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VEGETATION OF THE ANGMAGSSALIK DISTRICT SOUTHEAST GREENLAND

II. HERB AND SNOW-BED VEGETATION

BY

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WITH 68 FIGURES AND 32 TABLES
IN THE TEXT

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Abstract

The present study deals with the major part of the results of observations made during expeditions in 1968 and 1969 to the central part of the Southeast coast of Greenland.

The Angmagssalik District is a mountainous area deeply cut by fjords, and has a pronounced oceanic, low-arctic climate. The bedrock consists predominantly of Precambrian rocks. Soils are diverse and variable, shallow and of limited extent. Vegetation is of limited extent too and frequently acidophytic and more or less mesotrafent.

The herb and snow-bed communities are distinguished and classified according to the principles of the Zürich-Montpellier school of phytosociology as modified by Norwegian investigators. Altogether 15 sociations grouped in 5 complexes, 8 communities, and 38 associations (18 new ones), with 24 subassociations (all new) and a number of variants, classified in 16 alliances (2 new) with 3 suballiances (2 new), 13 orders (1 new) and 10 classes are recorded, described and discussed. The occurrence and composition of these communities appear to depend on a complex of interdependent conditions. Literature study shows that the majority have a wide, northern alpine to arctic, northern amphi-atlantic distribution.

Aquatic and amphibious vegetation (*Charetea*, *Potametae* and *Littorelletea*) is scarce as suitable habitats are rare. Spring vegetation (*Montio-Cardaminetea*) is common, but of limited extent and dominated by bryophytes. Both acidophytic as well as basiphytic communities occur.

Mires are varying in size, minerotrophic and found to represent the eutrafent to mesotrafent *Parvocaricetea* and a group of units intermediate between this syntaxon and the oligotrafent *Scheuchzerietea*. The more or less calciphytic *Tofieldietalia* is represented by communities grouped in the *Caricion bicolori-atrofuscae* and the *Campylio-Tomenthypnion*. Non-calciphytic, acidophytic to neutrophytic mire communities are represented by the *Caricion curto-nigrae* (*Caricetalia nigrae*). Three sociation complexes of *Sphagnum*-rich mire vegetation are considered to be intermediate.

The extreme chionophytic units of the *Salicetea herbaceae* are found to occur in somewhat unstable soil. The oligotrafent ones and the mesotrafent to eutrafent, less extreme chionophytic vegetation are grouped in separate alliances. Related communities of highly unstable substrates are grouped in the *Thlaspeetea rotundifolii*. The chomophytic and chalicophytic communities are classified in the *Androsacetalia alpinae*. The tropohydrophytic communities of recent alluvia are classified in the *Calamagrostion neglectae* (*Myricarietalia germanicae*).

Grass heaths are predominantly represented by non-calciphytic and non-basiphytic types considered as belonging to the *Nardo-Caricion bigelowii* (*Juncetea trifidi*). Xerophytic talus-slide and rock vegetation is mainly represented by non-calciphytic chomophytic communities.

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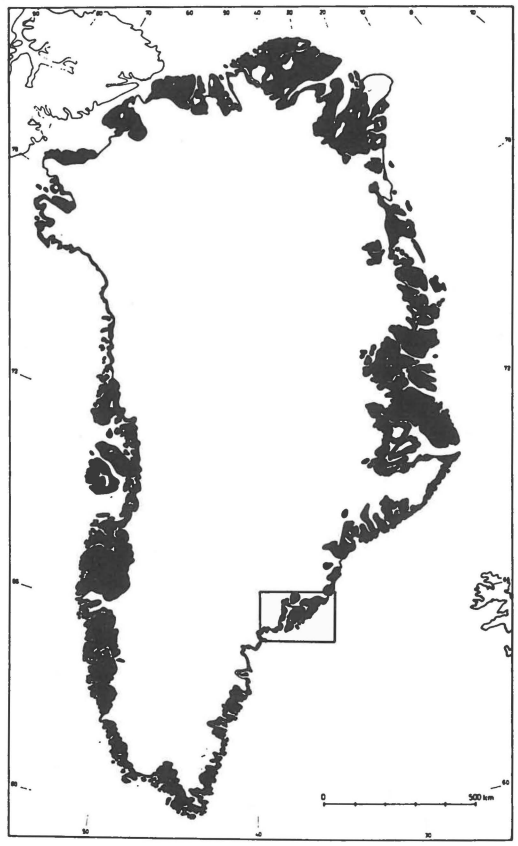


Fig. 1. Map of Greenland. The partly to completely ice free areas are given in black, the investigated area is outlined.

A. GENERAL PART

1. Introduction

In the first publication in this series on the vegetation of the Angmagssalik District the general introduction applies particularly to the subject treated in that publication, the littoral vegetation, (*Meddr Grønland* 198.1).

In cooperation with F. J. A. DANIËLS, the author of two future publications on the dwarf shrub and lichen vegetation of the district, the present author concludes the series with a general part which will contain a summary of the vegetation units and a detailed description of the Angmagssalik District.

Partially reverting to the first publication, partially anticipating the final publication in this series, I may confine myself now to a brief summary of the relevant general subjects, and a more detailed description on the subjects specifically concerning the plant communities which are dealt with in the present publication in the introduction to each chapter. It should be noted here that the first publication was to give a description of the littoral vegetation of the Angmagssalik District, as well as a survey of the Arctic and Subarctic northern Atlantic salt-marsh communities. The present publication, in contrast, is primarily intended to present a description and classification of the non-halophytic herb and snow-bed communities observed in the Angmagssalik District; secondarily these communities are compared with related units described from elsewhere, in particular from alpine Fennoscandia.

1.1. Geography

In the first publication in this series the Angmagssalik District is defined as the most extensive, coherent ice-free and central area on the low-arctic Southeast coast of Greenland, ranging approximately from 65°30′ to 66°30′ N.l. To the South and North of these limits the ice-free land dissolves into skerries, nunataks and isolated stretches of land separated by stretches where the ice sheet reaches right down to the ocean. The southern boundary is formed by the Denmark Strait, to the North the district is separated from the vast Greenland ice sheet by a transitional nunatak area.

The indication "Angmagssalik District" and this delimitation are used for reasons of convenience only, and have no official connotations whatsoever.

It constitutes a wild mountainous area deeply cut by numerous fjords.



Fig. 2. Air view of the central part of the Angmagssalik District. In the lower left the Angmagssalik Fjord, which branches in the centre in the Qíngertivaq (left) and the Tasîlaq fjord (right); in the left background the Sermilik fjord.
Photo courtesy of the Geodetic Institute of Denmark.

1.2. Physiography

The district can in general be divided into (1) the coastal area with low mountains comprising the large and small islands and skerries along the outer coast and the outer part of the mainland, including the Angmagssalik Ø, which is strongly intersected by numerous sounds, small fjords and bays (fig. 8), (2) the inland area consisting of the also largely ice-free and partly very mountainous mainland where several fjords cut deeply into the land (fig. 2); (3) the nunatak area forming the transition from the inland to the ice sheet, which in this publication is not considered as belonging to the Angmagssalik District proper.

According to the landscape there can be distinguished: (1) the low roches moutonnées landscape with predominantly bare, rounded ice-scoured rocks found on both sides along the Sermilik fjord in the western part of the district; (2) the lowland, exlusive of (1), which includes the valleys, the river deltas, the shores along the fjords, and the hilly areas found around the Kong Oscars Havn; this landscape is characterized by the occurrence of comparatively extensive stretches of closed vegetation, including palsa-mires, and of several lakes and ponds with aquatic vegetation; (3) the extensive alpine landscape constituting the central part of the district, characterized by groups and chains of steep, rugged mountains generally 600 to 1500(2000)m high with numerous corrie glaciers and firn fields, and intersected by the long and comparatively narrow ramifications of the Angmagssalik Fjord system and valleys formed by former glacier troughs; vegetation is here restricted to comparatively little sloping and stable talus slopes and to ledges; (4) the transitional nunatak area to the North and East of the central part of the district, consisting of largely bare mountains and mountain ranges protruding through the ice with peaks ranging from 1500 to 3500 m elevation.

1.3. Climate

The central part of the Southeast coast of Greenland has a low-arctic climate. The coastal areas have a pronounced oceanic local climate, which becomes gradually continental more inland under the increasing influence of the ice-cap and the decreasing influence of the cold East Greenland Current.

Extreme conditions are rare; in comparison with continental climates the climate is characterized by a narrow temperature amplitude, rather high precipitation more or less evenly distributed over the entire year, and almost perpetually blowing winds (HASTINGS, 1960).

The weather is dominated by a succession of cyclonic disturbances or low pressure areas which are most intense during the winter months and bring unsettled weather, higher frequency of strong winds, and increased precipitation. Relatively low pressures ("Icelandic low") persist throughout the year. These phenomena account for the rather fickle, unpleasant weather during most of the year (HASTINGS, l.c.).

Meteorological observations at Angmagssalik are regularly compiled by the Danish Meteorological Institute and published in the series Summaries of Weather Observations at Weather Stations in Greenland. The following is taken from these publications.

The mean annual temperature at Angmagssalik is − 1.2° C. The mean temperature of the coldest month, February, is − 8.3° C and of the warmest month, July, + 6.9° C (1895–1970). Absolute minimum and maximum temperatures during the period 1961–65 were − 25° C and + 23.5° C.

The mean total amount of annual precipitation is 819.5 mm (1895–1970). The mean relative humidity of the air fluctuating monthly from 72 to 83 %, the mean percentage of sky cover (cloudiness) from 53 to 66 % (30 years; HASTINGS, l.c., table 8, 9). Most precipitation falls as snow. Its accumulation is generally greatest in April and least in August; the ground at Angmagssalik is covered for 260 days annually by a snow layer of at least 15 cm (HASTINGS, l.c.).

The mean surface windspeed is abt. 4 MPH (abt. 6.4 km/hr). Gale force can be reached during any season of the year, but very heavy storms are most frequent in the winter. Gusts of 115 MPH (abt. 185 km/hr) have been recorded from coastal areas of the district. Strong winds and storms blow mainly from the North-Northwest (HASTINGS, l.c.).

Owing to the physiography and topography of the Angmagssalik District there is a considerable variation in the local climate. Small, sheltered valleys and fjords often appear to form climatological and also often botanical "oases" (Blomsterdalen, Torssukátak, Tasîlâlik, Tugtilik for instance), whereas harsh, barren and extreme conditions prevail in other, exposed localities.

The meteorological station at Angmagssalik is situated in the coastal part of the district. The inland part is climatologically more continental, though oceanic influences may occasionally be considerable, owing to the open connection to the ocean provided by the fjords. In general, cloud cover and fog seem to be less than in the coastal areas. In winter the temperatures are comparatively low, in summer comparatively high. According to TINBERGEN (1934, p. 26–27) the ground is covered by autumnal snow earlier in the inland at the head of the Qíngertivaq than near the coast at Angmagssalik. In summer one can observe in the Qíngertivaq, to a less degree also in the Tasîlaq, a marked diurnal shift of the surface wind, a strong katabatic landwind blowing during the first part of the day and a seawind during the second half (cf. KRUUSE, 1912, p. 78; HASTINGS l.c., p. 22). In summer, during the mid-day calm when the wind changes, whirlwinds frequently arise on the sandy outwash deltas at the heads of the inner ramifications of the Angmagssalik Fjord.

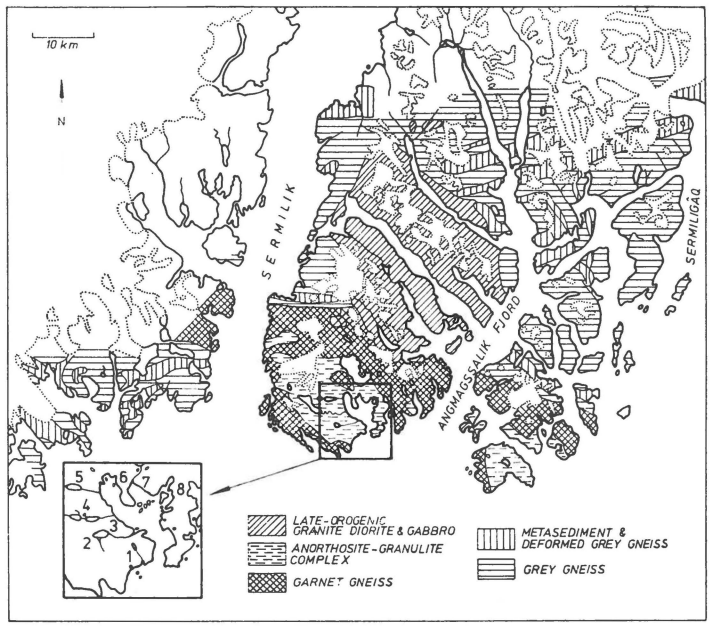


Fig. 3. Geological map of the Angmagssalik District (from: WRIGHT *et al.*, 1971)

1.4. Geology

Most rocks in the district consist of a metamorphic complex of Precambrian rocks penetrated by younger, also Precambrian intrusive rocks, in particular granites. Less frequently Postcambrian dykes of basaltic intrusives occur. (BRIDGWATER & GORMSEN, 1968; KRUUSE, 1912, p. 211; WAGER, 1934; WRIGHT *et al.*, 1971).

The metamorphised rocks consist predominantly of "gray gneiss"; most abundant are gneisses of intermediate composition, less abundant are more acid gneisses. In these gneisses are intercalated pelitic and related metasedimentary rocks (including altered limestone at Nagtivit kangertivat and at the head of the Qingertivaq fjord), with amphibolite facies mineral assemblages. The gneisses contain large numbers of bodies of metamorphised basic and ultrabasic rocks (including dunite, olivine-enstatic rocks). Basic hypersthene-bearing intrusives (charnockitic rocks of the anorthosite-granulite complex) occur locally in this complex, particularly on Angmagssalik Ø and Kulusuk, in close association with garnetiferous granite gneisses (garnet gneisses).

The youngest Precambrian plutonic rocks constitute a suite of late to post-tectonic gabbros, diorites, and granites.

The only rock outcroppings in the district other than the Precambrian rocks are scattered Tertiary dolerite (diabase) dykes. These basic dykes are not infrequent, with a noticeable decrease in number between Kulusuk and the head of the Angmagssalik Fjord.

A map of the general distribution of these types of rock is given in fig. 1.

1.5. Soil

The climate and the relief (site) are prominent factors in soil development in the district, beside the parent material, soil organisms, and time.

These mountain soils in general differ primarily because of variation in site, exposure, texture, and denudation balance rather than primary variations of parent rock. Most, if not all of these soils, have developed recently. As a rule, the types are numerous and divergent. It is therefore difficult to distinguish between those with little or no genetic horizons and those with more or less clearly, often relatively thin differentiated horizons.

The parent material in the district is derived by in situ physical weathering or by mass movement and colluviation, respectively; other parent materials are valley infillings, alluvium, and fresh glacial and periglacial deposits. In the district it is as a rule initially rich in relatively rapidly weathering minerals but poor in calcium (cf. section geology). The only rocks which seem to weather rapidly are the highly feldspathic rocks of the charnockitic suite which break down easily to a coarse feldspar sand that easily develops into soil by internal weathering processes. The remainder of the district is composed of hard rocks apparently very resistant to physical and subsequent chemical weathering.

Internal weathering in the soil operates at a low rate owing to the low temperatures and in spite of the relatively high precipitation. The biological activity is also slight; plant debris is sparse and is slowly decomposed, remaining usually unmixed as a mor or moder horizon, sometimes as a peat layer, at the surface of the soil or on the unaltered subsoil.

The local relief, interacting with the climate, influences the drainage of the site. Through this control on the water balance of the soil on the spot it also influences the internal or chemical weathering, eluviation, illuviation and wet flushing. It influences also the niveo-aeolian, glaciofluviatile and gravitational addition of fresh weathering products and humus development.

Disruptive factors on soil formation in the district are in particular erosion, sedimentation, and deflation. Frost action is a less disturbing factor than it is elsewhere in the Arctic in more level tundra areas; permafrost occurs only locally in wide, level, miry valleys like those at Nagtivit and Ilivnera.

Owing to the mountainous topography soils occur only locally on comparatively little sloping and level grounds and are rather shallow.

The very variable soils of the Angmagssalik District can roughly be divided into three large groups: terrestrial soils, semi-terrestrial soils, and subaquatic soils.

Terrestrial soils are most frequent and represented by at least four different types: (1) lithosols, viz. common, thin, little developed and stony soils with (A)–C profiles developed on rock, in comparatively exposed sites usually covered by fell-field vegetation, (2) regosols, viz. comparatively rare, deep, little developed and loose sandy soils with (A)–C profiles confined to sand dunes on deltas, recent glacial till and recent niveo-aeolian deposits covered by various types of usually graminoid vegetation, (3) rankers, viz. more or less common soils with A–C profiles the humus horizon of which lies immediately on the calcium-deficient parent material and which are usually covered with herb and dwarf shrub vegetation, and (4) arctic brown soils, viz. less common, weakly podzolidized soils with H–Ah–A2–A3C–C profiles which develop on well drained regosolic material on ridges, talus slopes, and niveo-aeolian deposits covered with snow-bed and dwarf shrub vegetation.

Semi-terrestrial soils occur less frequently and are represented by (1) fluvisols and (2) bog or peat soils.

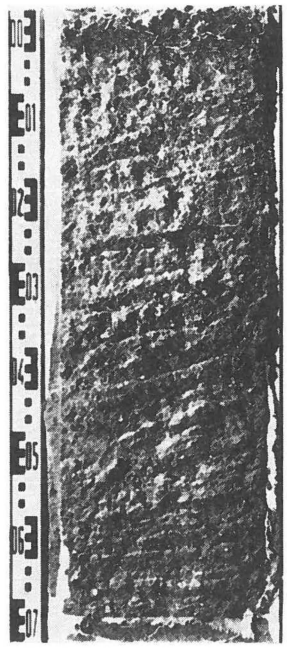


Fig. 4. Monolith of regosolic soil developed in niveo-aeolian sand deposits below *Carex bigelowii* grass heath (8.1.1.2.; leg. DANIËLS & DE MOLENAAR, Angmagssalik, VIII. 1968; coll. International Soil Museum, Utrecht, Netherlands).
Photo courtesy of the Int. Soil Museum, Utrecht.

Fluvisols are alluvial, usually light-coloured soils on level sites, which may evolve toward a developed soil by increase of hydromorphism or by intensification of zonal conditions. They usually have multi-phase profiles, with alternating layers of gravel, fine material, and organic debris. These "horizons" are rarely continuous further from the surface; reduction processes occur commonly. Consequently these soils are difficult to classify. In the Angmagssalik District it seems practical to distinguish: (1.1) Siliceous fluvisols of coarse texture, which are comparatively well drained, have a high vertical permeability, and dry out readily at the surface; the subsoils are in consequence little or not reduced; this type is common and occurs associated with meltwater streams and is usually covered with various types of herb and *Salix glauca* vegetation. (1.2) Fluvisols of fine texture (or with very shallow water tables), which have low vertical permeability, perennially moist surface layers, and (partly) reduced subsoils. Such soils are found on glaciofluviatile outwash deltas and can be subdivided into (1.2.1.) a comparatively common siliceous type usually covered with graminoid vegetation (*Calamagrostion neglectae*), and (1.2.2.) a very rare calcareous type (borovina-like), covered with calciphytic mire vegetation (*Tofieldietalia*).

Bog or peat soils are organic soils or histosols and are not uncommon in the district. They can be divided into (1) the comparatively common semi-bog soils with 0.2 to 1 m thick peaty surface layers, (2) the very rare full bog peats with 1 to 6 m deep organic surface layers (the maximum depth actually observed being 2 m, in the bog West of Angmagssalik near "Entreprenørspladsen"); both types are usually covered with acidophytic mire vegetation, and (3) the alpine bog soils, common,



Fig. 5. Arctic brown soil developed in mixed colluvial and niveo-aeolian deposit covered by snow-bed vegetation (6.1.2.3.); length of the profile about 12 cm. JGdM phot. VII. 1968.

though little extensive, and sloping soils with comparatively thin peaty surface layers, usually covered with dwarf shrub heath rich in mosses.

Subaquatic soils are very rare in the district and are represented by (1) embryonic underwater soils, viz. little developed stony soils with (A)–C profiles on the bottom of cold deep lakes and meltwater streams, usually not covered with vegetation of higher plants, and (2) dy or dygyttja soils, partially organic, muddy underwater A–C soils found in the rare, shallow, and often temporarily dry ponds where they are usually covered with various types of aquatic and amphibious vegetation.

Soils intermediate between the types mentioned are very frequent, in particular those transitional between the various terrestrial and semi-terrestrial ones.

2. Vegetation

The vegetation of the Angmagssalik District consists predominantly of dwarf shrub heath and related fell-field communities. Herb and snow-bed communities cover considerably less extensive areas and usually occur as patches in surrounding dwarf shrub heaths. The only herbaceous community covering relatively extensive tracts, the *Carex bigelowii* grass heath, does so only in just one area in the southern part of Angmagssalik Ø (3.1).

In the section physiography (1.2) a division of the landscapes of the district is given. Well developed, extensive vegetation is mainly restricted to the lowland as distinguished there. Most of the lowland is constituted by the extensive, little sloping and stable scree along the fjords at the bases of the steeper and/or mobile mountain slopes. These screes are covered by dwarf shrub heaths with scattered patches of herb and snow-bed vegetation. In the little extensive hilly lowland dwarf shrub heath, fell-field, herb, and snow-bed communities occur patchwise without any distinct predominance of any of these. In the valleys the mires and the alluvium communities dominate.

2.1. Previous investigations

The Angmagssalik District was reached by Europeans for the first time in 1883. On the 4th and 5th of September of that year a Swedish expedition led by A. E. NORDENSKIÖLD visited the southern part of the Angmagssalik Ø where various investigations were carried out. In the report on this expedition NORDENSKIÖLD (1885) gave a brief, general description of the vicinity of the Kong Oscars Havn (Konung Oscars hamn) on the southern part of Angmagssalik Ø (3.1.).

Beside references to the *Carex bigelowii* grass heaths and the *Salix glauca* scrub NORDENSKIÖLD also reported the occurrence of temporarily dry pools on the beach with *Subularia aquatica*, which were presumably destroyed by the establishment of the (later again largely depopulated) village Igtumît near Angmagssalik.

More than ten years later the district was visited by a Danish scientific expedition in which the botanist E. BAY participated. In the account of this expedition he broadly outlined the floristical composition of some formations, such as fell-field vegetation and dwarf shrub heath (BAY, 1896).

Then, first in 1898–1899 and subsequently in 1901–1902, the district was intensively investigated botanically by CHR. KRUUSE, both floristically and ecologically, according to the methods of that time. In his botanical travel account, which still provides an excellent guide for the district, he described the floristical composition of the various physiognomic-ecological, and in consequence broadly contrived vegetation types which he observed (KRUUSE, 1912).

In 1932 TYGE W. BÖCHER visited the district. He studied the vegetation in detail, applying the Raunkiaer circling method based on frequency and density analysis of individuals or shoots of plants. On the basis of data thus collected he recognized a number of associations; furthermore he reported the presence of several associations which he did not study in detail (BÖCHER, 1933).

Of the other parts of Greenland, in particular the West, Southwest, and South coast have been comparatively thoroughly investigated. In order to avoid a long enumeration of publications referring to these and other areas I refer the reader in principle to the index of the series *Meddelelser om Grønland*, in which the very great majority of these studies appeared. Of the early publications there may be mentioned here, for instance, those by BERGGREN (1871) and WARMING (1888). Recent, well

documented publications containing tables of analyzed sample plots are by BÖCHER 1949, 1954, 1959, 1963).

The only other area synecologically thoroughly investigated and in terms of vegetation readily comparable with the Angmagssalik District, and therefore frequently referred to in the following, is the Alpine zone of Fennoscandia (e.g. DAHL, 1957; GJAEREVOLL, 1949, 1950a, 1956; KALELA, 1939; NORDHAGEN, 1928, 1936, 1943).

2.2. The present investigation

The present investigation was carried out during the summers of 1968 and 1969 in the Angmagssalik District as delimited in section 1.1. Part of the results were published in the first publication in this series treating the halophytic littoral vegetation.

The present part deals with the rest of the vegetation, with the exception of the ericoid dwarf scrub, willow, and lichen vegetation which is being studied by F. J. A. DANIËLS, and the fell-field which is under study by H. F. FERWERDA (publications in preparation). Ruderal vegetation was not investigated.

In this context it is considered sufficient to note that the method of study was that of the Zürich-Montpellier school of phytosociology (e.g. BRAUN-BLANQUET, 1964) and that the analyses of the sample plots are coded in the Hult-Sernander scale. For a detailed description of the methods in the field and the working up of the data the reader is referred to the above-named preceding publication in this series.

The identification of the taxa observed in the sample plots was partly carried out in the field, partly, after the field work was over, at the Botanical Museum and Herbarium of the State University of Utrecht, Netherlands.

The determination of the vascular plants was made in the field; some critical ones were verified afterwards in the laboratory. The bryophytes, viz. mosses and hepatics, were all identified or re-identified in the laboratory. Most macrolichen identifications were made in the field, only a few were checked afterwards. Microlichens were only determined if they were fertile and conspicuous in the vegetation; this proved to be only exceptionally the case in the studied plant communities. The lichen identifications should consequently in general be treated with some reservation.

The nomenclature of the vascular plants is in accordance with *Grønlands Flora* (BÖCHER *et al.*, 1966) as far as taxa occurring in Greenland are concerned. Otherwise, as regards taxa not occurring in Greenland and listed as faithful taxa of certain higher syntaxa, the terminology follows LID (1963) or OBERDORFER (1970). The nomenclature of the musci follows the "Index Muscorum" (VAN DER WIJK *et al.*, 1959–1969), that of the hepatics in principle MÜLLER (1951–1958). The nomenclature of the lichens is largely in accordance with POELT (1969). The names of the authors are only cited with the taxa which are faithful to the various syntaxa.

The following taxa are only referred to by species name in this publication: *Angelica archangelica* L. ssp. *norvegica* (RUPR.) NORDH., *Cerastium alpinum* L. ssp. *lanatum* (LAM.) ARCH. et GR., *Leucorchis albida* (L.) E. MEY. var. *subalpina* (NEUM.) HYL., *Lycopodium selago* L. ssp. *arcticum* (GROSSH.) TOLM., *Rumex acetosella* L. ssp. *tenuifolius* WALLR., *Scirpus caespitosus* L. ssp. *austriacus* (PALLA) ASCH. et GRAEBN., *Vaccinium uliginosum* L. ssp. *microphyllum* LGE. The nomenclature of the *Lycopodiaceae* is not in accordance with *Grønlands Flora* but with LID's and OBERDORFER's floras.

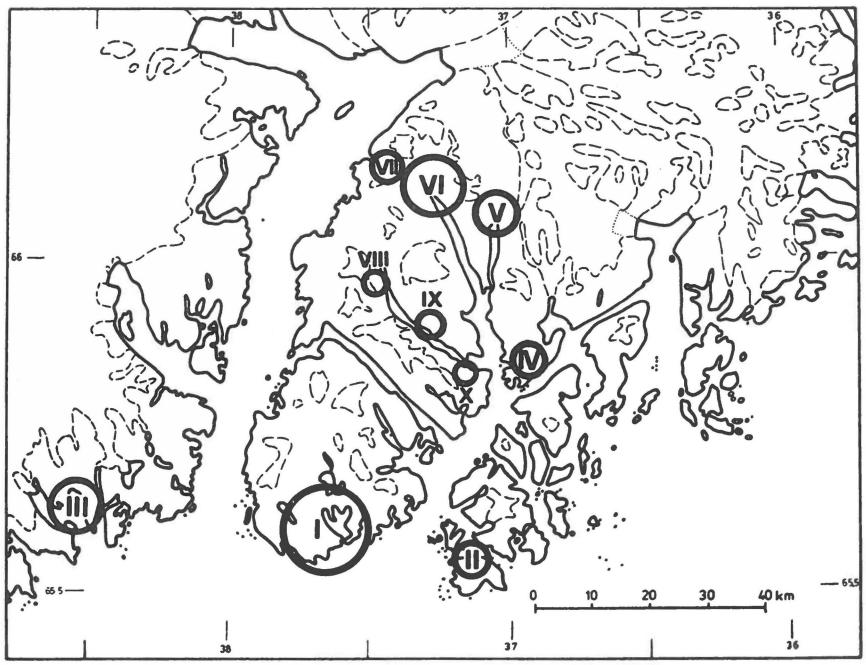


Fig. 6. Map of the localities visited in 1968 and 1969.

3. Localities

As excellent general descriptions of several of the investigated localities have been given by KRUUSE (1912), and as the concluding publication in this series will contain a detailed description of the Angmagssalik District, I will confine myself to as brief a description of the investigated localities as possible. See also fig. 6 and 3 (inset).

3.1. Locality I: Southern part of Angmagssalik Ø, about 65°37'N–36°37'W

Reconnaissance trips over and around the island showed most of it to be very poorly overgrown, with bare rock and screes determining the landscape.

The western part of the island along the Sermilik shows the observer a bare, desolated roches moutonnées landscape. The rest of the island displays a mountainous, Alpine scenery where vegetation is also very sparse. Only in the southern part large areas covered with well developed vegetation of any extent are to be found.

The investigated part of the island coincides roughly with the area around Kong Oscars Havn where the bedrock is made up of anorthosite-granulite, viz. charnockitic rocks (figs 3, 6, 7). These rocks are mostly rich in hypersthene and are subjected to rapid mechanical weathering yielding coarse, angular sand and fine gravel of a characteristic chocolate-brown colour. Because of this rapid weathering the landscape appears as low, hilly country with a number of shallow ponds surrounded by steep mountains consisting of resistant (garnet) gneiss. In fact this is the only low, hilly area in the district not composed of bare, rounded roches moutonnées.

NORDENSKIÖLD (1885) briefly characterized this area as follows: "... The mountains around the Konung Oscars hamn are up to 1000 m high and consist of

crystalline rocks, mainly granite-gneiss and diorite. Between the mountains and fjords one finds lakes and green valleys covered with a very dense grass carpet and 1 to 2 ft high willow scrub. However, no tree was found and the dwarf birch grew here procumbent as on Spitsbergen . . ." (translated), which gives a good general picture of this area (fig. 60).

BAY's and BÖCHER's investigations in the district were mainly restricted to this locality (BAY, 1896; BÖCHER, 1933). Beside other areas KRUUSE (1912) studied this area in great detail. He gave an extensive description supplemented by a vegetation map (KRUUSE l.c., e.g. p. 141–151, table III).

In the course of the present investigation the places in this locality described in the following were studied intensively.

Kong Oscars Havn (Konung Oscars hamn, Tasiussaq, Tasîlaq) is a short fjord or creek with a narrow bottleneck entrance. In its widened inner part it divides into three short branches: a northwestern one, Imîlâjiva, a middle northern one called Qortortup imîlâ, and a northeastern one or Nordfjord.

Around this fjord four areas are found which are mutually similar in physiography and vegetation, viz. the Elvbakker area Northwest of Angmagssalik (KRUUSE, l.c., p. 22, 24, 101, 103–108, 141), the peninsula Amarqâq between the Imîlâjiva and Qortortup imîlâ (KRUUSE l.c., p. 145–148), the eastern shore of Qortortup imîlâ, and the peninsula between Nordfjord and the small fjord immediately East of the Kong Oscars Havn, the Sarpakajik (KRUUSE, l.c., p. 102, 151) (fig. 3: 3, 6, 7, 8). These are all low hilly plateau areas, the only ones in the district which have not been modelled by ice. The plant cover is here more or less dissolved into patches. Fellfield is the most common type of vegetation in exposed places. In more sheltered ones one comes across the majority of the dwarf shrub heath, herb, snow-bed and mire communities known from the district. Of special interest is the occurrence in the Elvbakker area of several ponds, such as Sparganiumdammen (cf. KRUUSE, l.c., p. 22, 101; BÖCHER, 1933, p. 106–107; fig. 11) with communities of the *Callitricho-Batrachion*, and Subulariadammen (cf. KRUUSE, l.c., p. 106; fig. 13, 14) with communities of the *Subularion aquaticae* and on Amarqâq several ponds with similar communities, communities of the *Parvopotamion* and of the *Charetalia* (cf. KRUUSE, l.c., p. 145–148; fig. 12); in the other areas mentioned also several ponds are to be found.

West of Angmagssalik a stream runs through a very attractive valley called Blomsterdalen (Flowervalley), forming the southern boundary of the Elvbakker area (KRUUSE, l.c., p. 28, 63–64). The slopes in the lee of Elvbakker along the northern side of this valley consist of up to several meters thick deposits of niveo-aeolian sand and are covered by dense *Carex bigelowii* grass heaths; where these deposits are more shallow the vegetation consists of *Salix glauca* scrub (fig. 60). Through the *Carex bigelowii* grass heaths run numerous rills with spring vegetation belonging to the *Montio-Epilobion hornemanni*, whereas patches of herb vegetation are common in places with a favourable water supply and snow cover. In the frequent depressions and in other places where snow drifts accumulate in winter one comes across various types of snow-bed communities of the *Cassiopo-Salicion herbaceae* and the *Ranunculo-Oxyrion digynae* (fig. 45). Noticeable is the occurrence of chomophytic communities of the *Sedo-Thymion drucei* on very shallow soil, particularly on ledges.

The southern side of Blomsterdalen is formed by the slopes of the Sømandsfjeldet, (KRUUSE, l.c., p. 67; fig. 3: 1), the northern peak of a double-topped mountain Southwest of Angmagssalik the slopes of which mainly consist of mobile scree without coherent plant cover. Like the mountains mentioned hereafter the Sømandsfjeldet attains an altitude of somewhat over 600 m. On the lower part of its northern slope the occurrence of communities of the *Antitrichion-Sedion roseae* is noteworthy, higher up

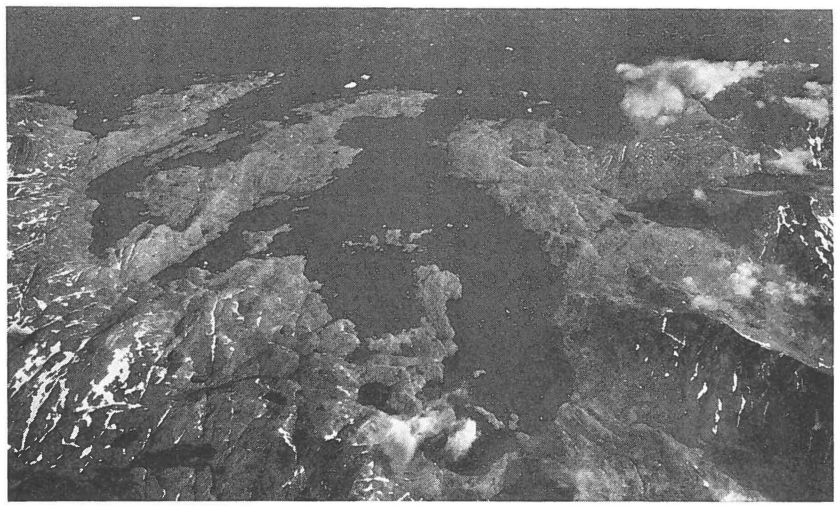


Fig. 7. Air view of the southern part of Angmagssalik Ø. In the centre Kong Oscars Havn, to the left the small Sarpakajik fjord; to the right from top to bottom the mountains Sømandsfjeldet, Ymers Bjerg and Præstefjeld.
Photo courtesy of the Geodetic Institute of Denmark.

Dryas integrifolia communities occur. The western slope is covered here and there by luxuriant dwarf shrub heaths rich in herbs and various herb and snow-bed communities.

At the bottom of Blomsterdalen a lake is found at the foot of the western promontory of a steep mountain range, the Ymers Bjerg (fig. 3:2). The eastern and western slopes of this promontory resemble the western slope of the Sømandsfjeldet in most respects. Its southern slope is covered with a very loose, sandy to stony scree largely without vegetation, except for the narrow strips of luxuriant snow-bed vegetation (*Ranunculo-Oxyrion digynae*) along a few rills with spring vegetation (*Montio-Epilobion hornemani*) on the lower part of this slope.

At the foot of the southern face of the Ymers Bjerg range a large, very deep and cold lake without higher plant life is found. At its western end there is a delta covered with graminoid vegetation belonging to the *Calamagrostion neglectae* (*Pohlio-Caricetum rufinae*).

Northeast of the Ymers Bjerg and Northwest of the Elvbakker area the third mountain, the Præstefjeld (fig. 3:4; cf. KRUUSE l.c., p. 148–149), is situated. The slopes of this mountain are also largely covered with open scree, with the exception of the eastern one which is covered with several extensive patches of vegetation. These are mostly dwarf shrub heaths and snow-bed communities, such as occur on the western slope of the Sømandsfjeldet, partly also grass heaths dominated by *Carex bigelowii*.

In the valley between the Ymers Bjerg and the Præstefjeld dwarf shrub heaths and fell-field communities are the most frequent vegetation types. On a few deltas in the large, cold and deep lakes found here there occurs the same type of vegetation as described above (*Pohlio-Caricetum rufinae*, fig. 54), here and there rich in *Cardamine nymannii*.

North of the Præstefjeld there runs a deep, shaded valley also partly occupied by large lakes, which in winter is used as a sledge route to the Sermilik fjord and in consequence is called Sermilikvejen. It is nearly devoid of vegetation, whereas its



Fig. 8. Air view of the Nagtivit area. In the left part of the picture the wide fjord Nagtivit kangertivat, in the centre its small branch Tasîlâlik and the Nagtivit peninsula.
Photo courtesy of the Geodetic Institute of Denmark.

widened, sloping entrance to the Imîlâjiva is covered with luxuriant grass heaths (*Deschampsio-Myrtilletalia*, fig. 59). The northern slope of the valley is formed by the southern flank of the Vegas Fjeld, covered with luxuriant, rich and eutrafent vegetation types, including dwarf shrub heaths with, for instance, *Rhododendron lapponicum*, willow scrub and herb vegetation frequently rich in orchids, snow-bed and spring communities with e.g. *Angelica archangelica* (fig. 3:5; c.f. KRUUSE, l.c., p. 24–26, 141–143).

3.2. Locality II: Kulusuk, about 65°34′N–37°13′W.

Detailed ecological investigations were carried out on the northern part of this island, whereas reconnaissance trips were made over much of the central part of it.

The investigated area is roughly delimited by Kap Dan village, the northern coast of the island, Kulusuk Airfield, and a line connecting the airstrip with the lake South of Kap Dan. The bedrock in this area is the same as in the investigated southern part of Angmagssalik Ø, and the vegetation, though more dwarfed and covering less extensive coherent areas, is about the same as in notably the Elvbakker area, but for the absence of *Carex bigelowii* grass heaths and aqautic plant communities.

Noticeable is the occurrence of a small mire on a low promontory West of the harbour of Kulusuk Airfield. In the vegetation a striking zonation occurs (see fig. 31, 32). In early summer (July 1968) the subsoil was frozen below -40 to -80 cm but palsas were not observed.

3.3. Locality III: Nagtivit Tasîlâlik (Nagdluit-Tasitalik), about 65°39′N–38°31′W.

The comparatively narrow strip of ice-free land West of the Sermilik shows predominantly a roches moutonnées landscape of gneiss rocks. Well developed tracts of vegetation occur in a few sheltered places only, where erosion material accumulates

to provide a suitable substrate, as, for instance, along the eastern side of the Tasîlâlik fjord, a short L-shaped northern branch of the Nagtivit kangertivat (Siporsôq fjord or Base Fiord) near the deserted village Nagtivit (fig. 8).

Along the eastern shore of the Tasîlâlik one can observe the rests of at least three raised former beaches at about 1, 3 and 5 m alt. On these flats several shallow, temporarily dry ponds are found with nitrophytic amphibious vegetation (*Subularion aquaticae*, fig. 15) and partly occupied or surrounded by halophytic-nitrophytic communities of the *Carici-Puccinellietalia* (see the first publication in this series). The talus is covered by vegetation types comparable with the conditions found in locality I near Angmagssalik.

Between Tasîlâlik and Nagtivit, in the extension of the "long leg" of the fjord parallel to the Nagtivit kangertivat, one may notice an extensive palsa-mire in a low, wide valley with permafrost in the subsoil (fig. 35). Most plant communities in this mire belong to the *Caricion curto-nigrae*.

Palsas (see p. 26) are also found in the Ilivnera valley (locality VII) and in a small mire near Qortortup imîlâ (Kong Oscars Havn, locality I). In these localities palsas were observed in valleys filled with levelled outwash (silt), covered with a moss and peat layer at least 30 to 40 (80) cm thick. The ground is frozen in summer below a depth of 40 to over 80 cm. The ice-core in the palsas is covered by an about 30 cm thick mantle of dried-out peat which is not or only very sparsely overgrown (*Saxifraga caespitosa*, *S. stellaris*, *Cerastium alpinum*, *Salix herbacea*, *Carex rariflora*), and makes the palsas stand out as up to 80 cm high, dark brown hummocks in the otherwise green mires. This suggests that these structures are more or less ephemeral phenomena, such as have been described from northern Fennoscandia by RUUHIJÄRVI (1960, p. 225–226) and SANDBERG (1963, p. 906, 907).

3.4. Locality IV: Torssukátak (Tunok), about 65°52½'N–36°54'W.

A detailed description of this area and the vegetation along the northern side of this small, sheltered fjord was given by KRUUSE (1912, p. 87–89, 138–139), who also sketched a map of this locality (l.c. table II; see also the first publication in this series, fig. 3).

In this gneiss area well developed vegetation is restricted to the northern side of the fjord where extensive, little sloping scree mainly covered by dwarf shrub heath is found, whereas the southern shore is largely formed by bare, steep mountain slopes. Of special interest in this area is the occurrence of chomophytic plant communities (*Sedo-Poietalia glaucae*, fig. 67) on ledges on the here comparatively numerous Tertiary diabase dykes.

3.5. Locality V: Tasîlaq (Tasîssârssik, Tasiusak Misutok), about 66°1'N–37°9'W.

The Tasîlaq fjord is the eastern branch of the innermost ramification of the Angmagssalik Fjord. It has a narrow bottleneck entrance and is lined on both sides by chains of steep mountains. In the extension of the fjord a long, narrow valley runs to the North, flanked by even steeper and more jagged mountain ranges from which numerous glaciers descend to the floor of the valley. The valley is filled by outwash, which is continuously supplied, levelled and redistributed by the braided meltwater stream system draining the valley and forming an extensive delta, Tasîlâp kua, at the head of the fjord. The bedrock in this area consists of grey gneiss.

The fjord was briefly visited by KRUUSE in 1902 (KRUUSE, l.c., p. 124–125).

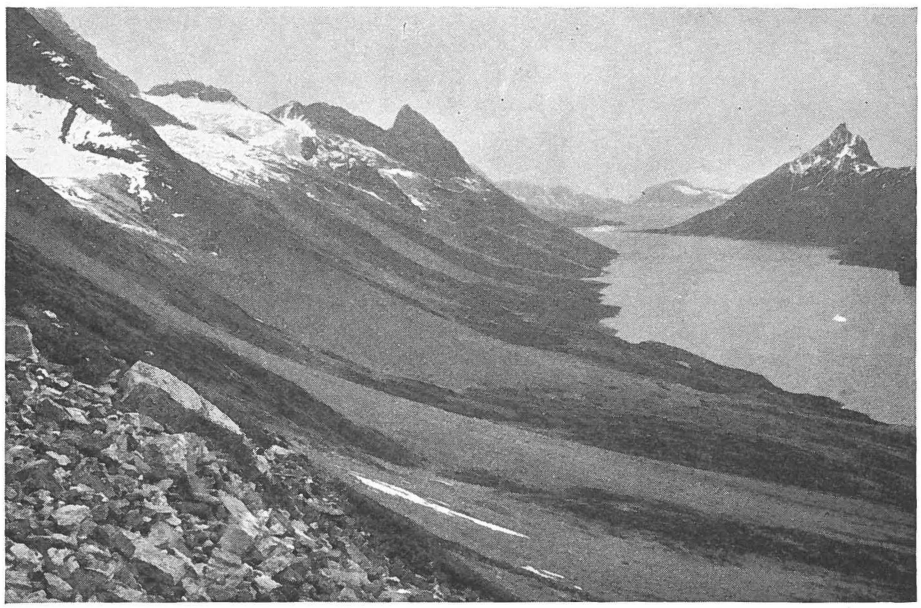


Fig. 9. The eastern side of the Qíngertivaq fjord, covered by heath clad scree, moraines of retreated corrie glaciers and blockfields, seen towards the South. JGdM phot. VII. 1969.

In the course of this study we visited the two shores along the inner part of the fjord, the delta at the head, the adjoining part of the valley, and the mountain on the eastern side of the valley between the first and the second glacier, about 3 $^1/_2$ km North of the head of the fjord.

At the foot of the steep mountain sides the slopes are covered with old earth-covered stabilized scree overgrown with dwarf shrub heath. Here and there patches of herb vegetation occur; comparatively large areas are covered with snow-bed communities of the *Ranunculo-Oxyrion digynae* (fig. 47). On the steep mountain sides the vegetation is restricted to ledges and ravines, but is otherwise of similar composition. These conditions also prevail in the valley.

In the dynamic habitat formed by the delta and the valley floor more or less impoverished communities of the *Calamagrostion neglectae* occur. On the terminal and lateral moraines various lichen communities dominate.

3.6. Locality VI: Qíngertivaq (Kingorsuak, Qingorssuaq), about 66°7′N–37°16′W.

The Qíngertivaq fjord is the western, longest branch of the innermost ramification of the Angmagssalik Fjord. The shores and slopes along the inner part of this fjord and the delta and the valley in its extension were investigated in particular. In 1902 this area was twice visited by Kruuse (1912, p. 73–83, 125–136), who gave a detailed description and a map of the area (Kruuse, l.c., table I).

The Qíngertivaq is a very scenic narrow fjord, flanked on both sides by steep, sharply serrated mountain ranges, predominantly built of grey gneiss and granites with diabase dykes. There impressive ranges are lined with a series of corrie glaciers. The lower, less steep parts of their slopes along the fjord consist of old stabilized

scree overgrown with heath vegetation, alternating with bare, mobile block fields and lateral moraines of regressed corrie and valley glaciers (cf. KRUUSE, l.c., p. 73). Plant communities rich in herbs and mosses occur here and there in patches in the heath, along rills, and at the foot of cliffs. Most of them represent types of common occurrence in the district. In general the vegetation appears to be more luxuriant on the eastern (KRUUSE, l.c., p. 126–127, 130, 134–136) than on the shaded western side of the fjord (KRUUSE, l.c., p. 80–81, 130–132).

The northernmost promontory of the mountain range along the western side of the fjord is the rounded, about 900 m high Cassiopefjeld, which is of special interest because of the occurrence of dwarf shrub heaths rich in *Cassiope tetragona* at higher altitudes (cf. KRUUSE, l.c., p. 81–83, 132).

West of Cassiopefjeld runs a valley which bends in a wide U-turn around this mountain, ending with an extensive delta at the head of the Qíngertivaq (fig. 55). The part of this valley North and East of the Cassiopefjeld is filled by glaciofluviatile deposits levelled and continuously reworked by a braided meltwater stream fed by numerous tributaries. Halfway in this part of the valley a large lake is found (whereas KRUUSE sketched two lakes in his map). West of this lake the valley is occupied by mire vegetation belonging along the inner bend to the *Caricion curto-nigrae* and along the outer, northern bend to communities of the very rare basiphytic *Caricion bicolori-atrofuscae* (see 5.1.A.) and related communities. The part of the valley beyond this lake is more delta-like and characterized by a more differentiated topography, with comparatively dry banks and diminutive flattened dunes between the stream-beds, where the occurrence of extensive stands of the *Calamagrostion neglectae* is worth noting (cf. KRUUSE, l.c., p. 78–79, 126, 133; fig. 55, 57).

Along the eastern side of the fjord, opposite the Cassiopefjeld, the steep, about 1545 m high mountain Qáqarssuaq (Kakasuak) is situated. On its slopes here and there various herb communities occur, with, for instance, *Angelica archangelica*, and communities of the *Sedo-Thymion drucei* with, for instance, *Rumex acetosella* (cf. KRUUSE, l.c., p. 79–80, 127–129).

South of the Qáqarssuaq, on the scree along the fjord, stands the Falkefjeld, a rock outcrop rising at its western side as a sheer cliff above a small pond. This cliff is of special interest because of the occurrence (below the deserted nest of a pair of Gyr Falcons) of interesting epilithic cryptogamic plant communities, dominated by the bright orange lichen *Caloplaca elegans* on the rock and by the moss *Orthotrichum blyttii* along the fissures (cf. KRUUSE, l.c., p. 75, 129–130).

The locality is of special phytogeographical interest because of the isolated occurrence of several plantspecies including the orchid *Corallorhiza trifida* (fig. 58) and the moss *Catoscopium nigritum* (cf. BÖCHER, 1956, p. 13–14).

3.7. Locality VII: Ilivnera (Itivdleq), about 66°9′N–37°22–29′W.

The Ilivnera valley runs from the Qíngertivaq valley to the Sermilik fjord, forming a wide, level valley occupied by an extensive mire with several large pools and here and there palsas (see 3.3.), which drains through a calm wide stream in a westerly direction (fig. 39).

The plant cover of the mire belongs in principle to the *Caricion curto-nigrae*. On the shores, at the foot of the slopes of the mountains lining the valley, one may observe various dwarf shrub heath and snow-bed communities. In a few places valley glaciers come down almost to the bottom of the valley. The precincts of these are characterized by chionophytic communities dominated by hepatics (*Cephalozia ambigua*, *Cephaloziella arctica*).

3.8. Locality VIII–X: Ikâsaulaq (Ikerasausak).

The Ikâsaulaq is a long, narrow, western branch of the Angmagssalik Fjord, flanked on both sides by more or less continuous mountain chains of less jagged appearance than along the Qîngertivaq (3.6). KRUUSE visited the fjord in 1899 and 1902, in particular the inner part and the delta and valley at its head (KRUUSE, 1912, p. 89–97). According to KRUUSE's and my own observations the fjord shores give the same general impression in terms of the plant cover as those of the Qîngertivaq and Tasîlaq (see 3.5. and 3.6.). From KRUUSE's study (KRUUSE l.c., p. 91) we may conclude that the delta at the head of the fjord is not covered with such interesting alluvium communities of the *Calamagrostion neglectae* as found at the heads of the Qîngertivaq and the Tasîlaq, perhaps except for some communities with *Calamagrostis neglecta* (*Calamagrostetum neglectae*).

In 1969 we investigated:

3.8.1.: LOCALITY VIII, at about 65°59′ N–37°27′ W, situated in the inner part of the fjord on the western shore just beyond a spit of land projecting far into the fjord. The bedrock here consists of grey gneiss.

3.8.2.: LOCALITY IX, at about 65°55 ½′ N–37°20′ W, a granite area halfway in the fjord on the eastern side.

3.8.3.: LOCALITY X, at about 65°51½′ N–37°10½′ W, near Qârtulâjik at the entrance of the fjord about 2 km West of Maries Havn and Griseøen. Noticeable in this granite area are the well developed moss communities in some meltwater rills dominated by *Hygrohypnum ochraceum*.

B. TERMINOLOGY

In this section is given a brief explanation of some terms as used in this publication, which refer to the ecology and other aspects of the relation plant-environment (such as life-forms and growth-forms) and the relation plant-vegetation unit as well as to some arctic (–alpine) geomorphological phenomena. The reader is referred to handbooks such as BRAUN-BLANQUET (1964) for the explanation of the employed terminology of the Zürich-Montpellier school of phytoecology (plant-sociology).

accessory taxon. Taxon occuring with more or less the same presence, abundance, cover and vitality in two or more vegetation units, not showing a higher fidelity to a given vegetation unit than to the other units in the investigated area.

acidophytic. Of plants growing in acid environments, viz. with a pH lower than 5.5. I prefer this neutral term over the term acidophilous which implies a supposed preference of the plant in question for such conditions.

aerohygrophytic. Of plants growing in humid air in a comparatively dry substrate.

amphiphyte. Terrestrial plant tolerating a long-continued submersion and even able to develop special water forms, but unable to achieve its generative cycle when all vegetative parts are submerged or floating at the surface; e.g. *Juncus bulbosus, J. subtilis, Echinodorus ranunculoides, Alopecurus aequalis;* hence amphibious.

anemophyte. Plant growing in wind-exposed places, which in arctic and alpine areas implies a thin, temporal discontinuous to absent snow cover in winter; syn.: chionophobe, the antonym of chionophyte/chionophilous.

aquatic. Of plants growing permanently in water. See: water plant.
basiphytic. Of plants growing in alkaline or basic environments with a pH higher than 7.0.
batrachiid. Aquatic, caulescent rhizophyte with specialized floating leaves and spatulate or finely dissected submerged leaves; generative organs rising above the water surface or not. Tendency to develop terrestrial forms; e.g. several species of *Ranunculus* subgen. *Batrachium* and of *Callitriche.*
block. An angular rock fragment over 256 mm in diameter showing little or no modification in form due to transportation.
boulder. A term for large rounded blocks of stone lying on the surface of the ground or sometimes embedded in loose soil, different in composition from the rocks in the vicinity, which must have been transported by natural means from a distance; similar in size to a block.
braided stream. A braided stream is one flowing in several dividing and reuniting channels resembling the strands of a braid, the cause of division being the obstruction by sediment deposited by the stream.
ceratophyllid. Aquatic, submerged pleustophyte with finely divided leaves and without floating leaves; in summer near the surface of the water, but in autumn sinking to the bottom, hibernating by turions; e.g. *Cerathophyllum, Utricularia.*
chalicophyte. A gravel slide plant.
chamaephyte Plant life-form; plant whose surviving buds or shot apices are borne on shoots very close to the ground or on it; hence bryochamaephyte, referring to bryophytes.
chasmophyte. Plant rooting in fissures and cracks in rocks.
chionophyte. Plant growing in snow-beds.
chomophyte. Plant growing in crevices in rocks and on ledges where rock debris has accumulated.
corrie. A deep, circular, steep-walled recess in a mountainside caused by glacial erosion; syn.: cirque (French), Kar (German), Botn (Swedish).
crenophytic. Of plants growing near or in springs.
cryoturbation. Frost action including frost heaving.
differential taxa combination. A certain combination of taxa which as such is characteristic of a given vegetation unit, whereas the relevant taxa (with the exception of possibly included faithful taxa) are individually not characteristic of that unit.
differential taxon. Taxon occuring more frequently in a given vegetation unit than in certain other units compared which that unit.
elodeid. Aquatic, caulescent rhizophyte with undivided ,submerged leaves and without specialized floating leaves; generative parts rising above the water surface or not; e.g. many species of *Potamogeton, Elodea.*
eutrafent. Of taxa mainly or exclusively growing in environments rich in nutrients.
eutrophic. Rich in nutrients (environment).
eutrophied. Of environments (commonly aquatic) which have become richer in nutrients than previously, often in consequence of direct or indirect human influences.
exclusive. The highest degree of fidelity of a faithful taxon, viz. when the occurrence of that taxon is restricted to a single given vegetation unit and when it is only exceptionally found in other units in the investigated area. See: fidelity.
faithful taxon. Taxon showing a higher fidelity to a given vegetation unit than to the other units in the investigated area.
fell-field. Physiognomic vegetation unit or formation, viz. sparse, very open vegetation of xerophytic species of tufted habit, characteristic of windswept, desert-like stony

barrens, mobile screes, extensive flat-lying terraces and the like in northern alpine and arctic areas.

fidelity. The phenomenon that a certain taxon shows a higher presence, a higher mean abundance or degree of cover, or at least a greater vitality in a given plant community than in one or more other ones as compared with that community, in the same investigated area. See: faithful taxon, exclusive, selective, preferent. The degree of fidelity can be deduced from the scale of Szafer-Pawlowski (BRAUN-BLANQUET, 1964, p. 95).

flushing. The process counteracting the normal process of leaching of mineral salts from the upper layers of the soil in humid areas, whereby the vegetation is affected in eutrophic or calciphytic direction; wet flushing acts by the agency of percolating water, dry flushing by gravitational addition of fresh mineral particles, biotic flushing by supply of nutrient salts via the litter of deep rooting plants.

frost heaving. The lifting of a surface by the internal action of frost. It generally occurs after a thaw when the soil is filled with water droplets and when a sudden drop of the temperature below freezing changes the droplets into ice crystals, which involves expansion and consequently an upward movement of the soil.

geophyte. Plant life-form; plants the perennating organs (buds, rhizomes, etc.) of which are more deeply buried than the surface layer of the substrate and therefore are but little exposed to the influences of the unfavourable season.

guanophytic. Of environments manured by birds nesting or frequenting in masses on the spot.

helophyte. Marsh plant rooting under water and with the stem and leaves at least partly above the water.

hemicryptophyte. Plant life-form; plants with the perennating organs situated at the level of or in the soil surface; hence bryohemicryptophyte, referring to bryophytes.

hydrophytic. Of plants characteristically growing under very wet conditions such as mires.

hygrophytic. Of plants living in moist conditions.

isoetid. Aquatic rhizophyte with a short stem, a rosette of stiff radical leaves, and with or without stolons; e.g. *Isoëtes lacustris*, *Littorella uniflora*, *Lobelia dortmanna.*

mesophotophytic. Of plants growing in moderately sunny habitats.

mesophytic. Of plants growing in moderately humid conditions.

mesotrafent. Of taxa mainly or exclusively growing in environments moderately rich in nutrients.

mesotrophic. Of environments moderately rich in nutrients.

metatrophic. Of (aquatic) environments subjected to a rapid change in the nutrient content (usually oligotrophic environments which owing to a disturbance of the original situation by men or animals have become eutrophied); hence: metatrafent.

minerotrafent. Of taxa growing in minerotrophic conditions.

minerotrophic. Of environments influenced by mineral supply by the groundwater.

mire. A small muddy marsh or bog with wet, spongy earth or soft, deep mud, including the vegetation of such sites. This term is used by, for instance, MCVEAN & RATCLIFFE (1962), PERSSON (1961), and SONESSON (1970), as the shortened term for all soligenous peat lands in alpine regions, whereas "fen" is traditionally used for lowland topogenous mires only, at least in Britain.

myriophyllid. Aquatic caulescent rhizophyte with finely dissected, submerged leaves and without floating leaves; generative parts rising above the water surface; e.g. *Hottonia*, *Ranunculus circinatus*, *R. confervoides.*

neutrophytic. Of plants growing in more or less neutral environments with a pH of 5.5 to 7.0.

