*.

In the valley between the fjord and the great lake behind it there was an abundant vegetation, especially consisting in heath rich in lichens and snow-patches. In one locality (plate 5, fig. 1) there was a large area with moss-tuft vegetation comprising *Salix herbacea* and *Carex rigida*, *Empetrum* and *Cassiope hypnoides* dominating. *Equisetum variegatum* was here very common and formed great tufts. At a small water-hole in the mountains there were some few tufts of *Carex rupestris*.

At the banks of the great lake there grew in the sand near the water *Salix herbacea*, *Equisetum arvense* var. *rivulare*, *Carex glareosa*, *C. rupestris* (one small stunted individual), *Ranunculus pygmaeus* and *Deschampsia alpina*. The vegetation continues with heath and snow-patches past the lake and into a valley trending north.

In Tugtilik I found, furthermore, the following species: *Cystopteris fragilis*, *Dryopteris Linnæana*, *Polystichum lonchitis*, *Cerastium alpinum*, *C. trigynum*, *Silene acaulis*, *Viscaria alpina*, *Sedum roseum*, *Arabis alpina*, *Cardamine bellidifolia*, *Draba rupestris*, *Epilobium anagallidifolium*, *Oxyria*, *Polygonum*, *Coptis trifolia*, *Ranunculus glacialis*, *Thalictrum alpinum*, *Alchemilla glomerulans*, *Potentilla Crantzii*, *Sibbaldia procumbens*, *Saxifraga cernua*, *S. caespitosa*, *S. nivalis*, *S. rivularis*, *Antennaria alpina*, *Taraxacum croceum*, *Pirola minor*, *Veronica alpina*, *Eriophorum Scheuchzeri*, *Phleum alpinum*, *Poa alpina* and *P. arctica*. The total number of species recorded were 82, but there are undoubtedly more.

Angmagssalik, Tasiusak. 65°37'.

For this locality see the works of KRUUSE (1906 and 1911) as well as the individual sociological investigations in the following, notably tables 17, 32 and 33. At the actual settlement *Poa annua* and *Polygonum aviculare* had spread everywhere on roads and on middens. All investigations have been carried on in the immediate vicinity of the settlement, particularly along the river (KRUUSE's "Elvbakker").

Methods applied in the investigation.

For the examination of the relative frequency of the species I have, in the main, used the RAUNKIÆR circling method (RAUNKIÆR 1909, 1918 (a.)). Determinations of frequency by means of this method have of late been greatly criticised, more specially by DU RIETZ (1930). DU RIETZ emphasizes the following drawbacks of the method: "Der Hauptmangel der Methode ist eine ungenügende Differenzierung zwischen den dichtesten Arten; nicht selten fallen nämlich recht viele Arten, die in Wirklichkeit eine recht verschiedene Dichte haben, in den höchsten Frequenzgrad, d. h. sie bekommen $F \% 100$. Als ein anderer Nachteil der Methode kann die subjektive Verteilung der Probeflächen betrachtet werden. Dass die Methode keine vollständige Artenliste der Gesamtprobefläche gibt, ist auch ein Nachteil — —" (see also NORDHAGEN, 1928, p. 74).

The three drawbacks stated by DU RIETZ can, however, easily be minimized by observing the following precautions:

1. Where it is evident that two or more species belonging to the highest frequency class (F-percentage between 80 and 100) have an unequal density of individuals or shoots, they may be kept apart by means of the following method: A radius is used, being of the usual length (17,84 cm), but divided into four equally great parts; thus, we have not one but four different circles to work with, and in the case of each circle investigated we must examine, whether the shoots of the dominating species are found within the interior fourth of the radius (noted: 4), within the interior half of the radius (noted: 3), within the interior three fourths of the radius (noted: 2) or only within the full length radius (noted: 1). By this means it is possible to form an idea of the mean density of individuals or shoots. MØLHOLM HANSEN (1928) has calculated the mean distance of individuals for the various F-percentages below 100, species with a mean distance between individuals of less than k_3 to the circle having in theory a F-percentage of more than 100. In practice all of these species, however, have a F-percentage = 100. By using the much smaller circles in the manner mentioned above, it is evident that one may make an exact distinction between the various distances of individuals in the species, which obtain a F-percentage approaching 100. It is an experience made by others besides myself that this modification of the RAUNKIÆR-method does not, in point of time, involve an essential increase of the work in the field. The area, radius and k_3 's length of each of the four circles will appear from table 1.

A species whose shoots are always to be found within the interior circle (radius 4,46 cm) will have a mean density of shoots amounting to 7,7 cm or less, which I have thought fit to indicate with the figure 4, added as an index to the F-percentage, e. g. F-percent = 100₄. The

Table 1.

Figure noted	area of circle	radius of circle	k ₃ to circle
1.	0,100 m ²	17,84 cm	30,9 cm
2.	0,056 m ²	13,38 cm	23,2 cm
3.	0,025 m ²	8,92 cm	15,5 cm
4.	0,006 m ²	4,46 cm	7,7 cm

significance of such a quantity is, for instance, shown by the investigations of *Caricetum rigidae* (table 17, Nos. **32** and **33**); here *Carex rigida* attains F-percentage = 100, *Chamænerium angustifolium* F-percentage = 88 and 92, and both are dominants belonging to the class of highest frequency; but to *Carex rigida*'s F-percentage I add, after an investigation by the method mentioned above, the index figure 4, which means that the mean distance of shoots in this species lies at 7,7 cm or lower; to the *Chamænerium* F-percentage the index figures 1—3 are added, which means that the shoots of this species are divided by a distance of between 30 and 15 cm¹⁾. The shoots of *Carex rigida* are thus about twice as closely set as those of *Chamænerium*. Where there is reason to distinguish between the distance of the shoots of those species, which by this method all attain an index of 4, we must adopt a somewhat different mode of procedure, possibly using an additional circle within the interior one; however, I think that the four circles will, as a rule, be sufficient. This method can only be used with any degree of exactitude in very high F-percentages, but also in individual cases where a species has a more scattered occurrence within the "association individual" (o: Assoziationsindividuum), but nevertheless, where it occurs, is found with the same distance of individuals or shoots. Example: *Hippuris vulgaris* in *Sparganietum affinis*, No. **94**.

2. As to the second objection raised by DU RIETZ the reader is referred to RAUNKIÆR's later works²⁾, where he does not always distribute the circles at random. Wherever I undertook such investigations, my proceeding was to investigate a circle for each $\frac{1}{2}$ or 1 m, by means of a tape measure.

3. As to the third point, I may add that in the area investigated in Greenland I had, after investigating 25 circles of $\frac{1}{10}$ m², almost invariably reached the full number of species; where this was not the case, I have marked the species with a cross, in view of its "Stetigkeit" (o: constancy) or "Treue" (o: loyalty), see BRAUN-BLANQUET 1928.

The RAUNKIÆR-method, as compared with other methods, has the great advantage that the apparatus (an alp-staff with a metal cross-

¹⁾ Whereas *Carex rigida* almost constantly attained 4, the value here varied between 1 and 3; only in rare cases 4 was attained.

²⁾ RAUNKIÆR (1918 (a) p. 69).

stick which is to be fastened with a screw and reaches as far as the radius in the circle (fig. 3. RAUNKIÆR 1918 (a)) is extremely light, even agreeable to carry, especially when investigating such a jagged alpine country as East Greenland. See further pp. 33—34.

More especially in the investigation of heaths I have, with a view to showing the thickness of the cover and the manner of growth of the species, investigated and drawn typical sample squares of the vegetation, their size as a rule being 1 m². (See fig. 9.)

Abbreviations used in the following tables.

The subsequent tables contain the following abbreviations and signatures:

Rubric G: The geographical distribution type of the species; here the letters A₁, A₂ and S are used in the usual sense (OSTENFELD 1926, T. B. 1933).

Rubric L: The life-forms of the species, according to RAUNKIÆR (1907). Of the RAUNKIÆR life-forms only the following occur, *viz.* N (Nanophanerophytes), Ch (Chamæphytes), H (Hemicryptophytes), G (Geophytes), Th (Therophytes) and HH (Helophytes).

Rubric S: "Stetigkeit" of the species, compare BRAUN-BLANQUET (1928).

Rubric T: "Treuegrad" of the species, compare BRAUN-BLANQUET (1928).

Rubric Str: (Stratum). The relative heights of the species in the vegetation. Here + means that the species exclusively occurs as an overshadowed undergrowth under an upper layer of leaves, (+) that the species is mainly an undergrowth, though now and again with a straw or shoot sticking out from the plant; finally, no signature means that the species help in forming the upper layer of leaves, cf. p. 125.

Each individual investigation includes a spectrum, where the most important conditions in the habitat, as well as the number of species and points, the density of species and the percentage of life-forms are enumerated. Under the rubric moisture, 5 means very moist, 4 moist, 3 moderately moist, 2 dry and 1 very dry.

Synonyms.

In the following I have used the names, which the botanists investigating the vegetation of East Greenland have agreed upon (as the result of a discussion between TH. SØRENSEN, J. GELTING, G. SEIDENFADEN and T. BÖCHER). To facilitate comparisons, it will be expedient to give the synonyms of some important species.

Cerastium trigynum Vill. = (*Cerastium cerastioides* (L) Britton).
Minuartia biflora (L) Wbg. = (*Alsine biflora* (L) Wbg.).
Sedum roseum (L) Scop. = (*Rhodiola rosea* L.).
Potentilla Crantzii Beck. = (*Potentilla maculata* Pourr.).
Saxifraga caespitosa L. = (*Saxifraga grønlandica* (L) Lge.).
Bryanthus coeruleus (L) Dippel = (*Phyllodoce coerulea* (L) Bab.).
Veronica fruticans Crantz. = (*Veronica saxatilis* Scop.).
Carex Lachenalii Schkur. = (*Carex lagopina* Wahlenb.).
Elyna Bellardi (All.) K. Koch. = (*Elyna myosuroides* (Vill.) Fritsch).
Phippsia algida (Soland) R. Br. = (*Catabrosa algida* (Soland) Fr.).
Poa arctica R. Br. = (*Poa cenisia* All.).
Luzula arcuata Wg. = (*Luzula confusa* Lindeb.).

COMMUNITIES OF PLANTS

The material is arranged in accordance with the system adopted by E. RÜBEL in his "Pflanzengesellschaften der Erde". In the area investigated the following eight communities occur with a moderately large number of associations:

Table 2.

Community	chief associations
1. Copse (AESTIFRUCTICETA)	<i>Salicetum glaucae</i>
2. Field of high perennials (Hochstauden- wiesen) (ALTHERBOSA)	<i>Alchemilletum glomerulantis</i> (<i>Archangelietum</i>)
3. Herb-field and related communities (SEMPERVIRENTIHERBOSA. I.)	<i>Taraxacetum crocei</i> <i>Chamænerietum latifolii</i> <i>Caricetum rigidæ</i>
4. Heath vegetation (ERICIFRUCTICETA)	<i>Saliceto-Vaccinietum.</i> <i>Empetreto-Vaccinietum.</i> <i>Vaccinietum.</i> <i>Cassiopetum tetragonæ.</i>
5. Snow-patch vegetation (SEMPERVIRENTIHERBOSA. II)	<i>Salicetum herbaceæ.</i> <i>Cerastietum trigyni.</i> <i>Anthelietum.</i>
6. Fell-field vegetation (FRIGORIDESERTA)	(Fell-field associations)
7. Moor vegetation (EMERSIHERBOSA)	<i>Scirpetum caespitosi.</i> <i>Salicetum herbaceæ muscosum.</i> <i>Caricetum rarifloræ.</i>
8. Freshwater vegetation (SUBMERSIHERBOSA)	<i>Sparganietum affinis.</i> <i>Hippurietum vulgaris.</i>

It seemed to me most natural to subdivide the *Sempervirentiherbosa*, so as to make the snow-patch associations an independent group (comp. TENGWALL 1920, DU RIETZ 1925 (b) p. 41). For that matter, there are naturally only very few associations (or groups of associations) which occupy an isolated position, the transitions everywhere being rather even. From an ecological point of view the associations are more particularly divided into three groups: 1. Associations with a southern character and occurring on the fertile southern slopes of the mountains (more especially *Salicetum glaucae*, *Alchemilleta*, *Taraxacetum crocei*, *Caricetum rigidae*, *Empetreto-Vaccinietum* and *Scirpetum caespitosi*). 2. Associations which have no special claims as to favourable habitats, the latter including a number of heath-associations, snow-patch-associations and fell-field-associations. 3. Associations connected with fresh water, including moss-moor, sedge-moor and the submerse associations.

1. Copse (*Aestifruticeta*, Sommergebüsch) (RÜBEL 1930).

SALICETUM GLAUCAE. Willow-copse.

Distribution. The willow-copses are characteristic of *regio arctica* and *alpina I*, being principally found where the mean July temperature exceeds 4—5° C. On the east coast of Greenland they are identified in the interior of Scoresby Sound, from a distance of 175 km from the outer coast and in the direction of the interior (HARTZ 1895). In particularly favourable localities at Cape Ravn, No. 17, and in d'Aunay Bay, No. 36, the willow already reached such heights against a steep wall that several species in the association in question had the character of an undergrowth; but only in Miki's Fjord in 68°10' was there a real, though low copse. In Kangerdlugssuak in the interior east of Watkins Fjord small copses were found, and also at Tugtilik (66°20'), and they are common from the Angmagssalik region and farther south. On the west coast the northern limit for willow-copse is put at 71°; north of this, they have only been found in a single locality (Fiske Fjord about 72°). Similar communities are found in Fennoscandia and the Alps.

A. The Copses at Scoresby Sound. This type of copse, which has a pronounced continental character, seems according to HARTZ to be without any known parallel. The copses were either without undergrowth (Gaaseland) or bore a xerophilous vegetation of high tuft-grasses (Røde Island). These grasses either formed an undergrowth chiefly consisting of Hemipterophytes, or they formed an independent association outside the copses, a kind of dry *Altherbosa*-association corresponding with the *Archangelica*- or *Alchemilla glomerulans*-association, which alternate with the moister willow copses. The dominating grasses

were *Calamagrostis arundinacea*, *Poa glauca*, *P. alpina*, *P. alpigena* and *Festuca rubra*.

B. The drought in the interior also left its impress on the small 4—5 m², 40—80 cm high copses at a distance of 20 km from the coast east of Watkins Fjord in Kangerdlugssuak. They were found on a southern slope with a inclination of 30—40° and 330 m above sea-level on a gneiss foundation. The willow shoots were often so closely set that no vegetation was able to thrive at the bottom, or, if there were any undergrowth at all, it consisted of *Festuca ovina* var. *vivipara*. The most frequently occurring plants in the undergrowth were here, besides this species, *Polygonum viviparum*, *Carex rigida*, *Taraxacum croceum*, *Campanula rotundifolia*, *Cystopteris fragilis*, *Poa alpina* and *Cerastium alpinum*; of less frequent occurrence were: *Vaccinium uliginosum*, *Hieracium alpinum*, *Salix herbacea* and *Sedum roseum*. Only a few of these plants flowered, many (more particularly *Cystopteris* and *Campanula*) were highly etiolated, *Cerastium alpinum* being vegetative and scraggy. Between the copses there was a rather luxuriant herb-field (No. 12).

C. Moist mould-copse (= field-copse (KRUUSE)) No. 1 and 2, fig. 4. In spite of the great difference in geographical situation and in the species of rock of the substratum, there is a distinct similarity, as well in the composition of species as in the spectra of the two copses investigated. The Hemicryptophytes dominate, and at Angmagssalik (No. 2) the percentage of subarctic species (S %) reaches 50. The copse in Miki's Fjord (No. 1) was immediately contiguous to herb-field and a *Alchemilletum glomerulantis* (No. 7), whereas the copse at Angmagssalik alternated with "grass-field" (*Caricetum rigidae*) see fig. 4, where, however, *Chamænerium angustifolium* in certain localities adjoining the copses formed rather dense covers¹). (Compare "Hochstaudenwiesenweidengebüsch" in Scandinavia, TENGWALL 1920.) Under the plants in No. 2 there was a layer of mould of 4—10 cm; under that a slightly sandy soil. From the rubric Str. it appears that more particularly *Thalictrum*, *Cerastium*, *Taraxacum*, *Arabis* and *Veronica* in this locality are pronounced subvegetation forms.

D. Heath-copse. In Tugtilik the willow-copses were found alternating with a very luxuriant *Empetrum*-heath, abundant in species. The willow was 30—80 cm high and extremely dense, so that in most localities there was no undergrowth except *Empetrum*, (No. 3). Beside the copses, *Salix* and *Empetrum* were often found in the same proportion as to quantity, only forming a heath, *Empetretum-Salicetum glaucae* p. 81. The vegetation is characterized by a high Ch-percentage. In No. 3 the

¹) See the index of this species in No. 2; owing to the shoots being so scattered, this high species does not, as *Alchemilla*, form a community with several different assimilation layers.



T. B. phot.

Fig. 4. Willow-copse at Angmagssalik, in the interspaces *Caricetum rigidae* with *Camp. rotundif.* flowering (light specks).



T. B. phot.

Fig. 5. Herb-field in the fjord north of Cape Ravn, 300 m above sea-level.

Table 3.

<i>Salicetum glaucae</i>	G.	L.	1	2	Str.
SALIX ARCTOPHILA × GLAUCA...	A ₂	N	100 ₄	100 ₄	..
THALICTRUM ALPINUM.....	S	H	80 ₁₋₄	84 ₂₋₄	+
CAREX RIGIDA f. BIGELOVII	A ₂	G	96 ₃₋₄	76 ₃₋₄	(+)
CHAMÆNERIUM ANGUSTIFOLIUM	S	H	..	72 ₁₋₄	..
Festuca rubra.....	S	H	..	56	(+)
Polygonum viviparum.....	A ₂	G	44	..	(+)
Cerastium alpinum.....	A ₂	Ch	32	40	+
Taraxacum croceum	S	H	40	8	+
Arabis alpina.....	A ₂	H	..	40	+
Sibbaldia procumbens.....	A ₂	H	36	..	+
Trisetum spicatum.....	A ₂	H	28	4	(+)
Poa alpigena.....	A ₂	G	24	12	(+)
Veronica alpina.....	A ₂	H	20	..	+
Ranunculus acer.....	S	H	..	28	(+)
Campanula rotundifolia.....	S	H	..	24	(+)
Salix herbacea.....	A ₂	Ch	20	..	+
Draba rupestris.....	A ₂	Ch	..	16	+
Pirola minor	S	H	4	12	+
Alchemilla glomerulans.....	S	H	4	8	..
Oxyria digyna.....	A ₂	H	8	..	+
Poa alpina.....	A ₂	H	8	..	(+)
Erigeron unalaschkensis	A ₂	H	8	..	+
Vaccinium uliginosum.....	A ₂	Ch	4	..	+
Carex Lachenalii.....	A ₂	H	4	..	(+)
Chamænerium latifolium.....	A ₂	H	4	..	(+)
Draba aurea	S	H	..	4	+
Euphrasia latifolia.....	A ₂	Th	..	4	+
Phleum alpinum.....	S	H	..	4	(+)

Table 4.

<i>Salicetum glaucae</i>	G.	L.	3	4	5	Str.
SALIX ARCTOPHILA × GLAUCA ..	A ₂	N	100 ₄	100 ₄	100 ₂₋₄	..
EMPETRUM NIGRUM var. HERMA- PHRODITUM.....	A ₂	Ch	88 ₃₋₄	84 ₃₋₄	100 ₁₋₄	+
Vaccinium uliginosum var. genuina ...	S	Ch	..	36	16	(+)
Thalictrum alpinum.....	S	H	..	..	36	+
Pirola minor	S	H	..	12	32	+
Alchemilla alpina.....	S	Ch	..	..	32	(+)
Campanula rotundifolia.....	S	H	..	4	24	+
Dryopteris Linnæana.....	S	G	4	24	..	+
Potentilla Crantzii	S	H	..	..	20	+
Carex rigida f. Bigelovii	A ₂	G	..	12	12	(+)
Salix herbacea.....	A ₂	Ch	..	8	12	+
Poa glauca.....	A ₂	H	..	12	12	(+)
Poa alpina.....	A ₂	H	..	4	8	+
Alchemilla glomerulans.....	S	H	..	..	8	(+)
Polygonum viviparum.....	A ₂	G	..	..	8	+
Taraxacum croceum	S	H	..	..	8	+
Trisetum spicatum.....	A ₂	H	..	..	8	+
Cerastium alpinum.....	A ₂	Ch	..	12	..	+
Coptis grönlandica.....	S	H	..	8	..	+
Bartschia alpina.....	A ₂	H	..	..	4	+

Spectrum: (Table 3—4).

No.	Lat. n.	Height in m above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	N°/o	Ch°/o	H°/o	G°/o	Th°/o	A ₁ °/o	A ₂ °/o	S°/o
1	68°10'	200	VSV	40°	3	basalt	19	564	5,6	17	10	43	30	0	0	77	23
2	65°37'	80	S	25°	3	mould gneiss mould	18	592	5,9	17	9	58	15	1	0	50	50
3	66°20'	30	S	45°	2	gneiss	3	192	1,9	52	46	0	2	0	0	98	2
4	—	—	—	—	—	—	12	316	3,2	32	44	13	11	0	0	73	27
5	—	75	—	40°	3	—	17	440	4,4	24	36	36	4	0	0	60	40

willow was densest, in No. 5 sparsest and the bottom slightly more moist; this increases the number of species in the undergrowth from No. 3 to No. 5, and also raises the percentages of H and S. It was characteristic that *Vaccinium uliginosum* here occurred in the form of var. *genuina* which, being a more southern ecotype, seems to have twice the number of chromosomes as the alpine ecotype var. *microphylla* (HAGERUP 1933).

Besides these, KRUISE mentions a great number of other copse

types from Angmagssalik (p. 228); he writes that the undergrowth is on an average variegated and rather poor in species, which quite agrees with my observations, there being a very great difference between the two afore-mentioned types C and D, and the number of species in the individual locality does not exceed 20. He finds *Cerastium alpinum*, *Arabis alpina*, *Thalictrum alpinum*, *Taraxacum croceum*, *Polygonum viviparum*, *Poa pratensis* (*alpigena*) and *Dryopteris Linnæana*, all of them being of great constancy. I have not been able, with certainty, to identify any species which are exclusively connected with the copse sub-vegetation, although an approach to it is made by *Pirola minor*, which favours the associations with two different assimilation layers (No. 7). A comparison with the willow-copses of Norway is interesting. H. RESVOLL-HOLMSEN (1920), also according to the RAUNKIÆR-method, has investigated the frequency of the species, thus providing the basis for a real comparison. It is characteristic that the number of species and the points' sum in Norway are so much higher than the corresponding figures in East Greenland, but a great number of the species which are common in Greenland recur with great frequency in the Norwegian copses, e. g. *Polygonum viviparum*, *Taraxacum*, *Ranunculus acer*, *Alchemilla glomerulans*, *Carex rigida*, *Thalictrum alpinum*, *Campanula rotundifolia* and *Veronica alpina*.

2. Field with high perennials. (*Altherbosa*, Hochstaudenwiesen).

ALCHEMILLETUM GLOMERULANTIS.

ALCHEMILLETUM FILICAULIS.

Altherbosa (RÜBEL, 1930) is used in the sense of a vegetation in which high perennials dominate. The associations mentioned above agree perfectly with the description given by RÜBEL, e. g. of the alpine "Karflur" and the demands of the latter as to habitat ("Sie verlangt günstige Bedingungen, nämlich frischen oder feuchten, humusreichen, nährstoffreichen Boden, gern auch starke Luftfeuchtigkeit."). *Altherbosa* is most widely distributed in the subalpine zone. The localities in Greenland where this type of vegetation occurs, are also the same as in the Alps; the likeness seems to me particularly striking, when I read that the vegetation is typical of the "Tropfregion" of the rocks: "Durch das Tropfen ist der Boden immer feucht gehalten, zwischen den Felsen sammelt sich wiederum guter Boden an. Dort entsteht sie aus den Geröllfluren. Wegen der Feuchtigkeitsliebe besteht Verwandtschaft und Übergänge zu Quellfluren." Such "Übergänge" (∴: transitions) were found in Greenland, see in particular No. 22. RÜBEL only mentions the *Archangelica*-association for the arctic regions. In the part of East Greenland, which I saw, *Altherbosa* was chiefly represented by *Alchemilla*-associa-

Table 5.

<i>Alchemilletum glomerulantis</i>	G.	L.	6	7	Str.
ALCHEMILLA GLOMERULANS.....	S	H	100	100	..
PIROLA MINOR	S	H	..	72	+
CAREX RIGIDA f. BIGELOVII	A ₂	G	20	60	(+)
Cerastium alpinum.....	A ₂	Ch	20	48	+
Taraxacum croceum	S	H	40	40	+
Oxyria digyna.....	A ₂	H	20	36	+
Polygonum viviparum.....	A ₂	G	40	36	(+)
Thalictrum alpinum.....	S	H	30	28	+
Salix arctophila × glauca.....	A ₂	Ch	..	28	..
Salix herbacea.....	A ₂	Ch	..	28	+
Veronica alpina.....	A ₂	H	30	16	+
Poa alpina.....	A ₂	H	10	16	(+)
Sibbaldia procumbens.....	A ₂	H	10	16	+
Trisetum spicatum.....	A ₂	H	..	16	(+)
Erigeron unalaschensis	A ₂	H	..	8	+
Chamænerium latifolium.....	A ₂	H	..	4	..
Cystopteris fragilis.....	S	H	10	..	+

Spectrum. (Table 5).

No.	Lat. n.	Height in m above sea-level	Exposure	Inclination	Moisture	Soil	Number of spec.	Points sum	Density of species	Ch°/°	H°/°	G°/°	A ₁ °/°	A ₂ °/°	S°/°
6	68°10'	150	S	40°	4	basalt mould	11	330	3,3	18	76	6	0	45	55
7	—	200	VSV	25°	3	—	16	552	5,5	19	64	17	0	54	46

tions; even in Angmagssalik where *Archangelica* occurs, it does not play such a great part as *Alchemilla glomerulans* (KRUUSE, 1912). On the Kakasuak Mountain KRUUSE found the most powerful growth of *Archangelica* and *Alchemilla* right up to the steep overhanging rock, from which the water oozes and dribbles.

Distribution: The distribution of the associations in Greenland probably agrees with that of the two *Alchemilla* species. The distribution of *A. glomerulans* is given in fig. 10 in T. B. 1933, that of *A. filicaulis* is mentioned on p. 30 in the said publication. The two associations are exclusively connected with *regio arctica I*. In Norway there are exactly similar associations; thus, H. RESVOLL-HOLMSEN (1920) mentions a herb-field, where the character species were *A. glomerulans* and *A. acutidens* (F °/° 52 and 68); and such a vegetation also occurs in northern Finland (R. HULT, 1887: *Alchemilleta muscosa*); in the Rätic and Lepontine Alps J. BRAUN (1913) found “Hochstaudenläger” with “ganze

Beete einer hochalpinen Taumantelart (*Alchemilla decumbens*)", and KRAJINA (1933) mentions *Alchemilla alpestris* as "Dominante und bezeichnende Art" in *Chaerophylletum cicutariae* (*Adenostyletalia*) in the Tatra-Mountains.

Alchemilletum glomerulantis. Both of the investigations shown in table 5 are undertaken in Miki's Fjord, but the association also occurs in the fjord north of Cape Ravn, 68°31'; this association, as it appears in the said locality, is shown on plate 1, fig. 1. The undergrowth was almost entirely lacking or represented by a single *Taraxacum croceum*, whose withered stem in one place is seen to stand out among the leaves. In the two investigations, Nos. 6 and 7, also *Taraxacum*, *Cerastium alpinum*, *Thalictrum alpinum* and *Veronica alpina* occur as pronounced forms of subvegetation (cf. willow-copses), but special attention should be paid to *Pirola minor* in No. 7, where it attained the F-percentage 72 and actually formed a shady "forest-floor vegetation" under the 10—14 cm broad leaves of *A. glomerulans* attached to 27—35 cm high leaf-stems. *Pirola* was very well developed and flowered frequently, whereas many of the other plants forming the undergrowth led a poor vegetative existence. *Carex rigida* occurred in its forma *Bigelovii*, which is so high that inflorescences and leaves frequently projected above the *Alchemilla*-leaf-layer. No. 6 occurred near a small spring and thus forms an even transition between Nos. 7 and 22. As in the willow-copses the number of species is small, and the percentage of Hemicryptophytes and subarctic species is here still greater, reaching 100 per cent in the cases where there is no undergrowth. We find the same interesting parallelity between the geographical types of distribution and the RAUNKIÆR-life-forms, which MÖLHOLM HANSEN identified in his investigations of the vegetation of Iceland (1930). The size of the leaves and the great thickness of the rhizoma testify to the more southerly, milder conditions, where the period of vegetation is sufficiently long for this great production of material; this also applies to the flowering period, which in this species falls at the end of July and the beginning of August, another proof of the longer period of vegetation. The shoots for next year are only protected by dying leaf-stems, and were already developed and ready for the coming of winter on 28 August (fig. 27 A); already two days later the first snow came, and the first thing covered was this very herb-field and *Alchemilletum*. One might imagine that a species like *A. glomerulans* would require great atmospheric moisture, seeing that it was wanting in the otherwise warm and protected, but dry inland behind Watkins Fjord, whereas it occurred in enormous quantities in the neighbouring Miki's Fjord with its ocean character. The drip from above may in certain inland localities provide the suitable atmospheric moisture (Kakasuak, KRUSE).

Table 6.

<i>Alchemilletum filicaulis</i>	G.	L.	8	Str.	± flower
ALCHEMILLA FILICAULIS.....	S	H	96	..	+ fl.
POLYGONUM VIVIPARUM.....	A ₂	G	92	(+)	+ fl.
SEDUM ROSEUM	S	H	64	..	+ fl.
Taraxacum croceum	S	H	48	+	÷ fl.
Cystopteris fragilis.....	S	H	36	+	..
Carex scirpoidea.....	A ₂	H	28	(+)	÷ fl.
Salix arctophila × glauca.....	A ₂	Ch	24	..	+ fl.
Poa alpina.....	A ₂	H	24	(+)	+ fl.
Campanula rotundifolia.....	S	H	16	+	÷ fl.
Veronica alpina.....	A ₂	H	12	+	÷ fl.
Hieracium alpinum	S	H	12	+	÷ fl.
Sibbaldia procumbens.....	A ₂	H	12	+	+ fl.
Poa glauca.....	A ₂	H	12	(+)	+ fl.
Cerastium alpinum.....	A ₂	Ch	8	+	÷ fl.
Epilobium lactiflorum.....	S	H	8	(+)	± fl.
Erigeron uniflorus	A ₂	H	8	(+)	± fl.
Agrostis borealis.....	A ₂	H	8	+	+ fl.
Festuca ovina var. vivipara.....	A ₂	H	8	(+)	..
Trisetum spicatum.....	A ₂	H	4	(+)	+ fl.
Carex rigida.....	A ₂	G	4	(+)	+ fl.
Luzula spicata	A ₂	H	4	(+)	+ fl.
Oxyria digyna.....	A ₂	H	4	+	÷ fl.

Spectrum: (Table 6).

Lat. n.	Height in m above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch°/o	H°/o	G°/o	A ₁ °/o	A ₂ °/o	S°/o
68°10'	50	SSE	30°	3	basalt	22	532	5,3	6	76	18	0	47	53

Alchemilletum filicaulis. Table 6 shows this vegetation. Besides *Alchemilla*, *Sedum roseum* (*Rhodiola rosea*) frequently bears the character of a high perennial, seeing that it reaches a height of 20—30 cm and in large dense plant-covers joins the *Alchemilla* growths and even mixes with them, as was the case with No. 8¹⁾. Owing to the smaller leaves, the ground is here less shaded than in the *A. glomerulans*-association, for which reason the number of species is higher. The H- and S-percentages are also here extremely high. The subterraneous shoot type of *Sedum roseum* belongs to the *Alchemilla*-type; when digging in a growth of these

¹⁾ In Miki's Fjord one must speak of a *Rhodioletum roseae*, but only growing in small patches on the southern slopes of the mountains; compare *Rhodioleto-Deschampsietum caespitosae* in the Tatra-Mountains (KRAJINA 1933 pp. 930—933).

two species (fig. 7) one must often actually thrust the spade through a thick layer of the nutritive rhizomes of these species. In the competition taking place underground plants supplied with this type of rhizomes are victorious. There are, as appears from figs. 6—7, all imaginable and quite even transitions between herb-field, rich in *Alchemilla* and *Alchemille-*

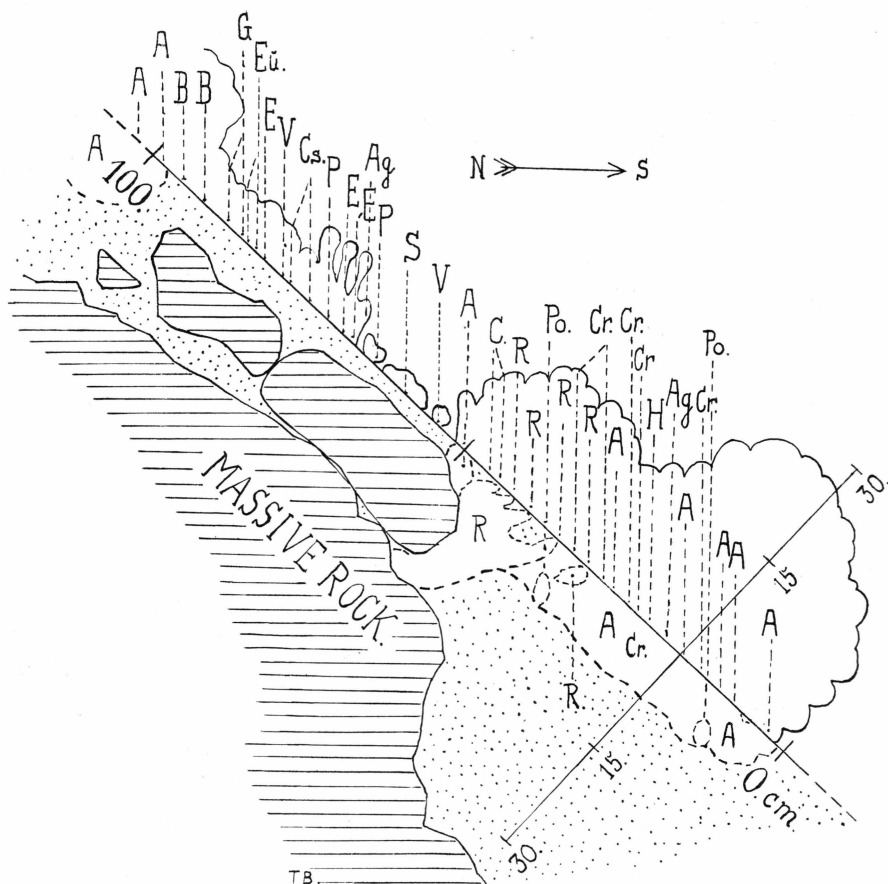


Fig. 6. Distribution of herb-field and *Alchemilletum filicaulis* on the south coast of Kraemer's Island, Kangerdlugssuak. 1 m long section through the vegetation (cf. the analyses of No. 14, explanation in text).

tum; it frequently proved to be the thickness of the soil which decided the distribution of *Alchemilletum filicaulis* and herb-field; in No. 14, fig. 6, which shows an investigation from the south coast of Kraemer's Island in Kangerdlugssuak, it is clear that the places where the layer of soil is deepest, become the habitats of the species with the thick rhizomes, a "micro-association" springing up in the place where the thickness of the soil is small; here plants are developed which can bear

drying out, such as *Veronica fruticans*, *Agrostis borealis*, annual herbs such as *Gentiana nivalis*, *Euphrasia latifolia* and particularly *Sedum annuum* (especially pronounced at Cape Ravn). Of the fifteen species in No. 14 *Alchemilla*, *Sedum roseum*, *Bartschia*, *Hieracium* and *Carex rigida* clearly belong together, whereas the remaining ones are to be found in the interspace, where the layer of soil is shallower. The letters mean: A = *Alchemilla filicaulis*, Ag = *Agrostis borealis*, B = *Bartschia alpina*, C = *Campanula rotundifolia*, Cr = *Carex rigida*, Cs = *Carex scirpoidea*, E = *Erigeron uniflorus*, Eu = *Euphrasia latifolia*, G = *Gentiana nivalis*, H = *Hieracium alpinum*, P = *Poa alpina*, Po = *Polygonum viviparum*, R = *Sedum roseum*, S = *Sibbaldia procumbens* and V = *Veronica fruticans*. The dotted section is soil with roots in it; the white sections stand for the stems (thick rhizomes) and the leaves of the plants; the oblique line indicates the surface of the ground.

The two cross-sections of the vegetation investigated (analyses Nos. 15 and 16) fig. 7, are taken from Miki's Fjord, in a place where *Alchemilletum* passed into herb-field, and they are two meters in length, the one forming the extension of the other. In the upper meter the diagram from left to right represents *Carex rigida*, *Alchemilla filicaulis*, *Thalictrum alpinum*, *Empetrum nigrum*, *Carex scirpoidea*, *Hieracium alpinum*, *Alchemilla*, *Carex scirpoidea*, *Polygonum viviparum*, *Carex scirpoidea*, *Thalictrum*, *Carex rigida*, *Poa alpina*, *Carex scirpoidea*, *Polygonum viviparum*, *Alchemilla*.

In the lower meter from left to right: *Alchemilla filicaulis*, *Sedum roseum*, *Carex rigida*, *Polygonum viviparum*, *Thalictrum alpinum*, *Campanula rotundifolia*, *Thalictrum*, *Campanula*, *Thalictrum*, *Polygonum*, *Thalictrum*, *Taraxacum croceum* and *Thalictrum*. In the ground severed fragments of *Salix glauca*.

In the two diagrams one sees clearly the different types of subterranean shoots, which characterize partly *Alchemilletum* and partly herb-field. The three figures, besides giving a picture of the vegetations and the transitions between them, represent a line taxation of such a transition vegetation. Table 7 gives the result: the same plants are found to be dominating as after an investigation according to the RAUNKIÆR-method, expressed by the number of shoots of these species, and when computing the biological spectra of the three meters investigated, based upon the number of shoots, this would prove to agree entirely with the results according to the RAUNKIÆR-method, as the H- and S-percentages would lie between the same percentages in *Alchemilletum*, No. 8, and herb-field, No. 13 (H = 69 %, S = 48 %). However, there are still differences between the results obtained by the one or the other method, the F-percentage of the species, whose shoots are closest together, becoming somewhat low when applying the RAUNKIÆR-method (cf. p. 20).

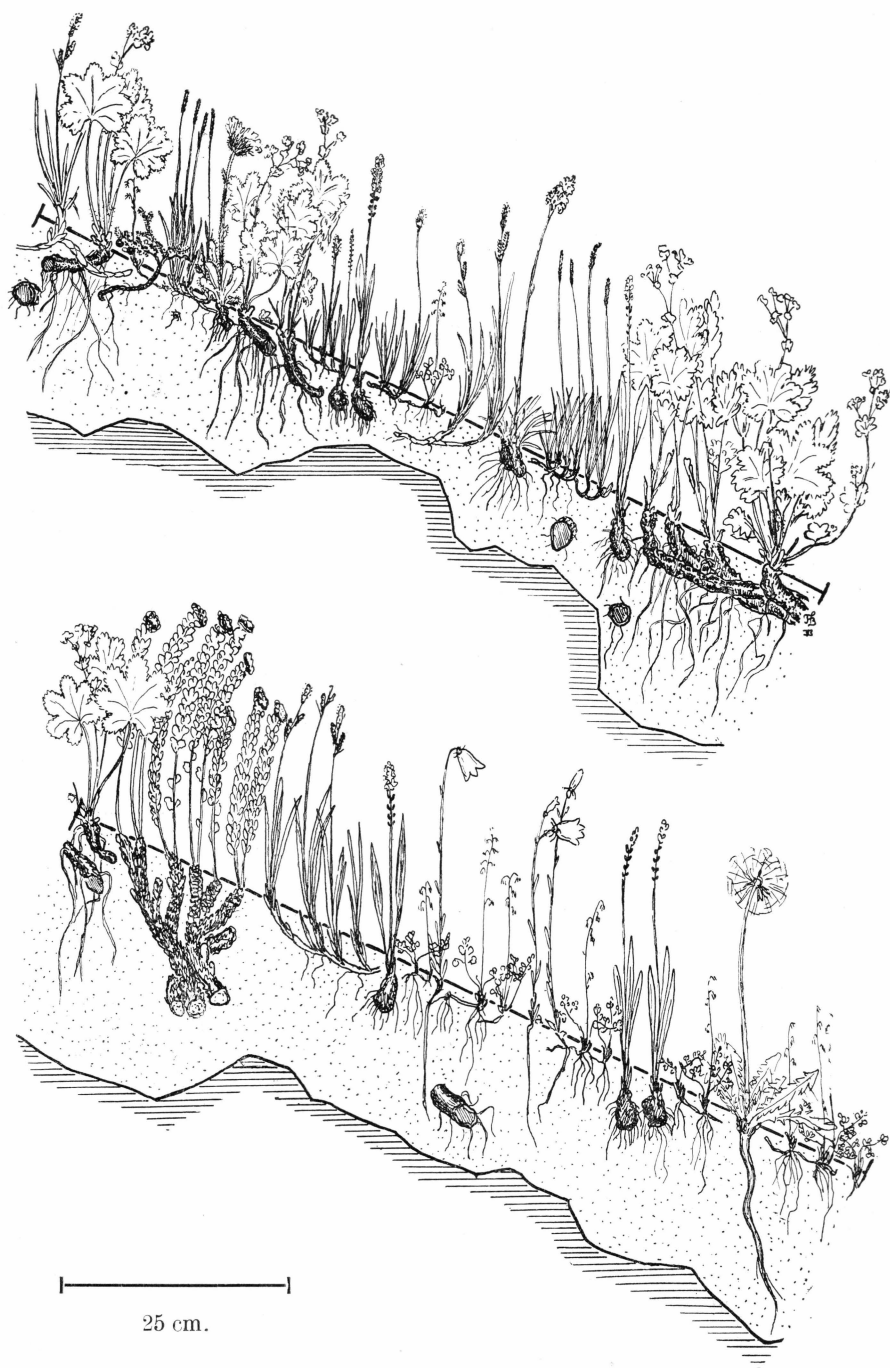


Fig. 7. Herb-field rich in *Alchemilla*, Miki's Fjord. 2 m long section through the vegetation (cf. the analyses No. **15** (upper row) and **16** (lower row), explanation in text p. 33).

It thus also appears that, by the method of counting the shoots, a species like *Carex scirpoidea* obtains a relatively higher value than by the RAUNKIÆR-method, and that a common, but scattered species like *Taraxacum* only occurs with one shoot. But everything considered, the latter method is quite impracticable, and by a simple device the RAUNKIÆR-method can be made very nearly as accurate. There proved to be an average of 37 shoots per meter, or 37^2 per $m^2 = 1369$ shoots or 1 shoot per $7,2\text{ cm}^2$.

Table 7.

			Number of shoots per meter			Total
			14 (Fig. 6)	16 (Fig. 7, lower row)	15 (Fig. 7, upper row)	
<i>Alchemilla filicaulis</i>	S	H	7	1	9	17
<i>Carex scirpoidea</i>	A ₂	H	1	..	15	16
<i>Sedum roseum</i>	S	H	4	10	..	14
<i>Thalictrum alpinum</i>	S	H	..	11	2	13
<i>Carex rigida</i>	A ₂	G	4	4	3	11
<i>Polygonum viviparum</i>	A ₂	G	2	3	3	8
<i>Empetrum nigrum</i> var.	A ₂	Ch	..	..	6	6
<i>Campanula rotundifolia</i>	S	H	2	3	..	5
<i>Bartschia alpina</i>	A ₂	H	2	..	..	2
<i>Poa alpina</i>	A ₂	H	2	..	1	3
<i>Erigeron uniflorus</i>	A ₂	H	3	..	..	3
<i>Taraxacum croceum</i>	S	H	..	1	..	1
<i>Hieracium alpinum</i>	S	H	1	..	1	2
<i>Agrostis borealis</i>	A ₂	H	2	..	..	2
<i>Sibbaldia procumbens</i>	A ₂	Ch	3	..	..	3
<i>Veronica fruticans</i>	A ₂	Ch	2	..	..	2
<i>Euphrasia latifolia</i>	A ₂	Th	2	..	..	2
<i>Gentiana nivalis</i>	S	Th	2	..	..	2
Total...	..	..	39	33	40	112

In d'Aunay Bay ($69^{\circ}05'$) a vegetation was found, in which *Salix* and *Sedum roseum* now and then formed an upper leav-layer over a lower lying stratum, No. 36; this vegetation, which will be dealt with under heath-associations, made an interesting beginning both of willow-copse and *Altherbosa*. At Angmagssalik *Chamaenerium angustifolium* often formed a very high herb-covering; farther south it will undoubtedly often leave its impress on the field of high perennials (see Fig. 17 SEIDENFADEN 1933). In the interior of Scoresby Sound, HARTZ found an association of high tuft-grasses, alternating with willow-copse, see p. 24.

In Fennoscandia *Altherbosa* is represented by *Cirsium-Geranium*-Wiesen, *Trollius*-Wiesen (DU RIETZ 1925 (b) p. 41), "kräuterreiche Hochstaudenwiesen" with *Aconitum septentrionale*, *Geranium silvaticum*,

Trollius, *Mulgedium alpinum*, *Chamænerium angustifolium*, *Anthriscus silvestris*, *Archangelica*-Wiesen or *Athyrium alpestre*-Wiesen (TENGWALL 1920, SAMUELSSON 1917 pp. 196—201). When comparing Greenland and Europe, I think *Altherbosa* in Greenland must be said to be rather pure in species, especially when comparing the Greenlandic associations with certain *Altherbosa*-associations, which I once saw on a journey in the Bavarian Alps. (Kreutzbeck).

3. Herb-field and related communities.

(*Sempervirentiherbosa* I).

TARAXACETUM CROCEI.

The demands of the herb-field as to habitat are very nearly the same as those of *Alchemilletum*, for which reason, as mentioned in the previous chapter, the two types also occur alternately. KRUSE (1912) mentions that the herb-field demands a constant and thick snow-covering, which forms early and vanishes rather late in spring. If this circumstance is used together with others as a definition of herb-field, this designation will be made to include associations which are too different in character; this, for instance, seems to me to be the case when H. RESVOLL-HOLMSEN (1920) mentions a *Cerastium trigynum*-herb-field; it will undoubtedly always be possible to distinguish between the types, which are marked by a cover of snow of particularly long duration, and those which are marked by a shorter one, seeing that the period of vegetation plays a decisive part in the growth of a number of southerly species, for which reason there proves to be a great difference in the S-percentage, compare e. g. No. 11 with No. 65. Consequently, under herb-field I will only mention the associations which, it is true, have a thick and lasting snow-cover, protecting them in winter, but melting comparatively early in the year, so that the period of vegetation does not become too short. KRUSE writes that most herb-fields become snow-bare slightly before the middle of June; as a rule, the period of vegetation will amount to at least three months. It must, however, be admitted that it is often difficult to draw the line between herb-field and snow-patch associations, cf. table 12.

Distribution: As to the distribution of herb-field in Greenland WARMING (1888) is of the opinion that it mainly follows the willow-copse, but that there are beginnings of a herb-field much farther north than the copses extend. The type of herb-field mentioned in table 8 undoubtedly coincides with *regio arctica* I, whereas the type mentioned in table 10 extends farther north; as fragment of an association herb-field practically occurs throughout the greater part of Greenland. Distinctly related with the Greenland herb-field is the herb-field

Table 8.

<i>Taraxacetum crocei</i>	G.	L.	9	10	11	12	13	T.	S.
TARAXACUM CROCEUM ..	S	H	52	60	52	36	36	5	5
POLYGONUM VIVIPARUM	A ₂	G	52	92	92	92	88	2	5
CAREX RIGIDA	A ₂	G	64	44	40	84	8	2	5
SALIX ARCTOPHILA × GLAUCA	A ₂	Ch	96	72	52	32	88	2	5
ALCHEMILLA GLOMERU- LANS	S	H	40	52	68	..	..	5	3—4
CAREX SCIRPOIDEA	A ₂	H	20	52	4	60	76	3	5
SIBBALDIA PROCUMBENS	A ₂	Ch(H)	20	48	56	60	24	4	5
THALICTRUM ALPINUM..	S	H	..	..	76	..	52	5	2—3
SALIX HERBACEA	A ₂	Ch	4	..	24	72	8	2	4
POA ALPINA	A ₂	H	4	24	12	48	76	3	5
Poa arctica	A ₁ ?	G	4	..	52	..	8	2	3
Agrostis borealis	A ₂	H	..	20	..	56	8	3	3
Campanula rotundifolia.....	S	H	8	36	..	..	52	4	3
Veronica fruticans	A ₂	Ch	12	48	..	..	..	4	2
Veronica alpina	A ₂	H	4	4	36	24	..	3	4
Hieracium alpinum	S	H	..	..	28	52	24	3	3
Cerastium alpinum	A ₂	Ch	8	36	24	12	..	2	4
Bartschia alpina	A ₂	H	8	4	12	36	8	3	5
Sedum roseum	S	H	4	4	16	32	16	3	5
Silene acaulis	A ₂	Ch	8	32	..	..	8	2	3
Juncus trifidus	S	H	12	16	..	32	20	3	4
Luzula spicata	A ₂	H	16	28	..	8	8	3	4
Empetrum nigrum	A ₂	Ch	28	4	16	28	16	2—1	5
Vaccinium uliginosum	A ₂	Ch	24	4	..	8	12	2—1	4
Cystopteris fragilis	S	H	12	24	4	4	12	3	5
Phleum alpinum	S	H	..	28	4	12	..	5	3
Alchemilla alpina	S	Ch	28	8	..	..	..	3	2
Alchemilla filicaulis	S	H	..	..	..	..	8	5	2—3
Potentilla Crantzii	S	H	4	4	20	..	..	4	3—4
Gentiana nivalis	S	Th	12	12	..	..	..	5	2
Sedum annuum	S	Th	8	8	..	..	..	4	2
Erigeron uniflorus	A ₂	H	12	4	12	..	..	5	3
Antennaria alpina	A ₂	Ch	..	8	12	4	..	3	3
Gnaphalium supinum	A ₂	Ch	..	..	..	4	..	2—1	1
Festuca ovina	A ₂	H	8	..	..	4	4	1	3
Trisetum spicatum	A ₂	H	8	12	24	..	4	2	4
Epilobium lactiflorum	S	H	4	4	..	..	4	5—4	3
Viscaria alpina	A ₂	H	4	..	..	..	..	2—1	1
Arabis alpina	A ₂	H	..	4	..	..	..	2	1
Pedicularis flammea	A ₂	H	..	4	4	..	..	2—1	2
Pirola minor	S	H	..	..	8	..	..	5	1
Oxyria digyna	A ₂	H	..	..	12	..	..	2	1
Chamænerium latifolium	A ₂	H	..	8	..	..	..	2—1	1
Saxifraga caespitosa	A ₂	Ch	..	..	..	..	4	2	1
Cerastium trigynum	A ₂	Ch	..	..	4	..	..	1	1
Lycopodium alpinum	A ₂	Ch	..	..	..	4	..	1	1
Botrychium lunaria	S	G	..	12	..	..	..	5	1
Botrychium lanceolatum	S	G	..	4	..	..	..	5	1

Spectrum: (Table 8 and 9).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch ^o / _o	H ^o / _o	G ^o / _o	TH ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o
9	68°31'	175	SSV	30°—45°	3	basalt	31	588	5,9	39	38	20	3	1	68	31
10	—	180	—	40°—45°	3	—	35	824	8,2	32	48	18	2	0	67	33
11	68°10'	150	S	40°	4	—	27	764	7,6	25	51	24	0	7	57	36
12	68°15'	330	S	30°—45°	3	gneiss	24	804	8,0	28	50	22	0	0	79	21
13	68°10'	50	SSE	30°—35°	3	basalt	26	672	6,7	24	61	15	0	1	66	33
17	68°31'	190	SSV	10°—20°	4—5	basalt	20	520	5,2	27	35	38	0	0	90	10
18	68°10'	40	S	30°	4—5	—	11	430	4,3	51	37	12	0	0	95	5

mentioned by H. RESVOLL-HOLMSEN, NORDHAGENS *Deschampsia caespitosa*-*Geranium silvaticum*-association (with *Taraxacum croceum*: constancy percentage 100) and MÖLHOLM HANSEN'S *Geranium silvaticum* zone in the Icelandic *geiri*-vegetation (snow-patch), the difference in the composition of species being, however, rather considerable as compared with that of the Greenland community¹). The Gramineæ are presumably nowhere more repressed than in the Greenland herb-field; upon this depends the great difference between the herb-field and the "matten" of the Alps; here J. BRAUN (1913) only in quite few localities found a vegetation, in which the Gramineæ were entirely repressed, i. e. on Pic des trois Evechés, 2720 m above sea-level, but from a floristic point of view there is no likeness whatsoever between the list of plants which he gives, and that of the Greenland herb-field. Everything considered, the herb-field is presumably the community which, more than any other, is associated with Greenland.

I have elected *Taraxacum croceum* as the species to give its name to the vegetation represented by tables 8 and 10, and for the following reason: *Taraxacum croceum* is the only species within the association which occurs with a high frequency, "constancy" and "Treue". It is true, there are species which have a higher F-percentage and occur with as great a constancy, but they must be said not to be limited to any definite association (*Polygonum viviparum*, *Salix arctophila* × *glauca*). *Taraxacum croceum* may occur as intermixed in the moist *Empetrum*-*Vaccinium*-heath, No. 43, which is so closely related to the herb-field, but it is, in preference to many others, entirely connected with the natural group of communities, consisting of willow-copse, *Altherbosa* and herb-field. The relationship between the different associations in

¹) A herb-field from Nowaja Semlia mentioned by A. TOLMATCHEW (1929, dritter Teil, p. 872) seems more closely related with the Greenland community, especially with the northern type (table 10); compare also SUMMERHAYES and ELTON (1928, p. 223).

Greenland is often so close that it may be difficult to express an opinion of the character-species of the associations. Thus, in this case, the species which also are rather frequent in willow-copse and *Alchemilletum* will have "Treuegrad" 5; the species, which are connected with *Taraxacetum crocei*, but are as closely, or perhaps still more closely, associated with the related *Empetretum-Vaccinietum* will have "Treuegrad" 3 (cf. BRAUN-BLANQUET 1928). Another difficulty is that, for instance, many species towards the north naturally have a higher "Treuegrad" than farther south, an interesting fact, which should be subjected to a closer examination; thus, in *Taraxacetum crocei* it appears that *Potentilla Crantzii* (table 10) towards the north (near the northern limit) only occurs in this association and with a higher frequency (presumably because in this locality it is not obliged to compete with the many other species, which occur farther south), whereas farther south it also occurs in heath-associations. It might be objected that five examinations are too slight material on which to base a judgement of these matters, but for further particulars also see the lists of species quoted under the description of localities, as well as in the works of KRUSE and HARTZ. The species chiefly dominating the herb-field appear from table 8; further, something is said about the constancy and "Treue" of the species. The chief character species are the following: *Taraxacum croceum*, *Alchemilla glomerulans*, *A. filicaulis*, *Potentilla Crantzii*, *Thalictrum alpinum*, *Campanula rotundifolia*, *Phleum alpinum*, *Gentiana nivalis*, *Pirola minor*, *Botrychium lunaria* and *B. lanceolatum*. It is well worth noticing that all of these are S-species. In more southern localities these species will no longer be character species; the notion of character species, therefore, only belongs to a limited geographical area (See further p. 61 and footnote p. 84).

Within the type of this vegetation given in table 8, deviations may arise, where conditions are slightly altered, two such being given in table 9. No. 17 comes from the locality in the luxuriant herb-fields at the fjord north of Cape Ravn, where the vegetation was exposed to particularly strong dripping from the overhanging terrace; No. 18 comes from a locality in Miki's Fjord, where the herb-field was intersected by a small water-way. The greater moisture causes the additional occurrence of *Oxyria* as a dominant. No. 17 has certain points of resemblance with willow-copse, No. 18 with No. 22.

As appears from the spectra, *Taraxacetum crocei* must be reckoned as a Hemicryptophyte community with a high percentage of southern species; nevertheless, the doubt expressed by RAUNKJÆR (1911) is justified, when we look upon the spectrum of No. 9 where the Ch-percentage is 39. A high Ch-percentage also occurs in the deviating type No. 18, whereas the other variation No. 17 shows the highest

Table 9.

	G.	L.	17	18
SALIX ARCTOPHILA × GLAUCA.....	A ₂	Ch	68	50
CAREX RIGIDA	A ₂	G	92	10
POLYGONUM VIVIPARUM.....	A ₂	G	88	40
OXYRIA DIGYNA.....	A ₂	H	68	60
SIBBALDIA PROCUMBENS.....	A ₂	Ch	32	70
SALIX HERBACEA	A ₂	Ch	16	100
Taraxacum croceum	S	H	40	20
Veronica alpina.....	A ₂	H	24	40
Poa alpigena.....	A ₂	G	20	..
Vaccinium uliginosum v. microphyllum	A ₂	Ch	8	..
Empetrum nigrum v. hermaphroditum	A ₂	Ch	8	..
Poa alpina.....	A ₂	H	8	10
Trisetum spicatum.....	A ₂	H	8	..
Phleum alpinum.....	S	H	8	..
Carex scirpoidea.....	A ₂	H	4	..
Erigeron uniflorus	A ₂	H	..	10
Cerastium trigynum.....	A ₂	Ch	4	..
Sagina Linnæi.....	S	Ch	4	..
Ranunculus pygmæus	A ₂	H	8	..
Saxifraga nivalis.....	A ₂	H	8	..
Saxifraga cernua.....	A ₂	H	4	..
Chamænerium latifolium.....	A ₂	H	..	20
Philonotis calcarea.....			+	..
Pohlia nutans			+	..
Drepanocladus uncinatus			+	..
Campothecium trichoides			+	..
Lophozia quinqueidentata.....			+	..

G percentage. *Taraxacetum crocei* is the association which within the area in question, as for that matter throughout Greenland, has the greatest density and abundance of species.

In No. 20 Ch distinctly prevails, and in No. 19 H and Ch are equal. Both come from the northern coastal area, No. 19 from Cape Dalton, No. 20 from d'Aunay Bay, and between them they give a good picture of the northern type of *Taraxacetum crocei*. That which distinguishes this type from the more southerly one is, apart from a minor floristic difference, that the relative competition of the species is a different one, seeing that the number of species belonging to the classes of highest frequency is greatest in the northern type (n) (table 11).

There is also an increase in the number of species from the northern to the southern type; further, *Cerastium alpinum* and *Antennaria alpina* occur as dominants, and there is a difference from a biological point of view in that the species of the northern type generally flower at an

Table 10.

<i>Taraxacetum crocei</i>	G.	L.	19	20	T.	S in tab. 8
TARAXACUM CROCEUM	S	H	60	84	5	5
SALIX HERBACEA	A ₂	Ch	92	40	2	4
CAREX RIGIDA	A ₂	G	88	84	2	5
POLYGONUM VIVIPARUM.....	A ₂	G	76	56	2	5
POTENTILLA CRANTZII.....	S	H	44	96	5	3—4
CERASTIUM ALPINUM.....	A ₂	Ch	52	68	2—3	4
ANTENNARIA ALPINA	A ₂	Ch	52	60	2—3	3
SALIX ARCTOPHILA × GLAUCA.....	A ₂	Ch	76	36	2—3	5
SIBBALDIA PROCUMBENS.....	A ₂	Ch	12	64	5	5
THALICTRUM ALPINUM.....	S	H	72	..	5	2—3
SEDUM ROSEUM	S	H	60	..	4	5
Vaccinium uliginosum.....	A ₂	Ch	..	44	2	..
Erigeron unalaschkensis	A ₂	H	32	12	4	..
Festuca ovina	A ₂	H	..	32	2	..
Poa arctica	A ₁	G	..	28	2	..
Trisetum spicatum.....	A ₂	H	16	8	2	..
Luzula spicata	A ₂	H	16	12	4	..
Minuartia biflora	A ₂	Ch	12	28	3	..
Silene acaulis.....	A ₂	Ch	4	16	2	..
Oxyria digyna.....	A ₂	H	..	4	2	..
Draba nivalis	A ₂	Ch	..	4	1	..
Draba daurica.....	A ₂ ?	Ch(H)	12	..	..	..
Draba crassifolia.....	A ₂	Ch(H)	4	..	4	..
Ranunculus pygmæus	A ₂	H	4	12	..	..
Saxifraga cernua.....	A ₂	H	8	8	1	..
Pedicularis lapponica.....	A ₂ ?	H	..	4	..	..
Veronica alpina.....	A ₂	H	8	8	4	..
Antennaria alpina v. glabrata	A ₂	Ch	..	24	..	..
Asterella Ludvigii.....	..	..	+	..	..	..

Spectrum: (Table 10).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch%	H%	G%	A ₁ %	A ₂ %	S%
19	69°25'	200	S	30°—55°	4	basalt	21	800	8,0	39,5	40	20,5	0	70	30
20	69°05'	400	SSE	25°	3—4	+	24	832	8,3	46	34	20	3	75	22

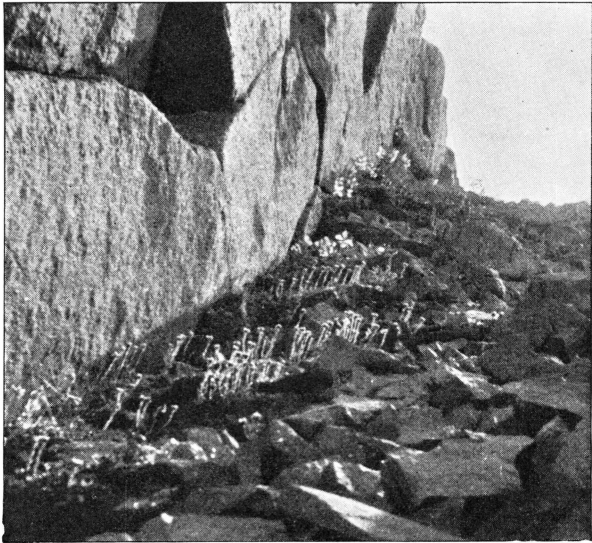
earlier period. The northern type (in other localities at Cape Dalton) also comprised *Melandrium apetalum*, *Draba alpina*, *Cardamine bellidifolia*, *Cystopteris* and *Equisetum arvense*. The mosses collected in this locality are recorded by HARMSSEN (1933) p. 30. Farther north several

Table 11.

Classes of frequency		n. Number of species Nos. 19 and 20	s. Number of species Nos. 10 and 11
V	F % 80—100	2,5	1
IV	— 60— 80	4	2
III	— 40— 60	3	5
II	— 20— 40	3	7
I	— 0— 20	10	16

northern species also occur, as for instance *Ranunculus affinis* and *Arnica alpina* (HARTZ).

Taraxacetum crocei is very rich in sociations (= Facies (DU RIETZ



T. B. phot.

Fig. 8. Fragment of herb-field along rocky wall facing south. Skærgaard Peninsula, Kangerdlugssuak. In the foreground *Antennaria alpina*, farther back *Chamænerium latifolium*.

1930)), the afore-mentioned individual investigations practically all of them being a sociation.

There does not seem to be any considerable difference between the herb-field of the east coast and that of the west coast; thus, WARMING mentions *Taraxacum croceum*, *Alchemilla vulgaris*, *Sibbaldia*, *Potentilla Crantzii*, *Campanula rotundifolia*, *Thalictrum alpinum*, *Polygonum viviparum*, *Sedum roseum* and others as the species always occurring, and RIKLI (1910) has a similar series, the first of these being *Taraxacum*

croceum. On the other hand, the herb-field in the most southerly sub-alpine area seems to derive its character from a number of other species, as e. g. *Anthoxanthum odoratum*, *Listera cordata*, *Habenaria albida* (ROSENVINGE, 1896).

Herb-field occurs frequently as a fragment of an association in snow-patches against a perpendicular wall, the radiation from the latter first causing the snow to melt right up to the rock; then a narrow strip of herb-field may form, but this strip is characterized by great incompleteness in the composition of species. In the locality marked II b in fig. 19, the chief species were *Chamænerium latifolium*, *Antennaria alpina*, *Salix arctophila* $\times$ *glaucæ*, *Bryanthus coeruleus*, *Erigeron unalaschkensis* and *Trisetum*; the two former are distinctly visible on fig. 8, the photograph being taken from the fissure in the rock which is to be seen at the north-eastern corner in fig. 19.

On Kraemer's Island, in the desert-like interior, a strip of vegetation resembling herb-field was also observed along another steep rock facing south. Outside this strip there was no life; the vegetation was undoubtedly caused by the fact that there were here conditions for a small drift of snow, which, when it melted, in its turn might carry a little moisture to the soil. We counted in all 10 shoots of *Chamænerium latifolium* and 8 of *Carex rigida*, 5 individuals of *Salix arctophila* $\times$ *glaucæ*, 2 of *Salix herbacea*, 2 of *Silene acaulis*, 2 of *Antennaria alpina*, 2 of *Trisetum spicatum*, 1 of *Luzula spicata*, 1 of *Erigeron unalaschkensis* and 1 of *Saxifraga oppositifolia*. The strip was $4\frac{1}{2}$ m long and 5—20 cm broad.

Wherever a snow-patch is intersected by a brook, the snow will also disappear more quickly on a strip on either side of the brook (see fig. 26 D). Here conditions will again favour a vegetation resembling herb-field; a *Salicetum herbaceæ*, very rich in species, occurs. Two examples of such a vegetation are given in table 12, No. 21 from Miki's Fjord, No. 22 from Angmagssalik.

The two vegetations do not resemble one another; No. 21 is rather a *Chamænerietum latifolii*, very rich in species (see table 13), but there are nevertheless several points of resemblance, also in the spectra; we are here dealing with two vegetations, which both of them resemble herb-field as well as snow-patch. In No. 22 *Alchemilla glomerulans*, in No. 21 *Chamænerium* dominated physiognomically.

I have chosen to call the typical herb-field in the area investigated *Taraxacetum crocei*, so that other closely related associations in other tracts may form an "association group" with it, which group ought to be called herb-field. Plate 2, fig. 1 represents the northern type of *Taraxacetum crocei*, physiognomically dominated by *Taraxacum* and *Potentilla Crantzii* (d'Aunay Bay). Plate 2, fig. 2 represents a section of the southern type, the species particularly in evidence being *Poly-*

Table 12.

	G.	L.	21	22
SALIX HERBACEA	A ₂	Ch	100 ₄	100 ₄
CHAMÆNERIUM LATIFOLIUM....	A ₂	H	100 ₁₋₄	..
CAREX RIGIDA	A ₂	G	..	96 ₃₋₄
SIBBALDIA PROCUMBENS.....	A ₂	Ch	48	64
VERONICA ALPINA.....	A ₂	H	60	28
Polygonum viviparum.....	A ₂	G	48	56
Alchemilla glomerulans.....	S	H	4	52
Trisetum spicatum.....	A ₂	H	40	..
Salix aretophila × glauca.....	A ₂	Ch	28	..
Gnaphalium supinum	A ₂	Ch	32	8
Epilobium anagallidifolium	S	H	..	28
Viola palustris.....	S	H	..	24
Erigeron unalaschkensis	A ₂	H	24	..
Taraxacum croceum	S	H	4	20
Equisetum variegatum	A ₂	H	24	..
Equisetum arvense.....	S	G	20	..
Carex Lachenalii.....	A ₂	H	12	16
Poa alpina.....	A ₂	H	4	16
Phleum alpinum.....	S	H	..	12
Luzula confusa.....	A ₂	H	16	..
Oxyria digyna.....	A ₂	H	12	8
Cerastium trigynum.....	A ₂	Ch	12	..
Cerastium alpinum.....	A ₂	Ch	4	..
Arabis alpina.....	A ₂	H	4	..
Thalictrum alpinum.....	S	H	..	12
Sedum roseum	S	H	..	4
Saxifraga cernua.....	A ₂	H	4	..
Empetrum nigrum var. hermaphrodit..	A ₂	Ch	4	..
Pirola minor	S	H	..	4
Bartschia alpina.....	A ₂	H	..	8
Pedicularis flammea.....	A ₂	H	..	4
Gentiana nivalis.....	S	Th	..	4
Antennaria alpina	A ₂	Ch	12	..
Festuca rubra.....	S	H	..	8
Deschampsia alpina.....	S	H	..	4
Agrostis borealis.....	A ₂	H	..	4

Spectrum: (Table 12).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch°/o	H°/o	G°/o	Th°/o	A ₁ °/o	A ₂ °/o	S°/o
21	68°10'	15—20	S	10°	4	basalt	24	620	6,2	39	50	11	0	0	95	5
22	65°37'	110	S	20°—25°	4	gneiss	23	580	5,8	29,7	43,4	26,2	0,7	0	70	30

gonum viviparum, *Taraxacum*, *Sibbaldia*, *Chamænerium latifolium* (in the lower right corner), *Alchemilla glomerulans* and a few handsome specimens of *Lycoperdon maximum* (Schaeff)¹⁾. Figure 5 (in the text) shows the position of the vegetation in the fjord north of Cape Ravn, right below the steep wall of a terrace.

Débris-Associations.²⁾

a. CHAMÆNERIETUM LATIFOLII.

Under "herb-field" p. 40, footnote, WARMING (1888) writes: *Chamænerium latifolium* thrives best in gravelly and stony soil, on the banks of rivers; as its roots spread wide, and form numerous root-shoots, it grows gregariously, and it frequently covers large patches so densely that these patches, during their flowering period, attract the attention from afar by their red colour." Such a river-bed vegetation is given in Nos. 21 and 26; *Chamænerium*, however, does not merely keep to the river-bed, but frequently covers large, as a rule gently sloping, gravelly, rather moist tracts near rivers, No. 25, or it occurs in great patches in the débris (talus), where it is not too dry, and where the snow remains throughout the winter. In such a locality *Chamænerium* frequently reigns superior, as I frequently saw, for instance, on the south coast of Kraemer's Island, in Miki's Fjord and in certain localities at Cape Daussy. Unless the débris becomes too prevailing, this species is followed by others, as I saw in one locality near Uttental Sound and in Miki's Fjord, Nos. 23 and 24. KRUSE mentions *Chamænerium latifolium* as the only species occurring in "sandfields" at Angmagssalik; ROSENVINGE mentions it as one of the species characteristic of the gravel slopes in the south coast country; HULTÉN mentions it as "a decumbent plant of the gravel on the river banks" in Kamtschatka and on Nowaja Semlia TOLMACHEW (1929) found "üppige Bestände von *Chamænerium latifolium*, welche die steinigen Inseln zwischen den Stromärlen bedeckten" (p. 877). Everything considered, the species — owing to its subterranean type of shoots — is particularly qualified to conquer the places where the débris prevails, or where generally speaking new soil is to be found; thus, *Chamænerietum latifolii* does not often acquire the character of a climax-association, but may frequently be classed as a "Dauer"-association, cf. BRAUN-BLANQUET. The pronounced vegetative propagation makes *Chamænerium* qualified to bear a snow-cover of longer duration; the associations investigated in table 13 must thus be said to be a

¹⁾ The determination of this fungus was kindly undertaken by Mr. AAGE LUND, M.sc. The species was formerly taken by KRUSE at Angmagssalik (ROSTRUP: Fungi Groenlandiæ orientalis, Medd. o. Grøn. XXX, 1904).

²⁾ "*Mobilideserta*", Wandereinöden, Geröllflur (RÜBEL 1930).

Table 13.

<i>Chamænerietum latifolii</i>	G.	L.	23	24	25	26
CHAMÆNERIUM LATIFOLIUM.....	A ₂	H	96	84	88	60
SALIX HERBACEA	A ₂	Ch	100	96	20	84
CAREX RIGIDA	A ₂	G	4	52	32	96
POLYGONUM VIVIPARUM.....	A ₂	G	20	..	64	88
SALIX ARCTOPHILA × GLAUCA.....	A ₂	Ch	..	4	84	64
SAXIFRAGA OPPOSITIFOLIA.....	A ₂	Ch	20	8	80	4
Saxifraga caespitosa.....	A ₂	Ch	44	..	..	..
Empetrum nigrum v. hermaphroditum ...	A ₂	Ch	..	4	4	44
Vaccinium uliginosum v. microphyllum...	A ₂	Ch	..	..	20	16
Silene acaulis.....	A ₂	Ch	..	..	44	..
Pedicularis flammea.....	A ₂	H	..	..	..	32
Oxyria digyna.....	A ₂	H	12	8	20	4
Minuartia biflora	A ₂	Ch	4	..	..	..
Carex Lachenalii.....	A ₂	H	..	8	..	..
Cassiope hypnoides	A ₂	Ch	..	4	..	4
Cerastium alpinum.....	A ₂	Ch	4	..	..	..
Diapensia lapponica.....	A ₂	Ch	..	..	4	8
Draba crassifolia.....	A ₂	Ch	4	..	..	..
Draba rupestris.....	A ₂	Ch	12	..	..	..
Luzula confusa.....	A ₂	H	..	4	8	4
Poa alpina.....	A ₂	H	8	..	..	..
Saxifraga cernua.....	A ₂	H	4	..	..	..
Sibbaldia procumbens.....	A ₂	Ch	8	..	..	..
Taraxacum croceum (vegetative).....	S	H	4	..	..	..
Trisetum spicatum.....	A ₂	H	4	4	..	..

Spectrum: (Table 13).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch°/o	H°/o	G°/o	A ₁ °/o	A ₂ °/o	S°/o
23	ca. 68°10'	10	S	0—5°	3	basalt	16	348	3,5	56	37	7	0	99	1
24	—	120	SV	15°	3	gabbro	11	276	2,8	42	39	19	0	100	0
25	—	10	S	0°	3	gnejss	12	452	4,5	57	22	21	0	100	0
26	—	—	—	—	4	—	13	524	5,2	43	22	35	0	100	0

special variety of the great snow-patch-association-“verband”, which is called *Salicion herbaceae* (see the F-percentage of *Salix herbacea* in table 13). Reminiscent of *Chamænerietum latifolii* is an association — also growing in débris — of *Equisetum variegatum* (table 14), which likewise occurs as a dominant in *Salicion herbaceae* (No. 76).

Distribution: *Ch. latifolium* is widely distributed in America and

has again found its way from Greenland to Iceland, but not to the continent of Europe, OSTENFELD (1926) p. 40. It occurs everywhere in Greenland.