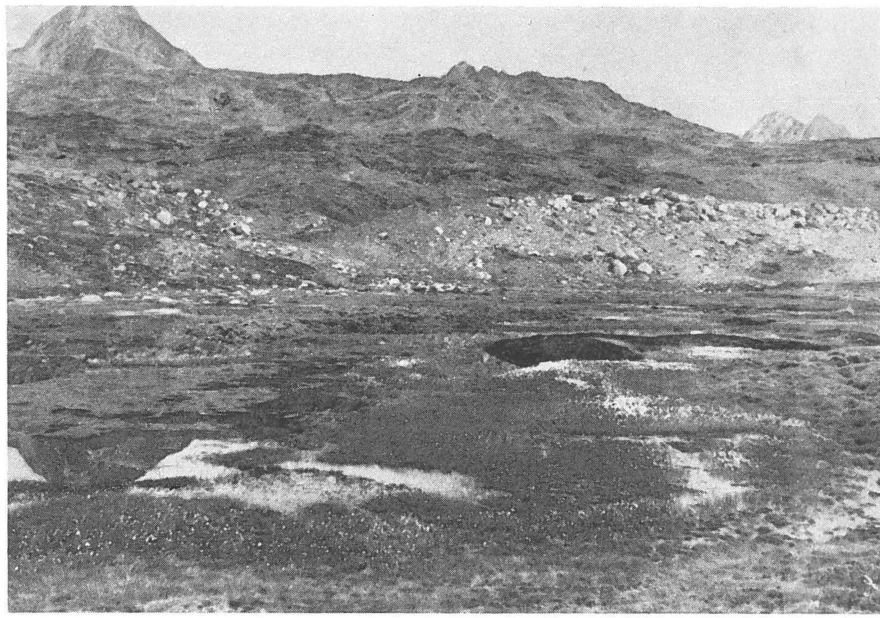


Fig. 10. Palsas in a small mire near Qortortup imîlâ (Kong Oscars Havn). To the right an older palsa (dark hummock), to the left a recently developed one (light coloured hummock). JGdM phot. VII. 1969.

nitrophytic. Of plants growing in environments rich in nitrogen (nitrates, etc.).
niveo-aeolian. Term applied to deposits arranged by the combined action of wind and snow, viz. sands, vegetative particles and other loose material deposited by the wind on snowdrifts where this material is held by the surface as the snow partially melts due to insolation and/or becomes covered by fresh snow.
nunatak. An isolated hill or peak which projects through the surface of a glacier or ice sheet.
nymphaeid. Aquatic rhizophyte with a little or not branched stem and longly petiolated floating leaves, in some cases also with submerged leaves; e.g. *Nuphar*, *Nymphaea*, *Potamogeton natans*.
oligotrafent. Of taxa mainly or exclusively growing in environments poor in nutrients.
oligotrophic. Of environments poor in nutrients.
ombrotrafent. Of taxa growing in ombrotrophic conditions.
ombrotrophic. Of environments in which the water and the nutrients therein dissolved originate exclusively from the atmosphere and not from the groundwater.
outwash. Drift deposited by meltwater streams beyond active glacier ice.
palsa. Hummock-structure with an ice-core surrounded by wet areas, in permafrost regions in arctic and alpine conditions (an originally Lappish word meaning a dry, low ridge, usually in a bog or mire). In the Angmagssalik District presumably a comparatively ephemeral phenomenon (cf. RUUHIJÄRVI, 1960, p. 237; SONESSON, 1970, p. 11; fig. 10).
periglacial. Refers to areas, conditions, processes, and deposits adjacent to the margin of a glacier or ice sheet.
permafrost. Permanently frozen subsoil.
photophyte. Plant growing in sunny habitats.

pleustophyte. Aquatic, macroscopical plant floating freely in the water and whose assimilatory organs are submerged or float on the water surface.
pond. A body of water which at least to some extent has a mineral shore.
pool. A body of water in a mire surrounded by mire communities on peat.
preferent. The lowest degree of fidelity of a faithful taxon, viz. when not the presence, but the abundance or degree of cover, and/or the vitality of that taxon in a given vegetation unit is higher than in all other units in the investigated area. See: fidelity.
psychrophytic. Of plants growing in comparatively cold conditions.
rheophytic. Of plants growing in rapidly flowing water.
rhizophyte. Plant with its basal parts penetrating into the bottom or covered by the substrate.
roche moutonnée. A glacially abraded, rounded bedrock eminence.
scree. A heap of rock waste at the base of a cliff or a sheet of coarse debris mantling a mountain slope.
selective. One of the degrees of fidelity of a faithful taxon, viz. when the presence of that taxon in a given vegetation unit is higher than in all other units in the investigated area. See: fidelity.
skiophyte. Plant growing in shaded habitats.
snow-bed. This English equivalent of the German "Schneetälchen" as used since its introduction by HEER (1835), refers to a certain arctic-alpine habitat, viz. a sheltered place where, owing to topographical features, large masses of snow accumulate each winter. The plants growing in snow-beds enjoy the protection afforded by the snow cover in winter and are assured a continuous water supply from the melting snow throughout the growing season but must be adapted to an even shorter growing season than those occupying more exposed habitats; syn.: late snow area.
snow-patch. A more arctic plant habitat, usually a rather shallow depression in the landscape, where, owing to the prevailing wind, a showdrift forms regularly each winter, affording protection for the plant cover beneath it. The snow drift melts early and does not keep the habitat moist throughout the growing season; syn.: latish snow area.
solifluction. The process of slow flowage from higher to lower ground of masses of waste saturated with water over a solid subsoil (either frozen ground or bedrock).
talus. A collection of fallen disintegrated material which has formed a slope at the foot of a steeper declivity.
thermophyte. Plant growing in habitats with a comparatively warm macroclimate, mesoclimate, or microclimate.
therophyte. Plant life-form; annual plants which die at the approach of the unfavourable vegetative season through which they pass in the form of seeds or spores.
tropohydrophytic. Term referring to plants growing in periodically inundated places.
vicariants. One or more closely related syntaxa or floristically much similar syntaxa which are geographically (or ecologically) mutually exclusive.
vicariate. The phenomenon that two vicariants (vicarious syntaxa) are geographically (sometimes ecologically) mutually exclusive.
waterplant. Plant which is able to achieve its generative cycle when all vegetative parts are submerged of are supported by the water (floating leaves), or which occurs normally submerged but is induced to reproduce sexually when its vegetative parts are dying due to emersion.
xerophytic. Refers to plants that characteristically live under dry conditions.

C. DESCRIPTION OF THE VEGETATION UNITS

Chapter I

Aquatic and amphibious vegetation

The large, often very deep and cold lakes occurring here and there in the Angmagssalik District are virtually devoid of higher plantlife. In summer this is restricted to the warmed, shallow, and often temporarily (partly) dry ponds, pools and puddles. Such bodies of water are in particular found only in the less mountainous part of the district, viz. the southern part of Angmagssalik Ø, Torssukátak and Tasîlâlik (cf. KRUUSE, 1912, p. 281–284; BÖCHER, 1933, p. 106–107).

The vegetation types of the pools are grouped in the mire-complex (chapter III), that the of spatially more isolated ponds and puddles with more or less stagnant water in the *Charetea*, the *Potametea* and the *Littorelletea*, and are discussed here.

The aquatic and amphibious plant communities in the district are usually very poor in taxa, and occur often side by side, separated by a narrow or broader transitional zone. The study of such communities at high latitudes and altitudes where the same taxa occur has been rather neglected. Detailed syntaxonomical and synecological studies are mainly carried out in the central European Alps. This holds namely for the still problematic *Littorelletea*. The classification of this class in the northern alpine and arctic regions complicated by the limited number of represented taxa and the comparative instability of the environment.

I therefore base the classification of these plant communities to a considerable extent on the life-forms and the synecology, and, moreover, on the similarity and parallelism with the classification employed in more extensively studied regions, namely Central and West Europe (DEN HARTOG & SEGAL, 1964). This similarity leads to distinguishing small basal units, which are characterized by only one or a very few faithful taxa and a considerable variability in the composition of the accessory flora, depending on the general severity of the environment, which is usually correlated with the altitude and latitude.

1. Class *Charetea* (Fukarek 1961 n.n.) Krausch 1964.

Faithful taxa are nearly exclusively *Charophyta*, namely *Chara aspera* Willd., *C. hispida* L., *C. tomentosa* L., *C. aculeolata* Kütz., *C. delicatula* Ag. The class comprises submerse charophyte-communities in clear, mainly stagnant, (eutrophic to) mesotrophic to oligotrophic, oligohaline to mesohaline waters with sandy bottoms; almost cosmopolitic (Den Hartog & Segal, 1964; Krausch, 1964; Westhoff & Den Held, 1969).

1.1. Order *Charetalia* Sauer 1937.

Kruuse (1912, p. 145, 147, 284) reports the occurrence of *Nitella transluscens* (Pers.) Ag. on the Amarqâq peninsula in the Angmagssalik District. This Charophyte forms there a dense plant cover on the sandy bottom of some deep ponds of limited extent, from 1 or 2 to at least 4 m in depth. The water in these ponds is cool, clear, rich in oxygen and presumably somewhat turbulent. From the recorded aquatic flora of these ponds it appears that the water is probably more or less mesotrophic.

Krausch (1964) was reluctant to consider the communities which are predominantly composed of this and some other *Nitella* taxa as belonging to the *Littorellion*. Den Hartog & Segal (1964) hold the view that these should be grouped in the *Charetea* because of ecological differences between these syntaxa (mainly concerning the depth of occurrence), presumably as the representatives of a separate alliance (*Nitellion?*).

2. Class *Potametea* (R. Tüxen & Preising 1942) Den Hartog & Segal 1964.

syn.: *Nymphaeetea* Klika 1944. Faithful taxa of the class are *Potamogeton natans* L., *P. pectinatus* L., *P. compressus* L., *P. obtusifolius* Mert. et Koch, *Myriophyllum spicatum* L., *Ceratophyllum demersum* L. The syntaxon comprises submerse communities mainly consisting of elodeids, myriophyllids, batrachiids and nymphaeids in fresh and slightly brackish water. It has presumably a holarctic, circumpolar distribution. (cf. Braun-Blanquet, 1948b, 1954; Den Hartog & Segal, 1964; Westhoff & Den Held, 1969).

2.1. Order *Parvopotametalia* Den Hartog & Segal 1964 em. Westhoff 1968.

syn.: *Potametalia* W. Koch 1926 p.p. (sub nom. *Potamogetonetalia*). Faithful taxa of the order are *Potamogeton crispus* L., *P. pusillus* L., *P. berchtoldii* Fiebr., *Elodea canadensis* Michx., *E. nuttallii* (Planch.)

ST. JOHN. In this syntaxon are grouped the communities of small elodeids, myriophyllids and batrachiids, which occur in shallow, to 1 m deep, sheltered mesotrophic to eutrophic and oligohaline waters such as pools, ponds etc. The order occurs presumably at least in most of the Eurosiberian region, including Greenland.

2.1.1. All. *Parvopotamion* (VOLLMAR 1947) DEN HARTOG & SEGAL 1964.

syn.: Potamion W. KOCH 1926 em. OBERDORFER 1957 p.p. (sub nom. *Potamogetion*). Faithfull taxa of the alliance are *Potamogeton* L. sect. *Graminifolii*, *Ranunculus circinatus* SIBTH. To this syntaxon are considered to belong communities of small elodeids and a few myriophyllids in stagnant, shallow waters of small demensions (see further 2.).

2.1.1.1. Ass. *Potametum filiformis* W. KOCH 1928.

syn.: *Potametum alpini* BR.-BL. 1949 n.n.

table 1:1,2.

composition: Characteristic of this syntaxon, and of its occurrence in the Angmagssalik District is the dominance of *Potamogeton filiformis* PERS. Faithful taxa of the association as such are, besides *P. filiformis*, *P. alpinus* BALB. and *P. praelongus* WULF. In general the composition varies from "pure" *P. filiformis* stand to quite well developed associates comparatively rich in taxa. The latter are in particular restricted to lower altitudes and latitudes (cf. KOCH, 1928; BÖCHER, 1954; OBERDORFER, 1957; VOLLMAR, 1947; GAMS, 1927). As a rule, especially when *P. filiformis* dominates, it is very poor in taxa and of more or less variable composition.

physiognomy: In "pure" stands of this elodeid community the dense plant cover is one-layered, up to 50 cm high; in stands with sterile *Sparganium angustifolium* it is two-layered, *S. angustifilium* forming an open undergrowth (table 1:2).

The community forms dense, submerse fields of thread-like, dark green "grassy" plants.

synecology & habitat: The generally boreal to montane-alpine and low-arctic, submerse hydrophytic, mesotrafent to eutrafent and often somewhat alkaliphytic and oligohalophytic (cf. BENUM, 1958), neutrophytic community occurs in the Angmagssalik District in sheltered, several meters deep ponds, at 0,75 to 1,5 m depth in cool, clear, stagnant to feebly moving water (either owing to turbulence caused by wind or to currents) in the coastal area at abt. (3–)15 to 20 m a.s.l.

The bottom of these ponds consists of sand, which becomes rapidly stony with increasing depth. The surface is covered with a thin layer of finely dispersed organic detritus.

The colorimetric pH of the rhizosphere is abt. 6.

succession & zonation: The association presents presumably a (semi-)permanent pioneer community ("Dauergesellschaft"). The zonation is given in fig. 12.

distribution: The syntaxon is very rare in the district (Amarqâq; cf. KRUUSE, 1912, p. 145–148, 281–284), just like elsewhere in Greenland (FREDSKILD, 1961; BÖCHER, 1963). It is also rare in montane and sub to low-alpine areas in North and Central Europe. The general area is probably circumpolar (cf. HULTÉN, 1968, p. 78).

syntaxonomy & discussion: In spite of the rather variable floristic composition the association is generally accepted as a well defined and delimited syntaxon.

2.1.2. All. *Callitricho-Batrachion* DEN HARTOG & SEGAL 1964.

syn.: incl. *Batrachion fluitantis* NEUHÄUSL 1959 p.p., *Ranunculion aquatilis* PASSARGE 1964.

Faithful taxa of this alliance are *Ranunculus* L. subgen. *Batrachium* (DC.) A. GRAY (exclusive of *R. circinatus*), *Callitriche* L. sect. *Callitriche* (exclusive of *C. verna* s.str.?). This syntaxon comprises communities composed mainly of batrachiids, some elodeids and some myriophyllids, in very shallow and often temporarily dry rivulets, brooks, ponds and upwellings; frequently in metatrophic waters (see also the class and the order). The alliance occurs in Central and Northern Europe and in Greenland.

2.1.2.1. Ass. *Callitricho-Sparganietum angustifolii* BR.-BL. 1919.

(sub nom. *Sparganium affine-Callitrice verna* var. *minima* Ass.)

syn.: *Sparganietum* RÜBEL 1912 n.n., *Sparganietum affinis* W. KOCH 1928; incl. *Micrasterieto-Sparganietum* GUINOCHET 1938, *Sparganium angustifolium* soc. BÖCHER 1963.

table 1:3–5.

composition: Faithful taxa are *Sparganium angustifolium* MICHX. (= *S. affine* SCHNIZL.), *S. diversifolium* GRAEBN., *S. simplex* HUDS. (= *S. emersum* REHM.), *Callitriche verna* L. (= *C. palustris* L.) var. *minima* HOPPE.

The rather variable set of accompanying taxa includes *Eleocharis acicularis*, *Alopecurus aequalis*, *Ranunculus flaccidus*, *R. reptans*, *Hippuris vulgaris*, *Drepanocladus exannulatus*, *Scorpidium scorpioides*, *Sphagnum platyphyllum* (BRAUN-BLANQUET 1948a, 1954; LÜDI, 1921; KOCH, 1928; GUINOCHET, 1938; OBERDORFER, 1957; ALLORGE, 1925; BÖCHER, 1933; 1963; FREDSKILD, 1961). As BRAUN-BLANQUET states, "Le plus souvent elle (i.c. the association) reste fragmentaire, ne réunissant que 2–3 espèces, toujours accompagnées de nombreuses Algues planktonique, Desmidiacées surtout" (see also GUINOCHET, 1938). In the Angmagssalik District,

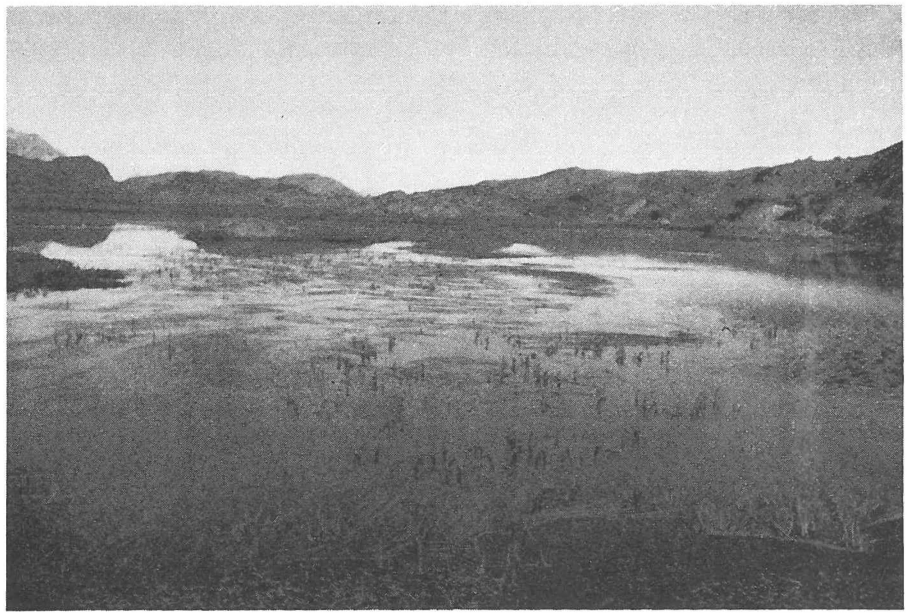


Fig. 11. The *Callitricho-Sparganietum angustifolii* in the pond Sparganiumdammen in the Elvbakker area.
JGdM phot. VIII. 1968.

as well as commonly in the rest of Greenland and alpine Central Europe, the associates representing the syntaxon consist, in fact, usually of two cormophytes, *S. angustifolium* and *D. exannulatus*.

physiognomy: In this district the predominantly nymphaeid community usually forms more or less one- or two-layered plant covers, wich consist of (1) a well developed or absent bottom layer of bryophytes (pleurocarpous), and (2) a well developed herbaceous field layer of *S. angustifolium*.

"Im August sieht es dort aus wie auf einer gemähten Wiese. Die breiten flutenden Blätter, mit der dicklichen Unterseite im Wasser, bedecken das Wasser, so dass die Oberseite trocken ist und durch das dichte Nebeneinanderlegen den Eintruck hervorruft, als läge Gras auf Land" (RÜBEL, 1912, p. 192; cf. also BRAUN-BLANQUET, 1954, p. 20; fig. 11). Close by the pond bottom often appears to be covered by fine beds of dark-brown aquatic mosses.

synecology & habitat: The boreal to low-arctic and montane to low-alpine, submerse to emerse-floating hydrophytic, oligotrafent to weakly mesotrafent (cf. SAMUELSSON, 1934, p. 37) and somewhat dystrafent, medium acidophytic to neutrophytic community occurs in the district in extensive stands in shallow, less than 1 m deep ponds and pools commonly with a level bottom and usually without distinct super-

ficial supply and discharge of water, rarely temporarily dried up, but as a rule between 10 to 75 cm depth below the watersurface (elsewhere to 120 cm, see OBERDORFER, 1970, or even 150 cm depth, see BRAUN-BLANQUET, 1954, p. 20); in clear, stagnant or intermittently turbulent but as a rule not flowing water, which in the course of the spring and the summer is gradually warmed up by insolation; also, but, less common, on level lake bottom in the shallow water of quiet bights along the shore of deeper ponds with flowing water; it is only observed in the coastal area, from 10 to at least 80 m a.s.l.

The substrate consist of an abt. 10 to 15 cm thick layer of somewhat sandy, loose flaky, more or less coherent dygyttja which is sometimes partly loose, amorphous peaty, overlying a superficially sandy, deeper gradually stonier subsoil; in more exposed places the dygyttja layer may be very poorly developed or absent. It is often covered and gradually passing into a to 15 cm thick, loose moss layer with microscopic algae (diatoms, desmids), which according to VAN DE WERFF (personal communication) suggest an oligotrafent to mesotrafent, halophobous, more or less acidophytic community.

The colorimetric pH of the rhizosphere varies from 5 to 6.

succession & zonation: See 2.1.1.1. When there exists a gradual transition from water to the lakeside fen the latter is characteristically dominated by *Sphagna* (*S. teres*, *S. riparium*) with *Comarum palustre* and *Carex rariflora*. See also fig. 11, 12.

distribution: The community is rare in the district (Tasîlâlik, Elvbakker, Amarqâq) as well as elsewhere in southern Greenland (cf. BÖCHER, 1963, fig. 48); it occurs also in northern and central Europe (see section composition) and has presumably a more or less circumpolar area (cf. HULTÉN, 1968, p. 67).

subdivision: In the district the syntaxon can be subdivided according to the absence or presence of a bottom layer:

(a) Variant *inops* (table 1:3), characterized by the absence of a well developed moss layer. It occurs in comparatively exposed habitats with respect to turbulence of the water caused by surface winds, and is also characterized by a comparatively thin to almost absent layer of dygyttja.

(b) Variant of *Drepanocladus exannulatus* (table 1:4–5), which is characterized by the occurrence of a well developed moss layer composed of *Drepanocladus exannulatus* .It is seen in the shallow zone along the shore and in shallow depressions in the bottom of shallow ponds and pools, more or less sheltered as regards the turbulence of the water caused by surface winds and consequently also with a well-developed layer of dygyttja on the bottom.

Table I

reference number		1	2	3	4	5	6	7	8	9
altitude (m)		20	20	20	20	80	45	20	20	20
total cover plants (in %)		45	50	70	60	100	90	10	20	75
cover phanerogams	–	45	50	70	2,5	15	60	10	20	75
– bryophytes	–	0	0	0	60	100	60	0	0	0
– open soil	–	95	95	98	40	0	–	–	95	95
pH rhizosphere		±6	±6	6	5	–	–	6	6	6
water depth (cm)		110	75	50	38	37	75	32	60	75
Potamogeton filiformis	B	4	4	+	..	..	..	+	1	..
Sparganium angustifolium	B	..	4	5	1	2	..	..	..	..
Ranunculus confervoides	B	..	..	..	..	..	5	2	3	5
Drepanocladus exannulatus	–	..	..	..	5	6	5	..	..	..
Hippuris vulgaris	B	..	..	+	..	1	..	1	..	..
Callitriche verna	B	..	..	+	..	..	..	+	..	..

syntaxonomy & discussion: The syntaxon represents an early recognized and described, well delimited "Braun-Blanquetian" association.

2.1.2.2. Ass. *Ranunculetum confervoidis* ass.nov.prov.

syn.: *Ranunculetum confervoidis* GAMS 1927 n.n.

table 1:6–9.

composition: Faithful taxon is *Ranunculus confervoides* (FR.) ASCH. & GRAEBN. (= *R. trichophyllus* CHAIX var. *eradicatus* (LAEST.) DREW, id. ssp. *lutulentum* (PERR. & SONG.) VIERH., id. ssp. *confervoides* (FR.) Soó; *R. paucastramineus Tausch.* var. *eradicata* LAEST., etc.; *Ranunculus aquatilis* L. var. *eradicatus* LAEST. etc.; also considered to be a taxon belonging to a separate, hydrophytic genus, *Batrachium* S. F. GRAY.).

The rather variable set of accessory taxa includes *Eleocharis acicularis* f. *submersa*, *Hippuris vulgaris*, *Ranunculus hyperboreus*, *Myriophyllum spicatum* var. *exalbescens*, *Drepanocladus exannulatus; rarely* also *Potamogeton filiformis* (sterile), *Calliergon richardsonii*, *Hypnum lindbergii* (cf. KRUUSE 1912, p. 146, 283; POLUNIN 1948, p. 80, 153, 199, 208, 219, 220; BÖCHER, 1954, p. 295; FREDSKILD, 1961, p. 51).

In general the composition varies from "pure" *R. confervoides* "sociations" to quite well developed associates comparatively rich in taxa. In the Angmagssalik District the community consists often of only one or two cormophytes, only *R. confervoides* or also *D. exannulatus.*

physiognomy: The, particularly when poorly developed, predominantly myriophyllid community is stratified in (1) a well developed or absent bottom layer of pleurocarpous musci, and (2) a well developed "field layer" of herbaceous taxa, dominated by *R. confervoides.*

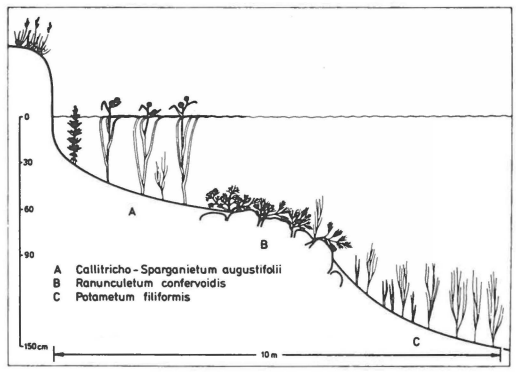


Fig. 12. Zonation in the aquatic vegetation along the shore of a pond on Amarqâq peninsula.

The appearance of the community is determined by the dark green submerse fields of *R. confervoides*, with its glistening white, much-branched axes conspicuous among the dark olive-green, finely divided flaccid leaves and submerse to floating solitary white flowers. On close examination it appears that the bottom is often covered by an undergrowth of fine beds of dark brown aquatic mosses. It usually covers small areas.

synecology & habitat: The sub to low-arctic and presumably boreal to temperate, montane to low-alpine, hydrophytic, rheophytic submerse (to partly floating), mesotrafent to eutrafent, somewhat alkaliphytic and/or oligohalophytic (cf. POLUNIN, 1948, p. 208; PORSILD, 1964), neutrophytic community is found in the Angmagssalik District in patches at 30 to 80 cm depth on the bottom of shallow, sometimes temporarily dried-up pools and ponds with flowing water, in deeper ponds and tarns near the shore, particularly where the depth suddenly increases (cf. fig. 12), and in slowly flowing, shallow, also occasionally drying up streams and rills, viz. in flowing or turbulent, clear, rather cool water; only in the coastal area from 20 to at least 45 m a.s.l.

The substrate is stony. Between the stones we find accumulated, fine to coarse sand, covered with a comparatively thin, discontinuous, dygyttja or sapropelium layer, and this in turn sometimes with a more or less coherent moss layer.

The colorimetric pH of the rhizosphere is abt. 6.

One may often meet with detached *R. confervoides* plants floating along sheltered lake shores.

succession & zonation: See 2.1.1.1. Usually the stands are noted to occur isolated from other vegetation types. See also fig. 12.

distribution: The community is very rare in the district (Elvbakker, Amarqâq); it is widely spread but rare in the rest of Greenland (cf. paragraph composition) and occurs also in Northeast Canada (POLUNIN,

l.c.) and presumably in northern and central Europe (cf. e.g. FRIES, 1913, p. 149; GAMS, 1927, p. 272). The area of the syntaxon is probably circumpolar (cf. HULTÉN, 1968, p. 470).

subdivision: The syntaxon in the Angmagssalik District can be subdivided conform the subdivision of the *Callitricho-Sparganietum angustifolii* in:

(a) Variant *inops* (table 1:7–9), and
(b) Variant of *Drepanocladus exannulatus* (table 1:6).

syntaxonomy & discussion: I distinguish this community and ascribe it tentatively to the rank of association after analogy with the above described associations (cf. the in the same alliance included temperate European *Ranunculetum fluitantis* ALLORGE 1922 and the *Ranunculetum peltati* (SAUER, 1947; SEGAL, 1967), thus recognizing the floristic variability of the syntaxon also as one of its characteristics and expecting that it is characterized elsewhere by one, or more, additional faithful or differential taxa.

3. Class *Littorelletea* BR.-BL. & R. TÜXEN 1943 em. DEN HARTOG & SEGAL 1964.

This class comprises amphibious plant communities, consisting mainly of isoetids, hydrophytes and amphiphytes, between the high and low water line on the sandy to loamy shore of oligotrophic to mesotrophic, sometimes dystrophic and oligohaline waters with a considerably fluctuating water level; in the boreal and low-arctic, suboceanic areas of the northern hemisphere. Faithful taxa are *Littorella uniflora* (L.) ASCHRS., *Echinodorus ranunculoides* (L.) ENGELM. ex ASCHRS., *E. repens* (LAMK.) KERN et REICHG., *Deschampsia setacea* (HUDS.) HACK., *Pilularia globulifera* L., *Elatina hexandra* (LAPIERRE) DC., *Juncus bulbosus* L., *Scirpus fluitans* L., *Potamogeton polygonifolius* POURR. (cf. DEN HARTOG & SEGAL, 1964; WESTHOFF & DEN HELD, 1969).

3.1. Order *Littorelletalia* W. KOCH 1926 em. DEN HARTOG & SEGAL 1964.

See the class.

3.1.1. All. *Subularion aquaticae* (SØRENSEN 1942) HADAČ 1971.

syn.: incl. *Subulariaflags* MØLHOLM HANSEN 1930; *Eleocharetum acicularis islandicum* SØRENSEN 1942.

The *Subularion aquaticae* has been recognized by HADAČ (1971a, p. 37) as the northern, sub to low-arctic (and boreal-alpine) vicariant of the atlantic, boreal to temperate European Littorellion uniflorae W. KOCH 1926 em. TH. MÜLLER & GÖRS 1960.

Both alliances are characterized by taxa which are not true hydrophytes, (DEN HARTOG & SEGAL, 1964, p. 370), such as *Alopecurus aequalis*, *Eleocharis acicularis*, *Juncus bulbosus*, *J. subtilis*, *Ranunculus reptans*, a taxa assemblage apparently characteristic of the transitional zone between land and water, between high and low water level.

The communities characterized by these taxa are as a rule in spatial contact with different coexisting communities as the aquatic ones at their lower border, the invading terrestrial ones at their higher border and, moreover, the ephemeral ones which may develop in the same zone during the period of emergence (viz. the *Nanocyperion flavescentis* W. KOCH 1926). These communities often occur in an intricate mosaic pattern, so that transitions often occur.

Comparing the *Littorellion* communities with the corresponding amphibious communities in the northern atlantic area of the *Subularion*, it appears that there can be observed a distinct floristic impoverishment which is mainly attributable to a marked disappearance of more temperate taxa, viz. most of the faithful taxa of the *Littorellion* (see HADAČ l.c., p. 37), at the transition in the subarctic and boreal-subalpine zones. This phytogeographical phenomenon is to a limited extent compensated by the appearance of such boreal to arctic taxa as *Subularia aquatica* and *Ranunculus reptans*, which HADAČ considers the characteristic (faithful) taxa of the syntaxon, and some other taxa (cf. HADAČ l.c.). Secondly, it appears that the dynamic environment becomes even less stable owing to the disturbing influences of heavy frost. This will result in a gradual obscuring of the separation between such communities and vegetation types related to the *Nanocyperion flavescentis* and the *Agropyro-Rumicion crispi* NORDH. 1940 em. R. TÜXEN 1950, as well as types of the therophytic *Koenigio-Microjuncion* SØRENSEN 1942. Further, there is often, owing to the local relief, influence of upwelling water from the surroundings. This frequently results in the occurrence of taxa more or less characteristic of spring vegetation.

A comparison of the rather incompletely known northern-alpine, subarctic and arctic, amphibious communities dominated by isoetids and characteristic of oligotrophic, mesotrophic and dystrophic waters with a fluctuating water level, shows, in my opinion, that these can nearly all be grouped in the *Subularion aquaticae*. This syntaxon is thus given a wider concept than originally proposed by HADAČ. The general floristic composition of this alliance varies considerably. This phenomenon appears to depend on gradual latitudinal and altitudinal differences and is continuous as such. This variation is, in my opinion, syntaxonomically fundamentally different from the discontinuous, floristic variation caused by the loss of a group of taxa at a certain phytogeographical, latitudinal or altitudinal limit or transition.

Table II

reference number		1	2	3	4	5	6	7	8	9
altitude (m)		20	130	130	5	20	130	130	130	130
total cover plants (in %)		50	<5	<5	100	100	20	10	15	50
cover phanerogams –		50	<5	<5	80	40	20	10	15	20
– bryophytes –		0	<1	0	55	95	<1	<1	1	40
– open bottom –		95	100	100	–	0	90	95	95	55
pH rhizosphere		4¾	6½	6½	4¾	4¾	6½	6½	6½	6½
max. depth of water (cm)		25	>36	>36	–	50	>29	>26	>26	>20
Subularia aquatica	B	4	1	1	2	..	+	+	+	+
Callitriche verna	B	3	+	+	..	..	..	..	..	..
Alopecurus aequalis	B	..	..	..	6	4	3	1	+	..
Juncus subtilis	B	..	..	..	..	..	+	2	3	3
Drepanocladus exannulatus		..	+	..	5	6	+	+	+	4
Polytrichum commune		..	..	..	..	..	..	..	+	1
Eriophorum scheuchzeri	A	..	..	..	..	..	..	..	..	+
Pohlia bulbifera		..	..	..	..	..	..	..	+	..
Hippuris vulgaris	B	+	..	..	..	..	..	..	..	..

Besides the mentioned gradual variation it is possible to recognize a basical variation which is uniform throughout the area of the alliance and correlated with certain environmental conditions, but independent of latitudinal and altitudinal differences.

Along this line of reasoning I interpret the mentioned continuous variation, and the resulting extreme floristic impoverishment under extreme conditions, as a characteristic property of the amphibic communities near the limit of aquatic plant life such as has been accepted for decades for the *Parvopotametalia* for instance, and I base the classification of the associations within the alliance on the ecologically determined, geographically uniform variation. This leads to a relatively narrow association concept, in accordance with the recent development in the syntaxonomical interpretation of the units in the vicarious Littorellion uniflorae.

3.1.1.1. Ass. *Callitricho-Subularietum aquaticae* ass.nov.prov.

syn.: various *Subularia aquatica* sociations, e.g. KALELA 1939; *Subularietum aquaticae* BÖCHER 1933 n.n.

table 2:1–3.

composition: Regional, selective faithful taxa are *Subularia aquatica* L. and *Callitriche verna* L. (= *C. palustris* L.). Accessory taxa are namely *Drepanocladus exannulatus*, *Hippuris vulgaris*, *Ranunculus reptans*. The community is usually entirely dominated by *S. aquatica* and poor in taxa (cf. KRUUSE, 1912, p. 106, 147; MØLHOLM HANSEN, 1930, table 17:1; KALELA, 1939, p. 319; BÖCHER, 1933, p. 107; FREDSKILD, 1961, p. 46).

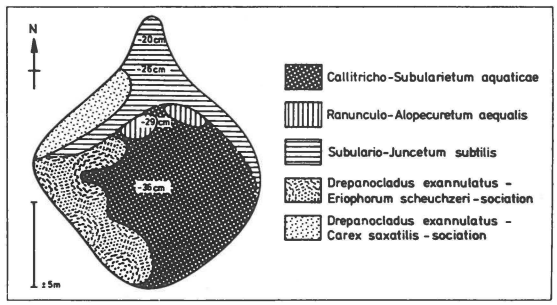


Fig. 13. Zonation in the pond Subulariadammen in the Elvbakker area; the depth of the water at the time of investigation is given in the sketch.

physiognomy: The therophytic and helophytic, isoetid community is not distinctly stratified in layers of different height. It forms inconspicuous, one to a few centimeters high, rather open patches in which the appearance of the muddy bottom or the sometimes present dull, brownish green mosses dominate the green, gregarious but scattered *S. aquatica* plants and the lighter green, star-like, scattered *C. verna* plants.

synecology & habitat: The sub to low-arctic and northern alpine, amphibious, oligotrafent, acidophytic to neutrophytic community occurs in the Angmagssalik District on the muddy bottom of spatially isolated temporary dry ponds and puddles in the coastal area from shortly above sealevel to abt. 130 m a.s.l. It is submerged in spring and early summer to a depth of 25 to 40(–50) cm in clear (to somewhat dystrophic), somewhat turbulent water; later on in summer and autumn it is intermittently, and shortly emerged.

The substrate consists of a $^1/_2$ to 1 cm thick, very loose, flocculent continuous layer of fine organic material (when submerged more or less floating), which develops polygonous cracks when it emerges but does not dry out so far as to become crusty. Below this layer one finds a 10 to 30 cm thick layer of amorphous, greasy, grayish brown loose humic material, which gradually passes into fine humic sand which latter at 34 to 40 cm depth lies on a subsoil of stony debris.

In winter the habitat is covered by ice or snow.

The colorimetric pH of the rhizosphere ranges from 4 $^3/_4$ to 6 $^1/_2$ and averages abt. 5.9.

succession & zonation: The course of the succession is presumably very slow to nearly stagnant. The hydrosere *Callitricho-Subularietum aquaticae*, *Ranunculo-Alopecuretum aequalis*, *Subulario-Juncetum subtilis* in the Angmagssalik District suggests a parallel succession, but the syntaxon is more probably gradually replaced by *Drepanocladus exannulatus-Eriophorum scheuchzeri* or *D. exannulatus-Carex saxatilis* sociations. See also fig. 13.

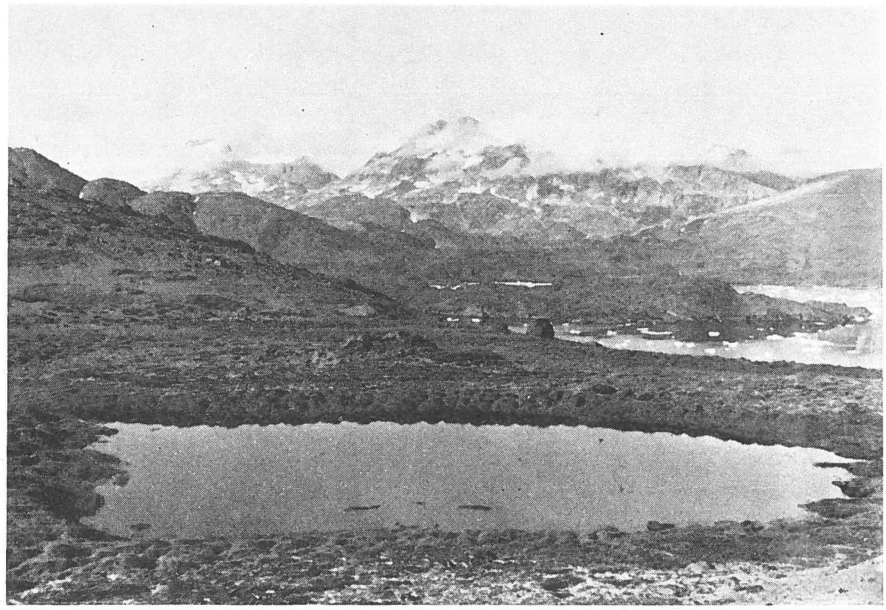


Fig. 14. Subulariadammen in early spring, with the Kong Oscars Havn in the background.
JGdM phot. VI. 1969.

distribution: The community occurs rather rarely inthe Angmagssalik District (Tasîlâlik, Elvbakker-Subulariadammen, Amarqâq; cf. also KRUUSE, 1912, p. 106, 146–147); it occurs also elsewhere in Greenland, as well as in Iceland and Fennoscandia (see section composition).

3.1.1.2. Ass. *Ranunculo-Alopecuretum aequalis* ass.nov.prov.

syn.: incl. *Alopecurus aequalis-Ranunculus reptans* Ass. NORDH. 1928; *Eleocharetum acicularis islandicum* SØRENSEN 1942 pro min. p.; *Alopecurus aequalis* mf. *natans*-Soz. KALELA 1939 n.n.

table 2:4–6.

composition: Regional, selective (to exclusive?) faithful taxon is *Alopecurus aequalis* SOBOL. (= *A. fulvus* SM., *A. aristulatus* MICHX.). Accessory taxa are *Subularia aquatica*, *Ranunculus reptans*, *Drepanocladus exannulatus* (all three more or less constant; *R. reptans* very rare in the Angmagssalik District for instance), further infrequently and in small numbers *Juncus subtilis*, *J. bufonius*, *J. bulbosus*, *J. alpinus*, *Veronica scutellata*, *Equisetum arvense*. The composition varies in general from fragmentary, "pure" *A. aequalis* stands with 2 to 3 taxa, to quite well developed associates comparatively rich in taxa in particular at lower altitudes and latitudes. (cf. KRUUSE, 1912, p. 106, 113, 146, 284; SAMUELSSON, 1917, p. 217; OSKARSSON, 1927, p. 407; MØLHOLM HANSEN,



Fig. 15. Temporary dry pond on a raised former beach along the Tasîlâlik fjord. On the dry bottom a community of the *Ranunculo-Alopecuretum aequalis*, along the edge a *Drepanocladus exannulatus-Carex saxatilis* sociation.

1930, p. 71; NORDHAGEN, 1928, table p. 465; SÖYRINKI, 1938, p. 59–60; KALELA, 1939, p. 319; KALLIOLA, 1939, p. 75; SØRENSEN, 1942, table 3:7–10; WASSÉN, 1965, p. 234).

physiognomy: The therophytic to hemicryptophytic, elodeid (to isoetid) community is in the district weakly stratified when submerged in: (1) a well developed or absent bottom layer with *Drepanocladus exannulatus*, *Subularia aquatica*, (*Ranunculus reptans*), and (2) a "field layer" of floating (when dry decumbent) *A. aequalis*. It forms, especially when dry, conspicuous graminaceous stands dominated by the whitish-greyish green, flaccid, floating, or when dry, lying grass, strewn with ascending spikelike panicles which are coloured brightly orange by the anthers.

synecology & habitat: The sub to low-arctic and northern alpine, amphibious, (eutrafent to) mesotrafent, metatrafent, guanophytic or nitrophytic and somewhat oligohalophytic, medium acidophytic to neutrophytic community is observed in the Angmagssalik District on the level bottom of spatially isolated shallow, temporary ponds or puddles (fig. 15) and in shallow water along the shore of somewhat deeper, isolated ponds and tarns in the coastal areas from less than 5 to abt. 130 m a.s.l. It is temporarily submerged to a maximum depth of 30 to 50 cm in spring and early summer in clear, stagnant to slightly turbulent water

more or less eutrophied by waterfowl, waders and sea gulls. In pools at very low elevations close to the shore there is an exceptional supply of saline water during high water at storm tides. The habitat is dry for a prolonged period from early to late summer and to late autumn (winter-early spring).

The substrate consists of a layer of somewhat compact, fine, amorphous greasy peaty material of (5–)18 to 50 cm thickness, which gradually passes into a subsoil of sandy to stony debris.

The community hibernates presumably (under or) enclosed in ice.

The colorimetric pH of the rhizosphere ranges from 4 $^{3}/_{4}$ to 6 $^{1}/_{2}$ and is on an average abt. 5.3.

succession & zonation: See 3.1.1.1., fig. 13, 15. The communities on the shore and bordering upon the community belong as a rule to the *Potentillo-Caricetum rariflorae*, the *Drepanocladus exannulatus-Carex saxatilis* sociation or to various chionophytic heath communities.

distribution: The community occurs scattered in the district (Tasîlâlik, Elvbakker, Amarqâq; also at Ise, cf. KRUUSE l.c.) and in Iceland and Fennoscandia (cf. paragraph composition).

subdivision: In the Angmagssalik District the syntaxon can be subdivided, in accordance with the subdivision of the syntaxa of the *Callitricho-Batrachion*, in:

(a) Variant *inops* (table 2:6), and

(b) Variant of *Drepanocladus exannulatus* (table 2:4,5).

syntaxonomy & discussion: The syntaxon shows ecologically affinity to the Bidention and the *Agropyro-Rumicion crispi*. It vicariates with the temperate European *Alopecuretum aequalis* BURRICHTER 1960.

3.1.1.3. Ass. *Subulario-Juncetum subtilis* ass.nov.prov.

table 2:7–9.

composition: Regional exclusive faithful taxon is *Juncus subtilis* E. MEY. In older publications, viz. KRUUSE (1912) this taxon is often erroneously referred to as *J. bulbosus* L. Constant accessory taxon is *Subularia aquatica*, elsewhere also *Ranunculus reptans*. Occasional accessories are for instance *Drepanocladus exannulatus*, *Polytrichum commune*, *Alopecurus aequalis*. The community is in general poor in taxa but little is known of the variability of the composition (cf. BÖCHER & LÆGAARD 1962, p. 171).

physiognomy: The hemicryptophytic, more or less isoetid community is not distinctly stratified. It forms inconspicuous, only a few centimeters high, more or less open, graminoid green stands with a distinct reddish hue, of limited extent.

synecology & habitat: The low-arctic (to subarctic and possibly northern-alpine), amphibious, mesotrafent to oligotrafent, neutrophytic community in the Angmagssalik District is found near the shore of spatially isolated, shallow, temporary ponds and puddles in the coastal areas from shortly above sea level to abt. 130 m a.s.l. In spring and early summer it is temporarily submerged to a depth of maximum abt. 40 cm in somewhat wind-exposed, turbulent, clear to dystrophic water; later it gradually emerges, to be dry for a comparatively long period.

The substrate consists of an upper, abt. 10 cm thick layer of comparatively compact, somewhat fine sandy, amorphous, greasy peat, which forms a crust when it dries out, and which rapidly passes into a subsoil of stony, diminishing humic sand.

Presumably the community hibernates enclosed in ice.

The colorimetric pH of the rhizopshere is abt. $6\,^1/_2$.

succession & zonation: See 3.1.1.1. and 2. and fig. 13.

distribution: The community is very rare in the district (Elvbakker-Subulariadammen, and is observed at Amarqâq, cf. KRUUSE 1912, p. 106, 146–148) as well as elsewhere in Greenland (cf. BÖCHER & LÆGAARD l.c.); The community presumably has a nearctic area (distribution maps of *J. subtilis* in BÖCHER 1938, fig. 133; HULTÉN 1958, p. 130).

subdivision: As the *Ranunculo-Alopecuretum eaqualis* in:

(a) Variant *inops* (table 2:7,8) and

(b) Variant of *Drepanocladus exannulatus* (table 2:9).

syntaxonomy & discussion: The syntaxon vicariates with the Icelandic *Subulario-Juncetum bulbosi* ass.nov. (SØRENSEN 1942, table 3:11–14) and the temperate European *Juncetum bulbosi* OBERDORFER 1957 em. PASSARGE 1964.

Chapter II

Spring vegetation

The hydrology of springs and shallow spring brooks, and the ecology and composition of the associated vegetation types has been studied frequently, but the descriptions in the literature referring to northern, alpine to arctic areas are mostly restricted to an enumeration of the observed species without regard to the zonation that is usually noticeable.

Because of the general topography of the area springs and spring-brooks are rather common in the Angmagssalik District. From the present study it appears that the conditions in Southeast Greenland are similar to those in northern Europe, and in the following is therefore mainly referred to publications and classification systems dealing with spring vegetation and its ecology in Fennoscandia.

Detailed studies carried out in the mentioned area have been published by NORDHAGEN (1943, p. 416–441), DAHL (1957, p. 200–210, 310–318) and PERSSON (1961, p. 133–151, and 1962).

From comparison with the works of these authors it appears that there are the following types of springs in the Angmagssalik District:

(a) Eustatic springs, which supply during the whole year or at least during the vegetation period fresh, flowing, oxygen-rich water, which varies little in temperature and chemical composition of the dissolved components. Characteristic of these habitats are communities of the *Montio-Cardaminetalia* PAWLOWSKI 1928. This type can be subdivided in:

(a1) Springs issuing non-calcareous, oligotrophic to eutrophic and neutral to acid water. The vegetation types associated with this type of spring are in the alpine regions of Scandinavia grouped in the *Montio-Epilobion hornemanni* NORDH. 1936; this syntaxon vicariates with the central European, colline to alpine *Cardamino-Montion* BR.-BL. 1925.

(a2) Springs issuing calcareous, eutrophic water. The vegetation types characteristic of this type of spring in the alpine region of Scandinavia NORDHAGEN grouped in the *Cratoneuro-Saxifragion aizoidis* NORDH. (1936) 1943, which vicariates with the central European ‚montane to alpine *Eucratoneurion commutati* suball.nov. (see 4.1.2. and 4.1.2.1.).

(b) Astatic springs, which supply water which varies temporary in quantity, temperature and chemical composition of the dissolved components. Associated with this type of springs in the Angmagssalik District are mainly plant communities belonging to the *Caricion curto-nigrae* which are dealt with in the next chapter on mire communities.

The directions of variation within spring vegetation are in particular discussed by the above mentioned authors (NORDHAGEN, 1943, p. 440–441; DAHL, 1957, p. 310–318; PERSSON, 1961: 147–151), especially the variation in the composition as well as in the degree of development of the field layer, and the spatial, floristic and ecological relation to other syntaxa.

DAHL (l.c., p. 317) has shown the correspondence between the mean annual temperature of the soil surface and the temperatures of the eustatic springs in alpine regions in Norway (Rondane). The zonation in the plant cover of such springs is usually more or less obvious, and DAHL (l.c., p. 313) supposes that this phenomenon is related to the temperature of the water.

4. Class *Montio-Cardaminetea* Br.-Bl. et R. Tüxen 1943.

syn.: *Aconito-Cardaminetea* Hadač 1962 p.p.

The class comprises communities rich in helophytes and commonly very rich in bryophytes, in eustatic springs and shallow spring brooks with clear, oxygen-rich water, which occur in the lowland to alpine areas of the Eurosiberian region and in low-arctic areas (e.g. Greenland, Canada). Faithful taxa are *Cardamine amara* L., *Epilobium alsinifolium* Vill., *Brachythecium rivulare* B.S.G. (cf. Braun-Blanquet, 1948b; Maas, 1959; Nordhagen, 1936, 1943; Oberdorfer *et al.*, 1967; Westhoff & Den Held, 1969).

4.1. Order *Montio-Cardaminetalia* Pawlowski 1928.

syn.: *Montio-Cardaminetalia* Pawlowski 1928 em. Maas 1959 + *Cardamino-Cratoneuretalia* Maas 1959.

For details see the class. The syntaxon is probably restricted to Europe, Greenland and presumably Canada.

4.1.1. All. *Montio-Epilobion hornemanni* Nordh. 1936.

syn.: *Mniobryo-Epilobion hornemanni* Nordh. 1943; *Epilobium hornemannii-Saxifraga stellaris* Type Böcher 1954 pro max. p.

In this alliance are grouped the crenophytic, bryophyte-rich communities of non-calcareous, more or less acid, mainly mesotrophic to eutrophic, cold eustatic springs and spring brooks which, from autumn to early summer are covered by a deep snow cover. It is restricted to the northern, alpine to arctic part of the area of the order (alpine northern Europe, Greenland, Canada). Faithful taxa are *Epilobium hornemanni* Rchb., *Montia lamprosperma* Cham. (very rare in the district); differential taxa regarding the geographical vicariating *Cardamino-Montion* Br.-Bl. 1925 (in the southern part of the area of the order) are *Petasites frigidus* (L.) Fr., *Ranunculus hyperboreus* Rottb. The syntaxon is in the same area, in calcareous habitats replaced by the *Cratoneuro-Saxifragion aizoidis* Nordh. (1936)1943.

4.1.1.1. Ass. *Mniobryo-Epilobietum hornemanni* Nordh. 1943.

syn.: *Saxifraga stellaris-reiche* Mooswiese + *Philonotis-Pohlia albicans*-Wiese Samuelsson 1916, *Stellaria nemoreum*-Wiese + *Petasites frigidus*-Wiese Kalela 1939, *Epilobium hornemanni-alsinifolium-Mniobryum*-sos. Vigerust 1949, *Weberetum albicantis* Gjaerevoll 1956, *Philonotis-Pohlia albicans* ass. Persson 1961 p.p., *Pohlietum glacialis* McVean & Ratcliffe 1962.

table 3:5–10.



Fig. 16. Moss community belonging to the *Mniobryo-Epilobietum hornemanni*. JGdM phot. VII. 1969.

composition: Regional, exclusive to selective faithful taxon is *Mniobryum wahlenbergii* (WEB. et MOHR) JENN. (= *M. albicans* (WBG.) LIMPR., *Pohlia albicans* (WBG.) LINDB., *P. wahlenbergii* ANDREWS, *Webera albicans* (WBG.) SCHIMP.). Frequent accessory taxa are in the Angmagssalik District namely *Poa alpina*, the extreme chionophytic *Cerastium cerastoides*, *Saxifraga stellaris;* in Scandinavia the most common accessory taxa are *Epilobium hornemanni*, *E. alsinifolium*, *Poa pratensis*, *Saxifraga stellaris*, *Cerastium cerastoides*. In general the number of these taxa is considerably higher there than in the Angmagssalik District (cf. SAMUELSSON, 1917, p. 203; KALELA, 1939, p. 370–373; NORDHAGEN, 1928, p. 546 and 1943, p. 423–429; VIGERUST, 1949, table 22; DAHL, 1957, p. 201; GJAEREVOLL, 1956, p. 396–397; MCVEAN & RATCLIFFE, 1962, p. 131–132; PERSSON, 1961, p. 142–144).

physiognomy: The predominantly bryophytic community (bryochamaephyta pulverulenta) is more or less two-layered: (1) a closed, thick bottom layer of acrocarpous musci, and (2) a more or less poorly to well developed, usually open field layer of vascular plants of various life-forms and height. It forms very conspicuous, waxy shining, pale greenish to light yellowish green, swelling carpets (fig. 16). At night the dew condenses as brilliant drops on the moss. Such drops also appear when the carpet is slightly pressed, and will roll like drops of mercury over its surface (cf. the vivid description in DAHL, 1957, p. 201).

synecology & habitat: The low-arctic and northern alpine, mesotrafent and minerotrafent, medium acidophytic, hydrophytic and extreme chinophytic, psychrophytic community occurs in the Angmagssalik District in eustatic springs, extending as swelling lobes into spring brooks or rills, and in the flush-zone along shallow rills and small brooks, more rarely also in irrigated soil below late or persistent snowdrifts, both in the coastal and inland areas up to considerable altitudes. It is found centrally in the spring where the water is coldest, and is capable of bearing a longer and thicker snow cover than the more excentral, other spring communities.

The substrate below the 5 to 6 cm thick moss carpet usually consists of washed, mineral, medium fine sand to fine gravel; in a single case it was observed to contain thin layers of buried, brown-black humus layers near the surface.

The habitat may be snow-covered until early July. The water level is as a rule found between 3 cm above to 5 cm below the surface of the moss.

The colorimetric pH of the substrate just below the moss ranges from 4 $^3/_4$ to 5 $^3/_4$ and averages abt. 5.

succession & zonation: The community presumably presents a (semi-)permanent pioneer community. The zonation is described in the preceding paragraph; see also fig. 17 and 18, and 4.1.1.2, 4.1.1.3. (synecology).

distribution: The community is of ordinary occurrence everywhere in the district, but usually covers small tracts; it is presumably also common elsewhere in Greenland, particularly in the more or less oceanic areas and also occurs in Iceland and Fennoscandia (see paragraph composition); the general area is probably circumpolar.

syntaxonomy & discussion: The qualitative and quantitative composition of the field layer of the different stands and in the different areas varies considerably (cf. PERSSON, 1961, p. 142–144). This phenomenon is presumably above all dependent on the depth and persistence of the snowcover and the rate of supply of water from the spring. In extreme conditions the stands consist of a dense, closed moss carpet devoid of vascular plants; this also applies to the *Philonoto-Saxifragetum stellaris*. For this reason GJAEREVOLL (1956, p. 396) refers to the syntaxon with the term *Weberetum albicantis*, but this name, though very suggestive, is superfluous (cf. also MCVEAN & RATCLIFFE, 1962, p. 131).

In view of the above mentioned observations a subdivision founded on the composition of the field layer seems impractical. The association presumably vicariates with the central European, subalpine to alpine *Bryetum schleicheri* BR.-BL. (1921) 1926 (Alps, Pyrenees).

4.1.1.2. Ass. *Philonoto-Saxifragetum stellaris* NORDH. 1943.

syn.: *Philonotis fontana* Soz. FAEGRI 1933, *Montia lamprosperma* spring MORK & HEDBERG 1937; *Philonotis-Pohlia albicans* ass. PERSSON 1961 p.p.

table 3:1–4.

Table III

reference nummer		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
altitude (m)		10	170	10	10	50	50	80	715	120	80	120	–	250	60	280
inclination		5	10	5	0	5	10	5	20	20	10	20	–	10	15	5
orientation		E	SW	E	E	SE	SE	S	S	S	S	S	S	S	SW	NW
total cover plants (in %)		100	100	100	100	100	95	95	85	100	100	100	–	95	100	90
cover phanerogams –		<5	20	30	40	<10	>10	<10	<1	2	<40	5	–	<10	1	<5
– bryophytes –		100	100	95	90	100	95	95	85	95	95	100	–	95	100	90
– open soil or water –		0	0	0	0	0	0	5	15	0	0	0	–	5	0	10
pH rhizosphere		5½	6¼	5	5½	5	5	4¾	5¾	4¾	4¾	4¾	–	5	4¾	–
water level below moss (-cm)		11	21	18	3	4	2	+3	1	+1	5	0	0	+½	–	–
idem below substrate surface		+2	5	0	+2	–	–	–	+5	+3	–	–	–	–	–	–
*Philonotis fontana**		6	6	6	5	1	+	..	..	..	1	..	..	..	..	2
Mniobryum wahlenbergii		..	..	..	..	6	6	6	6	6	6	1	10	..	..	..
Marchantia alpestris		..	..	..	..	..	..	..	..	..	..	6	100	..	..	..
Scapania uliginosa		..	..	..	..	..	..	..	..	..	..	..	..	5	6	6
Poa alpina	L	1	..	2	3	2	1	1	+	..	..	..	40	..	..	..
Equisetum arvense	B	..	1	2	+	+	+	..	..	..	..	..	..	..	..	..
Polygonum viviparum	A	..	..	1	2	..	..	..	..	+	+	1	20	2	+	1
Cerastium cerastoides	L	..	1	..	+	..	+	+	..	..	1	1	20	..	..	1
Saxifraga stellaris	L	..	..	..	..	..	2	1	..	..	3	..	20	..	..	..
Taraxacum croceum	L	..	..	..	2	..	+	..	..	..	+	1	20	..	..	..
Phleum commutatum	L	..	..	..	2	..	..	..	..	1	+	1	40	..	..	..
Comarum palustre	B	..	..	..	..	..	..	..	..	1	+	2	10	..	..	..
Deschampsia alpina	L	..	..	1	..	..	..	..	..	..	3	..	30	..	..	..
Carex bigelowii	L	..	..	3	..	..	..	..	..	..	1	..	..	1	+	..
Calliergon stramineum		..	..	+	1	..	..	..	..	1	..	..	..	..	+	..
Calliergon sarmentosum		..	..	..	..	..	..	..	..	..	..	..	..	..	+	2
Blindia acuta		..	..	..	..	..	..	..	..	..	..	..	..	3	..	..
Angelica archangelica	L	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Epilobium hornemanni	L	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..
Drepanocladus uncinatus		..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Mnium cinclidioides		..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Pohlia spec.		..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
Drepanocladus exannulatus		..	..	..	..	..	..	..	..	..	..	..	..	1	..	..
Cephaloziella arctica		..	..	..	..	..	..	..	..	..	..	..	..	1	..	..

Not recorded in the table are: *Pinguicula vulgaris* in sample plot 14(+); *Salix herbacea* 8(+); *Sibbaldia procumbens* 12(+); *Polytrichum alpinum* 8(+); *P. commune* 4(+); *P. sexangulare* 14(+); *Sphagnum teres* 14(+); *Gymnomitrium varians* 13(+). Explanation of column 12 in the text.

* *P. fontana* and *P. tomentella* which are in the district exceedingly difficult to separate from each other.

composition: Regional, exclusive to selective faithful taxon is *Philonotis fontana* (HEDW.) BRID., presumably also, or mixed with, *P. tomentella* MOL. Accessory taxa with a high frequency of occurrence are in the Angmagssalik District for instance *Poa alpina*, *Equisetum arvense*, *Cerastium cerastoides*, *Polygonum viviparum;* elsewhere, in northern alpine Europe this group includes *Epilobium hornemanni*, *Saxifraga stellaris* (rather rare in the Angmagssalik District), and, as differential taxa with respect to 4.1.1.1., *Montia rivularis*, *Phleum alpinum* (cf. FAEGRI 1933, p. 72–74; NORDHAGEN, 1943, p. 429–437; DAHL, 1957, p. 206–210; PERSSON, 1961, p. 142–144; MCVEAN & RATCLIFFE, 1962, p. 130–131).

physiognomy: Life-forms and structure of this community are identical with those of the previous association. It forms dull, glaucous-yellow green to olive-green, compact, deep moss carpets, in which the vascular plants occur as scattered individuals or in small groups (Fig. 16, lower left corner).

synecology & habitat: The low-arctic and northern alpine to subalpine, mesotrafent and minerotrafent, medium acidophytic to neutrophytic, hydrophytic and medium chionophytic community are found in the Angmagssalik District in eustatic springs and spatially more diffuse outflows of water ("durchsickerte Quellfluren"), in outlets of springs or as marginal lobes of vegetation extending into rills and small brooks, both in the coastal and inland areas at various altitudes. It occurs as a rule in a zone around or downstream following upon communities of the *Mniobryo-Epilobietum hornemanni*, sometimes also in mosaic pattern alternating with them.

The moss layer is 5 to 16 cm thick and often sagging through under its own weight and that of the retained water, so that the plants appear to be folded like an accordion in their lower parts; they are in fact much longer than the thickness of the layer suggests. The plants often show "annual rings" due to discontinuous growth.

The substrate is to a depth of 5 to 6 cm rich in raw humus to peaty; below this blackish layer it consists of washed, mineral, angular sand and fine gravel.

The habitat is covered by snow for a shorter time than the habitat of the *Mniobryo-Epilobietum hornemanni.* In summer the water level is found 3 to 18 cm below the surface of the moss.

The colorimetric pH of the substrate just below the moss layer ranges from 5 to 6 $^1/_4$ and averages 5 $^1/_2$

succession & zonation: See the preceding paragraph, 4.1.1.1.

distribution: See 4.1.1.1.

syntaxonomy & discussion: The syntaxon shows a similar variation in the composition of the field layer as the *Mniobryo-Epilobietum hornemanni* (cf. p. 47).

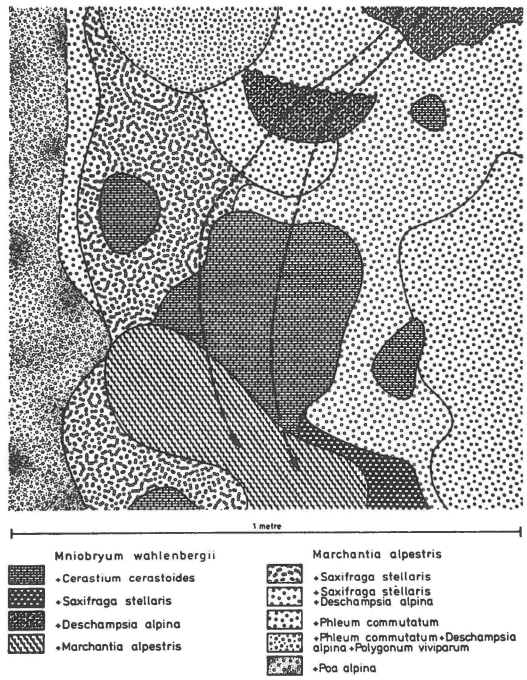


Fig. 17. Mosaic pattern in the plant cover in a small eustatic spring, in which the water wells more or less diffusely to the surface; the main concentrations in the waterflow are indicated by arrows.

PERSSON (1961, p. 142–144) does not distinguish two separate syntaxa, but unites the communities representing this and the previous syntaxon in northernmost Sweden in a single *Philonotis-Pohlia albicans* association. As the distinct spatial differentiation of these syntaxa depends largely on the degree of spatial concentration of the outflow of water it is not unlikely that some of his sample plots were studied in springs where they occurred in a small scale mosaic pattern, so that fragments of both are analysed in one sample plot. (cf. fig. 17).

The *Philonoto-Saxifragetum stellaris* vicariates with the atlantic, colline to montane European *Philonoto fontanae-Montietum* BÜKER & R. TÜXEN 1941.

4.1.1.3. Ass. *Phleo-Marchantietum alpestris* ass.nov.prov.

table 3:11, 12.

composition: Regional, exclusive to selective faithful taxon is *Marchantia alpestris* (NEES) BURGEFF (= *M. polymorpha* L. var. *alpestris* NEES). The accessory taxa are in general the same as those of the previous two syntaxa. Preferent differential taxa are *Phleum commutatum* and *Deschampsia alpina.*

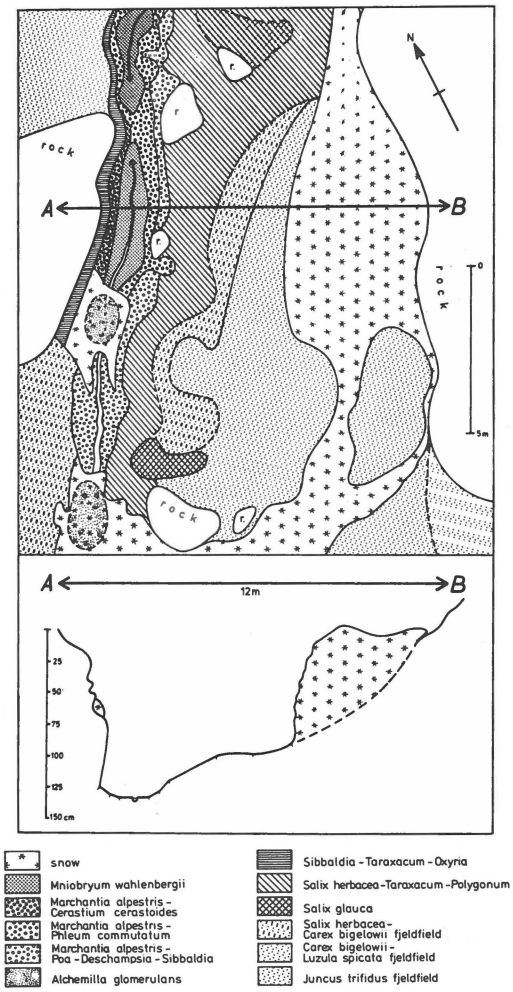


Fig. 18. Zonation in the vegetation in a gully in the Elvbakker area, in early spring. In and along the meltwater rill spring vegetation, bordering upon hygrophytic snow-bed vegetation in stable soil; further away from it mesophytic to xerophytic open communities in less stable soil.

physiognomy: The predominantly bryophytic (bryohemicryptophyta thallosa) community is stratified in (1) a closed bottom layer of predominantly thallose hepatics, and (2) a more or less poorly developed field layer mainly composed of scattered hemicryptophytic phanerogams of various height.

It forms stands of limited extent. The appearance is dominated by the dull, waxy shining, bluish-green closed leathery thallous moss or bottom layer, with here and there penetrated individuals or small clumps of herbs, grasses and other mosses.

synecology & habitat: The low-arctic and presumably northern alpine, mesotrafent and minerotrafent, more or less medium acidophytic, hydrophytic to hygrophytic and (extreme) chionophytic community can be noted in the Angmagssalik District in and along eustatic springs and in the flush-zone along cold rills and brooks, both in the inland and coastal areas of the district. It occurs in particular in narrow belts semicircular above, laterally along or sometimes in a mosaic pattern with communities belonging to the *Mniobryo-Epilobietum hornemanni* (cf. fig. 17), more rarely to the more excentrically situated *Philonoto-Saxifragetum stellaris*. With respect to depth and persistence of the snow cover it is intermediary between the two associations mentioned.

The substrate is more or less sloping. Below the closed moss layer it consists of coarse, washed mineral sand which is often filty-humic in the uppermost part.

The ground water moves obliquely or more or less parallel to the surface of the ground, which involves a certain closer setting of the soil-particles. Its level is usually close to or just at the very ground surface.

The single colorimetric pH measurement of the substrate just below the moss gave $4^3/_4$.

succession & zonation: See the preceding paragraph, the description of the *Mniobryo-Epilobietum hornemanni* and fig. 17 and 18.

distribution: The syntaxon is not uncommon everywhere in the district; presumably it also occurs elsewhere in low and middle-arctic Greenland, Iceland and Fennoscandia (cf. RESVOLL-HOLMSEN, 1920, p. 178–180). The general area is probably circumpolar.

syntaxonomy & discussion: The syntaxon is synecologically and floristically closely related to the other syntaxa of the *Mniobryo-Epilobion hornemanni*, and consequently grouped in this alliance.

The description is based on a single analysis of a sample plot (table 3:11) and on 9 floristic descriptions of stands in which *M. alpestris* covered nearly 100 % of the surface and the rest of the represented taxa maximum 15 %. These observations are combined in a constancy-table, which is also given in the table (table 3:12). Because of this procedure the syntaxon should be considered provisional.

The psychrophytic syntaxon is presumably vicarious with the temperate, colline european *Pellio-Conocephaletum* MAAS 1959 (syn.: *Cardaminetum amarae subatlanticum* (BR.-BL. 1926) R. TÜXEN 1937 p.p.).

4.1.1.4. Ass. *Scapanietum uliginosi* (SJÖRS 1946) DAHL 1957.

syn.: *Scapania uliginosa*-union SJÖRS 1946; *Scapania uliginosa* vegetation PERSSON 1961 p.p.; ? *Saxifraga stellaris*-Wiese, KALELA 1939.

table 3:13–15.



Fig. 19. Liverwort community dominated by *Scapania uliginosa* in the outflow of a small spring. JGdM phot. VIII. 1969.

composition: Regional, exclusive to selective faithful taxon is *Scapania uliginosa* (Sm.) Dum. *Drepanocladus exannulatus* can be conceived as a weakly differential taxon. Accessory taxa noticed in the Angmagssalik District are *Polygonum viviparum*, *Carex bigelowii*, *Calliergon stramineum*, *Philonotis fontana;* elsewhere, viz. in Fennoscandia, also *Saxifraga stellaris*, *Epilobium hornemanni*, *Sphagnum lindbergii*, *Deschampsia caespitosa* (cf. Sjörs, 1946, p. 78–82; Kalela, 1939, p. 376–377; Dahl, 1957, p. 210; Persson, 1961, p. 144–146).

physiognomy: The predominantly bryophytic community (bryohemicryptophyta reptantia) forms stands covering rather small areas. It is stratified in (1) a closed bottom layer dominated by reptant leafy liverworts, and (2) an usually sparse, open field layer with vascular plants of various life-forms and height. It forms conspicuous, dark, greenish to reddish black compact patches (cf. Persson, 1961, fig. 20; fig. 19).

synecology & habitat: The low-arctic and northern alpine, medium acidophytic, mesotrafent to oligotrafent and more or less minerotrafent, hydrophytic and chionophytic community occurs in the Angmagssalik District in late snow areas in more or less eustatic, cold, slowly moving water, viz. in rills issuing from spring or in springy places and on slightly sloping rock surfaces over which water, oozing from higher slopes, flows away, both in the inland and coastal areas. It is characteristic of less eustatic conditions than the three previous syntaxa.

The moss layer is up to 5 cm thick. The substrate consists, in contrast with the other vegetation types of springs, of coarse material, namely gravelly or stony, mainly colluvial material or solid rock. Below the moss layer one finds occasionally a 1 cm thick layer of raw humic to peaty organic material.

In winter the snow cover can presumably be compared with that over the *Mniobryo-Epilobietum hornemanni.*

The water supply is not constant. In early spring the moss layer is shallowly submerged and more or less floating; in late summer the habitat may dry out somewhat.

The colorimetric pH of the substrate just below the moss layer is close to 5.

succession & zonation: The community is presumably a (semi-) permanent pioneer. Spatially we often see it following communities of the *Philonoto-Saxifragetum stellaris* (cf. DAHL, 1957, p. 210), above *Racomitrium fasciculare* stands in drier places (cf. PERSSON, 1961, p. 146), also occassionally in mosaic pattern with (*Cephaloziella arctica-*)*Anthelia juratzkana* communities also in drier parts.

distribution: The community occurs everywhere in the district, but is not common; presumably it occurs scattered everywhere in the amphi-atlantic, boreal-alpine to arctic area of *Sc. uliginosa.*

syntaxonomy & discussion: See the corresponding paragraph in the description of the *Mniobryo-Epilobietum hornemanni* and PERSSON (1961, p. 144–150).

In Corsica there is a presumably vicarious association of *Scapania subalpina* and *Saxifraga stellaris* var. *obovata* LITT. & MALC. 1926.

4.1.2. All. *Cratoneurion* W. KOCH 1928.

This syntaxon comprises the crenophytic, bryophyte-rich communities of calcareous, neutral to weakly basic, eutrophic and more or less eustatic springs and spring brooks in the same area as the order. Faithful taxa are *Cratoneurum commutatum* (HEDW.) ROTH., *C. filicinum* (HEDW.) ROTH., *Saxifraga aizoides* L. (opt.). It vicariates ecologically with the *Cardamino-Montion* and the *Montio-Epilobion hornemanni.* (cf. BRAUN-BLANQUET, 1948b; MAAS, 1959; NORDHAGEN, 1943; OBERDORFER, 1957; and others).

4.1.2.1. Suball. *Cratoneuro-Saxifragion aizoidis* NORDH. (1936)1943.

See the alliance for the ecology and habitat. The unit occurs in the same area as the *Montio-Epilobion hornemanni* and is negatively differentiated from the northern European lowland and central European lowland to alpine calciphytic spring communities, the vicarious *Eucratoneurion* suball.nov., by the absence of *Arabis bellidifolia* JACQ., *Helio-*

Table IV

reference number		1	2
altitude (m)		20	20
inclination		>0	>0
orientation		(S)	(S)
total cover plants	(in %)	100	100
cover phanerogams	–	<50	50
– bryophytes	–	90	70
– open soil or water	–	0	0
pH rhizosphere	–	7	7
ground water level (-cm)		>10	>10
Catoscopium nigritum		6	5
Saxifraga aizoides	L	3	4
Equisetum variegatum	L	3	2
Pinguicula vulgaris	B	2	2
Polygonum viviparum	A	2	2
Bartsia alpina	L	+	2
Salix glauca juv.	L	+	1
Tofieldia pusilla	L	2	2
Campylium stellatum		+	2
Drepanocladus revolvens		+	1
Dichodontium pellucidum		+	..
Distichium inclinatum		+	..
Juncus arcticus	L	+	..
Carex bigelowii	L	..	+
Bryum pseudotriquetrum		..	+

sperma quadridentatum (MURRAY) SCHZ. et THELL., *Cochlearia pyrenaica* DC. and other central European, boreal calciphytes.

4.1.2.1.1. Ass. *Catoscopio-Saxifragetum aizoidis* ass.nov.prov.

table 4.

composition: Faithful (differential) taxa combination is *Saxifraga aizoides* L. and *Catoscopium nigritum* (HEDW.) BRID. Differential taxa in respect to the *Cratoneuro-Saxifragetum aizoidis* are *Bartsia alpina*, *Pinguicula vulgaris* and *Tofieldia pusilla*. Some conspicuous accessory taxa are *Equisetum variegatum*, *Polygonum viviparum*, *Salix glauca* (juv.), *Campylium stellatum*, *Drepanocladus revolvens*. The syntaxon is rather rich in taxa in comparison with the other represented syntaxa of the order in the Angmagssalik District, and related to the *Tofieldietalia*.

physiognomy: The bryophytic community (bryochamaephyta pulverulenta) is rich in hemicryptophytic and geophytic vascular plants. It is stratified in (1) a dense, closed and compact bottom layer of acrocarpous musci, and (2) a more or less closed to somewhat open, rather low field

layer of mainly herbaceous plants of various height. The community forms very conspicuous stands; the yellow to orange-coloured abundant flowers of the dense *S. aizoides* mats attract attention from far away, standing out against the dark, green to blackish brown fond of the moss layer.

synecology & habitat: The low-arctic, and probably also northern alpine, eutrafent and minerotrafent, calciphytic, basiphytic to neutrophytic, hydrophytic to hygrophytic and chionophytic community occurs in the Angmagssalik District in eustatic springy places, viz. in the slightly sloping flush-zone around the base of a semicircular debris-cone built by a tributary glacier-stream on the wet, level floor of a broad main valley filled with fluvioglacial deposits (fig. 25).

The substrate consists of silty to fine sandy outwash rich in calcite, which is at the surface somewhat brownish and humic and at 3 to 10 cm depth passes into a stony-gravelly subsoil.

The habitat is snow-covered all winter. The meltwater issuing from the nearby small icecap or firn field partly streams down superficially as a cascading meltwater stream over the debrid-cone, partly percolates down subterraneously through the cone. The ground water flows out along the whole margin of the cone at the level of the main valley as the direction of its flow is deviated there by the high ground water level in that valley. In early spring the water level rises above the ground, which can be deduced from the occurrence of less than 1 to 2 cm thick layers of silt in the living moss layer. Later on the water level falls to more than 10 cm below the ground suface.

The colorimetric pH of the rhizosphere is abt. 7

succession & zonation: The community is presumably a (semi-) permanent pioneer, which during raising of the substrate probably is replaced by *Salix glauca* scrub. Above the flush-zone there is an irregular, more or less fragmentary *Salix glauca* belt, and higher on the unstable debris-cone we meet with very open *Dryas integrifolia* vegetation. In front of the flush-zone communities of the *Caricion bicolori-atrofuscae* occur (fig. 25).

distribution: The community is very rare in the district, it is seen in fact in only a single locality in the valley turning West in the extension of the Qíngertivaq, where it covers a very extensive area of many hundreds of square meters (see for details on the locality 5.1.A.). It may be expected to exist elsewhere in Greenland as well as in arctic and boreal-alpine regions in general.

syntaxonomy & discussion: Calcareous springs and their characteristic vegetation are in the northern alpine to subalpine and arctic regions so far (to my knowledge) only studied in detail on the basis of analyzed sample plots by MORK & HEDBERG (1937, p. 662), KALELA (1939,

p. 375–376), NORDHAGEN (1943, p. 418–420), DAHL (1957, p. 210–212) and PERSSON (1961, p. 134–141) in Fennoscandia, and by MCVEAN & RATCLIFFE (1962, p. 133) in the Scottish Highlands. References to publications in which such vegetation types are mentioned are listed for instance by DAHL (l.c.) and PERSSON (l.c.). All the communities described by these authors are characterized by the moss genus *Cratoneurum*, and are grouped in the *Cratoneuro-Saxifragion aizoidis* in a single association, the *Cratoneuro-Saxifragetum aizoidis* NORDH. 1943. The new syntaxon described here apparently belongs to the same alliance. Regardless of the floristic composition, it differs from the *Cratoneuro-Saxifragetum aizoidis* also in habitat, of which I have the impression that it is less stable. It is on the other hand related to the *Caricion bicolori-atrofuscae*. NORDHAGEN (1936, p. 28) also observed that "die betreffenden Vereine (viz. of the *Cratoneuro-Saxifragion aizoidis*) nähern sich oft den Kalkliebenden Cyperaceengesellschaften der Verbände 'Schoenion' und 'Caricion bicoloris-atrofuscae' ".

In the foothills of the Alps in southern Germany the association is replaced by the *Catoscopietum nigriti* (LANGER 1958) BRAUN 1968, a syntaxon originally considered to represent a spring facies of the "*Schoenetum nigricantis* (W. KOCH 1926)" (cf. LANGER, 1958, p. 359–362; BRAUN, 1968, p. 19–20). Beside this syntaxon BRAUN distinguishes also a separate moss community, the *Catoscopium nigritum*-VEREIN (BRAUN, l.c., p. 108).

4.1.2.A. Note.

In the Angmagssalik District also an usually fragmentary, variable and rare community is found which is related to the *Cratoneuro-Saxifragion azoidis*. Because of its fragmentary development it was not studied in detail:

4.1.2.A.a. *Blindia acuta-Saxifraga aizoides* community.

Characteristic of this moss-rich community are *Blindia acuta* (HEDW.) B.S.G. (dominant in the more or less open to closed bottom layer) and *Saxifraga aizoides* L. (frequently codominant to dominant in the field layer). Accessory taxa are for instance *Luzula spicata*, *Oxyria digyna*, *Polygonum viviparum*, *Saxifraga oppositifolia*, *Selaginella selaginoides*, *Oncophorus*, *Solonostoma*, all occurring sparsely and the phanerogams often sterile.

The low-arctic and probably also northern-alpine, "chiono-indifferent", (hygrophytic to) hydrophytic, (mesotrafent to) eutrafent, and minerotrafent, neutrophytic and presumably calciphytic community is physiognomically similar to the *Catoscopio-Saxifragetum aizoidis*. As a rule it is more or less fragmentarily developed, both in the inland and



Fig. 20. Fragmentary *Blindia acuta-Saxifraga aizoides* community. JGdM phot. VIII. 1966.

coastal areas, occurring up to considerable altitudes (Tasîlaq, Amarqâq), where it covers small, more or less broad strip-like tracts on very steep, 65° or more inclined rocks of schistose gneiss. Over the rock a layer of water continuously percolates, and appears at the surface through cracks in the rock or at the base of the overhanging sod. The colorimetric pH of the thin earth layer in the basal part of the moss layer is abt. 7 (2 obs.).

The data of one analyzed sample plot are:
Locality: Imîlâjiva; altitude 2 m; inclination: 70°; orientation: SW; cover plants (total): 95 %; cover phanerogams: 20 %; cover cryptogams 90 %; cover bare soil, rock and litter: 50 %; pH rhizosphere: 7; water-level: + 0 cm. Composition:

Saxifraga aizoides	L	2–3	*Salix herbacea*	L	+
Agrostis borealis	L	+	*Saxifraga oppositifolia*	A	+
Bartsia alpina	L	+	*Selaginella selaginoides*	B	+
Carex scirpoidea	L	+	*Blindia acuta*		5
Luzula spicata	L	+	*Drepanocladus revolvens*		+
Oxyria digyna	A	+	*Mniobryum albicans*		+
Poa alpina	L	+	*Oncophorus wahlenbergii*		3
Polygonum viviparum	A	+	*Pohlia cruda*		+

Chapter III

Mire vegetation

In the following I only deal with the mires which are characterized by the absence of a well-developed dwarf shrub layer. In the Angmagssalik District the communities of the *Parvocaricetea* belong to this group; the remaining mire-communities with a well-developed dwarf shrub layer, which as a rule do not belong to this class (except for some which might appear to belong to the *Sphagno-Tomenthypnion*) will be treated by F. J. A. Daniëls in a future publication in this series.

The synecology and syntaxonomy of northern mires is a classical field of study in the Fennoscandian countries, particularly in Sweden and Finland. Major contributions to the knowledge of this subject have been made by Mentz (1912), Cajander (1913), Melin (1917), Osvald (1923), Malmström (1923), Kotilainen (1928), Booberg (1930), Paasio (1933), Kalela (1939), Kalliola (1939), Sjörs (1948, 1952), Du Rietz (1949), Dahl (1957), Ruuhijärvi (1960), Eurola (1962), Persson (1961), Sonesson (1970), Fransson (1972). Comparatively little is known of such communities in Greenland or elsewhere in the (low) arctic region.

The classifications used by most Fennoscandian investigators emphasize the importance of the composition of the bottom or moss layer, which in older studies has in particular often been more or less neglected by synecologists and syntaxonomists in Central Europe. These systems are mainly founded upon the communities of mires in the boreal lowland and subalpine regions (cf. Sjörs l.c.; Du Rietz l.c.; Fransson l.c.), and do not always prove to be suitable for the description and classifIcation of alpine Fennoscandian communities (Persson, 1961, p. 128).

In the alpine areas of Fennoscandia the large mire area is rarely developed. There is consequently no real mire expanse, so that the fundamental variation in mire expanse and mire margin which is usually applied as a major criterion in the classification of mire communities in the lowlands of Fennoscandia, cannot be determined and only vegetation of the mire margin type is to be expected. Also floristically, concerning the phanerogams, there can be observed a distinct difference between northern European montane and subalpine and northern European alpine mires (cf. Persson, 1961, p. 125).

Namely Nordhagen (1936, 1943), Kalliola (1939) and Dahl (1957) have employed a modification of the classification-methods of the Zürich-Montpellier school used in Central Europe, which they applied in contrast to alpine Fennoscandian mire vegetation. Nordhagen and

KALLIOLA attach less importance to the composition of the bottom layer than DAHL does, who in fact bases the classification in fundamental units on the dominance in this layer.

As DAHL (1957, p. 63) remarks, "it is wise to recognize that in some vegetation types the layers are relatively independent". In particular in the less rich mires many taxa appear to occur to a certain extent independently of each other. This applies notably to taxa of the field (and shrub) layer as opposed to those of the bottom layer, which is usually accompanied by the phenomenon that in each layer one taxon dominates, thus forming types often referred to as consociations.

This can also be observed in the low-arctic, oceanic mires in the Angmagssalik District. In consequence I have classified the units of the relatively poor mire complex on the basis of this quantitative character, as sociations. Such sociations I have grouped in sociation groups or complexes characterized by the fact that the dominant taxon in the their bottom layers is the same. On the other hand, it is in my opinion possible to classify the communities of the rich mires on the basis of more qualitative characters, viz. the combined criteria of fidelity and dominance; these communities I have described as associations.

In regard to the topography, the mires in the mountainous Angmagssalik District are mostly local and of small extent. Exceptions are the rather extensive mires near the Tasîlâlik fjord (Nagtivit) and the one in the Ilivnera valley near Nûk. These large and some smaller mires are characterized by the occurrence of (semi-)permafrost and palsa-like structures.

The mires in the district are (at least in part) fed by geogenous, namely as a rule (topogenous to) soligenous (or sometimes limnogenous) water and form minerotrophic mires (cf. PERSSON, 1961, p. 126). A differentiation in mire expanse and mire margin, as mentioned, and in a distinct hollow-hummock (Schlenken-Bülten) structure is hardly developed; as such they can be directly compared with the mires in the alpine region in Fennoscandia.

It seems possible, observing the restriction made in the first paragraph, to recognize fairly clearly three alliances of mire communities in the Angmagssalik District:

a. *Caricion bicolori-atrofuscae*, which comprises eutrafent, calciphytic and basiphytic (sometimes alkaliphytic), mainly arctic and northern alpine communities with scant peat formation or none, on slightly sloping, mineral, noticeably unstable soil with partially moving ground water and predominantly oxidizing conditions in the rhizosphere; the communities are floristically characterized by the presence of a group of arcto-alpine taxa, in particular *Juncaceae*, which are predominantly calciphytes; many of the bryophytes are acrocarpous, calciphytic musci;

b. *Campylio-Tomenthypnion*, in which are grouped mesotrafent to eutrafent, ± calciphytic, basiphytic to neutrophytic, mainly northern subalpine to low-arctic communities in sloping to level, predominantly organic (peaty), stable soil with little ground water movement and sometimes development of hydrogen sulphide in the rhizosphere indicating reducing conditions; the communities are characterized by the presence of many subalpine to low-arctic, ± calciphytic phanerogams and pleurocarpous musci;

c. *Caricion curto-nigrae*, which comprises mesotrafent, non-calciphytic, acidophytic to neutrophytic, widely spread boreal to arcto-alpine communities characteristic of localities with flowing water, in so-called intermediate fens where the water has a small amount of dissolved electrolytes (SJÖRS, 1946, p. 32, 41–46 and 1952, p. 248–249); it is characterized by the absence of calcicolous indicators (NORDHAGEN, 1943, p. 482) and the presence of indicator taxa of oxygen-rich surface water (mainly pleurocarpous musci; cf. DAHL, 1957, p. 216), although sulphide is sometimes developed deeper in the organic substrate.

d. Moreover, there occurs a fourth group of mutually closely related sociations, which is more or less related to the *Caricion curto-nigrae* as well as the *Rhynchosporion albae* (see 5.3.).

5. Class *Parvocaricetea* (WESTHOFF 1961 mscr.) DEN HELD & WESTHOFF 1969.

syn.: *Scheuchzerieto-Caricetea* (NORDH. 1936) R. TÜXEN 1937 p.p.; *Caricetales uliginosae* BR.-BL. & VLIEGER apud VLIEGER 1937 p.p.; *Sphagno-Caricetea fuscae* DUVIGNEAUD 1949 p.p.; *Sphagno-Drepanocladetea* DU RIETZ 1954 p.p.; incl. *Caricetalia fuscae* W. KOCH 1926 p.p.

The *Parvocaricetea* comprises minerotrafent, bryophyte-rich and graminoid-rich mire communities in mesotrophic to comparatively eutrophic, nitrogen-poor, acid to basic, sometimes calcareous, wet, commonly peaty but sometimes also mainly mineral soils with stagnant or fluctuating, always high ground water, in the arctic, boreal and temperate (in the South only in the alpine zones) parts of the Eurosiberian region inclusive of Greenland. Faithful taxa are *Pedicularis palustris* L., *Stellaria palustris* RETZ., *Calamagrostis neglecta* (EHRH.) G., M. et SCH., *Epilobium palustre* L., *Carex diandra* SCHRANK, *C. lasiocarpa* EHRH., *Comarum palustre* L., *Hydrocotyle vulgaris* L., *Riccardia pinguis* L., *Calliergon cordifolium* (HEDW.) KINDB., *Drepanocladus exannulatus* (B.S.G.) WARNST., *D. sendtneri* (SCHIMP.) WARNST. The class is in oligotrophic, acid and non-calcareous conditions replaced by the *Scheuchzerietea* DEN HELD, BARKMAN & WESTHOFF apud WESTHOFF & DEN HELD 1969 (cf. WESTHOFF & DEN HELD, 1969).

5.1. Order *Tofieldietalia* PREISING apud OBERDORFER 1949.

syn.: *Caricetalia fuscae* W. KOCH 1926 p.p., *Molinietalia* W. KOCH 1926 *sensu* R. TÜXEN 1937 and sensu HADAČ 1939 p.p., *Molinio-Caricetalia fuscae* DUVIGNEAUD 1949 p.p.; *Scorpidion* DU RIETZ 1949 p.p.; *Caricetalia davallianae* BR.-BL. 1949; *Tofieldietalia* MALMER (1964) 1968 prov. p.p.

The order comprises hygrophytic and tropohydrophytic, neutraphytic, basiphytic and frequently calciphytic, eutrafent and minerotrafent mire communities rich in taxa, in particular bryophytes and *Cyperaceae*, and is dominated by geophytes, hemicryptophytes and pleurocarpous mosses (further see the class). Faithful taxa are *Blysmus compressus* (L.) PANZER, *Carex adelostoma* KRECZ., *C. capillaris* L., *C. dioica* L., *C. flava* L., *C. frigida* ALL., *C. lepidocarpa* TAUSCH, *C. panicea* L., *Eleocharis pauciflora* (LIGHTF.) LINK., *Equisetum variegatum* SCHLEICH. *Eriophorum latifolium* HOPPE, *Juncus triglumis* L., *Molinea coerulea* (L.) MOENCH. var. *minima* BURKH., *Orchis incarnata* L., *Pinguicula vulgaris* L., *Primula farinosa* L., *Tofieldia calyculata* (L.) WAHLENB., *T. pusilla* (MICHX.) PERS., *Triglochin palustris* L., *Bryum marratii* WILS., *B. pseudotriquetrum* (HEDW.) GAERTN., MEYER et SCHERB. s.l., *Calliergon giganteum* (SCHIMP.) KINDB., *Campylium elodes* (LINDB.) KINDB., *C. polygamum* (B.S.G.) C. JENS., *C. stellatum* (HEDW.) C. JENS., *Catoscopium nigritum* (HEDW.) BRID., *Cinclidium stygium* SW., *Drepanocladus revolvens* (SW.) WARNST. s.l., *D. vernicosus* (MITT.) WARNST., *Tomenthypnum nitens* (HEDW.) LOESKE, *Mnium affine* FUNCK var. *elatum* B.S.G. et var. *rugicum* (LAUR.) B.S.G., *M. cinclidioides* HÜB., *M. pseudopunctatum* BRUCH. et SCHIMP., *Pellia endiviaefolia* DUM., *Riccardia multifida* DICKS., *Lachnea scutellata* GILIB. (BRAUN-BLANQUET, 1950, 1971; DAHL, 1957; NORDHAGEN, 1928, 1936, 1943; OBERDORFER, 1957; WESTHOFF & DEN HELD, 1969).

5.1.1. All. *Caricion bicolori-atrofuscae* NORDH. 1936.

syn.: Buntmoosbraunmoore KALELA 1939 p.p., *Salicion myrsinitis* KALLIOLA 1939 p.p., *Caricion atrofuscae-saxatilis* NORDH. 1943 p.p., *Euscorpidion* DU RIETZ 1949 p.p., *Salix myrsinitis-Campylium vegetation* PERSSON 1961 p.p.; incl. *Caricion bicoloris* and *Caricion atrofuscae* NORDH. 1935, *Ranunculus pedatifidus-Kobresia simpliciuscula*-Type BÖCHER 1954.

The subalpine and alpine northern European to arctic Greenlandic, eutrafent, minerotrafent and basiphytic to neutrophytic (to medium acidophytic), often calciphytic *Caricion atrofuscae-saxatilis* NORD. 1943 is an alliance with a rather heterogeneous content. Originally this led NORDHAGEN (1935, p. 91–92) to distinguish two separate alliances, the *Caricion bicoloris* and the *Caricion atrofuscae.* He considered the separ-

ation between these two syntaxa to be a "skjønsak", a matter of taste. Later, supplementary data obscured this line of separation to such an extent that NORDHAGEN became convinced that they should be united in a single alliance, the *Caricion bicolori-atrofuscae* (NORDHAGEN, 1936, p. 20–21). Because of a further extension of the concept of this syntaxon, he considered it in 1943 (NORDHAGEN, 1943, p. 451) appropriate to change this name to *Caricion atrofuscae-saxatilis*. The concept of this syntaxon was further extended by DAHL (1957, p. 22–28).

The more or less vicarious, montane northern and central European (probably Eurosiberian) *Caricion davallianae* KLIKA 1934 presents a comparable heterogeneity like the *Caricion atrofuscae-saxatilis*.
This gave several middle-European syntaxonomists reason for suggestions for a subdivision of said alliance (cf. BRAUN-BLANQUET & TÜXEN, 1943; PASSARGE, 1964; RYNBÍČEK, 1964; PIGNATTI, 1953; WESTHOFF & DEN HELD, 1969). This was in the beginning founded on differences in the composition of the vascular flora (viz. of the field layer), later also more and more involved considerations of the differences in the composition of the cryptogamic flora (particularly bryophytes, viz. of the bottom or moss layer) and environmental conditions. This tendency, including consideration of structural and phytogeographical aspects, is very appropriate and presumably provides the most fruitful combinations of practical criteria of classification at present.

On the ground of the mentioned criteria it appears in my opinion desirable and possible to attempt a satisfactory re-division of the heterogeneous *Caricion atrofuscae-saxatilis* in two floristic-phytogeographical and synecological homogeneous groups of syntaxa:

a. *Caricion bicolori-atrofuscae* NORDH. 1936 (not in DAHL's sense; DAHL, 1957). To this re-established alliance I consider to belong distinctly eutrafent, more or less open to closed mire communities with a variable degree of cover of the bottom layer, in calcareous, conspicuously unstable substrates (due to erosion and/or sedimentation by water, frost-heaving or solifluction; cf. also NORDHAGEN, 1943, p. 460; PERSSON, 1961, p. 51), with a fluctuating ground water level and moving ground water with a presumably high content of soluble minerals and salts, and limited or no production and accumulation of humus or peat so that vascular plants will root in the mineral substrate. Taxa, which are faithful or differential regarding the communities excluded from this syntaxon (see (b), in my opinion belonging to the *Campylio-Tomenthypnion*), are mainly distinctly alpine-arctic taxa such as: *Juncus arcticus* WILLD., *J. biglumis* L., *J. castaneus* SM., *J. triglumis* L., *Carex atrata* L., *C. atrofusca* SCHKUHR., *C. bicolor* ALL., *C. capillaris* L., *C. incurva* LIGHTF. (= *C. juncifolia* ALL., *C. maritima* GUNN.), *C. microglochin* WBG., *C. norvegica* RETZ.



Fig. 21. *Juncus arcticus*, characteristic of rich mires, found in the district at the heads of the Qíngertivaq and Tasîlaq, and at Nagtivit (distribution in Greenland, see GELTING, 1934, fig. 44). JGdM phot.VIII. 1969.

(= *C. alpina* LILJEB.), *C. parallela* (LAEST.) SOMMERF., *Scirpus* (= *Trichophorum*) *pumilis* VAHL. (= *S. alpinus* SCHLEICH.), *Equisetum variegatum* SCHLEICH., *Kobresia simpliciuscula* (WBG.) MACK. (= *K. caricina* WILLD., *Kobresia bipartita* (ALL.) DALLA TORRE), *Tofieldia pusilla* (MICHX.) PERS., *Saxifraga aizoides* L.; in the bottom layer *Catoscopium nigritum* (HEDW.) BRID., *Distichium* HEDW., *Oncophorus virens* (HEDW.) BRID., *Lachnea scutellata* GILIB. In the bottom layer also often *Drepanocladus revolvens* s.l. and *Campylium stellatum* occur.

In concept the alliance corresponds fully with the vicarious, alpine central European *Caricion juncifoliae* · BR.-BL. 1940 (cf. BRAUN-BLANQUET, 1971). In lowland to montane Europe both are replaced by the *Caricion davallianae* KLIKA 1934.

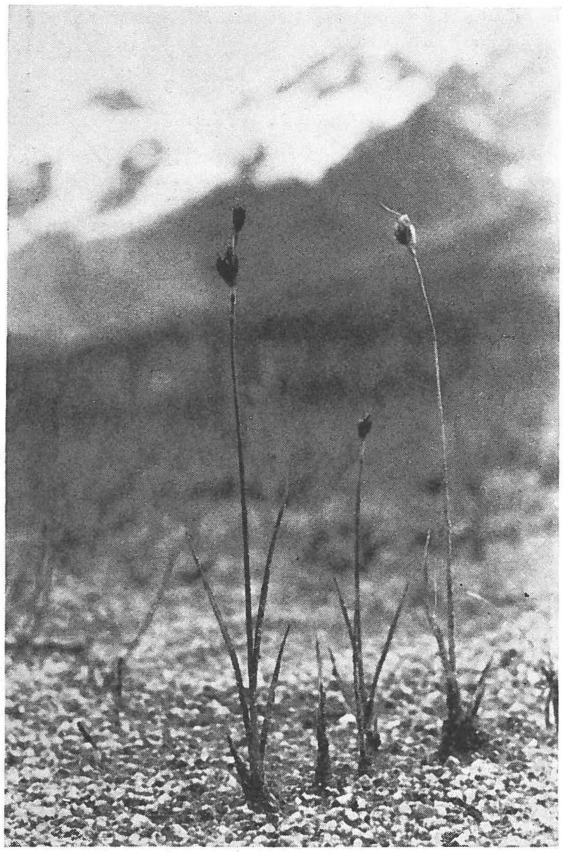


Fig. 22. *Juncus castaneus*, a species ecologically related to *J. arcticus* and found in the district only at the heads of the Qîngertivaq and the Tasîlaq (distribution in Greenland: see BÖCHER, 1938, fig. 130). JGdM phot. VIII. 1969.

Considering the indicative value of the different taxa with respect to the relation community-environment, I follow the classical classification of NORDHAGEN which is primarily based on the composition of the vascular flora (i.c. the field layer); this is also expressed in the nomenclature of the associations.

According to this concept the *Caricion bicolori-atrofuscae* comprises the *Caricetum atrofuscae-vaginatae* NORDH. 1943, *Junco-Caricetum bicoloris* ass. nov., *Caricetum bicoloris* LID. 1954 em.nov., *Caricetum microglochinis* NORDH. 1943, *Equiseto-Caricetum rariflorae* ass.nov., *Salicetum myrsinitis caricetosum* NORDH. 1943, *Caricetum saxatilis* NORDH. 1943 p.p., the communities of the *Ranunculus pedatifidus-Kobresia simpliciuscula*-Type BÖCHER 1954 and the *Scirpus pumilus*-sosiasjon NORDH. 1935. The syntaxon is restricted to

the (subalpine? and) alpine areas of North Europe (Fennoscandia) and Greenland. It is in this concept related to the *Calamagrostion neglectae*, in fact more or less intermediate between the *Tofieldietalia* and the *Myricarietalia germanicae* (8.2.).

b. *Campylio-Drepanocladion.* The communities of stable environments dominated by *Drepanocladus revolvens* s.l. and *Campylium stellatum* in the bottom layer are grouped in this new suballiance of the *Campylio-Tomenthypnion* all.nov. This group I consider to include closed communities in stable, undisturbed substrates with a dense bottom layer, with more or less constantly high, (very) weakly moving to stagnant ground water often comparatively poor in lime and presumably moderately rich in soluble nutrients, and with notable production and accumulation of humus and peat which provides the bulk of the rhizosphere. Taxa, which are faithful of this group or differential with respect to the *Caricion bicolori-atrofuscae* are mainly boreal montane and subalpine to subarctic taxa, such as: *Carex chordorrhiza* EHRH., *C. flava* L., *C. heleonastes* EHRH., *C. livida* WAHLENB.) WILLD., *C. lasiocarpa* EHRH., *C. panicea* L., *C. rostrata* STOKES, *Eriophorum angustifolium* HONCK., *E. latifolium* HOPPE, *Scirpus* (= *Trichophorum*) *caespitosus* L., *S. hudsonianus* (MICHX.) FERN. (= *Eriophorum alpinum*), *Molinea coerulea* (L.) MOENCH., *Menyanthes trifoliata* L., *Comarum palustre* L.; in the bottom layer *Campylium stellatum* (HEDW.) C. JENS. (optimum), *Drepanocladus revolvens* (SW.) WARNST. incl. var. *intermedius* (LINDB.) R. WILS. (optimum), *D. vernicosus* (LINDB.) WARNST., *Scorpidium scorpioides* (HEDW.) LIMPR., div. *Calliergon* (SULL.) KINDB. ssp.

This concept unites communities which were previously considered to belong to, or to be closely related to, the *Caricion atrofuscae-saxatilis* (cf. DAHL, 1957, p. 222–228), communities which are characterized by the composition of the bottom layer and the stability of the environment, while the composition of the field layer indicates affinity to various other syntaxa such as the *Sphagno-Tomenthypnion* DAHL 1957, as well as to the *Caricion curto-nigrae* W. KOCH 1926 em. NORDH. 1936 and the *Stygio-Caricion limosae* NORDH. 1943.

I consider this group of communities to belong to the *Campylio-Tomenthypnion* as a separate group of associations or new suballiance.

5.1.1.1. *Juncus castaneus-Juncus biglumis* community.

table 5:1–3.

compostion: Characteristic of this community is the occurrence of *Juncus castaneus* and *J. biglumis*. It is extremely poor in taxa, but its composition may vary somewhat in accordance with its status as an extreme pioneer community; on the one hand it is subjected to degradat-

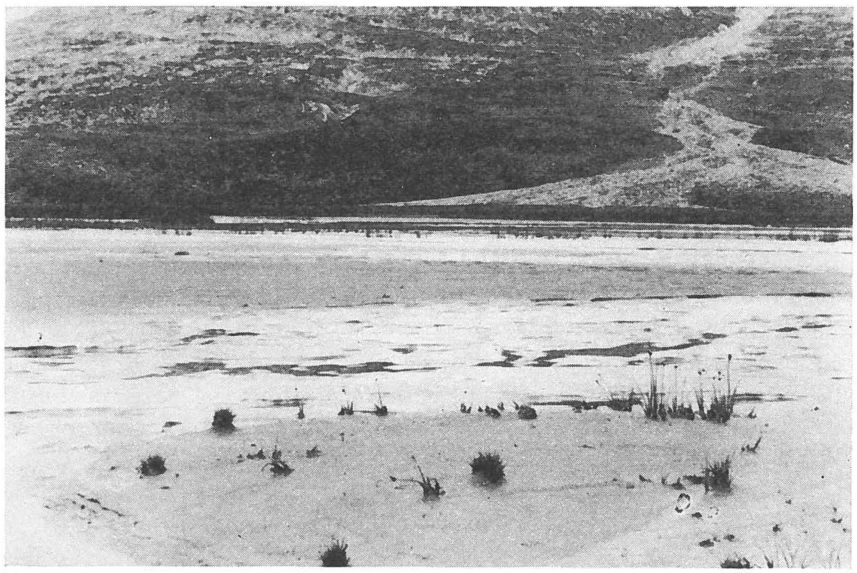


Fig. 23. *Juncus castaneus-J. biglumis* community on muddy shoal.
JGdM phot. VIII. 1969.

ion due to severe inundation and erosion, on the other, it is subjected to gradual invading of other taxa in the course of the development towards following successional stages.

physiognomy: This geophytic and hemicryptophytic community covers (very) small areas and consists of only a field layer, which is so open that the height of the represented taxa hardly results in a perceptable stratification. For an impression of the general appearance it is more illustrative to refer to fig. 23.

synecology & habitat: The low-arctic, slightly continental, eutrafent, more or less calciphytic, basiphytic, tropohydrophytic, presumably chionophytic pioneer community occurs in the Angmagssalik District as the first to invade emerging, muddy shoals and silty, low banks, which occur isolated or attached to larger, higher banks in between the braided meltwater streams on calcareous outwash deltas. The habitat is very unstable, being exposed to inundation, erosion and sedimentation (cf. 5.1.A.) and is snow-covered all winter.

The calcareous substrate consists at the surface of a few, 2 to $2^1/_2$ cm thick layers of silty to silty-medium fine (to partly coarse) sandy sediments, over ungraded, silty to gravelly fluvioglacial deposits.

The ground water becomes after emergence of the habitat in early summer, nearly stagnant in the uppermost part of the substrate, but remains slowly flowing in the deeper, coarse textured layers. The level of the ground water is in early August found at 0 to 3 cm depth.

The colorimetric pH of the rhizosphere is abt. $7^3/_4$.

zonation & succession: See p. 87–91 and fig. 28.

distribution: The community is very rare in the Angmagssalik District, where it is restricted to a single locality in the Qíngertivaq valley (see 5.1.A.). In that locality it is common, covering relatively small areas. The community possibly also occurs elsewhere in Greenland. From the distribution of the two *Juncus* taxa (cf. HULTÉN, 1968, p. 289, 294) it can be concluded that the community might have a circumpolar area.

syntaxonomy & discussion: I have refrained from ascribing to this community a certain syntaxonomical status and have described it as a community, a term without engagement, as I consider the data too limited and the nature of the community almost too ephemeral to provide a justified basis for classification. I presume that the community as such belongs to or is closely related to the *Caricion bicolori-atrofuscae* and therefore deal with it here.

J. biglumis grows in little tussocks with large interspaces, and the roots penetrate to abt. 13 cm depth. It is characteristic of unstable soil and also observed in wet, open, unstable soil subjected to solifluction in snow-bed habitats together with various small arcto-alpine *Marchantiaceae;* it is probably a very weak competitor. *J. castaneus* develops short stolons (cf. *J. arcticus*, p. 88; fig. 22) and roots very shallowly with roots of 5 to 10 cm length to 5 to 10 cm depth. It is occasionally observed to spread rather effectively in very unstable, often flooded environments such as the habitat of this community: the ripe seeds do sometimes not loosen from the inflorescence but germinate while still attached to it on dead, fallen-over stalks, which are still anchored to the spot by the attachment to the stolons.

5.1.1.2. Ass. *Junco-Caricetum bicoloris* ass.nov.

syn.: *Caricetum bicoloris* LID 1954 pro min.p.; non *Caricetum bicoloris* GAMS 1927 n.n.

composition: Regional faithful taxa are *Carex bicolor* ALL. (exclusive to selective faithful; in general faithful taxon of the alliance) and *Juncus biglumis* L. (selective within the alliance).

distribution: Arctic-subarctic to northern alpine; very discontinuous area (see paragraph syntaxonomy etc.).

5.1.1.2.1. Subass. *catoscopietosum* subass.nov.

table 5:4–8.

compostion: Differential taxa are *Catoscopium nigritum* (HEDW.) BRID. (faithful of the alliance), *Aongstroemia longipes* (SOMMERF.) B.S.G., *Bryum pallens* (SW.) SCHWAEGR., *Lachnea scutellata* L., *Salix*

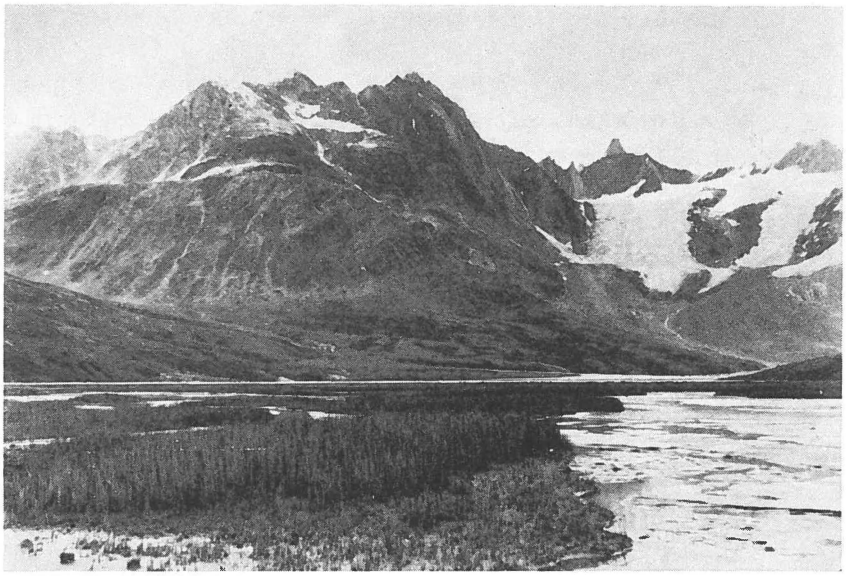


Fig. 24. Community of the *Junco-Caricetum bicoloris*, subass. *catoscopietosum*, variant of *Juncus arcticus* (central on the bank), surrounded by a transitional one intermediary between this type and the *Juncus castaneus-J. biglumis* community. JGdM phot. VIII. 1969.

glauca L. (juvenile). Constant accessory taxa are *Equisetum variegatum* and *Juncus castaneus*.

The qualitative and quantitative composition varies in correlation with the phase of development of the individual stands, depending on the degree of stability of the dynamic environment on the spot and the stage in the succession of the plant communities. On an average in one sample plot 13 taxa occur; the number of vascular and bryophytic taxa is on an average more or less equal.

Note: This syntaxon and the other communities which belong to the *Junco-Caricetum bicoloris* are of considerable interest because of the historical-phytogeographical aspects of their floristic composition (cf. NORDHAGEN, 1935, p. 85–94; GJAEREVOLL, 1950b; BRAUN-BLANQUET, 1971, p. 43–45; BÖCHER, 1956).

physiognomy: The predominantly rhizomatous geophytic community is as a rule stratified in three layers: (1) a very open to closed bottom layer of acrocarpous musci, (2) a to 12 cm high, open to closed lower field layer with *Carex bicolor*, *Equisetum variegatum*, *Salix glauca* juv., and (3) a 27 to 36 cm high, also open to closed upper field layer dominated by tall rushes (*J. arcticus*, *J. castaneus*). The appearance of the stand is quite variable and is therefore described with the variants of the syntaxon (paragraph subdivision).

synecology & habitat: The low-arctic (and probably also northern alpine), slightly continental, chionophytic, hygrophytic to tropohydrophytic, eutrafent, calciphytic and basiphytic "periglacial" pioneer community can be observed in the Angmagssalik District in calcareous mires on fluvioglacial, dynamic deltas deposited by highly ramified, continuously changing meltwater streams (BRAUN-BLANQUET, 1971, p. 45 speaks of the vicarious *Caricetum juncifoliae* in the Alps as a "Flusswandergesellschaft") and which are consequently affected by continuous processes of transport, sedimentation and redistribution of soil material (see for details p. 87–91). The community is found there on small, low, flat or slightly convex banks and on the comparatively high outer edge around more extensive, convex to concave banks (see also fig. 28), which are surrounded by very shallow, broad, usually more or less drying up muddy channels (figs 24, 25, 27).

Near the surface the substrate consists of little consolidated fluvioglacial, clayey-silty to medium fine sandy sediments, deeper down of coarse sandy to gravelly deposits. The sediments are well sorted and stratified in alternating, ($^1/_2$–)3 to 4(–8) cm thick layers of silty fine sand and (silty) medium fine to coarse sand. Humus has not been observed, and some (partly decomposed?) litter occurs only very locally and in infinitesimal quantities in the uppermost soil layer.

The habitat is snow-covered during the winter and becomes exposed rather late in spring, to be subjected thereupon to inundation and simultaneous erosion and/or sedimentation. In the summer, that is early August, the groundwater level is found at a depth of 0 to –35 cm. The ground water is then actuated by a very feeble current and is nearly stagnant at the surface of the soil.

The colorimetric pH of the rhizosphere ranges from $7^1/_4$ to $7^3/_4$ (8), and averages abt. 7.6.

zonation & succession: see p. 87–91 and fig. 28.

distribution: In the Angmagssalik District the community is presumably restricted to the locality where also the previous community occurs (see p. 68 and 87). In this locality it is well developed over large areas. It is possibly also seen elsewhere in Greenland and in other areas in the low-arctic and northern alpine regions.

subdivision: The quantitative composition of the syntaxon is rather variable, without this being directly correlative with qualitative differences. For this reason the subassociation in the district is subdivided according to the absence or gregarious occurrence of *Juncus arcticus*, which is clearly correlated with environmental conditions (see p. 88–90; cf. the subdivision of the vicarious central European, alpine *Caricetum juncifoliae* BR.-BL. 1918 in BRAUN-BLANQUET, 1971). This results in:

Table V

reference number		1	2	3	4	5	6	7	8	9	10	11
altitude (m)		20	20	20	20	20	20	20	20	20	20	20
inclination		0	0	0	0	0	0	0	0	0	0	0
total cover plants (in %)		1	5	<10	5	70	95	70	40	90	70	80
cover phanerogams –		1	5	<10	<5	65	60	50	40	85	65	80
– bryophytes –		0	0	<1	<3	5	60	60	1	15	25	<10
– litter –		0	0	0	0	0	0	0	0	0	0	0
– open soil . –		100	100	95	95*	50	15	35	80	40	50	60*
pH rhizosphere –		7 3/4	7 3/4	7 3/4	7 3/4	7 1/2	7 1/4	7 1/2	7 3/4	7 3/4	7 3/4	7 3/4
ground water level (-cm)		0	1/4	3	6	35	27	9	8	0	3	1/2
Carex bicolor	L	..	..	..	+	5	3	+	2	+	..	..
Juncus biglumis	A	+	1	..	+	..	..	+	..	..	+	..
Juncus castaneus	L	+	1	2	+	2	+	+	1	..	+	+
Equisetum variegatum	L	..	+	+	+	3	4	+	+	..	2	4
Salix glauca juv.	L	..	..	..	+	+	+	+	..	+	+	+
Juncus arcticus	L	..	..	+	..	..	4	5	4	1	1	..
Carex microglochin	L	..	..	..	..	..	..	..	+	6	5	6
Catoscopium nigritum		..	..	..	+	1	4	5	+	3	4	2
Bryum pallens		..	..	..	+	1	1	+	+	..	+	+
Distichium inclinatum et *capillaceum*		..	..	..	+	+	+	1	..	+	+	..
Aongstroemia longipes		..	..	..	+	+	+	+	..	..	..	..
Pohlia drummondii et *gracilis*		..	..	+	+	+	2	..	..	..	..	+
Bryum pseudotriquetrum		..	..	..	..	..	2	+	..	+	..	+
Campylium stellatum		..	..	..	..	..	+	+	..	..	+	..
Cephalozia		..	..	..	..	..	2	+	..	..	..	..
Pinguicula vulgaris	B	..	..	..	..	+	+	..	..	..	..	..
Leptobryum pyriforme		..	..	..	..	1	+	..	..	..	..	..
*Lachnea scutellata***		..	..	..	..	..	..	+	1	..	..	..
Pohlia spec.		..	..	..	..	..	2	..	..	..	..	..
Lophozia		..	..	..	..	..	2	..	..	+	..	..
Saxifraga aizoides	L	..	..	..	..	..	+	..	..	..	..	..
Calamagrostis neglecta	B	..	..	..	+	..	..	..	..	..	..	..
Drepanocladus revolvens		..	..	..	..	..	..	..	..	..	+	..
Chamaenerion latifolium	A	..	..	..	..	+	..	..	..	..	..	..
Eriophorum scheuchzeri	A	..	..	..	..	+	..	..	..	..	..	..
Pohlia ludwigii		..	..	..	..	+	..	..	..	..	..	..

* largely covered with slimy algae (*Nostoc* spec.?).

** the collective name for the highly critical assemblage of taxa with elliptical spores and bright red discs of the genus *Scutellinia* (Cook) Lambotte (*Humariaceae*, *Pezizales*); probably in this case *S. scutellata* (L. ex Amans) Lambotte.

(a) Variant *inops* (table 5:4,5; fig. 25), which forms open to closed, low, light dull green, cyperaceous vegetation.

(b) Variant of *Juncus arcticus* (table 5:6–8; fig. 24, 25), characterized by the dominance of *J. arcticus* in the field layer and by the occurrence of *Bryum pseudotriquetrum*, *Campylium stellatum*, *Cephalozia* and *Lachnea scutellata*. It forms more or less closed, high, dark dull green, juncaceous vegetation.

The variant of *J. arcticus* can in turn be subdivided according to the stage of development of the moss layer, depending on the rate of sedimentation:

(b.1.) a subvariant with a well developed moss layer dominated by *Catoscopium* (table 5:6, 7), which is comparatively rich in taxa and occurs in comparatively stable conditions, and

(b.2.) a subvariant without a well-developed moss layer (table 5:8), which is comparatively poor in taxa and occurs in unstable conditions. In extreme conditions, when, as a result of geomorphological changes the upper part of the substrate can dry out considerably, it is found impoverished as almost "pure" stands of *J. arcticus* on diminutive dunes of 20 to 30 cm height. These are hardly distinguishable from similarly impoverished communities with *J. arcticus* of the *Calamagrostion neglectae* NORDH. 1936.

In both variants a facies of *Equisetum variegatum* may occur.

syntaxonomy & discussion: *Carex bicolor* occurs in different types of calciphytic vegetation, which have mainly been studied in Scandinavia.

Below the alpine zone it occurs in South Norway (Dovre) along the sandy banks of rivers and brooks in a community rich in taxa and in which non-calciphytic taxa are prominent (LID, 1954, table 1–4). This community gives the impression of being rather atypical, which is partly explained by the fact that LID analyzed the sample plots primarily with the purpose of illustrating the ecology of *C. bicolor*. The community presumably represents a subalpine contact-community in rather stable, though dynamic gradient situations and may be considered to constitute a separate association.

In northern, mainly alpine Sweden *C. bicolor* occurs in different vegetation types, viz. in snow-beds, in rather extreme chionophytic communities (GJAEREVOLL, 1950a, table p. 434; idem 1950b, table p. 14–15:I), and in calcareous mires or fens, in communities apparently belonging to the *Caricion bicolori-atrofuscae* (NORDHAGEN, 1935, p. 90; ARWIDSSON, 1943, p. 135, 136; SELANDER, 1950, p. 55; GJAEREVOLL, 1950b, table p. 14–15:II, III) and which are closely related to the *C. bicolor* communities described from Greenland (BERGGREN, 1871, p. 870; BÖCHER & LÆGAARD, 1962, p. 181; BÖCHER, 1963, p. 131, 247, table 31:1–3; the present publication table 5:4–8).

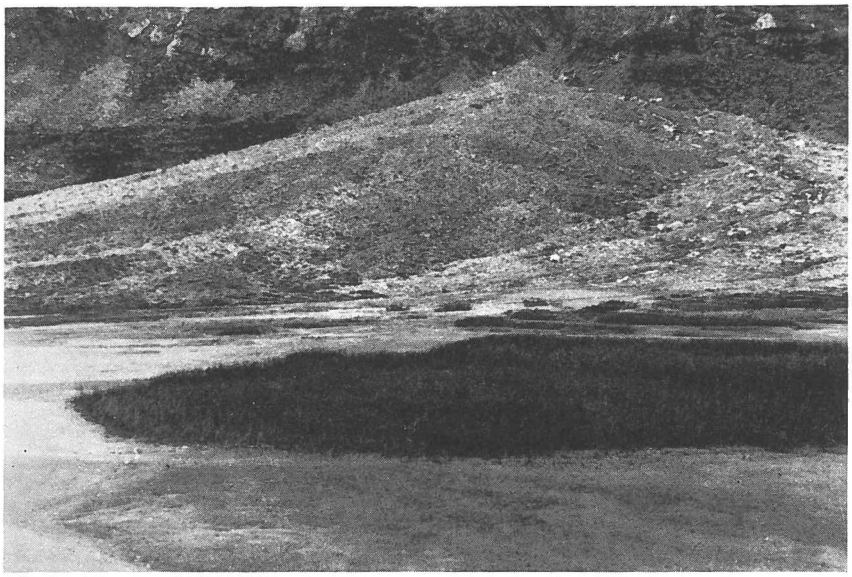


Fig. 25. Calciphytic mire vegetation on a convex bank in a river delta. In the central part a community belonging to the variant *inops* of the *Junco-Caricetum bicoloris catoscopietosum*, along the edge one belonging to the variant of *Juncus arcticus* of the same syntaxon. JGdM phot. VIII. 1969.

A mutual comparison of these observations is complicated by the dynamic nature of the vegetation itself, which represents various stages in the local succession. However, it appears that the northern alpine and arctic snow-bed and mire communities are clearly separable on account of differences in ecology and floristic composition, namely by the dominance of *Anthelia juratzkana* in the bottom layer of the snow-bed communities.