Table 13 especially shows two types of the association, one in which *Chamænerium* and *Salix herbacea* dominate entirely, and one in which also other species such as *Polygonum viviparum*, *Saxifraga oppositifolia*, *Carex rigida* and *Salix arctophila* $\times$ *glauca* play a part; along a river No. 26 the vegetation had a heath-like character. The prevailing life-form is Ch and the percentage of S is 0, whereas the A_2 -percentage is 100, as is also the case within other associations of *Salicion herbaceae*. Where *Chamænerium* dominates entirely in débris, the H-percentage is 100 (*Chamænerium* may, however, in inclement localities develop into a Chamæphyte).

b. EQUISETETUM VARIEGATI.

In Miki's Fjord *Equisetum variegatum* occurred with very great frequency in the valley trending north to Watkins Fjord; it was particularly characteristic to see this species clothe the loose material of the slope so entirely that in large tracts it was the only dominant in the sparse débris-flora. But also in the »*Salherbeta*« of the bottom of the valley it was very frequent (see also plate 5, fig. 2, where it occurs in the moor vegetation). The small débris association given in table 14 is interesting, in that it only occurred where the particles of stone, which made up the débris, were small. The size of these particles has been described in the spectrum from a measuring which Mr. GRY M. Sc. and Miss SOLE MUNCK were kind enough to undertake for me. On the surface this gravel was dry, but lower down it was rather moist, and the constituent particles were all greatly weathered. *Equisetum variegatum* and *Chamænerium* were the only species which attained dominance in this

Table 14.

<i>Equisetum variegati</i>	G.	L.	27
EQUISETUM VARIEGATUM	A_2	H	100
Oxyria digyna	A_2	H	16
Trisetum spicatum	A_2	H	12
Erigeron unalaschkensis	A_2	H	8
Saxifraga caespitosa	A_2	Ch	8
Arabis alpina	A_2	H(Ch)	8
Chamænerium latifolium	A_2	H	4
Salix herbacea	A_2	Ch	4
Cerastium alpinum	A_2	Ch	4
Luzula spicata	A_2	H	4

Spectrum:

68°10' lat. N.
40 m. above sea-level.
Exposure: west.
Inclination: 40°.
Number of species: 10.
Points sum: 168.
Density of species: 1.7.
Ch 0 / $_{10}$: 10. H 0 / $_{10}$: 90. A_2 0 / $_{10}$: 100.

Underground: loose débris of
highly weathered basalt
gravel.
Moisture: 1—3.
Sizes of particles of gravel:
5—10 mm: 17.5 %
2—5 mm: 54.5 %
1—2 mm: 23.7 %
 $\frac{1}{2}$ —1 mm: 3.1 %
0— $\frac{1}{2}$ mm: 1.2 % (differ.).

material, but also *Oxyria* with its deep-going root-stem was now and then rather common. The gravel was so weathered that the particles crumbled when squeezed, and in such localities (fig. 26 I) it surely cannot last very long before the associations will develop which are usual in finely grained basalt soil (*Taraxacum crocei* or a *Salicetum herbacea* as No. 29 a).

c. Other Débris Vegetation.

Besides the afore-mentioned types of débris vegetation there is still one more which never, or extremely rarely, has dominants, and whose individuals are so far removed from one another that the vegetation formerly would have been characterized as fell-field. When in the present article it is not mentioned under fell-field, this is due to the revaluation of this term, as used by WARMING, which revaluation was necessitated by the introduction of "snow-patch" (mentioned on p. 97 where fell-field is not merely defined as a community with a disconnected cover of vegetation, but as a community which is furthermore characterized by a lack of snow-cover). The débris-vegetation found below a continuous covering, either of herb-field or of *Salicetum herbaceae*, is most often covered with snow, and, in consequence, shelters many southern species. These conditions I studied more particularly in the fjord north of Cape Ravn; here, at a great distance from the herb-fields it was now and then possible to find large, very well developed specimens of *Phleum alpinum*, *Epilobium lactiflorum*, *E. anagallidifolium* and *Poa alpina* growing between the boulders, where there must be a constant snow-cover, and where small quantities of clay had gathered. On p. 10 the débris vegetation is mentioned which was recorded on the southern slope of the promontory of Cape Ravn, facing the Danmark Strait; a débris-vegetation of this kind need not be covered with snow. The converse is the case with the vegetation mentioned in tables 15 and 16, which must at any rate be covered with snow on top nearest the continuous covering. A small section of 1 m² of débris-vegetation in one locality, at a distance of 4 m from the continuous vegetation, numbered 14 species, represented by 40 specimens which were distributed in the following manner:

7 <i>Poa alpina</i> .	2 <i>Saxifraga caespitosa</i> .
6 <i>Veronica fruticans</i> .	2 <i>Cystopteris fragilis</i> .
6 <i>Epilobium lactiflorum</i> .	1 <i>Polygonum viviparum</i> .
5 <i>Sibbaldia procumbens</i> .	1 <i>Cerastium alpinum</i> .
3 <i>Luzula spicata</i> .	1 <i>Cerastium trigynum</i> .
2 <i>Arabis alpina</i> .	1 <i>Draba rupestris</i> .
2 <i>Minuartia biflora</i> .	1 <i>Agrostis borealis</i> .

Table 15.

	28a					28 b																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	(6-25)				
SIBBALDIA PROCUMBENS.....	+	+	+	+	..	+	+	..	+	+	+	+	+	+	+	+	+	+	..	..	..	..	..	..	..	..	60			
Luzula spicata	..	..	..	+	+	+	+	..	+	+	+	+	+	+	..	+	+	..	..	..	..	..	..	..	..	..	50			
Poa glauca.....	..	..	..	+	..	+	..	+	+	..	..	+	+	+	+	..	+	..	..	..	..	..	+	..	..	45				
Polygonum viviparum..	+	+	+	+	+	..	+	..	..	+	+	+	+	+	+	..	+	..	+	..	+	..	..	..	..	40				
Oxyria digyna.....	..	..	..	..	..	+	..	..	..	..	..	..	+	..	+	+	+	..	..	..	..	..	..	..	+	30				
Trisetum spicatum....	+	+	+	+	+	..	+	..	+	..	+	+	..	+	..	+	..	..	..	..	..	..	..	..	..	25				
Taraxacum croceum ...	+	+	..	..	..	..	+	..	..	+	+	..	..	..	..	+	..	..	..	..	..	..	..	..	..	20				
Epilobium lactiflorum ..	..	..	..	..	..	+	..	..	+	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	+	20				
Arabis alpina.....	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..	..	..	15				
Silene acaulis.....	..	..	..	..	..	..	..	..	..	..	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	15				
Salix arctoph. × glauca.	+	+	+	+	+	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10				
Veronica fruticans	..	..	+	+	+	..	..	..	+	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	10				
Gentiana nivalis.....	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..				
Gentiana nivalis var. albi- flora	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..				
Carex scirpoidea.....	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..				
Carex rigida.....	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..				
Salix herbacea.....	..	..	..	+	+	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5				
Empetrum nigrum.....	..	+	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5				
Antennaria alpina	..	+	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	5				
Botrychium lanceolatum	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..				
Veronica alpina.....	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5				
Agrostis borealis.....	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	+	..	..	..	..	..	..	..	..	..	10				
Gnaphalium supinum ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	+	10				
Saxifraga caespitosa....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	D	..	..	..	..	..	..	..	+	..	5				
Saxifraga cernua.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	5				
Cerastium trigynum....	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	5				
Minuartia biflora	..	..	..	..	..	..	..	..	..	..	..	..	..	..	D	..	..	..	..	..	..	..	..	..	..	..				
Density of species	9	10	6	8	6	6	7	2	7	4	7	6	7	5	6	5	3	3	2	1	2	1	0	2	3	3,95				

Of those mentioned above *Cystopteris fragilis* often occurred as a species forming an association, and the same was the case — though as a rule still nearer the steep terrace wall — with *Sedum annuum*.

It is naturally rather due to chance which of the species occur in the individual place; nearest the continuous vegetation the débris-vegetation is entirely dependent on the species found there, but farther away the composition of species becomes more uniform; still, there is hardly any species within this kind of vegetation which occurs with great "Stetigkeit" (cf. J. BRAUN 1913, p. 140). In tables 15 and 16 I have reproduced a circling investigation of the merging of a *Taraxacetum* and a *Salicetum herbaceae* into a débris-vegetation. The investigation was undertaken in the manner that a circle was examined after each meter, in a straight

Table 16.

	29a																29c										29b
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	1-25
SALIX HERBACEA	100	+	+	+	+	..	+	..	+	+	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	32
CAREX RIGIDA	100	+	+	+	+	+	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	24
VACCINIUM ULIGINOSUM v. MICROPHYLLUM	64	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8
AGROSTIS BOREALIS	60	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	4
POLYGONUM VIVIPARUM	60	+	..	..	..	..	..	..	+	..	+	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	20
Salix arctophila × glauca . . .	56	+	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	D	..	..	..	..	..	..	8
Cerastium alpinum	52	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4
Empetrum nigrum v. herma- phroditum	24	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8
Luzula confusa	20	+	+	..	+	+	..	..	..	..	..	..	..	..	+	..	..	+	..	..	..	..	..	..	..	..	24
Veronica alpina	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	4
Veronica fruticans	16	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cystopteris fragilis	12	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	8
Taraxacum croceum	8	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	8
Sibbaldia procumbens	8	..	..	..	..	..	..	..	..	..	..	+	..	+	+	..	..	..	..	..	..	..	..	..	..	..	12
Trisetum spicatum	8	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4
Antennaria alpina	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Chamænerium latifolium	4	..	..	..	..	..	..	..	..	..	..	+	+	D	..	+	..	..	..	..	..	..	..	..	..	..	12
Silene acaulis	4	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4
Oxyria digyna*)	..	..	..	..	..	..	..	..	..	..	+	+	+	+	+	+	..	+	..	..	..	..	..	+	+	..	32
Poa alpina	..	..	..	..	..	..	+	..	+	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	+	..	16
Epilobium lactiflorum	..	..	..	..	..	..	+	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	+	..	..	12
Minuartia biflora	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	+	..	..	..	..	..	..	..	8
Cerastium trigynum	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	+	..	..	8
Arabis alpina	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	4
Density of species	6,2	8	5	4	3	2	3	1	3	2	5	3	4	4	6	3	0	3	2	0	1	0	0	2	2	0	2,6

*) See footnote on p. 93.

Spectrum: (Table 15 and 16).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch ^o / _o	H ^o / _o	G ^o / _o	Th ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o
28a	68°31'	200	SSV	35°	3	mould, finely grained basalt.	..	..	7,8	41	31	21	7	0	85	15
28b	—	—	—	—	2	clay between basalt boulders	21	395	3,95	33	57	10	0	0	90	10
29a	—	150	—	40°	3	finely grained basalt	18	616	6,2	53	26	21	0	0	97	3
29b	—	—	—	—	2	clay between basalt boulders	21	264	2,6	34	48	17	0	0	90	10
29c	—	—	—	—	—	—	9	100	1,0	30	70	0	0	0	80	20

line, downwards across the débris. In table 15 the first 5 circles lay in a closed *Taraxacetum*. We see how the species vary very much in their endurance of the changed conditions of the underground. A number of these species cease at once, and new ones are added, the latter being the most interesting in this context, as for instance *Cerastium trigynum*. Later in summer, in a place like this one, the plants are frequently exposed to great drought, which may result in their dying (marked D). Table 16 shows the merging of a *Salicetum herbaceae* into the debris-vegetation. Of the dominants in **29 a** only *Salix herbacea*, *Carex rigida* and *Polygonum viviparum* are able to live for some distance into the débris, **29 b**, but there are some which occur with an increased F-percentage in the débris, as for instance *Luzula confusa*, *Chamænerium latifolium*, *Oxyria digyna*, *Poa alpina*, *Epilobium lactiflorum*, *Minuartia biflora*, *Cerastium trigynum* and *Arabis alpina*; these species are typical of the debris-vegetation.

The spectra of tables 15 and 16 show the interesting fact that the Hemicryptophytes increase in number, the farther one penetrates into the débris; from table 16 it also appears that the percentage of S-species in certain places is apt to increase, when passing from a closed *Salicetum herbaceae* to an adjoining debris-vegetation. It is difficult to reconcile this with the definition of fell-field proper.

CARICETUM RIGIDAE.

It will first of all be necessary to realize that what ROSENVINGE — when speaking of the country of the south coast — calls “grass-slope” (Græsli) or “grass-field” (Græsmark) can not, or at any rate can only with difficulty be compared with the two associations from Angmagssalik, which KRUSE defines by the same words. Whereas there seems to be some floristic resemblance between grass-field as used in the one case and the other, it is as far as the grass-slope is concerned practically impossible to find any likeness; the dominant in KRUSE’s grass-slope, *Carex rigida*, is not mentioned in the South Greenland community, and the dominants in the latter, *Anthoxanthum odoratum* and *Deschampsia flexuosa*, do not occur in Angmagssalik. The type of vegetation which KRUSE calls “grass-slope” is in the first place characterized by *Carex rigida*, at any rate in the localities which I visited; in the vegetation in question this species was so predominant as nowhere else, although it is a very important constituent of most closed formations. Consequently, it will be justifiable to define the Angmagssalik grass-slope as *Caricetum rigidae*. KRUSE found that it was the supply of water which was the decisive factor in the development or non-development of “herb-slope” or “grass-slope”; the latter — according to the said writer — occupies sand slopes (with an inclination of 20—30°) of æolian origin, without

Table 17.

<i>Caricetum rigidae</i>	G.	L.	30	31	32	33
CAREX RIGIDA	A ₂	G	100	100	100 ₄	100 ₄
CHAMÆNERIUM ANGUSTIFOLIUM	S	H	..	8	92 ₁₋₃	88 ₁₋₃
LUZULA SPICATA	A ₂	H	64	28	12	16
JUNCUS TRIFIDUS	S	H	60	+	+	4
THYMUS ARCTICUS	S	Ch	..	..	68	20
CAMPANULA ROTUNDIFOLIA	S	H	20	68	56	44
CERASTIUM ALPINUM.....	A ₂	Ch	28	60	20	24
Taraxacum croceum	S	H	12	20	40	36
Potentilla tridentata	S	Ch	36	..	+	..
Salix artophila × glauca.....	A ₂	Ch	56	..	..	..
Festuca rubra.....	S	H	..	32	..	..
Poa alpigena.....	A ₂	G	..	28	..	4
Trisetum spicatum.....	A ₂	H	12	4	8	4
Viscaria alpina	A ₂	H	8	4	4	4
Erigeron uniflorus	A ₂	H	12	8	16	4
Agrostis borealis.....	A ₂	H	8	16	+	..
Minuartia biflora	A ₂	Ch	4	..	..	..
Cystopteris fragilis.....	S	H	20	..	..	..
Gnaphalium supinum	A ₂	Ch	8	..	..	..
Hieracium alpinum	S	H	..	8	..	..
Poa alpina.....	A ₂	H	24	..	..	..
Polygonum viviparum.....	A ₂	G	24	..	..	..
Salix herbacea.....	A ₂	Ch	4	..	..	..
Sibbaldia procumbens.....	A ₂	Ch	16	..	..	..
Silene acaulis.....	A ₂	Ch	24	..	..	..
Thalictrum alpinum.....	S	H	..	..	..	8
Sedum roseum*)	S	H	4	..	..	..
Cladonia sp.....	..	..	..	..	+	+
Stereocaulon sp.....	..	..	..	..	+	+
ALCHEMILLA ALPINA.....	S	Ch	..	..	!!!	..

*) Dropped into a clump of moss from the vegetation of the rock situated above it; appeared to be able to live.

Spectrum (Table 17):

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch°/o	H°/o	G°/o	A ₁ °/o	A ₂ °/o	S°/o	M°/o
30	68°10'	120	S	0—10°	2	gabbro	21	544	5,4	32	45	23	0	72	28	49
31	65°37'	100	SE	5—10°	3	gneiss	14	384	3,8	16	51	33	0	65	35	54
32	—	120	S	28—33°	2	—	13	416	4,2	21	55	24	0	38	62	29
33	—	150	S	40°	2	—	13	356	3,6	12	59	29	0	44	56	36

a constant supply of running water, where the underground water lies deep down, and where in winter there is a constant, though not thick (frequently at most 20 cm) cover of snow.

Distribution. *Caricetum rigidae* seems, until now, only to have been described from the region round Angmagssalik. If similar associations are found in West Greenland, it may be said *a priori* that they are associated with the southern parts. The association has a pronouncedly sub-arctic character; it occurred as fragment of an association as far north as the Skærgaard Peninsula in Kangerdlugssuak, 68°10' (No. 30). H. RESVOLL-HOLMSEN mentions a *Carex rigida* grass-field, rich in mosses, which, it is true, reminds somewhat of the said Greenlandic association, although no actual comparison is possible, and NORDHAGEN's *Carex rigida* association is a snow-patch association, which can be compared with my *Salicetum herbaceae*. Nevertheless, I think my *Caricetum rigidae* most closely associated with Norwegian xerophilous grass-field, in which association group *Caricetum rigidae* must be classed.

In table 17 four examples are given of the vegetation. No. 30 which, as mentioned above, is to be considered as an association fragment, and in several respects distinguishes itself from the other investigations was found as a strip of vegetation along a rocky wall facing south, from which no water oozed. Nos. 31 and 32 are from "Elvbakker" at Angmagssalik, No. 33, from "Udsigtsfjeldet" at Angmagssalik. In Nos. 32 and 33 *Chamaenerium angustifolium* is physiognomically dominating; however, this species does not attain the same importance as *Carex rigida*, its shoots being twice as far removed as the shoots of the sedge (cf. p. 21). In No. 30 *Juncus trifidus* reaches a F-percentage of 60, and may thus be imagined as forming a *Juncetum trifidi*, an association which may make the basis of comparisons with Scandinavian and other similar European associations. The character species of the herb-field, viz. *Taraxacum croceum*, also occurs constantly in *Caricetum rigidae*, which shows the relation between *Taraxacetum* and *Caricetum rigidae*. However, *Taraxacum* did not thrive so well in the *Caricetum*, which in the course of the summer became quite dry; at the beginning of September it was entirely faded, and it looked as if most specimens had not flowered. *Caricetum rigidae* was frequently rich in *Cladoniae* and *Stereocaulon* (see KRUSE, p. 248).

The spectrum shows that the vegetation is poor in species, with Hemicryptophytes dominating, and in the latter investigations chiefly subarctic species. The percentage of grass-like plants (M-percentage) is particularly high in No. 31, but on an average also high when compared with the same quantity in a *Taraxacetum crocei* where it will be about 20 per cent.

In the vicinity of Angmagssalik the vegetation covers very extensive tracts; when approaching the settlement from the north it is this vegetation which, in the first place, gives one a feeling of being in more southern latitudes. From a physiognomical point of view it resembles a Danish community, and one is here confronted with a Hemicryptophyte community; the vegetation is not conditioned by the water flowing constantly down from melting snow, but in summer it is reduced to the rain fall. The association must presumably be described as bearing the character of an oceanic association.

ALCHEMILLETUM ALPINAE.

In "Elvbakker" at Angmagssalik *Alchemilla alpina* occupied large, densely covered patches in the vegetation of the southern slopes. It frequently occurred together with the willow-copses and the heath, but more particularly it formed extensive patches of vegetation, of the shape of islands, in *Caricetum rigidae*. This is suggested in table 17 at the bottom. That *Alchemilletum alpinae* is regarded as an independent association, and is not merely mentioned as an important sociation under the *Caricetum* is, in the first place, due to the fact that its shoots form a dense cover of the character of heather, which to some extent conditions a change in the number of species, and more particularly a reduction in the frequency of occurrence of the species in the surrounding vegetation. It is, however, a factor of decisive importance that the association may occur in localities where *Caricetum rigidae* is not recorded; this was, for instance, the case in Miki's Fjord (No. 34) and as far as north as the fjord north of Cape Ravn (68°31') where the photograph showing the association (plate 1, fig. 2) was taken. Thus, the distribution of the association on the east coast coincides with that of *A. alpina*; on the west coast its northern limit is at Holstensborg. The association belongs to *regio arctica* I. H. RESVOLL-HOLMSEN records a corresponding association from Norway, also as larger or smaller patches in "xerophilous grass-field".

The association individual in table 18, No. 30, occurred just below a rocky wall, from which no water oozed. The size was 50 m². While sailing through Miki's Fjord we saw *Alchemilletum alpinae* shining brightly in vivid light-yellow colours, while the other *Alchemilleta* stood out succulently green. The species occurring in the patch of vegetation examined are nearly all species which are able to bear drought, more particularly *Agrostis borealis*, *Festuca ovina* and *Veronica fruticans*. The percentage of grass-like plants is high (34), which shows that it is related to *Caricetum rigidae*. H and Ch are equal, and there is a high S-percentage.

In the particularly luxuriant heath at Miki's Fjord I saw, in many

Table 18.

<i>Alchemilletum. alpinae</i>	G.	L.	34
ALCHEMILLA ALPINA	S	Ch	100
Polygonum viviparum	A ₂	G	40
Agrostis borealis	A ₂	H	40
Festuca ovina var. vivipara	A ₂	H	32
Veronica fruticans	A ₂	Ch	24
Salix arctophila × glauca	A ₂	Ch	24
Carex scirpoidea	A ₂	H	16
Epilobium lactiflorum? (vegetative)	S	H	16
Trisetum spicatum	A ₂	H	12
Bartschia alpina	A ₂	H	12
Juncus trifidus	S	H	8
Poa alpina	A ₂	H	8
Luzula spicata	A ₂	H	8
Silene acaulis	A ₂	Ch	8
Oxyria digyna (vegetative)	A ₂	H	4
Saxifraga caespitosa	A ₂	Ch	4
Empetrum nigrum var. hermaphroditum	A ₂	Ch	4
Cystopteris fragilis	S	H	4

Spectrum: (Table 18).

Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch ^o / _o	H ^o / _o	G ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o	M ^o / _o
68°10'	50	SSE	30°	2	basalt	18	364	3,6	45	44	11	0	65	35	34

places, fairly large tracts consisting of a *Salix arctophila* × *glauca-Alchemilla alpina* association. The vegetation was 25 cm high; the *Salix*-leaves did not shadow *Alchemilla* to any great extent, but there was nevertheless a distinct, incipient formation of layers. By tilting over a large boulder in the midst of the vegetation one was able to form an idea of the underground shoots. *Salix* and *Alchemilla* sent their shoots through the soil as two genuine Chamæphytes (heather-types); apart from that there were only great quantities of threadlike runners from *Poa arctica* and somewhat thicker rhizods of *Carex rigida*, which more particularly intersected the upper layer of soil (10—15 cm in thickness), whereas the two Ch went much deeper. Finally, some stem-tubers of *Polygonum viviparum* were identified, and close to the surface some runners of *Thalictrum alpinum* which were very well shaded. In fact, a Chamæphyte-Geophyte-association. It was interesting to notice how farther south, where the willow attained still greater heights and formed a heath-

copse (table 4) *Alchemilla alpina* disappeared in the strong shade, while outside the copses it formed, together with *Salix*, a heath which was quite similar to the one found in Miki's Fjord.

4. Heath-series.

(*Ericifructiceta* (RÜBEL 1930)).

I. Moist heath, rich in species, on slope facing south.

SALICETO-VACCINIETUM.

In d'Aunay Bay (69°05'), slightly north of the area where the actual *Empetrum-Vaccinium* heath begins, *Empetrum* was frequently lacking in localities, where farther south it would be dominating, and this often caused *Salix arctica* × *arctophila* × *glauca* to gain the upper hand. A vegetation of this kind was investigated in one place (table 19); it is worth noticing that this place in every respect corresponded with the locality, where farther south one would be sure to find *Alchemilla* or *Taraxacum crocei* (fig. 26 B. 3). There is also only a minor difference between such a luxuriant heath, rich in species, and the herb-field association, and the transition between them is quite gradual. The particularly high H-percentage is evidence of the relationship with the herb-field, whose species also occur here as intermixtures. The northerly position of the heath investigated is shown by the occurrence of a number of species with a northerly distribution: *Arnica alpina*, *Draba lactea* and *Pedicularis lapponica*. Nevertheless, the S-percentage is higher than the A₁-percentage.

As to the height attained by the vegetation see p. 35.

EMPETRETO-VACCINIETUM.

Moist con-sociation, rich in species, cf. No. 59.

As corresponding with conditions in Scandinavia, this name comprises a number of con-sociations (sub-associations); of great importance here, as in Scandinavia, is a type without a bottom vegetation of lower plants¹⁾, one type rich in mosses and one rich in lichens. These types, however, are not so pronounced as in Scandinavia, and my material, particularly of mosses from heath-associations, is not sufficiently large to enable me to give a sociation-(Facies-) division of the heath, as the one given by RÜBEL 1930 (pp. 126—128). The *Empetreto-Vaccinietum* type, which is given in tables 20 and 21, must rather be described as

¹⁾ The most common type in the Alps (DU RIETZ 1924. p. 92) perhaps also in Greenland.

Table 19.

<i>Saliceto-Vaccinietum</i>	G.	L.	36
SALIX ARCTICA × ARCTOPHILA × GLAUCA.	A ₂	Ch	80
VACCINIUM ULIGINOSUM (var. microphyl.) ...	A ₂	Ch	72
SEDUM ROSEUM.....	S	H	64
Pedicularis lapponica	A ₂ ²	H	36
Antennaria alpina.....	A ₂	Ch	28
Cerastium alpinum	A ₂	Ch	32
Potentilla Crantzii.....	S	H	24
Polygonum viviparum	A ₂	G	24
Poa arctica.....	A ₁	G	20
Veronica alpina	A ₂	H	20
Sibbaldia procumbens.....	A ₂	Ch	16
Trisetum spicatum	A ₂	H	16
Poa alpina	A ₂	H	16
Hieracium alpinum.....	S	H	12
Arnica alpina.....	A ₁	H	12
Veronica fruticans.....	A ₂	Ch	12
Juncus trifidus.....	S	H	12
Euphrasia latifolia.....	A ₂	Th	8
Draba lactea.....	A ₁	Ch	8
Minuartia biflora.....	A ₂	Ch	8
Saxifraga cernua	A ₂	H	8
Saxifraga nivalis	A ₂	H	8
Carex scirpoidea	A ₂	H	8
Cystopteris fragilis	S	H	8
Salix herbacea	A ₂	Ch	8
Luzula spicata.....	A ₂	H	8
Silene acaulis	A ₂	Ch	4
Bryanthus coeruleus	A ₂	Ch	4
Taraxacum croceum.....	S	H	4

Spectrum: (Table 19).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch°/o	H°/o	G°/o	Th°/o	A ₁ °/o	A ₂ °/o	S°/o
36	69°05'	310	SSE	35°	3	basalt	29	580	5,8	47	44	7	2	7	72	21

being rich in mosses, seeing that there are often, though not as a rule, a fairly great abundance of them; what I have used as a basis for grouping the individual investigations is, consequently, neither the abundance nor the species of mosses, but the common conditions under which the vegetations occurred. The common conditions are here, in the first place, the moisture and secondly the southern exposure and the inclination. In Nos. 37, 38 and 39, the inclination is less than in the following investiga-

Table 20.

<i>Empetretum-Vaccinietum</i>	G.	L.	37	38	39	40	41	42	43	44	S
EMPETRUM NIGRUM var.											
HERMAPHRODITUM	A ₂	Ch	100	92	68	100	100	92	100	80	8
VACCINIUM ULIGINOSUM											
var. MICROPHYLLUM ...	A ₂	Ch	68	100	88	56	88	64	100	88	8
SALIX ARCTOPHILA ×											
GLAUCA	A ₂	Ch	12	48	32	72	40	68	24	16	8
POLYGONUM VIVIPARUM	A ₂	G	24	48	12	12	20	68	92	32	8
CAREX RIGIDA	A ₂	G	36	64	48	36	12	..	60	4	7
CAREX SCIRPOIDEA	A ₂	H	..	..	..	..	40	16	32	52	4
SCIRPUS CÆSPITOSUS var.											
AUSTRIACA	S	H	..	..	..	..	..	8	12	96	3
DIAPENSIA LAPPONICA..	A ₂	Ch	..	..	60	..	..	..	..	..	1
Agrostis borealis	A ₂	H	..	..	..	4	..	..	52	8	3
Antennaria alpina	A ₂	Ch	..	..	..	..	..	..	44	..	1
Bartschia alpina	A ₂	H	..	..	..	..	12	4	16	8	4
Betula nana	A ₂	Ch	..	..	..	28	..	..	..	..	1
Cerastium alpinum	A ₂	Ch	..	..	..	16	..	36	..	..	2
Chamænerium latifolium	A ₂	H	..	..	48	..	4	..	4	..	3
Chamænerium angustifolium .	S	H	..	..	..	20	..	..	..	..	1
Hieracium alpinum	S	H	..	..	..	4	..	4	28	4	4
Juncus trifidus	S	H	8	..	..	4	20	12	24	..	5
Pedicularis flammea	A ₂	H	..	..	..	..	..	..	4	56	2
Bryanthus coeruleus	A ₂	Ch	..	..	..	..	12	..	16	..	2
Salix herbacea	A ₂	Ch	36	12	16	12	8	..	8	..	6
Silene acaulis	A ₂	Ch	+	..	..	..	4	8	8	32	5
Tofieldia palustris	A ₂	H	..	..	..	..	..	..	12	52	2
Alchemilla alpina	S	Ch	..	..	..	4	..	16	..	..	2
Alchemilla vulgaris	S	H	..	..	..	..	..	..	12	..	1
Campanula rotundifolia	S	H	..	..	..	4	..	..	..	..	1
Cassiope hypnoides	A ₂	Ch	8	8	..	..	..	..	..	..	2
Carex nardina	A ₂	H	..	..	..	..	4	..	..	..	1
Carex capillaris	A ₂	H	..	..	..	..	..	..	..	4	1
Cystopteris fragilis	S	H	..	..	..	4	..	..	..	..	1
Epilobium lactiflorum	S	H	..	..	..	..	..	8	..	..	1
Erigeron uniflorus	A ₂	H	..	..	..	4	..	..	..	..	1
Festuca ovina var. vivipara ..	A ₂	H	..	..	..	4	..	..	..	..	1
Festuca rubra	S	H	..	..	..	24	..	..	..	..	1
Gentiana nivalis	S	Th	..	..	..	..	..	..	8	..	1
Juniperus communis	S	Ch	..	..	..	8	..	..	..	..	1
Loiseleuria procumbens	A ₂	Ch	..	..	..	..	8	..	..	..	1
Luzula confusa	A ₂	H	4	8	..	..	..	..	..	..	2
Luzula spicata	A ₂	H	..	..	..	4	..	16	20	..	3
Lycopodium alpinum	A ₂	Ch	..	..	..	..	..	..	24	..	1
Lycopodium Selago	A ₂	Ch	..	..	..	..	..	..	..	20	1
Pedicularis hirsuta	A ₁	H	..	8	..	..	..	..	..	..	1
Pinguicula vulgaris	S	H	..	..	..	..	..	..	..	36	1

(Continued next page).

Table 20 (continued).

<i>Empetreto-Vaccinietum</i>	G.	L.	37	38	39	40	41	42	43	44	S
<i>Poa alpigena</i>	A ₂	G	..	..	..	4	..	..	..	..	1
<i>Poa alpina</i>	A ₂	H	..	..	..	..	..	16	4	..	2
<i>Potentilla Crantzii</i>	S	Ch(H)	..	..	..	..	..	..	4	..	1
<i>Potentilla tridentata</i>	S	Ch	..	..	..	12	..	..	..	..	1
<i>Sedum roseum</i>	S	H	..	..	..	..	..	..	12	..	1
<i>Saxifraga oppositifolia</i>	A ₂	Ch	..	..	4	..	..	..	..	..	1
<i>Sedum annuum</i>	S	Th	..	..	..	..	..	20	..	..	1
<i>Sibbaldia procumbens</i>	A ₂	Ch	..	..	..	4	..	..	4	..	2
<i>Taraxacum croceum</i>	S	H	..	..	..	..	..	..	16	..	1
<i>Thymus arcticus</i>	S	Ch	..	..	..	4	..	..	..	..	1
<i>Trisetum spicatum</i>	A ₂	H	4	..	..	..	..	4	4	..	3
<i>Veronica alpina</i>	A ₂	H	..	..	..	..	..	..	4	..	1
<i>Veronica fruticans</i>	A ₂	Ch	..	..	..	4	..	12	..	..	2
<i>Viscaria alpina</i>	A ₂	H	..	..	..	4	..	12	..	..	2
<i>Cladonia coccifera</i>			..	..	..	+	..	..	..	..	..
<i>Cladonia elongata</i>			..	..	..	..	..	..	12	..	..
<i>Cladonia mitis</i>			..	..	..	..	..	..	4	48	..
<i>Stereocaulon alpinum</i>			+	+	..	+	..	..	..	..	..
<i>Aulacomnium palustre</i>			..	..	..	..	..	..	..	!	..
<i>Drepanocladus lycopodioides</i>			..	..	..	..	..	..	..	!	..
<i>Philonotis tomentella</i>			..	..	..	..	..	..	..	+	..
<i>Bryum cirrhatum</i>			..	..	..	..	..	..	..	+	..
<i>Scapania hyperborea</i>			..	..	..	..	..	..	..	+	..
<i>Nardia scalaris</i>			..	..	..	..	..	..	..	+	..
<i>Cephaloziella</i> sp.....			..	..	..	..	..	..	..	+	..

Spectrum: (Table 20).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Pointsum	Density of species	Ch ^o / _o	H ^o / _o	G ^o / _o	Th ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o
37	68°10'	80	VSV	10°—15°	3—4	gabbro	11	300	3,0	75	5	20	0	0	97	3
38	—	150	SSV	10°	3	basalt	9	388	3,9	67	4	29	0	2	98	0
39	68°15'	15	S	0°—5°	3	gneiss	9	376	3,8	71	13	16	0	0	100	0
40	65°37'	120	S	28°—33°	3	—	26	452	4,5	71	18	11	0	0	81	19
41	68°14'	325	S	20°—45°	3	—	14	372	3,7	70	22	8	0	0	95	5
42	68°31'	300	SSV	30°—45°	3—4	basalt	19	484	4,8	61	21	14	4	0	86	14
43	—	180	—	35°—40°	3—4	—	29	748	7,5	45	34	20	1	0	84	16
44	—	—	—	30°—40°	4—5	—	16	588	5,9	40	54	6	0	0	77	23

tions, for which reason the number of species is smaller. There are hardly two patches of heath which are entirely alike, so great is the abundance of sociations (micro-associations, Facies, cf. Du RIETZ, 1930) in a Greenland heath-slope. Within *Taraxacetum crocei* there are, it is

true, many sociations, but perhaps not to the same extent as here in the luxuriant, moist heath. However, before entering into the more elaborate details, I will examine the association in broad outline.

Distribution: The association, it is true, occurs sporadically in Greenland, even very far to the north, but the luxuriant *Empetrum-Vaccinium*-heath, rich in species, which is mentioned here, belongs in the first place to *regio alpina I* (THORE FRIES 1917) and to *regio arctica I* (T. B. 1933). Farther north *Cassiope tetragona* prevails. Similar associations with the same two dominants occur in Scandinavia and the Alps as well as f.i. in Kamtchatka (HULTÉN I, pp. 27—28).

VAHL (1913) mentions *Empetrum*-heath, where *Vaccinia* are hardly ever wanting, and under Moosreiche *Empetrum nigrum*-Assoziation THORE FRIES (1913) mentions an association, which reminds one of the Greenlandic association in question, by *Empetrum* and *Vaccinium uliginosum* being most frequent. As a rule these two species, so predominant in Greenland, do not seem to be of such great importance in Scandinavia and on Iceland, owing to the presence and competition of the other heather species. Nevertheless there are sufficient localities in Scandinavia, where the likeness with this heath type is great; least favourable for a comparison are conditions in the heath rich in lichens, these being scarce in Greenland as compared with Scandinavia (LYNGE 1932, a). In the Alps the *Empetretum-Vaccinietum* is mentioned by DU RIETZ (1924 p. 70) and BRAUN-BLANQUET and JENNY (1926); here it occurs in numerous sociations throughout the alpine chain. From a floristic point of view the latter has not many species in common with Greenland, but the genera are very largely the same.

In his mention of the Scandinavian heath RÜBEL has the following remark: "Die Arten wechseln in der Vorherrschaft und in der Regelmässigkeit des Auftretens stark, aber in der Möglichkeit des Vorkommens sehr wenig." — "So begegnen wir in der *Empetrum*-heide sehr viel *Vaccinium uliginosum*, aber auch zwischen den *Myrtillus*-stöcken fehlt es fast nie." Somewhat similar conditions are to be found in the heaths which I saw in East Greenland, where one always wonders at the heterogeneity of the vegetation; as a rule *Empetrum* and *Vaccinium* were rather equal and occurred constantly, even though in patches I frequently saw one or the other prevailing.

At the present time it is impossible to say whether this type of *Empetretum-Vaccinietum* is most European or most American in its composition. Perhaps it is a type which is associated with Greenland, and even here there are so many differences between the different regions that a much more complete collection of material will be necessary, before it is possible to say anything for certain (see WARMING, 1888, pp. 66—68).

Dominants. The principal species constituting the heath is, besides *Empetrum* and *Vaccinium*, *Salix arctophila* $\times$ *glauca*; as to herbs

Polygonum viviparum, *Carex rigida* and *Carex scirpoidea* frequently dominate. Where the soil is particularly moist, *Scirpus cæspitosus* var. *austriaca* also occurs, forming a *Scirpetum*, No. 44, which will be mentioned separately. In a single locality on a gneiss foundation *Diapensia lapponica* occurred as a dominant, No. 39. See, further, table 20.

Constants. In accordance with BROCHMANN-JEROSCH I apply the term "constants" to the species occurring in more than half the individual investigations. In table 20 only 8 investigations are recorded, but in table 21 there are 12 further investigations of various *Empetrum*-*Vaccinium*-heaths or closely allied associations, where the frequency of the species is only estimated in the usual manner and indicated by a series of figures 5—1 (as in BRAUN-BLANQUET, 1928, p. 26), and this together with the 8 investigations recorded in table 20 make a fairly adequate foundation for forming a judgment of the constancy of the species. The individual investigations were undertaken at Cape Daussy (a), at the fjord north of Cape Ravn (b, c), at Miki's Fjord (d, k), at Kangerdlugssuak (e—j) and Tugtilik (l)¹). The result is that there are 9 constants, 12 accessories and a great number of species with a constancy of less than 5. In other parts of Greenland an investigation of this kind will give a picture, often essentially differing, of the constants of this heath type, and it will be interesting to compare these conditions with what is to be found elsewhere.

Character species. As species with a high "Treuegrad" may perhaps in this association be mentioned: *Bryanthus coeruleus*, *Lycopodium alpinum*, *L. annotinum*. Some species, which will be mentioned later on under *Scirpetum cæspitosi*, seem confined to this association. For that matter, it is a question whether it is at all possible in the Greenland communities to speak of character species in the sense in which this term is employed by the Swiss botanists; I personally think that conditions in Greenland resemble those in Scandinavia, cf. NORDHAGEN (1928) pp. 89—90; compare also GAJEWSKI (1932 p. 197).

In tables 20—21 about 60 species are recorded, only *Taraxacum crocei* attaining a similar number. Besides these species KRUSE in a similar vegetation at Angmagssalik found *Coptis grönlandica*, *Pirola minor*, *Phleum alpinum*, *Woodsia ilvensis*, *Draba incana*, *Hieracium hyparcticum* and *Deschampsia flexuosa*. None of these, however, are of any importance in the vegetation.

The spectrum, p. 59, shows the naturally great preponderancy of Ch, and that H and G are equal; further, it shows that the vegetation is composed of almost exclusively arctic species with a wide distribution within the arctic area. On the other hand, in spite of the great intermixture of

¹) Owing to the insufficiency of the time at my disposal it was unfortunately impossible to complete the investigations in all cases, nor were the areas of investigation all of the same size.

Empetreto-Vaccinietum, *Scirpetum cæspitosi* bears a somewhat more southern stamp, in that that H prevails and the S-percentage is 23.

Besides the mosses mentioned in table 20 other species were collected in various localities in moist heath, rich in species, viz. *Blepharostoma trichophyllum*, *Cephaloziella Starkii*, *Lophozia alpestris*, *L. Kunzeana*, *Oncophorus virens*, *Pohlia nutans*, *Polytrichum juniperinum*, *Sphagnum plumulosum*; the latter species, as well as *Aulacomnium palustre* were of particularly frequent occurrence farthest out on a terrace, where the moisture gathered in order to drip down to the next one; in such places the heather-plants grew in large moss-cushions, fastened at the top, which hung from the rocks like dripping sponges. In other places the moss-layer had almost entirely disappeared; lichens play practically no part in this type of heath.

In order to give an impression of the "Deckungsgrad" i. e. degree of covering, and "Häufungsweise" (Soziabilität) of the heath-plants, and to show the interchange and fusion of some of the sociations and associations, I undertook a few investigations of typical squares, as a rule 1 m² large, and by means of a measuring tape I drew an exact picture of the vegetation. This method must necessarily make a good foundation for comparisons, but is slow in use; however, such figures give important details, which are difficult to describe and are not brought out by the determination of frequency. Everywhere in the figures the black patches stand for stones or boulders, the white patches for soil devoid of vegetation or gravel.

Examination Nos. 45 and 46, fig. 9. *Empetreto-Vaccinietum*.

No. 45 fig. 9 to the left. 1 m² luxuriant, moist heath, 260 m above sea-level. Incl.: 45° SSW. Fjord north of Cape Ravn. Horizontal hatching: Uniform cover of *Empetrum*, *Vaccinium*, *Carex scirpoidea* and *Polygonum viviparum*. Cross-hatchings *Salix arctophila* × *glauca*. A dense tuft of *Silene* and a larger plane with *Juncus trifidus* visible. H = *Hieracium alpinum*, B = *Bartschia alpina*, V = *Veronica alpina*, T = *Tofieldia palustris*, Tx = *Taraxacum croceum*, C. r. = *Campanula rotundifolia*, A = *Antennaria alpina*, E = *Chamænerium latifolium*, L = *Luzula confusa*. Black dots = *Stereocaulon* sp. 16 phanerogams.

No. 46, fig. 9 to left. 1 m² luxuriant heath, somewhat drier than No. 45, 325 m above sea-level. Incl. 45° towards south. "Lomsøen" (i. e. divers' lake) in the interior behind Watkins Fjord. Horizontal hatching = *Vaccinium* and *Empetrum*. Cross-hatching = *Salix arctophila glauca*. Hatching with small circles = *Loiseleuria procumbens*; hatching with vvvv = *Bryanthus coeruleus*; black dots = *Stereocaulon alpinum*; C = *Carex scirpoidea*; P = *Polygonum viviparum* and J = *Juncus trifidus*. 8 phanerogams.

Table 21.

		a	b	c	d	e	f	g	h	i	j	k	l	
Lat. N. 68° Min:		43'	31'	31'	10'	20'	20'	20'	14'	15'	15'	10'	66°20'	
Height in m above sea-level..		250	400	260	100	70	90	120	325	445	445	40	100	
Exposure		SE	SSV	SSV	S	SE	SE	E	S	S	S	V	S	
Inclination		35°	ca. 35°	45°	40°	20°	20°	15°	40°	30°	30°	15°	ca. 35°	
9 Constants:														
<i>Empetrum nigrum</i> var. <i>hermaphroditum</i>	Ch	4	4	5	4	4	5	4	5	5	5	5	5	20
<i>Vaccinium uliginosum</i> var. <i>microphyllum</i>	Ch	5	4	5	5	5	5	5	5	4	5	4	4	20
<i>Polygonum viviparum</i>	G	4	5	5	4	4	5	5	3	4	4	3	3	20
<i>Salix arctophila</i> × <i>glauca</i>	Ch	4	3	4	5	5	3	3	3	..	4	3	3	19
<i>Carex rigida</i>	G	4	4	..	4	2	2	..	..	..	5	1	3	15
<i>Salix herbacea</i>	Ch	3	5	..	..	4	..	..	..	..	2	4	2	12
<i>Carex scirpoidea</i>	H	..	..	4	..	..	2	..	3	4	2	..	3	10
<i>Juncus trifidus</i>	H	..	..	3	..	..	..	..	2	..	2	1	2	10
<i>Bartschia alpina</i>	H	1	1	1	2	..	..	..	..	..	1	..	2	10
12 Accessories:														
<i>Hieracium alpinum</i>	H	..	..	3	1	4	..	..	..	..	2	..	3	9
<i>Bryanthus coeruleus</i>	Ch	2	1	1	..	..	..	..	3	..	2	..	1	8
<i>Silene acaulis</i>	Ch	1	..	2	..	..	..	..	..	..	..	..	2	8
<i>Cassiope hypnoides</i>	Ch	2	5	..	..	..	..	..	..	..	2	..	1	6
<i>Cerastium alpinum</i>	Ch	3	2	..	..	..	..	..	..	..	..	1	..	5
<i>Antennaria alpina</i>	Ch	..	1	1	..	..	1	..	..	..	..	..	1	5
<i>Alchemilla alpina</i>	Ch	..	..	1	4	..	..	..	..	..	..	..	3	5
<i>Sedum roseum</i>	H	..	..	..	3	..	1	..	..	..	1	..	1	5
<i>Tofieldia palustris</i>	H	..	..	1	..	..	..	..	..	1	..	..	1	5
<i>Scirpus caespitosus</i>	H	..	..	..	..	..	..	..	..	3	..	..	1	5
<i>Diapensia lapponica</i>	Ch	..	..	..	..	..	..	4	..	3	1	..	1	5
<i>Trisetum spicatum</i>	H	2	..	..	..	1	..	..	..	..	..	1	..	5
Further:														
<i>Pedicularis flammea</i>	H	..	..	..	..	..	..	..	..	2	..	..	1	4
<i>Poa arctica</i>	G	5	..	..	4	..	1	..	..	..	..	1	..	4
<i>Luzula confusa</i>	H	..	..	1	..	..	..	..	..	..	..	1	..	4
<i>Luzula spicata</i>	H	..	..	..	..	..	..	..	..	..	..	1	..	4
<i>Loiseleuria procumbens</i>	Ch	..	..	..	..	..	..	..	1	1	..	..	1	4
<i>Chamænerium latifolium</i>	H	..	..	1	..	..	..	..	..	..	..	..	..	4
<i>Campanula rotundifolia</i>	H	..	..	1	1	..	..	..	..	..	..	..	3	4
<i>Lycopodium Selago</i>	Ch	1	..	..	..	..	..	..	..	2	..	..	1	4
<i>Lycopodium alpinum</i>	Ch	..	..	..	..	..	..	..	..	..	2	..	1	3
<i>Lycopodium annotinum</i>	Ch	..	..	..	..	..	..	..	..	..	1	..	1	2
<i>Saxifraga oppositifolia</i>	Ch	..	..	..	..	..	1	1	..	..	..	1	..	4
<i>Saxifraga aizoon</i>	Ch	..	..	..	1	..	..	..	..	..	1	..	..	2
<i>Rhododendron lapponicum</i>	Ch	..	..	..	..	..	..	..	..	3	..	..	1	2
<i>Pinguicula vulgaris</i>	H	..	..	..	..	..	..	..	..	2	..	..	1	3
<i>Elyna Bellardi</i>	H	..	..	..	..	..	1	4	..	1	..	..	..	3
<i>Carex cappilaris</i>	H	..	..	..	..	..	1	..	..	..	..	..	..	2
<i>Carex microglochin</i>	G	..	..	..	..	..	..	..	..	..	..	..	1	1
<i>Arabis alpina</i>	H	..	..	..	..	..	..	..	..	..	..	1	..	1
<i>Juniperus communis</i>	Ch	..	..	..	..	..	..	..	..	..	..	..	1	2
+ 23 species mentioned in table 20.														

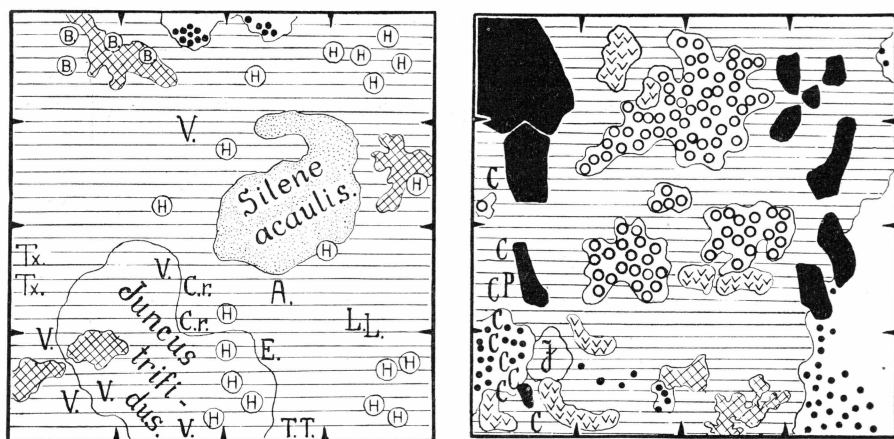


Fig. 9. 2 square metres of *Empetretum-Vaccinietum*. Explanation in the text.

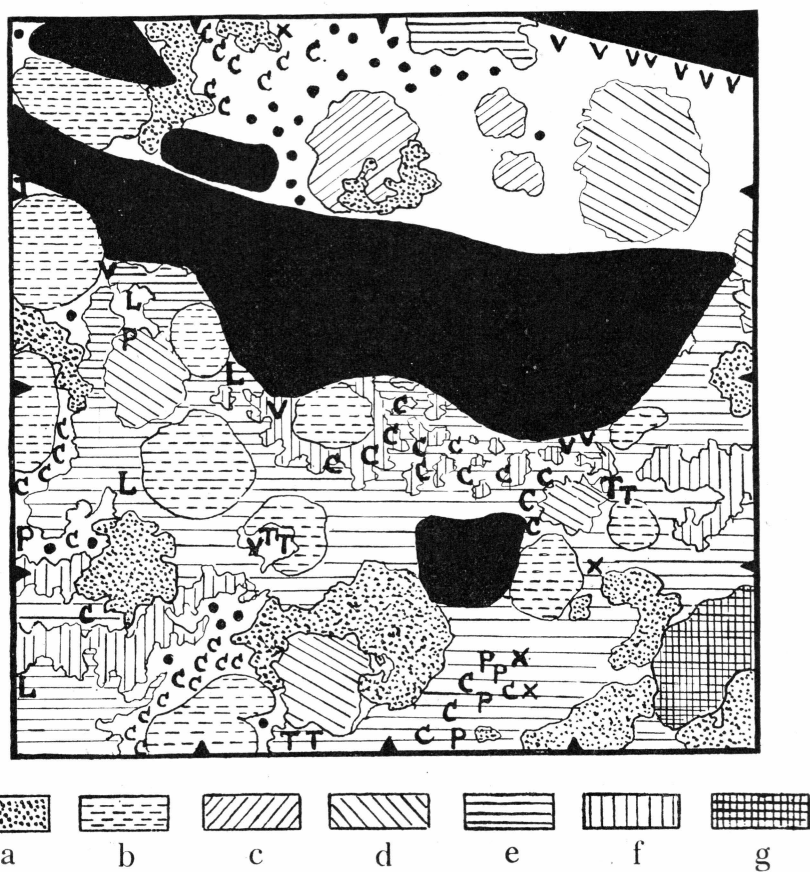


Fig. 10. Explanation in the text.

Examination No. 47, fig. 10. Mosaic of sociations.

1 m² moist luxuriant heath. 445 m above sea-level. Incl. 30° towards south. In the inland east of Watkins Fjord. Hatchings: a = *Rhododendron lapponicum*; b = *Diapensia lapponica*; c = *Elyna Bellardi*; d = *Scirpus cæspitosus* var. *austriaca*; e = *Vaccinium uliginosum*; f = *Empetrum nigrum*; g = *Loiseleuria procumbens*. Letters: C = *Carex scirpoidea*; P = *Polygonum viviparum*; T = *Tofieldia palustris*; V = *Pinguicula vulgaris*; X = *Pedicularis flammea*; L = *Lycopodium Selago*; black dots = *Cladonia*. 13 phanerogams.

There are here at least two entangled sociations, one consisting of *Vaccinium*, *Empetrum*, *Loiseleuria* and *Carex scirpoidea*, cf. No. 45, one consisting of *Vaccinium*, *Empetrum* with *Scirpus cæspitosus*, *Pinguicula*, *Tofieldia*, *Pedicularis flammea* and *Lycopodium Selago*, cf. Nos. 44 and 52, or with *Rhododendron*, *Diapensia*, *Tofieldia* and *Pinguicula*, which KRUSE (1912) records as a characteristic heath-sociation on the surface of outstanding crags, where the soil is moist, because the rocky ground holds the water without causing stagnation, there being a free flow down the side of the rock. In the figure one sees the projecting flat boulders on the same level as the vegetation, quite as in the fjord north of Cape Ravn (fig. 13); here *Scirpetum cæspitosi* was also often associated with such places, where the rock close below the vegetation pressed forth the water, so as to make the earth a slimy, clayey mass (figs. 13—14). In both places *Pinguicula* was seen to favour the moistest places, where the stone crops out of the soil; perhaps *Pinguicula* is also better protected in these places or prefers them, because the fighting power of the heath-plants is reduced here. *Elyna Bellardi* and *Cladonia* presumably ought to be regarded as a third sociation in this one m².

Examinations Nos. 48 and 49. Fig. 11.

The two examinations have that in common that they form the transition to snow-patch-heath-associations. Everywhere in the heath little depressions are to be found, some quite small, and wherever this happens, the typical species viz. *Salix herbacea*, *Carex rigida*, *Polygonum viviparum* and *Cassiope hypnoides* occur with increased frequency in the small patch, or else predominating in patches in these small depressions. No. 48, fig. 11 to the left is from d'Aunay Bay, 150 m above sea-level. Incl.: 50° WSW. No. 49, fig. 11 to the right is from the east coast of Kangerdlugssuak, about midway of the fjord, 70 m above sea-level. Incl.: 20° SE. Hatchings: a = *Vaccinium*; b = *Salix arctophila* × *glauca*; c = *Salix herbacea*; d = moss-cover; e = *Peltigera rufescens*; f = *Hieracium alpinum*; g = *Empetrum* and h = a homogeneous mixture of *Salix arctophila* × *glauca* and *Salix herbacea*. Letters: P = *Polygonum viviparum*; C = *Carex rigida*; P. c. = *Poa cenisia* (*arctica*); T = *Tri-*

setum spicatum; F = *Festuca ovina* var. *vivipara*; S = *Saxifraga tenuis* and O = *Oxyria digyna*. In both areas of investigation there was a distinct layer of moss below all the phanerogams; in No. 48 (fig. 11 to the left) this cover consisted of *Anthelia juratzkana*, *Aulacomnium palustre*, *Blepharostoma trichophyllum*, *Bryum cirrhatum*, *Lophozia Kunzeana*, *Oncophorus virens*, *Pohlia nutans* and *Polytrichum juniperinum*; in No. 49 (fig. 11 to the right) of *Aulacomnium palustre*, *Cephaloziella Starkii*, *Lophozia alpestris*, *Oncophorus Wahlenbergii*, *Pohlia nutans* og *Polytrichum juniperinum*. In No. 48, a total of 8 phanerogams and 9 cryptogams; in No. 49, 7 phanerogams and 6 cryptogams. Both are characterized by

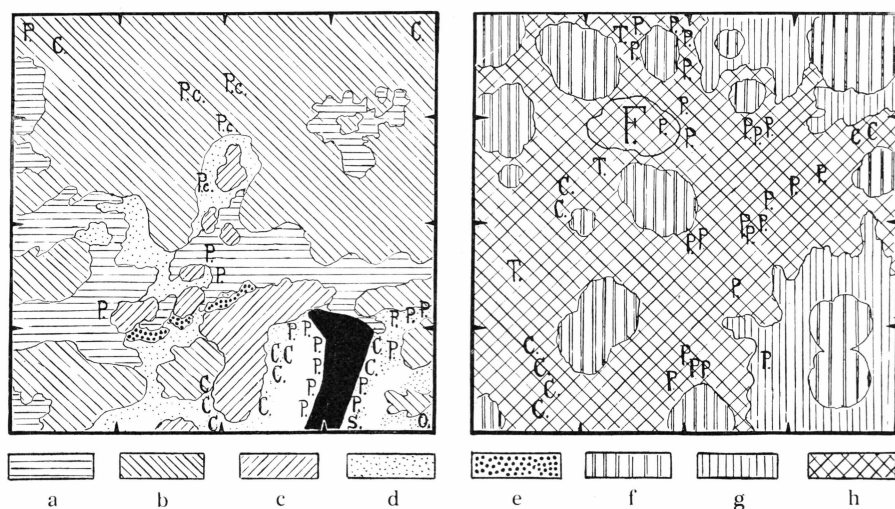


Fig. 11. Explanation in the text.

the two *Salix*-species, No. 49 furthermore by *Hieracium alpinum*, which in this place was unusually great and beautiful. In No. 48 it is seen once more that the plants prefer to grow close to the stones.

Examinations Nos. 50 and 51, fig. 12.

In his description of fell-field KRUUSE mentions that there are constantly snow-bare patches round all large boulders and to windward of rocky walls. This condition in a heath may cause the presence of associations, or fragments of such, which are fit to endure hoar frost and wind in places nearest a mountain side, where conditions might otherwise seem suited for a herb-field. This was, for instance, very clearly the case with the *Loiseleurieto-Vaccinietum*, which was to be found east of Watkins Fjord (No. 60). Similar conditions seem to prevail in some localities on the east coast of Kangerdlugssuak; the two examinations shown in fig. 12 were made in this place, and represent two examples

of a transition from dense *Vaccinium*-heath to a more open vegetation, where stones or (in No. 50, fig. 12 to the left) a low boulder project. Here, nearest the boulder or between the stones, there is an *Elynetum* or an *Elyneto-Diapsensietum* in miniature. *Elyna Bellardi* (*myosuroides*) is described, for instance by BRAUN, as "die windhärteste Glumiflore des Gebietes und wohl der Schweizeralpen überhaupt". OSTENFELD and LUNDAGER (1910) record the same thing with regard to *Elyna* in north-eastern Greenland, where it is also described as being "often snowless during winter". However, *Vaccinium uliginosum* var. *microphyllum*

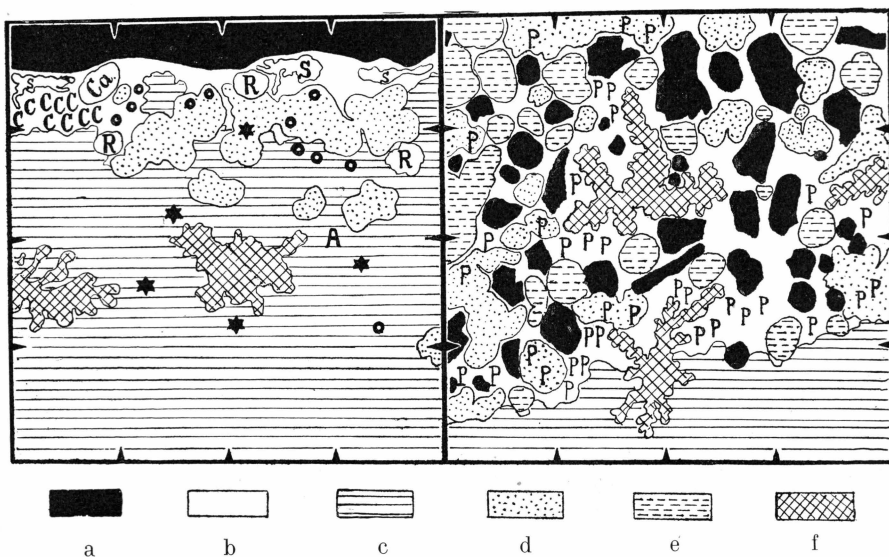


Fig. 12. Explanation in the text.

is known to prevail in such localities in Scoresby Sound, where the heath is swept bare of snow in winter (HARTZ), so that it is difficult to decide whether *Elynetum* or *Vaccinietum* in Nos. 50—51 is barest of snow; perhaps the conditions for snow-covering are the same, and the difference is caused by the fact that the power of competition of the *Vaccinium* is weakened near the stones; the latter supposition seems to be borne out by the occurrence of *Sedum roseum* in No. 50.

No. 50 (fig. 12 to the left): 90 m above sea-level. Incl.: 15—20° SE. No. 51 (fig. 12 to the right): 120 m above sea-level. Incl.: 10—15° towards east. Hatchings: a = stone or rock; b = gravel or earth, bare of vegetation; c = *Vaccinium uliginosum* (+ *Polygonum viviparum*); d = *Elyna Bellardi*; e = *Diapensia lapponica*; f = *Salix arctophila* × *glauca*. Letters: A = *Antennaria alpina*; Ca = *Carex capillaris*, C = *Carex scirpoidea*, P = *Polygonum viviparum*; R = *Rhodiola rosea*

(*Sedum roseum*); S = *Saxifraga oppositifolia*; the rings = *Carex rigida*; the asterisks = *Poa arctica*.

In No. 50 12 phanerogams, in No. 51 5.

With regard to other heath-sociations or variants of the heath see No. 39, the summary pp. 80—81 and KRUSE 1912.

SCIRPETUM CÆSPITOSI (S. Austriaci).

(Recorded here, because the association chiefly occurred as an intermixture in heath).

In the fjord north of Cape Ravn (68°31'), the place on the east coast where I found the most northerly occurrence of *Scirpus cæspitosus* var. *austriaca*, this species here and there formed associations, viz. particularly in two types of localities, one near a steep wall, where it was very wet, with water dripping from above, and another farthest out on the terraces, where the rock approached the surface of the earth, and the water consequently came out again. In the first locality *Scirpus* might prevail entirely; in the second it had to share the space at its disposal with a number of other species; thus, *Vaccinium* and *Empetrum* occurred with great frequency (No. 44), but everywhere they gave the impression of being left over from an earlier *Empetretum-Vaccinietum*, as the *Scirpetum*, on all sides and upwards, was surrounded by this association, and the two heath-shrubs in the *Scirpetum* were frequently rather sickly in appearance. Of species, which thrive particularly well together with *Scirpus* and, therefore, belong to the association I mention: *Carex scirpoidea*, *Pedicularis flammea*, *Tofieldia palustris*, *Pinguicula vulgaris* and *Cladonia mitis*. Of these perhaps *Pinguicula* has a high "Treuegrad". The mosses (see No. 44) were of secondary importance.

Fig. 14 represents examination No. 52, fig. 13 (1 m², 180 m above sea-level. Incl.: 30° WSW, 68°31'). Vertical hatchings indicate a homogeneous mixture of *Scirpus*, *Vaccinium*, *Empetrum* and *Cladonia mitis*; B = *Bartschia alpina*; C = *Carex scirpoidea*; L = *Lycopodium Selago*; P = *Polygonum viviparum*; S = *Silene acaulis*; St = *Stereocaulon* sp.; T = *Tofieldia palustris*; V = *Pinguicula vulgaris*; X = *Pedicularis flammea*. Between the boulders in the middle there was a little moss. *Pinguicula* favours growing right up to the boulders.

As one of the elements which in certain localities in moist heath form a mosaic of different sociations, I have already under No. 47 mentioned a *Scirpus*-sociation, and in Tugtilik I also saw *Scirpus* in moist localities in the heath, frequently together with *Pinguicula* and *Tofieldia* and several of the species mentioned above.

From West Greenland WARMING records *Scirpus cæspitosus* as be-

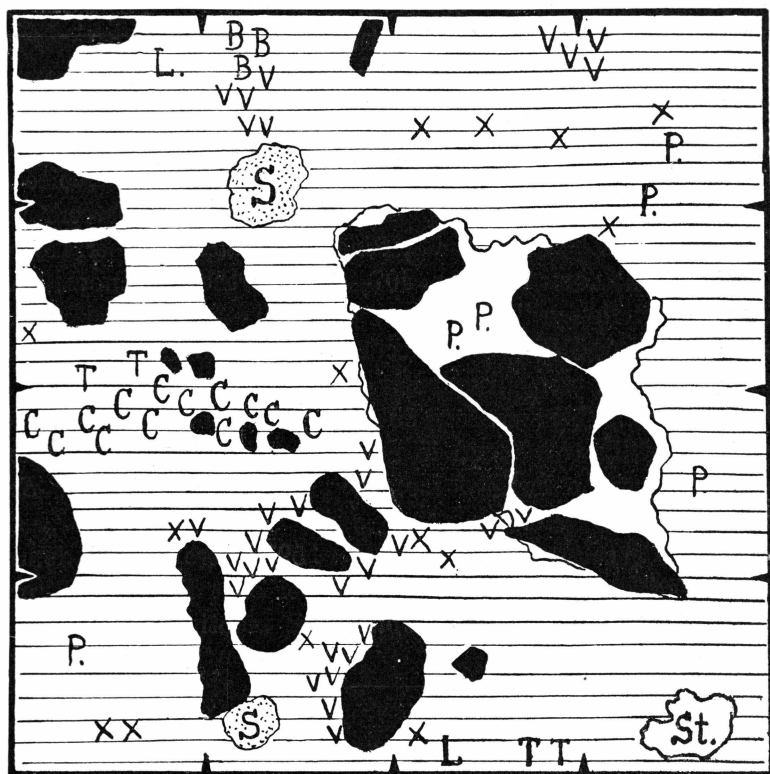


Fig. 13. Explanation in the text.



T.B. phot.

Fig. 14. 1 m² square of investigation (No. 52). Fjord north of Cape Ravn.

longing to the grass-moor vegetation; it is doubtful whether the said association from East-Greenland quite falls under this category; (see also ROSENVINGE, 1896). The only place in the literature on the subject where I find something corresponding to the vegetation in Nos. 44 and 52 is in RESVOLL-HOLMSEN, who mentions a *Scirpus caespitosus* association growing on sloping rocky ground in Jotunheim, 1150 m above sea-level (*Scirpus caespitosus*, F-percentage 100; *Betula nana* F-percentage 68; *Tofieldia palustris* F-percentage 68; *Pinguicula vulgaris* F-percentage 52) and also in NORDHAGEN 1928, pp. 407—410. Further, MÖLHOLM HANSEN mentions a "Hallamyri" (Wellmyr) at Lækjamot on Iceland, where *Scirpus*, *Tofieldia* and *Pinguicula* occur with F-percentage 76, 56 and 44, besides a series of very frequently occurring species, among which *Carex microglochin* (F-percentage 80). I mention the latter because this species in Tugtilik was found in a place where the water came out, oozing down over an inclined mountain slope, and here also *Scirpus* and *Pinguicula* occurred.

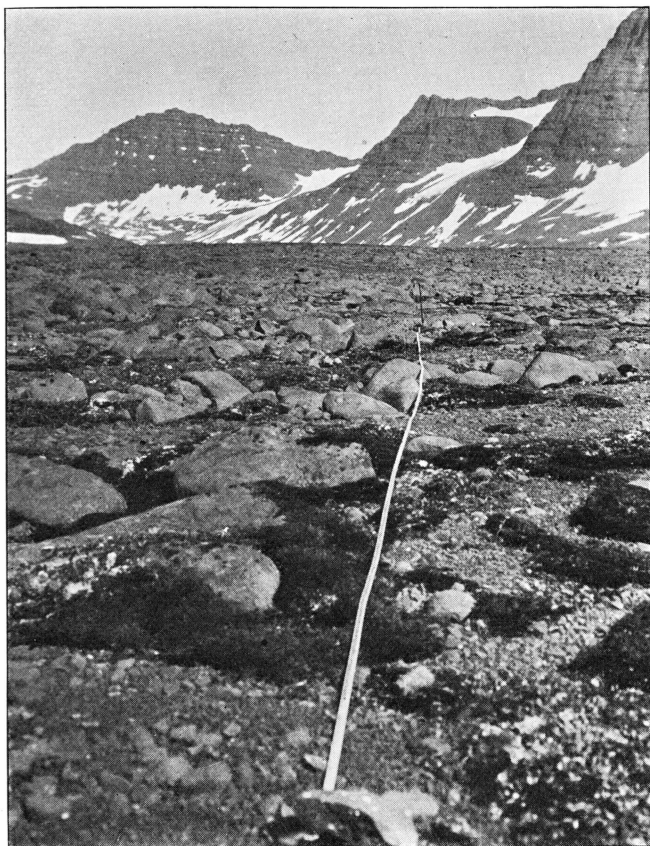
As to the spectrum of No. 44 see p. 59, where *Scirpus* dominates entirely, we get an association with 100 per cent H and 100 per cent S! The distribution of *Scirpus caespitosus* is mentioned in T. B. 1933, pp. 46 and 51.

II. Heath-associations making no special demands as to a favourable habitat with southern exposure.

Before setting up the different associations it will be practical to mention the individual investigations separately.

Table 22 shows 3 associations, which grew in closely adjoining localities in the valley north of Cape Daussy; the underground was here moving soil, and there was only a closed vegetation in the neighbourhood of the large stone rings, which had formed in that place (figs. 1 and 15). The plane, on which the vegetation was found, sloped gently towards the sea shore; farthest up the motion in the soil seemed to be the least (the driest parts), and greatest lowest down (the moistest parts); No. 53 corresponds with the former locality, No. 55 with the latter, while No. 54 lies in the middle. The transition from one type of vegetation to the other was entirely gradual, and the three examinations were undertaken in such a manner that there were 100 m between each. Farthest up there was a closed heath-vegetation along the stone rings, and besides there grew scattered herbs in the central parts of the soil between them; lowest down the vegetation only consisted of scattered herbs, growing both along the stones and out in the central parts. Thus, there were two associations along the upper line, a heath and an open vegetation of

herbs in the central and moistest parts. The heath (No. 53) can be characterized as *Salix arctica* $\times$ *arctophila* $\times$ *glauca*-*Vaccinium uliginosum*-association rich in lichens, the most frequently occurring herbs in the central parts being *Luzula confusa*, *Saxifraga cernua* and *S. nivalis*. No. 54 still had the character of a heath, but was somewhat richer in mosses and resembled snow-patch-heath associations, as *Salix herbacea*,



T. B. phot.

Fig. 15. Heath on slowly moving soil. The valley at Cape Daussy. From the foreground to the stick 15 m (the length of the measuring tape).

Polygonum viviparum and *Carex rigida* were frequently seen together, and *Cassiope hypnoides* in certain localities (fig. 16) formed small carpets. The chief species growing in the central part of the soil between the stone rings were *Saxifraga cernua*, *Sagina intermedia* and *Poa alpina*. The lower vegetation (No. 55) was entirely scattered and thus comes under WARMING's "fell-field", though it should rather be characterized as a snow-patch association (*Salix herbacea*, *Cerastium trigynum*, *Ranunculus glacialis*, *R. pygmaeus* and *Oxyria*). Several herbs increase in frequency

Table 22.

	G.	L.	53	54	55
POLYGONUM VIVIPARUM.....	A ₂	G	68	40	..
SALIX ARCTICA × ARCTOPHILA × GLAUCA	A ₂	Ch	64	28	4
Vaccinium uliginosum v. microphyllum.	A ₂	Ch	56	..	..
Empetrum nigrum v. hermaphroditum .	A ₂	Ch	20	..	..
Salix herbacea.....	A ₂	Ch	12	44	20
Carex rigida.....	A ₂	G	12	16	..
Luzula confusa.....	A ₂	H	8	28	16
Silene acaulis.....	A ₂	Ch	4	16	..
Cassiope hypnoides	A ₂	Ch	4	4	..
Pedicularis hirsuta.....	A ₁	H	4	..	..
Saxifraga cernua.....	A ₂	H	4	20	32
Saxifraga nivalis.....	A ₂	H	4	4	16
Saxifraga caespitosa	A ₂	Ch	+	16	4
Cerastium alpinum.....	A ₂	Ch	+	20	..
Cerastium trigynum.....	A ₂	Ch	..	32	24
Sagina intermedia	A ₂	Ch	..	28	28
Cardamina bellidifolia.....	A ₂	H	..	4	..
Draba alpina.....	A ₁	Ch	+	4	..
Draba rupestris.....	A ₂	Ch	..	8	8
Poa alpina v. vivipara	A ₂	H	..	20	24
Ranunculus glacialis	A ₂	H	..	4	20
Ranunculus pygmæus	A ₂	H	..	..	8
Oxyria digyna.....	A ₂	H	..	..	16
CETRARIA DELISEI.....			80	52	12
STEREOCAULON ALPINUM.....			60	44	16
Ochrolechia frigida.....			4	..	..
Polytrichum alpinum.....			12	28	8
Drepanocladus revolvens			24	32	..
Oncophorus Wahlenbergii.....			8	20	4
Webera nutans.....			..	4	..
Blepharostoma trichophyllum			+	+	..
Bryum purpurascens.....			+	+	..
Drepanocladus Sendtneri			+	+	..
Rhacomitrium Jensenii.....			+	+	..
Anthelia Juratzkana			..	+	..

from No. 53 to 55; thus, more particularly *Saxifraga cernua*, *S. nivalis*, *Poa alpina*, *Ranunculus glacialis*, *R. pygmæus* and *Oxyria*, even though the vegetation becomes more open. The spectrum shows a transition from Ch to H as a dominating life-form, when one passes from heath to open vegetation (60 per cent H in No. 55).

Examination No. 56, fig. 16.

A 25 m² square of investigation in the tract mentioned above, situated between No. 53 and 54. Hatchings: a = the boulders; b = *Cetraria Delisei*, *Stereocaulon alpinum* with *Salix herbacea*, *Polygonum viviparum*, *Luzula confusa* and *Draba alpina*; c = *Salix arctica* × *arctophila* × *glauca*; d = *Cassiope hypnoides*; e = *Silene acaulis*. These species

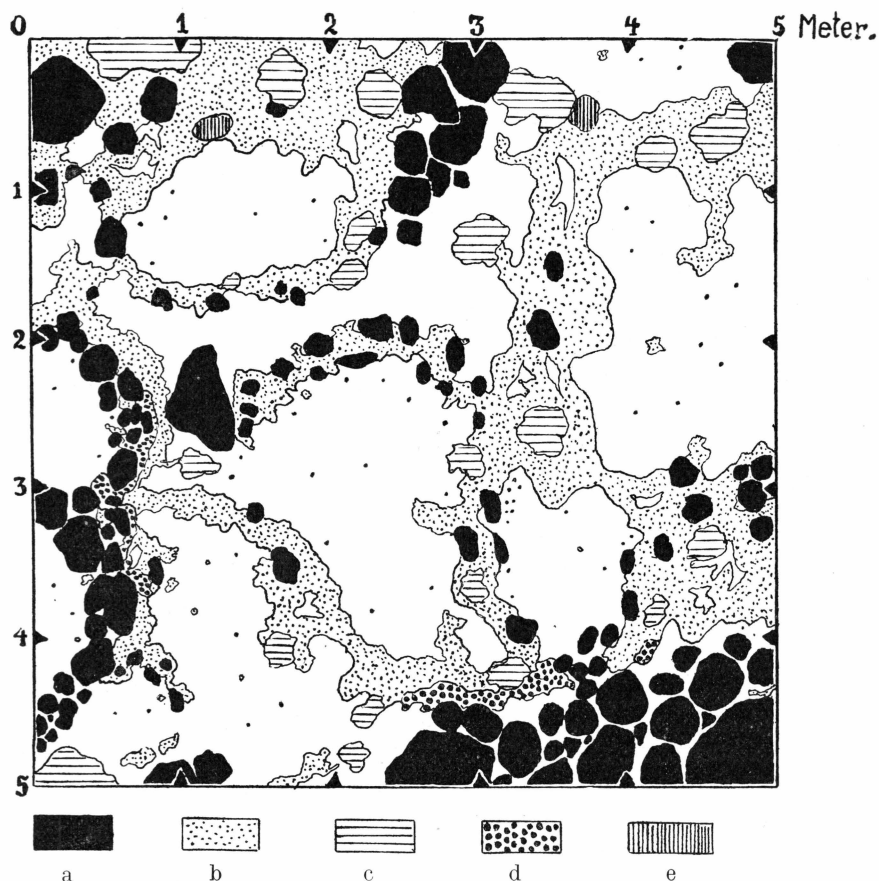


Fig. 16. 25 m² square of investigation in slowly moving soil in the valley at Cape Daussy. Explanation in the text.

together formed the heath round the stones. In the planes of earth between the closed heath-formation there chiefly grew *Polygonum*, *Poa alpina*, *Luzula confusa*, *Salix herbacea*, *Cetraria Delisei*, *Ranunculus pygmaeus*, *Saxifraga nivalis*, *S. cernua*, *S. caespitosa*, *Cerastium alpinum*, *Draba alpina*, but none of the species seemed to thrive well in the movable clay.