The subalpine, southern Norwegian fen or mire community differs from the alpine, northern Swedish and Greenlandic mire communities by the occurrence of the following differential taxa: *Agrostis borealis*, *Betula nana*, *Empetrum hermaphroditum*, *Euphrasia frigida*, *Festuca ovina* and *F. rubra*, *Oxytropis lapponica*, *Primula stricta*, *Salix arbiscula*, *Vaccinium uliginosum*, *Blasia pusilla*, *Hypnum arcuatum*, *Philonotis tomentella*, *Tomenthypnum nitens;* differential taxa of the northern alpine and arctic communities are *Juncus biglumis*, *Campylium stellatum*, *Drepanocladus revolvens* s.l., *Pohlia commutata.* These mire communities were previously grouped in the *Caricetum bicoloris* Lid 1954. In my opinion the mentioned differences justify a division of this syntaxon into a northern subalpine *Caricetum bicoloris* Lid 1954 em.nov., and a northern alpine and arctic *Junco-Caricetum bicoloris* ass.nov. Irrespective of minor phytogeographical differences the latter association can be subdivided according to the composition of the bottom layer, which is presumably dependent on

slight differences in texture, composition, hydrology and stability of the upper layer of the substrate. The community representing the association in the Angmagssalik District can thus be described as a subassociationof *Catoscopium nigritum*.

The syntaxonomic position of the *Caricetum bicoloris* and the *Junco-Caricetum bicoloris* should as yet be considered as somewhat provisional, until more is known about the composition, synecology and syntaxonomy of the other syntaxa of the *Caricion bicolori-atrofuscae* (cf. NORDHAGEN, 1928, 1935, 1943; BÖCHER, 1954, p. 237–264), and the relation of this alliance to the vicariating alpine central European *Caricion juncifoliae* (cf. 5.1.1.). The two associations differ from related extremely rich mire communities of the alliance by the absence (or very low frequency of occurrence) of several faithful taxa of the alliance and order such as *Carex atrofusca*, *C. juncifolia* (= *C. incurva*, *C. maritima*), *C. microglochin*, *C. capillaris*, *Juncus triglumis*, *Kobresia simpliciuscula* (= *K. bipartita*), *Trichophorum* (= *Scirpus*) *pumilum*, and of many other, more or less constant accessory taxa of these communities.

Inherent to the ecologically highly specialized nature of the *C. bicoloris* communities representing stands may be expected to occur very locally, to be of limited extent and to be more often than not somewhat fragmentarily developed.

C. bicolor shows a markedly discontinuous, arctic-alpine distribution (Greenland: BÖCHER, 1954, fig. 64; Scandinavia: GJAEREVOLL, 1950b: fig. 1; general area: HULTÉN, 1968, p. 253), presumably caused by historical conditions.

5.1.1.3. Ass. *Caricetum microglochinis* NORDH (1928) 1943.

syn.: incl. Braunmoosreiche *Carex microglochin*-Ass. NORDH. 1928, *Carex microglochin-Carex bicolor*-sociasjon NORDH. 1935, *Carex microglochin*-Buntmoosbraunmoor KALELA 1939, *Carex microglochin*-sociations BÖCHER 1954.

composition: Regional faithful taxon is *Carex microglochin* WBG. (exclusive to selective faithful of the association; in general faithful of the alliance and the vicarious *Caricion juncifoliae*).

distribution: arctic-subarctic and northern alpine, probably circumpolar-eurasiatic.

5.1.1.3.1. Subass. *catoscopietosum* subass.nov.

table 5:9–11.

composition: Differential taxa are *Catoscopium nigritum* (HEDW.) BRID., *Bryum pseudotriquetrum* (HEDW.) SCHWAEGR. (both faithful of the alliance), *Br. pallens* Sw. and *Juncus biglumis* L. Constant accessory taxa are *Equisetum variegatum*, *Juncus arcticus*, *J. castaneus*, *Salix glauca* (predominantly juvenile), *Distichium inclinatum*.

The composition varies in the district mainly with regard to the abundance of *Equisetum variegatum*. It is comparatively poor in taxa, the number of taxa recorded in one sample plot is on an average 9; the qualitative representation of bryophytes and vascular plants is on average more or less equal.

physiognomy: The life-form spectrum is dominated by geophyta rhizomata. The plant cover is more or less stratified in (1) a closed, compact bottom layer of bryophytes (acrocarpous musci), (2) a 13 to 17 cm high, dense lower field layer with *C. microglochin*, *Salix glauca*, *Equisetum variegatum* and (3) a 21 to 38 cm high, open upper field layer with *Juncus castaneus*, *J. arcticus*. The community forms in general low, dense, grayish yellow, graminoid stands with a dark, blackish green moss carpet.

synecology & habitat: cf. 5.1.1.2.1. In the Angmagssalik District the community occurs on calcareous outwash deltas, in more wet and stable conditions than the corresponding unit of the *Junco-Caricetum bicoloris*, viz. in muddy, very wet and very shallow, level depressions (more or less diminutive oxbow marshes) on or along somewhat drier and sandier banks covered with *Juncus arcticus-Catoscopium* communities (cf. 5.1.1.2.1b.; see fig. 28h).

The habitat is more or less continuously covered with snow from early autumn to late in spring, and during and following the melting period subjected to temporary, shallow inundation and simultaneous sedimentation of clayey-silty material. The physiography of the habitat accounts for relatively stable conditions.

The substrate consists of calcareous, clayey-silty glacial outwash. It is more consolidated than below the previous mire community, and pedogenetic processes have been observed to have started: the upper 10 cm consists of superficially somewhat humic and brownish, in quiet water deposited clayey silt, which gradually with increasing depth becomes mineral, medium fine sandy. The substrate below this decimeter of fine material consists of clayey-silty medium fine to coarse sand (to gravel). At the transition one or two, $^1/_2$ to 3 cm thick clear blue reduction horizons occur.

The ground water level occurs in summer between + $^1/_2$ and –3 cm; in the upper zone it is stagnant, deeper down it is (feebly) moving.

The colorimetric pH of the rhizosphere is abt. $7^3/_4$.

zonation & succession: See p. 88 and fig. 28.

distribution: See 5.1.1.2.1.

syntaxonomy & discussion: As such the various tables with analyses of the *Caricetum microglochinis* as published by different authors appear to be very homogeneous, but mutual comparison of these reveals a considerably heterotony. This heterotony is probably largely to be explained by the dynamic nature of the habitats, the fact that the



Fig. 26. Close view of a stand of the *Caricetum microglochinis*.
JGdM phot. VIII. 1969.

described communities form different stages in the succession towards various other vegetation types. Hence I will confine myself to a provisional, practical division of the association primarily in two groups of subunits:

a. A group of boreal-alpine to subarctic, Fennoscandian communities characterized by the high frequency of occurrence of *Polygonum vivipara*, *Carex capillaris*, *Juncus triglumis*, *Festuca ovina*, *F. rubra*, *Euphrasia*, *Parnassia palustris*, *Selaginella selaginoides*, *Pinguicula vulgaris* and several *Salices* (cf. NORDHAGEN, 1928, table p. 422–425:I, II, 1935, table p. 90 and 1943, table p. 456; KALELA, 1939, table 89, II:9), which are in general very rich in taxa and probably represent further developed stages in the succession in comparatively stable conditions. The bottom layer is usually more or less well developed; *Campylium stellatum* is abundant, and either accompanied by *Drepanocladus revolvens* s.l. or by *Catoscopium nigritum*.

b. A group of low to middle arctic, Greenlandic communities characterized by the absence of the previously enumerated taxa and by the more or less constant occurrence of *Juncus arcticus* and *Salix glauca* (BÖCHER, 1954, table 33:3–7 and 1963, table 31:4; this publication table 5:9–11), which are comparatively poor in taxa and apparently represent earlier stages in less stable conditions. The composition of the bottom layer in these Greenlandic communities leads to a subdivision in two local units:

b.1. Subass. *inops* subass.nov. (cf. BÖCHER, l.c.), without or with a very poorly developed bottom layer with *Campylium polygamum* and *Distichium inclinatum.*

b.2. (5.1.1.3.1.) Subass. *catoscopietosum* subass.nov. (table 5:9–11) with a poorly to well developed bottom layer dominated by *Catoscopium nigritum* and with such taxa as *Bryum*, *Pohlia.* This unit is the arctic counterpart of KALELA's *Carex microglochin*-Buntmoosbraunmoor from Petsamo Lappland (KALELA, l.c.).

5.1.1.4. Ass. *Equiseto-Caricetum rariflorae* ass.nov.

syn.: incl. *Carex rariflora* Buntmoosbraunmoor KALELA 1939 pp.. table 6:1–5.

composition: Regional, exclusive faithful taxon within the alliance is *Carex rariflora* WBG. Constant accessory taxa are *Equisetum variegatum*, *Catoscopium nigritum*, *Campylium stellatum*, *Bryum pseudotriquetrum*, all faithful taxa of the alliance and its vicarious units.

The community of the syntaxon in the Angmagssalik District is poor in taxa, on an average 9 taxa occur in one sample plot, of which usually at least half are bryophytes; in the Subarctic it is considerably richer in taxa (cf. KALELA, 1939, table 89:III:9).

Remarkable is the absence, in the field layer, of *Carices* (*C. atrofusca*, *C. curta*, *C. incurva*, *C. norvegica*, *C. panicea*, *C. paralella*) which are elsewhere found to be associated with the dominant bryophytes in the bottom layer. This should presumably be explained by historic-phytogeographical reasons. Instead of these *Carices* we find the generally mesotrafent to oligotrafent and acidophytic *C. rariflora*, which obviously is extremely tolerant as regards chemical properties of the soil (cf. BÖCHER, 1963, p. 247) and which is often dominant in oligotrafent mire communities (cf. also p. 109) and also in certain halophytic communities (*Potentillo-Caricetum rariflorae;* see the first publication in this series).

physiognomy: See the previous two syntaxa. The plant cover is usually stratified in two layers: (1) a dense, closed bottom layer of acrocarpous and pleurocarpous musci, and (2) a well-developed, comparatively low field layer. It forms dense stands of a deep dark green to golden green, dependent on the composition of the bottom layer, with a dull grayish green hue owing to the dominant sedge in the field layer.

synecology & habitat: The low to subarctic (to northern alpine?) more or less chionophytic, hygrophytic to tropohydrophytic, eutrafent, calciphytic and basiphytic community occurs in the Angmagssalik District in calcareous mires (cf. 5.1.1.2.1. and 5.1.1.3.1.) in the wet central parts of more or less concave low banks surrounded by the ramifications of stream channels (see fig. 28e), in more stable conditions than the two previous mire communities.

Table VI

reference number		1	2	3	4	5	6	7
altitude (m)		20	20	20	20	20	20	20
total cover plants (in %)		100	100	100	100	100	100	100
cover phanerogams –		25	25	35	30	45	75	60
– bryophytes –		95	95	95	95	95	90	90
pH rhizosphere		8=	8=	8=	8=	8=	8=	8=
ground water level (-cm)								
below surface moss layer		11	13	12	14	13	12	6
below surface substrate (±)		8	7	11	12	10	6	2
Carex rariflora	L	3	3	3	4	4	3	..
Equisetum variegatum	L	1	+	1	+	1	..	1
Campylium stellatum		1	1	6	6	6	5	2
Catoscopium nigritum		6	5	2	2	1	..	..
Bryum pseudotriquetrum		1	2	+	+	..	3	..
Dichodontium pellucidum		2	2	+	..	..	..	..
*Distichium inclinatum**)		+	+	+	..	..	..	..
Salix glauca juv.	L	+	+	+	..	..	..	..
Paludella squarrosa		..	..	+	..	+	..	..
Calamagrostis neglecta	B	..	+	2	..	2	4	3
Eriophorum scheuchzeri	A	..	..	..	..	..	4	4
Drepanocladus revolvens		..	..	..	..	..	3	6
Calliergon richardsonii		..	..	..	..	..	2	1
Leptobryum pyriforme		..	..	..	+	1	..	..
Bryum pallens		..	..	..	2	..	..	..
Equisetum arvense	B	..	..	1	..	..	..	..
Juncus castaneus	L	+	..	..	..	..	..	..
Polygonum viviparum	A	+	..	..	..	..	..	..
Philonotis tomentella		..	+	..	..	..	..	..

*) largely sterile, possibly partly mixed with *D. capillaceum.*

The calcareous substrate consists of well-sorted silty, sometimes very fine sandy deposits of several decimeters thickness, over ungraded silty coarse sandy to gravelly sediments. It is very poor in humus and contains one (or a few) layers of a striking bright, blue-gray colour indicating conditions of reduction. The mineral substrate is covered by a $3^1/_2$ to 12 cm thick moss layer. The upper part of this consists of living, assimilating plants with enclosed thin layers of silt, while the lower part consists of their well preserved dead parts embedded in brownish silt in state of oxidation.

The habitat is snow-covered during the winter and becomes free of snow rather late in the season, to be subsequently subjected to temporary, shallow and quiet inundation and simultaneous sedimentation of silt (cf. 5.1.A.). In early August the water level falls to abt. 11 to 14 cm

below the surface of the bottom layer, viz. immediately below the upper limit of the few centimeters thick reduced horizons in the substrate; this is also the maximum depth reached by the roots of *C. rariflora*. The ground water is at that time stagnant at least in the upper, silty part of the substrate; in the porous sandy subsoil it is presumably feebly moving.

The colorimetric pH of the rhizosphere is abt. $7^3/_4$ to 8; one determination in the subsoil gave a pH of $8^1/_2$.

zonation & succession: see p. 87–91 and fig. 28.

distribution: See 5.1.1.2.1.; it occurs also in northern Fennoscandia (KALELA, 1939, p. 429).

subdivision: Two local variants can be distinguished, founded on the quantitative composition of the bottom layer:

(a) Variant of *Catoscopium nigritum* (table 6:1, 2), an earlier stage in the succession characterized by the dominance of *C. nigritum* in the bottom layer. Under the $3^1/_2$ to 6 cm thick living bottom layer the substrate consists of an about 6 cm thick, somewhat humic, brownish grey layer of silt in state of oxidation, which at a depth of 9 to 12 cm abruptly becomes bright-bluish, mineral and reduced; the subsoil is again in oxidation condition.

(b) Variant of *Campylium stellatum* (table 6:3–5), a later stage in the succession characterized by the dominance of *C. stellatum* in the bottom layer. The bottom layer is composed of a 1 to 3 cm thick uppermost layer of living parts, and a basal, 8 to 10 cm thick layer of well-preserved dead plant rests embedded in brownish silt. This layer is sharply separated from the following upper, mineral, brightly bluish silty layer of the substrate.

syntaxonomy & discussion: The described community is so different from the other units of the alliance that I consider it justified to describe it as an independent association. I am supported on this point by the description of a similar community from northern Fennoscandia by KALELA (l.c.), which represents a subarctic counterpart of the variant of *Campylium stellatum* from the Angmagssalik District, in a presumably later stage in succession. It is illustrated by one of two analyses made in two different stands of *Carex rariflora*-Buntmoosbraunmoor, which are mutually quite different (cf. also NORDHAGEN, 1943, p. 454–455); the other analysis (KALELA, l.c., table 89, III:10) belongs presumably to the *Campylio-Tomenthypnion.*

5.1.2. All. *Campylio-Tomenthypnion* all.nov.

syn.: *Caricion bicolori-atrofuscae* NORDH. 1935 *sensu* DAHL 1957 p.p., Buntmoosbraunmoore KALELA, 1939 p.p., *Salicion myrsinitis* KALLIOLA 1939 p.p., *Caricion atrofuscae-saxatilis* NORDH. 1943 p.p., *Euscorpidion*

DU RIETZ 1949 p.p., incl. *Sphagneto-Tomenthypnion* DAHL 1957, *Salix myrsinitis-Campylium* vegetation PERSSON 1961 p.p.

In the discussion of the *Caricion bicolori-atrofuscae* (5.1.1.) I have motivated the division of the former *Caricion atrofuscae-saxatilis* in the alliance mentioned and a group of communities which I consider to belong to this *Campylio-Tomenthypnion.*

The composition of the bottom layer of the *Caricion atrofuscae-saxatilis* is clearly different from that of the *Sphagno-Tomenthypnion* DAHL 1957, but at least in the rich types of the latter syntaxon there are no obvious differences in the composition of the field layer and the stability of the environment in comparison with the communities with *Drepanocladus revolvens* s.l. and *Campylium stellatum* dominating in the bottom layer, which were originally included in the *Caricion atrofuscae-saxatilis* (cf. KALELA, 1939; KALLIOLA, 1939; NORDHAGEN, 1943; DAHL, 1957).

PERSSON (1961, p. 129, 251; see also NORDHAGEN, 1943, p. 475) because of this floristic similarity of the field layers considers it more reasonable to include the *Sphagno-Tomenthypnion* in the *Caricion atrofuscae-saxatilis.* In view of what I have put forward concerning the status of the *Caricion bicolori-atrofuscae* and the *Caricion atrofuscae-saxatilis* (5.1.1.), in favour of re-establishing the first syntaxon by excluding the communities with *D. revolvens* s.l. and *C. stellatum* in stable environments, I agree with PERSSON's observations and conclusion to the extent that I propose to combine these *D. revolvens* and *C. stellatum* communities with the *Sphagno-Tomenthypnion* in a new alliance *Campylio-Tomenthypnion.* Faithful taxa of this syntaxon are *Carex chordorrhiza* EHRH., *C. heleonastes* EHRH., *C. saxatilis* L., *Scirpus hudsonianus* (MICHX.) FERN., *S. caespitosus* L. ssp. *austriacus* (PALLA) ASCH. et GRAEBN., *Eriophorum medium* ANDERSS., *E. russeolum* FR., *Tomenthypnum nitens* (HEDW.) LOESKE, *Sphagnum warnstorfianum* RIETZ, *Aulacomnium palustre* (HEDW.) SCHWAEGR., *Campylium stellatum* (HEDW.) C. JENS., *Drepanocladus revolvens* (SW.) WARNST. s.l., *D. vernicosus* (MITT.) WARNST. (most taxa selective-preferent); see also 5.1.1.b. and III, introduction b. The syntaxon is restricted to the alpine and subalpine zones of Northern Europe (Fennoscandia) and Greenland, and vicariates with a part of the *Caricion davallianae* (see 5.1.1.).

The alliance can be subdivided according to wetness and composition of the bottom layer in two groups of associations or suballiances:

a. *Campylio-Drepanocladion* suball.nov., comprising units of comparatively wet habitats (cf. 5.1.1.). To this group belong the *Drepanoclado-Campylietum stellatae* (5.1.2.1.1.) and the *Drepanocladetum revolventis* DAHL 1957, incl. the *Caricetum saxatilis* NORDH. 1943 p.p., *Caricetum flavae subarcticum* NORDH. 1943 p.p., *Scirpetum caespitosi-trichophori*

subarcticum NORDH. 1943 p.p., and many other communities described by various other authors after other principles than those of the (modified) Zürich-Montpellier school (cf. 5.1.2.1.1.).

b. *Sphagno-Tomenthypnion* (DAHL 1957) suball.nov., comprising units of comparatively dry habitats (cf. DU RIETZ, 1949, p. 297; DAHL, 1957, p. 288–232). To this group belong for instance the *Aulacomnio-Sphagnetum warnstorfiani* DAHL 1957 and communities described from Finland (CAJANDER, 1913, p. 134–136; PAASIO, 1933, p. 62; KOTILAINEN, 1933, p. 7; KALLIOLA, 1939, p. 94–99, 105–108; KALELA, 1939, p. 404–435; LUKKALA & KOTILAINEN, 1945, 1951; RUUHIJÄRVI, 1960, p. 105–108; HAVAS, 1961.b, p. 38–41, 56–62), from Sweden (SJÖRS 1948, p. 125–128; DU RIETZ, 1949, p. 297; PERSSON & RUNEMARK, 1950, p. 229; PERSSON, 1961, p. 61–62), from Norway (RESVOLL-HOLMSEN, 1920, p. 160; NORDHAGEN, 1943, p. 505–511; DAHL, 1957, p. 229–232), from Russia (KATZ, 1930, p. 348–349, 353–354) and from Greenland (BÖCHER, 1963, p. 247); see also the literature cited by DAHL (l.c.).

Related communities also occur in wooded fens in the boreal zone (cf. SJÖRS l.c.; RUUHIJÄRVI, 1960, p. 165–170, 195–170, 195–202; LOUNAMAA, 1961, p. 32–38; FRANSSON, 1972, p. 47–48).

Considering the indicative value of the represented taxa in respect to the relation community-environment, I follow DAHL (l.c.) in founding the classification of the associations primarily on the qualitative and quantitative composition of the bottom or moss layers.

In spite of the previously advanced arguments I consider the alliance tentative, since too little is still known in particular about the *Caricion davallianae* KLIKA 1934 (syn. for instance *Schoenion ferruginei* NORDH. 1936) in northern subalpine and subarctic areas to delimit the *Campylio-Tomenthypion* satisfactorily from that alliance. In the altitudinal and latitudinal overlapping zonation the *Campylio-Tomenthypnion* occupies an intermediate position between the arctic to northern alpine *Caricion bicolori-atrofuscae* and the temperate to boreal, montane *Caricion davallianae.*

5.1.2.1. Suball. *Campylio-Drepanocladion* suball.nov.

see 5.1.1.b. and 5.1.2.a.

Faithful taxa: *Campylium stellatum* (HEDW.) C. JENS., *Drepanocladus revolvens* (Sw.) WARNST. s.l. (opt.).

5.1.2.1.1. Ass. *Drepanoclado-Campylietum stellatae* ass.nov.

syn.: *Campylietum* DU RIETZ 1949 n.n., ?p.p.; non *Campylio-Revolvetum* FRANSSON 1972.

composition: regional selective faithful taxon is Campylium stellatum (HEDW.) C. JENS. See further the paragraph syntaxonomy of the subassociation.

distribution: arctic-subarctic to boreal alpine, probably circumpolar.

5.1.2.1.1.1. Subass. *calamagrostetosum neglectae* subass.nov.prov.

table 6:6, 7.

composition: Differential taxa are *Calamagrostis neglecta* (EHRH.) G., M. & S. and *Eriophorum scheuchzeri* HOPPE. The composition varies little, both sample plots represent the most common extremes which I observed in the variation. The first sample plot represents an earlier, the second a later stage in the development and succession. The syntaxon is poor in taxa.

physiognomy: The hemicryptophytic and geophytic community is stratified in (1) a closed, dense bottom layer of pleurocarpous musci, and (2) an up to 42 cm high, rather dense graminoid field layer. It forms a dull (greyish-) green fen community, in which the woolly white heads of *E. scheuchzeri* are very conspicuous from far away (fig. 27).

synecology & habitat: The low-arctic (to northern alpine?), more or less chionophytic, hydrophytic, eutrafent, calciphytic and basiphytic community is observed in the Angmagssalik District in calcareous mires (cf. 5.1.1.2.1. and 5.1.1.3.1.), forming a narrow to rather broad margin around little pools on large, concave banks or forming more extensive stands in the central part of such bowl-shaped, miry banks without a central pool (cf. p. 91 and fig. 27, 28:f).

The 4 to 6 cm thick layer of living moss on the ground becomes near the base gradually more silty and passes into a 2 to 3 cm thick layer of brownish, coarse peaty, silty material with scarcely decomposed dead moss and roots and rhizomes of the vascular plants; this layer passes abruptly into a to 6 cm thick bright bluish layer of the same composition, followed by a deposit, also in state of reduction, of mineral silt (sample plot 7), or in the case that the preceding layer is absent in the upper part with mostly dead or poorly thriving roots (sample plot 6); the subsoil consists presumably of ungraded, silty-coarse sandy to gravelly sediments in state of oxydation.

The groundwater level occurs in early August at or just below the upper limit of the zone of reduction, at abt. 6 to 12 cm below the surface of the moss layer (viz. abt. 2 to 6 cm below the upper limit of the peaty silt). The ground water is stagnant in the upper part of the substrate. See further 5.1.1.4.

The colorimetric pH of the rhizosphere is abt. $7^3/_4$ to 8.

zonation & succession: See p. 87–91 and fig. 27, 28.

distribution: See 5.1.1.2.1.

syntaxonomy & discussion: The two sample plots representing this

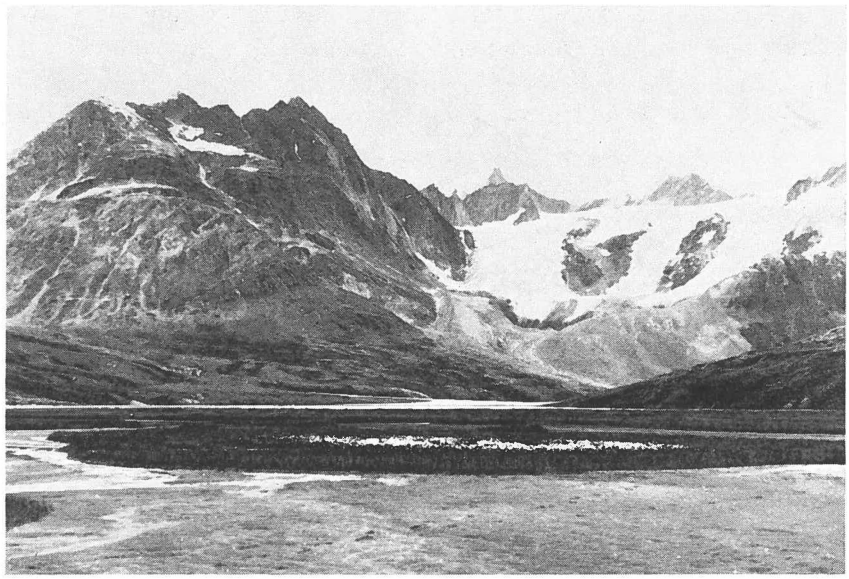


Fig. 27. Calciphytic mire vegetation on a concave bank in a river delta. On the ridge along the outer edge a community of the variant of *Juncus arcticus* of the *Junco-Caricetum bicoloris catoscopietosum*, then mire vegetation belonging to the *Equiseto-Caricetum rariflorae*, followed by mire communities belonging to the *Sphagno-Tomenthypnion*, and in the pool in the centre one belonging to the *Drepanocladо-Campylietum stellatae* subass. *calamagrostetosum neglectae*. JGdM phot. VIII. 1969.

unit were studied in the field with the intention to give as comprehensive an impression as possible of the variability with a minimum of data, considering the difficult, hampered circumstances. The observed stands varied little, and I presume that more analyses would have yielded little more information.

The classification of this unit in the system of the Zürich-Montpellier school forces me to give a rather extensive digression:

The rich fen communities of stable environments has been extensively investigated in particular in Fennoscandia, viz. Norway and Finland (see the extensive list of references in DAHL, 1957; RUUHIJÄRVI, 1960; LOUNAMAA, 1961). In the more recent publications these communities are usually classified according to the ecological differences between *Drepanocladus revolvens* and *Campylium stellatum: D. revolvens* has a wider amplitude towards the wetter direction, *C. stellatum* in contrast towards the drier (cf. MÅRTENSSON, 1956, p. 246, 259; RUUHIJÄRVI, 1960, p. 100), which results in general in distinguishing two groups of communities:

1. the *Drepanocladus revolvens* mires, characterized by the dominance of *D. revolvens* s.l. and the weak representation or absence of *C. stellatum* in the bottom layer. In the field layer one finds moisture indicating mire hollow or rimpi taxa, and

2. the *Campylium stellatum* mires, often apparently following on the *D. revolvens*-mires in the succession, and occurring together with these in mosaic pattern, characterized by the dominance of *C. stellatum* and the nearly always sub to codominance (rarely dominance) of *D. revolvens* in the bottom layer. In the field layer there occur mire-expanse taxa indicating comparatively dry conditions.

DAHL (1957, p. 223) described the first group of communities as the *Drepanocladetum revolventis*. According to the classification criteria and the classification system of the Zürich-Montpellier school, particularly as adapted by Norwegian syntaxonomists since NORDHAGEN, the second group belongs in my opinion to a separate association, the *Drepanoclado-Campylietum stellatae* ass.nov., or (con) sociation complex.

To the suballiance belong thus:

(a) *Drepanocladetum revolventis* DAHL 1957 (syn.: *Drepanocladetum* DU RIETZ 1949 n.n., ?p.p.). To this syntaxon belong eutrafent to somewhat mesotrafent, hydrophytic, acidophytic, neutrophytic to sometimes basiphytic communities in localities with constantly high ground water, which is not necessarily calcareous, and pronounced water logging in the substrate. Preferent taxa with respect to the *Drepanoclado-Campylietum stellatae* are *Carex chordorrhiza*, *C. limosa*, *C. nigra*, *C. rostrata*, *C. livida*, *C. heleonastes*, *C. rotundata*, *C. aquatilis*, *C. saxatilis*, *Eriophorum angustifolium*, *E. medium*, *E. russeolum*, *Comarum palustre*, *Menyanthes trifoliata*, and the preferent *Drepanocladus revolvens* s.l.; *C. stellatum* is weakly represented or absent. The subdivision is primarily based on the composition of the field layer.

(b) *Drepanoclado-Campylietum stellatae* ass.nov. (see 5.1.2.1.1.). To this syntaxon I consider to belong eutrafent, hydrophytic to hygrophytic, (acidophytic-)neutrophytic to basiphytic communities with fluctuating, comparatively low, usually calcareous groundwater and sometimes less pronounced water logging in the substrate. Preferent taxa in regard to the *Drepanocladetum revolventis* are *Carex dioeca*, *C. flava*, *C. lasiocarpa*, *Trichophorum* (= *Scirpus*) *alpinum*, TR. (SC.) *caespitosum*, *Eriophorum latifolium*, *Molinea coerulea*, and the selective faithful *Campylium stellatum; D. revolvens* is often sub to codominant in the bottom layer.

Transitions between the two syntaxa occur frequently (± table 6:7).

To the *Drepanocladetum revolventis* belong for instance the subass. *caricetosum fuscae* (DAHL, 1957, table 45), *Carex goodenowii-Hypnum intermedium-H. revolvens* swamp (CHRISTOPHERSEN, 1925, p. 451), *C. goodenoughii* graesmyr (RESVOLL-HOLMSEN, 1920, table 23), *C. goodenowii-Amblystegium revolvens*-Ass. (OSVALD, 1925, table p. 38), *D. intermedius*-reiche *C. goodenoughii*-Ass. (NORDHAGEN, 1928, table p. 404), *C.*

goodenoughii-Amblystegium intermedium-soc. (Booberg, 1930, p. 89), *C. goodenoughii- D. intermedius*-soc. (Nordhagen, 1943, table 82); the subass. *caricetosum chordorrhizae* (Dahl, 1957, table 45), *Carex chordorrhiza-Amblystegium revolvens*-Ass. (Osvald, 1925, table p. 37), *D. intermedius*-reiche *C. chordorrhiza*-Ass. (Nordhagen, 1928, table p. 402), *C. rostrata- C. chordorrhiza-Drepanocladus*-soc. & *Eriophorum polystachum-Drepanocladus*-soc. (Mork & Hedberg, 1937, table 3); the *Carex saxatilis-D. intermedius*-soc. (Nordhagen, 1943, p. 467), *C. saxatilis-D. intermedius*-Soz. (Kalliola, 1932, p. 74), Braunmoosreiche *C. saxatilis*-Soz. (Kalliola, 1939, p. 103), *Carex limosa-Amblystegium revolvens*-Ass. (Osvald, 1925, table p. 38); the *Amblystegium* Braunmoore (Cajander, 1913, p. 131–132), *D. revolvens*-Rimpibraunmoore (Ruuhijärvi, 1960, table 26), *D. revolvens*-Braunmoore (Lounamaa, 1961, table 21).

The more variable *Drepanoclado-Campylietum stellatae* comprises for instance the subass. *calamagrostetosum neglectae*, the *Campylium-D. intermedius*-Braunmoorfläche (Kotilainen, 1933, p. 7), *C. stellatum-D. intermedius* & *C. stellatum-Oncophorus* variants of the *Carex vaginata-*, *C. polygama* var. *alpina-*, *C. dioeca-* and *Scirpus austriacus*-Buntmoosbraunmoore (Kalela, 1939, p. 406–431 and tables), *C. stellatum*-Braunmoore (Ruuhijärvi, 1960, table 21); Artenreiche *Carex vaginata*-Soz. (Kalliola, 1939, p. 102); Braunmoosreiche *Carex panicea-*, *C. flava-* and *Eriophorum alpinum*-Ass. (Nordhagen 1928, table p. 412); *Carex flava-C. stellatum-D. intermedius*-sos. (Nordhagen 1943, p. 469), *C. flava-D. intermedius*-ass. (Sjörs, 1946, p. 46), *C. flava-intermedius*-ass. (Sjörs, 1946, p. 46), *C. flava-Trichophorum-C. stellatum*-Siedlungsgruppe (Havas, 1961, table 5); *Carex panicea-Amblystegium stellatum*-Ass. (Osvald, 1925, table p. 39); *Carex dioeca-Amblystegium stellatum*-Ass. (Osvald, 1925, table p. 37); *Intermedius*-Braunmoore (Lukkala & Kotilainen, 1951, p. 18); somewhat intermediate are: *D. intermedius*-reiche *Scirpus austriacus*-Ass. (Nordhagen, 1928, table p. 408), Artenreiche *S. austriacus*-Soz. (Kalliola, 1939, table 13), *S. caespitosus-D. intermedius*-sos. (Nordhagen, 1943, table p. 477), *S. caespitosus-C. stellatum* Teilsiedlung (Heikurainen, 1953, p. 25).

5.1.2.2. Suball. *Sphagno-Tomenthypnion* (Dahl 1957 pro all.) suball. nov.
see 5.1.2.b.

Faithful taxa: *Tomenthypnum nitens* (Hedw.) Loeske, *Sphagnum warnstorfianum* Rietz, *Aulacomnium palustre* (Hedw.) Schwaegr. (all opt.), *Pedicularis oederi* Vahl.

This suballiance is, observing the restriction mentioned in the introduction to this chapter (p. 59), in the Angmagssalik District represented by two vegetation types which I did not have the opportunity to study extensively enough and of which I found too few comparable

Table VII

reference number		1	2	3
altitude (m)		20	20	20
total cover plants (in %)		100	100	100
cover phanerogams –		10	15	20
– bryophytes –		100	100	100
pH rhizosphere		7	7	7
ground water level (-cm) (below surface moss layer)		18	21	22
Tomenthypnum nitens		..	..	4
Philonotis tomentella		4	5	..
Paludella squarrosa		5	5	6
Carex rariflora	L	2	2	3
Salix glauca juv.	L	1	+	1
Campylium stellatum		1	+	..
Equisetum variegatum	L	+	..	1
cf. *Riccardia pinguis**)		..	..	1
Equisetum arvense	B	..	..	+
Calliergon stramineum		..	+	..
Drepanocladus uncinatus		..	+	..
Bryum pseudotriquetrum		..	+	..

*) not collected.

observations in the literature to be able to classify them justifiably and satisfactorily in the employed system. Moreover, they are represented by small stands, presumably influenced by vicinism. I therefore refrain from classifying them and describe them here as communities:

1. *Carex rariflora-Philonotis tomentella-Paludella* community (table 7:1, 2), and
2. *Carex rariflora-Tomenthypnum nitens-Paludella* community (table 7:3).

These low-arctic (to possibly northern alpine), chionophytic, hygrophytic-hydrophytic, eutrafent and basiphytic communities occur in the Angmagssalik District in mosaic pattern on concave banks on a delta associated with a fluvioglacial debris fan of a tributary meltwater stream which carries basic sediments. The gradual inversion of the relief from convex to concave banks resulted in creating a stable, wet environment (see 5.1.A.). During a short period in spring, these bowl-shaped banks are, possibly not every year, water-logged to submerged, during which small quantities of mixed coarse sandy to silty material settle down.

The profiles below the first community show below the 10 to 11 cm thick moss layer a 7 to 8 cm thick layer of unhumified peat with very little mineral matter, followed by in the upper few centimeters a somewhat

humic, blue silt layer in reduction condition; the ground water level is found 1 to 2 cm below the peat layer at 8 to 10 cm depth.

The one profile below the second, somewhat drier community shows below a 9 cm thick moss layer a 10 to 11 cm thick layer of unhumified peat as described above, over a similar subsoil; the ground water level is found also 2 cm below the peat layer, at 13 cm depth.

The colorimetric pH of the rhizosphere below both is abt. 7.

The ground water is stagnant.

Both communities belong doubtless to this suballiance because of the composition of the bottom layer and the general ecology.

BÖCHER (1963, p. 247 and table 32:1–5) describes a community from middle West Greenland, which is closely related to the first community, namely with a more open bottom layer and *C. stans* replacing *C. rariflora* in the field layer (cf. also KALELA 1939, table 88:3, with *C. dioica*, Petsamo Lappland).

The second community is closely related to a part of the northern Finnish *Paludella*-Braunmoore described by RUUHIJÄRVI (1960, table 22:1–3), in which *C. caespitosa*, *C. chordorrhiza*, *Comarum palustre* and *Caltha palustris* dominate in the field layer.

5.1.A. Succession & zonation in the *Tofieldietalia* in the district.

In the Angmagssalik District the occurrence of communities of extremely rich fens is restricted to a single locality on the northern side of the valley in the extension of the Qíngertivaq fjord, North of the Cassiopefjeld and immediately West of the large lake in that valley (p. 22). They occur there in front of the flush-zone of a debris fan built of rock waste rich in calcite and further for instance zoisite, epidote, biotite, serecite, amphibole, garnet, plagioclase and quartz (fig. 25). This fan is built up by a cascading tributary meltwater stream issuing from a small local ice-cap or firn field on the triangular mountain group roughly delimited by the Qíngertivaq-Ilivnera valley, Solporten valley and the Sermilik fjord.

The fan spreads across part of the flat valley floor once occupied by a now vanished glacier and at present rather marshy and filled with non-basic fluvioglacial debris. The floor of the valley is levelled by continuous redistribution of the debris by the main meltwater stream system. This comes from present glaciers and flows in braided channels, reworking across nearly the whole width of the valley the material which it transports and deposits.

The development of the geomorphology and the establishment and succession of vegetation on the calcareous delta in front on the mentioned debris fan is outlined below.

The geomorphology is first determined by the levelling effect of periodical flooding each spring. The system is consequently in the first stage unstable, comparatively simple and differentiated in a large-scale pattern. Transport of material is only directed horizontally. The shoals and low banks have a weakly convex shape, the stream channels in-between, a weakly concave shape.

The first theoretical stage in the development of vegetation in this marshy area consists of a very open plant cover with spread individuals of *Juncus biglumis* and *J. castaneus*. These plants establish themselves as pioneers on the wet, muddy areas which in summer appear just above the water (fig. 28a; cf. 5.1.1.1.).

Continuing sedimentation of predominantly fine sand and silt results in a gradual further differentiation of the geomorphology and raising of the shoals and banks.

In this next stage a gradually denser plant cover on the higher banks will develop. At the start of this stage the bottom layer of bryophytes is poorly developed. A characteristic moss of this phase is *Aongstroemia longipes*. In the field layer *Equisetum variegatum* stands out, which may locally become dominant particularly on low, almost level banks where closer settling of the superficial soil particles occurs. *Carex bicolor* stands out in more sandy areas, and *Juncus arcticus* on smaller convex to almost level banks as well as around more extensive ones covered with *C. bicolor-E. variegatum* communities (fig. 28b and c).

Under the influence of the denser plant cover the rate of sedimentation increases, involving a more rapid relative raising of the substrate. The rate of sedimentation decreases again in the next stage on the central parts of the banks, when these attain a certain height in respect to the surroundings. This results in an increase in the degree of cover of the bottom layer, which becomes dominated by *Catoscopium nigritum* (fig. 28c and d; 5.1.1.2.1.).

The acceleration of the sedimentation and the resulting relative raising of the substrate is in particular promoted by the dense growth and comparative firm attachment of *Juncus arcticus*. This rush forms rather long stolons from which the shoots sprout with very short interspaces. The stolons are attached by numerous parallel lateral roots which attain a length of more than 30 cm and a depth of 5 to 10 cm (fig. 21; cf. *J. castaneus*, 5.1.1.1.).

Between some of the higher banks develop dense, low *Carex microglochin* stands with a dense, closed bottom layer of *Catoscopium* in very shallow, more or less cut off branches of the meltwater channel system, where the water stagnates in summer, and which are gradually filled with very fine sediments. Also in this type of vegetation there may develop an *Equisetum variegatum* facies, in conditions as described previously. This

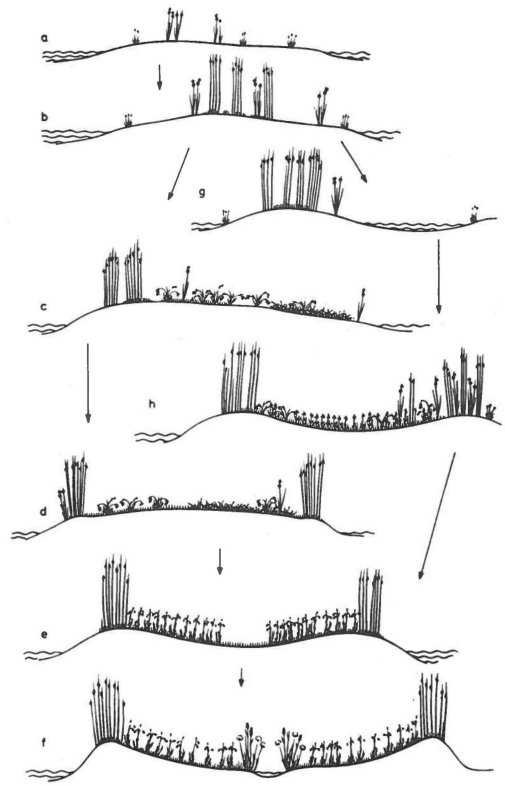


Fig. 28. Development of the geomorphology and the corresponding succession in the vegetation on the calcareous river delta in Qíngertivaq valley North of Cassiopefjeld.

type is sometimes also preceded by the initial *Juncus biglumis-J. castaneus* pioneer stage (fig. 28g and h; 5.1.1.3.).

The water layer flooding the delta during spring becomes gradually less deep over the banks as long as this succession of events is not disturbed. Consequently the velocity of the water current over the banks decreases in regard of the velocity in the stream channels. This spatial differentiation involves that the rate of sedimentation on the banks, particularly of the coarser grades, and under the influence of the plant cover, diverges towards the margin of the banks. This will result in the formation of diminitive marsh bars around the still convex banks (fig. 28d). This implies that the transport of material from the stream channels towards the banks takes place over a gradually shortened distance. This whole process, when remaining undisturbed, finally leads to inversion of the relief of the banks, so that the original shape changes to a convex model (fig. 28c to f). This process also implies that the flow of water is more and more restricted to the stream channels. Under the influence of the water current concentrated there the erosive action increases,

which gradually modifies the originally sloping margins of the banks to steep edges.

Along with the increasing spatial differentiation of the process of sedimentation hardly any differentiation in the process of erosion occurs. The latter process remains mainly restricted to the first phase of periodical total flooding, which has a levelling effect on the geomorphology by the sudden large supply of water. In this phase continuously new systems of stream channels are formed at the cost of existing, mainly young unconsolidated banks, and old systems are abandoned resulting in the development of new shoals and banks where *Juncus biglumis* and *J. castaneus* may establish themselves again. The following emergence of the area is a much more gradual phenomenon. It is accompanied by a very gradual decrease in the velocity of the water current, spatial concentration of the water flow to the stream channels, and a fall of the water level. As soon as the water level has fallen below the level of the top of the bars around the concave banks, the superficial drainage of these comes to an end; divergence of the process of erosion, manifested by the occurrence of regressional erosion into the banks is not observed.

Continued relative raising of the higher, concave banks is dependent on the transport of material during flooding of the surrounding marsh by the stream channels. The coarser, sandy grades of this material is mainly deposited on and next to the bars, which are characteristically covered by dense, high *Juncus arcticus* vegetation. The finer, silty grades settle on the central parts, which are at first still covered by *C. bicolor-E. variegatum* communities rich in *Catoscopium nigritum.* The substrate below the plant cover on the comparatively well drained and aerated bars appears distinctly to consist of layers of graded sediment. Below the plant cover in the centre it consists of an almost continuous deposit of poorly drained, wet, fine silty material usually with thin, clearly blue streaks indicating a state of reduction.

The processes described result in an increased spatial differentiation in structure and pattern. The originally unstable system develops towards a continuously more stable and more complex one, while the pattern develops from a large scale to a small scale one.

In the first phase of inversion of the relief of the banks *Carex rariflora* replaces the other vascular plants as a dominant in the field layer, while the bottom layer remains dominated by *Catoscopium* (fig. 28d and e; cf. 5.1.1.4.). This vegetation type may presumably also develop under the influence of a parallel geomorphological process from the muddy *Carex microglochin-Catoscopium* stands (fig. 28h and e).

During continued relative deepening of the centre of the still relatively rising banks the bowl-shaped centre becomes more and more isolated from the surroundings, creating a stabilized, wet environment.

Catoscopium is then gradually replaced by *Campylium stellatum* (cf. 5.1.1.4.). This bryophyte is in turn replaced by *Philonotis tomentella* and *Paludella squarrosa* (cf. 5.1.2.2.1.), and in the next stage replaces *Tomenthypnum nitens Philonotis tomentella* in drier conditions (cf. 5.1.2.2.2.); *Sphagnum teres* establishes itself here and there in small quantities, and parasitic on *Paludella* the discomycete *Mitrula* cf. *gracilis* (*Geoglossaceae*). During this development the humus (peat) accumulation increases and oxygen-deficiency in the substrate becomes more pronounced.

Finally the inversion and extension of the banks result in the development of a small, shallow central pool filled with water practically all summer. This pool is characteristically surrounded by a more or less well developed, narrow or wider zone of shore-vegetation dominated in the field layer by *Eriophorum scheuchzeri* and *Calamagrostis neglecta*, and in the bottom layer by *Campylium stellatum* and *Drepanocladus revolvens*, accompanied by for instance *Calliergon richardsonii*. The latter moss can also occur submerged in the pool (fig. 28e and f; cf. 5.1.2.1.1.1.).

The entire complex of processes described is, at irregular intervals, in various degrees disturbed or nullified by unusual heavy flooding of the tributary meltwater stream which builds the fan, or by unusual severe inundation by or radical changes in the course of the stream channels of the braided main meltwater stream system in the valley.

From nearly the very first phase in which plants establish themselves on the emerged parts of the delta does *Salix glauca* germinate en masse and homogeneously spreads over the emerse areas. After attaining a height of 10 (to 15) cm nearly all the young individuals apparently perish during the following period of inundation, after which a new generation germinates anew. This phenomenon is repeated year after year. Only very rarely does a single isolated *S. glauca* individual manage to survive, and it subsequently grows into a mature plant which attains an ascending, shrub-like shape (fig. 29), in contrast to the more characteristic procumbent growth of the isolated *S. glauca* plants in other habitats. From this phenomenon I conclude that the final stage in the succession will be a *Salix glauca* shrub, when the substrate is no longer exposed to sedimentation and would come to rest in the future (cf. Nordhagen, 1935, p. 95; Gams, 1927, p. 288; Braun-Blanquet, 1971, p. 48).

This would probably also be the last stage in the succession in the noncalcareous parts of the main valley, which is at present covered with communities which mainly belong to the *Caricetalia nigrae* (5.2.) and the *Myricarietalia germanicae* (8.2.).

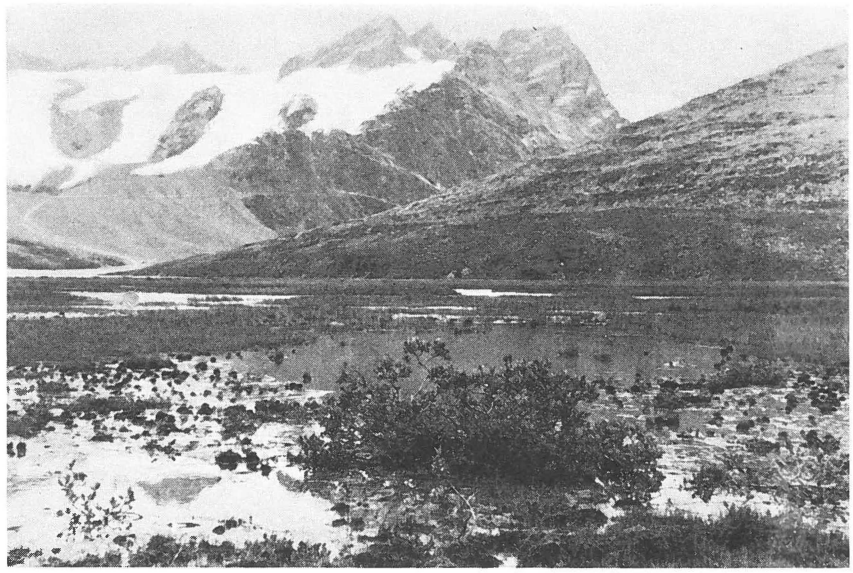


Fig. 29. Solitary *Salix glauca* shrub in the calcareous mire on the river delta in Qíngertivaq valley. JGdM phot. VIII. 1969.

5.2. Order *Caricetalia nigrae* W. KOCH 1926 em. NORDH. 1936 denuo em. R. TÜXEN 1937 (sub nom. *Caricetalia fuscae*).

syn.: *Drepanocladetalia exannulati* KRAJINA 1933; *Molinio-Caricetalia* DUVIGNEAUD 1949 p.p.; *Junco-Caricetalia nigrae* DOING 1963; *Scheuchzerio-Caricetalia fuscae* (W. KOCH 1926) GÖRS & TH. MÜLLER mscr. apud OBERDORFER *et al.* 1967 p.p.

See for details the *Caricion curto-nigrae.*

5.2.1. All. *Caricion curto-nigrae* W. KOCH 1926 em. NORDH. 1936 (sub nom. *Caricion canescentis-goodenowii*).

syn.: *Drepanocladion exannulati* KRAJINA 1933 non HADAČ et VÁŇA 1967, *Parvocaricion canescentis-fuscae* DUVIGNEAUD et VANDEN BERGHEN 1945; *Subsecundo-Apiculation* DU RIETZ pro suball. p.p.; *Sphagnion palustris* SEGAL 1966 n.n. and *Sphagnion amblyphylli* SEGAL n.n. p.p.; *Caricion fuscae* W. KOCH sensu auct., non sensu W. KOCH 1926; incl. *Eriophorion scheuchzeri* HADAČ 1939.

For an outline of this syntaxon I refer to the introduction to this chapter. As mentioned there I have based the classification of the "poorer" mire communities also on quantitative criteria primarily referring to the composition of the bottom layer and secondarily to the composition of the field layer, assuming that the ecological indicative value of the dominant occurrence of the relevant bryophytes is more

significant than the dominant occurrence of the relevant phanerogames (cf. p. 109). Thus I have classified the communities as (con) sociations s.str., which are grouped in sociation complexes according to similarity in the composition of the bottom layers. These units I regard in fact as the fundamental units, which correspond with the associations delimited by DAHL (1957) by the same criterion in corresponding mire vegetation, and which can not be considered as true associations in the sense of the Zürich-Montpellier school, but rather as consociations.

As a consequence of the applied classification system I have incorporated the *Eriophorion scheuchzeri* HADAČ 1939 in the *Caricion curtonigrae*, as has also previously been done by several Central European syntaxonomists (BRAUN-BLANQUET, 1949, p. 301 and 1954, p. 29; cf. WESTHOFF & DEN HELD, 1969, p. 197).

The faithful and differential taxa of the alliance are enumerated among others by BRAUN-BLANQUET (1949, p. 299) and WESTHOFF & DEN HELD (1969, p. 198). At high altitudes and latitudes are the most conspicuous faithful taxa *Eriophorum scheuchzeri* HOPPE, *Calliergon sarmentosum* (WAHLENB.) KINDB., *C. stramineum* (BRID.) KINDB., *Drepanocladus badius* (HARTM.) ROTH, *D. exannulatus* (B.S.G.) WARNST., *Sphagnum teres* (SCHIMP.) AONGSTR.; *Paludella squarrosa* (HEDW.) BRID., has there its ecological optimum in this unit.

5.2.1.1. *Drepanocladus exannulatus* sociation complex.

syn.: *Amblystegium exannulatus*-Kärr MELIN 1917; Braunmoosreiche Graskrautmoore NORDH. 1928 p.p.; *Drepanocladus exannulatus*-Verband KATZ 1930; *Calliergon sarmentosum-Drepanocladus exannulatus purpurascens*-Braunmoore KALELA 1939 pro min. p.; *Drepanocladus exannulatus*-Rimpiweissmoore RUUHUJÄRVI 1960; *Caricion canescentis* KALLIOLA 1939 p.p.; *Drepanocladetum exannulati scandinavicum* DAHL 1957; incl. *Potentilla palustris-Drepanocladus exannulatus* ass. PERSSON 1961, *Paludella-Drepanocladus purpurascens* ass. SONESSON 1970; see further DALH, 1957, p. 218.

composition: Dominant taxon in the bottom layer is *Drepanocladus exannulatus* (B.S.G.) WARNST. s.str., incl. *D. purpurascens* (SCHIMP.) LOESKE (also as a variety of *D. exannulatus*). Accessory taxa in this layer are for instance *Calliergon stramineum*, *C. sarmentosum*, *Paludella squarrosa*. Characteristic of the field layer are mostly moisture indicating taxa such as *Eriophorum scheuchzeri*, *E. angustifolium*, *Carex rostrata*, *C. aquatilis*, *C. saxatilis*, *Calamagrostis neglecta* (cf. NORDHAGEN, 1928, p. 389–397; KALELA, 1939, p. 302–507; KALLIOLA, 1939, p. 89–91; DAHL, 1957, p. 213–219; RUUHIJÄRVI, 1960, p. 84; PERSSON, 1961, p. 71–73; SONESSON, 1970, p. 59).

distribution: Presumably northern alpine and arctic, viz. Greenland, Fennoscandia, Iceland; probably circumpolar. The complex is in the Alps and Pyrenees partly, at lower altitudes, replaced by the *Caricetum nigrae* BR.-BL. 1915, and in the Tatra by the *Drepanocladetum exannulati brachydictyi* KRAJINA 1933.

syntaxonomy & discussion: see 5.2.1. and p. 109.

5.2.1.1.1. *Drepanocladus exannulatus* sociation.

table 8:1–4.

composition: The sociation is extremely poor in taxa, and is characterized by the absence of differential, vascular taxa compared with the other units of the sociation complex. Accessory taxa are in the Angmagssalik District *Calliergon sarmentosum*, *Hippuris vulgaris*.

physiognomy: The more or less ceratophyllid, bryophytic unit usually consists only of a submerged to floating or amphibious bottom layer of pleurocarpous musci; occasionally a fragmentary field layer with *Hippuris* is found. It forms fine beds of dark, brownish olive-green to somewhat reddish aquatic mosses, occasionally as a undergrowth below a very open "forest" of *Hippuris*.

synecology & habitat: The arctic to probably (northern) alpine, hydrophytic to amphiphytic, mesotrafent to oligotrafent, minerotrafent and more or less rheophytic, medium acidophytic community occurs in the Angmagssalik District in shallow, at least near the surface oxygen-rich clear water affected by a more or less distinct current or by turbulence caused by surface winds, viz. in communicating pools in mires and in shallow (temporary) ponds, in shallow quiet bights in small lakes and tarns and occasionally in shallow, widened parts of clear streams.

The thickness of the bottom layer depends on the fluctuating level of the water, which occurs from 10 cm above to $4^1/_2$ cm below the water surface. The moss layer is, when submerged, very loose-feathery and up to 25 cm thick (table 8:1), floating loosely about 10 cm thick, and in temporary dry conditions compressed to abt. 3 cm thickness (table 8:4).

The substrate consists of a thin layer of fine humus over a sandy to stony bottom (table 8:2), or of a up to 44 cm thick layer of more or less loose, unhumified, often yellowish and smelling (hydrogen sulphide) *Hypnaceae*-peat, frozen from 37 to 83 cm depth below the water of moss layer surface downward in extensive mires (table 8:1, 3, 4).

The colorimetric pH of the rhizosphere is abt. 5.

succession & zonation: The community is in the spatial and the temporal succession followed by various other units of the *Caricion curto-nigrae* (fig. 31, 32).

distribution: The sociation is rather common in suitable habitats in the district (Tasîlâlik, Torssukátak, Kulusuk); it presumably occurs everywhere in the area of the sociation complex.

5.2.1.1.2. *Drepanocladus exannulatus-Eriophorum scheuchzeri* sociation.

syn.: *Eriophoretum scheuchzeri* (Brockmann-Jerosch 1907) Rübel 1912 p.p.; ± *Drepanocladus purpurascens*-reiche Eriophorum *scheuchzeri*-Ass. Nordh. 1928, *Eriophorum scheuchzeri*-Wiese Kalela 1939; *Drepanocladetum exannulati* (*scandinavicum*) *eriophoretosum scheuchzeri* Dahl 1957.

table 8:5–7.

composition: Dominant taxon in the field layer is *Eriophorum scheuchzeri* Hoppe. Accessory taxa are, in the Angmagssalik District for instance *Calliergon sarmentosum*, *Koenigia islandica*, *Carex bigelowii*, *Deschampsia alpina* (all rare); elsewhere also *Calliergon stramineum*, *Carex curta*, *C. nigra*, *Eriophorum angustifolium*, *Juncus filiformis* (cf. Braun-Blanquet, 1949, p. 300; id. 1954, p. 29; Kalela, 1939, table 83; Dahl, 1957, table 42; Rübel, 1912, p. 190–191).

physiognomy: The predominantly helophytic, hemicryptophytic community is stratified in (1) a closed bottom layer of pleurocarpous musci, and (2) a up to 15 cm high graminoid field layer. It is recognized from far away by the shining white, soft woolly heads of the dominant cotton-grass, which presents a picturesque aspect against the dark bottom layer and the open water itself, and a lively element in the often stony, grey-brown alpine surroundings, a picture known to most alpine wanderers and often suggestively described in the literature (e.g. Ellenberg, 1963, p. 550; cf. fig. 10).

synecology & habitat: Cf. 5.2.1.1.1. The extreme chionophytic and sometimes metatrafent community occurs in the Angmagssalik District usually in shallow water by the edge of ponds or tarns, in communicating pools in mires, in or along the shore of small, sometimes temporary dry rockpools where water collects from the surroundings, and in muddy places occasionally near human habitation sites where it is (often strongly) manured by organic, mostly animal matter.

The substrate below the 2 to 12 cm thick moss layer consist of a 3 to more than 40 cm thick layer of unhumified, often partly smelling (hydrogen sulphide) peat which is frozen about 42 cm below the surface of the moss layers, or rests on a stony or rocky subsoil. The water level occurs ɐt 0 to 12 cm below the surface of the moss layer.

The colorimetric pH of the rhizosphere is abt. 5.

succession & zonation: The community often represents the first stage in the succession towards the development of terrestrial vegetation. In the spatial and temporal succession it is as a rule preceded by communities of the previous sociation or of the *Callitricho-Sparganietum angustifolii*, and is usually followed by the sociations described below or other chionophytic mire communities (cf. fig. 31, 32; Braun-Blanquet, 1954, fig. 3).

Table VIII

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13	14
altitude (m)		25	10	25	25	25	25	20	20	20	20	2	20	10	20
total cover plants (in %)f		100	100	100	100	100	100	100	100	100	100	100	25	60	100
cover phanerogams –		0	5	2	0	15	15	45	70	80	40	20	>20	60	100
– bryophytes –		100	100	100	100	100	100	100	90	95	95	95	<5	20	<1
pH rhizosphere		5	–	4 3/4	5	4 3/4	5	5	5	5	5	6 1/2	5	6	4 1/2
ground water table (cm) (below surface moss layer)		+54	+35	0	−4 1/2	+12	−12	0	0	0	0	−17	+11	+22	−50
Drepanocladus exannulatus		6	6	6	6	6	6	6	6	6	6	6	1	3	+
Eriophorum scheuchzeri	A	..	..	..	..	3	3	4	4	3	1	..	..	..	..
Calamagrostis neglecta	B	..	..	..	..	..	..	..	4	5	3	3	3	..	..
Carex bigelowii	L	..	..	..	..	..	..	..	2	+	+	..	..	..	..
Carex saxatilis	L	..	..	..	..	..	..	..	..	..	..	..	..	5	6
Comarum palustre	B	..	..	..	..	..	..	..	..	..	3	..	..	..	..
Deschampsia alpina	L	..	..	..	..	..	..	2	..	..	..	..	..	..	..
Koenigia islandica	A	..	..	..	..	..	..	2	..	..	..	..	..	..	..
Gymnocolea inflata		..	..	..	..	..	..	..	..	..	..	3	..	..	..
Calliergon stramineum		..	..	..	..	..	..	..	..	..	..	2	..	..	..
Oncophorus virens		..	..	..	..	..	..	..	..	..	..	2	..	..	..
Hippuris vulgaris	B	..	1	1	..	..	..	+	..	..	(+)	..	1	..	..
Calliergon sarmentosum		..	..	1	..	..	1	(+)	..	..	..	..	..	..	..
Saxifraga stellaris	L	..	..	..	..	..	..	..	+	..	..	..	..	..	..
Salix herbacea	L	..	..	..	..	..	..	..	..	..	..	+	..	..	..
Cerastium cerastoides	L	..	..	..	..	..	..	+	..	..	..	..	..	..	..
Philonotis fontana/tomentella		..	..	..	..	..	..	+	..	..	+	..	..	..	..
Polytrichum commune		..	..	..	..	..	..	..	..	..	..	..	..	..	+
Bryum spec.		..	..	..	..	..	..	..	..	..	..	+	..	..	..
Cephalozia spec.		..	..	..	..	..	..	+	..	..	..	..	..	..	..

distribution: The community is of frequent occurrence in the district (Tasîlâlik, Kulusuk, Qortortoq; cf. also KRUUSE, 1912, for instance p. 277; BÖCHER, 1933, p. 104); also elsewhere in Greenland, Iceland, Fennoscandia (cf. DAHL, 1957, p. 218), the Alps (BRAUN-BLANQUET, 1949, p. 300 and 1954, p. 28) and the Pyrenees (GUINOCHET, 1938, p. 212–224); in general temperate and northern alpine and arctic.

5.2.1.1.3. *Drepanocladus exannulatus-Calamagrostis neglecta* sociation.

syn.: *Calamagrostidetum neglectae* BÖCHER 1933; *Eriophorum scheuchzeri-Calamagrostis neglecta-Drepanocladus exannulatus* soc. BÖCHER 1954 n.n.; ± *Drepanocladus*-reiche *Eriophorum scheuchzeri*-Ass. NORDH. 1928.

table: 8:8–12.

composition: Dominant taxon in the field layer is *Calamagrostis neglecta* (EHRH.) G., M. & S. (= *C. stricta* (TIMM) KOEL.); *Eriophorum*

scheuchzeri frequently occurs, sometimes subdominant. Other accessory taxa are *Carex lachenalii*, *C. bigelowii*, *Deschampsia alpina*, *Comarum palustre*. The unit is in general poor in taxa (cf. BÖCHER, 1933, table 32:92, 93; NORDHAGEN, 1928, p. 337).

physiognomy: The predominantly helophytic, hemicryptophytic to more or less geophytic community is stratified in (1) a closed bottom layer, and (2) a 28 to 41 cm high graminoid field layer. In appearance it resembles the previous unit, but the pretty cotton-grass is less conspicuous and the stands have usually a distinct grey-violet hue.

synecology & habitat: Cf. 5.2.1.1.1. The hygrophytic, chionophytic community occurs in the Angmagssalik District along the shores of shallow ponds and pools with slow drainage (cf. BÖCHER, 1933, p. 104), also more or less fragmentary on meltwater stream deltas in shallow depressions in comparable conditions.

The substrate below the more or less floating, thin moss layer consists of a very thin peaty layer over a predominantly silty, usually partly stony to sandy subsoil in which *C. neglecta* roots. The ground water level is usually at the surface of the bottom layer.

The colorimetric pH of the rhizosphere is 5.

succession & zonation: The sociation often follows in the spatial and temporal succession on the previously described sociation.

distribution: The unit is rather uncommon in the district (Qortortoq, Qíngertivaq delta; cf. also KRUUSE, 1912, p. 249 and BÖCHER l.c.); also elsewhere in Greenland (BÖCHER, 1954, p. 258) and presumably in Norway (NORDHAGEN, 1928, p. 337); possibly also elsewhere in the area of the sociation complex.

5.2.1.1.4. *Drepanocladus exannulatus-Carex saxatilis* sociation.

syn.: ? *Carex saxatilis*-Marsh FREDSKILD 1961.

table 8:13, 14.

composition: Dominant taxon in the field layer is *Carex saxatilis* L. (= *C. pulla* GOOD.), presumably a local race of this taxon closely related to *C. rotundata* WBG. (cf. HULTÉN, 1962, p. 22; BÖCHER, 1954, p. 240). The unit is extremely poor in taxa.

physiognomy: The helophytic and geophytic community is stratified in (1) an open, often poorly thriving bottom layer, and (2) a very dense, up to almost 50 cm high graminoid field layer. In appearance it resembles the corresponding unit of the *Calliergon sarmentosum* sociation complex (see 5.2.1.2.5., fig. 30).

synecology & habitat: Cf. 5.2.1.1.1. The medium acidophytic to neutrophytic community is found in the Angmagssalik District in shallow water at the edge of isolated, usually not communicating and often temporarily dry pools and ponds. The dense growth of the sedge

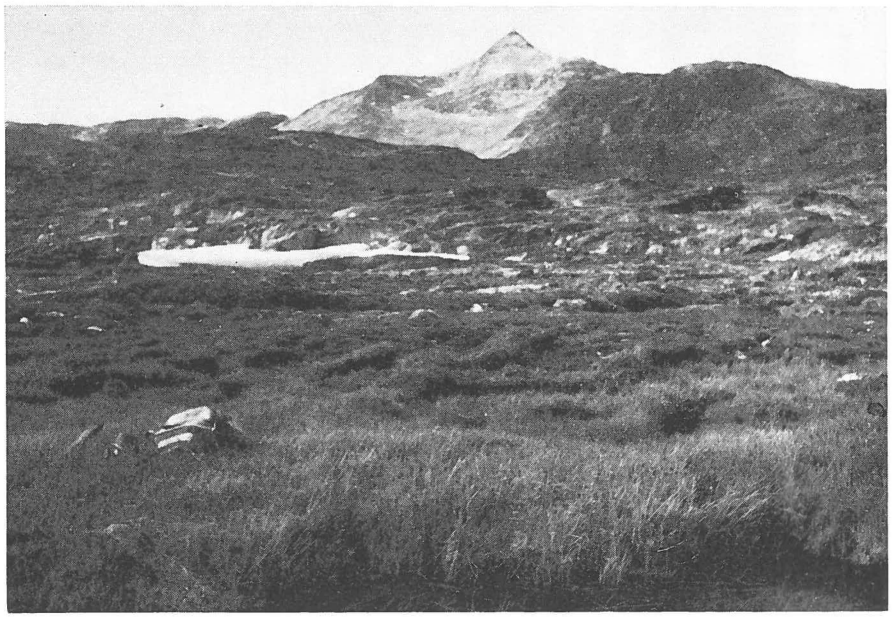


Fig. 30. *Drepanocladus exannulatus-Carex saxatilis* community by the edge of a pond with aquatic vegetation belonging to the *Callitricho-Sparganietum angustifolii*, near Nagtivit. JGdM phot. VII. 1968.

seems to suppress the development of a closed bottom layer. Below this layer the substrate consists of an up to 45 cm thick, dark deposit of predominantly sedge-peat over a compact stony subsoil.

The ground water level is comparatively very variable, and found from 22 cm above to 50 cm below the ground surface. The ground water is fed by the variable supply of melt and rainwater from the close surroundings.

The colorimetric pH of the rhizosphere ranges at least from $4^3/_4$ to 6.

succession & zonation: The unit possibly represents a stage in the succession parallel with the *D. exannulatus-Eriophorum scheuchzeri*-soc. in presumably less minerotrophic, oxygen-rich conditions and with a wider amplitude of the ground water fluctuations. In the ponds along which it occurs one usually observes communities of the *Callitricho-Batrachion* or of the *Subularion aquatilis*, and around the ponds or pools various dwarf shrub heath communities. Temporal succession is probably extremely slow.

distribution: The unit is rare in the district (Amarqâq, Tasîlâlik; observed in the Elvbakker and Torssukátak area; cf. also KRUUSE, 1912, p. 276, 106). Presumably also elsewhere in Greenland (cf. FREDSKILD, 1961, p. 33) and probably elsewhere where the areas of the sociation complex and *C. saxatilis* coincide.

5.2.1.2. *Calliergon sarmentosum* sociation complex.

syn.: *Amblystegium sarmentosum*-Kärr MELIN 1917; Braunmoos-reiche Graskrautmoore NORDH. 1928 p.p.; *Calliergon sarmentosum-Drepanocladus exannulatus purpurascens*-Braunmoore KALELA 1939 pro max. p.; *Caricion rotundatae* KALLIOLA 1939 p.p.; *Calliergonetum sarmentosi* SJÖRS 1950; incl. *Calliergon sarmentosum-Paludella* vegetations PERSSON 1961 p.p.; *Calliergon sarmentosum-Drepanocladus purpurascens* ass. SONESSON 1970; see further DAHL, 1957, p. 220.

composition: Dominant taxon in the bottom layer is *Calliergon sarmentosum* (WAHLENB.) KINDB. Accessory taxa in that layer are *Drepanocladus exannulatus*, *Sphagnum teres*, elsewhere also *Calliergon stramineum*, *Paludella squarrosa* and occasionally *Drepanocladus revolvens*, *D. badius*, *Scorpidium scorpioides*. Characteristic of the field layer are such moisture indicating taxa as *Carex saxatilis*, *C. rariflora*, *Eriophorum scheuchzeri;* elsewhere also *C. rostrata*, *C. rotundata*, *C. limosa*, *C. lasiocarpa*, *Eriophorum angustifolium*, *Scirpus caespitosus* (cf. NORDHAGEN, 1928, p. 379–429; KALELA, 1939, p. 482–507; KALLIOLA, 1939, p. 80–74; DAHL, 1957, p. 220–222; PERSSON, 1961, p. 68–81; SONESSON, 1970, p. 63–64 a.o.).

distribution: The distribution of the sociation complex coincides presumably more or less with the main area of the dominant taxon on the northern hemisphere, where it is northern alpine to arctic, circumpolar.

syntaxonomy & discussion: see 5.2.1. and p. 109.

5.2.1.2.1. *Calliergon sarmentosum* sociation.

table 9:1–4.

composition: The unit is extremely poor in taxa and characterized by the absence of differential, vascular taxa as regards the other units of the sociation complex. Accessory taxa are mainly bryophytes (musci) such as *Calliergon trifarium*, *Drepanocladus revolvens*, *D. exannulatus*, *Philonotis fontana.*

physiognomy: The more or less ceratophyllid-elodeid, bryophytic community consists practically only of a dense, emerged to more or less floating bottom layer of pleurocarpous musci. It forms conspicuous, dark reddish-purplish to blackish-greenish moss carpets.

synecology & habitat: The northern alpine and arctic, hydrophytic to hygrophytic, mesotrafent to somewhat eutrafent, minerotrafent and more or less rheophytic, medium acidophytic to neutrophytic, somewhat chionophytic community occurs in the Angmagssalik District characteristically in moderately wet places, viz. intermediate fens on sloping ground or in similar places such as small, springy depressions on slopes where water collects and subsequently discharges, in rills draining such

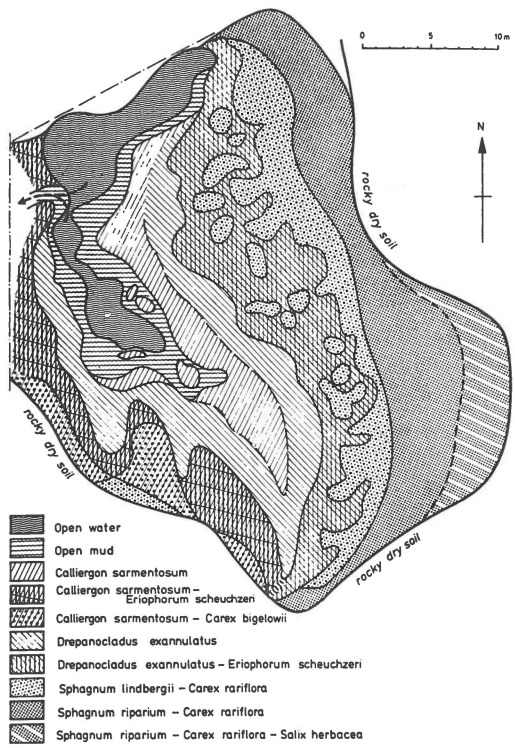


Fig. 31. Zonation in the plant cover of a mire on Kulusuk; see also fig. 32.

places, and in widened parts (pools) of channels with flowing water in large mire complexes on more or less level soil (fig. 31, 32, 35).

The habitat is characterized by a permanently high water level and movement of the oxygen-rich surface water.

The substrate below the 3 to 24 cm thick, emerged to more or less floating moss layer (cf. 5.2.1.1.1.) consists of an up to at least 52 cm thick deposit of *Hypnaceae*-peat, often with enclosed layers of sandy to silty sediments of variable thickness. The subsoil consists of bedrock, debris or sandy to silty mineral material.

The ground water level is found from 0 to 14 cm below the surface of the moss layer.

The colorimetric pH at abt. 10 cm depth ranges from 5 to $6^1/_4$ and averages 5.6.

succession & zonation: The unit represents probably the first stage in the succession under mesotrophic to somewhat eutrophic conditions, which via units characterized by *Eriophorum scheuchzeri* and by *Carex rariflora* finally develops to bryophyte-rich *Salix herbacea* communities. It is often noticed in mosaic with communities of the *Drepanocladus*



Fig. 32. Picture of the mire sketched in fig. 31, taken from a point in the lower left of that figure towards the Northeast.
JGdM phot. VI. 1968.

exannulatus sociation complex or the *Drepanocladetum revolventis*. One of the observed zonations is sketched in fig. 31; see also fig. 32.

distribution: The unit is common, but usually of small extent (Tasîlâlik, Elvbakker, Kulusuk), both in the Angmagssalik District as well as presumably elsewhere in Greenland and the rest of the area of the sociation complex.

5.2.1.2.2. *Calliergon sarmentosum-Eriophorum scheuchzeri* sociation.

syn.: *Eriophoretum scheuchzeri* (Brockmann-Jerosch 1907) Rübel 1912 pro min. p.

table 9:5.

composition: Dominant taxon in the field layer is *Eriophorum scheuchzeri* Hoppe. The unit is extremely poor in taxa.

physiognomy: Cf. 5.2.1.1.2.

synecology & habitat: Cf. 5.2.1.2.1. The medium acidophytic, extremely chionophytic and occasionally somewhat metatrafent community occurs in the Angmagssalik District in strips or patches by the edge of pools with feebly moving water.

The substrate is peaty; below the one analyzed sample plot the soil profile showed: (4–0 cm: moss); 0–27 cm: unhumified, yellow peat smelling

of anaerobic rotting; 27–37 cm: gray, greasy-humic coarse sand; 37–? cm (temporary?) frozen; groundwater at –4 cm; pH at –10 cm abt. 5 (early July).

The stands are obviously irrigated with water more or less diffusely percolating through the ground. The supply, the level and the movement of the ground water is variable in time. The movement is, particularly when the substrate is (still) partly frozen, restricted to its upper layers.

succession & zonation: The zonation in the one studied locality is sketched in fig. 31; the spatial succession may presumably partly reflect the temporal succession.

distribution: The unit is rare in the district as compared with the corresponding unit of the previous sociation complex (Kulusuk; observed also near Angmagssalik); presumably this also applies to the occurrence in the rest of the area of the sociation complex.

5.2.1.2.3. *Calliergon sarmentosum-Carex bigelowii* sociation.

syn.: *Carex rigida-Calliergon sarmentosum*-Braunmoore KALELA 1939; ± *Calliergon sarmentosum*-reiche *Carex rigida*-Ass. NORDH. 1928.

table: 9:6.

composition: Dominant taxon in the field layer is *Carex bigelowii* TORR. (= *C. rigida* GOOD.) The unit is generally rather poor to very poor in taxa and more or less variable. Accessory, frequent taxa elsewhere are *Polygonum viviparum*, *Comarum palustre*, *Deschampsia alpina*, *D. caespitosa*, *Eriophorum angustifolium*, *Scirpus caespitosus*, *Drepanocladus exannulatus* (cf. NORDHAGEN, 1928, p. 392; KALELA, 1939, table 104:I; DAHL, 1957, p. 220).

physiognomy: The predominantly geophytic, elsewhere for a considerable part hemicryptophytic community is stratified in (1) a closed bottom layer of pleurocarpous musci, and (2) a 8 to 10 cm high (elsewhere 20 to 30 cm and probably higher, cf. KALELA, 1939, p. 392), open to rather closed graminoid field layer. It forms rather inconspicuous, dull darkgreen grassy stands against a dark red-brown to blackish underground.

synecology & habitat: Cf. 5.2.1.2.1. In the Angmagssalik District the hygrophytic community occurs in somewhat drier, but otherwise similar conditions as 5.2.1.2.2. (fig. 31, 32).

The profile below the one analyzed sample plot showed: (3–0 cm: moss); 0–1 cm: sandy layer; 1–11 cm: unhumified, redbrown to orange smelling peat; 11–31 cm: brownish coarse sand (11–18 cm with gravel and small stones); 31–54 cm lighter brown sand; 54–? cm: stones; groundwater at –7 cm; pH at –10 cm abt. 5 (early July).

succession & zonation: See 5.2.1.2.2.

Table IX

reference number		1	2	3	4	5	6	7	8	9
altitude (m)		50	25	50	25	25	25	25	30	5
total cover plants (in %)		100	60	100	100	100	100	100	100	90
cover phanerogams –		0	0	1	0	15	30	25	30	80
– bryophytes –		100	60	100	100	100	100	100	100	80
pH rhizosphere		6 1/4	5	6 1/4	5	5	5	4 3/4	4 3/4	5
ground water level (-cm) (below surface moss layer)		6	0	9	0	8	10	0	3	6
Calliergon sarmentosum		6	5	5	5	6	6	6	6	5
Drepanocladus exannulatus		..	1	..	..	..	+	2	1	..
Drepanocladus revolvens		..	..	4	..	..	..	..	..	..
Calliergon trifarium		..	..	..	4	..	..	..	..	..
Eriophorum scheuchzeri	A	..	..	..	..	3	..	+	..	..
Carex bigelowii	L	..	..	..	..	..	4	..	..	..
Carex rariflora	L	..	..	..	..	..	..	3	4	..
Carex saxatilis	L	..	..	..	..	..	..	..	..	4
Polygonum viviparum	A	..	..	+	..	..	..	..	+	+
Salix herbacea	L	..	..	..	..	..	..	..	1	+
Gymnocolea inflata		..	..	..	..	..	..	..	..	3
Sphagnum teres		..	..	..	..	..	..	..	..	+
Scapania uliginosa		..	..	..	..	..	+	..	..	..

distribution: See 5.2.1.2.2.; also in Fennoscandia (NORDHAGEN, 1928, p. 392; KALELA, 1939, p. 484; KALLIOLA, 1939, p. 79; DAHL, 1957, p. 220) and presumably elsewhere in the northern part of the area of the sociation complex.

5.2.1.2.4. *Calliergon sarmentosum-Carex rariflora* sociation.

syn.: *Carex rariflora*-Niedermoore FRIES 1913, *Carex rariflora-Amblystegium sarmentosum*-Ass. OSVALD 1925, *Carex rariflora-Calliergon sarmentosum-Drepanocladus exannulatus*-Soz. KALLIOLA 1939, *Carex rariflora-Calliergon sarmentosum-Drepanocladus exannulatus purpurascens*-Braunmoor KALELA 1939.

table 9:7, 8.

composition: Dominant taxon in the field layer is *Carex rariflora* WBG. In the northern alpine to subarctic counterparts of the Southeast Greenlandic representative of the unit the flora is generally comparatively rich in taxa: *Eriophorum angustifolium* is constantly subdominant, occasionally replaced or equalled by *Scirpus caespitosus*, *Carex rostrata* or *C. rotundata* (cf. KALELA, 1939, table 108:I; KALLIOLA, 1939, table p. 84:2; also OSVALD, 1925, p. 39).

physiognomy: See 5.2.1.2.3., as a rule somewhat more olive-green.

synecology & habitat: Cf. 5.2.1.2.1. The community occurs in the Angmagssalik District in wet, very shallow depressions in mires, usually associated with superficial drainage systems.

The substrate below the two analyzed sample plots differs: below sample plot 7 (in palsa-mire, along communicating pools): (5–0 cm: moss); 0–10 cm: unhumified dark brown peat; 10–20 cm: idem, yellowish; 20–52 cm: very uniform bluish grey silt with Cyperaceae-roots; 52–? cm: idem, frozen; below sample plot 8 (in small mire between brook ramifications): (4–0 cm: moss); 0–6 cm: mixed, brown fluviatile sand; 6–? cm: orange-brown, angular coarse sand.

In late July the ground water level is found in the moss layer at 0 to 3 cm below its surface. It fluctuates between presumably narrow limits. In spring, when the habitat is very shallowly inundated, the water is horizontally moving; in summer, when it falls a few centimetres, it becomes stagnant in the deeper (thawing) soil layers.

The colorimetric pH at abt. 10 cm depth is abt. 4.75.

succession & zonation: See the previous units. The unit is usually partly surrounded by slightly higher situated snow-bed communities with *Salix herbacea*, *Oncophorus wahlenbergii*, *Drepanocladus uncinatus*, *Sphagnum teres*, which possibly also reflects the temporal succession.

distribution: The unit is not uncommon in the district (Blomsterdalen, Tasîlâlik), but local as it is also in Fennoscandia; it may be expected to occur widely spread in the northern part of the area of the sociation complex.

subdivision: The low-arctic communities and the northern alpine to subarctic ones presumably belong to two different variants (see composition).

5.2.1.2.5. *Calliergon sarmentosum-Carex saxatilis* sociation.

syn.: *Calliergon sarmentosum*-reiche *Carex saxatilis*-Ass. NORDH. 1928; ± *Carex saxatilis*-Marsh FREDSKILD 1961.

table 9:9.

composition: Dominant taxon in the field layer is *Carex saxatilis* L. (see 5.2.1.1.4.). The boreal flora element, which is present in the closely related vicarious alpine, Norwegian unit, is absent (*Carex limosa*, *C. rostrata* etc., cf. DAHL, 1957, table 43; compare also NORDHAGEN, 1928, table p. 398) in the Angmagssalik District.

physiognomy: The geophytic, when rich in taxa, partly hemicryptophytic community is stratified in (1) a closed, thin bottom layer of pleurocarpous musci, and (2) a 22 cm (elsewhere more) high, more or less open to closed graminoid field layer. It forms comparatively high, conspicuous belt-like shining greenish stands with a variegated brownish black hue caused by the mature spikes of the sedge; cf. fig. 30.

synecology & habitat: Cf. 5.2.1.2.1. and 2; also 5.2.1.1.4. The community occurs in the Angmagssalik District in a narrow zone along the edge of shallow, sometimes temporarily dry small lakes, ponds or pools, in amorphous peaty substrates (below the single analyzed sample plot, forming an abt. 20 cm thick layer) over a somewhat humic, coarse sandy to gravelly subsoil.

The habitat is periodically affected by the turbulence, caused by the wind, of the clear, oxygen-rich water and by irrigation of meltwater diffusely percolating from the surroundings towards the body of water.

The colorimetric pH at 10 cm depth is abt. 6.

succession & zonation: The succession is presumably very slow (cf. 5.2.1.1.4. and 5.2.1.2.1.). In the water one generally finds communities of the *Parvopotamion* or the *Callitricho-Batrachion*, and on the surrounding bank communities of the *Cassiopo-Salicion* herbaceae or *Empetrum-Vaccinium* dwarf shrub heath communities.

distribution: See 5.2.1.1.4.

subdivision: See 5.2.1.2.4.

5.2.1.3. *Calliergon stramineum* sociation complex.

syn.: *Amblystegium*-Kärr, *Stramineum*-Facies Melin 1917, *Calliergon stramineum*-Verband Katz 1930, *Calliergonetum straminei* Dahl 1957, *Calliergon stramineum* ass. Persson 1961; see further Dahl (1957, p. 219).

composition: Dominant to subdominant taxon in the bottom layer is *Calliergon stramineum* (Brid.) Kindb. Accessory taxa are *Calliergon sarmentosum*, *Paludella squarrosa*, *Cinclidium subrotundum*, *Drepanocladus exannulatus* s.l., *D. revolvens* s.l., *Sphagnum teres*, *S. warnstorfi* in the bottom layer; characteristic of the field layer are *Carex rariflora* and elsewhere, e.g. in Fennoscandia, also *Eriophorum angustifolium*, *Carex curta*, *C. rostrata*, *C. chordorrhiza*, *Comarum palustre*, and of the elsewhere often developed shrub layer various *Salices* such as *S. glauca*, *S. lapponum* (cf. Nordhagen, 1928, p. 427–429, 186–188 and 1943, p. 511–516; Kalela, 1939, p. 431–435; Kalliola, 1939, p. 91–93; Ruuhijärvi, 1960, p. 105–108; Persson, 1961, p. 80–81).

distribution: The distribution presumably coincides more or less with the northern low-alpine and alpine to arctic part of the circumpolar area of *C. stramineum*.

5.2.1.3.1. *Paludella squarrosa-Carex rariflora* sociation.

syn.: *Paludella squarrosa*-reiche *Carex rariflora*-Ass. Nordh. 1928, *Paludella squarrosa*-Verband Katz 1930, *Paludella squarrosa*-Braunmoore Kalela 1939; See further Dahl (1957, p. 219).

table 10.

Table X

reference number		1	2	3	4	5	6	7	8	9
altitude (m)		120	25	60	70	60	60	25	70	10
total cover plants (in %)		100	100	100	100	100	100	100	100	95
cover phanerogams –		20	15	30	15	15	10	20	15	15
– bryophytes –		100	100	100	100	100	100	100	100	95
pH rhizosphere		4 1/2	4 3/4	5	4 3/4	5 1/4	4 3/4	4 3/4	4 3/4	4 3/4
ground water level (-cm)		0	9	5	8	10	9	21	9	10
Calliergon stramineum		2	2	2	2	4	4	2	3	5
Paludella squarrosa		6	6	6	5	5	4	5	6	3
Carex rariflora	L	3	3	4	2	3	2	2	3	3
Sphagnum teres		2	2	3	1	2	2	4	..	..
Salix herbacea	L	1	1	2	2	1	2	2	..	+
Oncophorus wahlenbergi		..	..	..	2	+	1	..	2	2
Cephalozia bicuspidata		..	..	..	+	..	1	..	+	..
Polytrichum juniperinum		..	..	+	..	+	..	+	..	..
Scapania cf. *uliginosa*		..	..	..	..	..	..	..	+	2
Calliergon sarmentosum		..	..	..	..	..	..	+	..	1
Vaccinium uliginosum	L	..	..	..	..	+	..	..	..	..
Drepanocladus exannulatus		..	..	..	..	..	..	..	..	+
Drepanocladus uncinatus		..	..	..	..	..	..	..	1	..
Sphagnum warnstorfi		..	..	..	..	..	..	..	..	1
Eriophorum scheuchzeri	A	..	..	..	..	..	..	+	..	..
Polygonum viviparum	A	..	..	..	..	..	..	..	..	+

composition: Shifting dominant taxa in the bottom layer are *Paludella squarrosa* (HEDW.) BRID. and *C. stramineum*; dominant taxon in the field layer is *Carex rariflora* WBG. In the Angmagssalik District constant taxa are *Salix herbacea*, *Sphagnum teres*.

physiognomy: The bryophytic, regarding the phanerogams mixed geophytic, hemicryptophytic, chamaephytic and nanophanerophytic community is stratifield in (1) a closed bottom layer of predominantly acrocarpous musci, sometimes also with *Salix herbacea*, (2) a more or less open graminoid field layer, and elsewhere also (3) a more or less open to closed shrub layer of Salices.

The appearance depends on the presence or absence of a shrub layer. In the Angmagssalik District where this is lacking, it looks like open, dull dark green grassy vegetation over a dense, swelling, conspicuous bright dark green velvety variegated moss layer with a characteristic brown to brick-red hue.

synecology & habitat: The arctic and northern low-alpine to alpine, hygrophytic, mesotrafent, minerotrafent and somewhat rheophytic, chionophytic and medium acidophytic community occurs in the this district in moderately wet to rather dry, mostly slightly, viz. less than 5°

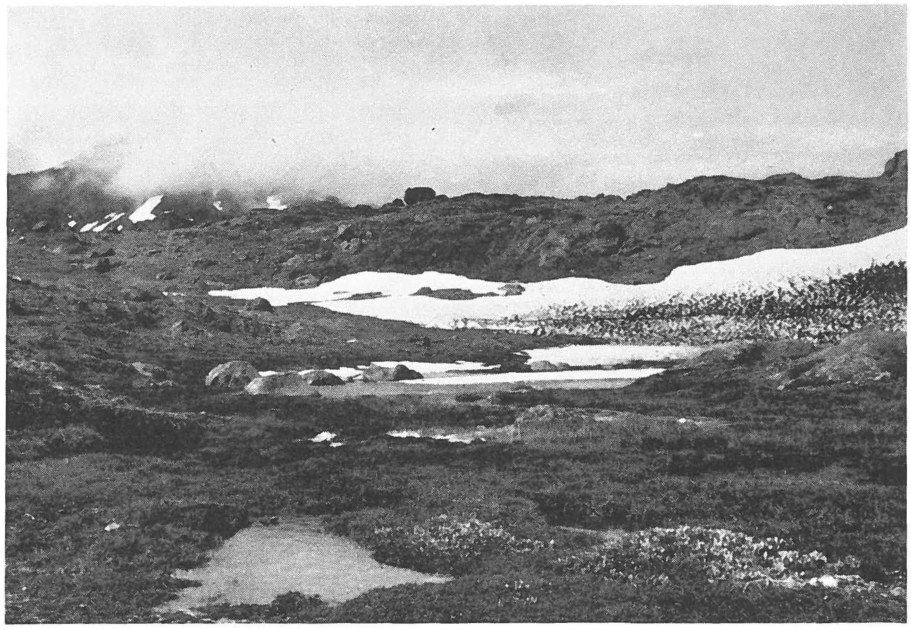


Fig. 33. *Paludella squarrosa* mire in the Elvbakker area.
JGdM phot. VI. 1968.

sloping places, namely in and around depressions where cold, oxygen-rich water collects and wells up to the surface, in or along channels or depressions draining such places, in comparable conditions around ponds and pools and in the marginal zone of extensive mires, often near long persistent snow drifts (fig. 33).

The ground water level varies irregularly. In spring it is found 0 to 21 cm, usually abt. 8 cm below the surface of the moss layer; later in the season the localities may dry up (cf. NORDHAGEN, 1943, p. 514; DAHL 1957, p. 318).

The thickness of the moss layer varies from 2 to 9 cm, and is as a rule abt. 3 to 4 cm. The substrate underneath consists of a 2 to 10 cm thick layer of dark brown to blackish unhumified peat; this rests in very springy localities directly on the mineral, coarse sandy subsoil, or, in less springy places on a layer of yellowish brown, 8 to 34 cm thick somewhat humified peat over a similar subsoil.

The colorimetric pH at abt. 10 cm depth ranges from $4^1/_2$ to $5^1/_4$ and is on an average 4.8.

succession & zonation: The community is found on one side bordering upon fragmentary stands of the *Mniobryo-Epilobion hornemanni* and on the other side, in sandy to stony dry soil, upon fell-field, with in the transition zone spread procumbent *Salix glauca* individuals; between the

so-called '*Sphagnetum riparii*' (5.3.1.) near the water, and drier *Empetrum-Vaccinium* heath on higher ground around ponds; also directly along the water of communicating pools in mires, where it is followed by different *Salix herbacea* communities rich in bryophytes.

Whether this spatial zonation also reflects a temporal succession is not clear.

distribution: The unit is common in the district (Elvbakker, Blomsterdalen, Kulusuk, Tasîlâlik; observed at Amarqâq, Ilivnera, Nuk, Torssukátak); also in Fennoscandia and presumably elsewhere in the area of the complex.

syntaxonomy & discussion: *Paludella squarrosa* grows mainly in mires of intermediate or richer types, and when it does occur usually in such quantities that it (co-)dominates in the bottom layer. It is not noted in extremely poor fens (MÅRTENSSON, 1956, p. 204). See for details DAHL (1957, p. 220).

The general composition of *Paludella mires* is variable. For the time being one can distinguish in general at least three types:

(1) a first type characterized by a well developed, rather dense, up to at least 70 cm high (KALELA, 1939, p. 431) shrub layer of nanophanerophytic *Salices*, particularly *S. glauca* and *S. lapponum* (cf. NORDHAGEN, 1928, table p. 187; id. 1943, table 88; KALELA, 1939, table 90:1–4; VIGERUST, 1949, table 28; DAHL, 1957, table 42; PERSSON, 1961, table 12:I);

(2) a second type, like the first one of comparatively temperate latitudes and altitudes, without a shrub layer, and with a field layer characterized by *Carex curta* and *Eriophorum angustifolium* (cf. NORDHAGEN, 1928, table p. 428:1–10; KALELA, 1939, table 90:5–8); it presumably includes communities with a field layer in which for instance *Carex rostrata* dominates (MALMSTRÖM, 1923, p. 33; RUUHIJÄRVI, 1960, table 22; KALELA, 1939, p. 434–435);

(3) a third type of comparatively high latitudes and altitudes, also without a shrub layer, and with a field layer characterized by *Carex rariflora;* presumably the "coldest" type, which differs in the fact that the upwelling water is and remains colder, and that its habitat is snow covered for a comparatively long time (cf. NORDHAGEN, 1928, table p. 428: 11–15, p. 427–429; this publication table 10).

Paludella communities with *Sphagnum warnstorfi*, *Tomenthypnum nitens* and also *Drepanocladus revolvens* represent a separate group of communities of drier, more eutrophic conditions, which should not be grouped in the *Caricion curto-nigrae;* they belong in my opinion to the *Campylio-Tomenthypnion* (5.1.2.).

Remarks:

The vascular plants occurring in the low-arctic representatives of the *Caricion curto-nigrae* in the Angmagssalik District are mostly taxa with a wide ecological amplitude, which by the qualitative and quantitative aspects of their occurrence give cause to a more or less parallel subdivision of the different sociation complexes.

These taxa are the following ones:

Eriophorum scheuchzeri, which has a comparatively narrow ecological amplitude; it can be considered faithful of the alliance in the concept adopted here, but within the alliance it occurs in different vegetation types.

Carex saxatilis is apparently tolerant of a wide range of acidity of the rhizosphere and trophic conditions of the substrate (Böcher, 1954, p. 240; Persson, 1961, p. 162; McVean & Ratcliffe, 1962, p. 125), in contrast with earlier observations (Tengwall, 1916; Fries, 1925, p. 8; Benum, 1958, p. 177); it is a variable taxon, but the subspecific variability does not seem to be correlated with differences in ecological behaviour; in the Angmagssalik District there is a type close to *C. rotundata.*

Calamagrostis neglecta alse has a rather wide ecological amplitude (Böcher, 1954, p. 250, table 32:14 and 15, 16; idem 1963, table 32:6–10).

The euryoicic behaviour of *Carex rariflora* is already observed by Kalliola (1939, p. 84) and Böčher (1963, p. 247), and appears distinctly also from Kalela's studies (Kalela, 1939).

The behaviour of *Carex bigelowii* seems to be even more euryoicic.

Elsewhere, namely in Fennoscandia, are characteristic such euryoicic taxa as *Eriophorum angustifolium*, *Carex rostrata*, *C. aquatilis*, *C. chordorrhiza*, *C. curta*, *Salix phylicifolia* (see Dahl, 1957, p. 218–222 and cited publications).

5.3. Related communities rich in *Sphagna.*

A comparison mainly of the studies of Nordhagen (1928, 1943), Kalliola (1932, 1939), Dahl (1957) and the present study reveal that in the alpine and subarctic zones of Fennoscandia and in Greenland there occur a number of mire communities which are synecologically and floristically related to both the *Caricion curto-nigrae* and the *Rhynchosporion albae* W. Koch 1926 (syn.: *Leuco-Scheuchzerion* Nordh. 1943). This fact has been recognized in Fennoscandia by Kalliola (1939, p. 78) and Nordhagen (1943, p. 531). Kalliola (l.c.) in consequence described such communities from the alpine-subalpine region in Finnish Lappland as a separate all. *Caricion rotundatae*, a floristically weakly defined unit which partly should be grouped in the above mentioned two alliances, partly agrees with the intermediate mire communities I observed in the Angmagssalik District.

Due to the scanty knowledge of this heterogeneous, intermediate group I will describe the communities in question in the following without classifying them in higher syntaxa.

5.3.1. *Sphagnum riparium* sociation complex.

syn.: *Sphagnum riparium*-reiche Siedlungen WARÉN 1926, *Sphagnum riparium*-Verband KATZ 1930, *Sphagnetum riparii* DAHL 1957; see further DAHL (1957, p. 239).

composition: Dominant taxon in the bottom layer is *Sphagnum riparium* ÅNGSTR. Characteristic of the field layer are mainly moisture indicating "rimpi" (mire-hollow) taxa such as for example *Carex rostrata*, *C. limosa*, *C. chordorrhiza*, *C. aquatilis*, *C. rariflora*, *Eriophorum angustifolium*, *E. vaginatum*, *Comarum palustre*, *Menyanthes trifoliata*. The bottom layer is usually very poor in taxa; beside *S. riparium* occur weakly represented for instance *Calliergon stramineum*, *Sphagnum lindbergii*, *S. nemoreum* (cf. DAHL, 1957, p. 239–240; PERSSON, 1961, p. 83–85; SONESSON, 1970, p. 56–57; see also p. 113–115).

distribution: Presumably coinciding with the main area of *S. riparium*, viz. boreal and low-arctic, circumpolar (BUEN, 1961, p. 31).

syntaxonomy & discussion: see p. 113–115.

5.3.1.1. *Sphagnum riparium-Carex rariflora* sociation.

table 11:1–4.

composition: Dominant taxon in the field layer is *Carex rariflora* WBG. The unit is in general very poor in taxa.

physiognomy: The bryophytic, as regards the phanerogams predominantly geophytic and partly hemicryptophytic community is stratified in (1) a closed, dense bottom layer of bryophytes and scarce *Salix herbacea*, and (2) a more or less open, low field layer of *Cyperaceae*. It forms small stands of loose, soft, green to yellowish green moss carpets composed of robust *Sphagna*, to which the graminoid field layer lends a dull greyish green hue; when *Eriophorum scheuchzeri* occurs it resembles from a distance 5.2.1.1.2. and 5.2.1.2.2. See also fig. 32, 34.

synecology & habitat: The low-arctic, presumably also northern alpine, hygrophytic-hydrophytic, mesotrafent and sometimes slightly metatrafent, minerotrafent and somewhat rheophytic, chionophytic and medium acidophytic mire-margin community occurs in the Angmagssalik District at the margin of mires near and along lakelets or rills, avoiding places with stagnant water; viz. especially in very wet habitats in mires at the margin of deep communicating pools occupied by purely bryophytic communities of the *Caricion curto-nigrae* (5.2.1.1.1. and 5.2.1.2.1.), or as broad, almost to more or less floating lobes projecting from the shore into shallow ponds with communities of the *Callitricho-Batrachion*.



Fig. 34. *Sphagnum riparium-Carex rariflora* sociation by the edge of the pond Sparganiumdammen near Angmagssalik.
JGdM phot. VI. 1968.

The substrate below the 2 to 8 cm thick layer of living green *Sphagnum* consists of an upper, 8 to 12 cm thick layer of loose, yellow unhumified *Sphagnum* peat, and a lower, 11 to 42 cm thick layer of yellow brown, light brownish-greyish to blackish more humified peat, which becomes gradually medium fine sandy and rests upon a subsoil of stony debris. Below sample plot 2 the deepest peat evidently consisted of *Hypnaceae* peat, halfway of intact *Drepanocladus exannulatus* plants, and near the surface of *Sphagnum* peat.

The habitat is snow-covered all winter. The ground water is affected by some lateral movement or some upwelling resulting from periodical supply of meltwater and rain water. The ground water level occurs between 0 and 25 cm below the surface of the moss carpet in early summer.

The colorimetric pH of the rhizosphere at abt. 10 cm depth ranges from $4^3/_4$ to $5^1/_4$ and averages abt. 5.

succession & zonation: See the previous paragraph and fig. 31. The succession presumably starts from the shore by the extension of semi-submerged to floating *Sphagnum* lobes into the water of pools and rills, or from submerged *Drepanocladus exannulatus* communities (5.2.1.1.1., possibly also 5.2.1.2.1.?) in deep pools, which become emergent and invaded by *Eriophorum scheuchzeri* and later *C. rariflora*, whereupon

S. riparium replaces *D. exannulatus*. The zonation towards the wetter conditions has been mentioned in the preceding section; towards the other side occur various hygrophytic mire communities, viz. often stands of the *Paludella squarrosa-Carex rariflora* sociation.

distribution: The unit occurs here and there in the district (Blomsterdalen, Kulusuk, Tasîlâlik) and probably also elsewhere in Greenland and the remainder of the northern alpine and arctic regions.

Remark: The sample plots 1, 3 and 4 represent the sociation in its typical form. Sample plot 2 possibly represents a separate unit or *Sphagnum riparium – Eriophorum scheuchzeri* sociation.

Associated with this sociation I observed another one, viz. a more or less fragmentary, more or less floating *S. riparium-Comarum palustre* community (cf. WARÉN, 1926, p. 76).

5.3.1.2. *Sphagnum riparium-Scirpus caespitosus* sociation.

table 11:5, 6.

composition: Dominant taxon in the field layer is *Scirpus caespitosus* L. ssp. *austriacus* (PALLAS) ASCH. & GRAEBN. Accessory and partially also differential taxa as for the previous sociation are *Paludella squarrosa*, *Oncophorus wahlenbergii*, *Carex bigelowii*, *Anthelia juratzkana*. The unit is in the district comparatively rich in taxa and in this respect approaches the boreal alpine, Fennoscandian units of the sociation complex.

physiognomy: See 5.3.1.1. The community forms small stands, in appearance dominated by the dull, often rather dark brownish green, compact moss carpet in which the phanerogams occur mostly individually.

synecology & habitat: Cf. 5.3.1.1. The community occurs in the Angmagssalik District very locally in the extensive marginal zone of a palsa-mire, along communicating deep pools with submerged bryophytic communities of the *Caricion curto-nigrae*.

The habitat has possibly been created by or along (collapsed) frost boils or ephemeral, "embryonic" palsas (cf. RUUHIJÄRVI, 1960, p. 255–266). On such hummocks the *Sphagnum* carpet has been subjected to dessication and subsequent degeneration and partially creep. After the collapse of such structures this substrate became to a certain degree wet again, so that *Scirpus caespitosus* and *Oncophorus* were able to establish themselves in the poorly recovering, partly irreversibly damaged *Sphagnum* carpet. These hummocks and this type of vegetation are as a rule situated along pools (fig. 35; cf. RUUHIJÄRVI, 1960, fig. 39).

The substrate below the 2 to 3 cm thick, partly poorly thriving compact layer of living moss, consists of an upper, 5 to 8 cm thick layer of compact, more or less compressed poorly humified black raw peat; below that layer follows a 22 to 35 cm thick layer of better humified,

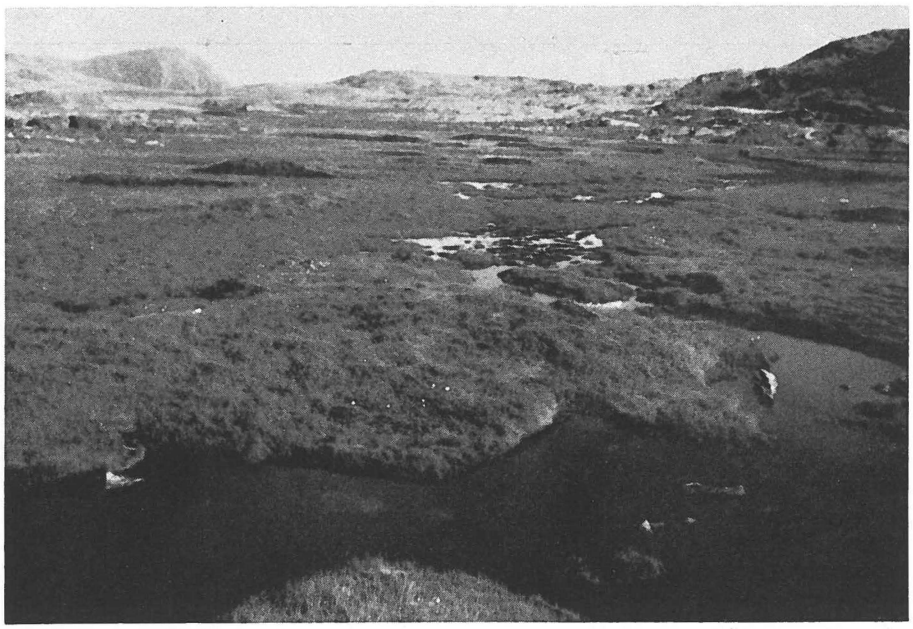


Fig. 35. *Sphagnum riparium-Scirpus caespitosus* sociation in the palsa mire near Nagtivit; in the communicating pools *Calliergon sarmentosum* sociations. JGdM phot. VII. 1968.

amorphous, brown to blackish brown greasy peat, which in the lower part is more or less washed and lighter coloured (*Hypnaceae*-peat). The subsoil, below 30 to 39 cm depth, consists of blocks and stones, between which the rather wide interspaces are filled with clear, feebly moving water.

The ground water level is found at 9 to 12 cm below the surface of the moss layer.

The colorimetric pH of the rhizosphere at abt. 10 cm depth is abt. $4^3/_4$.

distribution: The unit is rare in the district (Tasîlâlik). It probably occurs also elsewhere in suitable conditions in the northern part of the area of the sociation complex.

succession & zonation: See the paragraph on the habitat.

syntaxonomy & discussion: Dahl (1957, p. 239) distinguishes as a separate association the mire communities with a bottom layer characterized by *Sphagnum riparium* and a field layer without taxa characteristic of rich fens. This opinion is shared by Persson (1961, p. 83, 109, table 14). This unit is little variable in Fennoscandia. Most of the described types belong to the "facies *caricetosum rostratae* Dahl 1957" (Cajander, 1909, table p. 106:1: Melin, 1917, table 19:8–10; Osvald, 1925, table p. 45; Persson, 1961, table 14; Sonesson, 1970, table 2:9; Ruuhijärvi, 1960,

Table XI

reference number		1	2	3	4	5	6	7	8	9
altitude (m)		25	25	60	60	25	25	25	25	25
total cover plants (in %)		100	100	100	100	100	100	100	100	100
cover phanerogams	–	15	12	15	10	40	50	25	35	20
– bryophytes	–	100	100	95	100	100	90	100	100	100
pH rhizosphere		5	4 3/4	5	5 1/4	4 3/4	4 3/4	4 3/4	5	4 3/4
ground water level (-cm)										
below surface bottom layer		31	19	5	12	9	12	21	14	23
below surface substrate		25	11	+1	10	6	10	17	12	20
Sphagnum lindbergii		..	..	..	..	..	..	4	4	4
Sphagnum riparium		6	6	6	6	5	5	..	..	..
Carex rariflora	L	3	1	3	2	2	2	3	4	3
Salix herbacea	L	..	..	+	1	2	4	1	..	2
Calliergon stramineum		..	..	..	1	2	1	1	3	1
Polytrichum commune		..	..	2	1	..	..	+	..	2
Oncophorus wahlenbergii		..	..	..	..	3	2	4	+	5
Polygonum viviparum	A	..	..	..	..	1	2	2	..	+
Paludella squarrosa		..	..	..	..	4	4	3	..	..
Scirpus caespitosus	B	..	..	..	..	3	3	..	..	..
Carex bigelowii	L	..	..	..	..	1	1	..	..	..
Anthelia juratzkana		..	..	..	..	1	+	..	..	..
Eriophorum scheuchzeri	A	..	2	..	..	+	..	..	..	..
Scapania cf. *irrigua*		..	..	..	..	..	+	2	3	+
Cetraria delisei		..	..	..	..	..	..	+	+	1
Drepanocladus exannulatus		..	..	..	..	..	..	+	3	+
Calliergon sarmentosum		..	..	..	..	..	..	1	2	..
Kiaeria glacialis		..	..	..	..	..	..	+	..	+
Pleuroclada albescens		..	..	..	..	..	..	1	..	+
Lophozia spec.		..	..	..	..	..	..	..	..	+
Comarum palustre	B	+	..	..	..	..	..	..	..	..
Euphrasia frigida	L	..	..	..	..	..	+	..	..	..

table 1:10–13), or represent closely related sociations which should perhaps be considered as subunits including those (also) characterized by *Carex chordorrhiza* (MELIN, 1917, table 19:10–13; WARÉN, 1926, p. 76), *C. limosa* (OSVALD, 1925, p. 42; WARÉN, 1926, p. 76), *Eriophorum angustifolium* (RESVOLL-HOLMSEN, 1920, table 24:2; OSVALD, 1925, p. 45; DAHL, 1957, table 48), *E. vaginatum* (OSVALD, 1925, p. 46), *Menyanthes trifoliata* or *Comarum palustre* (WARÉN, 1926, p. 76). Such vegetation types represent, according to RUUHIJÄRVI (1960, p. 51) southern mires, while the corresponding northern mires are characterized in Fennoscandia by *Carex aquatilis* (cf. CAJANDER, 1909, table p. 101:1, 10).

Related communities characterized by the presence of a shrub layer from the Fennoscandian coniferous region have been described by SJÖRS

(1948, p. 144–151, table S) and EUROLA (1962, p. 77–80, table 18) among others.

The vicarious low-arctic community replacing the northern low-alpine, Fennoscandian *Sphagnum riparium-Carex rostrata* sociation in the Angmagssalik District is the *Sphagnum riparium-Carex rariflora* sociation. The *Sphagnum riparium-Scirpus caespitosus* sociation represents a somewhat deviating type, which parallels certain Fennoscandian vegetation types (cf. PERSSON, 1961, p. 83; SONESSON, 1970, p. 57). These two low-arctic units differ from the boreal ones in the phytogeographically determined absence of a set of boreal taxa, such as *Carex limosa*, *C. chordorrhiza*, *C. rostrata*, *C. aquatilis*, *C. rodundata*, *C. lasiocarpa* and *Eriophorum vaginatum*, which do not reach into the Arctic.

The synecology and floristic composition of the sociations indicate relationship to the *Caricion curto-nigrae* (cf. PERSSON, 1961, p. 132; SCHROEVERS & VAN DER VOO, 1965, p. 85; SONESSON, 1970, p. 57).

5.3.2. *Sphagnum lindbergii* sociation complex.

syn.: *Sphagnum lindbergii*-reiche Siedlungen WARÉN 1926, *Sphagnum lindbergii*-Verband KATZ 1930, *Sphagnetum lindbergii* DAHL 1957; see further DAHL (1957, p. 235, 239) and HADAČ & VÁŇA (1967, p. 227).

composition: Dominant taxon in the bottom layer is *Sphagnum lindbergii* SCHIMP. The sociation complex is closely related to the "*Sphagnetum riparii*" and the variability in the composition of the field layer is quite similar in both (DAHL, 1957, p. 239; see 5.3.1.). The bottom layer is poor in taxa. Besides *S. lindbergii* frequently occur *S. riparium*, *S. jensenii*, *S. balticum*, and in the southern parts of its area also *S. tenellum*, *S. apiculatum*, *S. magellanicum;* furthermore *Drepanocladus fluitans*, *D. exannulatus*, *Calliergon stramineum*, *Oncophorus wahlenbergii* (cf. KALELA, 1939, p. 507–513; DAHL, l.c.; RUUHIJÄRVI, 1960, p. 80; PERSSON, 1961, p. 85–88).

distribution: Presumably more or less coinciding with the area of *S. lindbergii*, viz. arctic-subarctic and northern (montane to) alpine, circumpolar (SJÖRS, 1949, p. 569).

5.3.2.1. *Sphagnum lindbergii-Carex rariflora* sociation.

syn.: *Carex rariflora-Sphagnum lindbergii*-Ass. OSVALD 1925 n.n.; *Carex rariflora-Sphagnum lindbergii*-Weissmoor KALELA 1939; ± *Sphagnum dusenii-lindbergii*-reiche *Carex rariflora*-Ass. NORDH. 1928.

table 11:7–9.

composition: Dominant taxon in the field layer is *Carex rariflora* WBG. Frequent accessory taxa met with in the Angmagssalik District are *Oncophorus wahlenbergii*, *Calliergon stramineum*, *Drepanocladus exan-*

nulatus. The communities of the unit are both in the district and also in northern Europe moderately poor in taxa (lit.: see distribution).

physiognomy: See 5.3.1.1. and 2. The community forms rather small stands of brownish-greenish, soft moss carpets, sometimes more dirty, dark olive to blackish green, less soft ones, and an open, dull grayish green grassy field layer.

synecology & habitat: The low and subarctic, hydrophytic, oligotrafent to somewhat mesotrafent, somewhat minerotrafent, chionophytic and medium acidophytic mire-expanse and mire-margin community occurs in the Angmagssalik District along the margin of local, small, soligenous mires (fig. 31, 32).

The substrate, below the 2 to 4 cm thick carpet of living moss, consists of a 3 to 7 cm thick layer of unhumified, brown dead moss (raw peat), followed by a 17 to at least 21 cm thick layer of unhumified, often strongly smelling (hydrogen sulphide), bright orange to redbrown moss peat which is frozen below 31 cm depth or rests on a mineral, sandy to stony subsoil at 23 to 26 cm depth.

The habitat is snow-covered all winter. The groundwater fluctuates somewhat vertically, but remains in general permanently high. In early summer the groundwater level is found at 12 to 20 cm depth below the surface of the moss layer. In spring and early summer the water is feebly horizontally moving near the surface, later on it is stagnant.

The colorimetric pH of the rhizosphere at abt. –10 cm depth ranges from $4^3/_4$ to 5.

zonation & succession: The spatial zonation in the single locality where this unit is observed is given in fig. 31, and possibly corresponds to the temporal succession.

distribution: The unit is very rare in the district (Kulusuk), rather common in Petsamo Lappland (KALELA, 1939, p. 511–512), and occurs also in northern European Russia (ANDREJEW, 1932, table 25:222, 135.2), and fragmentary, ± atypical in central Fennoscandia (OSWALD, 1925) p. 43; NORDHAGEN, 1928, p. 441); it occurs probably also elsewhere in Greenland and the northern part of the area of the sociation complex.

syntaxonomy & discussion: Mire communities characterized by the dominance of *Sphagnum lindbergii* in the bottom layer and the occurrence of rimpi-taxa in the field layer have been mentioned and described frequently in publications namely from Fennoscandia. DAHL (1957, p. 235, 239) has given a very comprehensive review of such published communities up to 1956, and united these in a separate association, the *Sphagnetum lindbergii*. Recently RUUHIJÄRVI described several northern Finnish communities which apparently belong to the same unit (RUUHIJÄRVI, 1960, p. 45–47, 59–61, 80, table 2:45–47, 4:22–24, 13:18–38).

These communities differ from the northern ones, with *Carex rariflora*, in the presence of a set of boreal taxa which are absent in the Arctic

(5.3.1.: discussion). DAHL does not mention these *Carex rariflora-Sphagnum lindbergii* communities, which are mutually quite different.

Chapter IV

Snow-bed vegetation

A first attempt to classify the alpine Scandinavian, non-calciphytic snow-bed communities was made by VESTERGREN (1902) and SAMUELSSON (1916, 1917). On the basis of physiognomical criteria they distinguished a heath-series and a meadow-series.

The modern classification of these snow-bed communities has been introduced by NORDHAGEN (1936, p. 45–53 and 1943, p. 229–307). His system is based on a combination of floristic and ecological criteria. In Norway NORDHAGEN distinguishes four alliances, which he groups in the *Salicetalia herbaceae* BR.-BL. 1926, thus giving this syntaxon a wider application than it was originally, and still is given in Central Europe.

These alliances are the *Nardo-Caricion bigelowii* (sub nom. *Nardeto-Caricion rigidae*), the *Cassiopo-Salicion herbaceae*, the *Ranunculo-Oxyrion digynae* and the *Cryptogrammo-Athyrion alpestris* (sub nom. *Allosoreto-Athyrion alpestris*).

The *Nardo-Caricion bigelowii* comprises the subalpine to alpine, seasonally wet, acidophytic and oligotrafent, chionophytic grass heath communities. The *Cassiopo-Salicion herbaceae* the alpine, also seasonally wet and acidophytic and oligotrafent, extremely chionophytic (moss-)heath communities. The *Ranunculo-Oxyrion digynae* the alpine, irrigated, medium acidophytic and eutrafent, chionophytic grass heath communities. The *Cryptogrammo-Athyrion alpestris* at last comprises the sub to low-alpine, irrigated, medium acidophytic, mesotrafent to oligotrafent, chionophytic fern communities of rocky and stony soils.

NORDHAGEN (1943, p. 286–297) later subdivided the *Ranunculo-Oxyrion digynae* in two suballiances, the *Alchemillion glabrae chionophilum* (comparatively mesophytic and less extreme chionophytic communities) and the *Saxifrago-Ranunculion nivalis* (comparatively hygrophytic and more chionophytic communities).

GJAEREVOLL (1949) adopts this system in his classification of the snow-bed communities of Jämtland in Sweden, with one modification: following a suggestion made by DU RIETZ (1942a, p. 180) he separates the most extreme chionophytic, cryptogamic communities entirely lacking a field layer of vascular plants from the *Cassiopo-Salicion herbaceae.* These communities are grouped in a fifth alliance, the *Polytrichion norvegici.*

In his description of the snow-bed vegetation of Swedish Lappland and in his monography on the Scandinavian alpine snow-bed communities GJAEREVOLL (1950a, 1956) gives a clear description of the

fundamental distinction between snow-bed communities (alliances) poor in calciphytes and those rich in calciphytes. This distinction was previously pointed out for instance by DU RIETZ (1942a) and corresponds to the distinction made in alpine Central Europe between the *Salicetalia herbaceae* BR.-BL. 1926 and the *Arabidetalia coeruleae* RÜBEL 1933. GJAEREVOLL subdivides both groups of alliances in a "season-hygrophilous sub-series" (heath-series), a "permanently hygrophilous sub-series" (meadow-series) and a series of communities without a field layer (moss-series).

In the seasonally wet sub-series with a field layer of the *Salicetalia herbaceae* BR.-BL. 1926 em. NORDH. 1936 he groups the *Nardo-Caricion bigelowii* (sub nom. *Deschampsio-Anthoxanthion* DU RIETZ 1942) and the *Cassiopo-Salicion herbaceae* NORDH. 1936 em. GJAEREVOLL 1949 (sub nom. *Herbaceon* (DU RIETZ in lectures) GJAEREVOLL 1950); in the permanently wet sub-series with a field layer he groups the *Cryptogrammo-Athyrion alpestris* as well as the *Ranunculo-Oxyrion digynae*, the latter of which he divides more or less parallel with NORDHAGEN's subdivision in two suballiances in two separate alliances: the medium chionophytic *Ranunculo-Anthoxanthion* (DU RIETZ in lectures) GJAEREVOLL 1950 and the extreme chionophytic *Stellaro-Oxyrion digynae* (DU RIETZ 1942) GJAEREVOLL 1950; in the last sub-series he groups the *Polytrichion norvegici.*

DAHL (1957) has drastically revised NORDHAGEN's classification system. In his description of the plant communities of the Rondane mountains in Norway he has further emphasized and elaborated the importance of ecological criteria in vegetation classification.

As a consequence he restricts the concept of the *Salicetalia herbaceae* BR.-BL. 1926 em. NORDH. 1936, so that it only comprises the communities on solifluction soils and with a short vegetative season (l.c. p. 167), viz. the *Cassiopo-Salicion herbaceae* and *Ranunculo-Oxyrion digynae.* In this concept this order is again identical with the original *Salicetalia herbaceae* BR.-BL. 1926, as described from Central Europe.