From north-eastern Greenland (Clavering Island) SEIDENFADEN (1931) mentions a heath-vegetation in a similar moving soil; this heath

Table 23.

	G.	L.	57	58	59	53
VACCINIUM ULIGINOSUM var. MICRO-PHYLLUM	A ₂	Ch	!	52	96	56
SALIX ARCTICA × ARCTOPHILA × GLAUCA	A ₂	Ch	!	56	56	64
CASSIOPE TETRAGONA.....	A ₁	Ch	!	24	..	..
EMPETRUM NIGRUM var. HERMAPHRODITUM	A ₂	Ch	..	12	80	20
POLYGONUM VIVIPARUM.....	A ₂	G	..	16	52	68
Carex nardina.....	A ₂	H	..	..	40	..
Arnica alpina	A ₁	H	..	20	..	..
Antennaria alpina	A ₂	Ch	..	4	..	..
Antennaria alpina var. glabrata	A ₂	Ch	..	8	..	..
Cassiope hypnoides	A ₂	Ch	..	8	..	4
Carex rigida.....	A ₂	G	..	..	..	12
Cerastium alpinum.....	A ₂	Ch	+	8	4	+
Draba alpina.....	A ₁	Ch	..	..	..	+
Draba rupestris.....	A ₂	Ch	..	4	4	..
Festuca ovina.....	A ₂	H	..	8	..	..
Luzula confusa.....	A ₂	H	+	4	12	8
Luzula spicata	A ₂	H	..	4	12	..
Minnartia biflora	A ₂	Ch	+	8	..	..
Pedicularis hirsuta.....	A ₁	H	..	..	8	4
Poa arctica	A ₁	G	+	4	..	..
Poa glauca.....	A ₂	H	..	4	..	..
Salix herbacea.....	A ₂	Ch	+	..	..	12
Saxifraga cernua.....	A ₂	H	..	12	..	4
Saxifraga caespitosa.....	A ₂	Ch	..	12	..	+
Saxifraga nivalis.....	A ₂	H	..	4	..	4
Silene acaulis.....	A ₂	Ch	..	8	8	4
Trisetum spicatum.....	A ₂	H	..	12	..	..
Viscaria alpina	A ₂	H	..	..	4	..
STEREOCAULON ALPINUM.....			+	72	64	60
CETRARIA DELISEI.....			!	20	..	80
Cetraria nivalis.....			..	..	48	..
Cetraria islandica.....			..	..	8	+
Cladonia coccifera			+	24	..	..
Cladonia mitis.....			..	..	24	..
Cladonia lepidota.....			+	..	..	..
Ochrolechia frigida.....			..	..	..	4
Peltigera rufescens.....			..	8	..	..
Peltigera malacea.....			..	+	..	..
Pertusaria oculata			+	..	..	..
Rinodina mniaraea.....			..	+	..	..
Solorina crocea.....			+	..	..	..
Drepanocladus revolvens			..	..	..	24
Oncophorus Wahlenbergii.....			..	..	..	8

(Continued next page).

Table 23 (continued).

	57	58	59	53
Polytrichum alpinum.....	..	..	12	12
Rhacomitrium canescens.....	!	..	8	..
Rhacomitrium Jensenii.....	..	..	..	+
Blepharostoma trichophyllum	..	..	..	+
Drepanocladus Sendtneri	..	..	..	+
Drepanocladus uncinatus	+	..	..	..
Dicranum scoparium.....	+	..	..	..
Scapania mucronata.....	+	..	..	..

Spectrum: (Table 22—23).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch ^o / _o	H ^o / _o	G ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o
57	69°20'	100	V	10°	2	basalt	8	..	..	!	..	..	!	!	0
58	69°05'	260	S	8°—10°	2	—	22	292	2,9	67	26	7	17	83	0
59	68°43'	325	SE	30°—40°	1—2	—	12	376	3,8	66	20	14	2	98	0
53	—	10	S	10°	2	—	15	260	2,6	62	8	30	2	98	0
54	—	6	S	10°	3	—	18	336	3,4	59	24	17	1	99	0
55	—	3	S	10°	3	—	13	220	2,2	40	60	0	0	100	0

is, however, a *Cassiope tetragona*-*Dryas octopetala* heath, which in the composition of species reminds somewhat of No. 53. A *Cassiope tetragona*-*Salix*-*Vaccinium* heath, like the one mentioned in No. 57 from Cape Ewart, and which also grew in slowly moving soil, has surely more resemblance with the association of northeastern Greenland.

In "Description of Localities" I mentioned from Cape Ewart and Cape Barclay an association in moving soil, but on sloping ground with northern or western exposure; it seems to distinguish itself considerably from the related association, mentioned in No. 55, probably owing to the inclination and the exposure. Characteristic was the half-moss *Sauteria alpina*; furthermore, *Phippsia algida*, *Luzula confusa*, *Ranunculus glacialis*, *R. pygmæus*, *Saxifraga cernua* and *S. nivalis*.

Table 23 shows 4 examples of dry heath, rich in lichens. No. 53 was already mentioned under table 22. No. 57 grew in slowly moving soil and was characterized by *Cassiope tetragona*, *Salix* and *Vaccinium* and was rich in *Cetraria*. This combination of heath species was frequent everywhere in the northern part of the investigated area (north of lat. 69° N), but also occurred in the interior of the country round Kangerdlugssuak¹⁾. The vegetation was often so scattered that it might be

¹⁾ The pure *Cassiope tetragona* association was particularly in evidence at Cape Dalton (see fig. 6, T. B., 1933) and in Kangerdlugssuak (Loc. X).

called an open vegetation, though, on the other hand, one could not call it a "fell-field". Thus, No. 58 was so open that in three of the investigated circles ($1/10 \text{ m}^2$ with a distance of 1 m between the circles) the number of species was 0. On the other hand, the number of species in such an open heath may very well be great, even greater than in an entirely closed heath-vegetation, this being due to the reduced power of competition in the heath-shrubs (22 species in No. 58). In No. 58 *Arnica alpina* occurred pretty frequently, and might dominate in patches, as also appears from the photograph, fig. 17. No. 58 must be



T. B. phot.

Fig. 17. *Arnica alpina* association in the interior of d'Aunay Bay.

described as an open lichen-heath (dominated by *Stereocaulon alpinum*) rich in heather.

No. 59 is an example of an *Empetreto-Vaccinietum*, rich in lichens. Perhaps it is wrong to group such an association with the heath associations, which do not demand such favourable conditions, seeing that the vegetation was here found on a sea-slope with an inclination of 30—40°, facing southeast, but at the same time looking upon a small, open, inclement sea-bay. The vegetation is a counterpart of the heath, mentioned on pp. 58—59, and is another, dry con-sociation under the *Empetreto-Vaccinietum*. The dryness of the heath also appears from the frequency of *Carex nardina*. In the interior of Kangerdlugssuak I found a corresponding type of heath on a southern slope in the innermost basin of the fjord; besides *Carex nardina* I found *Carex rupestris*, *Luzula spicata*, *Juncus trifidus* and of Ch. *Diapensia lapponica*.

Table 24.

	G.	L.	60	61	62
VACCINIUM ULIGINOSUM var. MICROPHYLLUM.....	A ₂	Ch	92	92	16
EMPETRUM NIGRUM var. HERMAPHRODITUM.....	A ₂	Ch	28	60	32
CASSIOPE TETRAGONA.....	A ₁	Ch	4	60	4
CASSIOPE HYPNOIDES.....	A ₂	Ch	4	4	92
LOISELEURIA PROCUMBENS.....	A ₂	Ch	80	..	..
SALIX HERBACEA	A ₂	Ch	..	..	100
CAREX RIGIDA	A ₂	G	16	48	100
POLYGONUM VIVIPARUM.....	A ₂	G	16	12	72
Salix arctophila × glauca.....	A ₂	Ch	12	36	12
Carex scirpoidea.....	A ₂	H	8	12	..
Carex pedata.....	A ₂	H	4	..	..
Bartschia alpina.....	A ₂	H	4	+	..
Tofieldia palustris.....	A ₂	H	4	4	4
Lycopodium Selago.....	A ₂	Ch	4	12	..
Juncus trifidus	S	H	4	..	..
Saxifraga oppositifolia.....	A ₂	Ch	..	20	..
Diapensia lapponica.....	A ₂	Ch	..	16	..
Luzula confusa.....	A ₂	H	..	4	8
Silene acaulis.....	A ₂	Ch	..	4	4
Chamænerium latifolium (vegetative)...	A ₂	H	..	12	..
Pedicularis flammea.....	A ₂	H	..	..	4
Euphrasia latifolia.....	A ₂	Th	..	..	4
Cladonia coccifera			28	..	..
Stereocaulon alpinum			24	..	..
Sphagnum plumulosum.....			..	..	+
Aulacomnium palustre			..	..	+

Spectrum: (Table 24).

No.	Lat. n.	Heigh in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch ^o / _o	H ^o / _o	G ^o / _o	Th ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o
60	68°15'	470	S	10°	1	gneiss	14	280	2,8	80	9	11	0	1	98	1
61	68°11'	140	SE	30°—40°	2—3	—	16	396	4,0	77	8	15	0	15	85	0
62	—	20	S	25°	3—4	—	13	452	4,5	57	4	38	1	1	99	0

The three associations in table 24 are arranged in such a manner that No. 62 has the snow-cover of the longest duration, No. 60 that of the shortest.

No. 60 is a *Loiseleurieto-Vaccinietum*, which as mentioned on p. 66 was found to windward in front of a rock; it only occupied a narrow

strip of vegetation, and farther away from the rock there was a gradual transition to an *Empetreto-Vaccinietum*, rich in *Loiseleuria*.

No. 61 was found in a place situated at a cross-valley on the northern side of Kraemer's Island, which was shaded in the afternoon. The vegetation is a *Vaccinietum*, where *Cassiope tetragona* and *Empetrum* are equally common, and play a great part; where there was no shade, a rich *Empetreto-Vaccinietum* was found without *Cassiope tetragona*.

No. 62 was found at Uttental Sound and was a typical example of a snow-patch-heath-association, with the three dominants: *Salix herbacea*, *Carex rigida* and *Polygonum viviparum*, and in this place also *Cassiope hypnoides*. As compared with Nos. 60 and 61 the G-percentage is here much higher, cf. *Salicetum herbaceae* p. 90.

Table 25.

	G.	L.	63	64
VACCINIUM ULIGINOSUM var. MICROPHYLLUM	A ₂	Ch	100	20
CAREX RIGIDA	A ₂	G	90	100
POLYGONUM VIVIPARUM.....	A ₂	G	80	60
ELYNA BELLARDI	A ₂	H	60	10
SALIX HERBACEA	A ₂	Ch	20	100
Salix arctophila × glauca.....	A ₂	Ch	40	20
Diapensia lapponica.....	A ₂	Ch	30	30
Hierochloë alpina.....	A ₂	H	20	..
Silene acaulis.....	A ₂	Ch	10	20
Cerastium alpinum.....	A ₂	Ch	10	..
Sagina intermedia	A ₂	Ch	10	..
Empetrum nigrum v. hermaphroditum	A ₂	Ch	10	10
Carex cappilaris	A ₂	H	10	..
Poa glauca.....	A ₂	H	10	..
Pedicularis flammea.....	A ₂	H	..	20
Luzula confusa.....	A ₂	H	..	10

Spectrum: (Table 25).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Cl ^o /o	H ^o /o	G ^o /o	Th ^o /o	A ₁ ^o /o	A ₂ ^o /o	S ^o /o
63	68°20'	55	..	0°	2	gnejss	14	500	5,0	46	20	34	0	0	100	0
64	—	53	V	5°—10°	3	—	11	400	4,0	50	10	40	0	0	100	0

The two examinations were made, the one immediately after the other, and show the merging of a *Vaccinietum* into *Salicetum herbaceae*.

It occurred on a gently sloping substratum between the rocks of Kangerdlugssuak (east coast, midway of fjord). Here only 10 circles in each association were examined.

No. 63. *Vaccinietum* intermixed with a vegetation which, it is true, I did not see quite pure, but will call by the name of *Elynetum*, because the three species *Elyna Bellardi*, *Hierochloë*¹⁾ and *Carex cappillaris* always occurred together in the different circles investigated. This name is all the more justifiable, as this alpine vegetation occurs in other localities in Greenland (OSTENFELD and LUNDAGER, 1910, GELTING (unpublished)).

No. 64. *Salicetum herbaceae*. The vegetation was found protected

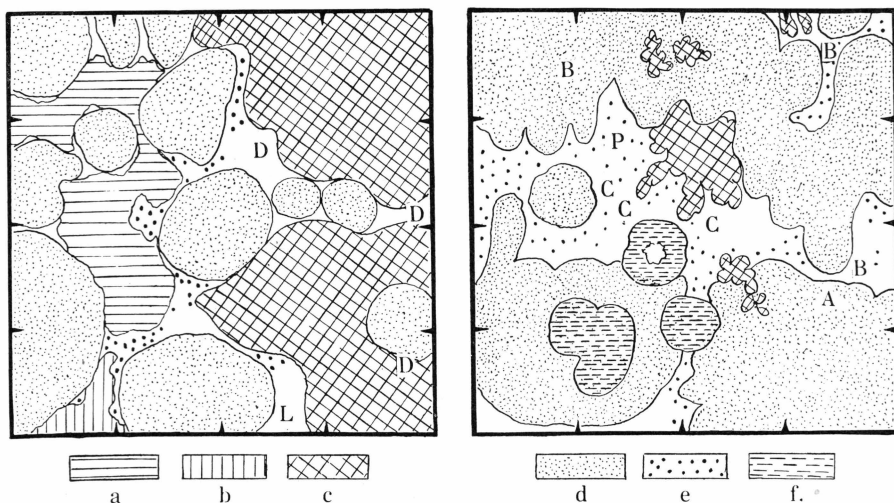


Fig. 18. *Cassiope tetragona*. Explanation in the text.

from the wind, whereas No. 63 occupied the upper margin of the snow-patch, which would become bare of snow at an earlier period or was always snowless, because the wind might sweep across it.

The spectrum shows an almost equal distribution of the life-forms in the two associations.

Examinations Nos. 65 and 66, fig. 18. (Size: 1m²).

Hatchings: a = *Vaccinium uliginosum*; b = *Empetrum nigrum*; c = *Salix arctica* × *arctophila* × *glauca*; d = *Cassiope tetragona*; e = moss or lichen-cover on the ground; f = *Diapensia lapponica*. Letters: A = *Pedicularis hirsuta*; B = *Lycopodium Selago*; C = *Carex*

¹⁾ Cf. "flechtenreiche *Hierochloë alpina*-assoziation", characterized by the lack of snow-covering as well as by the strong exposure to the wind and little moisture in the soil (THORE FRIES, 1913).

rigida; D = *Poa arctica*; L = *Luzula confusa* and P = *Polygonum viviparum*. In No. 66 (fig. 18 to the right) the lichen-cover especially consisted of *Stereocaulon*, *Cetraria* and *Cladoniae*. Near the sample square the vegetation further comprised *Empetrum*, *Saxifraga oppositifolia*, *Silene acaulis*, *Cassiope hypnoides* and *Luzula confusa*.

No. 65 (fig. 18, to the left) was found at 120 m above sea-level, on an eastern slope towards the sea near Cape Barclay. See "Description of Localities", p. 6. The association may be described as a *Cassiopetum tetragonae*, rich in *Salix*.

No. 66 (fig. 18 to the right) occurred in 350 m above sea-level, on a plateau facing north along the small mountain ridge at "Divers' Lake" in the interior east of Watkins Fjord. The vegetation was very dry and rich in lichens, viz. a *Cassiopetum tetragonae* rich in *Salix* and *Diapensia*.

While fully recognizing that the summary to be given in the following of the various heath-associations and the con-sociations and sociations of the latter, is by no means exhaustive and certainly cannot be regarded as a final result, I am still of the opinion that a summary of this kind may prove valuable to anyone wanting to compare results from other parts of Greenland with the results from these parts, and for this reason I feel justified in making the attempt. Not until a more complete material is at hand, will it be possible to contemplate a summary of the heath-associations of the whole of Greenland; this is merely a contribution to the knowledge of heath-associations along the distance Scoresby Sound—Angmagssalik.

1. *Empetreto-Vaccinietum*.

A. Moist (frequently rich in mosses)

- | | |
|--|----------------------|
| a. typical | Nos. 38, 41, 43, 45. |
| b. rich in <i>Diapensia</i> | - 39, (47). |
| c. rich in <i>Salix glauca</i> | - 40, 42. |
| d. rich in <i>Salix herbacea</i> | - 37. |
| e. rich in <i>Loiseleuria</i> | - 46. |
| f. rich in <i>Rhododendron</i> | - 47. |
| g. rich in <i>Scirpus cæspitosus</i> | - 44, 52. |

(Intermixture from *Scirpetum*)

B. Dry (frequently rich in lichens)

- | | |
|---------|---------|
| a. | No. 59. |
|---------|---------|

2. *Vaccinietum*.

- | | |
|--|---------------------|
| a. rich in <i>Poa arctica</i> | table 21 a. (moist) |
| b. rich in <i>Elyna</i> | Nos. 50, 63. |
| c. rich in <i>Empetrum</i> and <i>Cassiope tetragona</i> | - 61. |

3. *Saliceto-Vaccinietum*.
 - A. Moist (facing south)
 - a. No. 36.
 - B. Dry (level ground)
 - a. - 53.
4. *Loiseleurieto-Vaccinietum* - 60.
5. *Empetretum*. Pure *Empetrum*-heath was seen in Tugtilik (66°20').
6. *Empetreto-Betuletum nanae*. Mentioned by KRUUSE (Kingsorsuak).
7. *Salicetum glaucae* (heath-association).
 - a. rich in *Alchemilla alpina*. Mentioned on p. 55.
 - b. rich in *Salix herbacea* Nos. 48, 49.
8. *Saliceto-Empetretum*. Tugtilik. Mentioned on p. 25.
9. *Phyllodoctum coeruleae*. Observed on a small strip along a rocky wall, Cape Daussy. Mentioned by KRUUSE.
10. *Diapensietum* (with *Elyna*) No. 51.
11. *Cassiopetum tetragonae*
 - a. typical. Scoresby Sound (HARTZ); Cape Dalton (fig. 6 T. B., 1933).
 - b. rich in *Salix* and *Vaccinium* Nos. 57 (65 and 66).
12. *Cassiopetum hypnoidis* was found in patches. Cape Dalton; fjord north of Cape Ravn; Kangerdlugssuak. Mentioned for instance by R. HULT for northern Finland.
13. *Salicetum herbaceae*. Summary of sociations found on p. 92.

Of the associations given above *Salicetum herbaceae* will be mentioned in the following section.

There is a pronounced geographical difference as to the distribution of these associations. *Empetreto-Vaccinietum*, *Loiseleurieto-Vaccinietum*, *Empetretum* and *Salicetum glaucae* with *Alchemilla alpina* must be said to be more southerly forms, connected with *regio arctica I*, whereas *Cassiopetum tetragonae* and certain *Vaccinieta* and *Saliceto-Vaccinieta* belong to *regio arctica II*. (Distribution of *Cassiope tetragona* in Greenland, fig. 12 in T. B., 1933). Compare SUMMERHAYES and ELTON, 1928 pp. 233—235, 252—256, T. B., 1933 pp. 33—37 and also TRAPNELL's climatic types (TRAPNELL, 1933 pp. 311—316).

Before taking leave of the heath, mention should still be made of two examinations, which show examples of heath-associations in new soil.

No. 65. At the lagoon behind Cape Dalton. On an alluvial fan on level, gravelly ground a heath was found, rich in mosses and lichens and composed in the following manner:

Dominants: *Salix herbacea*.
 Salix arctica × *glauca*.
 Polygonum viviparum.
 Stereocaulon alpinum.
 Polytrichum alpinum v. *septentrionale*.

- Common: *Stellaria longipes*.
Poa alpina v. *vivipara*.
Carex Lachenalii (*C. glareosa*?)
Poa arctica.
Luzula confusa.
Pedicularis hirsuta.
Saxifraga caespitosa.
Saxifraga cernua.
Peltigera rufescens.
Rhacomitrium canescens.
Drepanocladus revolvens.
- Here and there: *Trisetum spicatum*.
Cerastium alpinum.
Minuartia biflora.
Oxyria digyna.
Ranunculus pygmæus.
Aulacomnium turgidum.
Conostomum tetragonum.
Dicranum scoparium v. *orthophyllum*.
Timmia bavarica.

No. 66. As mentioned in "Description of Localities" there was an incipient heath-vegetation in patches along the driest parts of the moraine walls in Miki's Fjord (p. 12). In 1 m² *Salix arctophila* × *glauca* was recorded, covering about $\frac{1}{3}$ m², together with a small shoot of *Empetrum* and one of *Vaccinium*. The remainder was covered by lichens and mosses (particularly *Cladonia coccifera*, *Stereocaulon* and *Drepanocladus revolvens*) in which 6 specimens of *Draba cinerea* × *rupestris*?, 3 specimens of *Trisetum spicatum* and 1 specimen of *Poa glauca*.

In No. 65 as well as in No. 66 it appears that *Salix*-associations seem to be initial stages of a heath with *Vaccinium* or *Vaccinium* and *Empetrum*.

5. Snow-patch associations (*Sempervirentiherbosa II*).

As was done in the case of the heath it will be most practical to summarize the individual examinations before setting up the various associations.

Table 26: The three examinations were all made near the headland in Miki's Fjord, where the Eskimo house-ruins were found. It is difficult to decide whether the manure lying round a place of this kind may have a lasting influence on the composition of the vegetation; perhaps

Table 26.

	G.	L.	67	68	69
OXYRIA DIGYNA.....	A ₂	H	72	76	76
SIBBALDIA PROCUMBENS.....	A ₂	Ch	100	88	4
VERONICA ALPINA.....	A ₂	H	68	16	8
CERASTIUM TRIGYNUM.....	A ₂	Ch	36	32	64
Gnaphalium supinum	A ₂	Ch	12	40	16
Salix herbacea.....	A ₂	Ch	36	12	24
Trisetum spicatum.....	A ₂	H	36	32	4
Poa arctica	A ₁ (?)	G	56	..	..
Carex Lachenalii.....	A ₂	H	16	20	28
Cerastium alpinum.....	A ₂	Ch	28	36	..
Draba crassifolia.....	A ₂	A ₂	12	24	..
Saxifraga cernua.....	A ₂	H	12	20	4
Salix arctophila × glauca.....	A ₂	Ch	8	12	8
Antennaria alpina	A ₂	Ch	12	12	..
Erigeron unalaschkensis	A ₂	H	4	12	..
Taraxacum croceum var.....	S	H	20	..	..
Minuartia biflora	A ₂	Ch	..	8	..
Cardamine bellidifolia	A ₂	H	..	4	..
Luzula confusa.....	A ₂	H	..	..	4
Luzula spicata	A ₂	H	..	16	..
Poa alpina.....	A ₂	H	8	..	16
Ranunculus pygmaeus	A ₂	H	..	16	..
Saxifraga caespitosa.....	A ₂	Ch	..	8	..
Polytrichum alpinum.....	..	..	+	..	..
Polytrichum sexangulare	..	..	..	32	44

Spectrum: (Table 26).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch ^o / _o	H ^o / _o	G ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o
67	68°10'	52	S	15°	3	gabbro (manured soil at dwelling place)	18	544	5,4	45	45	10	10	86	4
68	—	20	S	0°	3	gabbro (perhaps manured)	19	484	4,8	56	44	0	0	100	0
69	—	10	S	15°	3	gabbro clay plane	12	256	2,6	45	55	0	0	100	0

it was due to the highly nutritive, nitrogenized soil that some species here occurred with a higher F-percentage than usual; but everything considered, the three vegetations in table 26 do not seem to bear the stamp of being a particularly unnatural growth.

No. 67, found on the southern slope of one of the ruins. The snow-cover is of comparatively long duration. *Sibbaldia procumbens* dominates together with *Veronica alpina* and *Oxyria*; common is furthermore *Poa arctica*.

No. 68. Along the southern wall in one of the rather broad, but shallow fissures in the rocks (direction east-west). Dominants: *Sibbaldia procumbens* and *Oxyria*. Common is *Gnaphalium supinum*. Also *Draba crassifolia* seems characteristic of this vegetation¹). *Polytrichum sexangulare* is rather common. Nos. 67 and 68 together are two examples of a *Sibbaldietum*, which can be compared with THORE FRIES' *Sibbaldia procumbens*-Wiese, which in Torne Lappmark was found in localities with the same rather long duration of the cover of snow.

No. 69. Long duration of snow-cover. Scattered vegetation between the rocks in one of the fissures mentioned above. *Oxyria digyna* and *Cerastium trigynum* (*C. cerastioides*) dominate, in some places *Polytrichum sexangulare*. *Carex Lachenalii* (*lagopina*) common. *Cerastium* mentioned by J. BRAUN as "Konstante des Schneetälschens und überdüngter Läger", so that in this case the predominance of the species might be ascribed to both of these factors, viz. the long duration of the snow-cover and the manured soil. However, unmanured snow-patches are found with snow-covers of particularly long duration, where *Cerastium* is entirely dominating (No. 71), and such snow-patch vegetation there is reason to call *Cerastietum trigyni*. As regards the frequency of *Oxyria* it occurs with the same percentage in Nos. 67 and 68 as in No. 69 and can, in certain places where the duration of the snow-cover is long, surpass *Cerastium* in percentage (No. 75). *Carex Lachenalii* is common in similar vegetations in Fennoscandia. At times the character of the vegetation was rather like that of a *Polytrichetum sexangularis*, compare the examination No. 82. The spectrum shows an increase of the H-percentage, and a lowering of the Ch-percentage from No. 68 to 69.

Table 27 shows three associations which grew quite close to one another on a small ledge in the rocks behind the Skærgaard Peninsula in Kangerdlugssuak. They represent three stages of snow-covering. No. 37 has a snow-cover of short duration, No. 70 one of rather long and No. 71 one of very long duration. Fig. 19 shows a map of the distribution of the associations on the small ledge: I. is the *Empetreto-Vaccinietum*, farthest out (No. 37), II. is the *Salicetum herbaceae* (No. 70) in the

¹) I always found *D. crassifolia* in associations belonging to, or related with *Salicetum herbaceae* (Nos. 19, 23, 67 and 68). TENGWALL (1920, p. 323) mentions *D. crassifolia* as the only "Charakterart I Ordnung" in *Salicetum herbaceae* in northern Norway.

Table 27.

	G.	L.	37	70	71
EMPETRUM NIGRUM var. HERMAPHRODITUM.....	A ₂	Ch	100	..	..
VACCINIUM ULIGINOSUM var. MICROPHYLLUM.....	A ₂	Ch	68	8	..
SALIX HERBACEA	A ₂	Ch	36	100	12
Carex rigida.....	A ₂	G	36	56	..
Polygonum viviparum.....	A ₂	G	24	12	..
Cassiope hypnoides	A ₂	Ch	8	36	..
Salix arctophila × glauca.....	A ₂	Ch	12	4	..
Juncus trifidus	S	H	8	..	..
Trisetum spicatum.....	A ₂	H	4	..	..
Luzula confusa.....	A ₂	H	4	28	12
Silene acaulis.....	A ₂	Ch	+	4	..
Ranunculus glacialis	A ₂	H	..	4	12
Saxifraga nivalis.....	A ₂	H	..	4	..
Saxifraga rivularis	A ₂	H	..	..	4
CERASTIUM TRIGYNUM.....	A ₂	Ch	..	..	72
Oxyria digyna.....	A ₂	H	..	..	32
Phippsia algida.....	A ₂	H	..	..	12
Carex Lachenalii.....	A ₂	H	..	..	4
Sphagnum sp. and other mosses.....	..	..	+	..	..
Drepanocladus intermedius	..	..	..	..	+
Pohlia sp.....	..	..	..	..	+
Fungus (Agaricaceae)	..	..	..	+	..

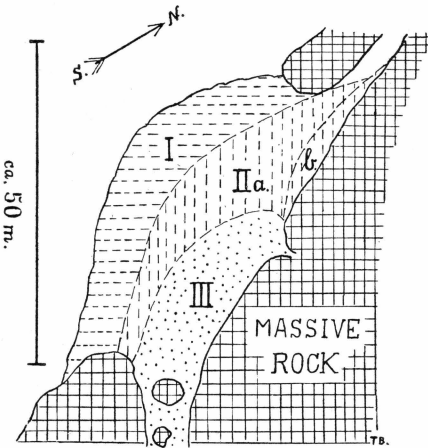


Fig. 19.

centre, which nearest the warm southern wall (II b), where the snow melts most quickly, rather attains the character of a herb-field, as mentioned on p. 43; III. is, finally, a *Cerastietum trigyni* nearest the wall,

shaded and consequently with a lower temperature than the others, and there the snow remains the longest (No. 71).

No. 37. *Empetretum-Vaccinietum*. Farthest out very rich in mosses, where the water from the ledge comes out (*Sphagnum*!).

No. 70. *Salicetum herbaceae*. Typical are here *Carex rigida* and *Cassiope hypnoides*.

No. 71. *Cerastietum trigyni*. Interesting as compared with Scandinavia are here particularly *Phippisia algida*, *Ranunculus glacialis*, *Luzula confusa* and *Carex Lachenalii*. The two mosses mentioned, viz. *Drepanocladus intermedius* and *Pohlia* sp. covered the ground, often in ragged, dry flakes, an evidence of the greater moisture which the vegetation must have had in the early summer.

The spectrum (p. 90) of the *Empetretum-Vaccinietum* and *Salicetum herbaceae* shows a preponderance of Chamæphytes; there is, however, a great biological difference in the Chamæphytes of the two associations, which is expressed in the heights of the individuals. Here one might perhaps with DU RIERZ (1931) distinguish between Chamæphytes of a height of less than 0,05 m and Chamæphytes of a height above 0,05 m; the result would in this case be that the *Empetretum-Vaccinietum* had 75 per cent Ch or 60 per cent above 0,05 m, 15 per cent below 0,05 m, and that *Salicetum herbaceae* had 59 per cent Ch, or 6 per cent above and 53 per cent below 0,05 m. All the 53 per cent Chamæphytes in the *Cerastietum* are finally Ch of less than 0,05 m in height. It further appears that the Hemicryptophytes increase very much with the increasing duration of the cover of snow, so that in No. 71 there are 47 per cent H, and *Cerastium* which is a passive Chamæphyte (RAUNKJÆR 1907) and frequently has the buds lying in the moss of the snow-patch can, in consequence, not be said to be a good Chamæphyte, which further confirms the rise of the H-percentage. The Geophytes have their maximum in *Salicetum herbaceae* (*Carex rigida* and *Polygonum viviparum*). Geographically the associations are characterized by arctic, widely distributed species.

Table 28: Like the preceding table 28 shows some associations which from left to right are subjected to conditions with a snow-cover of a longer and longer duration. They occurred in connection with one another in a flat gravelly plane on the east coast of Kangerdlugssuak. Right against the mountain slope there was still so much snow that the drift might be regarded as perennial; see fig. 26 F.

No. 72. Farthest out there was an open fell-field vegetation, the gravel cropping out everywhere and nearly all plants being typical fell-field species; the only dominant is *Polygonum viviparum*; next in frequency stands *Salix herbacea*, which may be due to the fact that the snow

Table 28.

	G.	L.	72	73	74	75
Elyna Bellardi	A ₂	H	8	..	..	..
Carex nardina	A ₂	H	4	..	..	..
SALIX HERBACEA	A ₂	Ch	48	100	+	..
POLYGONUM VIVIPARUM	A ₂	G	76	72	..	..
CAREX RIGIDA	A ₂	G	+	60	..	..
Salix arctophila × glauca	A ₂	Ch	36	36	+	..
Luzula confusa	A ₂	H	44	32	+	+
Saxifraga oppositifolia	A ₂	Ch	12	20	..	..
Silene acaulis	A ₂	Ch	12	16	..	..
Cerastium alpinum	A ₂	Ch	..	12	..	..
Minuartia rubella	A ₂	Ch	..	12	..	..
Trisetum alpinum	A ₂	H	..	8	+	..
Saxifraga cernua	A ₂	H	..	8	+	+
Oxyria digyna	A ₂	H	..	8	!	!!
Ranunculus glacialis	A ₂	H	..	..	+	..
Carex Lachenalii	A ₂	H	..	..	+	+
Cerastium trigynum	A ₂	Ch	..	..	+	+
Russula sp.	..	..	..	!	..	..
Lachnea sp.	..	..	..	+	..	..
Lichens compare No. 78	..	..	..	!	..	..
Anthelia Juratzkana	..	..	..	!	!	..
Other Mosses (see text)	..	..	..	..	!	!

perhaps settles closely round the larger stones, in this manner providing small refuges for this species; however, *Salix herbacea* also often seemed to thrive well in pure gravel, without any stone being near, and frequently in company with wind-eroded tufts of *Elyna* or *Carex nardina*, so that one may suppose that *Salix herbacea* on the east coast of Greenland, at any rate towards the south, also lives in places free of snow and open to the wind, as recorded from the Alps by BRAUN and from Iceland by MØLHOLM HANSEN.

No. 73. Farther in the fell-field gradually merged into a *Salicetum herbaceae* with a very typical composition of species. The earth was here frequently covered by flakes of *Anthelia*; lichens were common, and also fungi, particularly *Agaricaceæ* (cf. Nos. 70, 77 and 78), suggesting a sour soil; this vegetation was the only one where fungi occurred constantly and frequently. The spectrum (p. 90) shows 34 per cent G.

Nos. 74 and 75. Nearest the snow the vegetation consisted of moss, in which more particularly *Oxyria*, *Carex Lachenalii* and *Cerastium trigynum*, but the mosses collected were unfortunately lost. The soil was so moist with the rivulets of melting water that the vegetation farthest in resembled a moss-moor vegetation.

Table 29: Nos. 76 to 80 show some examples of snow-patch vegetation, with a snow-cover of long duration, No. 81 an example of such a vegetation with a snow-cover of very long duration. Nos. 81 and 78 lay beside each other on a small ledge in the mountains on the east coast of Kangerdlugssuak. In fig. 20 I have attempted to illustrate the distribution of the two associations on the ledge; nearest the perennial snow-drift there is a *Cerastium-trigynum* association or a *Phippsia-Carex lagopina* (*C. Lachenalii*) association (No. 81). Outside these there is a closed vegetation (No. 78) in the shape of a *Salicetum herbaceae* (*Salherbetum* as it was called by RÜBEL) with the usual 3 dominants, but furthermore rich in *Salix arctophila* $\times$ *glauca*, *Stereocaulon alpinum*,

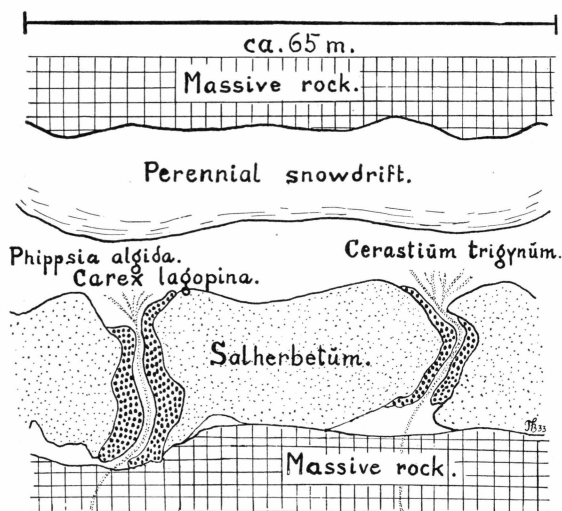


Fig. 20.

Cetraria Delisei and *C. islandica*. The soil was here, as frequently in this vegetation, split up into polygons (drying-out phenomenon). Along the small water-ways which in the early spring had been far more watery and were now almost dried out, this vegetation merged into a moss-tuft vegetation which was dominated by *Salix arctophila* $\times$ *glauca*, *Polygonum* and *Carex rigida*. The difference is explained by the supposition that the snow disappears most quickly round a water-way. The moss-tuft vegetation in fig. 20 is indicated by larger black dots.

The great wealth of lichens, which often characterized the Kangerdlugssuak *Salicetum herbaceae* was so great in certain places towards the south in Angmagssalik that the lichens smothered the phanerogams. This can surely not be said to be common in East Greenland (cf. LYNGE, 1932, a), nor was the vegetation at any time very widely distributed. Nos. 79 and 80 are two examples of this vegetation; the wealth of *Cladoniae* is well worth noticing (cf. LYNGE, 1933).

Table 29.

	G.	L.	76	77	78	79	80	81
SALIX HERBACEA	A ₂	Ch	100	100	100	+	+	..
CAREX RIGIDA	A ₂	G	..	100	92	+	+	..
POLYGONUM VIVIPARUM ..	A ₂	G	..	100	88	+	(+)	+
EQUISETUM VARIEGATUM..	A ₂	H	100	..	..	..	..	..
Salix arctophila × glauca.....	A ₂	Ch	40	20	44	..	..	..
Silene acaulis.....	A ₂	Ch	..	10	12	..	..	..
Pedicularis flammea.....	A ₂	H	..	..	12	..	..	..
Euphrasia latifolia.....	A ₂	Th	..	..	4	..	..	..
Sedum roseum	S	H	..	..	8	..	..	..
Trisetum spicatum.....	A ₂	H	..	..	8	..	..	+
Luzula confusa	A ₂	H	..	10	..	..	..	+
Saxifraga nivalis.....	A ₂	H	..	..	4	..	..	+
Saxifraga caespitosa.....	A ₂	Ch	..	..	..	..	..	+
Carex Lachenalii.....	A ₂	H	..	..	..	..	..	!
Phippsia algida.....	A ₂	H	..	..	..	..	..	!
Cerastium trigynum.....	A ₂	Ch	..	..	..	..	..	+
Fungus (Agaricaceae).....			..	+	+	..	..	..
Anthelia Juratzkana			..	..	+	..	..	+
Polytrichum juniperinum.....			..	..	..	+	..	..
Dicranum fuscescens			..	..	..	+	..	..
Lophozia Kunzeana.....			..	..	..	+	..	..
CETRARIA DELISEI.....			100	..	44	..	..	..
CETRARIA ISLANDICA			..	..	..	!	!	..
Cetraria nivalis.....			..	..	40	..	..	..
Cladonia bellidiflora.....			..	..	..	+	..	..
Cladonia coccifera var.....			..	..	..	+	..	..
Cladonia deformis.....			..	..	..	..	+	..
Cladonia elongata.....			..	..	..	+	+	..
Cladonia lepidota var.....			..	..	..	+	..	..
CLADONIA MITIS.....			..	..	..	+	!	..
Cladonia pyxidata(?).....			..	..	8	..	..	..
Cladonia rangiferina.....			..	..	..	+	..	..
Cladonia uncinatis			..	..	..	+	+	..
Ochrolegia frigida.....			..	..	8	..	..	..
Pertussaria oculata			..	..	..	+	..	..
Psoroma hypnorum.....			..	..	..	+	..	..
Sphaerophorus globosus.....			..	..	..	+	..	..
STEREOCAULON ALPINUM.....			40	..	80	+	..	..
Stereocaulon paschale			..	..	..	..	+	..

No. 76 is an example of a *Salicetum herbaceae* with *Equisetum variegatum* as a second dominant; it was found in patches in the valley between Miki's Fjord and Watkins Fjord; as elsewhere, both *Polygonum* and *Carex rigida* frequently occurred as dominants, so that there

is no reason to establish any special association on this basis. The vegetation was rich in lichens, *Cetraria Delisei* occurring everywhere. Only 10 circles of $\frac{1}{10}$ m² were examined.

No. 77. The only closed vegetation in the little valley north of Notched M. in the interior of Kangerdlugssuak. Only 10 circles examined. *Salicetum herbaceae* with the three typical dominants. The vegetation merged into fell-field, bearing the stamp of the north wind, which here might blow unhindered from the Inland Ice. In this fell-field only *Silene acaulis* and *Luzula confusa* were seen. The *Silene* tufts were frequently dead on their northern sides.

Spectrum: (Tables 27—28—29).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch ^o / _o	H ^o / _o	G ^o / _o	Th ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o
37	68°10'	80	VSV	10°	3—4	gabbro	11	300	3,0	75	5	20	0	0	97	3
70	—	—	—	—	3	—	10	256	2,6	59	14	27	0	0	100	0
71	—	—	—	—	3	—	8	160	1,6	53	47	0	0	0	100	0
72	68°20'	10	E	0—5°	2	gnejss	9	240	2,4	45	23	32	0	0	100	0
73	—	—	—	—	3	—	12	384	3,8	51	15	34	0	0	100	0
76	68°10'	c. 75	..	0°	2—3	basalt	3	240	2,4	58	42	0	0	0	100	0
77	c. 68°30'	c. 15	..	0°	2—3	gnejss	6	340	3,4	48	3	59	0	0	100	0
78	68°20'	230	(S)	0°	3	—	10	372	3,7	42	9	48	1	0	98	2

Examinations Nos. 82 and 83, fig. 21.

No. 82, fig. 21 to left. Examination of 1 m² of a snow-patch in Miki's Fjord, small part of No. 69. The black dots indicate *Polytrichum sexangulare*, which in this place more particularly grew round the beginning fissures in the polygon soil (drying-out phenomenon). O = *Oxyria digyna*; C = *Cerastium trigynum*; P = *Poa alpina*. The vegetation has a character resembling *Polytrichetum sexangularis*, the well-known alpine snow-patch community (cf. BRAUN-BLANQUET, 1926). Plate 4, fig. 2 represents a *Cerastium trigynum* taken at close quarters in the course of this examination.

No. 83, fig. 21 to the right. Examination of 1 m² of a snow-patch between the low rocks near the houses of the expedition on the Skærgaard Peninsula at Kangerdlugssuak. The bottom was throughout covered by moss (the dotted part), which owing to the drying-out later in summer had split more or less into moss-flakes. The moss consisted of *Anthelia Juratzkana*, *Gymnomitrium corallioides* and *Drepanocladus*

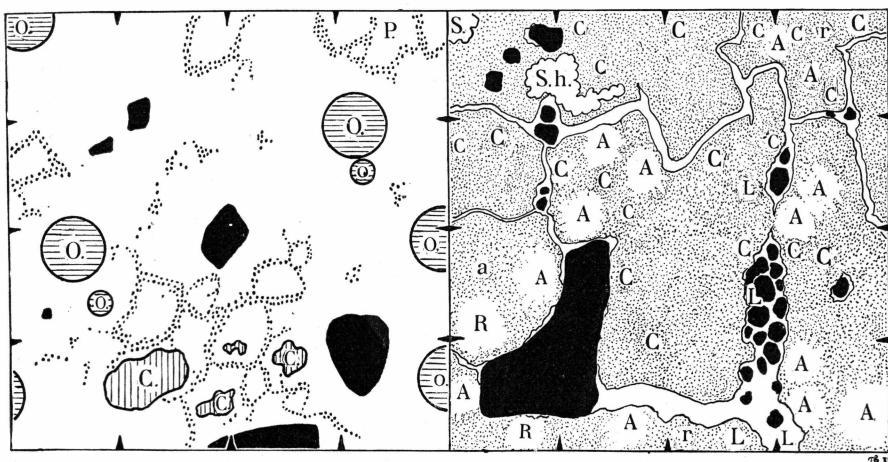


Fig. 21. Explanation in the text.

revolvens; further and secondarily of *Lophozia alpestris* and *Pohlia nutans*. Letters: C = *Cerastium trigynum*; A = *Carex Lachenalii*; R = *Ranunculus glacialis*; S = *Salix arctophila* × *glauca*; S.h. = *Salix herbaceae*; L = *Luzula confusa*; a = *Minuartia biflora*, and r = *Saxifraga rivularis*. Outside the square this vegetation furthermore was seen to comprise *Oxyria*, *Saxifraga nivalis* and *Phippsia algida*. The vegetation was characterized by *Cerastium trigynum* and *Carex Lachenalii*.

This vegetation was found everywhere between the flat rocks. At the time of the snow-melting it should be as moist, as was the rather large valley basin behind the houses in the month of August; here the vegetation was practically the same, only very wet from the numerous rivulets of melting water, which in this place gathered from the mountains behind the houses.

Table 30. The three examinations from Miki's Fjord would in former time have been classed with fell-field. There is, however, so much in the composition of species which points towards snow-patch that I dare not, without further proof, refer it to fell-field, as I define it (*viz.* as an open vegetation caused by the lack of a cover of snow). This must, consequently, be left an open question; there was not a trace of snow anywhere near it (about 15 August), but one might very well imagine a snow-covering of long duration in this place, particularly in Nos. 85 and 86, which occurred on level gravel near small vertical rocky walls. The vegetation was so scattered that there were no dominants; the density of species is very small, but the H-percentage is large.

Table 30.

	G.	L.	84	85	86
Salix herbacea.....	A ₂	Ch	40	8	!
Oxyria digyna.....	A ₂	H	36	16	!
Luzula confusa.....	A ₂	H	20	28	!
Trisetum spicatum.....	A ₂	H	20	..	..
Saxifraga oppositifolia.....	A ₂	Ch	8	4	+
Saxifraga nivalis.....	A ₂	H	4	4	+
Silene acaulis.....	A ₂	Ch	4	+	+
Cerastium alpinum.....	A ₂	Ch	4	..	..
Cerastium trigynum.....	A ₂	Ch	4	4	+
Minuartia biflora	A ₂	Ch	4	..	+
Sagina intermedia	A ₂	Ch	..	..	+
Cardamine bellidifolia	A ₂	H	..	4	..
Ranunculus glacialis	A ₂	H	..	4	..
Salix arctophila × glauca.....	A ₂	Ch	..	..	+
Veronica alpina.....	A ₂	H	4	..	..
Gnaphalium supinum	A ₂	Ch	4	..	..
Poa glauca.....	A ₂	H	4	..	..
Carex Lachenalii.....	A ₂	H	..	..	+
Polytrichum sexangulare			8	..	..
Stereocaulon alpinum			4	..	..

Spectrum: (Table 30).

No.	Lat. n.	Height in m. above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch ^o / _o	H ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o
84	68°10'	150	S.	15°	2	gabbro	13	156	1,6	44	56	0	100	0
85	—	c. 25	..	0°	2	—	9	72	0,7	22	88	0	100	0

Summary of snow-patch associations.

“SALICION HERBACEAE”

NB. *Salicetum herbaceae*, transition-form to *Taraxacetum crocei*. Nos. 18 and 22 from the sides of water-ways, Nos. 12 and 19 *Taraxacetum* with *S. herbaceae* as a dominant.

- 1. *Salicetum herbaceae* (with *Carex rigida* and *Polygonum viviparum*).
 - a. rich in herbs (*Agrostis borealis*, *Cerastium alpinum*) and Chamæphytes (*Vaccinium*, *Salix*, *Empetrum*), on southern slope... 29 a.
 - b. rich in *Viola palustris* (S!), observed on southern slope at the Angmagssalik Settlement.
 - c. rich in *Cassiope hypnoides* Nos. 62, 70.
 - d. rich in *Equisetum variegatum*..... - 76.
 - e. rich in *Equisetum arvense* v. *rivulare* - 87.
 - f. rich in lichens..... - 79, 80.
 - g. typical..... - 64, 73, 77, 78.
- 2. *Chamænerietum latifolii* (p. 45) with *Salix herbacea* as a dominant - 23, 24, 26, 21.

The material does not seem sufficient for the setting up of more than a couple of associations, besides those mentioned above, seeing that the individual investigations of snow-patches with snow-covers of very long duration are in reality rather different in kind. In particular there seems to be a *Cerastietum trigyni* (Nos. 69 and 71) which contains a great number of sociations, as it is frequently rich in mosses (with *Anthelia*, *Gymnomitrium corallioides*, *Drepanocladus revolvens* and *Carex Lachenalii*, No. 83) or with *Oxyria digyna* and *Polytrichum sexangulare* (No. 82). *Oxyria* was frequently seen to dominate so entirely that it would be correct to speak of an *Oxyrietum* (No. 75); this would, however, be rather a misleading name, as the alpine *Oxyrietum* is a débris-vegetation (cf. BR. BL., 1926)¹).

Nos. 67 and 68 suggest the presence of *Sibbaldietum*, where the snow lies for a long time, but not as long as in the most extreme cases.

In several places in Kangerdlugssuak I saw an *Anthelietum*, almost devoid of phanerogams. In Miki's Fjord there were patches of an incipient *Polytrichetum sexangularis*.

Carex Lachenalii and *Phippsia algida* in one locality occurred with great frequency (No. 81), and at Cape Dalton *Phippsia algida* was seen quite alone on the newly exposed soil in front of the snow-drifts.

It holds good for the greater part of these associations that they are arctic-alpine. As to their distribution in Greenland not much is known at the present time; still, I am inclined to think that they are rather widely distributed, as the species making part of the associations are practically without exception A₂-types. WARMING includes them under fell-field, when describing a typical fell-field locality as a place "where the ground is stony and gravelly and cold, because the snow is left there for a long time" — "therefore, places where the snow remains for a long time, and where the soil is consequently cold and moist, chiefly favour certain species as e. g. *Ranunculus pygmaeus*, *Oxyria*, *Salix herbacea*, *Saxifraga rivularis*, *Lycopodium Selago* and others." The rich Scandinavian literature, on the other hand, comprises several investigations, which show that there is a great similarity between the snow-patch associations there and in the area I examined. This fact I shall recur to later on, but in this place I should like to give the dominants of a *Cerastium trigynum* "herb-field" from Norway (H. RESVOLL-HOLMSEN), see p. 94.

A vegetation of this kind deviates from my *Cerastietum trigyni* by the far greater points sum and number of species, but all the said species

¹) *Oxyria* occurred with particular frequency in several places in the débris, f. i. at Cape Barclay, so it is possible to speak of an incipient association of this kind; interesting in this context is the *Oxyrietum* reproduced in fig. 3, where *Oxyria* (and *Poa glauca*) took possession of the soil on the large, sandy, but rather moist moraine wall about the middle of the fjord on the east coast of Kangerdlugssuak.

(After H. RESVOLL-HOLMSEN)

	F %	F %
<i>Cerastium trigynum</i>	92	100
<i>Carex Lachenalii</i>	84	64
<i>Gnaphalium supinum</i>	84	40
<i>Oxyria digyna</i>	76	44
<i>Ranunculus pygmæus</i>	12	96
<i>Phippsia algida</i>	..	92
<i>Saxifraga rivularis</i>	..	68
<i>Trisetum spicatum</i>	..	52

occur either as dominants or very commonly in my snow-patch investigations.

The spectrum on p. 90 shows that Chamæphytes (especially below a height of 0,05 m) and Hemicryptophytes are common, where the cover of snow is of particularly long duration; Geophytes especially occur in *Salicetum herbaceae*.

As a characteristic transition-type between snow-patch associations and moor-associations may be mentioned the *Equisetetum arvensis*, which was found in the valley northwest of Cape Daussey, see "Description of Localities", p. 8. It was found on a level clayey plain near a very small water-hole. In the period of the snow-melting this plain will be very wet, because the water cannot penetrate into the frozen soil; later on, when the soil is thawed, the water will disappear, and the drought in summer causes the earth to crack into polygons. Plate 4, fig. 1 shows a photograph taken on 18 July (where this plane is seen); a couple of *Salix* individuals are visible, being entirely level with the ground. In this area there were two associations: farthest away from the small water-hole, a *Salicetum herbaceae*, rich in *Equisetum arvense* v. *rivulare* and *Salix arctica* × *arctophila* × *glauca* (No. 87), nearest the small water-hole an *Equisetetum arvensis*, rich in *Koenigia islandica* and *Phippsia algida* (No. 88). Both associations were very rich in mosses; in the former *Drepanocladus revolvens*, in the latter *Oncophorus Wahlenbergii* played a great part, the latter so great that it caused No. 88 to become a closed vegetation as contrasted with No. 87. No. 87 was besides rather rich in lichens.

The said *Equisetetum* must be defined as a curious mixture of snow-patch and moss-moor. It shows its snow-patch character by the high F-percentage of *Phippsia algida* and *Cerastium trigynum* and the occurrence of *Ranunculus pygmæus*; on the other hand, *Koenigia islandica*, *Cardamine pratensis*, *Juncus biglumis* and, in particular, *Equisetum* seem to suggest moss-moor. Hardly any shoot attained more than 3—4 cm in height, and they were generally hidden in the moss. Strictly speaking, *Koenigia* should not be regarded as making part of the association, as

Table 31.

	G.	L.	87	88
EQUISETUM ARVENSE var. RIVULARE ..	A ₂ (S)	G (?)	76	96
SALIX HERBACEA	A ₂	Ch	88	32
KOENIGIA ISLANDICA	A ₂	Th	4	80
Salix arctica × arctophila × glauca	A ₂	Ch	56	20
Luzula confusa	A ₂	H	44	..
Minuartia biflora	A ₂	Ch	24	12
Poa alpina var. vivipara	A ₂	H	20	28
Saxifraga nivalis	A ₂	H	4	4
Saxifraga caespitosa	A ₂	Ch	8	12
Cerastium trigynum	A ₂	Ch	4	28
Phippsia algida	A ₂	H	..	44
Cardamine pratensis ssp. angustifolia	A ₂ (S)	H	..	20
Ranunculus pygmaeus	A ₂	H	..	8
Juncus biglumis	A ₂	H	..	4
DREPANOCCLADUS REVOLVENS			76	28
ONCOPHORUS WAHLENBERGII			12	80
Polytrichum alpinum			12	..
Calliergon turgescens			+	+
Calliergon sarmentosum			+	+
Cetraria Delisei			40	8
Stereocaulon alpinum			48	8

Spectrum: (Table 31).

No.	Lat. n.	Height in m above sea-level	Exposure	Inclination	Moisture	Soil	Number of species	Points sum	Density of species	Ch°/o	H°/o	G°/o	Th°/o	A ₁ °/o	A ₂ °/o	S°/o
87	68°43'	10	—	0°	2 (18/7)	clay, basalt	10	328	3,3	55 (44)	21 (0)	23 (0)	1	0	100 (77)	0 (23)
88	—	—	—	—	3 (18/7)	—	13	384	3,8	27 (52)	28 (0)	24 (0)	21	0	100 (71)	0 (29)

it only occurred in the cracks between the polygons and thus, together with the mosses, formed a *Koenigietum* having a F-percentage of 100; when I made no distinction this is due to the fact that *Cardamine*, *Juncus* and *Equisetum*, which are also moor-plants, lived in the moss above the polygons. The reason why *Koenigia* preferred the cracks was undoubtedly that the soil here remained moist for a longer period. When in this case I class *Equisetum arvense* with the moor-plants, it is because its var. *rivulare* elsewhere in this valley proved associated with the moors.

When regarding *Equisetum arvense* as a Geophyte (RAUNKJÆRS Flora 1922) and, geographically, as an S-type (OSTENFELD 1926) one gets a spectrum for this vegetation, which shows 24 per cent G; the spectrum of No. 88 would show an equally high percentage for all four

life-forms and 29 per cent S. Here one has, however, the strongest impression of being confronted with a pronounced arctic vegetation, so that a S-percentage as high as that of *Taraxacum crocei* makes quite a wrong picture. This misrepresentation is caused by the two S-species, *Equisetum arvense* and *Cardamine pratensis*. To one who has seen these two species growing in this vegetation and the peculiar appearance presented by both of them, there is no doubt that the two species here occurred in two arctic ecotypes, and must thus be regarded as A₂-types. It is beyond a doubt their capacity of forming ecotypes, which enables them both to occur as far north as in the most northerly part of Greenland. It is then not forms, but varieties we are dealing with; I therefore call *E. arvense* f. *rivulare* Huth *E. arvense* var. *rivulare*¹⁾. This variety is an A₂-type, and as regards the life-form perhaps a Hemicryptophyte, seeing that it here was creeping in the thin, but dense layer of moss growing on top of the soil. The strange appearance presented by the variety was due to its growth as being passively pressed to the ground, and to the green vegetative cross-branches, which it bears on the lower parts of the fructiferous shoots.

¹⁾ OSTENFELD and GELERT (1902): "*Equisetum arvense* f. *rivulare* Huth. — — — to this form belong f. *riparia* Fr. and f. *arctica* Rupr. as dwarf forms". It seems to have been established as a species: *Equisetum riparium* E. Fries, see MILDE: Monographia Equisetorum, Dresden 1865.

Cardamine pratensis was found as vegetative specimens of *C. pratensis* ssp. *angustifolia* Hook. It was this sub-species I referred to on p. 22 in T. B., 1933, when speaking of ecotypes in Greenland. RIKLI (1917 a) mentions ssp. *angustifolia* as the type which is characteristic of arctic regions, whereas var. *Hayneana* Schur., is characteristic of the Alps. RIKLI (1917 b) compares the occurrence of *Cardamine pratensis* in the Alps with its occurrence in arctic regions: "Im zentralen Teil der Alpen ist sie selten oder sie fehlt stellenweise ganz. Nirgends vermag sie über die Waldgrenze vorzudringen. Als maximale Höhengrenze, die jedoch nur ganz lokal erreicht wird, gibt JACCARD für das Wallis 1800, RÜBEL für das Berninagebiet 1780 m an. Und diese Pflanze geht im Norden nicht nur sehr weit in die Arktis hinein, sie überschreitet sogar den 80° n. . . . Beim Übergang der Art von der gemässigten Zone in den höchsten Norden hat dieselbe somit eine ziemlich weitgehende formative und biologische Umprägung erfahren, die vollständig rechtfertigt die nordische Pflanze als besondere Unterart aufzufassen". This difference between the species occurring in the Alps and in the arctic countries is interesting, and reminds one of the fact that a species may have an unequal supply of ecotypes in two different localities, which in its turn may cause an unequal distribution in those two localities. Thus TURESSON (1931) found that *Polygonum bistorta* and *Solidago virgaurea* lacked special ecotypes in the Alps and the Carpathians which, on the other hand, they possessed in the Altai Mountains, and he writes: "The capacity on the part of these species to push their way into alpine altitudes in the Altai, and to flourish in such situations, depends primarily on the existence in these populations of biotypes fitted for the building up of alpine ecotypes". In Kamtschatka and great parts of Asia two races occur viz: *C. pratensis* L. sensu strictu and *C. dentata* Schulz., see E. HULTÉN II. p. 154.

The vegetation is consequently purely arctic, characterized by Hemipterophytes and in the cracks between the polygons by Therophytes. It merges gradually into a more heath-like vegetation (*Salicetum herbaceae*, No. 87) with Chamæphytes dominating.

6. Fell-Field. (*Frigorideserta*).

Wherever one passes from a closed to an open vegetation, the fell-herbs will as a rule replace the greater heather-like plants, which causes a rise in the H-percentage. As this openness in the vegetation may depend on three entirely different factors, viz. a snow-cover of too long or too short duration or no snow-cover at all, or the fact that the boulders become too prevailing ("Geröll"- or "Schuttflur") it is evident that the fell-field is extremely heterogeneous. The snow-covered debris-vegetation mentioned on p. 48 had certain peculiarities, which made it a natural, separate group of vegetation, associated with the *Semprevirentiherbosa*; this was also the case with the open vegetation with a snow-cover of the longest possible duration. What is left is then the soil, which is rather constantly bare of snow and does not bear a closed vegetation; on this some plants live which might be comprised into a form of vegetation, the fitting definition of which might be fell-field. As a rule the plants in the fell-field are arranged in such a manner that the idea of fell-field associations does not present itself, and one only imagines a large association with a rather homogeneous number of species of varying frequency; however, I have on several occasions been able to identify real associations within the fell-field.

1. *Papaver radicatum* association. The plateau at 300 m height at Cape Dalton. Papaver nearly predominating; a few specimens of *Cerastium alpinum* and *Ranunculus glacialis* were visible. In Loc. XIII in Kangerdlugssuak (nunatak in the nepheline-syenite area) *Papaver* was also the prevailing and only species. Compare: Poppy Herb Barren, TRAPNELL 1933.

2. *Dryas octopetala* association. Seen in the interior of d'Aunay Bay on a slope, rather resembling a debris-vegetation (basalt-gravel).

3. *Silene acaulis* association. Level gravel plane in the small valley north of Notched Mt. in Kangerdlugssuak. A few specimens of *Luzula confusa*, otherwise only *Silene*.

An incipient *Vaccinium uliginosum* var. *microphyllum* association was often seen, and in Kangerdlugssuak there were further a few examples of *Empetrum*, *Loiseleuria* and *Diapensia* forming fell-field associations.

In the preceding (table 28 (No. 72) and table 30) I have described some associations, which only with reservation can be grouped with fell-field.

The species which should be common in fell-field are the following (the list to a certain extent based upon that of KRUISE from Angmagssalik):

Papaver radicum. H.
Dryas octopetala. Ch. (southern limit at 69°05')
Silene acaulis. Ch.
Vaccinium uliginosum v. *microphyllum*. Ch.
Empetrum nigrum v. *hermaphroditum*. Ch.
Loiseleuria procumbens. Ch.
Diapensia lapponica. Ch.
Cerastium alpinum v. *lanatum*. Ch.
Ranunculus glacialis. H.
Luzula confusa. H.
Saxifraga tenuis. H.
Saxifraga oppositifolia. Ch.
Carex nardina. H.
The 4 *Salix*-species. Ch.
Polygonum viviparum. G.
Oxyria digyna. H. See table 30!
Elyna Bellardi. H.
Juncus trifidus. H.
Poa glauca. H.
Festuca ovina. H.

From a biological point of view the fell-field shows a preponderancy of Chamæphytes and Hemicryptophytes, whereas the Geophytes are very rare; the picture presented is consequently quite parallel with the life-form percentages in the biological spectrum, which OSTENFELD (1923) was able to establish for the most northerly part of Greenland. Like OSTENFELD, I am inclined to refer to the Chamæphytes species like *Carex nardina*, *Elyna Bellardi*, *Festuca ovina* var. *brevifolia* and perhaps also *Papaver radicum*, which also emphasizes the chamæphytic arctic character of this vegetation. VAHL (1913 p. 18) found that the fell-field in Lapland was not "characterized by any distinguished ecological features"

Fresh-Water Associations (*Aquiherbosa*).

7. Moor-vegetation (*Emersiherbosa*).

1. Moss-moor. a. stagnant water
b. running water.

It was proved by the work of the expedition that Blossville's Coast, on the whole, offered very bad conditions for the formation of moor, and consequently the observations made there are few. For the mosses,

complete lists of species will be found in HARMSSEN's article (1933); and so in this place only the most important mosses will be mentioned. The two moss-moor types mentioned above are different, both as a result of the greater or smaller movement in the water, and of the conditions caused by the angle of inclination.

As the only example of moss-moor with stagnant water I shall mention the moors found on level ground in front of the large snow-drifts at Cape Dalton (see fig. 26 A 2). In one locality a *Paludella squarrosa*-*Aulacomnium palustre* association was found, *Saxifraga stellaris comosa* being the only important phanerogam. In another locality a moss-vegetation with *Ranunculus sulphureus (altaicus)* was found as the only phanerogam of any importance. Other phanerogams from these moors that should be mentioned are: *Saxifraga rivularis*, *Saxifraga cernua*, *Ranunculus hyperboreus* (KRUUSE), *Ranunculus pygmæus*, *Poa arctica* and *Koenigia islandica* (KRUUSE).

On the southeastern slope of Cape Daussey a moss-moor was observed along a water-course on gently sloping ground, *Sphagnum plumulosum* dominating, and the phanerogams were at times so closely set that the vegetation partook of the character of a meadow-vegetation; here a *Ranunculetum affinis* was found in patches, where *Ranunculus affinis*, together with *Poa arctica*, frequently formed a very fine, close carpet of phanerogams above the moss-cover.

The moss-moor along a spring in the fjord north of Cape Ravn is mentioned on pp. 9—10. The scattered flowering plants were chiefly southern species, an interesting difference from the moor-type found at Cape Dalton, which chiefly contained A₁- and A₂-species.

At Uttental Sound in Kangerdlugssuak moss with *Epilobium anagallidifolium* was found along a small water-way.

Along small water-courses on the mountain slope at Tugtilik moss-moor with *Saxifraga stellaris* or *Deschampsia alpina* was found; besides, *Saxifraga aizoides* was common in this locality.

As to the vegetation near hot springs found in the course of the expedition see pp. 5 and 7.

One must regard as a special variety of moss-moors the moss-associations, which were found along the edges of melting snow-drifts, and which consequently bear a certain resemblance to the snow-patch associations. Such associations occurred in many localities, and were as a rule lacking in important phanerogams, but in a few localities they were found with a typical snow-patch phanerogam-vegetation (*Oxyria*, *Cerastium trigynum* Nos. 74 and 75). Farthest in towards the snow-drifts the moors at Cape Dalton (see above) belonged to this type.

2. Phanerogam-moors.

By this I understand a vegetation where the moss is overgrown by a more or less dense, but homogeneous vegetation of phanerogams (or vascular cryptogams). Under moos-moors I have already mentioned the *Ranunculetum affinis* found at Cape Daussey. In the fjord north of Cape Ravn *Equisetum arvense* (upright S-type) formed rather dense covers along small water-courses. KRUSE's distinction between "tuft-bogs" and "flat-bogs" was based upon the physiognomy of the moors, and cannot with full justice be said to divide the moors into two association groups; nevertheless, "tuft-bogs" very nearly correspond with my *Salicetum herbaceae muscosum*. An objection might, perhaps, be raised that confusion is created by all of these names, which mean a splitting up of the older plant-communities in Greenland, but it has been done because comparisons can best and most accurately be undertaken between associations or still smaller unities; one must first of all know the species, before it is possible to speak of families; in the study of the communities of plants in Greenland regard has hitherto only been had to "families". The two former associations correspond very nearly with THORE FRIES' "Niedermoorgebüsche", being "tuft-bogs" with a dense vegetation of Chamæphytes above the moss-tufts. Such vegetations are associated with the heath-series, inasmuch as it is only certain heath-associations which recur in this locality, but growing in very dense moss-tufts.

SALICETUM GLAUCAE MUSCOSUM.

Moss-tufts with a homogeneous vegetation of *Salix arctophila* × *glauca*, *Pedicularis lapponica* and *Polygonum viviparum*, in a few localities also with *Vaccinium uliginosum* var. *microphyllum*, at 400 m above sea-level in the interior of d'Aunay Bay, on a nearly level ground above a herb-field, as shown on fig. 26 B 1. *Pedicularis lapponica* was undoubtedly here a parasitic growth on the *Salix*-roots (fig. 1, plate 3), whereas HARTZ in the interior of Scoresby Sound found it closely associated with the roots of *Betula nana*. *Pedicularis lapponica* has not been found farther south on the east coast than here in d'Aunay Bay.

VACCINIETUM ULIGNOSI MUSCOSUM.

Moss-tufts (*Sphagnum plumulosum*, *Aulacomnium palustre*, *Aulacomnium turgidum*) with a dense vegetation of *Vaccinium uliginosum* var. *microphyllum*, *Carex rigida* and *Salix arctophila* × *glauca*; besides, but not quite so homogeneously or frequently, *Empetrum*, *Polygonum viviparum*, *Pedicularis hirsuta*, *Bryanthus coeruleus* and *Carex scirpoidea*. The lichens found in the moss were more particularly *Cetraria nivalis*, *Cladonia mitis* and *Cl. uncialis*. In the depressions between the tufts

(snow-cover of longer duration) *Cassiope hypnoides*, *Carex rigida*, *Salix herbacea* and *Polygonum viviparum*. The vegetation was found at 440 m above sea-level, in the inland east of Watkins Fjord on a southern slope with an inclination of 10°.

SALICETUM HERBACEAE MUSCOSUM.

Moss-tufts with a homogeneous vegetation of *Salix herbacea*, *Carex rigida* and *Polygonum viviparum*, or the very same dominants as in the typical *Salicetum herbaceae*. This association seemed rather common, and my observations are so numerous that I am also able to establish a couple of sociations under this association.

a. Rich in *Salix arctophila* × *glaucula* and *Vaccinium*.

Moss-tufts (*Sphagnum-Aulacomnium-Paludella*) with *Carex rigida*, *Salix herbacea* and *Polygonum*; then rather commonly *Salix arctophila* × *glaucula* and *Vaccinium uliginosum* v. *microphyllum*. Besides, *Empetrum Pedicularis flammea* and *P. hirsuta* occurred. Between the tufts *Equisetum arvense* var. *riculare* occurred (here without *Sphagnum*). As to the size and extent of the tufts, see HARMSSEN 1933, figs. 9 and 10, where also the complete list of mosses is to be found. The vegetation occurred on level ground, in the valley at Cape Daussy.

b. Rich in *Poa arctica* (No. 89).

Moss-tufts, very long and 20—35 cm in height, divided by elongated depressions, 0.5 m broad and 5—8 m long. The three usual dominants; but besides these *Poa arctica*, *Calamagrostis neglecta* are rather common. The vegetation occurred near the Angmagssalik Settlement and here constituted the marginal regions of the rather extensive moors between the flat ridges (fig. 22). The tuft vegetation on slightly drier ground merged into a meadow-like vegetation, with the same phanerogams, but entirely level. In Tugtilik the same sociation was found with *Poa arctica*; and here *Deschampsia alpina* occurred between the tufts. Fig. 1 on plate 5 shows the vegetation in Tugtilik.

c. Rich in *Empetrum*.

At Tugtilik and Angmagssalik, *Salix herbacea*, *Carex rigida* and *Empetrum* were observed as dominants; of common occurrence were also *Cassiope hypnoides* and *Polygonum*.

d. Rich in *Equisetum variegatum*.

Observed at Tugtilik; in one locality *Equisetum* dominated so entirely in the tufts that it became necessary to speak of an *Equisetum variegatum* association; see thus fig. 2, plate 5, where *Equisetum* grows over the entire tuft and only permits *Salix herbacea* to live between the tufts.

In drier regions, adjoining a *Caricetum rariflorae* in the very moist localities, MØLHOLM HANSEN found on Iceland a moor-vegetation: *Carex*

rigida (F-percentage 100), *Salix herbacea* (F-percentage 92), and *Polygonum viviparum* (F-percentage 96), but also with *Equisetum arvense*, *Salix glauca*, *Cardamine pratensis* and *Calamagrostis neglecta* as domi-

Table 32.

	G.	L.	89	90	91	92	93
SALIX HERBACEA	A ₂	Ch	100	100	36	16	..
CAREX RIGIDA	A ₂	G	100	4	24	..	20
CAREX RARIFLORA	A ₂	G	..	100	100	..	8
POLYGONUM VIVIPARUM	A ₂	G	88	100	28	8	4
POA ARCTICA	A ₂ (A ₁ ²)	G	80	..	..	..	..
CALAMAGROSTIS NEGLECTA	S	H	48	..	..	100	68
ERIOPHORUM SCHEUCHZERI	A ₂	HH	..	..	28	72	20
COMARUM PALUSTRE	S	HH	16	12	76	32	..
Empetrum nigrum v. hermaphrodit. .	A ₂	Ch	4	28	20	..	..
Vaccinium uliginosum v. microphyll. .	A ₂	Ch	..	8	8	..	..
Deschampsia alpina	S	H	..	..	..	..	56
Bartschia alpina	A ₂	H	4	..	..	..	..
Carex Lachenalii	A ₂	H	..	..	4	..	..
Cerastium alpinum	A ₂	Ch	4	..	..	..	..
Cerastium trigynum	A ₂	Ch	..	..	..	..	36
Euphrasia latifolia	A ₂	Th	..	8	..	..	..
Saxifraga stellaris	S	H	..	..	..	..	20
Sphagnum Girgensohnii			..	+	+	..	..
Sphagnum plumulosum			..	..	+	..	..
Sphagnum riparium			..	..	+	..	..
Calliergon stramineum			..	+	..	..	..
Cephalozia bicuspidata			..	+	..	..	..
Cynodontium strumiferum			..	+	..	..	..
Dicranum scoparium			..	..	+	..	..
Lophozia Kunzeana			..	..	+	..	..
Lophozia porphyrolacea			..	+	..	..	..
Paludella squarrosa			..	+	+	..	..
Polytrichum commune			..	+	+	..	..
Drepanocladus exannulatus			..	..	..	+	..

Spectrum: (Table 32).

No.	Lat. n.	Height in m above sea-level	Exposure	Inclination	Moisture	Ground	Number of species	Points sum	Density of species	Ch ^o / _o	H ^o / _o	G ^o / _o	HH ^o / _o	Th ^o / _o	A ₁ ^o / _o	A ₂ ^o / _o	S ^o / _o
89	65°37'	ca. 50	—	0°	4—5	moss	9	444	4.4	24	12	60	4	0	0	86	14
90	—	—	—	0°	5	—	8	360	3.6	38	0	57	3	2	0	97	3
91	—	100	—	0°	5	—	9	324	3.2	20	1	47	32	0	0	77	23
92	—	ca. 50	—	0°	5	—	5	228	2.3	7	44	3	46	0	0	42	58
93	—	—	—	0°	5	sand (mud)	8	232	2.3	15	62	14	9	0	0	38	62

nants (the latter was also a frequent dominant at Angmagssalik). Points sum, number of species and density of species is greater on Iceland, but the association is the same; at Angmagssalik it also merged into a *Caricetum rariflorae*. At Jotunheim H. RESVOLL-HOLMSEN found a moor with *Carex rigida* (F-percentage 100), *Polygonum viviparum* (F-percentage 100) and *Salix herbacea* (F-percentage 68), furthermore, with *Festuca ovina* as a dominant; in its upper part the moor merged into a grass-field rich in lichens, as I saw it at the Sparganium Pond near Angmagssalik. There is also some resemblance with the THORE FRIES' *Carex rigida* "Niedermoor". The association, on the other hand, is not mentioned by WARMING under the grass-moors of West Greenland.