The concept of the *Cassiopo-Salicion herbaceae* is also restricted. DAHL groups only the strictly oligotrafent communities in this alliance: "The scope of this alliance has been restricted in this work since many communities previously grouped in the *Cassiopeto-Salicion herbaceae* would be better referred to the *Ranunculeto-Oxyrion*, because of the presence of an element of eutrophic species" (l.c. p. 168). In this alliance he also groups again the *Polytrichion norvegici*, considering that a fundamental distinction between snow-bed communities with some vascular plant cover and those with none cannot be maintained, since vascular plants appear to drop out gradually when the snowcover lasts longer (DAHL, 1957, p. 168; cf. also MCVEAN & RATCLIFFE, 1962, p. 100).

DAHL also delimits the *Ranunculo-Oxyrion digynae* somewhat differently. He does not refer to GJAEREVOLL's division of this syntaxon

(communities belonging to the *Stellaro-Oxyrion digynae* are not described by him) and he groups in this alliance also many chionophytic and eutrafent (-calcicolous) communities which were previously referred to the *Nardo-Caricion bigelowii*, *Deschampsio-Anthoxanthion* and *Cassiopo-Salicion herbaceae* (DAHL, l.c. p. 117, 186–187).

The *Cryptogrammo-Athyrion alpestris* would according to DAHL (l.c. p. 167) and HADAČ (1971b, p. 114) be better placed in the *Adenostyletalia* BR.-BL. 1930.

The *Nardo-Caricion bigelowii* has been classified by DAHL in the *Deschampsio-Myrtilletalia* DAHL 1957, which order comprises the oligotrafent, chionophytic and/or seasonally wet dwarf shrub and grass heath communities in stable soils. Moreover, he divides this order in (a) a *Nardo-Caricion bigelowii* NORDH. 1936 em. DAHL 1957, comprising communities in seasonally wet locations with impeded drainage, and which are usually snow-covered and often also with a ground-ice cover in winter (l.c. p. 144), and in (b) a *Deschampsio-Anthoxanthion* DAHL 1957 (non DU RIETZ 1942), comprising communities of late snow-beds on stable or relatively stable soil without seasonal water logging or ground-ice cover in winter (l.c. p. 129). However, the floristic differences between these alliances is slight (l.c. p. 129 and table 13).

HADAČ (1971b), recently described a new *Antitrichio-Sedion roseae* from Iceland. This alliance comprises chionophytic and acidophytic communities of damp, coarse gravel, which are dependent on dripping of water from above ("Tropf-region"). It seems to be intermediary between the *Ranunculo-Oxyrion digynae* NORDH. 1936 and the *Androsacion alpinae* BR.-BL. 1926. Floristic and ecological arguments seem to justify the distinction of this new alliance (l.c. p. 106), but its syntaxonomical position is somewhat questionable. HADAČ thinks that it belongs most probably to the *Androsacetalia alpinae* BR.-BL. 1926 and not to the *Salicetalia herbaceae* BR.-BL. 1926.

To arrive at a conveniently arranged classification of the floristically usually very closely related snow-bed communities with their many mutual transitions, I think that it is most expedient to emphasize in particular the similarities and differences in the ecology of these communities and their structure. This seems to offer the most practical solution for the classification of at least such communities in the Angmagssalik District. This leads to the adoption of the system developed by NORDHAGEN, partly as modified by GJAEREVOLL and partly as modified by DAHL.

I prefer to follow DAHL's conception of the *Salicetalia herbaceae*, so that the concept of this order remains identical both in alpine central Europe, alpine Fennoscandia and arctic Greenland. Within this syntaxon I also agree for the greater part with, and follow consequently here, his deli-

mitation of the *Cassiopo-Salicion herbaceae*. Concerning the *Ranunculo-Oxyrion digynae* it appears from DAHL's work that all his observations and considerations regarding the syntaxonomical position and the concept of this alliance refer predominantly to the group of communities described by NORDHAGEN as the suball. *Alchemillion glabrae chionophilum* and by DU RIETZ and GJAEREVOLL as the all. *Ranunculo-Anthoxanthion*. In this concept it belongs also in my opinion to the *Salicetalia herbaceae*. The nomenclatorical correct name for this syntaxon should thus be *Ranunculo-Oxyrion digynae* NORDH. 1936 em. DAHL 1957.

The rest of the original *Ranunculo-Oxyrion digynae*, described by DU RIETZ (1942a, and GJAEREVOLL (1950a, 1956) as the all. *Stellaro-Oxyrion* and by NORDHAGEN (1943), in a somewhat wider concept as the suball. *Saxifrago-Ranunculion nivalis*, is floristically and ecologically quite different from the *Ranunculo-Oxyrion digynae* NORDH. 1936 em. DAHL 1957. It is, as the *Antitrichio-Sedion roseae*, both related to the *Salicetalia herbaceae* and the *Androsacetalia alpinae*, concerning the latter ecologically especially to the *Androsacion alpinae*. NORDHAGEN (1936, p. 52), elaborating a suggestion of e.g. RÜBEL (1933, p. 24, 27), proposes the grouping of the alpine, central European *Androsacion alpinae* BR.-BL. 1926 in the *Salicetalia herbaceae* and not in the *Androsacetalia alpinae*. This alliance is, according to this author (NORDHAGEN, 1936, p. 52 and 1943, p. 283), in alpine northern Europe replaced by both the *Ranunculo-Oxyrion digynae* NORDH. 1936 and the *Cassiopo-Salicion herbaceae* NORDH. 1936. Synecologically this is in my opinion only true for those communities of the original *Ranunculo-Oxyrion digynae* that are later grouped in the *Stellaro-Oxyrion* (DU RIETZ, 1942) GJAEREVOLL 1950, and for the *Luzulo-Ranunculetum glacialis* NORDH. 1943 of the *Cassiopo-Salicion herbaceae*, viz. for communities which like those of the *Androsacetalia alpinae* in general "den trockenen oder durchfeuchteten, lockeren, durchlässigen Silikatschutt besiedeln" (BRAUN-BLANQUET, 1948b, p. 241). As will be pointed out on p. 181, I consider the nature of the instability of the substrate and the floristical and structural differences and similarities arguments in favour of including the *Luzulo-Ranunculetum glacialis* provisionally in the *Stellaro-Oxyrion* and of grouping this alliance in the *Androsacetalia alpinae* together with the *Senecion leucophyllae* BR.-BL. 1948, thus disagreening with NORDHAGEN (l.cl) and agreeing with most central European syntaxonomists. The *Stellaro-Oxyrion* corresponds and vicariates in this concept with the central European Androsacion alpinae. It comprises herbaceous communities sometimes rich in cryptogams whereas the related *Cassiopo-Salicion herbaceae* comprises cryptogamic and cryptogam-rich dwarf shrub communities. It occurs in mobile soil, whereas the related *Ranunculo-Oxyrion digynae* occurs in stable (or relatively stable) soil. To the faithful and differential taxa of the *Stellaro-*

Oxyrion as listed by GJAEREVOLL (1956, p. 183–187) one should add the chalicophytes *Cardamine bellidifolia*, *Minuartia biflora*, *Luzula confusa* and *Ranunculus glacialis*.

The *Nardo-Caricion bigelowii* NORDH. 1936 seems to be satisfactorily grouped in the *Deschampsio-Myrtilletalia* DAHL 1957. However, the communities representing this syntaxon in the Angmagssalik District are intermediary between the two alliances in which the original *Nardo-Caricion bigelowii* is divided by DAHL (1957). It must be borne in mind here that DAHL himself considered this division provisional. As he observes, it seems possible in the comparatively continental Rondane, but may not be possible in more oceanic tracts. The latter is apparently the case in the Angmagssalik District; in consequence I will here group the communities in question in the *Nardo-Caricion bigelowii* NORDH. 1936 (non em. DAHL 1957).

The low arctic and oceanic snow-bed communities in the mountainous Angmagssalik District are as a rule locally developed and of (very) small extent. This is strikingly different from the occurrence of such communities in for instance Fennoscandia, where they often cover extensive areas. Only on the screes along the fjords in the district may communities of the *Ranunculo-Oxyrion digynae* cover comparatively large areas, usually in an intricate mosiac with *Empetrum-Vaccinium* dwarf shrub and *Salix glauca* shrub communities.

In the Angmagssalik District it seems possible to recognize fairly clearly the following five alliances of snow-bed communities. The first two alliances comprise the snow-bed communities in the strict sense. The position of the other three is also largely determined by other environmental factors than mainly the snow cover; these alliances are treated in other chapters (V and VI).

a. *Cassiopo-Salicion herbaceae* (*Salicetalia herbaceae*), which consists of strictly oligotrafent, very or extremely late snow-free, more or less two-layered, comparatively exposed, seasonally wet cryptogamic and cryptogam-rich dwarf shrub communities of unstable, in regard to the amount of seasonal water supply temporarily poorly drained (oversaturated) substrates which are subjected to solifluction and partly also to limited cryoturbation (but not to intense soil displacement), with a superficial, very acid and usually thin but distinct humus layer. The core of the alliance consists of the cryptogamic communities of the *Polytrichion norvegici*, supplemented with related *Cassiope hypnoides*, *Gnaphalium supinum* and *Salix herbacea* communities.
b. *Ranunculo-Oxyrion digynae* (*Salicetalia herbaceae*), which comprises mesotrafent to eutrafent, (very) late snow-free, as a rule three-layered, seasonally wet, comparatively exposed herbaceous communities dominated by hygrophytes, of relatively stable, well-drained sub-

strates, enriched by dry or wet flushing and rich in humus to peaty in the superficial layers.

c. *Antitrichio-Sedion roseae* (*Androsacetalia alpinae*), a syntaxon which consists of eutrafent, late snow-free, as a rule three-layered, permanently wet to moist, comparatively sheltered communities dominated by hygrophytes, of more or less unstable, well-drained, loose, gravelly to coarse sandy substrates on rocky ledges and comparable sites, enriched by the continuous dripping of water from often overhanging rocks and rich in humus to peaty in the superficial soil layers.

d. *Stellaro-Oxyrion* (*Androsacetalia alpinae*), which comprises eutrafent to mesotrafent, very or extremely late snow-free, usually more or less two-layered, more or less exposed herbaceous communities dominated by herbaceous hygrophytes, of prolongedly irrigated to permanently wet, (more or less) unstable, loose, sandy to gravelly (to stony) substrates poor in humus and subjected to often intense soil displacement due to intense solifluction, earth-slides and sedimentation.

e. *Nardo-Caricion bigelowii* (*Deschampsio-Myrtilletalia*), which comprises (mesotrafent to) oligotrafent, late snow-free, as a rule three-layered, somewhat sheltered and over a comparatively short period seasonally wet, graminaceous communities dominated by mesophytes, of stable substrates rich in humus, which keep a rather high content of moisture after the irrigation stops and which are sometimes covered by a layer of ground-ice in winter.

6. Class *Salicetea herbaceae* Br.-Bl. 1947.

This class groups the usually closed, arcto-alpine snow-bed communities which tolerate an 8 to 10 months and even longer persistent snow cover and which mainly consist of musci, hepatics and hemicryptophytic and reptant chamaephytic phanerogams; in oligotrophic to eutrophic, acid substrates which are more or less unstable owing to solifluction and cryoturbation but only in limited degree mobile due to erosion, in the alpine and arctic areas of Europe and in Greenland, presumably also elsewhere in the Holarctic. Faithful taxa are *Cerastium cerastoides* (L.) Britton, *Sedum alpestre* Vill., *Veronica alpina* L., *Sagina saginoides* (L.) H. Karst., *Luzula spadicea* DC., *Solorina crocea* (L.) Ach. (See 6.1.).

6.1. Order *Salicetalia herbaceae* Br.-Bl. 1926.

The *Salicetalia herbaceae* comprises pronounced chionophytic, mesophytic to hygrophytic, acidophytic, non-calciphytic, oligotrafent to

eutrafent communities found in places with a long lasting snow cover (snow-beds) and an unstable, sandy, superficially frequently very humic substrate. It occurs in the same area as the class, and vicariates ecologically with the calciphytic *Arabidetalia coeruleae* RÜBEL 1933. (cf. BÖCHER, 1933, 1937, 1954, 1963; BRAUN-BLANQUET, 1948a, 1949, 1964; DAHL, 1957; GJAEREVOLL, 1949, 1950a, 1956; HADAČ, 1956, 1962, 1971b, KRUUSE, 1912; MCVEAN & RATCLIFFE, 1962; NORDHAGEN, 1928, 1936, 1943).

6.1.1. All. *Cassiopo-Salicion herbaceae* NORDH. 1936 em. DAHL 1957.

syn.: *Salicion herbaceae* DU RIETZ 1942, *Herbaceon* DU RIETZ 1950; incl. *Polytrichion norvegici* GJAEREVOLL 1949.

The communities that represent the *Cassiopo-Salicion herbaceae* in the district are rather common, but usually cover small tracts, as the mostly mountainous physiography prevents the accumulation of snow drifts over large areas and, in combination with the geology, the development of suitable substrates there on the steep slopes. Comparatively large, deep snow drifts are in particular found more or less commonly in the coastal low land areas (Elvbakker, Kulusuk), where the usually stony to gravelly substrate is yet often too well drained and mobile to allow the development of these communities.

Succession of vegetation types hardly occurs in the extreme late snow areas in the district, so that the communities of such habitats must be characterized as "Dauergesellschaften" (cf. BRAUN-BLANQUET, 1964, p. 149), permanent communities of plants which remain unchanged for a long time and maintain their individuality without corresponding to the climax of the region. This is caused by their primary dependence on a few decisive, over long periods constant ecological factors, viz. the depth and persistence of the snow cover and the phenomena correlated with that factor (irrigation, solifluction, cryoturbation). One single factor can bring about a very gradual succession (not regarding a gradual change in the climate), namely the sedimentation of niveo-aeolian and colluvial, allochtonous material, which causes a very gradual rising of the substrate and thus indirectly influences the previously mentioned factors.

BRAUN-BLANQUET (1948a, p. 80 and 1964, p. 602–603) mentions *Anthelia juratzkana* as the first pioneer, in the Alps and Pyrenees, on bare gravel in late snow areas. Small tufts of *Kiaeria falcata* establish themselves in the *Anthelia* carpet later on. In these tufts, and in particular in the *Anthelia* carpets but never on bare gravel, *Polytrichum norvegicum* invades "qui généralement termine ce rudiment de cycle évolutif" (BRAUN-BLANQUET, 1948a, p. 82). This remark is mainly based on the observation that the humus below the liverwort mat is less acid than below the moss carpet, and that in consequence the last can succeed the first but not the

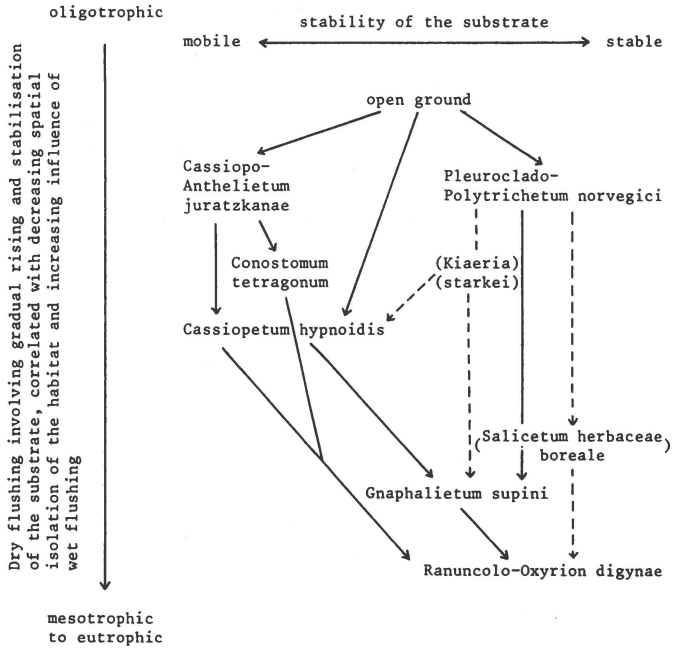


Fig. 36. Trends in the succession in the *Cassiopo-Salicion herbaceae*. The subassociations are indicated by the names of the dominant, differential taxa; syntaxa of the alliance not observed in the district are in brackets.

reverse (BRAUN-BLANQUET, 1926, p. 219; cf. also GJAEREVOLL, 1956, p. 238–240 and this publication p. 128, 135). If continued, the succession leads towards the *Salicetum herbaceae* in the Alps and towards the *Ghaphalieto-Sedetum candollei* in the eastern Pyrenees (l.c., p. 82). See also POORE (1955, p. 634).

In the Angmagssalik District the stability of the substrate appears to be an important factor beside the snow cover and irrigation. In contrast, *A. juratzkana* as well as *P. norvegicum* communities there are both the first pioneers on bare gravel, the liverwort in unstable, the moss in more stable substrates. Both are, when succession takes place, gradually replaced by the corresponding variants of the *Cassiopetum hypnoidis*, which in turn develops towards the other variants of this association and communities of the *Gnaphalietum supini* and the *Ranunculo-Oxyrion digynae* (see fig. 36).

The rocks in the district are in general non-calcareous but their weathering products are initially rather rich in mineral (cf. p. 10). Oligotrafent communities such as those of the *Cassiopo-Salicion herbaceae* only occur there where the upper part of the substrate is washed by excessive supply of water poor in minerals from nearby snow drifts. Rising of the substrate with niveo-aeolian and colluvial material rich in

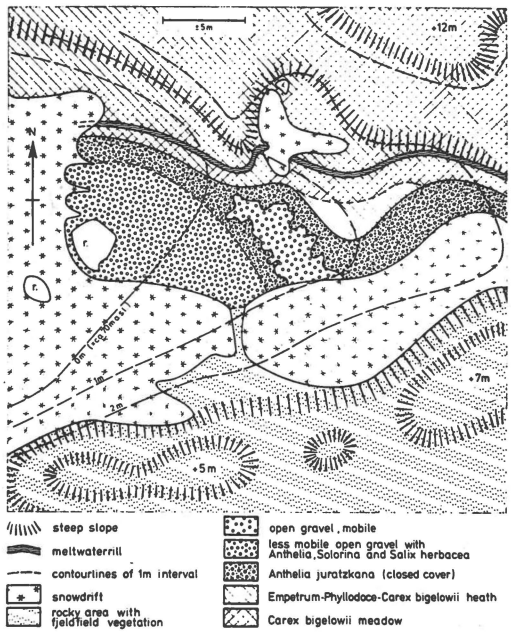


Fig. 37. Zonation in the chionophytic vegetation along a meltwater rill in the Elvbakker area.

minerals and diminishing leaching of the upper soil layers with increasing depth of the ground water will thus result in the development of more mesotrafent to eutrafent communities on the spot (*Ranunculo-Oxyrion digynae;* cf. fig. 36).

The vicarious *Salicion herbaceae* of the central European mountains represents according to BRAUN-BLANQUET (1964, p. 757), like the *Loiseleurio-Vaccinion*, a boreoarctic-alpine relict-type. It differs from the *Cassiopo-Salicion herbaceae* in the occurrence of the faithful taxa *Alchemilla pentaphyllea* L., *Arenaria biflora* L., *Cardamine alpina* WILLD., *Potentilla aurea* L., *Sedum alpestre* VILL., *Soldanella pusilla* BAUMG., a series of accessory, also central and southern European orophytes, and the absence of a.o. *Cassiope hypnoides.*

Faithful taxa of the *Cassiopo-Salicion herbaceae* are *Cassiope hypnoides* (L.) DON., and, also of the *Salicion herbaceae*, *Anthelia juratzkana* (LIMPR.) TREV., *Marsupella varians* (LINDB.) K. M., *Gymnomitrium concinnatum* (LIGHTF.) CORD., *Pleuroclada albescens* (HOOK.) SPR., *Conostomum tetragonum* (BRID.) LINDB., *Kiaeria starkei* (WEB. et MOHR) HAG., *Polytrichum norvegicum* HEDW., *Cephalozia ambigua* MASS., *Pohlia commutata* SCHIMP. (cf. DAHL, 1957, table 36).

Because of a gradual disappearance of the phanerogams with increasing depth and persistence of the snow cover the distinction between

the most extreme chionophytic, predominantly cryptogamic communities of the *Salicion herbaceae* and the *Cassiopo-Salicion herbaceae* becomes gradually somewhat obscured.

6.1.1.1. Ass. *Cassiopo-Anthelietum juratzkanae* GJAEREVOLL 1949 nom. mut.

syn.: incl. *Anthelia* Skorpen JONSSON 1901, *Anthelietum* SMITH 1912, Lebermoosreiche *Anthelia nivalis*-Assoziation FRIES 1913, Skandinavische *Anthelieten* RÜBEL 1930 n.n., *Anthelio-Polytrichetum sexangularis* NORDH. 1943 n.n., p.p., and others, see the subassociations; non *Anthelietum juratzkanae* (RÜBEL 1912) BR.-BL. 1926.

table 12:1–12.

composition: regional faithful taxon is *Anthelia juratzkana* (LIMPR.) TREV. (= *A. nivalis* LINDB.; selective (to exclusive) faithful and dominant). The composition varies, depending on the extremeness of the habitat. As a rule in the district close to 10 taxa occur in one sample plot, of which on an average close to 7 are cryptogamic. The phanerogams are qualitatively and quantitatively noticeably subordinated.

physiognomy: see the subassociations.

synecology & habitat: The arctic and northern alpine, oceanic, extreme chionophytic, extreme to medium acidophytic, hygrophytic, oligotrafent community occurs in the Angmagssalik District at low altitudes in particular in the coastal areas in usually more or less Northwest-facing, as a rule abt. 5° sloping, more or less flat to somewhat convex late snow areas, in wet, unstable soil subjected to solifluction and limited cryoturbation. The colorimetric pH of the rhizosphere ranges from 4 to $5^1/_2$ and is on an average about 4.6.

succession & zonation: See p. 123–124. The stands occur usually in extreme conditions, often on one side bordering upon open, mobile gravel which, far into the vegetation season, is covered by long persistent snow-drifts, or upon low ridges against which such drifts accumulate; on the other side they frequently border upon less chionophytic and mesotrafent, often tussocky communities belonging to the *Ranunculo-Oxyrion digynae*. See also fig. 36 and 37.

distribution: The syntaxon is common in the Angmagssalik District (see the subassociations); it occurs also elsewhere in Greenland (e.g. BÖCHER, 1933, p. 93, 1954, table 13:8 and 1963, table 28:22), in Fennoscandia (GJAEREVOLL, 1949, p. 72–79, 1956, p. 228–236 and previous publications) and in Iceland, the Faeroes and Scotland (see the discussion); presumably also in arctic to northern alpine North America and Asia.

subdivision: The association is subdivided by GJAEREVOLL (1949, p. 73) in three subunits on the basis of the composition of the bottom layer. All three subunits are observed in the Angmagssalik District, but

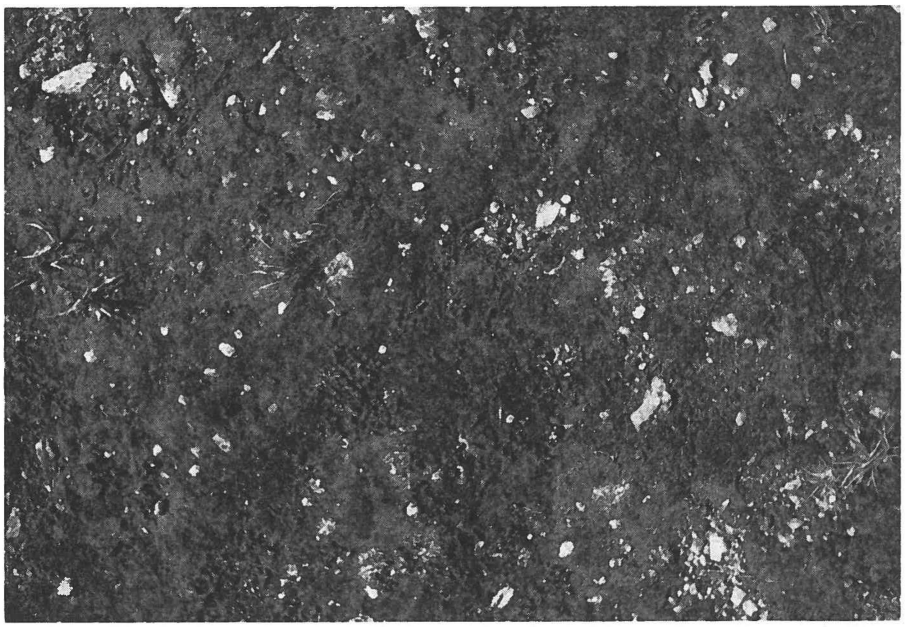


Fig. 38. Community of the subass. typicum of the *Cassiopo-Anthelietum juratzkanae;* protruding through the *Anthelia* carpet are plants of *Carex bigelowii* and *Salix herbacea.* JGdM phot. VI. 1968.

the one characterized by the lichen *Solorina crocea* occurs only fragmentarily and is not described here.
In contrast to GJAEREVOLL I describe these subunits as subassociations and not as sociations.

6.1.1.1.1. Subass. *typicum* (GJAEREVOLL 1949) subass.nov.

syn.: *Anthelia* Skorpen JONSSON 1901 n.n., *Anthelietum* SMITH 1912 n.n., Lebermoosreiche *Anthelia nivalis*-Assoziation FRIES 1913 n.n., *Anthelia*-Schneeboden TENGWALL 1920 n.n., *Anthelia juratzkana*-Ass. NORDH. 1928 n.n., *Anthelia-Cesia*-Ass. NORDH. 1928 n.n., Skandinavische *Anthelieten* RÜBEL 1930 n.n., *Anthelia Juratzkana*-associaatio KALLIOLA 1932, *Anthelia juratzkana-Gymnomitrium varians*-sosiasjon GJAEREVOLL 1949, *Anthelia juratzkana*-sociation GJAEREVOLL 1956; ? *Cesietum* ARNELL & JENSEN 1910, *Cesia*-Heiden SAMUELSSON 1917.

table 12:1–8.

composition: regional differential, more or less preferent (to selective) faithful taxon is *Anthelia juratzkana.* Better than with this taxon is the syntaxon, though negatively, characterized by the absence of the differential taxa of the two other subassociations. It is comparatively poor in taxa, in the district on an average more than 8 taxa occur in one sample plot, of which on an average 5 are cryptogams.

physiognomy: The predominantly bryophytic community (bryohemicryptophyta reptantia) is stratified in 2 to 3 layers: (1) a well-developed, coherent bottom layer of (predominantly) small hepatics, (2) an open to absent lower field layer of 1 to 3 cm high ligneous phanerogams, and (3) a very fragmentary to absent upper field layer of up to 10(–15) cm high poorly thriving graminoid phanerogams.

It forms conspicuous, highly characteristic greyish to silvery-blackish, shrivelled, $^1/_4$ to $^1/_2$ cm thick, almost skin-like coherent mats over the substrate; the phanerogams appear as scattered individuals, here and there penetrating the moss mat, in particular in the furrows (fig. 38).

synecology & habitat: The extreme chionophytic community is found in very late snow-beds near the extreme limit of vegetation, close to the base of snowdrifts which last too long to permit higher terrestrial plantlife after they have melted away, often along the shores of lakes and streams.

The substrate consists predominantly of loose, angular coarse sand, with gravel, stones and also finer grades admixed. It is of colluvial, partly sometimes also of niveo-aeolian origin and noticeably affected by solifluction and cryoturbation. The upper 5 (1 to 15) cm of the soil is moist to wet, more or less rich in humus and dark brown, coarse sandy, followed by a (0–)8 to more than 45 cm thick deposits of wet, not to scarcely humic, yellowish light brown, washed out (fine to) coarse sand and gravel which becomes gradually more stony with increasing depth and mostly covers coarse debris or solid rock.

The substrate is drenched with water for a long time after the local snow cover has melted, which is due to prolonged, often excessive irrigation (cf. FRIES, 1913, p. 120; POORE, 1955, p. 634; GJAEREVOLL, 1956, p. 228) and sometimes more or less impeded local drainage. Later on it dries out superficially, so that the moss mat becomes almost crusty or breaks up in small polygons, but the soil immediately under the mat remains notably moist.

The colorimetric pH of the rhizosphere varies from 4 to $5^1/_4$ and is on an average close to 4.7.

succession & zonation: see p. 123–124 and the previous paragraph, fig. 37.

distribution: The syntaxon is common in the coastal areas (Blomsterdalen, Elvbakker, Kulusuk, Tasîlâlik) and rare in the inland (Ikâsaulaq). See further 6.1.1.1.

subdivision: The subassociation varies somewhat in composition in the Angmagssalik District, so that two local variants can be distinguished:

(a) variant *inops* (table 12:1–4), the most extreme stage of the syntaxon. It is very poor in taxa, on an average 5 (3 to 7) taxa per sample plot are found.

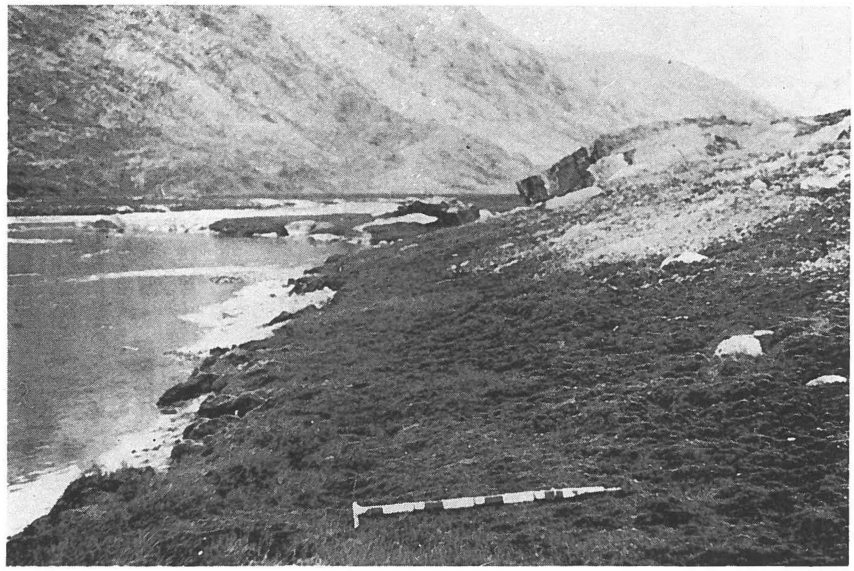


Fig. 39. Community of the subass. *conostometosum* of the *Cassiopo-Anthelietum juratzkanae* on the bank of the river draining Ilivnera valley. JGdM phot. VII. 1969.

(b) variant of *Polytrichum piliferum* (table 12:5–8), a less extreme stage. It is comparatively rich in taxa, on an average occur 12 (8 to 15) taxa in one sample plot. Differential taxa are *Polytrichum piliferum*, *P. norvegicum*, *Juncus trifidus*, *Solorina crocea* e.g.

6.1.1.1.2. Subass. *conostometosum* (GJAEREVOLL 1956) subass.nov.

syn.: *Conostomum tetragonum*-sociation GJAEREVOLL 1956; *Conostomum tetragonum*-sosiasjon GJAEREVOLL 1949 n.n.

table 12:9–12.

composition: regional differential, selective faithful taxon is *Conostomum tetragonum* (BRID.) LINDB.; local differential are *Oncophorus wahlenbergii*, *Scapania subalpina*, *Marsupella condensata*. In the district the syntaxon is comparatively rich in taxa, on an average 12 taxa in one sample plot are observed, of which on an average 2 are phanerogams. Notable is the alternating sub to co-dominance of various small hepatics such as, apart from *A. juratzkana*, *Marsupella condensata*, *Gymnocolea inflata*, *Scapania subalpina*, *Pleuroclada albescens* (cf. GJAEREVOLL, 1956, table 34:I–II; this publication, table 12:9–12).

physiognomy: The predominantly bryophytic community (bryohemicryptophyta reptantia and bryochamaephyta pulverulenta) is stratified in 3 to 4 layers; (1) a more or less open to closed lower bottom layer of reptant small hepatics and various acrocarpous musci, (2) a more or less

Table XII

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
altitude (m)		60	2	120	120	50	60	50	110	30	140	20	3	210	500	60	65
inclination		30	5	<5	5	5	5	10	5	5	5	>1	0	10	10	<5	0
orientation		SW	NW	NW	NE	W	W	SW	W	N	N	NW	–	NW	NW	N	N
total cover plants (in %)		100	60	80	<100	100	85	<85	80	100	95	99	50	95	95	50	100
cover phanerogams –		<1	25	8	<5	5	<15	<25	30	25	<20	10	<1	<1	2	1	1
– cryptogams –		100	40	80	95	>95	80	65	75	95	95	95	50	95	95	50	100
– litter –		0	0	5	0	0	0	5	0	5	5	0	0	0	0	0	0
– open soil –		0	40	20	2	1	15	15	20	0	0	1	50	5	5	15	0
pH rhizosphere		5	5 1/4	4 3/4	4 1/4	4	4	5	5	4 3/4	4	4 1/4	5 1/2	4 3/4	4	4 3/4	4 1/2
maximum depth soil (cm)		3	13	>50	>30	17	>20	>50	26		15	>55	5	9	4	20	20
ground water level (-cm)		0		40	10	14				30		3					
Marsupella varians		..	4	..	..	2	3	..	..	..	..	..	..	..	..	..	..
Anthelia juratzkana		6	1	6	6	5	2	5	5	3	3	2	..	..	..	..	..
Carex bigelowii	L	+	..	1	1	1	+	1	..	2	1	2	+	..	..	..	..
Salix herbacea	L	..	3	1	1	1	2	3	3	3	3	1	+	+	1	..	..
Pohlia commutata		..	..	..	2	2	1	+	+	..	+	..	..	+	..	1	3
Cassiope hypnoides	L	..	..	1	..	..	+	+	1	..	..	..	..	..	..	..	..
Polytrichum piliferum		..	..	..	..	+	+	1	1	..	..	..	..	..	..	..	..
Stereocaulon cf. *denundatum*		..	..	..	..	+	..	+	3	..	+	..	..	..	..	..	..
Juncus trifidus	L	..	..	..	..	..	+	+	+	..	..	..	..	..	..	..	+
Conostomum tetragonum		..	..	2	+	..	2	1	+	6	5	4	4	..	..	..	..
Oncophorus wahlenbergii		..	..	..	..	..	..	..	..	3	3	3	1	..	..	..	..
Scapania subalpina		..	..	..	..	..	..	..	..	2	3	3	..	..	..	..	..
Marsupella condensata		..	..	..	..	..	..	..	..	..	1	3	4	..	..	..	3
Lophozia alpestris		..	..	..	..	..	..	..	..	+	2	..	+	..	..	..	3
Calliergon stramineum		..	..	..	..	..	..	..	..	2	2	..	..	..	..	..	..
Drepanocladus uncinatus		..	+	..	..	..	..	..	..	..	2	..	+	..	..	..	..

Table XII (continued)

Table XII (continued)

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Pleuroclada albescens		..	..	..	..	+	+	..	+	3	..	..	..	2	3	..	3
Polytrichum norvegicum		..	..	..	..	..	..	..	..	+	..	..	+	6	6	4	5
Loiseleuria procumbens	L	..	..	..	..	..	+	..	+	..	..	..	..	..	..	..	..
Nardia geoscypha		..	..	..	..	..	..	+	..	2	..	..	..	..	..	..	..
*Arctoa fulvella**		..	..	..	..	..	..	..	+	..	..	..	..	..	+	..	..
Cladonia spec.		..	..	..	..	..	..	..	..	..	..	..	+	..	+	..	..
Pohlia nutans		..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	3
Cetraria delisei		..	..	..	..	..	..	..	..	..	..	+	1	..	..	..	..
Ochrolechia spec.		..	..	..	..	..	..	..	..	..	..	..	+	..	..	2	..
Oxyria digyna	A	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	+
Equisetum arvense	B	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..
Gymnocolea inflata		..	..	..	..	..	..	..	..	..	..	4	..	..	..	..	..
Cephalozia ambigua		..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..
Polytrichum commune		..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..
Calliergon sarmentosum		+	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..
Polytrichum alpinum		..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..
Dicranum fuscescens		..	..	..	..	..	+	..	..	..	..	..	..	..	..	1	..
Agrostis borealis		..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..
Cerastium cerastoides		..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..
Empetrum hermaphroditum	L	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..
Sedum rosea juv.	L	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Silene acaulis	A	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Aulacomnium turgidum		..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..
Dicranoweissia cirrhata		..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Kiaeria starkei		..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..
Polytrichum juniperinum		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+
fungus		..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..

* var. *andersonii*.

closed, 1 to 3 cm high upper bottom layer of tufts of *C. tetragonum*, which occurs in mosaic with (3) an open, also 1 to 3 cm high lower field layer with *Salix herbaceae*, and (4) a very open to fragmentary, 5 to 8 cm high upper field layer with *Carex bigelowii*.

The community forms closed, dark brownish green, low patches of limited extent, characterized by a more differentiated microtopography than the stands of the subass. *typicum: C. tetragonum* dominates the general appearance, growing in remarkably bluish green, hard, dense, semiglobular tufts on the more or less blackish to greenish-brown mat of the lower bottom layer (fig. 39).

synecology & habitat: This less extreme chionophytic community occurs in latish to late snow areas, in percolation zones below snow-beds and in the upper flood zone on the shores of meltwater streams and marshes, usually in wet, unstable conditions in humic to peaty, coarse to fine sandy, slightly sloping soil subjected to solifluction, limited cryoturbation and irrigation or flooding. It occurs more frequently than the subass. *typicum* also in the inland, at low elevations.

The substrate consists of amorphous peaty sand, or, when comparatively thick, of alternating irregular layers of amorphous peaty and more or less humic sand. It is very wet until late in the vegetation season, though not oversaturated to the same extent as below the subass. *typicum*. Later it dries out to some extent, but it remains moist.

The colorimetric pH of the rhizosphere varies from 4 to $5^1/_2$ and is on an average 4.5.

succession & zonation: See p. 128. The communities presumably succeed the subass. *typicum* under favourable conditions. See also fig. 36.

distribution: The syntaxon is somewhat less common than the previous one, and occurs both in the inland and coastal areas (Elvbakker, Qortortoq, Ilivnera, Nuk), See further 6.1.1.1.

subdivision: This community from the Angmagssalik District differs from the Scandinavian *C. tetragonum* communities in the constant, abundant occurrence of *Oncophorus wahlenbergii* and of *Scapania subalpina* in the bottom layer (cf. paragraph composition). It should therefore be considered as a separate variant.

syntaxonomy & discussion: The extreme chionophytic *Anthelia juratzkana* communities described from Europe belong to two different, vicarious groups. This was observed already by RÜBEL (1930, p. 258–260), who makes a distinction between the central European "*Anthelietum*" and the northern European "Skandinavische Anthelieten". These vegetation types correspond to the *Anthelietum juratzkanae* (RÜBEL 1912) BR.-BL. 1926 and the *Cassiopo-Anthelietum juratzkanae* GJAEREVOLL 1949 nom. mut., which are respectively grouped in the *Salicion herbaceae* BR.-BL. 1926 and the *Cassiopo-Salicion herbaceae* NORDH. 1936 em. Dahl 1957.

To the list of differential taxa between the two alliances (NORDHAGEN, 1936, p. 48; this publication p. 125) we may add as differential taxa between these two associations the for the *Anthelietum juratzkanae* characteristic taxa *Chrysanthemum alpinum*, *Saxifraga bryoides*, *Gentiana bavarica* var. *imbricata*, *Minuartia sedoides*, *Trifolium*, *Sedum alpestre*, and other temperate-alpine taxa, and the for the *Cassiopo-Anthelietum* characteristic *Cassiope hypnoides* and *Carex bigelowii*.

The *Anthelietum juratzkanae* of the central European mountains (Alps, Carpathians, Pyrenees) is rather rare, covers comparatively small tracts and seems to be less autostatic than the *Cassiopo-Anthelietum juratzkanae* (RÜBEL, 1912, p. 153; BRAUN, 1913, p. 116; FREY, 1922, p. 60, 147 etc.; GAMS, 1927, p. 324–326; RÜBEL, 1930, l.c.; KRAJINA, 1933, p. 844–872; GUINOCHET, 1938, p. 141–157; BRAUN-BLANQUET, 1949, p. 290–291; KLIKA, 1948, p. 306 and 1955, p. 307; HADAČ, 1956, p. 32–34; PUSČARU *et al.*, 1956, p. 146, 149; a.o.).

The *Cassiopo-Anthelietum juratzkanae* of the northern European regions and Greenland is in particular widely spread over large areas in Fennoscandia. Less detailed investigations of the *A. juratzkana* communities in Iceland (JONSSON, 1901, p. 32; HESSELBO, 1918, p. 423; STEINDORSSON, 1965, p. 104), the Faeroer (BÖCHER, 1937, p. 174) and the Scottish Highlands (SMITH, 1912; RÜBEL, 1930, p. 259; POORE, 1955, p. 634; MCVEAN & RATCLIFFE, 1962, p. 99) suggest in my opinion that these, as well as the community from Southeast Greenland described here should be grouped together in a single association with the very well known *A. juratzkana* communities from Scandinavia. As the original name of this syntaxon is identical with the name of the central European syntaxon I propose to add the term *Cassiopo*.

POORE (l.c.) remarks that the Scottish *A. juratzkana* community "occupies stony localities irrigated by snow water, rather than snow beds per se", whereas FRIES (1913, p. 120), referring to conditions in northern Sweden states "Durch sehr langdauernde Schneebedeckung und durch Überrieselung vom Schmelzwasser entstehen reine Leebermoossoziationen, wo Anthelia nivalis die Charakterpflanze ist". This stress laid on the factor water supply is according to GJAEREVOLL (1956, p. 228) somewhat over-emphasized, which agrees with the observed synecology of the community in the Angmagssalik District. The differing opinions concerning the dependence on a prolonged snowcover is probably explained by latitudinal differences correlated with a varying oceanity of the areas in question.

6.1.1.2. Ass. *Pleuroclado-Polytrichetum norvegici* RÜBEL 1930 em. GJAEREVOLL 1949 nom. mut.

syn.: *Polytrichetum sexangularis* BÖCHER 1933 n.n., *Polytrichum sexangulare*-Ass. NORDH. 1928 n.n., *Anthelio-Polytrichetum sexangularis*

NORDH. 1943 n.n., p.p.; incl. Skandinavisches *Polytrichetum* RÜBEL 1930, *Dicranetum starkei* DAHL 1957.

composition: regional faithful taxa are *Polytrichum norvegicum* HEDW. (= *P. sexangulare* FLOERKE), *Pleuroclada albescens* (HOOK.) SPR. and *Kiaeria starkei* (WEB. et MOHR) HAG.

distribution: See the following description.

6.1.1.2.1. Subass. *typicum* (GJAEREVOLL 1949) subass. nov.

syn.: *Polytrichum norvegicum* Soc. GJAEREVOLL 1949; see also the previous description (6.1.1.2.).

table 12:13–16.

composition: regional differential, selective faithful taxa are *Polytrichum norvegicum* HEDW. and *Pohlia commutata* SCHIMP. (= *P. drummondii* (C. MÜLL.) ANDR.). The community is comparatively poor in taxa, in the district occur on an average abt. 6 taxa in one sample plot, of which on an average 5 are cryptogamic. Phanerogams are very scarce (cf. also GJAEREVOLL, 1950a, table 8 and 1956, table 30, 31).

physiognomy: The predominantly bryophytic community (bryochamaephyta) is indistinctly stratified in (1) an usually losed, dense 1 (to 4) cm high bottom layer dominated by bryophytes, which is sometimes indistinctly stratified in a lower layer of small hepatics and acrocarpous musci, and an upper layer of tall, acrocarpous *P. norvegicum*, and (2) a very fragmentary, low, ligneous or herbaceous field layer.

The community forms dense, compact, dull greenish brown moss carpets, which cover as a rule limited areas (fig. 40).

synecology & habitat: The arctic and northern alpine, more or less oceanic, extreme chionophytic and acidophytic, hygrophytic and oligotrafent community occurs in the Angmagssalik District in the coastal areas from 60 to 210 m a.s.l., in the inland only at higher altitudes up to 500 m a.s.l., in North-facing, sheltered, level to 10° sloping, flat to concave late snow areas with stable substrate.

The substrate consists of a shallow, up to 20 cm thick deposit of dark-coloured, humic, wet to moist medium fine sand overlying coarse debris or solid rock; when it is relatively thick it becomes less humic in the deeper parts. The humus is distinctly more acid than below *Anthelia juratzkana* and *Cassiope hypnoides* communities. The sand (and part of the humus) is of niveo-aeolian, partly of colluvial origin, non-calcareous and poor in minerals owing to intensive leaching. The substrate is not subjected to solifluction or frost heaving, in contrast with the substrate below the *Cassiopo-Anthelietum juratzkanae* and the *Cassiopetum hypnoidis* (cf. GJAEREVOLL 1956, p. 218).

The habitat is snow-covered from early autumn to early summer, viz. late September to at least early July or later.

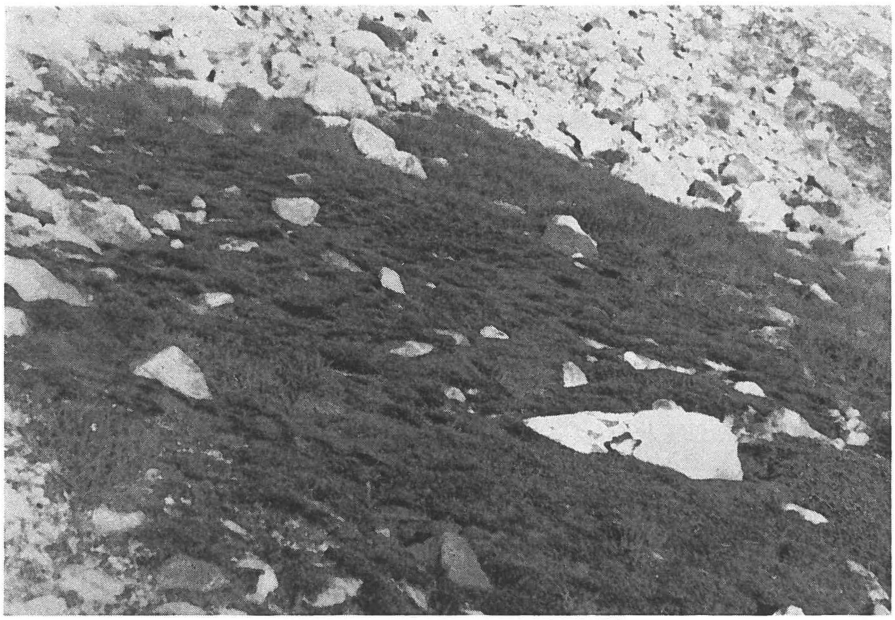


Fig. 40. Patch of vegetation of the *Pleuroclado-Polytrichetum norvegici typicum* on the eastern shore of Ikâsaulaq fjord at about 500 m a.s.l., in unusually mobile soil. JGdM phot. VIII. 1969.

It is irrigated until far into the vegetation season, and during most of that period saturated with meltwater. Later, when the water supply diminishes, the soil remains rather moist under the dry looking moss carpet.

The colorimetric pH of the rhizosphere ranges from 4 to $4^3/_4$ and is on an average 4.5.

succession & zonation: See p. 123–124. The stands of the syntaxon occur more or less isolated, or centrally in extreme snow-bed areas surrounded by less chionophytic, terrestrial *Ranunculo-Oxyrion digynae* communities or epilithic *Andreaea blyttii* vegetation.

distribution: The community is rare in the Angmagssalik District (Kulusuk, Sømandsfjeldet, Ikâsaulaq) and elsewhere in Greenland (Böcher, 1933, p. 93 and 1954, p. 173); also in the Fennoscandian mountains (Gjaerevoll, 1956, p. 318–228 and the cited earlier literature), presumably also in alpine areas in Iceland, North America.

syntaxonomy & discussion: *P. norvegicum* communities are also described from the central European mountains, alpine northern Europe and the Scottish Highlands.

The communities from central Europe are classified in three separate associations, which are grouped in the *Salicion herbaceae.* These are the *Polytrichetum sexangularis* (*alpinum*) (Rübel 1912) Br.-Bl. 1926 from

the Alps and the Pyrenees (cf. BRAUN-BLANQUET, 1948b, p. 290 and 1948a, p. 79–82; GUINOCHET 1938, p. 143-148), the *Polytrichetum sexangularis tatricum* (BL. 1926) KRAJINA 1933 from the *Carpathians* (BRAUN-BLANQUET, 1930, p. 90; DOMIN, 1930, p 183; KRAJINA, 1933, p. 853–863; HADAČ, 1956, p. 33) and the *Polytrichetum sexangularis balcanicum* HORVAT, 1960, p. 194). The differences between these geographically vicariating syntaxa were discussed for instance by KRAJINA (1933, p. 858–859).

The *P. norvegicum* communities from the Scottish Highlands and Fennoscandia are classified in two separate, floristic-phytogeographical different associations, which are grouped in the *Cassiopo-Salicion herbaceae.* These syntaxa are the *Polytricho-Dicranetum starkei* MCVEAN & RATCLIFFE, 1962 (MCVEAN & RATCLIFFE, 1962, p. 96) and the *Pleuroclado-Polytrichetum norvegici* GJAEREVOLL 1949 nom.mut. (GJAEREVOLL, 1949, p. 62–72 and 1956, p. 218–228). To the latter also seem to belong the *P. norvegicum* communities from Greenland and presumably also those occurring in Iceland.

The present opinion concerning the nomenclature of *P. norvegicum* (cf. VAN WIJK *et al.*, 1967) implies that the term *sexangularis* should be replaced by *norvegici* in the names of the central European syntaxa. The name of the arctic and boreal-alpine syntaxon described by GJAEREVOLL should be changed by adding the prefix *Pleuroclado*, to avoid confusion.

All five associations appear to be subdivisible in a subassociation (or socation) characterized by *Kiaeria starkei* and *K. falcata*, and in an equivalent subunit characterized by *Polytrichum norvegicum* and *Pohlia commutata* (cf. BRAUN-BLANQUET, 1948b, p. 291; GJAEREVOLL, 1949, p. 71 and 1956, p. 218–228; MCVEAN & RATCLIFFE, 1962, table 46).

In my opinion there is no doubt that at least the Greenlandic *P. norvegicum* community from the Angmagssalik District belongs to the same syntaxon as the corresponding Fennoscandian community.

6.1.1.3. Ass. *Cassiopetum hypnoidis* NORDH. 1943.

syn.: incl. *Andromeda hypnoides*-Formation HULT 1887 n.n., Flechtenreiche *Andromeda hypnoides*-Ass. FRIES 1913, *Andromeda hypnoides*-lyngmark RESVOLL-HOLMSEN 1914, *Cassiope hypnoides*-Heiden TENGWALL 1920 n.n., *Cesia varians-Anthelia* reiche *Cassiope hypnoides*-Ass. NORDH. 1928, *Cassiope hypnoides*-associaatio KALLIOLA 1932, *Cassiopetum hypnoidis* BÖCHER 1933 n.n., ± *Salicetum herbaceae* rich in *Cassiope hypnoides* BÖCHER 1933, *Cassiope hypnoides*-Schneebodenvegetation SÖYRINKI 1938 n.n., *Cassiope hypnoides*-Soz. KALLIOLA 1939, *Cassiope hypnoides-Trisetum spicatum-Pertusaria*-sos. NORDH. 1943, *Cassiope hypnoides-Anthelia Cesia*-sos. NORDH. 1943, *Cassiope hypnoides-Anthelia juratzkana-Gymnomitrium varians*-sociation GJAEREVOLL 1956.

table 13.

composition: Regional, exclusive to selective faithful taxon is the (co-)dominant *Cassiope hypnoides* (L.) D. Don (= *Harrimanella h.* (L.) Coville, *Andromeda h.* L.); differential taxon is *Cetraria delisei.* Constant taxa are in the district *Carex bigelowii*, *Polygonum viviparum*, *Salix herbacea*, *Anthelia juratzkana*, *Drepanocladus uncinatus*, *Lophozia alpestris* and *L. wenzelii*, *Cladonia mitis*, *Psoroma hypnorum*, *Stereocaulon;* elsewhere more or less occasionally also *Carex lachenalii*, *Deschampsia flexuosa*, *Festuca vivipara*, *Gnaphalium supinum*, *Luzula confusa*, *Sibbaldia procumbens*, *Conostomum tetragonum*, *Pohlia commutata*, *Kiaeria starkei*, *Polytrichum alpinum*, *P. norvegicum*, *Cetraria islandica*, *Cladonia coccifera*, *C. elongata*, *C. gracilis*, *C. sylvatica*, *Ochrolechia frigida*, *Pertusaria oculata*, *Solorina crocea* (cf. Böcher, 1933, table 24:62 and 27:70; idem 1959, table 1:1–2(–5); Gjaerevoll, 1949, table 7 and 1956, table 10; Kalliola, 1932, p. 93; Nordhagen, 1928, p. 260 and 1943, table 41; Resvoll-Holmsen, 1914, p. 43; idem 1920, table 4).

In this district the community is comparatively rich in taxa, which it is not when compared with communities of the association in particular in Fennoscandia. The average number of taxa observed in one sample plot lies between 17 and 18, of which on an average 6 are phanerogams.

physiognomy: The, in particular quantitatively, predominantly chamaephytic, to a considerable degree also partly hemicryptophytic and geophytic community is rich in cryptogams of various life-forms, and is stratified in (1) a 0,3 to 1(–3) cm high, very fragmentary to well developed, rather closed bottom layer of cryptogams, (2) a 2(–4) cm high, more or less closed lower, ligneous field layer of *C. hypnoides* and *Salix herbacea*, and (3) a 6 to 10 cm high, open field layer of herbaceous and graminoid plants.

It covers usually small tracts and forms quite inconspicuous, dark brownish to greenish low patches, except when *C. hypnoides* is in flower. Then it forms attractive vegetation, where the ground is strewn with the pretty, small, white bell-shaped flowers of this species (fig. 41).

synecology & habitat: The low-arctic and northern alpine, oceanic, (mesophytic to) hygrophytic, medium acidophytic to neutrophytic, oligotrafent to somewhat mesotrafent, as the *Cassiopo-Anthelietum juratzkanae* solifluction and cryoturbation tolerating community occurs in the Angmagssalik District in 10 to 30°(–60°) sloping, predominantly North-facing late snow areas both in the coastal areas below 100 m a.s.l. as well as in the inland up to at least 400 m a.s.l. It is found on temporarily wet solifluction slopes, along rills, in ravines and among boulders on irrigated slopes.

The substrate is usually shallow, 7 to more than 50 cm deep and consists of unstable, sandy to gravelly, more or less peaty or humic, usually more or less leached material, which is of niveo-aeolian and/or



Fig. 41. The Moss Heather, *Cassiope hypnoides*, in flower.
JGdM phot. VI. 1966.

Table XIII

reference number		1	2	3	4	5	6	7	8	9	10
altitude (m)		100	30	50	380	375	60	35	10	410	420
inclination		10	10	15	15	25	0	30	60	20	30
orientation		NW	NE	N	W	N	W	N	E	N	N
total cover plants (in %)		75	75	85	60	65	50	90	90	95	95
cover phanerogams –		75	70	70	50	60	25	40	65	75	60
– cryptogams –		1	15	25	20	10	25	60	35	65	90
– litter –		60	60	25	35	35		3	10	10	
– open soil –		0	0	0	5	15	50	7	5	0	5
maximum depth soil (cm)		16	36				20	30	31	7	40
pH rhizosphere		5	5	5	5	7	$4^1/_2$	$4^3/_4$	5	5	5
Cassiope hypnoides	L	5	4	5	4	4	2	3	5	5	4
Salix herbacea	L	3	4	3	2	3	3	3	3	3	4
Polygonum viviparum	A	+	2	..	2	1	..	2	2	1	2
Carex bigelowii	L	1	2	1	+	+	+	2	..	2	2
Stereocaulon paschale s.l.		..	+	2	1	+	..	1	+	2	+
Drepanocladus uncinatus		..	2	..	+	+	+	3	..	3	5
Lophozia alpestris / *Lophozia wenzelii*		+	+	+	1	1	..	..	3	..	4
Cladonia mitis		..	..	+	+	+	..	+	+	1	1
Psoroma hypnorum		+	..	1	+	..	..	..	..	+	+

(continued)

Table XIII (continued)

reference number		1	2	3	4	5	6	7	8	9	10
Cetraria delisei		+	1	3	2	+	..	..	..	..	..
Pohlia nutans		..	+	+	..	+	..	..	..	..	..
Pleuroclada albescens		+	..	..	+	+	..	..	..	2	1
Anthelia juratzkana		..	..	..	+	..	2	5	2	+	..
Marsupella varians		..	..	..	..	1			1	..	..
Pohlia commutata		+	..	..	..	..	+	+	+	..	..
Crocynea neglecta		..	..	..	..	..	2	2	..	..	..
Conostomum tetragonum		+	..	..	+	..	1	+	..	..	..
Kiaeria starkei		..	..	..	..	+	..	+	..	4	..
Solorina crocea		..	..	+	..	..	+	..	+	..	..
Polytrichum juniperinum		+	+	..	..	..	..	..	..	..	2
Polytrichum norvegicum		..	..	+	..	+	..	..	..	..	..
Luzula spicata	L	..	..	+	..	+	..	..	..	..	..
Bartsia alpina	L	..	..	..	..	+	..	..	..	1	..
Silene acaulis	A	..	..	..	..	+	..	+	..	..	..
Cetraria crispa		..	..	..	..	..	..	+	..	+	+
Polytrichum alpinum		..	..	..	..	..	+	+	..	..	..
Cladonia ecmocyna		..	..	..	+	..	..	..	+	..	+
Peltigera canina s.l.		..	..	..	..	..	..	..	1	+	1
Cladonia gracilis		..	..	+	..	..	..	..	+	..	..
Empetrum hermaphroditum	L	..	..	..	..	..	+	..	+	..	+
Ochrolechia frigida		..	..	+	+	..	..	..	..	..	..
Blepharostoma trichophylla		+	..	..	+	..	..	..	..	..	..
Equisetum variegatum	L	..	..	..	+	+	..	..	..	..	..
Oncophorus wahlenbergii		..	..	..	..	..	..	1	..	..	..
Racomitrium heterostichum		..	..	..	..	..	..	1	..	..	..
Timmia austriaca		..	..	..	..	..	..	..	1	..	2
Cladonia spec. (prim. *thallus*)		..	..	..	+	+	..	..	..	..	..

Not recorded in the table are, all with "+": *Chamaenerion latifolium* in sample plot 5; *Equisetum arvense* 2; *Gnaphalium supinum* 9; *Juncus trifidus* 7; *Loiseleuria procumbens* 6; *Luzula spicata* 8; *Minuartia rubella* 5; *Oxyria digyna* 8; *Pedicularis flammula* 2; *Poa arctica* 8; *Sibbaldia procumbens* 9; *Trisetum spicatum* 8; *Arctoa fluvella* var. *andersonii* 2; *Barbilophozia hatcheri* 4; *Bartramia ithyphylla* 8; *Cephalozia ambigua* 8; *Desmatodon latifolius* 5; *Dicranum scoparium* 6; *Distichium capillaceum* 5; *Oncophorus virens* 4; *Polytrichum hyperboreum* 4; *P. piliferum* 3; *Racomitrium canescens* 9; *Sphagnum warnstorfianum* 4; *Cetraria islandica* 9; *Cladonia coccifera* 5; *Cl. lepidota* 5; *Polytrichum piliferum* 10; *Cladonia rangiferina* 10; *Cetraria islandica* 10.

colluvial, sometimes glacial or fluvio-glacial origin. It is also subjected to displacement and reworking by solifluction and frost heaving, so that the micro-topography of the surface becomes uneven, irregularily ridged and shrivelled. The cryptogams, especially the hepatics, favour in particular the diminutive depressions in this surface. The profile, below a very thin litter layer, shows in general a superficial 3 to 4 cm thick blackish brown layer of raw humus or raw peaty material, which is sometimes

followed by a 4 to 10 cm thick layer of amorphous, greasy peat, over a light brown, slightly humic, gradually more gravelly to stony and more or less loamy coarse sandy layer; the subsoil constists usually of old block scree (cf. GJAEREVOLL, 1956, p. 96).

The habitat is snow-covered from late September-early October to June-early July. For some time after exposure it is over-saturated by meltwater and water percolating down from the slopes above. Later it gradually dries out, occasionally interrupted by irrigation after rainfall with water from the higher slopes.

The colorimetric pH of the rhizosphere ranges from $4^1/_2$ to 7 and is on an average ca. 5.1.

succession & zonation: The community represents presumably a (semi-)permanent stage in the succession ("Dauergesellschaft"), which in favourable conditions succeeds in particular the *Cassiopo-Anthelietum juratzkanae*, or which develops as a pioneer-community on bare soil in less extreme chionophytic conditions than the syntaxon mentioned. It is usually bordered on one side by communities of the *Cassiopo-Anthelietum juratzkanae* where the snow lies longer, and on the other side by *Salix herbacea* communities (*Ranunculo-Salicetum herbaceae* subass. *inops*) in more stable substrate.

distribution: The community occurs, though variously developed, everywhere in the district (Elvbakker-Blomsterdalen, Qíngertivaq, Ilivnera, Tasîlaq); it occurs also elsewhere in Greenland (BÖCHER, 1933, p. 81, 92 and 1959, p. 21) and in Fennoscandia (RESVOLL-HOLMSEN, 1920, p. 80; HULT, 1887, p. 174; FRIES, 1913, p. 70; TENGWALL, 1920, p. 378; SÖYRINKI, 1938, p. 53; KALLIOLA, 1939, p. 162–164; see also the literature cited in the section on the composition).

subdivision: The vegetation type varies mainly in the composition of the bottom layer. This variation also seems to occur commonly in Fennoscandia, where it does not seem to be clearly correlated with distinct differences in environmental conditions. In the Angmagssalik District there is often a more evident correlation with the environment, but there are also many intermediate vegetation types between the subunits which can be distinguished on the basis of this variation. In consequence I will for the present describe those subunits there as variants:

(a) Variant of *Cetraria delisei* (table 13:1–5); this type is common in the inland and characterized by a comparatively poorly developed bottom layer with *Cetraria delisei* (= *C. hiascens*), *Pohlia nutans*, *Psoroma hypnorum*. The substrate below the variant is in general comparatively rich in loamy material.

(b) Variant of *Anthelia juratzkana* and *Marsupella varians* (table 13:6–8); this most common type is characterized by the prominent occurrence of *A. juratzkana*, *M. varians* and *Pohlia commutata* in the bottom

layer. The substrate is comparatively the one most unstable and often least differentiated.

(c) Variant of *Kiaeria starkei* (table 13:9), characterized by the dominance of *K. starkei* in the bottom layer. The substrate below this variant and the following is presumably the least unstable.

(d) Variant of *Drepanocladus uncinatus* (table 13:10), characterized by the dominance of the mesotrafent to eutrafent *D. uncinatus* in the bottom layer; cf. (c).

syntaxonomy & discussion: According to NORDHAGEN (1943, p. 263) and GJAEREVOLL (1956, p. 95) *Cassiope hypnoides* is a "capricious" ("lunefull") plant, of which the ecology is difficult to grasp. It appears to become dominant in places where the vitality of *Salix herbacea* is reduced, viz. often in snow-beds where the substrate is subjected to solifluction and cryoturbation, a habitat also favoured by *Anthelia juratzkana* and *Marsupella varians*. *C. hypnoides* seems to prefer snow-beds which become free of snow somewhat earlier than at least the most extreme *S. herbacea* communities, and which are subsequently more excessively irrigated than these, and later on dry out more intensively.

The bottom layer of the *C. hypnoides* communities is usually dominated by *A. juratzkana* and *M. varians*. Patchwise *Drepanocladus uncinatus*, *Kiaeria starkei*, *Polytrichum* or *Cetraria* may be conspicuous in that layer of such communities, but neither the bryophytes nor the lichens give, according to GJAEREVOLL (1956, p. 96) any sufficient basis for subdividing the *C. hypnoides* communities into several sociations (or subassociations), a view previously also expressed by TENGWALL (1920, p. 378).

In the Angmagssalik District I observed at least four types of *C. hypnoides* vegetation. On the basis of these observations and comparison with tables and descriptions in the literature I arrive at the same interpretation of the variation in the bottom layer as TENGWALL and GJAEREVOLL (l.c.). In consequence I describe these types as variants (cf. paragraph subdivision).

NORDHAGEN (1943) and GJAEREVOLL (1956) are not completely convinced that it is correct to separate the *C. hypnoides* communities and to interpret them as belonging to an independent association. They are evidently closely related to the *S. herbacea* communities of the *Salicetum herbaceae boreale* NORDH. 1943 (which is not observed in the Angmagssalik District), in particular to those with a bottom layer characterized by *A. juratzkana* and *M. varians*. The discussed variation in the composition of the bottom layer is qualitatively and quantitatively less pronounced and less clearly correlated with environmental variation in the *Cassiopetum hypnoides* than in the *Salicetum herbaceae boreale*, where it is more or less similar. This variability is in consequence syntaxonomically variously

interpretative, which provides one of the criteria for not including the *C. hypnoides* communities in the *Salicetum herbaceae boreale.*

Comparison of the *C. hypnoides* communities described in the literature and in this publication reveals a considerable variation in the composition, especially in the field layer, and consequently in the average number of taxa in one sample plot in various area. This variation does not seem to be strictly geographically determined, although in concerns in particular the boreal flora element. It is mainly dependent on the severity of the environment, viz. the variation in depth and persistence of the snow cover. The syntaxonomic value of this variation within the syntaxon should, in my opinion, be considered of subordinate importance.

6.1.1.4. Ass. *Gnaphalietum supini* (NORDH. 1928) ass.nov.

syn.: *Gnaphalium supinum*-Formation BORG 1903 n.n., *Gnaphalium supinum*-reiche Moosheiden SAMUELSSON 1917 n.n., *Gnaphalium supinum*-Urtemark RESVOLL-HOLMSEN 1920, *Salix herbacea-Gnaphalium supinum*-Snöläge SMITH 1920, *Gnaphalium supinum*-Variante der *Salix herbacea*-Ass. TENGWALL 1920, *Gnaphalium supinum-Salix herbacea*-Soz. NORDH. 1936, *Gnaphalium supinum-Salix herbacea*-Moss-Sociation BÖCHER 1937, *Gnaphalium-supinum*-Wiese KALELA 1939, *Gnaphalium supinum-Kiaeria starkei*-sos. NORDH. 1943.

table 14.

composition: Regional, selective faithful taxon is *Gnaphalium supinum* L. The syntaxon is floristically primarily characterized, with respect to the *Salicetum herbaceae boreale*, by the replacement of *Salix herbacea* by *G. supinum* as the dominant taxon in the field layer (cf. *Cassiopetum hypnoidis*), and the frequent occurrence of several more or less eutrafent phanerogamous taxa. Constant accessory taxa are in this district *Sibbaldia procumbens*, *Salix herbacea*, *Carex bigelowii*, to a less extent also *Taraxacum croceum*, *Polygonum viviparum*, *Pohlia commutata*, *Polytrichum norvegicum;* elsewhere also for instance *Veronica alpina*, *Agrostis borealis*, *Anthoxanthum odoratum*, *Deschampsia flexuosa*, (cf. RESVOLL-HOLMSEN, 1920, table 10; NORDHAGEN, 1928, table p. 254–255:16–25; BÖCHER, 1937, table 10:2; KALELA, 1939, table 44; GJAEREVOLL, 1949, table 9, 1950, table 3:31–40 and 1956, table 13:1–20; LID, 1964, table 34).

The community is here rather rich in taxa, on an average there are over 17 taxa in one sample plot; the average number of phanerogams is close to the number of phanerogams per sample plot.

physiognomy: The predominantly hemicryptophytic community is rich in cryptogams, and usually stratified in three layers: (1) an usually well-developed bottom layer of cryptogams (mainly bryophytes), (2) a

well-developed lower field layer of a few centimeters height with *Gnaphalium supinum*, *Salix herbacea*, *Sibbaldia procumbens*, and (3) an open to very poorly developed upper field layer of 10 to 15 cm height, with mainly herbaceous plants, often of reduced vitality.

It forms usually low, dense patches of a noticeable silver-grayish colour, and covers usually only small areas.

syntaxonomy & habitat: The low-arctic, subarctic and northern alpine, (medium to) extreme chionophytic, mesophytic to hygrophytic, medium to extreme acidophytic, oligotrafent to mesotrafent community occurs in the Angmagssalik District in seasonally wet snow-bed habitats on 10 to 30° sloping, predominantly South to Southwest-facing slopes, from 40 to at least 120 m a.s.l. in the coastal areas up to at least 650 m a.s.l. in the inland. It is found in more or less sheltered habitats, in small, shallow depressions in *Salix herbacea* snow-beds (*Ranunculo-Salicetum herbaceae* subass. *inops;* fig. 42) along and below rock outcroppings, and in and along ravines and gullies of temporary meltwater discharges (fig. 43).

The substrate is more or less subjected to solifluction. It consists of 10 to more than 60 cm thick deposits of mixed niveo-aeolian and colluvial coarse sand, which are rich in humus and near the surface often more or less peaty. Covering the ground is found a discontinuous, 0 to 1 cm thick litter layer, which covers on an average more than 10 % of the surface.

The soil profile in general shows (1) a 2 to 8 cm thick layer of more or less raw humus to fibrous peat below the loose litter layer, (2) a 0 to 6 cm thick transitional layer of amorphous peaty to humic sand, and (3) a layer of varying thickness of very humic, brownish sand, which lies on solid bedrock or a comparatively thin layer of old, coarse debris.

The habitat is less excessively irrigated than the habitat of the previously described three plant communities. This phenomenon involves leaching, but also to some extent a certain enrichment of the soil; the habitat is as a rule spatially less isolated from higher, relatively fine textured soils from which mineral rich water seeps down, than those three syntaxa. The soil remains moist to wet until late in the vegetation season.

The colorimetric pH of the rhizosphere ranges from $4^1/_4$ to $5^1/_2$ and is on an average close to 4.7.

succession & zonation: see p. 123–124 and the previous section. The community is usually found associated with stands of the *Ranunculo-Salicetum herbaceae* subass. *inops* in comparatively elevated, drier and more stable places.

distribution: The community is not uncommon in the district (Kulusuk, Elvbakker, Ikâsaulaq, Tasîlaq valley); it also occurs elsewhere in Greenland (cf. Böcher, 1954, p. 113), the Faeroes (Böcher, 1937,



Fig. 42. Stand of the subass. *desmatodetosum latifolii* of the *Gnaphalietum supini*, surrounded by *Salix herbacea* snowbed vegetation (6.1.2.3.1.); at the base of the rock *Alchemilla glomerulans sociations*.
JGdM phot. VI. 1968.

Table XIV

reference number	1	2	3	4	5	6	7	8	9	10
altitude (m)	40	120	40	650	520	520	40	85	480	500
inclination	20	10	15	30	30	20	20	20	10	20
orientation	S	SW	S	S	SW	SW	SE	S	SE	SW
total cover plants (in %)	85	95	100	70	95	90	95	90	50	45
cover phanerogams –	75	>90	90	70	75	85	70	65	15	15
– cryptogams –	30	5	25	5	65	30	35	60	40	35
– litter –	20	20	5	40	5	25	0	15	0	0
– open soil –	0	0	0	20	0	5	5	0	50	55
maximum depth soil (cm)	20	>60	>50	28	12	32		25		
pH rhizosphere	$4^3/_4$	$4^1/_4$	$4^1/_4$	$4^3/_4$	$4^1/_4$	$4^1/_4$	$4^1/_2$	$4^3/_4$	$5^1/_2$	$5^1/_2$

(continued)

Table XIV (continued)

reference number		1	2	3	4	5	6	7	8	9	10
Gnaphalium supinum	L	5	4	4	4	5	5	5	4	2	2
Sibbaldia procumbens	L	2	3	4	3	2	4	+	4	+	+
Salix herbacea	L	2	4	4	4	3	4	3	4	..	..
Carex bigelowii	L	1	+	1	..	+	+	1	+	+	+
Desmatodon latifolius		1	+	2	+	..	..	..	..	..	..
Polytrichum juniperinum		1	+	1	..	..	..	..	..	..	..
Peltigera aphthosa		1	1	1	..	..	..	..	..	..	..
Empetrum hermaphroditum	L	1	+	2	..	..	..	+	1	..	..
Hieracium alpinum	L	2	..	+	..	..	..	..	..	..	..
Taraxacum croceum	L	..	2	3	1	+	+	2	..	..	..
Polygonum viviparum	A	+	..	2	+	+	+	2	..	..	..
Bartsia alpina	L	..	+	..	+	+	+	2	..	..	..
Drepanocladus uncinatus		..	+	+	..	+	+	..	..	..	..
Pohlia commutata		..	..	1	+	+	+	+	1	2	+
Polytrichum norvegicum		..	..	..	+	2	2	1	+	1	2
Anthelia juratzkana g *Marsupella varians* g		..	..	..	..	..	+	3	4	4	2
Polytrichum piliferum		..	..	+	..	..	..	..	2	+	2
Lophozia alpestris		..	..	..	..	1	+	+	+	..	..
Kiaeria starkei		..	..	..	..	5	2	..	1	+	..
Pleuroclada albescens		..	..	..	..	1	+	..	..	..	..
Vaccinium uliginosum	L	..	..	..	..	+	+	..	..	..	..
Agrostis borealis	L	..	..	..	+	+	+	..	..	..	..
Veronica alpina	L	..	..	..	+	+	+	..	..	..	..
Poa alpina	L	..	..	1	+	..	..	+	..	..	..
Phleum commutatum	L	..	..	+	+	..	..	1	..	..	..
Epilobium hornemanni	L	..	..	..	1	..	+	+	..	..	..
Carex lachenalii	L	..	..	..	..	..	..	..	..	+	+
Cerastium cerastoides	L	..	+	..	..	..	..	..	..	+	+
Stereocaulon		..	..	+	..	..	..	..	..	+	+
Ochrolechia frigida		..	..	..	..	..	..	..	..	3	1
Psoroma hypnorum		+	..	2	..	..	..	..	2	..	..
Dicranum elongatum		2	+	..	..	..	2	..	..	..	..
Conostomum tetragonum		..	..	..	..	+	..	+	1	..	..
Tofieldia pusilla		..	..	..	..	+	..	+	..	..	..
Cladonia coccifera		..	+	..	..	+	..	..	..	..	..
Brachythecium glaciale		+	..	+	..	..	..	..	..	..	..
Racomitrium fasciculare		..	..	..	..	..	..	2	..	..	..
Crocynea neglecta		1	..	..	..	..	..	..	..	..	..
Festuca brachyphylla	A	..	..	1	..	..	..	..	..	..	..
Sphagum teres		..	..	..	..	..	1	..	..	..	..

Not recorded in the table are, all with "+": *Cassiope hypnoides* in sample plot 7, *Deschampsia alpina* 2; *Luzula spicata* 3; *Lycopodium selago* 5; *Minuartia* spec. (vegetative) 10; *Poa glauca* 1; *Scirpus caespitosus* 7; *Trisetum spicatum* 6; *Viola palustris* 7; *Brachythecium reflexum* 4; *Calliergon sarmentosum* 7; *Polytrichum alpinum* 2; *Oncophorus wahlenbergii* 7; *Racomitrium canescens* 6; *R. heterostichum* 6; *Scapania* spec. 8; *Cladonia bellidifolia* 1; *Cl. ecmocyna* 1; *Cl. mitis* 1, 5; *Cl. uncialis* 1; *Cl. spec.* (prim. thallus) 9.

p. 182–183, 199), Jan Mayen (LID, 1964, table 34), Iceland (cf. KALELA, 1939, p. 259), Fennoscandia (KALELA, 1939, p. 259 and the earlier cited literature; NORDHAGEN, 1943, p. 269; GJAEREVOLL, 1956, p. 127–134; see also the section composition).

subdivision: The syntaxon varies in particular in the composition of the bottom layer. This variation is qualitatively and quantitatively more pronounced than in the *Cassiopetum hypnoidis*, especially also in Fennoscandia, and is conformable to the variation in, for example, the *Salicetum herbaceae boreale*. It is also distinctly correlated with environmental differences. This leads me to interpreting the major subunits as subassociations.

6.1.1.4.1. Subass. *desmatodetosum latifolii* subass.nov.

table 14:1–4.

composition: Differential taxa are *Desmatodon latifolius*, *Polytrichum juniperinum*, *Peltigera aphthosa*, *Empetrum hermaphroditum*, *Hieracium alpinum* and *Taraxacum croceum*, arranged in this order according to decreasing fidelity from more or less exclusive to preferent.

The community is moderately rich in taxa.

synecology & habitat: The comparatively mesotrafent and early exposed community occurs in small depressions and furrows in surrounding *Salix herbacea* vegetation (6.1.2.3.1.), on 10 to 30° sloping soil (fig. 42), from 40 to at least 120 m a.s.l. near the coast up to at least 650 m a.s.l. in the inland.

The habitat is rather sheltered, being situated in broad, shallow ravines or in the lee of bedrock outcrops to the North of it.

The community occurs in 20 to more than 60 cm deep, very humic, predominantly fine to coarse sandy deposits. These are enriched in vegetative matter by the combined action of wind and snow, as well as by water which gathers in these depressions during and after rainfall.

The substrate is comparatively briefly irrigated, owing to the hydrographically somewhat isolated situation of the habitat in relation to higher slopes. After the irrigation stops the substrate dries out considerably so that the surface becomes almost crusty. The habitat of this syntaxon is the one most exposed to desiccation of the association in this district, and as such this subassociation is comparable with GJAEREVOLL's Scandinavian "*Gnaphalium supinum*-sociation without a coherent bottom layer" (GJAEREVOLL, 1956, p. 134).

The colorimetric pH of the rhizosphere ranges from $4^1/_4$ to $4^3/_4$.

6.1.1.4.2. Subass. *kiaerietosum starkei* (NORDH. 1928) subass.nov.

syn.: *Gnaphalium supinum* variante der *Dicranum-Polytrichum*-reiche *Salix herbacea*-Ass. NORDH. 1928, *Gnaphalium supinum-Kiaeria starkei*-sos. NORDH. 1943.

table 14:5, 6.

composition: Differential taxa are *Kiaeria starkei*, *Pleuroclada albescens*, *Lophozia alpestris*. The community is comparatively rich in taxa.

synecology & habitat: The community occurs on 20 to 30° inclined, Southwest-facing slopes in the inland at considerable altitudes (abt. 500 m a.s.l.), in large patches below slightly sloping flat rocks and in turn followed by *Salix herbacea* vegetation; often on terraced slopes, on which this sequence is regularly repeated.

The substrate consists of loose, somewhat mobile, 10 to 32 cm thick wet, coarse sandy to fine gravelly, predominantly colluvial deposits rich in humus. It is irrigated for much of the vegetation season by melt and rain water which oozes down from the higher slopes over the rocks.

The colorimetric pH of the rhizosphere is abt. $4^1/_4$.

6.1.1.4.3. Subass. *anthelietosum* (Resvoll-Holmsen 1920) subass.nov.

syn.: *Gnaphalium supinum*-rik *Anthelia* Mosmark Resvoll-Holmsen 1920 n.n.; incl. *Gnaphalium supinum-synedria* Lid 1964.

table 14:7–10.

composition: Differential taxa are *Anthelia juratzkana*, *Marsupella varians*, *Cerastium cerastoides*, locally also *Polytrichum piliferum*, *Carex lachenalii*, *Ochrolechia frigida*. The community is comparatively poor in taxa.

synecology & habitat: The extreme chionophytic community occurs on 10 to 20° inclined, more or less South-facing slopes, below 100 m a.s.l. in the coastal areas, more common up to at least 500 m a.s.l. in the inland. It is found in earth slips and solifluction slopes in and along sheltered, damp ravines and beds of (temporary) meltwater discharges, where a deep snowdrift accumulates and does not disappear until at least the middle of July (fig. 43).

The very unstable substrate consists of loose, humic, medium fine sandy to gravelly colluvial material of varying depth. A litter layer is usually absent, and if found of allochtonous origin.

The site is irrigated until late in the summer, in the beginning usually excessively. The substrate is by far the wettest of the substrates below the *G. supinum* communities here.

The colorimetric pH of the rhizosphere ranges from $4^1/_2$ to $5^1/_2$.

syntaxonomy & discussion: More or less detailed studies of *G. supinum* communities are frequently published (extensive enumeration of the literature in Kalela, 1939, p. 259 and in Gjaerevoll, 1956, p. 127–135), but considerably fewer studies go so far into detail that the composition is illustrated by tables (cf. the cited literature in paragraph composition). These studies and those made of related plant communities with *G. supinum* in Central Europe (Braun-Blanquet, 1948a, p. 87–91; Guinochet, 1938, table 10; cf. also Oberdorfer, 1957, 1970) show that

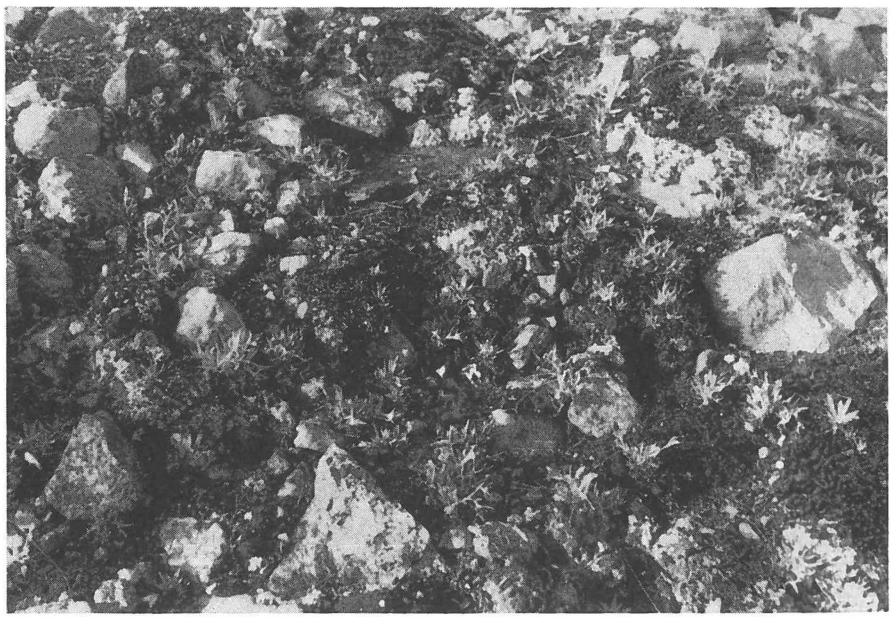


Fig. 43. Patch of vegetation of the subass. *anthelietosum* of the *Gnaphalietum supini* on mobile soil.
JGdM phot. VIII. 1969.

such communities occur well-developed in the alpine to arctic amphi-atlantic region.

The *G. supinum* communities of Central Europe are grouped in the *Gnaphalio-Sedetum candollei* BR.-BL. 1948 (Pyrenees) and the *Nardo-Gnaphalietum supini* BARTSCH 1940 (northern Alps; both in *Salicion herbaceae*), those from the northern amphi-atlantic region belong to a separate syntaxon.

The northern *G. supinum* communities differ principally from related *Salix herbacea* communities in the replacement of *S. herbacea* by *G. supinum* as the dominant taxon in the field layer. They are recognized as distinct vegetation types and usually classified in the Fennoscandian literature as "variants" (most often units with the level of sociation) or sociations of the *Salicetum herbaceae boreale* NORDH. 1943. The subdivision of the two groups of communities is founded on the qualitative and quantitative composition of the bottom layer and its relation to the environment; this criterion varies in both groups in a similar, nearly identical way, so that the subunits of both groups should be considered syntaxonomically equivalent.

In order to maintain a balanced classification system, and considering what has been put forward in the foregoing as well as the general difference in ecology between the two groups of communities (cf. GJAEREVOLL, 1956, p. 127), it is, in my opinion, the most practical and elegant

solution to distinguish the *G. supinum* communities as a separate, independent association along with the *Salicetum herbaceae boreale* s.str.

This solution does imply a rather narrow association concept, but this is not in contradiction with the concept of such related, "established" associations as the *Cassiopo-Anthelietum juratzkanae*, the *Pleuroclado-Polytrichetum norvegici*, the *Sibbaldietum procumbentis* and the *Alchemilletum alpinae* (see also DAHL, 1957).

The geographical variation in the composition of the *Gnaphalietum supini*, as in the *Sibbaldietum procumbentis* and *Alchemilletum alpinae*, is caused both by environmental and by phytogeographical differences. The first are in particular expressed in the composition of the bottom layer whereas the latter are only expressed in the composition of the field layer. The phytogeographical difference between such communities from northern alpine Fennoscandia and from low-arctic (West and) East Greenland concerns the presence or absence of the boreal flora element, represented by for instance *Anthoxanthum odoratum*, *Deschampsia flexuosa*, *Rumex acetosa*, *Solidago virgaurea*, *Viola biflora*.

The studies of HADAČ (1971b) of the *Sibbaldietum procumbentis* in Iceland have, in my opinion, shown that this variation is not geographically discontinuous, and therefore cannot be considered of high syntaxonomic value. All northern atlantic *S. procumbens* communities should consequently be grouped in a single association.

Although detailed studies of *G. supinum* communities in Iceland have not been published to my knowledge, at least not with tables with analyses, I consider in view of the arguments put forward that all discussed, northern Atlantic *G. supinum* communities analogously belong to a single association.

A continuous, regional variation in the phytogeographical composition of the field layer I think thus to be one of the characteristics of this *Gnaphalietum supini* and of the other mentioned associations.

The *Gnaphalietum supini* is evidently intermediary between the oligotrafent *Cassiopo-Salicion herbaceae* and the eutrafent *Ranunculo-Oxyrion digynae:* the composition of the bottom layer and the relative instability of the substrate indicate that it is closely related to the *Cassiopo-Salicion herbaceae*, the composition of the field layer indicates that it is closely related to the *Ranunculo-Oxyrion digynae*. Also considering the composition and synecology of the syntaxon elsewhere, particularly in Fennoscandia, I prefer to group it in the *Cassiopo-Salicion herbaceae*.

6.1.2. All. *Ranunculo-Oxyrion digynae* NORDH. 1943 em. DAHL 1957.

syn.: *Ranunculo-Anthoxanthion* (DU RIETZ 1942) GJAEREVOLL 1950; incl. *Alchemillion glabrae chionophilum* NORDH. 1943 (pro suball.), low herb meadow poor in *calciphiles* DU RIETZ 1942 p.p.

Concerning the general distribution and extension of the communities of this alliance in the Angmagssalik District the reader is referred to p. 14 and p. 121; for details to the different descriptions; see also p. 117 to p. 119.

In particular the *Sibbaldietum procumbentis*, the *Alchemilletum alpinum* and the *Ranunculo-Salicetum herbaceae* must be regarded in this district as "Dauergesellschaften", whereas the *Chamaenerietum latifolii* and the sociations of *Alchemilla glomerulans* and *A. filicaulis* represent presumably less (semi-)permanent communities.

The first mentioned three communities are extreme acidophytic, (pH range from 4 to $5^1/_2$), mesophytic to hygrophytic, seasonally wet and arranged according to increasing length of the period of irrigation. The other three communities are medium acidophytic (pH range from $4^1/_2$ to 7), hygrophytic and irrigated during most of the vegetation period. They all occur in more or less stable substrates, which are not or very little affected by pronounced solifluction or cryoturbation.

The *Ranunculo-Oxyrion digynae* presumably partly succeeds the *Cassiopo-Salicion herbaceae* under favourable conditions (see p. 124–125). The *Gnaphalietum supini* of the *Cassiopo-Salicion herbaceae* is probably replaced by the *Sibbaldietum procumbentis* or the *Ranunculo-Salicetum herbaceae*. The latter probably also succeeds the *Sibbaldietum procumbentis*, as well as communities of the *Stellaro-Oxyrion* and of the *Antitrichio-Sedion roseae*.

The communities of the *Alchemilletum alpinae*, the *Chamaenerietum latifolii* and the sociations of *Alchemilla glomerulans* and *A. filicaulis* establish themselves presumably usually in more or less bare, in the beginning mobile and more or less wet substrates.

Faithful taxa of the alliance are *Agrostis borealis* HARTM., *Alchemilla alpina* L., *Phleum commutatum* GAUD., *Polygonum viviparum* L., *Ranunculus acris* L. (very rare in the district), *Sibbaldia procumbens* L., *Taraxacum croceum* DAHLST., *Barbilophozia lycopodioides* (WALLR.) LOESKE, *Brachythecium reflexum* (STARKE) B. S. G., *Drepanocladus uncinatus* (HEDW.) WARNST., *Leontodon autumnalis* L. (absent in the district); local differentiating in respect of the *Cassiopo-Salicion herbaceae* are for instance *Hieracium alpinum*, *Oxyria digyna*, *Sedum rosea*, *Veronica alpina*, *Dicranum fuscescens*, *D. scoparium*, *Cladonia mitis*. The fidelity is mainly preferent to selective.

The floristic composition is in general somewhat variable, which in particular applies to the composition of the higher, partly graminoid field layer. This variability is not distinctly correlated with ecological and/or (phyto) geographical differences but rather continuous, and this phenomenon is in consequence considered to be of little syntaxonomical importance. The association concept is in this respect interpreted com-

paratively widely; this also applies to a less to the previous alliance (see for example the discussion of the *Sibbaldietum procumbentis*).

6.1.2.1. Ass. *Sibbaldietum procumbentis* Böcher 1933 em. Gjaerevoll 1956.

syn.: *Sibbaldia procumbens*-Formation Hult 1881 n.n., *Sibbaldia* Vegetationen Jonsson 1901 n.n.; incl. *Sibbaldia procumbens-Solidago virgaurea-Deschampsia flexuosa*-Ass. Fries 1913, *Sibbaldia procumbens*-Wiese Fries 1913, *Sibbaldia-Trisetum*-Schneewiese Lippmaa 1929.

table 15.

composition: Regional faithful taxa are *Sibbaldia procumbens* L. (preferent faithful), *Phleum commutatum* Gaud., *Viola palustris* L., *Trisetum spicatum* (L.) Richt. (all selective). In the district constant taxa are *Carex bigelowii*, *Gnaphalium supinum*, *Polygonum viviparum*, *Taraxacum croceum*, *Salix herbacea*, *Veronica alpina*, *Polytrichum juniperinum;* elsewhere also for instance *Deschampsia flexuosa*, *D. alpina*, *Anthoxanthum odoratum*, *Festuca vivipara*, *Ranunculus acris*, *Drepanocladus uncinatus*, *Polytrichum alpinum*, *Racomitrium canescens* (cf. Kalela, 1939, table 46; Gjaerevoll, 1956, table 23; Hadač, 1971b, table 7).

The community is rather rich in taxa in the district, on an average close to 16 taxa occur in one sample plot, of which on an average abt. 12 are phanerogams.

physiognomy: The hemicryptophytic community is stratified in 2 to 3 layers: (1) a poorly developed to absent bottom layer of cryptogams, (2) a well developed lower field layer or undergrowth with *Sibbaldia procumbens*, *Salix herbacea*, and (3) a well developed, often more open field layer of comparatively tall herbs, grasses and sedges.

The community forms low, dense, luxuriant patches of a characteristic bright greyish green to slightly glaucous colour, which cover comparatively small tracts and which appear usually in sharp contrast with the surrounding vegetation types (fig. 44). Elsewhere, where the upper field layer is richer in species, the stands appear to form more graminaceous vegetation.

Synecology & habitat: The low-arctic to subarctic and northern alpine, acidophytic, chionophytic, mesophytic to hygrophytic, (eutrafent to) mesotrafent community occurs in the Angmagssalik District in predominantly Southwest-facing, 20 to 60° sloping, moist, sheltered snow-bed habitats mainly in the coastal areas from 60 to 375 m a.s.l. It is found in patches along low rockwalls, in depressions at the foot of bedrock outcrops, or in depressions below *Salix glauca* scrub growing over shallowly earth-covered bedrock outcrops.



Fig. 44. Community of the *Sibbaldietum procumbentis* rich in herbs, including *Gentiana nivalis* (centre).
JGdM phot. VII. 1968.

Table XV

reference number		1	2	3	4	5	6	7	8	9	10	11	12
altitude (m)		70	80	60	325	230	240	375	85	70	60	80	90
inclination		30	60	30	40	20	45	30	40	60	30	60	20
orientation		SW	S	SW	E	W	W	E	W	W	SW	S	SW
total cover plants (in %)		95	95	95	>80	95	90	75	95	85	85	90	>95
cover *Salix herbacea*		35	>50	<20	20	70	55	} 75	95	3	45	65	} 95
– herbs	–	80	80	85	75	>50	65			85	60	65	
– cryptogams	–	1	<5	0	15	>10	<15	1	<1	<1	2	0	0
– litter	–	20	15	25	>50	>50	>50	>90	80	90	40	90	<90
– open soil	–	0	0	0	5	0	0	0	0	0	0	0	0
maximum depth soil (cm)		32	37	>40	35	>30	>50	50	21	45	60	27	20
pH rhizosphere		$4^3/_4$	$4^1/_4$	$4^3/_4$	$4^3/_4$	$4^3/_4$	$4^3/_4$	5	4	$4^1/_2$	$4^1/_4$	$4^3/_4$	5
Sibbaldia procumbens	L	4	4	5	4	4	4	4	5	6	5	4	6
Salix herbacea	L	4	5	3	3	5	5	4	5	1	4	5	5
Taraxacum croceum	L	1	1	2	3	2	3	2	..	+	..	3	2
Polygonum viviparum	A	2	2	2	2	1	2	1	..	1	1	3	+
Carex bigelowii	L	+	2	1	2	1	+	2	2	..	1	1	+
Hieracium alpinum	L	3	2	2	3	..	+	..	..	..	..	..	..
Sedum rosea	L	+	3	1	1	..	..	..	+	..	..	..	..

(continued)

Table XV (continued)

reference number		1	2	3	4	5	6	7	8	9	10	11	12
Gnaphalium norvegicum ..	L	4	+	3	..	..	..	..	..	..	+	..	..
Bartsia alpina	L	2	3	1	..	..	..	..	..	..	..	..	..
Viola palustris	B	+	+	1	..	..	..	..	..	..	..	..	..
Empetrum hermaphroditum	L	1	1	..	+	+	..	..	..	..	..	..	..
Veronica alpina	L	+	+	..	+	..	+	+	+	..	..	..	+
Polytrichum juniperinum .		+	+	..	1	2	+	+	+	+	..	..	..
Gnaphalium supinum	L	2	..	..	+	+	+	..	+	+	2	+	..
Desmatodon latifolius		..	+	..	1	1	..	+	+	+	..	..	..
Trisetum spicatum	A	..	..	+	+	+	+	+	+	..	..	..	..
Poa artica	A	+	..	..	..	+	+	+	..	1	+	..	+
Peltigera spec.....		..	..	..	+	1	+	+	..	..	..	..	..
Tortula norvegica		..	..	..	..	+	2	+	..	..	..	..	..
Brachythecium reflexum ...		..	..	..	1	1	..	+	..	..	..	..	..
Pohlia nutans		+	+	..	..	..	+	..	+	..	..	..	..
Agrostic borealis	L	+	1	..	..	..	..	..	..	..	1	..	..
Thalicrum alpinum	L	..	..	..	..	..	3	+	..	..	..	..	2
Pyrola minor	B	..	..	..	+	..	..	..	..	..	..	1	+
Gentiana nivalis	L	..	..	..	..	1	1	..	..	..	..	+	..
Poa alpina	L	..	..	..	..	..	..	+	+	..	..	..	1
Chamaenerion lattifolium .	A	..	..	..	..	2	..	..	+	..	..	..	+
Barbilophozia hatcheri		..	..	..	1	..	+	..	+	..	..	..	..
Bartramia ithyphylla		..	..	..	+	..	..	..	+	..	..	..	..
Oxyria digyna	A	..	..	..	..	..	..	+	..	..	..	1	..
Psoroma hypnorum		..	..	..	+	..	+	..	..	..	..	..	..
Bryum spp.....		+	..	..	+	..	..	..	..	..	..	..	..
Aulacomnium palustre		..	1	..	..	..	..	..	..	..	..	..	..
Polytrichum alpinum		..	..	..	1	..	..	..	..	..	..	..	..
Polytrichum commune		..	..	..	..	..	..	..	..	..	1	..	..

Not recorded in the table are, all with "+": *Alchemilla alpina* in sample plot 11; *Antennaria canescens* 4; *Carex brunnescens* 5; *Cassiope hypnoides* 6; *Epilobium hornemanni* 1; *Equisetum arvense* 8; *Euphrasia frigida* 6; *Juncus trifidus* 11; *Listera cordata* 1; *Lycopodium alpinum* 11; *L. selago* 4; *Luzula spicata* 5; *Phleum commutatum* 2; *Pinguicula vulgaris* 1; *Thymus drucei* 4; *Dicranum scoparium* 2; *Drepanocladus uncinatus* 4; *Lophozia* spec. 4; *Polytrichum norvegicum* 4; *Scapania* spec. 2; *Cladonia ecmocyna* 6; *Peltigera aphthosa* 4; *fungus* 11.

The substrate consists of 20 to more than 60 cm thick, stable deposits of moist, niveo-aeolian and/or colluvial coarse sand over old debris. It is very rich in humus to (superficially) peaty.

The profiles of the soils vary. They show in general (1) a (0) $^1/_2$ to 2 cm thick, loose litter layer, predominantly of *Salix herbacea* leaves, which covers 15 to more than 90, usually 50 % or more of the surface, (2) a 0 to 5 cm thick layer of brown, loose raw humus, (3) a (0) 6 to 20 cm thick blackish layer of more or less sandy, rather compact and greasy, humified

vegetable material to peaty matter, (4) a 10 to 40 cm thick layer of dark brown, moist, humic (to peaty) coarse sand, and (4) a subsoil of old debris (mostly boulders or blocks).

The habitat is seasonally wet. It is subjected to prolonged though not excessive irrigation from the time of exposure until at least the middle of the vegetation period. It is rather well drained and gradually dries out when the irrigation diminishes. Extreme desiccation is prevented by the dense plant cover, the often well developed litter layer and the high content of organic matter of the soil. The habitat is subjected to dry and wet flushing, involving enrichment of the soil.

The colorimetric pH of the rhizosphere ranges from 4 to 5 and averages abt. 4.6.

succession & zonation: The community represents presumably a semipermanent stage in the succession towards the *Ranunculo-Salicetum herbaceae*, which is often found bordering upon this community in drier, deeper soil.

distribution: The community is common in the district (Blomsterdalen-Elvbakker, Sømandsfjeldet, Kulusuk, Tasîlâlik, Tasîlaq, Qíngertivaq; cf. also KRUUSE, 1912, p. 162, 168, 169, 172 etc.) and elsewhere in low to middle arctic Greenland (see for instance BÖCHER, 1933, p. 93, 1954, p. 84, 114, 116, and 1963, p. 227); also in Iceland and Fennoscandia (see paragraph syntaxonomy & discussion).

subdivision: The variable composition of the community in the district is more or less correlated with variation in the environment, which leads me to distinguish two local subunits of a provisional status and syntaxonomic level (see the following paragraph):

(a) Variant of *Hieracium alpinum* (table 15:1–4), with the differential taxa *Hieracium alpinum*, *Sedum rosea*, *Gnaphalium norvegicum*, *Bartsia alpina*, *Viola palustris*. It is comparatively rich in taxa and characteristic of sheltered sites at the base of bedrock outcrops and low rockwalls. The substrate is characterized by the occurrence of an up to 5 cm thick layer of loose raw humus below the litter layer, in which in particular *H. alpinum*, *S. rosea* and *G. norvegicum* develop their root system.

(b) Variant *inops* (table 15:5–12), which is floristically negatively differentiated from variant (1). It is comparatively poor in taxa and occurs especially in slight depressions often sheltered by rock outcrops or *Salix glauca* scrub. A loose raw humus layer as found below variant (a) is absent.

syntaxonomy & discussion: A "*Sibbaldietum procumbentis*" appears to have been published by at least three different authors, viz. by BÖCHER (1933, p. 93) from East Greenland, by GJAEREVOLL (1956, p. 117–183) from Scandinavia, and, very recently, by HADAČ (1971b, p. 121–123)

from Iceland, apart from several *Sibbaldia procumbens*-Wiesen, -vegetations and -sociations also from these areas by various other authors (Jonsson, 1901; Samuelsson, 1917; Kalela, 1939, p. 262–264; Fries, 1913; Böcher, 1954, table 8:1, 2, 1959 table 8:6 and 1963, table 25:10–14, and the cited earlier publications). These *S. procumbens* communities are mutually closely related.

A close examination of the tables illustrating these descriptions reveals some variation in the floristic composition. On the one hand this variation is attributable to slight ecological differences, viz. mainly the extent of seasonal wetness of the substrate, expressed in the absence or presence of more or less hygrophytic taxa such as *Deschampsia alpina*, *Ranunculus acris*, *Epilobium anagallidifolium*, *Pyrola minor*, on the other it is attributable to phytogeographical differences, particularly concerning the absence or presence of boreal taxa such as *Anthoxanthum odoratum*, *Viola biflora*, *Deschampsia flexuosa*. Also the phytogeographical variation is rather gradual, though on a different scale, comparing the data from Fennoscandia, Iceland and East and West Greenland in this sequence. It is in consequence quite impossible to divide the discussed *S. procumbens* communities on a regional-floristic (phytogeographical) basis and therefore I consider these communities to belong to a single association (see also p. 149).

Regarding the gradual variation, both floristic-phytogeographical and floristic-ecological, there are in my opinion more additional data desired before a satisfactory subdivision of this association can be attempted. The *Sibbaldia procumbens* communities observed in the Angmagssalik District can be divided in two groups, which in view of the foregoing I prefer to describe for the present as variants.

A related *Sibbaldia procumbens nodum* (Poore, 1955, p. 635–639), *Alchemilla-Sibbaldia nodum* (McVean & Ratcliffe, 1962, p. 85–87) or *Alchemilla alpina-Sibbaldia procumbens* association (McVean, 1964, p. 518–520) occurs in the Scottish Highlands (*Alchemillo-Sibbaldietum procumbentis* Poore 1955 nom. mut.).

In the northern Urals there occurs yet another *S. procumbens* community (Sočava, 1930, in Hadač, 1971b, p. 122), which probably represents a vicarious syntaxon.

In Central Europe *S. procumbens* is regarded as one of the faithful taxa of the *Salicion herbaceae* Br.-Bl. 1926 (cf. Oberdorfer, 1957; Braun-Blanquet, 1948b) and as a differential taxon of certain syntaxa of the *Nardion* and the *Caricion curvulae* occurring in wet conditions.

6.1.2.2. Ass. *Alchemilletum alpinae* Böcher 1933 em. Dahl 1957.

syn.: incl. *Alchemilla alpina*-Formation (Hult 1887) Resvoll-Holmsen 1914, *Alchemilla alpina*-Urtemark Resvoll-Holmsen 1920, *Alchemilla*

alpina-Sibbaldia-Ass. STEINDORSSON 1936, *Alchemilla alpina*-Weise (SAMUELSSON 1917) KALELA 1939, *Alchemilla alpina-Deschampsia flexuosa*-sosiasjon NORDH. 1943, *Alchemilla alpina*-Ass. STEINDORSSON 1945, *Alchemilla alpina*-soc. BÖCHER 1954.

table 16.

composition: Regional, exclusive (to selective) faithful taxon is *Alchemilla alpina* L. s.str. Constant accessory taxa are in the district *Salix herbacea*, *Carex bigelowii*, *Chamaenerion angustifolium*, *Taraxacum croceum*, *Campanula gieseckiana*, *Cladonia mitis;* elsewhere for instance *Deschampsia flexuosa*, *Anthoxanthum odoratum*, *Solidago virgaurea*, *Rumex acetosa*, (cf. RESVOLL-HOLMSEN, 1920, table 11; BÖCHER, 1933, table 18, 1937, table 20, 1954, table 8:3–7 and 1963, table 26:9–14; STEINDORSSON, 1936, table 10:1, 2 and 1945, table 4:3; KALELA, 1939, table 20; NORDHAGEN, 1943, table 38; GJAEREVOLL, 1949, table 5 and 1956, table 4; DAHL 1957, table 35).

In this district the community is somewhat variable and comparatively poor in taxa; on an average 12 taxa occur in one sample plot, of which on an average 10 are phanerogams. More "southern" occurrences are also characterized by the poor representation of cryptogams, but, like in the *Gnaphalietum supini*, *Sibbaldietum procumbentis* and *Ranunculo-Salicetum herbaceae*, noticeably richer in taxa.

physiognomy: The predominantly hemicryptophytic community consists as a rule only of a well-developed, two-layered field layer: (1) a well-developed, closed lower field layer of less than 10 cm high, with *Alchemilla alpina*, *Salix herbacea*, *Sibbaldia procumbens*, and (2) an open to very open upper field layer of tall, several decimeters high herbs, grasses and sedges such as *Chamaenerion angustifolium*, *Campanula gieseckiana*, *Polystichum lonchitis*, *Poa alpina*, *Carex bigelowii;* a bottom layer of cryptogams (bryophytes) is very fragmentarily developed or absent.

It forms remarkable, luxuriant and dense patches of vegetation of a vivid light yellowish to silver-greyish green, which are often of limited extent and contrasting with the surroundings (fig. 45).

synecology & habitat: The low-arctic to northern alpine and more or less oceanic, chionophytic, medium to extreme acidophytic, mesophytic to hygrophytic, mesotrafent community occurs in the Angmagssalik District in sunny, sheltered and limited seasonally wet snow-bed and snow-patch habitats, on 10 to 60° inclined, predominantly South-facing slopes between 20 and at least 180 m a.s.l. in the coastal areas and up to at least 450 m a.s.l. in the inland. It is commonly found in belts or patches along or between other vegetation types, e.g. in small, shallow depressions, along rockwalls, outcrops and large boulders, and occasionally on narrow ledges along steep cliffs along the fjords.

The substrate is 20 to more than 100 cm deep and characterized by a usually distinct, rather sudden increase in depth over a short distance on the spot. It consists of humic, sometimes superficially peaty to raw humic coarse sand mixed with finer and coarser grades. The mineral material is predominantly of colluvial, partly also of niveo-aeolian origin.

The soil profiles are usually not distinctly differentiated; the $^1/_2$ to 3 cm thick, as a rule well-developed litter layer passes gradually into a $2^1/_2$ to 5(–12) cm thick raw humus layer containing the rhizomes of *A. alpina*, which in turn fades into the more or less humic sandy subsoil; all these layers are usually light brown.

The snow cover is thin, often only a few decimeters deep and superficially covered by an icy crust or "harst". It leaves the habitat exposed from the middle (-late) of June to late September.

The habitat is irrigated to a limited degree during a variable, usually short period after exposure. It is enriched by dry and wet flushing.

The colorimetric pH of the rhizosphere ranges from 4 to $5^1/_4$ and averages 4.6.

succession & zonation: The community is probably preceded by communities of the *Sedo-Thymion drucei* in more unstable, shallower substrate. With increasing depth of the substrate it is probably succeeded by communities of the *Caricetum bigelowii*, more rarely possibly by *Salix glauca* scrub. See further the subunits.

distribution: The community is very common in the Angmagssalik District, in particular not too far from the coast and along the fjords (southern part of the Angmagssalik Ø, Kungmiut, Ikâsaulaq, Qíngertivaq; observed in most of the visited localities), and occurs also elsewhere in low-arctic Greenland (Böcher, 1933, p. 54, 1954, p. 60, 83 and 1963, p. 230–236); also in Iceland (Jonsson, 1895, p. 70; Steindorsson, 1936, p. 195 and 1945, p. 25), the Faeroes (Böcher, 1937, p. 180–182), Fennoscandia (Kalela, 1939, p. 163–166 and cited earlier literature; Nordhagen, 1943, p. 245–246; Gjaerevoll, 1949, p. 49 and 1956, p. 53–62; Dahl, 1957, p. 184–188).

subdivision: Comparison of the variation in the community here described with that of related *A. alpina* communities in particular from West Greenland, shows that there exists in Greenland a subunit in unstable, coarse textured soil, related to the *Androsacetalia alpinae* (*Sedo-Thymnion drucei*), and a subunit in stable, finer textured soil. The correlation of distinct floristical differences with these differences in environmental conditions leads me to distinguish these subunits as subassociations, whereas the minor variation in floristical composition and correlated environmental conditions within these subunits can be expressed by distinguishing variants.

Table XVI

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13
altitude (m)		180	180	180	90	20	20	225	70	45	120	65	60	35
inclination		40	60	30	50	60	60	45	35	10	30	40	20	15
orientation		W	W	S	S	SE	SW	SE	SW	SW	S	S	S	SW
total cover plants (in %)		60	35	70	90	100	100	85	80	70	80	90	80	80
cover *Salix herbacea* –		0	2½	20	1	20	45	85	0	40	0	0	0	0
– herbs –		60	35	60	90	95	85		80	35	80	90	80	80
– cryptogams –		2	2	1	0	0	<1	<1	<1	<5	<1	0	0	0
– litter –		25	25	20	80	90	80	90	90	20	80	15	25	90
– open soil –		45	60	15	10	0	0	0	0	10	0	0	0	0
maximum depth soil (cm)		21	19	19	35	45	40	50		>50	16	>100	>100	>100
pH rhizosphere		5	5¼	5	5	4¾	4¾	4¼	4¾	4	4¾	4	4	4½
Alchemilla alpina	L	5	3	4	6	5	5	6	6	4	6	6	6	6
Salix herbacea	L	..	1	3	1	3	4	2	1	4	..	..	..	..
Chamaenerion angustifolium	B	+	+	1	1	+	+	..	+	1	..	+	1	+
Carex bigelowii	L	+	..	..	+	+	+	+	1	1	..	+	+	+
Taraxacum croceum	L	+	1	+	..	2	1	..	+	+	+	..	+	+
Campanula gieseckiana	L	1	1	+	+	+	+	..	..	..	+	..	..	..
Polystichum lonchitis	L	3	3	2	..	..	..	..	..	..	..	..	..	..
Cystopteris fragilis	B	+	+	+	..	..	..	..	..	..	..	..	..	..
Poa arctica	A	1	+	+	..	..	..	..	..	..	..	..	..	..
Peltigera canina s.l.		+	+	+	..	..	..	..	..	..	..	..	..	..
Carex scirpoidea	L	..	+	+	..	..	..	..	..	..	..	..	..	..
Thymus drucei	B	..	1	1	1	..	..	..	..	..	1	..	..	..
Cladonia mitis		+	+	+	..	..	..	+	+	+	+	..	..	..
Luzula spicata	L	..	+	+	..	..	..	..	..	+	+	+	..	..
Thalictrum alpinum	L	..	..	1	+	2	2	..	..	..	..	..	..	..
Polygonum viviparum	A	..	..	..	+	2	4	..	+	..	..	..	..	..
Poa glauca	A	..	..	..	+	+	+	..	..	..	..	..	..	..
Viola palustris	B	..	..	..	+	2	+	..	..	..	..	..	..	..
Gentiana nivalis	L	..	..	..	+	..	+	..	..	..	..	..	..	..
Sibbaldia procumbens	L	..	..	..	..	4	2	..	..	..	..	..	..	..
Empetrum hermaphroditum	L	..	..	..	+	..	+	..	..	..	..	..	..	..
Veronica alpina	L	..	..	..	..	1	+	..	..	..	..	..	..	..
Coptis trifoliata	B	..	..	..	..	1	+	..	..	..	..	..	..	..
Pyrola minor	B	..	..	..	..	2	+	..	..	..	..	..	..	..
Alchemilla filicaulis	B	..	..	..	..	+	1	..	..	..	..	..	..	..
Phleum commutatum	L	..	..	+	..	+	+	..	1	..	..	..	..	..
Desmatodon latifolius		+	..	+	..	..	+	+	..	..	+	..	..	..
Poa alpina	L	..	..	..	..	..	..	+	..	+	..	+	+	..
Sedum rosea	L	..	+	..	..	1	..	..	..	..	..	..	..	..
Bartsia alpina	L	..	..	+	+	..	..	..	..	..	..	..	..	..
Trisetum spicatum	A	..	+	..	+	..	..	..	..	..	..	..	..	..
Juncus trifidus	L	2	..	..	+	..	..	..	..	..	..	..	..	..
Leucorchis albida	L	..	..	..	1	..	..	..	..	..	..	..	..	..
Cetraria islandica		..	..	..	..	..	..	..	..	1	..	..	..	..

Not recorded in the table are, all with "+": *Agrostis borealis* in sample plot 3; *Carex brunnescens* 5; *Cerastium alpinum* 6; *Erigeron unflorus* 2; *Euphrasia frigida* 4; *Festuca rubra* 8; *Saxifraga oppositifolia* 8; *Sedum annuum* 3; *Stellaria calycantha* 6; *Woodsia ilvensis* 2; *Bartramia ithyphylla* 2; *Brachythecium collinum* 2; *Dicranum elongatum* 1; *D. scoparium* 1.

6.1.2.2.1. Subass. *polystichetosum lonchitis* subass.nov.

syn.: *Alchemilla alpina* sociations Böcher 1963 p.p.

table 16:1–3.

composition: Differential taxa are *Polystichum lonchitis* and *Carex scirpoidea;* locally also *Cystopteris fragilis*, *Poa arctica*, *Peltigera canina*, *Thymus drucei.* The community is in the district comparatively rich in taxa, on an average 17 taxa occur in one sample plot, of which on an average 4 are cryptogams.

physiognomy: The community differs in appearance from the generalization given previously. It forms rather luxuriant belt-like stands, which display a scala of different shades of green, and in which the dull shining dark green clumps of *P. lonchitis*, the large blue flowers of *C. gieseckiana* and the large bright yellow ones of *Taraxacum* are very striking from a distance. *Chamaenerion angustifolium* develops buds but does not flower every year, and if so, only very late in summer; in the other subunit it usually does not develop buds.

synecology & habitat: The medium chionophytic, medium acidophytic, mesophytic and comparatively thermophytic, more or less chalicophytic, rather eutrafent community occurs in patches and strips of limited extent along steep, South to West-facing rock walls.

The substrate consists of well drained and aerated, rather unstable, abt. 20 cm deep, undifferentiated deposits of humic, loose, dry, light brownish coarse sandy to stony gravel of predominantly colluvial origin.

In winter the habitat is covered by a deep snowdrift; warming up of the rocks by insolation causes the snow near to it to melt away rather early in spring, so that the habitat becomes exposed comparatively early. The temperature conditions of the local and microclimate of the habitat are relatively extreme.

The colorimetric pH of the rhizosphere ranges from 5 to $5^1/_4$.

succession & zonation: With increasing depth, consolidation, humus content and water retention capacity of the substrate the community is probably succeded by *Salix glauca* scrub or the other subunit of the association. The community occurs immediately adjoining the rock, and is followed by open fell-field (*Juncus trifidus*) vegetation on unstable, gravelly to stony debris slopes.

distribution: The community is rare in the district, and is only observed on the southern slopes of the Vegas Fjeld near Sermilikvejen valley; it occurs also in West Greenland (cf. Böcher, 1963, table 26:9, 12, 14).

6.1.2.2.2. Subass. *typicum* subass.nov.

syn.: most of the synonyms mentioned previously for the association are more or less synonymous with this syntaxon.

table 16:4–13.

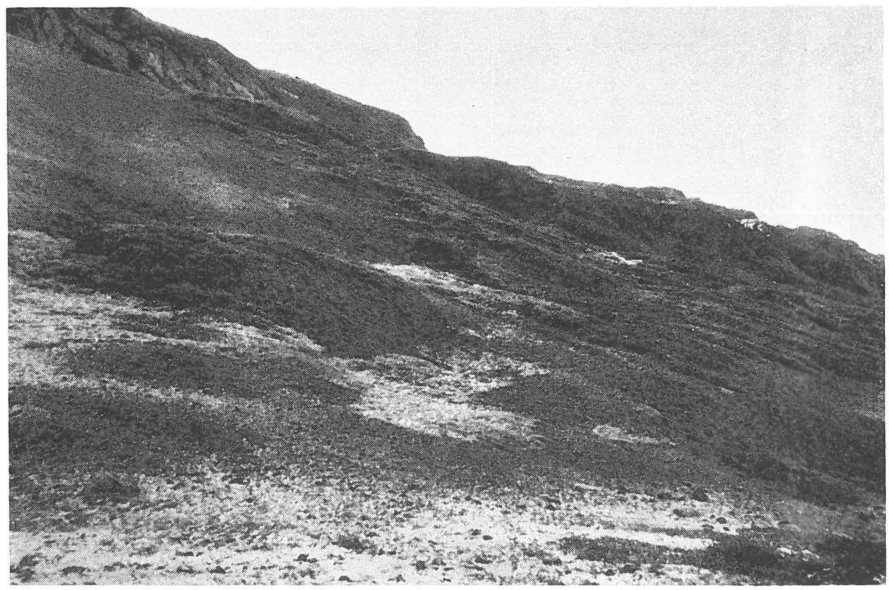


Fig. 45. The northern slope of Blomsterdalen valley during the thaw following the first snowfall in early autumn. *Carex bigelowii* grass heath covers the deep niveo aeolian sand deposits, *Salix glauca* scrub grows over the shallowly earth covered rock outcrops; in the slight depressions below the latter stands of the *Alchemilletum alpinae typicum* are seen still partly covered by some snow.
JGdM phot. IX. 1966.

composition: This community agrees in every respect closely with the bulk of the association as described previously, except for those characteristics which have been mentioned above as typical for the subass. *polystichetosum lonchitis*.

subdivision: The community is rather heterogeneous. It varies in the qualitative and quantitative composition mainly because of the nutrient content and the hydrology of the substrate, and, moreover, in the phytogeographical composition. In the Angmagssalik District it can be subdivided in two local variants:

(a) Variant of *Thalictrum alpinum* and *Viola palustris* (table 16:4–6), with the differential taxa *Thalictrum alpinum*, *Viola palustris*, *Poa glauca*, *Gentiana nivalis*, *Veronica alpina*, *Pyrola minor*, *Alchemilla filicaulis*, locally also *Sibbaldia procumbens* and *Polygonum viviparum*. It is comparatively rich in taxa and characteristic of comparatively sheltered, prolonged moist habitats such as clearings in *Salix glauca* scrub.

(b) Variant *inops* (table 16:7–13), without differential taxa and comparatively very poor in taxa. It occurs in comparatively exposed and dry places such as shallow depressions below bedrock outcrops or *Salix glauca* scrub, surrounded by *Carex bigelowii* grass heath.

Elsewhere in Greenland variants of for instance *Deschampsia flexuosa* and of *Calamagrostis canadensis* can be distinguished (cf. BÖCHER, 1954, table 8 and 1963, table 26).

syntaxonomy & discussion: *Alchemilla alpina* has an eastern amphi-atlantic, low-arctic to alpine distribution (HULTÉN, 1958, map 93). In the northern part of its area the taxon varies little, but in the southern subalpine to alpine central European part there is a considerable variation, partly owing to apomictic types (HULTÉN, l.c., p. 112). Its synecological behaviour is therefore variable. This variability has also been mentioned by OBERDORFER (1970); according to this author the species in Central Europe is a faithful taxon of the Eu-Nardion.

In the northern part of its area *A. alpina* appears to be more uniform and more stenoicic. It is there characteristic of communities which BÖCHER described from East Greenland as a separate association, apart from the floristic composition also motivated by the structure of the root system (BÖCHER, 1933, p. 54). DAHL (1957, p. 148–188) also included the corresponding Fennoscandian and Icelandic communities in the concept of this *Alchemilletum alpinae.*

The geographical variation in the composition of this syntaxon appears to be conformable to the variation in the *Sibbaldietum procumbentis* and the *Gnaphalietum supini* (cf. the cited literature; see also p. 149 and 150). As in those syntaxa, I do not consider the phytogeographical variation in the composition to be of high syntaxonomic value, at least not above the level of variant.

NORDHAGEN (1943, p. 245) and GJAEREVOLL (1956, p. 53) group the association in the *Nardo-Caricion bigelowii*, whereas DAHL (1957, p. 184) reclassifies it in the *Ranunculo-Oxyrion digynae.* Considering DAHL's arguments (l.c. p. 177) I follow him.