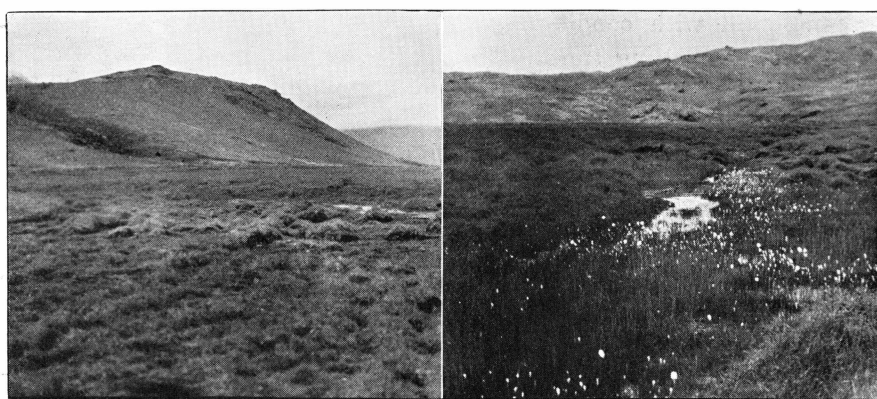


Fig. 22.

T. B. phot.

Fig. 23.

T. B. phot.

Fig. 22. View across the moor behind the Angmagssalik Settlement.

Fig. 23. *Calamagrostidetum neglectae* with *Eriophorum Scheuchzeri*. The moor behind the Angmagssalik Settlement.

Whereas the three associations mentioned in the preceding were connected with the heath series and were characterized by Ch and G, this is not the case with the associations occurring on still moister ground. There were in particular three associations which were found at Angmagssalik.

CARICETUM RARIFLORAE (Nos. 90 and 91).

No. 90: Moss-tufts about 10 cm in height, 80—150 cm in length, divided by depressions 25 cm broad. On the tufts grew *Carex rariflora*, *Polygonum* and *Salix herbacea*, between the tufts in the moss-sludge only *Carex rariflora*. The vegetation found in the part of the moor which was the second wettest, is depicted in fig. 22.

No. 91: The vegetation found as a marginal vegetation round the "Sparganium Pond" at Angmagssalik. In the moss the *Sphagnum* species dominated. The vegetation is rich in HH (the dominant *Comarum palustre*

and *Eriophorum Scheuchzeri*); furthermore, the spectrum shows the great predominance of the Geophytes and the complete retirement of the Hemicryptophytes.

Caricetum rariflorae, which occurred at Angmagssalik, greatly resembled the Icelandic *Carex rariflora* moor, and is mentioned by WARMING from West Greenland (BERGGREEN: Disko Bay). By its wealth of *Sphagnum* it has certain points of resemblance to high-moor, but must surely be classed with what OSVALD (1925) terms Niedermoores ("Seggenmoore"). OSVALD points out the connection between "Moortypus" and "Klimatypus"; any one coming from more northern parts of Greenland could have no doubt that this moor-type at Angmagssalik testified to the far more oceanic climate of that locality, seeing that the moors here, as contrasted with conditions in the north, were not necessarily associated with melting snow-drifts, but seemed to depend very largely upon the precipitation.

CALAMAGROSTIDETUM NEGLECTAE. (Nos. 92 and 93).

In the middle of the moor-tract at Angmagssalik, in the very moistest part where the water came out everywhere, there was a vegetation with *Calamagrostis* and *Eriophorum* (No. 92), very poor in species, but with a high HH and S-percentage (compare the "Floi"-vegetation on Iceland, MØLHOLM HANSEN). The vegetation is most clearly seen on fig. 23, and ceased where the water gathered as a faintly flowing waterway in the middle of the moor. No. 93 is a variety of this vegetation, which was found water-soaked on sand or mud ground somewhere in this moor-tract at Angmagssalik. Of common occurrence are here *Deschampsia alpina*, *Cerastium trigynum* and *Saxifraga stellaris*. The high H-percentage is due to *Calamagrostis neglecta*, but must in this place be taken with a reservation, as the buds are surely often hidden in the moss, thus making it a Geophyte like *Carex rariflora*.

The association is mentioned from Norway by NORDHAGEN (1928, pp. 337—338), but there belonging to "moosarme Wiesen".

ERIPHORETUM SCHEUCHZERI.

As the very outermost vegetation towards the open water there were often pure occurrences of *Eriophorum Scheuchzeri*. This association also occurred in small water-basins in the gneiss rocks in the interior of Kangerdlugssuak. In other places in Greenland *Eriophorum polystachyum*, as in the Alps, make part of this association (WARMING 1888, LUNDAGER 1912), but here at Angmagssalik only *E. Scheuchzeri* occurs. (As to the distribution of *Eriophorum polystachyum* see SEIDENFADEN 1933.)

CARICETUM GLAREOSAE.

This association, which belongs to RÜBEL's "Salzwasser-Emersiherbosa", is peculiar — at any rate at Angmagssalik — in that it practically only consists of dominating species, as a rule not more than three in number. It occurred at Angmagssalik near a protected sea-shore in the Tasiusak



T. B. phot.

Fig. 24. Strand-meadow at the Angmagssalik Settlement. To the right of the stick is seen a small hole with open water.

sea-bay. Fig. 24 shows this strand-meadow vegetation as seen from the outside. The letters indicate the various sociations from the outside and towards the interior: a: *Puccinellia phryganodes-Carex glareosa-Stellaria humifusa* sociation; b: *Carex glareosa-Stellaria humifusa* sociation; c: *Carex glareosa-Calamagrostis neglecta* sociation; d: marginal zone of e, with *Deschampsia alpina*; e: *Carex rigida-Salix herbacea-Polygonum* tuft-vegetation, rich in *Empetrum* (compare p. 101). All sociations were rich in

mosses, particularly with *Drepanocladus aduncus*, a and b being the most halophile sociations. See also fig. 26 K.

KRUUSE mentions a similar vegetation, *Caricetum subspathaceae*, from Angmagssalik (KRUUSE, p. 280); compare also DEVOLD and SCHOLANDER, pp. 155—157.

8. Vegetation of the Lakes.
(*Submersiherbosa*).

The investigation of the few lakes or ponds found by the expedition yielded very sparse results, there being no lake with a vegetation consisting of phanerogams. Only as far south as at Angmagssalik, in the many small lakes behind the settlement, phanerogam-associations occurred. The first lake which was found in the mountains behind Cape

Table 33.

<i>Sparganietum affinis</i>	G.	L.	94	Spectrum: 65°37' lat. N. 100 m above sea-level Depth of water: 25—50 cm HH% 100 S% 100 Density of species 1,92
SPARGANIUM AFFINE....	S	HH	100 ₃₋₄	
Callitriche hamulata (?).....	S	HH	52	
Hippuris vulgaris.....	S	HH	40 ₂₋₄	
DREPANOCLADUS ADUNCUS (f. pseudofluitans)....			100 ₁	

Barclay was still frozen over as late as the middle of July; at Cape Daussy the vegetation in the great fresh-water lagoon to the northwest of the cape only consisted of a few green algæ on the stones; farther south in the Kangerdlugssuak area the highest form of vegetation in the lakes east of the head of Watkins Fjord was an association of *Drepanocladus aduncus* f. *aquatica*, rich in algae and diatoms, and in a small water-hole in the rocks at the east coast of the main fjord there were only a few lichenized blue-green algae, as well as *Calliergon sarmentosum* var. *fontinaloides* on the stones. DEVOLD and SCHOLANDER mentions *Callitriche verna* (f.) from this locality.

SPARGANIETUM AFFINIS.

Table 33 (No. 94) shows an investigation of the vegetation in the "Sparganium Pond" in "Elvbakker" at Angmagssalik. *Sparganium* and *Drepanocladus aduncus* were found everywhere, whereas *Callitriche* and *Hippuris* were lacking in certain localities, but where they occurred, the distance between the shoots, as far as *Hippuris* was concerned, was very much the same in all cases, for which reason also the index is given for

this species, compare p. 21. It appears that the *Drepanocladus* individuals are very close to one another (index 4!).

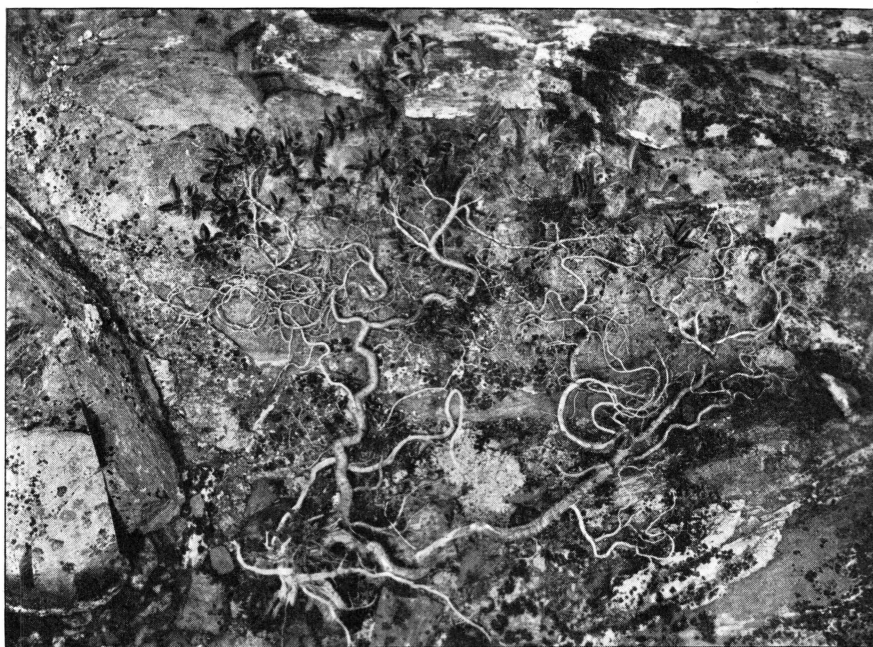
Sparganietum affinis is mentioned by WERNER LÜDI (1921) from the Lauterbrunnen valley: "Als erste wurzelnde Phanerogamen stellen sich submerse Wasserpflanzen ein, von denen in unsern Tümpeln nur *Sparganium affine*, ssp. *Borderi* und *Callitriche palustris* vorhanden sind. Ich möchte diese Entwicklungsstufe als *Sparganietum affinis* bezeichnen; sie wäre in grösserem Rahmen wohl zu dem *Potamogeton* zu stellen". Also from "Alpes du Briançonnais" PIERRE ALLORGE (1925) mentions *Sparganietum* as the "association d'hygrophytes vasculaires qui atteint, en Europe, les plus hautes altitudes". Besides *Sparganium*, *Potamogeton*, *Hippuris* and *Callitriche* play a part, and among the mosses mention is made of *Calliergon*- and *Drepanocladus*-species. The similarity with the association at Angmagssalik is great. Also in Denmark a *Sparganietum affinis* may occur, though rarely; thus, on a botanical excursion to the heaths of Jutland I found on the southern brink of a small lake (Hornum Lake) a fine example of this vegetation. (K. WIINSTEDET, Botanisk Tidsskrift Vol. 41, p. 420).

At Angmagssalik there were also other associations in the small lakes; in particular I observed a *Hippurietum vulgaris* (rich in *Callitriche*), an association which was also found by HARTZ at Scoresby Sound, by LUNDAGER near Danmarks Havn (LUNDAGER, fig. 6 p. 386).

Particularly interesting is the *Subularietum aquaticae*, described by KRUSE, from Angmagssalik; in one locality he found the bottom of a small shallow pond covered with *Subularia*; further, *Callitriche verna*, *Hippuris vulgaris*, *Juncus bulbosus*, *Alopecurus aristulatus*, *Sparganium affine*, *Ranunculus hyperboreus* and *Cardamine pratensis* (sterile), a quite unusual wealth of species.

The vegetation of the lakes is characterized by HH and S! (100 per cent in table 33). *Sparganietum* is characterized by "Eigentliche Schwimmblattkräuter", *Hippurietum* by "Luftblattkräuter" (LINKOLA 1933).

Concerning associations of cryptogams mention must finally be made of the associations of green algae which occur frequently on rocky walls, down which the water oozes, this type of vegetation being particularly well developed in the fjord north of Cape Ravn, and the lichen-moss flora occurring on stones and rocks. Only at Cape Barclay I found mosses which may be of importance in such a locality, viz. *Andreaea Blytii*; the lichen-associations found were more particularly *Gyrophoreta*, the latter (cf. LYNGE 1933) on basalt in the northern coastal area consisted of *Gyrophora cylindrica*, *Lecanora polytropa*, *L. gibbosa*, *Rhizo-*



Möhl Hansen phot.

Fig. 25. *Salix arctophila* × *glauca* entirely addressed to the rock. On the stones *Gyrophoretum*. East coast of Kangerdlugssuak, midway of fjord.

carpon geographicum, *Candelariella vitellina*, *Lecidea Dicksonii*, *L. fusco-atra*, *Verrucaria aethiolaula*, or on gneiss in the Kangerdlugssuak area (fig. 25) *Gyrophora cylindrica*, *G. erosa*, *Rhizocarpon geographicum*, *Lecanora polytropa* and *Lecidea* sp., and besides these *Stereocaulon denudatum*. On a peak in d'Aunay Bay on basalt were found: *Lecanora polytropa*, *L. perrachiata*, *L. melanophthalina*, *Biatorella coracina* and *Acarospora chlorophana*. *Usnea sulphurea* (a northern type) was found as far south as on the rocks at Cape Dalton.

With regard to the marine algal vegetation see p. 18.

CONDITIONS.

The chief factors determining the conditions of the associations have already been mentioned, partly in the descriptions of the associations and partly in the related spectra. Of the greatest importance to the vegetation of Greenland is the snow-covering, which clearly divides the vegetation into three groups. In these three groups the cover of snow is: 1) of an optimal duration (willow-copse, herb-field etc.), 2) of a maximal duration (snow-patch association), and 3) of a minimal duration

or without any snow at all (certain heath-associations, fell-field). The snow-covering is tantamount to a relatively high degree of heat in the vegetation in winter, and its duration is of the greatest importance, because the period of vegetation is dependent upon it. Willow-copse, *Alchemilleta*, herb-field and many heath-associations must have a long summer-season in order to exist. The actual length of the vegetation period is reflected in the mean summer-temperature, so that certain July isotherms become of importance by emphasizing the places, where the summer-season is just long enough for the development, for instance, of willow copses or birch-woods¹). This is about all that is shown by the mean temperatures with regard to the vegetation, seeing that the meteorological measurings have often taken place near the sea, perhaps at a distance from the actual vegetation here. I had the opportunity to undertake some comparisons between the temperature found ashore, where the plants grew, and the temperature which was measured at the same time on the vessel of the expedition, the "Søkongen", lying near land in the bay. In table 34 I put together the observations deriving from d'Aunay Bay (69°05'), the bay north of Cape Daussey (68°43'), the fjord north of Cape Ravn (68°31') and Miki's Fjord (68°10'); the measurings ashore were undertaken near the vessel, excepting those on 23 August, where the land temperature comes from the inland east of the head of Watkins Fjord, about 20 km from the vessel. When going over the table, one finds that the temperature is on an average 3—4° C

Table 34.

Date	Lat. N.	Height of barometer	weather		T. on vessel at 2 p.m.	T. ashore at 2 p.m.	T. in sun ashore	T. in sheltered vegetation	Height above sea-level of place of observation
			vessel	ashore					
15/7	69°05'	764	clear	clear	7°	12—13°	..	..	150
16/7	—	765	{ clear- foggy }	clear	..	12°	..	..	300
17/7	68°43'	760	foggy	{ foggy- overcast }	2,5°	3,5—7°	..	..	10
18/7	—	761	{ hazy- clear }	clear	5,5°	8°	..	..	25
19/7	—	757	{ foggy- clear }	clear	6,7°	8°	18°	..	250
20/7	—	759	overcast	clear	..	7—8°	..	..	20
26/7	68°31'	765	clear	clear	6,3°	9—11°	24°	18°	180
27/7	—	762	clear	clear	6,5°	12°	24°	14—19°	175
30/7	—	758	clear	clear	8,1°	13—15°	30°	17—18°	300
23/8	68°10'	758	clear	clear	4,4°	12°	..	15—18°	330

¹) T. B., 1933, pp. 38—41.

higher ashore, and in the latter case, where the observation took place inland, the difference is $7,6^{\circ}$. If the thermometer was thrust into the lower part of the vegetation, the temperature was often 18° . The highest temperature measured was 15° in the shade in open air, but far higher maxima will undoubtedly be reached in the more continental regions. It is necessary to say that the two first and the two last measurements were undertaken on the southern slopes of the mountains, as the conditions of heat are here particularly favourable for the vegetation. This is very much the case, when the mountain slope consists of terraces, as is common in basalt regions; here the strong radiation from the steep wall of the terraces causes the temperature to be particularly high farthest in on the terrace, and here the snow also melts first, which causes a particularly southern vegetation in the place. The height above sea-level is also of great importance to the temperature, seeing that the warm air in a valley (fjord) system rises; the cold air which comes in from the sea carries large masses of fog with it, which fill the valley and fjord, but do not reach the vegetation. In the fjord north of Cape Ravn I measured one day, at the end of July, a temperature of 12° in the shade, at 2 p.m. and at a height of 200 m, whereas the temperature on the same day and at the same hour was only 4° in a dense fog at the surface of the sea. In the spring when the fjord is covered with ice, conditions may possibly arise which remind one of those identified by LAUGE KOCH (1928) in the most northerly part of Greenland (Dragon Point), where the temperature at one time was $\div 1^{\circ}$ at the surface of the sea, whereas it was 9° at a height of 600 m and $4-5^{\circ}$ at a height of 1000 m. Such conditions would greatly help to lengthen the period of vegetation in the mountains. Owing to the currents of cold air, often very considerable, which may come down the sloping side, the situation of the mountain slope is in the night particularly favourable in relation to the valley, which may lead to the gathering of great quantities of cold air there. The difference between the bottom of the valley and the slope of the mountains was very well brought out in the distribution of the vegetation in the valley north of Cape Daussey; there was here a luxuriant heath on the mountain slope, frequently interspersed with a number of more southern species. On these southern slopes oases of heat appear, as expressed by RUDOLF GEIGER (1930): "Diese thermischen Verhältnisse finden häufig ihren Ausdruck in der Anordnung der Vegetation in horizontalen Zonen. Die frostempfindlichsten Gewächse kommen dabei in dieser warmen Hangzone vor; im Talgrund und höher oben können nur klimahärtere Pflanzenfamilien fortkommen. Ist der Hang auch nach Süden exponiert, so dass er auch bei Tage durch die Sonnenstrahlung besonders begünstigt ist, so entstehen inmitten eines rauheren Klimas Inseln mit viel wertvollerem Mikroklima". The very southern

character of the vegetation in the fjord north of Cape Ravn was due to just such a warmer microclimate high up on the south slope. It faced west-south-west, which may perhaps also play some part, seeing that the day-maximum of the earth temperature lies on the south-western, not on the southern slope of the mountain (GEIGER 1930); I also mention this, because I generally found slopes facing south-west more southern in character than those facing south-east.

As regards the conditions of moisture it seemed that the rain might keep away for the greater part of the summer in the northern section of the area; the vegetation was then in these localities entirely dependent on the snow-drifts, and for those on the slope on the existence of snow blown together, from which the water can ooze. As to vegetation with water dripping down upon it see *Alchemilletum* and No. 17. In this connection the terrace form of the mountains is important, since it causes every possible degree of moisture, so that one association replaces another all the way down the mountain, see fig. 26 E. When the terraces incline inwards, the water may become stagnant and bogs form; when they incline outwards, bogs become rare, and only occur where the water wells forth. At the end of August, in lat. 68°10', there was at one time a very heavy rainfall for six days; all the water-courses which had been nearly dried out, became rapid streams, and there were several new ones created; however, it was surprising to see how soon the conditions of moisture again became normal; the six rainy days were succeeded by a föhn-storm (13° heat), which melted the newly fallen snow on the tops of the mountains and dried out and stopped the water-courses, and in the end it left the vegetation about as dry or moist as before the rain-falls.

As to edaphic factors the attention is drawn to the difference between gneiss and basalt (see T. B., 1933, p. 28). Measurements of the degree of acidity were, unfortunately, not undertaken, and pending such measurements from Greenland, the reader is referred to the work of NORDHAGEN (1928). The lesser or higher degree of disintegration, as well as the size of the grains in the débris material on the terraces, plays a great part in the distribution of the associations.

THE DISTRIBUTION AND MERGING OF THE ASSOCIATIONS.

Fig. 26 shows a number of profiles, which are meant to illustrate where the associations are to be found, and the manner of their merging into one another; the profiles have all been drawn on the spot, but

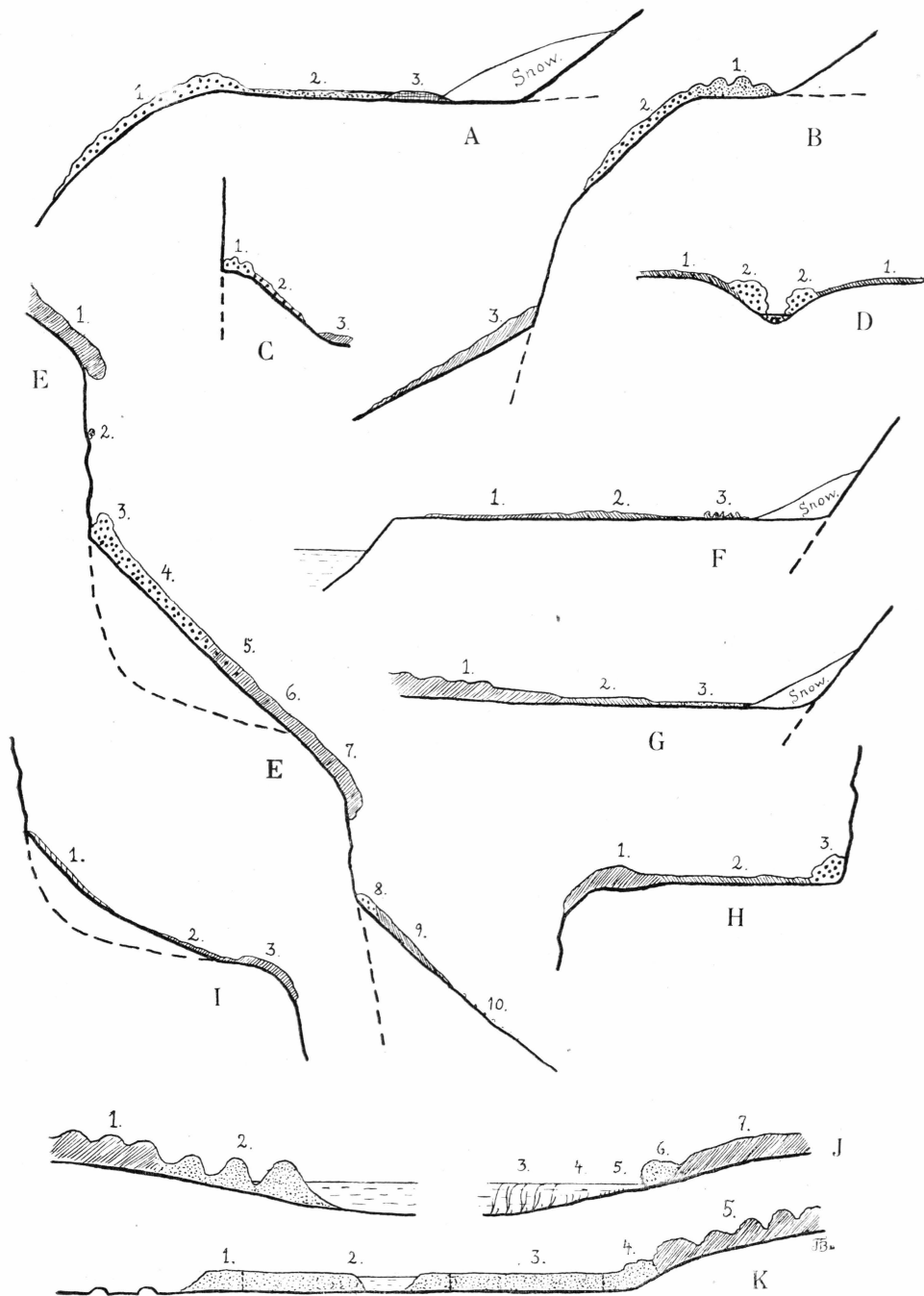


Fig. 26. (Explanation in text.)

make no pretence of being accurate map-sketches. Similar sketches are, for instance, made by SEIDENFADEN (1931), and from arctic Russia by TOLMATCHEW (1929, III, fig. 2 cf. my fig. 26A).

Fig. 26 A: Cape Dalton 200 m above sea-level. Southern slope.

1. *Taraxacetum crocei*, rich in *Salix herbacea*, No. 19.
2. Moss-moor either with *Saxifraga stellaris comosa* or *Ranunculus sulphureus*. The water stagnant.
3. Moving soil in front of snow-drift: *Phippsia algida* association.

B: Interior of d'Aunay Bay, 400 m above sea-level. Southern slope.

1. *Salicetum glaucae muscosum*, see p. 100 and plate 3, fig. 1.
2. *Taraxacetum crocei*, rich in *Potentilla Crantzii*. No. 20, see plate 2, fig. 1.
3. *Saliceto-Vaccinietum uliginosi*. Moist heath, rich in species. No. 36.

C: Skærgaard Peninsula, Kangerdlugssuak. 120 m above sea-level. Southern slope.

1. As contrasted with B. 3 and E. 3 there are here nearest the rock a dry vegetation, an association fragment of *Caricetum rigidae*. No. 30.
2. Like 1, but more scattered. The gravel crops out everywhere.
3. *Empetreto-Vaccinietum*, rich in *Juncus trifidus* and *Luzula spicata*.

D: At the Angmagssalik Settlement. 120 m above sea-level.

1. *Salicetum herbaceae*. Snow-patch.
2. Vegetation from the bank of a spring, physiognomically dominated by *Alchemilla glomerulans*. The snow melts quickly round the water-way. No. 22.

E: The fjord north of Cape Ravn. About 200 m above sea-level. Southern slope.

1. Moist *Empetreto-Vaccinietum*, dripping *Sphagnum cusheons*.
2. Rock-vegetation, see below p. 116.
3. Moist herb-field, characterized by water dripping from above, see No. 17. Here and there in this place *Scirpetum caespitosi*.
4. Typical herb-field. *Taraxacetum crocei*. Nos. 9 and 10.
5. Merging of *Taraxacetum* and *Empetreto-Vaccinietum*. Example: No. 45.
6. Moist, *Empetreto-Vaccinietum*, rich in species. No. 43.
7. The water which follows the upper side of the rock (dotted

line) here again comes right to the surface, which causes a strong intermixture into the heath from *Scirpetum caespitosi*, No. 44.

8. Farthest in, against the moist wall, where the snow first melts, a little herb-field-vegetation.
9. *Salicetum herbaceae*, rich in herbs. No. 29 a.
10. Débris-vegetation, No. 29 b.

F: Kangerdlugssuak. The east coast midway of fjord.

1. Farthest out towards the fjord fell-field with much *Salix herbacea* (gravel surface), No. 72.
2. *Salicetum herbaceae*, No. 73.
3. Snow-patch association, particularly mosses and *Oxyria*, very wet from the melting water. Nos. 74 and 75.

G: Cape Daussy. The valley, about 50 m above sea-level.

1. *Salicetum herbaceae muscosum*. See p. 101.
2. Level plain with *Salix arctophila* × *glauca*, *Salix herbacea*, *Carex rigida* and *Equisetum arvense* var. *rivulare*. Very rich in mosses; in drier places rich in lichens. (Snow-patch.)
3. Moss-moor (the melting water from the drift) (*Sphagnum-Calliergon-Drepanocladus*).

H: Behind the Skærgaard Peninsula, Kangerdlugssuak. Profile of the vegetation, fig. 19. Table 27. 3: farthest in towards the wall a fragment of a herb-field (fig. 8). 2: *Salicetum herbaceae*. 1: *Empetretum-Vaccinietum*.

I: Miki's Fjord. 40 m above sea-level. Western slope.

1. *Equisetum variegatum*, on gravel. No. 27.
2. Open dry heath with *Salix glauca*, *S. herbacea*, *Polygonum*, *Luzula confusa*, *Juncus trifidus* and *Stereocaulon*.
3. *Empetretum* with *Salix glauca* and *Vaccinium*.

J: Profile through the Sparganium Pond at Angmagssalik.

1. Lichen-heath, immigrated on former tuft-vegetation.
2. Moss-tufts with *Salix herbacea*, *Empetrum*, *Carex rigida* and *C. rariflora*, the latter only in the moor-slush between the tufts.
3. *Sparganietum affinis*. No. 94.
4. Association of *Callitriche* and *Drepanocladus*.
5. Owing to the ice in winter only small *Drepanocladus* individuals can grow on the stones.
6. Living *Sphagnum-Paludella*-plain, with *Caricetum rariflorae*, rich in *Comarum palustre*. No. 91.
7. Heath immigrated on the moss: *Salix herbacea*, *Carex*

rigida, *Empetrum*, *Loiseleuria*, *Cassiope hypnoides*, *Vaccinium*, *Lycopodium alpinum*, *Bryanthus coeruleus*.

K: Profile through the strand-meadow at Angmagssalik. See fig. 24. 1 corresponds with a in this figure; 2 with b; 3 with c; 4 with d and 5 with e.

Besides the profiles reproduced in fig. 26, I noted near the Angmagssalik Settlement a couple of places, where the moor-associations were distributed from the driest to the moistest ground. As already mentioned, the great moor, figs. 22, 23, is found here, with the associations investigated in Nos. 89, 90 and 92 (from driest to moistest).

Water-hole near the house of the rector.

1. Moss-tufts with *Salix herbacea* and *Carex rigida* (*Comarum* and *Deschampsia alpina*).
2. 4 m moss-slush with *Carex rariflora*.
3. 4 m moss-slush (*Drepanocladus exannulatus*) with *Calamagrostis neglecta*.
4. 1½ m moss-slush with *Eriophorum Scheuchzeri*.
5. Muddy ground with *Hippuris vulgaris* and *Callitriche verna*.

Small moor-tract to the east of the settlement.

1. Moss-tufts with *Carex rariflora*, *Salix herbaceae* and *Polygonum*. Compare No. 90.
2. 2—3 m moss-slush with *Carex rariflora* (a few specimens of *Salix herbacea*).
3. 4 m moss-slush with *Eriophorum Scheuchzeri*.
4. The small water-course without vegetation.

On fig. 26 herb-field and similar communities of a southern character are indicated by the same hatching (large dots). All of these localities are characterized by the possibility of a constant, great, but not too long snow-covering and, also, of the heat and light in summer (exposure and inclination), which occur in abundance. There is, however, a great difference between the position of the herb-field in A—B and in E; in the former case the water oozes down over the herb-field from the moor-association (small dots), situated above it and rich in mosses. Here the northern type of herb-field (table 10) was found, whereas the southern (table 8) almost exclusively occurred in a locality like the one indicated 4 in E. The water oozes down over the rock, heated by the sun, or drips down from ledge to ledge; as the water on the terrace follows the surface of the solid rock, it appears that the place, where the herb-field occurs, will be particularly favourably situated from the point of

view of draining. The merging of herb-field into heath farther out on the terrace may be conditioned partly by the poorer draining out there, partly by the fact that the snow-covering is of shorter duration, and in other localities by the drought, the water not appearing again until farthest out on the terrace. Where no water oozes down the rocky wall a more xerophilous vegetation forms, frequently bearing the character of *Caricetum rigidae*.

There is a great difference between the flora found on wet and that found on dry rocky walls. Those on the wet walls are frequently slimy with green algae, and in the moss *Saxifraga rivularis*, *Ranunculus glacialis* and *R. pygmaeus* occur, as also *Saxifraga cernua*, *S. oppositifolia* and *Sedum villosum*. On drier walls I noticed more particularly *Woodsia ilvensis*, *Cystopteris fragilis*, *Sedum annuum*, *Sedum roseum*, *Cerastium alpinum*, *Saxifraga aizoon*, *Campanula rotundifolia*, *Carex nardina* and *Luzula spicata*. The vegetation on the rocks is excellently described by KRUISE (1912) pp. 260—62. (The snow-cover rather sparse, with a fairly constant ice-cover and a highly heterothermic ground).

Alchemilleta and *Archangelietum* may frequently occur in localities corresponding with 3 and 4 in E, and also the willow-copses, at any rate those which were mentioned in table 3, occur in places corresponding with 4 in E.

The examples quoted are not to be taken as an exhaustive description of the distribution of the associations, and of the many stages of transition from the one type of vegetation to the other.

LIFE-FORMS IN THE COMMUNITIES.

In the preceding description of the communities I mentioned some of the chief biological features, seeing that each spectrum recorded the percentages of the RAUNKJÆR life-forms in each individual investigation; then, the type of geographical distribution (according to OSTENFELD) was indicated and treated, as also the RAUNKJÆR life-form, a similar method as was followed by MØLHOLM HANSEN in his studies on Iceland. The type of geographical distribution is, without a doubt, one of the most important biological characters of the plant, as it shows something of the manner in which the species physiologically reacts upon the conditions (MØLHOLM HANSEN). However, MØLHOLM HANSEN has based his types of distribution on the northern limits of the species in West Greenland; but a classification by northern limits in Greenland has proved less favourable for the purpose, seeing that, by this method, too widely

varying types of distribution were made to belong to the same group, and because the northern limits of the species were not always conditioned by the same factor. It is true, that it is most frequently the cold which conditions the northern limit, but this is not quite reliable, as the most northerly parts of Greenland have quite a different and drier continental climate as compared with the southern parts. In such a grouping the total distribution of the species will be a better criterion than the northern limits, and OSTENFELD's 3 types of distribution are, consequently, a step in the right direction, even though great alterations, as regards the limitation of the contents of species of the different types, are necessary before a satisfactory result can be arrived at. The point which it seems most important to elucidate is which species are continental-arctic. Roughly speaking, such a group constitutes an interesting biological unity, which can be compared with a life-form and may even be included under life-forms. It is difficult for the person, who has seen the distribution of the species in Greenland, to put e. g. *Carex rigida* and *Carex rupestris* in the same group, even though they have perhaps more or less the same northern limit. Physiologically, the ubiquitous *Carex rigida* hardly has much in common with the continental-arctic *Carex rupestris*. The fine result attained in Iceland was due to the fact that Iceland naturally lacks most of the continental species, for which reason the groups become rather homogeneous in their claims to heat. The classification of the Greenland types of distribution, which were given on p. 44 in T. B. (1933), is very nearly the same as that of OSTENFELD. His A₁-type rather corresponds with the continental-arctic type; the widely distributed A₂-type also ecologically seems a fairly homogeneous type, which is reflected in its exclusive predominance in certain associations; finally, there is the S-type representing a group, which is partly conditioned by its claim to heat, and partly by its oceanity, or both. The groups of MØLHOLM HANSEN are based upon the reaction to one and the same factor, viz. the temperature, and indicate one "chemical-physiological reaction", and the RAUNKIÆR life-forms indicate one morphological reaction; if regard was had to the total distribution types, the latter would show something in the line of the total physiological reaction, and if regard was had to as many morphological-anatomical reactions as possible, the result would be somewhat like the total morphological reaction to the conditions.

When in the following I am going to occupy myself with the life-forms in the communities, I will consequently follow the definition of WARMING: the structure of the entire shoot, its duration of life, the physiology of the plant etc. (WARMING 1895), at the same time contenting myself with the life-forms, which are of importance towards the characterization of the vegetation, and can be examined in a practical

manner, subjecting each type of life-form to a separate investigation in accordance with DU RIETZ (1931) pp. 42—45.

I. Bud-height life-forms (RAUNKJÆR 1907). To summarize the observations made in the preceding as to the distribution of these life-forms in communities, I may divide the communities into the following groups:

Nanophanerophyte-communities, with a sub-vegetation of Hemicyptophytes: the willow-copses (however, with the exception of certain heath-copses with a high Ch-percentage).

Chamæphyte-communities. These first and foremost include many associations of the heath-series; within the heath-associations the H-percentage may, however, be high in the moist, fertile *Empetretum-Vaccinietum*, and the G-percentage high in certain heaths of a snow-patch character. The Ch-communities, roughly speaking, also include the "fell-field", although the H-percentage here is surely very high; further, *Salicetum herbaceae* and *Alchemilletum alpinae*, where the H-percentage is also high. (*Salix herbacea* Ch $\gtrsim$ H, cf. RÜBEL 1930).

Hemicyptophyte-communities. These first of all include *Alchemilletum*, where 76 % H was reached; further, *Taraxacetum crocei*, which, however, now and then has a high Ch-percentage. In spite of the fact that the life-form of the principal species is G, *Caricetum rigidae* is a Hemicyptophyte-community, and the same holds good of the pure *Chamænerietum latifolii* on débris, as well as the other débris-associations. *Scirpetum caespitosi* likewise belongs here. But also within the snow-patches H-associations are to be found, e. g. the *Carex Lachenalii-Phippisia algida* association. And on the border-line between H- and Ch-communities stand *Sibbaldietum*, p. 82, and *Cerastietum trigyni*, which can only with reservation be termed a Ch-community, seeing that *Cerastium* is a passive Chamæphyte, its buds being concealed in the moss of the snow-patch. There are also fell-field associations belonging to this group (the *Papaver radicum* association).

Geophyte-communities. Owing to the frequent predominance of *Polygonum viviparum* and *Carex rigida* in *Salicetum herbaceae*, the G-percentage in this association often becomes very high, nay, may at times exceed the Ch-percentage. When the same species form a moss-tuft vegetation, the G-percentage is also highest. *Caricetum rariflorae* is another Geophyte-community.

Helophyte-communities. These include *Eriophoretum Scheuchzeri*, *Sparganietum affinis* and *Hippurietum vulgaris*.

The indications of life-forms relating to the species in the spectra only have regard to the life-form of the species in the individual investigation or investigations, as the life-form in the species frequently varies.

The most frequent variation is a vacillation between H and Ch. Thus, in willow-copse and *Alchemilletum*, I most frequently saw *Sibbaldia procumbens* as H, whereas in heaths and snow-patches it was Ch; *Potentilla Crantzii* I saw in heaths at Kangerdlugssuak as Ch, but perhaps in this case it may have been a special chamæphytic ecotype. The Therophytes occur rarely: *Sedum annuum* as a débris-plant, *Koenigia islandica* in No. 88.

II. Types of distribution. As under the former type of life-form there were two principal groups, the H-group and the Ch-group, so there are, when regard is had to the types of distribution, two groups, more particularly one group of communities with a high S-percentage and one with a high A_2 -percentage. In order to get an idea of what is meant by a high percentage, one must have a normal spectrum, viz. the percentage which the three types of distribution reach, when regard is had to the list of the flora in the area investigated. I here, naturally, choose the coast-stretch along which most of the investigations took place, the distance 68° — $68^\circ 44'$. Here there are (table I, T. B., 1933) 4 % A_1 , 65 % A_2 and 31 % S (from $68^\circ 48'$ — 70° there are 20 % A_1 , 70 % A_2 and 10 % S).

1. Communities with a S-percentage higher than 30. These first and foremost include the associations, which reach a S-percentage of 50 and even more: willow-copse at Angmagssalik, *Alchemilletum glomerulantis*, *Alchemilletum filicaulis*, *Caricetum rigidæ*, the pure *Scirpetum caespitosi*. With S-percentage between 30 and 50: willow-copse in Tugtilik, *Taraxacetum crocei*, which, however, rarely is lower than 30 % S. Finally *Alchemilletum alpinae*, *Calamagrostidetum neglectæ* and *Sparganietum affinis*.

2. Communities with a very high A_2 -percentage. To this belong *Salicetum herbaceæ*, with a rather constant 100 % A_2 ; then, roughly speaking, the heath-series and the fell-field. The fertile *Empetretum-Vaccinietum*, rich in species, however often show high S-percentages corresponding with high H-percentages.

3. Communities with a high A_1 -percentage. Such vegetations were only found in the more continental regions, but now and then they reached such high A_1 -percentages that they must be supposed to exceed the normal proportion of A_1 -types even there. To these belong the *Caspiopetum tetragonæ*, *Arnica*-association and *Ranunculetum affinis*. Further, certain arctic species bearing a continental character ought to be classed with them; these, however, consist of species which are still included in the A_2 -group, particularly the heath, which is greatly intermixed by an *Elynetum* or moss-tuft vegetation with *Salix* and *Pedicularis lapponica*. Where the high A_1 -percentage is due to the frequent occur-

rence of *Poa arctica*, it must be taken with reservation, as the whole question regarding the taxonomy and the geographical distribution of "*Poa pratensis*" in Greenland is not yet satisfactorily elucidated.

It appears that the two upper groups are rather closely associated, partly with the Hemicryptophyte-group (S-group), partly with the Chamæphyte-group (A_2 -group). Besides, the S-group includes the Helophyte-communities, the A_2 -group the Geophyte-communities.

III. Leaf-size life-forms. (RAUNKIÆR 1916). RAUNKIÆR first distinguishes between evergreen and deciduous plants, and then he proceeds to divide them into leaf-size groups. In Greenland the heath (with species such as *Empetrum* and *Cassiope*) is characterized by the evergreen leaf-type, whereas herb-field and similar communities are characterized by deciduous species. However, it is difficult in this case to say anything for certain, as the main species of the heath, *Vaccinium uliginosum*, is deciduous, and the species of the herb-field, e. g. *Taraxacum croceum*, *Potentilla Crantzii* and *Sibbaldia procumbens* winter under the snow in a green state (at any rate in the Alps, RÜBEL 1925). If, however, regard is merely had to the size of the leaf, a result is obtained which seems more easily surveyed; in this connection it would be interesting if — as is made probable by the observations of HAGERUP (1933) — there should be a small-leaved ecotype of *Vaccinium uliginosum* with a more northern distribution.

The relatively large-leaved communities are then: willow-copse, *Alchemilleta*, *Taraxacetum crocei* and *Sparganietum affinis*; or in other words all associations which are characterized by H, HH and S. The significance of the leaf-size is brought out very well when calculating the percentages of Leptophyllæ, Nanophyllæ and Microphyllæ and Mesophyllæ (RAUNKIÆR) in the two closely related associations, *Alchemilletum* and *Taraxacetum*. Table 35 shows the biological leaf-size spectrum for the individual investigations Nos. 7, 10 and 20. No. 7 is an *Alchemilletum glomerulantis*, No. 10 the typical *Taraxacetum* and No. 20 the northern variety of *Taraxacetum*. It appears that there is a great difference in the leaf-size, the Mesophyllæ reaching 18 % in No. 7, 0 % in No. 20, whereas the Leptophyllæ occur in 0 % in No. 7 and in 22 % in No. 20.

Table 35.

	Mes. %	Micr. %	Nan. %	Lept. %
Nr. 7. 68°10'. <i>Alchemilletum</i>	18	55	27	0
Nr. 10. 68°31'. <i>Taraxacetum</i>	6	28	48	18
Nr. 20. 69°05'. <i>Taraxacetum</i>	0	22	56	22

On the other hand, the snow-patch, the heath and the fell-field are a group of relatively small-leaved communities, characterized by Nanophyllæ and Leptophyllæ. *Caricetum rigidæ* approaches most nearly a small-leaved association, but at the same time it contains a dominating species, which is microphyle, viz. *Chamænerium angustifolium*.

All in all, it may be said that the communities which are characterized by Hemicryptophytes and southern species are also relatively large-leaved, whereas the xerophile *Caricetum rigidæ* is rather small-leaved.

IV. Main life-forms (cf. DU RIETZ 1931). "Types based upon the general physiognomy of the plants". The willow-copses should be characterized by "tall dwarf-shrubs" with a sub-vegetation of low herbaceous plants, *Alchemilletum* by "medium herbaceous plants", *Taraxacetum* by "low herbaceous plants", the heaths by "low dwarf shrubs", and the snow-patches by "very low dwarf-shrubs" as well as "low herbaceous plants". Also RÜBEL applies a physiognomic life-form system, parallel with the RAUNKIÆR system; it is the system upon which he has based his division of the communities, and it is the system which I have used for the division of the material in this article.

V. Growth-forms. (Life-forms based upon shoot-architecture, WARMING, DU RIETZ). In this place I can only record a few features of importance. If we look upon the overground parts, it is clearly a heather-type (*Vaccinium*), a "woody cushion-plant"-type etc., corresponding with heath and fell-field, but also within the herb-communities the grass-type may at any rate be set apart as a special life-form, as is also done by WARMING (1918). In Greenland there were clearly certain associations which were characterized by the grass-type, as contrasted with the herb-type. (As to this see the mention of *Caricetum rigidæ*, where in the spectrum I have also calculated the percentage of the shoots of the Monocotyledons (Gramineae, Cyperaceae and Juncaceae)). H. RESVOLL-HOLMSEN also says that the grass-field is determined by the life-form: grass. WARMING mentions three other types, long-shoot-type, rosette-shoot-type and semi-rosette-shoot-type, which are more difficult to find as being characteristic of the communities in question. The long-shoot-type should be a more southerly type (e. g. *Chamænerium angustifolium*) than the semi-rosette-type (e. g. *Alchemilla vulgaris*).

When we look upon the underground parts, conditions become more distinct. The heath is here characterized by the type, which occurs in DU RIETZ's semi-sedentary (creeping) dwarf-shrubs. DU RIETZ describes it in this manner: "An old trunk of *Calluna* usually consists of an ascending terminal crown and a rather long horizontal, simple or

more or less branched part, running as a secondary plagiogeocorm in the upper layers of the soil and in the moss- or lichen-layer, and developing abundant adventitious roots". To this type belong *Cassiope tetragona*, *Bryanthus coeruleus*, *Loiseleuria procumbens* and *Salix arctophila* $\times$ *glauca*, and also *Vaccinium uliginosum*, its offshoots being of less importance. *Empetrum* and *Cassiope hypnoides* in all probability also belong here, although they are in other respects "true creeping dwarf-shrubs", whereas the woody cushion-plant, *Diapensia*, with its tap-root does not resemble this type.

In the sub-vegetation of the willow-copses and the herb-field quite different underground shoot-types occur. Here there is an abundance more particularly of species with a multicapal root (*radix multiceps*), the rhizod-plants (WARMING 1918), the off-shoot plants (with suboles) and, finally, *Polygonum viviparum*'s stem-tubers ("Stängelknolde", cf. RAUNKJÆR 1907, fig. 50). The rhizomes (underground shoots with short internodes, and rich in nutritive matter and therefore thick) on the other hand belong to the *Altherbosa*, seeing that this vegetation is constituted of *Alchemilla glomerulans* and *Sedum roseum* (as to this see pp. 31—32 and figs. 6 and 7).

VI. Bud-type life-forms (life-forms based entirely upon the structure of the buds perduring the most unfavourable seasons). The type is established by DU RIETZ and mentioned by WARMING (1908), and RAUNKJÆR uses the covering of the bud in the division of the Phanerophytes. In Greenland there are "naked", "open" buds in a great number of herb-field species, these plants being constantly covered with snow; others have distinctly protected buds. The two Hemicyptophytes, viz. *Alchemilla glomerulans* and *Chamaenerium latifolium*, clearly show this difference. On 31 August I investigated in Miki's Fjord what was the condition of both of those species as regards buds, and both were quite ready to face the winter; on fig. 27 are seen: in A *Alchemilla glomerulans* with the naked bud merely surrounded by the rosette-leaves, dating from this season; in B *Chamaenerium latifolium* with four buds protected by firm, white bud-scales. This further emphasizes the difference between these two Hemicyptophytes, which are already distinguished by the type of geographical distribution, the size of leaves and structure of the plant (*Alchemilla* is a semi-rosette plant, whereas *Chamaenerium* is a long-shoot plant). This is an example of the necessity of applying other life-form systems parallel with that of RAUNKJÆR for the characterization of plant-communities; it also shows that *Altherbosa* is only an ecological type, if at the same time it shows a series of other life-forms; thus, it is undoubtedly necessary, if *Altherbosa* is to be regarded as anything but a morphological type, that it should also be a S-type. This difference

in the buds of the two species is, for that matter, very well expressed by the last system, mentioned by DU RIETZ (Periodicity life-forms) and worked out in detail by LINKOLA; according to this *Chamænerium* should be a "Knospenüberwinterner", whereas *Alchemilla* should be a "Rosettenüberwinterner".

A factor which is very conspicuous in a country like Greenland is the duration of the vegetation period (cf. VAHL 1919 pp. 39—41). The species which flower earliest in the year are best qualified for the

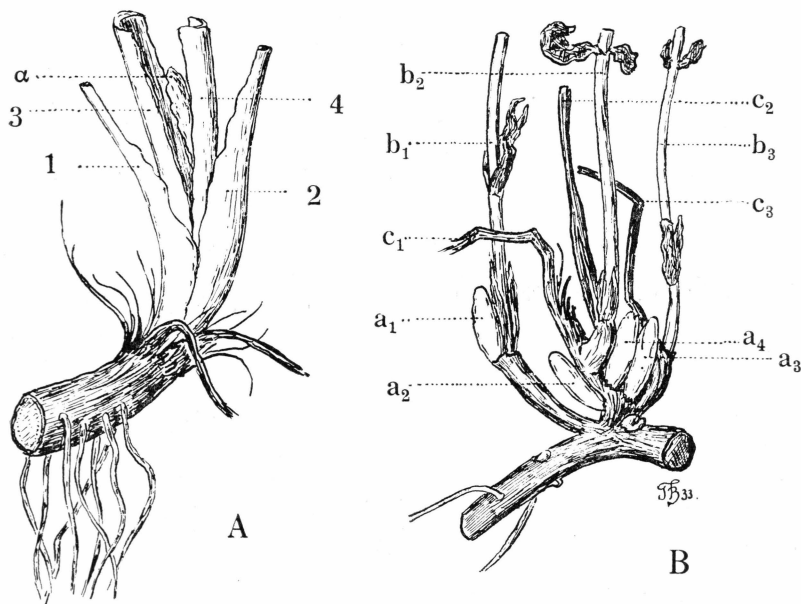


Fig. 27. A: *Alchemilla glomerulans* 1—4 lower parts of this year's rosette-leaves, which enclose the shoots of next year α . B: *Chamænerium latifolium*, a_1 — a_4 : the protected buds, next year's shoots; b_1 — b_3 : this year's shoots; c_1 — c_3 : the dead remains of last year's shoots.

most inclement regions with a short vegetation period, whereas the species which flower late in the year, only can complete maturing of fruits, if conditions are more southerly with a longer vegetation period. The flowering season then expresses a life-form, which seems to correspond with the type of distribution of the plant¹⁾. In table 36 I have given an account of the flowering season of some important herb-field or heath-plants, based upon the observations made in 1932. As an indication of the condition of the plant on the individual date I give

¹⁾ In this connection I may mention the interesting facts, which Professor Dr. J. CLAUSEN told me in the spring of 1933 that *Potentilla glandulosa* in California occurs in a high-alpine, constantly early-flowering, as well as a subalpine, constantly lateflowering ecotype, cf. CLAUSEN, KECK and HEUSI (1932).

the abbreviations used by BR.-BL. 1928, viz. kn. Knospenzustand (here used of the flower), fl. blühend and fr. fruchtend.

Table 36.

Species	10/7	20/7	30/7	10/8	20/8	30/8	10/9	G
<i>Polygonum viviparum</i>	fl	fl-(fr)	fl-(fr)	(fr)	(fr)	(fr)	(fr)	A ₂
<i>Carex rigida</i>	fl	fl	fl-fr	fl-fr	fl-fr	fr	fr	A ₂
<i>Taraxacum croceum</i>	fl	fl	fl-fr	(fl)-fr	fr	fr	fr	S
<i>Potentilla Crantzii</i>	fl	fl-(fr)	fl-fr	fl-fr	fr	fr	fr	S
<i>Sibbaldia procumbens</i>	fl	fl-fr	(fl)fr	fr	fr	fr	fr	A ₂
<i>Alchemilla vulgaris</i> (3 species)	..	kn-fl	fl	fl	fl-fr	fl-fr	fr	S
<i>Hieracium alpinum</i>	kn	kn(fl)	fl	fl	fl(fr)	fl-fr	(fl)fr	S
<i>Campanula rotundifolia</i>	kn	kn(fl)	kn(fl)	fl	fl	fl	fl-fr	S
<i>Pirola minor</i>	..	..	kn(fl)	fl	fl	fl-fr	fr	S
<i>Chamaenerium angustifolium</i> .	..	..	..	..	..	..	kn-fl	S
<i>Cassiope tetragona</i>	fl	fl-fr	fr	fr	fr	fr	fr	A ₁
<i>Bryanthus coeruleus</i>	fl	fl	fl-fr	fl-fr	fr	fr	fr	A ₂
<i>Vaccinium uliginosum</i>	fl	fl-fr	fr	fr	fr	fr	fr	A ₂
<i>Papaver radicatum</i>	fl-fr	fl-fr	fr	fr	..	..	..	A ₂ (?)
<i>Silene acaulis</i>	fl	fl-fr	(fl)fr	(fl)fr	fr	fr	fr	A ₂

The examples given in table 36 are sufficient to show that the flowering season of the species is in complete agreement with its geographical type. The two S-species, *Taraxacum croceum* and *Potentilla Crantzii*, extend somewhat farther north than the five other S-species mentioned, and this agrees with the fact that their flowering season falls somewhat earlier. The extremes are species like *Papaver radicatum* and *Chamaenerium angustifolium*; however, it proved (after an examination undertaken by HARMSÉN) that the buds found on *Chamaenerium* about 10 September in Angmagssalik were sterile. In conformity with the different flowering period, it will surely be possible in Greenland to distinguish types with reduction division in the autumn (e. g. *Papaver*?) and types with reduction division in the spring (*Vaccinium uliginosum*, HAGERUP 1933), and types with this division in midsummer. That it is here really a question of biological differences, is i. a. made probable by my investigation of the conditions of Danish *Ranunculaceae* (BÖCHER, 1932). Early forest-floor plants such as *Anemone nemorosa*, *A. ranunculoides*, *A. hepatica* and *Eranthis hiemalis* (but not *Ficaria verna*) have their reduction division in the autumn, whereas *Pulsatilla verna*, *P. vulgaris*, *P. pratensis* and *Ranunculus acer*, which all flower early and are all field plants, have it shortly before the flowering. The short assimilation period of the species mentioned first perhaps conditions the fact that the autumn is used for the reduction division, and the same might be supposed to apply to many high-arctic species.

In the associations which consist of several layers (tables 3, 4, 5 and 6) I have indicated, whether the species formed the upper or a lower layer of leaves, thus making an attempt to distinguish types with different CO₂-assimilation conditions (see e. g. *Pirola minor* in No. 7 p. 30). Best of all it would be to undertake ecological-physiological experiments, which would supply information as to "physiological life-forms" within the communities, compare BOYSEN JENSEN's "Lichtpflanzen" (a. *Sinapis*-typus, b. *Cucumis*-typus) and "Schattenpflanzen" (e. g. *Oxalis*, *Marchantia*). BOYSEN JENSEN 1932, see further LUNDEGÅRDH 1930.

The summarizing of the life-forms of the communities has made it clear that it is possible to form a more accurate idea of the suitability of the plants for their habitats by making use of several life-form systems parallelly; but on the other hand, it was seen that the systems, as it were, varied parallelly within the series of communities and, as the result of this, certain systems which are particularly practical in use, for instance, the RAUNKJÆR-system, cannot, when applied alone be said to express only one single important biological character. In the Greenland *Alchemilletum glomerulantis* we have thus a H-community, but at the same time it is a S-community, a large-leaved mesophyte community, an *Altherbosa*-community, a community characterized by rhizomes, by uncovered buds in winter, and by species with a late flowering period. *Cassiopetum tetragonae*, the other extreme, is a Ch-community of high Ch, but at the same time a A₁-community, a small-leaved community, a xerophyte-community, a community characterized by low dwarf-shrubs, of the shoot-type of the *Calluna*-type both over- and underground, and composed of species, the flowering of which falls early in the year. In this respect the flora of southern parts is hardly so paradigmatic as that of Greenland.

THE GEOGRAPHICAL DISTRIBUTION OF THE ASSOCIATIONS.

In table III in T. B., 1933, p. 34 the distribution of some of the most important associations along the coast investigated were discussed, and it proved that a number of associations ceased near the floristic boundary, which was identified near Store Glacier. Of the associations mentioned in the preceding as ceasing at this boundary, the southern ones were: the willow-copses, the three *Alchemilleta*, the southern type of *Taraxacetum crocei*, *Empetreto-Vaccinietum*, *Scirpetum cæspitosi*, while the northern ones were: *Cassiopetum tetragonae* and some fell-field-asso-

ciations. In Angmagssalik *Caricetum rigidae*, *Caricetum rariflorae*, *Sparganietum affinis* occur, the former, however, also as a fragment farther north.

Wherever possible, an attempt has been made in the preceding to compare the Greenland associations with the Scandinavian ones; unfortunately, the Canadian communities of plants do not seem to have been subjected to such thorough investigations that a real comparison can be undertaken, for which reason the fixing of the geographical position of the associations must be put off. Nevertheless, certain associations can, with some degree of certainty, be said to be eastern, i. e. Scandinavian, others western, e. g. *Chamænerietum latifolii*. It is in particular species of *Rosales* and *Ranales* which may be said to be eastern and to have immigrated from the east. In the first place, all the *Alchemilla*-species seem eastern, their distribution on the east coast being far greater than on the west coast; *Sedum annuum* and *Sedum roseum* being both associated with them; *Ranunculus glacialis* has only been found on the east coast, and *R. acer* may be imagined to have immigrated from the east. The distribution of *Archangelica*, *Hieracium alpinum* and *Carex atrata* also points towards their having come from the east. But why should not species with a circumpolar distribution have come from the east in far greater numbers than OSTENFELD thought possible?

It is characteristic that most of these eastern types occurred in such a manner that they constituted associations or important parts of associations, and this on Blosseville's Coast, the very coast which is closest to Iceland. This suggested to me the advisability of renewing the discussion of the possibilities of an immigration to Greenland from Europe, *via* the Faroes and Iceland (cf. the WARMING-NATHORST controversy on this subject). If the supposition is true that Greenland moves towards west, and the theory of WEGENER proves correct, Greenland should, at the beginning of the glacial period, have been much nearer Scandinavia. The Pole then lay to the west of Greenland, and consequently the conditions for a plant-life must have been much poorer on the west than on the east coast. One may then imagine that the mountains of Scandinavia and East Greenland at that time had a common nival flora. This is very largely borne out by the distribution of *Ranunculus glacialis* and by the fact that fell-field associations and snow-patch associations in Scandinavia and East Greenland have many more features in common than the associations, within both areas, which bear a more southern character (see p. 93). In a later period Greenland should then have moved westwards. At the beginning of the post-glacial period one may imagine an immigration to have taken place to East Greenland along the route the Faroes-Iceland to Blosseville's Coast, that is, the basalt area from the tertiary period, which must then have been divided by straits, far

narrower than Danmark Strait or the water between Iceland and the Faroes, the position of Greenland being more easterly than it is at present; and further that the Faroes probably covered a greater area than they do now. In this manner it becomes very probable that the *Alchemilla* and the other species mentioned above, together with a number of others (SEIDENFADEN (1933) mentions *Athyrium alpestre* and *Listera cordata*), at this time immigrated to Greenland along this route.

I draw attention to this route of immigration, because it may possibly become of importance for the understanding of the immigration of that part of the vegetation of South Greenland, which according to PORSILD's latest investigations cannot have been carried there during the time of the Norse settlement (PORSILD, 1932). The whole thing will be more easily understood when reckoning with an immigration in the post-glacial warm period. The distribution of the eastern type *Carex rufina* suggests that, in former times, it has been very commonly distributed from Scandinavia *via* Iceland-East Greenland to West Greenland, whereas later on it has become rare on Iceland and in East Greenland. The occurrence of a number of southern species along the inner parts of Scoresby Sound, which then only recur farther south on the coast ($68^{\circ}31'$), also suggest a wider distribution during the post-glacial warm period (see pp. 11—12 in T. B. 1933).

Finally, there is the question of an immigration across a land-connection; most interesting is in this respect a species of beetle, *viz.* *Otiorhynchus arcticus* which cannot fly and which has hitherto been supposed to have been carried to South Greenland at the time of the Norsemen, but which was taken this summer by M. DEGERBØL on Blossville's Coast in the very basalt area facing Iceland; perhaps it should have been able to exist during the glacial period(?)

In phytogeography the number of species surviving the glacial period in Greenland is still an open question; WARMING gives a high figure, OSTENFELD a lower one. I will not profess any definite opinion, but only in this connection call to mind the excellent conditions which at the present time may prevail on the mountains projecting above the ice as nunataks; here we may find a climate which conditions a very high percentage of southern species and a vegetation entirely characterized by southern associations, as was the case in the fjord north of Cape Ravn. A microclimate of this kind may also have occurred during the glacial period on the nunataks facing south, and the number of species which were able to live there was undoubtedly rather considerable; the same opinion was held by SEIDENFADEN (1933, p. 108). There were several southern species which in the fjord north of Cape Ravn only occurred on the ice-enclosed mountain, at the head of the fjord; the free development of life is consequently not made essentially more

difficult by the nearness of the ice. Perhaps it is not correct to speak of "nunataks", when the mountain is only situated at a short distance from the fjord, the area in question being similar in character to the localities, which LYNGE (1932, a) terms sun hills ("Solbakker") and mentions as localities where the flora might presumably best have been able to exist during the glacial period.

The facts mentioned above may possibly become of importance in view of subsequent phytogeographical investigations in Greenland. The vegetation there is first and foremost Greenlandic, inasmuch as Greenland has a number of specifically Greenlandic associations, and whether they have an eastern or a western character, they are distinctly Greenlandic by their poverty of species, for instance, in comparison with the Scandinavian associations. An exhaustive investigation of the flora of Greenland, as compared with that of the Scandinavian countries and Canada, will perhaps substantiate WEGENER's theory, which has proved of such valuable assistance to the understanding of the distribution of plants (see in particular IRMSCHER 1922 and 1929, KÖPPEN-WEGENER, 1924 and WALTER 1927).

Dr. BERNT LYNGE, Oslo, has determined the lichens, and cand. mag. LOUIS HARMSSEN, Copenhagen, the mosses mentioned in this article. I am greatly indebted to them both for their kindness in undertaking, with such expediency, a task, the accomplishment of which was essential to the preparation of this article.

Further, I owe a great debt of gratitude to Professor KNUD JESSEN, Dr.sc., and KAI GRAM, M.sc. for valuable advice and guidance in the actual work and the preliminary studies for the same.

And last not least, I should like once more to thank Captain EJNAR MIKKELSEN, who with unfailing kindness and understanding has made it possible for me to exploit to the fullest extent the opportunity given me as a member of the expedition.

Copenhagen, Autumn 1933.

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PLATES

Plate 1.

- Fig. 1. *Alchemilletum glomerulantis*, the fjord north of Cape Ravn, 68°31', July 23 (1932). About the middle of the picture to the right two deflorate stalks of *Taraxacum croceum* are seen to project among the *Alchemilla*-leaves. (T. B. phot.)
- Fig. 2. *Alchemilletum alpinae*, the fjord north of Cape Ravn, 68°31', July 23. At the bottom twigs of *Salix arctophila* × *glauca*, and to the left a specimen of *Cystopteris fragilis*. (T. B. phot.)



Fig. 1.

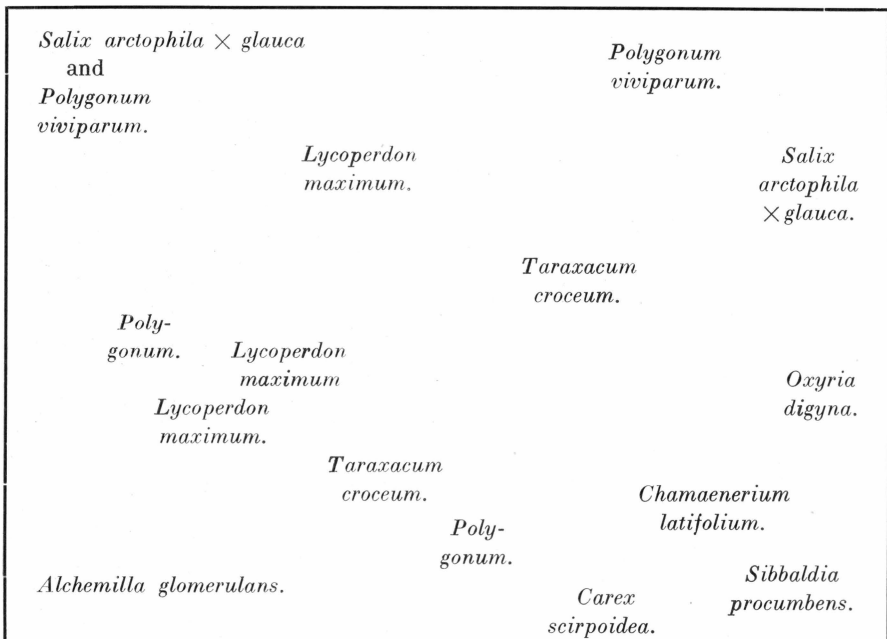


Fig. 2.

Plate 2.

Fig. 1. Herb-field at the head of d'Aunay Bay, 69°05', July 16. The dominants *Taraxacum croceum* and *Potentilla Crantzii* characterize the vegetation with their yellow flowers (*). In the foreground *Salix*-heath. (MØHL HANSEN phot.)

Fig. 2. A short-range photograph of herb-field (transition-form to debris vegetation) in the fjord north of Cape Ravn. 68°31', July 25. (MØHL HANSEN phot.)



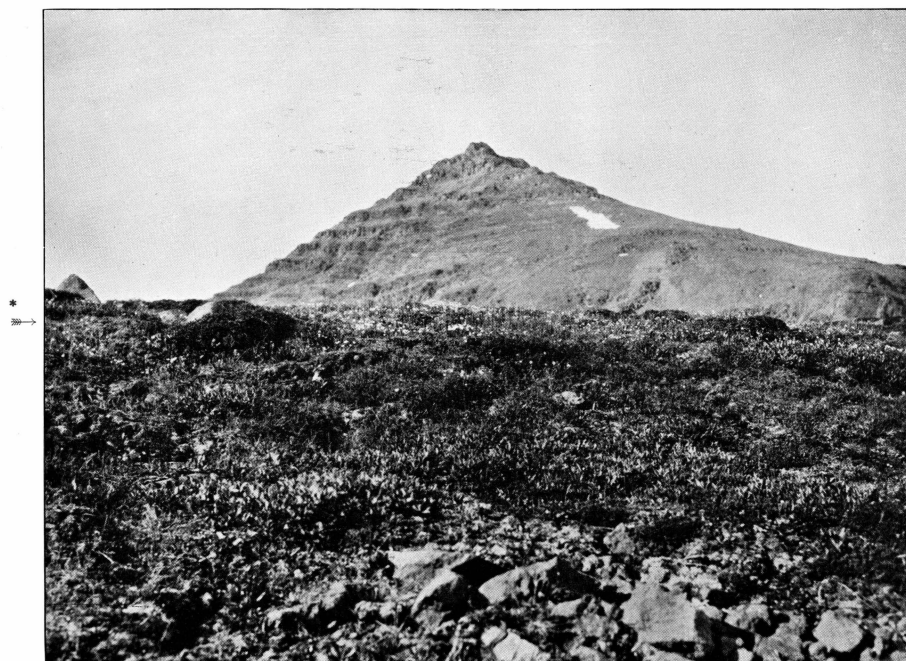


Fig. 1.



Fig. 2.

Plate 3.

- Fig. 1. *Salix glauca*-*Polygonum viviparum*-*Pedicularis lapponica*-association, growing in moss-tufts. The interior of d'Aunay Bay, 69°05', July 16. (T. B. phot.)
- Fig. 2. *Viscaria alpina*. Cape Daussey, 68°43'. July 18. To the right of the rosette-leaves, leaves of *Luzula* (probably *L. confusa*) and *Stereocaulon* visible among the stones. (T. B. phot.)



Fig. 1.



Fig. 2.

Plate 4.

- Fig. 1. Polygons due to drying out (diagonal 40—60 cm). Level clay-plain in the valley north of Cape Daussy, $68^{\circ}43'$. The vegetation consists of moss with *Equisetum arvense* var. *rivulare*, compare table 31. Specimens of *Salix arctica* $\times$ *arctophila* $\times$ *glauca*, adpressed to the ground. (T. B. phot.)
- Fig. 2. *Cerastium trigynum* and *Oxyria digyna* in snow-patch in Miki's Fjord, $68^{\circ}10'$, compare No. 69. August 5. (T. B. phot.)

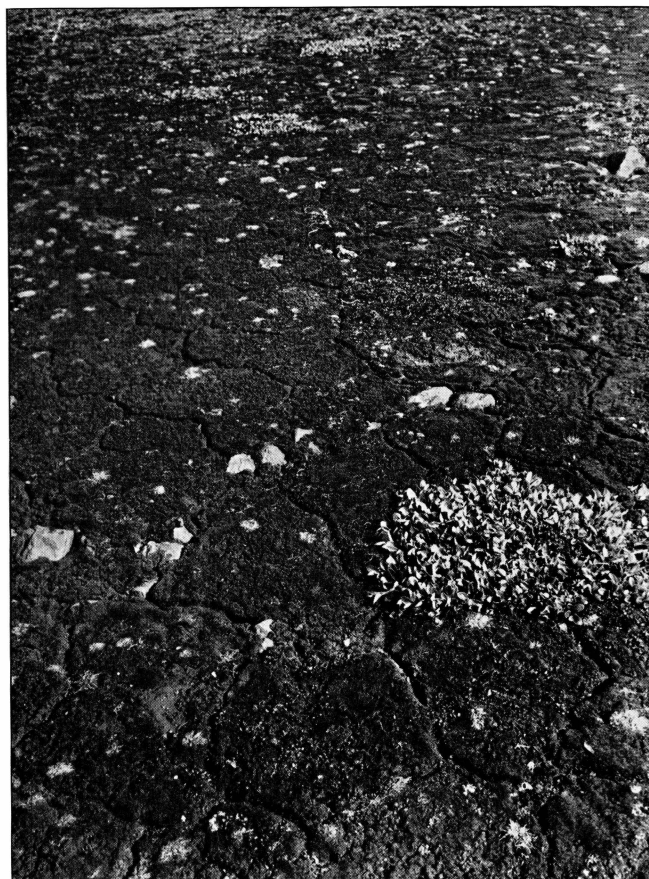


Fig. 1.



Fig. 2.

Plate 5.

- Fig. 1. *Salix herbacea*-*Carex rigida*-*Polygonum viviparum*-association in moss-tufts. Between the lake and the fjord, Tugtilik, 66°20'. (T. B. phot.)
- Fig. 2. Tuft of *Equisetum variegatum*, at bottom to the right *Salix herbacea*. The mountains at the lake, Tugtilik, 66°20'. (T. B. phot.)

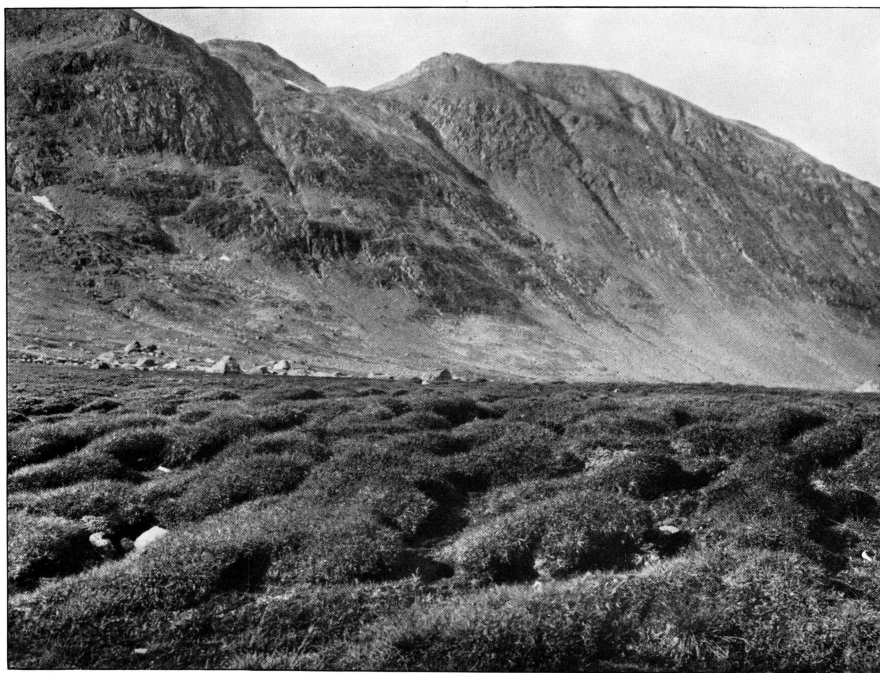


Fig. 1.

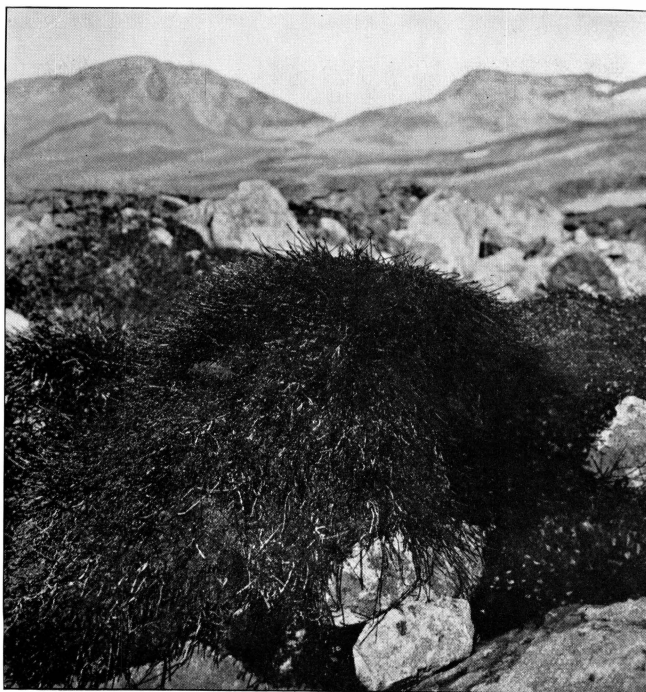


Fig. 2.