6.1.2.3. Ass. *Ranunculo-Salicetum herbaceae* NORDH. 1928 (sub. nom. *Ranunculus acer-Salix herbacea*-Ass.) em. nov.

syn.: *Anthoxanthum odoratum*-Wiese FRIES 1913 n.n.; *Ranunculus acer*-äng SMITH 1920 n.n.; *Taraxacetum crocei* BÖCHER 1933 pro min. p.; *Ranunculus acris-Taraxacum croceum*-Soz. NORDH.1936; *Ranunculus acer*-WIESE SÖYRINKI 1938 n.n.; *Ranunculus acris*-Wiese KALELA 1939 p.p.; *Ranunculetum acris chionophilum* NORDH. 1943, *Salix herbacea* snow patches MCVEAN 1955, *Ranunculetum acris acidophilum* GJAEREVOLL 1956, *Polygono-Salicetum herbaceae* DAHL 1957, *Polygonum viviparum-*, *Taraxacum-Ranunculus acris-Polygonum viviparum-* and *Salix herbacea*-sociations BÖCHER 1963; ? *Caricetum rigidae-lachenalii* NORDH. 1943 p.p.

composition: Regional faithful taxa are absent. The syntaxon is fundamentally characterized negatively by the absence (or subordinate representation) of the faithful, dominant taxa of the other associations in the *Ranunculo-Oxyrion digynae* (viz. *Alchemilla*, *Sibbaldia procumbens*,



Fig. 46. *Salix herbacea* in flower (male katkins). JGdM phot. VII. 1966.

Chamaenerion latifolium) and by its requirements of the environment; positively by the differential taxa combination *Ranunculus acris*, *Salix herbacea*, *Polygonum viviparum* and *Veronica alpina*, and by the constant accessory taxa *Carex bigelowii*, *Taraxacum croceum*, *Poa alpina*, *Drepanocladus uncinatus*, *Stereocaulon*, *Barbilophozia lycopodioides*, *Sibbaldia procumbens*, *Ghaphalium supinum;* also, but absent in the northern part of the area of the association, *Anthoxanthum odoratum*, *Deschampsia flexuosa*, *Rumex acetosa*, *Viola biflora*, and less constant but locally conspicuously frequent *Epilobium anagallidifolium*, *Ranunculus pygmaeus*, *Carex lachenalii*, *Trisetum spicatum*, *Leontodon autumnalis*, *Saussurea alpina*, *Brachythecium reflexum*, *B. turgidum*, *Polytrichum*, *Lophozia alpestris*, *Tritomaria quinquedentata*, *Cetraria islandica*, *Cladonia ecmocyna*, *Cl. mitis*. (cf. SMITH, 1920, p. 16–17; NORDHAGEN, 1928, table p. 350 and 1943, table 48:9–13; BÖCHER, 1933, table 9:18 and 1963, table 25:15, 26:20, 28:1–11; KALELA, 1939, table 30; MCVEAN, 1955, table 3; GJAEREVOLL, 1956, table 20; DAHL, 1957, table 35).

distribution: northern alpine to low (middle) arctic: Fennoscandia, Iceland, Greenland; amphi-atlantic.

The vegetation types which represent the association in the Angmagssalik District are very common there. They usually occur associated with various types of dwarf shrub and grass heath. Between these a range of different transitional communities can be observed, which sometimes cover rather extensive tracts. Because of their supposed intermediate nature they are not treated here.

Table XVII

reference number		1	2	3	4	5	6	7	8	9	10	11
altitude (m)		60	60	30	30	60	210	40	50	40	30	30
inclination		20	10	0	5	35	5	0	10	10	10	5
orientation		S	S	SE	S	NE	SW	S	SW	NE	SW	S
total cover plants (in %)		100	95	80	80	85	95	90	90	95	85	95
cover *Salix herbacea* –		100	95	80	80	95	95	70	60	80	75	80
– herbs –		2	5	3	10	20		15	45	20	25	50
– cryptogams –		1	0	0	15	5	1	5	5	25	10	25
– litter –		75	80	30	60	5	90	10	30	10	60	50
– open soil –		0	0	0	0	20	0	0	0	0	0	0
maximum depth soil (cm)		27	>50	100	>60	120	80	>60	10	>80	>60	37
pH rhizosphere		4 1/2	4 3/4	5	4 1/2	5	4 3/4	4 1/4	4 3/4	5	4 3/4	5
Salix herbacea	L	6	6	6	6	5	6	5	5	6	6	6
Carex bigelowii	L	+	1	1	2	3	..	2	3	2	2	2
Polygonum viviparum	A	1	1	+	1	2	..	1	4	2	1	2
Drepanocladus uncinatus		..	..	..	..	..	+	+	+	3	2	4
Dicranum scoparium		..	..	..	..	..	+	+	+	+	..	..
Taraxacum croceum	L	..	..	..	..	+	+	..	1	..	1	..
Chamaenerion angustifolium	B	..	..	..	..	+	..	..	1	..	..	..
Comarum palustre	B	..	..	..	..	..	..	+	..	..	..	3
Empetrum hermaphroditum	L	..	..	..	..	..	..	..	..	2	+	..
Agrostis borealis	L	..	..	..	..	..	..	..	..	..	+	+
Pyrola minor	B	..	..	..	..	..	..	..	..	..	2	..
Viola palustris	B	..	..	..	..	..	..	..	..	..	..	2
Polytrichum juniperinum		..	..	..	3	2	..	..	..	..	..	..
Aulacomnium palustre		1	..	..	..	..	..	..	..	..	..	1
Lophozia alpestris		..	..	..	..	..	+	+	..	..	..	..
Polytrichum commune		..	..	..	..	..	..	..	2	..	..	..
Phleum commutatum	L	..	..	..	..	1	..	..	..	..	..	..
Equisetum arvense	B	..	..	..	..	..	1	..	..	..	..	..
Poa arctica	A	..	+	..	..	..	..	..	..	..	..	..
Festuca brachyphylla	A	..	+	..	..	..	..	..	..	..	..	..
Hieracium alpinum	L	..	..	..	..	+	..	..	..	..	..	..
Veronica alpina	L	..	..	..	..	..	+	..	..	..	..	..
Trisetum spicatum	A	..	..	..	..	..	..	..	+	..	..	..
Sedum rosea	L	..	..	..	..	..	..	..	+	..	..	..
Euphrasia frigida	L	..	..	..	..	..	..	..	..	..	..	+
Racomitrium canescens		..	..	..	..	..	..	..	..	1	..	..
Kiaeria starkei		..	..	..	..	..	..	..	..	..	1	..

Not recorded in the table are, all with "+": *Aulacomnium turgidum* in sample plot 8; *Barbilophozia hatcheri* 7; *Philonotis tomentella* 6; *Pohlia nutans* 7; *Polytrichum alpinum* 11; *P. norvegicum* 6; *Ptilidium ciliare* 9; *Cetraria crispa* 10; *C. delisei* 11; *Cladonia ecmocyna* 10; *Cl. lepidota* 11; *Stereocaulon* spec. 10.

subdivision: In the Angmagssalik District two types of vegetation occur, which must be grouped in this syntaxon.

They differ mutually in the floristic composition, e.g. the mean number of taxa per sample plot, the constant accessory taxa, the qualitative and quantitative representation of bryophytes and lichens; further also in soil development, seasonal wetness and orientation of the site. They both differ considerably from the more southern types of the syntaxon. For that reason I shall not attempt to give a detailed description of the association. Below I will only give a description of these two types and discuss their classification.

6.1.2.3.1. Subass. *inops* subass.nov.

table 17.

composition: The community is characterized by the absence of differential taxa; it is very poor in taxa. On an average nearly 8 taxa occur in one sample plot, of which on an average 5 are phanerogams. Constants are *Salix herbacea* (dominant), *Polygonum viviparum*, *Carex bigelowii*, to a less extent also *Drepanocladus uncinatus*. The rest of the represented taxa occur rather infrequently; they are mainly (hydrophytic to) hygrophytic taxa. Extreme chionophytic and oligotrafent taxa are absent. A rather conspicuous taxon in the bottom layer, though not observed in the sample plots here presented, is the acrocarpous moss *Desmatodon latifolius*.

physiognomy: The in particular quantitatively chamaephytic and geophytic community is stratified in (1) an open to absent, usually poorly thriving bottom layer of cryptogams (bryophytes), (2) a 2 to 9, as a rule 3 to 4 cm high, closed, ligneous lower field layer dominated by *S. herbacea*, and (3) a 6 to 15 cm high, more or less open to fragmentarily developed graminoid and herbaceous upper field layer.

The community forms rather inconspicuous, glossy, dark green, dense and very low stands of variable extent (fig. 47).

synecology & habitat: The low-arctic and oceanic, acidophytic, chionophytic, mesophytic to hygrophytic, seasonally wet and mesotrafent community occurs in the Angmagssalik District mainly in the coastal areas up to at least 60 m, rarely in the inland up to at least 210 m a.s.l., in level to 35°, as a rule 0 to 10° inclined, predominantly South-facing latish snow areas. It is in particular found in shallow depressions on stabilized, earth-covered old screes and on more or less level ground bordering upon flattened ridges along temporary meltwater rills; rarely also on such ridges. Also on old, stabilized screes along fjords.

The substrate consists of humic to peaty medium fine to coarse sand, which is mainly of niveo-aeolian and colluvial origin; partly of secondary fluviatile origin. The generalized soil profile shows: (1) a 1 to



Fig. 47. Extensive, more or less hummocky stands of the subass. *inops* of the *Ranunculo-Salicetum herbaceae* on the scree along the eastern shore of Tasîlaq fjord. JGdM phot. VII. 1966.

4 cm thick, usually well-developed litter layer of *S. herbacea* leaves, (2) a (0)3 to 8 cm thick layer of dark, fibrous raw peat or humus, (3) a (0)3$^1/_2$ to 12 cm thick layer of blackish, greasy amorphous peat to brownish very humic sand, (4) a layer of brown, humic to occasionally more or less peaty sand, which at 27 to at least 120 cm depth rests on old debris (blockscree). The differentiation and development of the soil varies in dependence on the rate of supply of sandy soil material, which presumably also accounts for the often observable faint stratification in the different horizons. The accumulation of dry, slowly decomposing, loose, airy litter in the lower field layer between the twigs of *S. herbacea* seems to be the main reason for the poor development of the bottom layer.

Presumably the snow cover is not very thick or long persistent. The substrate is subjected to irrigation by meltwater and to some extent also by seeping rainwater until far into the vegetation season. Surficial irrigation does not occur, and the subterraneous irrigation is in general restricted to the deeper layers of the soil. Strong desiccation of the soil is prevented by the dense litter layer and plant cover.

The colorimetric pH of the rhizosphere ranges from 4$^1/_2$ to 5 and averages 4.75.

succession & zonation: The community represents a (semi-)permanent stage in the succession towards *Salix glauca* scrub. It is closely

related to the *Caricetum bigelowii* subass. *salicetosum herbaceae*, which may presumably sometimes succeed the community in favourable conditions.

It occurs often bordering upon more hygrophytic, frequently also more chionophytic herbaceous communities (sociations of *Alchemilla glomerulans*, *A. filicaulis*) and communities of the subass. *lophozietosum* of the *Ranunculo-Salicetum herbaceae*, commonly also upon *Salix glauca* scrub in somewhat drier soil.

distribution: The community is very common in the district, in particular in the coastal areas (Kulusuk, southern part of the Angmagssalik Ø, Tasîlâlik, Qíngertivaq).

subdivision: The composition of the community is rather variable. For the time being I consider this variation too diversified to propose a subdivision.

6.1.2.3.2. Subass. *lophozietosum* subass.nov.

table 18.

composition: Regional or local differential taxon is the genus *Lophozia* DUM. em. K. MÜLL., viz. the subgenera *Lophozia* DUM. and *Barbilophozia* (LOESKE) K. MÜLL. and from these taxa in particular the species *L. wenzelii* (N.) STEPH., *B. hatcheri* (EVANS) LOESKE and *B. lycopodioides* (WALLR.) LOESKE, probably also *B. floerkei* (WEB. et MOHR) LOESKE. Constant taxa, beside those also constant in the subass. *inops*, are *Cladonia mitis*, *Cl. ecmocyna*, *Cl. rangiferina*, *Stereocaulon alpinum* coll., *Dicranum scoparium;* less constant taxa preferent of this community

Table XVIII

reference number	1	2	3	4	5	6	7	8	9
altitude (m)	35	90	60	15	90	45	150	30	120
inclination	5	5	5	0	25	25	5	20	50
orientation	E	NE	N	–	N	N	NE	N	N
total cover plants (in %)	>95	90	100	100	100	90	100	100	95
cover *Salix herbacea* –	60	55	60	40	10	60	45	30	3
– herbs –		15			35	5	80	25	2
– cryptogams –	65	60	95	95	90	40	80	95	95
– litter –	5	15			15	5			
– open soil –	0	0	0	0	0	5	0	0	0
maximum depth soil (cm)		>35	24		>80	50	30	40	10
pH rhizosphere	4³/₄	4³/₄	5	5	4³/₄	4³/₄	4³/₄	4	4³/₄
Salix herbacea L	4	5	5	4	2	5	4	4	1
Drepanocladus uncinatus	5	4	2	3	4	3	+	3	4
Polygonum viviparum A	2	+	+	3	2	+	2	2	+

(continued)

Tabl XVIII (continued)

reference number	1	2	3	4	5	6	7	8	9
Cladonia mitis	+	+	3	2	+	1	1	+	+
Stereocaulon alpinum s.l.	+	+	+	..	+	+	2	+	+
Carex bielowii..... L	3	3	+	2	3	..	4	3	..
Cladonia ecmocyna	..	+	3	+	+	..	2	+	+
Lophozia alpestris ..... / *Lophozia wenzelii*	2	3	3	3	..	..	..	..	+
Barbilophozia hatcheri..	..	..	3	3	4	3	..	..	..
Barbilophozia lycopodioides	..	..	..	..	..	..	4	4	5
Dicranum scoparium...	..	+	4	4	..	..	3	..	2
Polytrichum alpinum ..	..	+	..	..	+	..	+	3	+
Cladonia rangiferina...	..	..	..	1	..	+	1	+	+
Cetraria delisei.....	2	..	+	+	..	..	+	..	..
Cetraria crispa.....	..	+	..	..	..	+	..	1	..
Aulacomnium palustre .	..	..	..	1	2	..	1	+	..
Peltigera aphthosa	..	..	..	..	+	1	..	+	1
Cerastium alpinum L	..	..	..	..	+	..	+	+	+
Cetraria islandica	..	..	..	..	..	1	2	2	1
Psoroma hypnorum....	..	2	+	..	+	..	..	2	..
Solorina crocea.....	..	..	..	..	+	..	..	+	+
Cladonia gracilis	..	..	..	+	..	..	2	2	..
Ptilidium ciliare	..	2	..	..	..	..	+	+	..
Polytrichum juniperinum	+	..	..	+	..	..	+	..	+
Bryum cf. *elegans*	+	..	..	..	..	..	..	+	+
Peltigera canina s.l.....	..	+	2	..	..	..	..	2	..
Cladonia coccifera	..	..	+	+	..	..	..	+	..
Empetrum hermaphroditum L	..	+	..	..	..	..	..	1	..
Taraxacum croceum.... L	..	..	..	..	..	+	..	..	+
Poa arctica..... A	..	..	..	..	2	..	+	..	..
Hieracium alpinum.... L	..	..	..	..	..	+	2	..	..
Thalictrum alpinum ... L	..	..	..	..	+	+	..	..	..
Dicranum elongatum...	..	..	..	..	..	+	..	1	..
Hylocomium splendens .	..	..	..	..	+	..	..	..	+
Oncophorus wahlenbergii	2	+	..	..	..	..	..	..	..
Pohlia nutans.....	+	+	..	+	..	..	..	..	..
Polytrichum strictum...	..	..	..	+	+	..	..	..	..
Racomitrium canescens .	..	+	..	..	..	+	..	..	..

Not recorded in the table are: *Arabis alpina* in sample plot 9(+); *Campanula gieseckiana* 5(1); *Equisetum arvense* 1(+); *Luzula confusa* 6(+); *L.spicata* 9(+); *Lycopodium selago* 9(+); *Oxyria digyna* 9(+); *Pedicularis flammea* 1(2); *P.hirsuta* 1(1); *Poa alpina* 6(+); *P.glauca* 8,9(+); *Silene acaulis* 6(+); *Trisetum spicatum* 6(+); *Anthelia juratzkana* 1(+); *Bartramia ithyphylla* 9(+); *Brachythecium starkei* 6(+); *Cephalozia bicuspidata* 9(+); *Desmatodon latifolius* 2(+); *Dicranoweisia crispula* 9(+); *Kiaeria* sp. 3(+); *Pleurozium schreberi* 8(2); *Scapania* spec. 9(+); *Sphagnum teres* 1 (1); *Tortula norvegica* 6(+); *T.ruralis* 5(+); *Cladonia bellidifolia* 4(+); *Cl.ecmocyna* 1,4 (+); *Cl.pyxidata* 3(+); *Cl.uncialis* 7(+); *Cl.*spec. 2(+), 3(1); *Nephroma arctica* 8(3).



Fig. 48. Close view of a community belonging to the subas.. *lophozietosum* of the *Ranunculo-Salicetum herbaceae*.
JGdM phot. VIII. 1969.

with respect to the subass. *inops* are *Cerastium alpinum*, *Polytrichum alpinum*, *Cetraria islandica*, *C. delisei*, *Peltigera aphthosa*, *Psoroma hypnorum*, *Pohlia nutans*. Absent, as in the subass. *inops* and the low arctic units of the other associations of the *Ranunculo-Oxyrion digynae*, are the more or less boreal taxa which occur in the more southern, boreal communities of the association (see p. 155). The community is rich in taxa, on an average 21 taxa were observed to occur in one sample plot, of which on an average only 6 are phanerogams. It is quite variable.

physiognomy: The chamaephytic and geophytic, partly also hemicryptophytic community is rich in bryophytes and lichens of various life-forms, and stratified in: (1) a 1 to 3 cm high, usually closed, dense bottom layer of cryptogams, (2) a 2 to 4 cm high, open to closed, ligneous lower field layer dominated by *S. herbacea*, and (3) a 10 to 16 cm high, (fragmentary to) more or less open (to closed) herbaceous and graminoid upper field layer.

The appearance of the community depends largely on the development of the upper field layer. In general it forms more or less tussocky, closed stands resembling those of the subass. *inops*, but they are usually lighter in colour, more grassy and cover comparatively extensive tracts. From a distance it is often strongly reminiscent of the *Caricetum bigelowii*.

synecology & habitat: The community is in most respects synecologically more or less similar to the subass. *inops;* it differs in being more chionophytic and less photophytic and thermophytic. It occurs in the Angmagssalik District both in the inland and coastal areas commonly up to at least 150 m a.s.l., in 0 to 50°, as a rule 5 to 25° inclined, predominantly North-facing, more or less tussocky latish snow areas, particularly in slight depressions or in more or less level parts on old, stabilized and comparatively shallowly earth-covered screes and talus slopes.

The substrate consists of peat or peaty to very humic, more or less colluvial and partly niveo-aeolian coarse sand of 10 to more than 80 cm thickness. The soil development varies. The generalized soil profile shows: (1) a very poorly to nearly absent, discontinuous layer of litter in various stages of decomposition diffusely distributed through the lowest vegetation (bottom) layer, (2) a 1 to 3 cm thick layer of (dark) brown raw humic to peaty material ,(3) a 2 to 8 (24) cm thick layer of blackish, more or less sandy peat (or humus), (4) a layer of dark brown to blackish sandy peat, peaty sand or very humic sand of very variable thickness, which at 10 to more than 80 cm depth rests on consolidated old debris.

The snow cover is presumably deeper and longer persistent than over the previous community. The substrate is subjected to irrigation in a similar way as the subass. *inops.* Desiccation is very limited because of the protective action of the well developed bottom layer and the less extreme meso- and microclimate caused by the general topography and the orientation, and the high humus content of the soil.

The colorimetric pH of the rhizosphere ranges from 4 to 5 and averages 4.7.

succession & zonation: See the subass. *inops.* The community is usually found bordering upon various dwarf shrub and fell-field communities.

distribution: The community is very common in the Angmagssalik District (southern part of the Angmagssalik Ø, Qíngertivaq, Tasîlaq; observed practically everywhere).

syntaxonomy & discussion: In northern Europe (Fennoscandia, Iceland, Faeroes) and Greenland there appear from the literature and the present study to occur a complex of closely related, more or less eutrafent *Salix herbacea* communities (cf. paragraphs synonyms and composition). These communities doubtless should be grouped in the *Ranunculo-Oxyrion digynae*, and on account of their mutual floristic and synecological conformity and their differences from the other associations of this alliance I propose, as previously, to group these communities in a single association.

The classification of the associations in the alliance is principally based on the composition of the lower field layer, and in some cases, in

combination with other criteria, also on the composition of the upper field layer when this is not correlated directly with phytogeographical variation.

The subassociations are primarily characterized by the absence of differential taxa. The diversity in the association is mainly attributable to the composition of the upper, herbaceous and graminoid field layer, owing to phytogeographical variation and local, floristic variation particularly due to the hydrology of the habitat, which is also expressed in the composition of the bottom layer. The syntaxonomic value which I attach to the gradual phytogeographical variation is discussed on p. 149 and p. 155, whereas the mentioned local, floristic variation in this instance is, in my opinion, important as a criterion for the distinction of subassociations.

In view of the general composition of the association DAHL's synonym *Polygono-Salicetum herbaceae* would better define the syntaxon than NORDHAGEN's name: in particular in the northern part of its area *Ranunculus acris* is rare to frequently absent in the association.

6.1.2.4. Ass. *Chamaenerietum latifolii* BÖCHER 1933.

table 19.

composition: Regional (local?) faithful taxa are *Chamaenerion latifolium* (L.) SWEET. and *Poa alpina* L., both selective faithful within the alliance. Constant accessory taxa are in the district *Salix herbacea*, *Carex bigelowii*, *Polygonum viviparum*, *Polytrichum juniperinum*, to a less extent also *Veronica alpina*, *Bartramia ithypylla*, *Drepanocladus uncinatus;* elsewhere in Greenland also *Oxyria digyna*, *Saxifraga oppositifolia*, *Luzula confusa* (cf. BÖCHER, 1933, table 12:21 and 13:23–25(26), and 1963, table 17:5–6).

The syntaxon is in general rather variable in composition. In the district it is rather rich in taxa, on an average 17 taxa occur in one sample plot; the number of cryptogams is on an average slightly less than the number of phanerogams, but their abundance is variable probably owing to the varying stability of the habitat. The represented taxa are all

Table XIX

reference number	1	2	3	4	5
altitude (m)	140	170	120	2	2
inclination	10	15	10	10	5
orientation	NW	SW	S	SE	N
total cover plants (in %)	100	100	90	80	95
cover *Salix herbacea* –	90	100	70	75	65
– herbs –			65		

(continued)

Table XIX (continued)

reference number		1	2	3	4	5
cover cryptogams (in %)		15	10	25	5	75
– litter –		75	70	25	80	20
– open soil –		0	0	0	0	0
maximum depth soil (cm)		20		31	15	
pH rhizosphere		4 1/4	5	5	7	6
ground water level (-cm)			19	12		
Chamaenerion latifolium	A	3	4	4	3	5
Salix herbacea	L	6	6	5	5	4
Carex bigelowii	L	2	2	1	2	+
Polygonum viviparum	A	1	1	1	1	+
Polytrichum juniperinum		+	+	3	1	..
Poa alpina	L	+	1	+	..	..
Veronica alpina	L	+	+	1	..	..
Drepanocladus uncinatus		+	..	+	..	5
Bartramia ithyphylla		..	..	1	+	+
Lophozia alpestris		1	..	..	+	+
Taraxacum croceum	L	..	4	1	..	..
Sibbaldia procumbens	L	+	..	2	..	..
Stellaria calycantha	B	+	+	..	..	..
Peltigera aphthosa		1	..	+	..	..
Philonotis tomentella		+	1	..	..	..
Bryum capillare		+	+	..	..	..
Kiaeria glacialis		+	..	..	..	+
Pohlia nutans		..	..	..	+	+
Angelica archangelica	L	..	2	..	..	..
Equisetum arvense	B	..	2	..	..	..
Salix glauca	L	..	..	..	..	2
Polytrichum alpinum		..	..	..	..	2
Phleum commutatum	L	..	1	..	..	..
Barbilophozia lycopodioides		1	..	..	..	..
Timmia austriaca		1	..	..	..	..
Mniobryum albicans		..	1	..	..	..
Oxyria digyna	A	+	..	..	..	..
Sedum rosea	L	..	+	..	..	..
Calamagrostis neglecta	B	..	+	..	..	..
Bartsia alpina	L	..	..	+	..	..
Luzula confusa	A	..	..	+	..	..
Saxifraga cernua	A	..	..	+	..	..
Trisetum spicatum	A	..	..	+	..	..
Poa arctica	A	..	..	..	+	..
Antennaria canescens	L	..	..	..	+	..

Not recorded in the table are, all with "+" in sample plot 1: *Aulacomnium palustre, Dicranum scoparium, Cetraria delisei, C. islandica, Peltigera* spec.; in sample plot 3: *Brachythecium reflexum, Desmatodon latifolius, Tortula norvegica;* in sample plot 4: *Blasia pusilla;* in sample plot 5: *Anthelia juratzkana, Stereocaulon* spec.

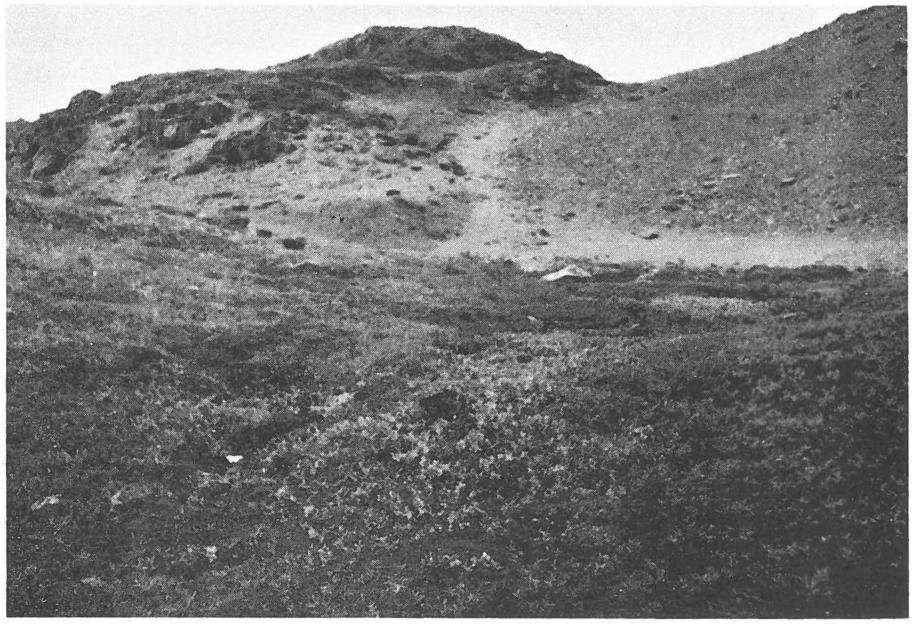


Fig. 49. Stand of vegetation belonging to the *Chamaenerietum latifolii* along a meltwater rill in Blomsterdalen valley.
JGdM phot. VII. 1968.

mesophytic to hygrophytic; extremely chionophytic taxa are not prominent.

physiognomy: The hemicryptophytic, to a considerable degree also partly chamaephytic and geophytic community is stratified in: (1) an open to closed bottom layer of cryptogams (mainly bryophytes), (2) an only a few centimeters high, closed, ligneous lower field layer or undergrowth of *Salix herbacea*, and (3) a 16 to 30 cm high, rather closed, predominantly herbaceous upper field layer.

It forms often extensive, dense patches, which are physiognomically dominated by the glaucous, fleshy leaved *Ch. latifolium* (fig. 49). This plant flowers as a rule abundantly with very remarkably, large and showy purple-red flowers, so that these patches in early summer are often reminiscent of Dutch bulb-fields.

synecology & habitat: The low to middle-arctic, chionophytic, more or less hygrophytic, neutrophytic to medium acidophytic, mesotrafent to eutrafent community occurs in the Angmagssalik District on rather exposed, variously orientated, usually comparatively little sloping sandy to gravelly, well irrigated ground such as moist tracts near rivers, on flood plains, along and on islands in meltwater brooks, also in irrigated debris slopes and rocky ledges; viz. in general where "new", still somewhat

unconsolidated, more or less mobile soil is to be found which is snow-covered all winter.

The substrate consists of humic colluvial and/or fluviatile sand, which passes into coarser debris. The soil profile is little developed and shows in general: (1) a 1 to 2 cm thick layer of *Salix herbacea* litter, (2) a 3 to 13 cm thick layer of peaty sand, (3) a layer of somewhat humic fine to medium fine sand which at 7 to 30 cm depth gradually passes into a stony subsoil. Thin sandy layers in the upper, peaty layer show that the habitat is in some habitats subjected to discontinuous sedimentation.

The habitat is presumably snow-covered from October through June. During the vegetation period it is to diminishing degree constantly irrigated. In spring the ground water is close to or just above the ground surface, later on it sinks to at least 19 cm depth. In summer the accurate level is often not measurable, owing to the stony texture of the deeper substrate. The ground water moves horizontally.

The colorimetric pH of the rhizosphere ranges from $4^1/_4$ to 7 and averages 5.5. The variation in acidity is presumably explained by the rate of sedimentation, redistribution and of humus accumulation.

succession & zonation: The pioneer community is presumably succeeded by other communities of the *Ranunculo-Oxyrion digynae* or by various heath or shrub communities. It is found to border upon *Salix glauca* scrub on low ridges, sometimes also on lower situated *Salix herbacea* communities; often it also occurs more or less spatially isolated.

distribution: The community is common in the Angmagssalik District (Elvbakker-Blomsterdalen, Ilivnera, Qíngertivaq, Ikâsaulaq; also observed at Tasîlaq). Communities belonging to this association are also described from areas further North on the Southeast coast of Greenland and from West Greenland (Böcher, 1933, p. 45–47, and 1963, p. 190–192).

syntaxonomy & discussion: The *Chamaenerietum latifolii* is a rather variable syntaxon, of which the level of classification needs further investigation. The evident dynamic and unstable environment and the semi-permanent nature of the syntaxon explains for the greater part the variable composition, which complicates the delimitation. This delimitation as such depends largely on the qualitative and quantitative occurrence of a very few taxa in correlation with a distinct synecology.

The syntaxon is floristically and ecologically related to the *Stellaro-Oxyrion.*

6.1.2.5. *Alchemilla glomerulans* sociation. (prov.)

syn.: *Alchemilla vulgaris*-Urtemark Resvoll-Holmsen 1920, *Alchemilletum glomerulantis* Böcher 1933, *Alchemilla vulgaris*-Wiese Kalela, 1939, *Alchemilla vulgaris*-soc. Böcher 1954; *Alchemilletum vulgaris chionophilum* Nordh. 1943 p.p.

table 20:1–10.

composition: Dominant taxon is *Alchemilla glomerulans* BUS.; local differential taxa with respect to the *A. filicaulis* sociation are *Plagiothecium denticulatum* (exclusive) and *Phleum commutatum* (selective). Constant taxa are *Taraxacum croceum*, *Polygonum viviparum*, *Sedum rosea*, less constant also for instance *Cares bigelowii*, *Chamaenerion angustifolium*, *Bryum capillare;* elsewhere also *Anthoxanthum odoratum*, *Cerastium cerastoides*, *Ranunculus acris*, *Veronica alpina*, *Viola biflora*, *Pohlia commutata*, less constant also *Deschampsia flexuosa*, *Rumex acetosa* (cf. BÖCHER, 1933, table 5, 1959, table 3 and 1963, table 27:22–26; RESVOLL-HOLMSEN, 1920, table 8; KALELA, 1939, table 19; GJAEREVOLL, 1956, table 21).

The composition of the sociation varies. On an average 19 taxa occur in one sample plot, of which only nearly 4 are non-vascular cryptogams.

physiognomy: The hemicryptophytic community is stratified in (1) an absent-fragmentary to well-developed, usually very open bottom layer of mainly bryophytes, (2) an up to abt. 8 cm high, absent to well-developed lower field layer or undergrowth below the *Alchemilla* canopy, with *Salix herbacea*, *Sibbaldia procumbens*, and (3) a 20 to 40 cm high, closed upper field layer of perennial high herbs, dominated by *Alchemilla*, above which the tall grasses occasionally form a fourth, very open layer of up to almost 60 cm height.

The sociation forms conspicuous, luxuriant, dense bright yellowish green stands of herb vegetation of limited extent, which are physiognomically completely dominated by the large-leaved *Alchemilla* and sprinkled with the large, bright yellow *Taraxacum* flowers. It is often in sharp contrast with the surrounding, lower and less conspicuous communities (fig. 50).

synecology & habitat: The low-arctic to northern alpine, oceanic, extreme to medium chionophytic, hygrophytic, (medium) acidophytic, eutrafent community occurs in the Angmagssalik District on 10 to 70° inclined, South-facing slopes between 20 to 275 m a.s.l. in the coastal areas and up to 500 m a.s.l. in the inland. It is found in late snow areas such as places where in summer water drips from above, along rills through *Carex bigelowii* grass heaths (fig. 50) and other types of closed vegetation usually belonging to the *Salicetalia herbaceae*, near springs or also in springy places.

The substrate consists of humid to wet, peaty to humic niveo-aeolian and colluvial coarse to medium fine sandy deposits of 25 to more than 60 cm depth. It is for the greater part, on an average 80 %, covered with a 1 cm thick coherent "cake" of filty, often almost cardboard-like raw humus layer of whitish gray, partly decomposed *Alchemilla* litter.

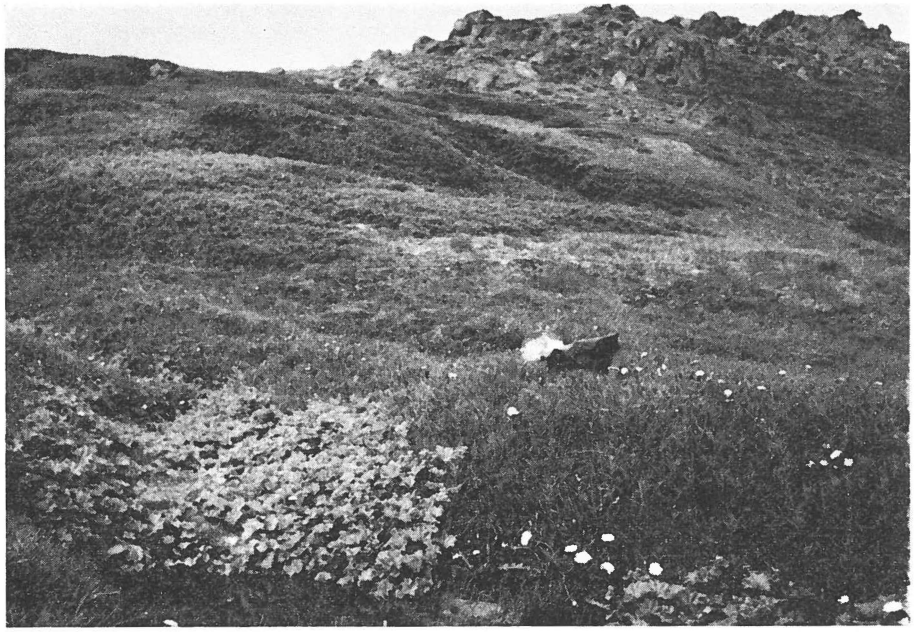


Fig. 50. *Alchemilla glomerulans* sociation along a meltwater rill in Blomsterdalen valley; to the right a *Carex bigelowii* grass heath rich in *Taraxacum croceum* (8.1.1.2.1.c.), in the background *Salix glauca* scrub.
JGdM phot. VI. 1968.

This layer prevents the development of a more closed bottom layer of cryptogams, especially as regards lichens. The generalized soil profile shows; (1) a 1 cm thick compact raw humus layer, (2) a (0)3 to 9 cm thick layer of blackish, sometimes sandy peat, (3) a (5)15 to more than 38 cm thick horizon of brownish, peaty to humic sand which gradually becomes more mineral in composition and rests on old debris or bedrock.

The habitat is snow-covered all winter and becomes free of snow in the second half of June. The substrate is kept moist to wet by irrigation during nearly the entire vegetation period. The compact raw humus layer and the humus content of the soil prevent desiccation during the rare periods of relative drought. Consequently, the aeration is poor. The rhizomes of the *Alchemilla* are mainly restricted to the upper 5 cm of the soil.

The colorimetric pH of the rhizosphere ranges from $4^1/_4$ to 6 and averages 4.8.

succession & zonation: In the district the sociation establishes itself on bare ground or succeeds various communities of the *Mniobryo-Epilobion hornemanni*, and is in turn followed by communities of the *Ranunculo-Salicetum herbaceae*, the *Caricetum gibelowii* or *Salix glauca* scrub, sometimes by various wet dwarf scrub heath communities. This

Table XX

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
altitude (m)		70	80	90	90	275	20	40	130	130	150	30	320	560	390	150	40
inclination		40	10	60	60	20	30	25	70	70	60	35	40	60	5	50	70
orientation		S	SW	S	SW	SW	SE	S	S	S	S	S	S	S	SW	SE	SE
total cover plants (in %)		100	90	100	75	90	100	100	95	95	95	100	95	80	70	85	100
cover shrubs	–	0	0	0	0	<1	0	0	0	0	<1	0	0	<1	>1	>1	>5
– herbs	–	100	90	100	75	90	100	100	95	95	95	100	95	80	70	85	95
– cryptogams	–	<5	25	5	0	5	60	1	1	15	<1	0	20	<5	<1	>1	<5
– litter	–	75	90	95	95	75	40	90	80	80	80	90	60	60	75	70	90
pH rhizosphere		4½	5	5	5	4¼	4½	4½	4¼	6	5	5	5	5¼	5¼	6	5
maximum depth soil (cm)		>50	30	25	29	60	43	42	26	30	40	31	38	35	21	>40	40
Alchemilla glomerulans	L	6	5	5	4	3	6	5	5	4	4	..	..	..	..	..	..
Alchemilla filicaulis	B	..	..	..	..	..	..	..	..	..	..	5	3	4	5	6	6
Taraxacum croceum	L	+	2	3	2	3	2	2	3	3	4	1	2	1	1	3	1
Polygonum viviparum	A	+	2	2	2	2	3	2	2	2	3	2	2	2	1	2	1
Phleum commutatum	L	1	..	1	+	1	..	+	+	1	+	..	1	+	..	..	..
Sedum rosea	L	..	..	+	4	3	3	4	2	3	3	3	2	2	..	..	..
Carex bigelowii	L	..	1	..	..	3	..	1	2	2	2	1	3	1	1	+	+
Bryum capillare		..	..	+	..	1	2	..	+	1	+	..	3	+	..	+	+
Salix herbacea	L	..	5	..	+	..	..	2	2	..	2	3	..	..	3	..	+
Poa alpina	L	..	..	..	..	+	..	..	2	2	+	..	+	+	+	..	+
Veronica alpina	L	+	+	..	..	..	..	+	..	+	..	..	+	1	+	..	+
Campanula gieseckiana	L	..	..	1	+	..	..	..	+	+	1	..	..	..	+	..	1
Ranunculus acris	B	..	..	1	2	..	..	..	..	+	+	..	1	..	..	..	2
Oxyria digyna	A	..	+	..	..	3	..	..	+	3	..	..	..	+	+	..	..
Plagiothecium denticulatum		1	..	+	..	+	3	+	+	+	+	..	..	..	..	1	..
Chamaenerion angustifolium	B	+	..	3	+	..	..	+	..	+	+	+	..	..	..	..	+

Table XX (continued)

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Veronica alpinum australis	B	..	..	..	..	..	+	1	+	1	1	..	..	..	..	..	..
Cystopteris fragilis	B	..	..	..	..	..	1	+	1	+	9	..	..	..	..	..	..
Desmatodon latifolius		..	..	..	..	..	1	+	+	+	+	..	..	+	+	+	..
Stellaria calycantha	B	..	+	..	..	..	+	+	..	..	..	..	..	..	..	..	..
Gnaphalium norvegicum	L	..	..	+	..	..	..	..	+	..	+	..	..	..	..	..	..
Salix glauca	L	..	..	..	..	+	..	..	..	..	+	..	..	+	1	1	2
Thalictrum alpinum	L	..	1	1	..	..	..	..	4	3	4	3	2	4	4	4	1
Bartsia alpina	L	..	..	..	..	..	..	..	..	1	+	..	+	+	+	+	+
Coptis trifoliata	B	..	..	..	..	..	..	..	..	..	..	+	+	..	..	+	+
Pyrola minor	B	..	..	..	..	..	..	+	..	..	..	..	..	1	+	+	+
Selaginella selaginoides	B	..	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..
Philonotis tomentella		..	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..
Empetrum hermaphroditum	L	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	+
Polytrichum juniperinum		..	+	..	..	..	+	+	..	..	..	..	..	+	..	..	..
Lophozia alpestris		..	+	+	..	..	..	..	+	+	..	..	..	+	..	..	..
Epilobium anagallidifolium	L	+	..	..	..	..	3	2	..	..	..	..	..	..	..	1	..
Chamaenerion latifolium	A	..	+	..	..	1	..	..	..	+	..	..	..	..	..	+	..
Sibbaldia procumbens	L	..	3	..	..	..	..	2	..	..	2	1	..	..	..	..	..
Agrostis borealis	L	..	..	+	..	..	..	..	..	+	+	..	..	..	..	..	..
Marchantia alpestris		+	..	..	..	..	3	..	..	+	..	..	..	+	..	..	..
Brachythecium reflexum		..	2	..	..	+	..	..	..	..	..	..	..	..	+	..	..
Alchemilla alpina	L	..	..	..	..	..	..	+	..	..	+	..	..	..	..	..	..
Epilobium lactiflorum	L	..	..	..	..	..	..	1	..	..	+	..	..	..	..	..	..
Erigeron uniflorus	L	..	..	..	..	..	..	..	+	..	+	..	..	..	+	..	..
Gentiana nivalis	L	..	..	+	..	..	..	..	..	..	+	..	..	..	..	..	..
Juncus trifidus	L	..	..	..	..	..	..	..	+	..	+	..	..	..	..	..	..
Luzula spicata	L	..	..	..	..	..	..	..	+	..	1	..	+	..	..	..	..

Table XX (continued)

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Potentilla crantzii	L	..	..	..	..	..	..	..	..	1	+	+	..	+	..	..	..
Carex scirpoidea	L	..	..	..	..	..	..	..	2	1	..	..	1	1	..	..	..
Bartramia ithyphylla		..	..	+	..	..	..	..	+	..	..	..	..	..	..	..	1
Poa arctica	A	..	+	..	2	..	..	..	..	..	..	..	..	..	..	..	..
Platanthera hyperborea	B	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..
Angelica archangelica	L	..	..	..	..	3	..	..	..	..	..	..	2	4	..	..	..
Viola palustre	B	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	1
Scirpus caespitosus	B	..	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..
Tortula norvegica		..	2	..	..	..	..	..	..	..	..	..	..	..	+	..	..
Peltigera aphthosa		..	+	..	..	..	..	..	+	..	..	..	..	..	..	..	..
Gymnocarpium dryopteris	B	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..
Hieracium hyparcticum	B	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..
Polystichum lonchitis	L	..	..	..	..	..	..	..	1	..	+	..	..	..	..	..	..
Poa glauca	L	+	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
Barbilophozia lycopodioides		..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lycopodium alpinum	L	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Euphrasia frigida	L	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Trisetum spicatum	A	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Saxifraga cernua	A	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..
Mniobryum albicans		..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..
Leucorchis albida	L	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..
Cerastium alpinum	L	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..
Hieracium alpinum	L	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..
Tofieldia pusilla	L	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..
Oncophorus virens		..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..
Arabis alpina	L	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..
Lycopodium selago	A	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..
Equisetum variegatum	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..

presumed succession in time corresponds to the spatial zonation from wet to dry soil (see also fig. 14).

distribution: The community is common in the district (southern part of the Angmagssalik Ø, Qíngertivaq, Tasîlaq; observed also in the other visited localities) and elsewhere in Greenland (Böcher, 1933, p. 28–30, 1954, p. 82, 1959, p. 25 and 1963, p. 236, and the earlier literature cited there); also in Iceland (Jonsson, 1895, p. 70; Stefansson, 1985, p. 197) and in Fennoscandia (Hult, 1887, p. 186–187 ff; Samuelsson, 1917, p. 63–64; Resvoll-Holmsen, 1920, p. 108; Söyrinki, 1938, p. 40; Kalela, 1939, p. 161–163; Gjaerevoll, 1956, p. 173–177).

syntaxonomy & discussion: This and the next unit show the variability characteristic of the alliance (cf. p. 150). Both are dominated by taxa of the *A. vulgaris* complex and very closely related, constituting within the alliance a quite autostatic group related to the *Stellaro-Oxyrion*. Consequently, they might be grouped in a separate unit, either as sociations in a suball. *Alchemillion glabrae chionophilum* Nordh. 1943, or as subunits in an ass. *Alchemilletum vulgaris chionophilum* Nordh. 1943. For the present I describe them provisionally as sociations.

6.1.2.6. *Alchemilla filicaulis* sociation. (prov.)

syn.: *Alchemilletum filicaulis* Böcher 1933;? incl. *Alchemilla filicaulis-Lastraea* soc. Böcher 1963.

table 20:11–16.

composition: Dominant taxon is *Alchemilla filicaulis* Bus.; local differential taxa are with respect to the *A. glomerulans* sociation *Coptis trifoliata* (exclusive), *Pyrola minor* and *Thalictrum alpinum* (preferent). Constant taxa are *Bartsia alpina*, *Polygonum viviparum*, *Sedum rosea*, *Taraxacum croceum*.

On an average 19 taxa occur in one sample plot, of which on an average only close to three are non-vascular cryptogams.

physiognomy: The hemicryptophytic community is stratified in (1) a well-developed to absent, usually fragmentary bottom layer of bryophytes, (2) a 6 to 12 cm high, more or less well developed lower field layer as an undergrowth below (3), with *Salix herbacea*, *Sibbaldia procumbens*, *Coptis trifoliata*, *Thalictrum alpinum*, *Viola palustris*, and (3) a 20 to 46 cm high, more or less closed upper field layer dominated by *A. filicaulis*, and with other, often even higher tall herbs such as *Angelica archangelica*, *Ranunculus acris*.

The sociation forms conspicuous, luxuriant, more or less dense, rather small, yellowish to bluish-green high perennial stands, which are quite similar in appearance to those of the above sociation.

synecology & habitat: The low-arctic,? to northern alpine, medium acidophytic, mesophytic to hygrophytic, chionophytic, eutrafent com-

munity occurs in the Angmagssalik District on 5 to 70° inclined, South-facing slopes between 40 to 320 m a.s.l. in the coastal areas, and up to 560 m a.s.l. in the inland. It is found in latish to late snow areas, in localities where water oozes from above over rock walls and outcrops or along the margin of *Salix glauca* scrub occurring in shallow soil.

The substrate consists of 21 to more than 40 cm thick humic to peaty, coarse sandy to gravelly colluvial deposits, which are less moist than below the *A. glomerulans* sociation. It is largely covered with an up to 3 cm thick layer of coherent, filty but less compact and cardboard-like raw humus than below the previous sociation. The soil profiles are very variable; the soil below the litter layer can be very humic to peaty near the surface and become gradually less humic and more sandy with increasing depth, or more rarely, be differentiated in several more distinct horizons as for example in: (1) a 2 cm thick litter layer, (2) 5 cm thick loose, airy and fibrous raw humus or raw peat layer, (3) 6 cm thick, sandy fibrous peat layer, (4) 14 cm thick layer of brownish sand rich in humus. The subsoil consists of old debris or bedrock.

The habitat is snow-covered all winter and becomes free of snow shortly before the habitat of the *A. glomerulans* sociation. After exposure the substrate is kept moist until far into the vegetation season; later it dries out superficially to a limited extent (cf. 6.1.2.5.). The aeration, particularly in the upper part of the soil, is then better than below the *A. glomerulans* sociation.

The colorimetric pH of the rhizosphere ranges from 5 to 6 and averages abt. $5^1/_4$.

succession & zonation: The sociation establishes itself as a pioneer on wet colluvium, or succeeds *Salix glauca* scrub or communities of the *Mniobryo-Epilobion hornemanni* in springy places below shallow earth-covered rock outcrops; possibly it may also succeed the *A. glomerulans* sociation. It is presumably followed by other communities of the *Ranunculo-Oxyrion digynae* or wet heath communities.

It occurs as a rule at the base of rock walls or *Salix glauca* scrub, above moist dwarf shrub heath communities or, rarely, above open fell-field communities.

distribution: The community is somewhat less common than the *A. glomerulans* sociation in the district (Blomsterdalen, Vegas Fjeld, Qíngertivaq); it also occurs more to the North on the Southeast coast of Greenland (Kangerdlugssuaq; BÖCHER, 1933, p. 31–35, table 6) and possibly also elsewhere in the area of the dominant taxon.

syntaxonomy & discussion: See 6.1.2.5.

Chapter V

Debris, scree and alluvium vegetation

The plant communities of dynamic, unstable environments with mobile new soil in the (subalpine and) alpine regions of Europe have been classified in a single class, the *Thlaspeetea rotundifolii* Br.-Bl. 1926. This syntaxon is subdivided in four orders, viz. the *Thlaspeetalia rotundifolii* Br.-Bl. 1926 (communities of calcareous debris), the *Drabetalia* hoppeanae Zollitsch 1966 (high alpine communities of shale-debris), the *Androsacetalia alpinae* Br.-Bl. 1926 (communities of siliceous, non-calcarous debris) and the *Myricarietalia germanicae* G. Br.-Bl. 1931 (communities of alluviums).

The *Androsacetalia alpinae* and the *Myricarietalia germanicae* are both apparently also represented in the Angmagssalik District; communities belonging to the other two orders were not observed.

The vegetation types of these groups of communities are often evidently chionophytic. As can be expected many of the mentioned types are floristically related to the chionophytic communities of the *Salicetalia* herbaceae (7; chapter 4). The position of the most closely related chinophytic communities of mobile, new soil in the district, viz. the *Antitrichio-Sedion roseae* and the *Stellaro-Oxyrion*, has therefore already been briefly discussed in the introduction to the previous chapter.

As already mentioned, I consider the stability of the substrate one of the decisive, ecological criteria in the classification of and the distinction between the *Androsacetalia alpinae* and the *Salicetalia herbaceae*, in combination with other criteria.

For instance in the habitat of the chalicophytic *Stellaro-Oxyrion* (*Androsacetalia alpinae*) the substrate is ungraded and undifferentiated loose sandy to gravelly-stony and usually steeply sloping. It is instable-mobile on a spatially large scale during most or the whole of the vegetation period owing to creep, earth slides and other drastic phenomena of erosion and sedimentation. This mobility prevents soil development and frequently involves repeated destruction of the plant cover.

In the habitat of the *Salicetalia herbaceae* the substrate is, usually, more graded and pedologically differentiated, more compact sandy to gravelly and frequently less sloping. It is comparatively little unstable and mobile, which phenomena are spatially restricted to a small scale and temporarily to a relatively short period early in (and sometimes also at the end of) the vegetation period. The instability and mobility are caused by limited processes of cryoturbation and solifluction, which can partly break up the bottom layer of the communities but never involve partial or even total, repeated destruction of the plant cover, and which hardly

disturb the developing soil features as it never leads to any sudden, considerable ground displacement.

The taxa shared by both syntaxa are mainly oligotrafent, chionophytic cryptogams (such as *Anthelia juratzkana*, *Marsupella varians*, *Pohlia commutata*).

The *Antitrichio-Sedion roseae* is with respect to the foregoing intermediate. The chomophytic to chalicophytic habitat and the gravitational supply of soil material during most of the vegetation period as well as the, though rare, total destruction by earth and gravel slides, induce me to follow HADAČ's classification (HADAČ, 1971b) and to group this syntaxon provisionally in the *Androsacetalia alpinae.*

In the opinion here advocated the concept of the *Androsacetalia alpinae* in Southeast Greenland and in North Europe is conformable to that of this syntaxon in Central Europe.

Several communities in the Angmagssalik District belonging to the *Myricarietalia germanicae* (*Calamagrostion neglectae*) are also evidently chionophytic and floristically related to the *Salicetalia herbaceae.* Regularly repeated erosion, deflation and sedimentation cause the substrate in their habitats to be comparatively unstable and mobile, having the same effect on the plant cover and soil development, as the conditions in the habitat of the *Androsacetalia alpinae.* Conforming to the foregoing arguments these communities are classified in the *Thlaspeetea rotundifolii* and not in the *Salicetea herbaceae.*

7. Class *Thlaspeetea rotundifolii* BR.-BL. (1926) 1947.

The *Thlaspeetea rotundifolii* comprises the chalociphytic to psammophytic, chionophytic to extreme chionophytic, open to closed pioneer communities and (semi)permanent succession stages, dominated by hemicryptophytes, in dynamic-unstable environments, viz. in sandy to stony, due to erosion and sedimentation comparatively highly mobile "new" soils on erosion slopes (screes) and on alluvial plains with little or no soil development. It is known from the alpine areas of Central and North Europe and from Greenland.

Faithful taxa are *Rumex scutatus* L., *Galeopsis ladanum* L., *Gypsophila repens* L., *Epilobium dodonaei* VILL., *Linaria alpina* (L.) MILL. *Leontodon hispidus* L. ssp. *hyoseroides* (WELW.) MURR., *Hieracium staticifolium* All., *Cynanchum vincetoxicum* (L.) PERS. var. *laxum* (BARTL.) HAYEK (cf. BRAUN-BLANQUET 1948; OBERDORFER, 1957, 1970; and others).

7.1. Order *Androsacetalia alpinae* BR.-BL. 1926.

In this order are grouped the communities which occur on comparatively (very) unstable erosion slopes with oligotrophic to eutrophic, more or less excessively irrigated sandy to stony soils poor in lime, and

are covered in winter with a deep snow cover which lasts until late in early summer. It is related to the *Salicetalia herbaceae*, but comparatively poor in chamaephytic taxa and characterized by the dominant occurrence of conspicuous pulvinate chamaephytes. It occurs in the oceanic parts of the area of the class and vicariates ecologically with the *Thlaspeetalia rotundifolii* Br.-Bl. 1926 (on calcareous substrates) and the *Salicetalia herbaceae* Br.-Bl. 1926 (on substrates less subjected to soil displacement).

Faithful taxa are *Cryptogramma crispa* (L.) R. Br., *Epilobium anagallidifolium* Lam. (also in 7.1.), *Ranunculus glacialis* L., *Poa flexuosa* Sm. (= *P. laxa* Haenke), *Cardamine resedifolia* L.

7.1.1. All. *Antitrichio-Sedion roseae* Hadač 1971.

The *Antitrichio-Sedion roseae* is, like the other alliances of snow-bed vegetation, a syntaxon which is to a considerable extent delimited by ecological criteria. The hygrophytic and more or less chomophytic to somewhat chalicophytic syntaxon replaces to some extent the central European *Androsacion alpinae* Br.-Bl. 1926 at high latitudes. It is related there to the hygrophytic and more chalicophytic *Stellaro-Oxyrion* and the more or less chomophytic communities of the *Ranunculo-Oxyrion digynae* such as the *Alchemilletum alpinae polystichetosum* and the variant of *Hieracium alpinum* of the *Sibbaldietum procumbentis*. Being more or less chomophytic, is the extent of the communities of the *Antitrichio-Sedion roseae* as a rule small also in the Angmagssalik District.

The communities of the alliance all represent presumably semi-permanent pioneer communities or communities of a very early stage in the succession in their habitat. They are possibly sometimes preceded by communities of the *Stellaro-Oxyrion* (the *Luzulo-Ranunculetum glacialis* or the *Oxyrietum triviale*) and presumably for the greater part followed, with increasing accumulation and stabilisation of the substrate, by communities of the *Ranunculo-Salicetum herbaceae*.

The taxa which are usually preferent faithful of this syntaxon or differential with respect to the other alliances of the *Androsacetalia alpinae* and the related syntaxa of the *Salicetea herbaceae* are: *Sedum rosea* (L.) Scop., *Poa glauca* M. Vahl, *Crystopteris fragilis* (L.) Bernh., *Bartsia alpina* L., *Draba incana* L., *Saxifraga hypnoides* L., *S. oppositifolia* L., *Antitrichia curtipendula* (Hedw.) Brid., *Hylocomium splendens* (Hedw.) B. S. G., *Rhytidiadelphus loreus* (Hedw.) Warnst., *Peltigera canina* (L.) Willd. The syntaxon occurs is the coastal areas of Iceland and Southeast Greenland.

7.1.1.1. Ass. *Hylocomio-Salicetum herbaceae* Hadač 1971 em.nov.

composition: Regional faithful taxa are *Hylocomium splendens* (Hedw.) B. S. G. (exclusive within the alliance), *Festuca vivipara* (L.) Sm. (preferent), and probably also *Timmia austriaca* Hedw. Constant

Table XXI

reference number		1	2	3	4	5	6	7	8	9
altitude (m)		60	60	50	60	80	65	75	30	75
inclination		20	35	30	10	5	40	30	30	60
orientation		NE	N	N	E	N	N	N	N	N
total cover plants (in %)		100	100	95	100	100	95	100	100	100
cover dwarf shrubs	–	2	0	0	20	<1	<1	0	0	0
– herbs*)	–	35	5	10	35	10	35	45	25	45
– cryptogams	–	100	100	90	90	100	75	90	100	95
– litter	–	5	0	2	0	0	4	5	0	0
– open soil	–	0	0	5	0	0	3	0	0	0
maximum depth soil (cm)		>60	20	20	30	25	21	25	28	35
pH rhizosphere		5	4 3/4	4 1/2	4 3/4	4 3/4	4 3/4	4 1/4	4 3/4	4 3/4
Salix herbacea	L	3	1	1	4	4	2	1	3	4
Hylocomium splendens		3	6	4	4	4	3	4	4	2
Drepanocladus uncinatus		..	+	4	5	4	5	1	1	1
Pleurozium schreberi		..	..	..	+	1	2	4	4	5
Peltigera canina coll.		1	1	..	1	1	2	1	3	2
Polytrichum alpinum		..	+	..	+	1	1	..	2	1
Carex bigelowii	L	1	..	+	+	+	..	3	..	1
Polygonum viviparum	A	2	..	..	2	+	1	..	2	..
Festuca vivipara	L	2	..	..	1	+	..	1	2	..
Oxyria digyna	A	..	+	+	..	..	+	..	3	+
Luzula spicata	L	+	+	+	..	..	..	2	1	..
Cerastium alpinum	L	+	1	+	..	..	..	1	1	..
Ptilidium ciliare		..	1	..	..	+	..	+	2	1
Cetraria crispa		..	..	1	..	+	+	+	+	..
Stereocaulon paschale s.l.		..	..	+	..	+	1	..	+	..
Cladonia rangiferina		..	..	1	..	+	1	+	..	..
Barbilophozia hatcheri		..	..	3	..	..	..	..	2	2
Barbilophozia lycopodioides		..	..	..	..	4	3	..	..	..
Cladonia mitis		..	..	2	..	+	..	+	..	..
Dicranum fuscescens		..	..	..	..	+	..	1	..	2
Dicranum scoparium		3	..	..	1	..	..	..	2	..
Peltigera aphthosa		1	..	1	..	..	..	..	+	..
Tortula ruralis		1	+	..	..	..	..	..	..	1
Poa glauca	A	1	+	..	..	..	..	+	..	..
Luzula confusa	A	..	..	+	..	..	..	2	..	..
Silene acaulis	A	..	..	1	..	..	..	..	+	..
Empetrum hermaphrodit.	L	..	..	..	..	+	+	..	..	..
Aulacomnium turgidum		..	+	..	..	..	..	..	3	..
Timmia austriaca		..	..	+	..	+	..	..	..	..
Climacium dendroides		2	..	..	1	..	..	..	..	..
Lopho ia cf. ventricosa		2	..	..	..	..	..	1	..	..
Vaccinium ulignosum	L	..	..	..	3	..	..	..	..	..
Lycopodium selago	A	..	..	1	..	..	..	..	..	..

* Incl. *Salix herbacea.*

(continued)

Table XXI (continued)

reference number		1	2	3	4	5	6	7	8	9
Salix glauca	L	1	..	..	..	..	..	..	..	..
Sedum rosea	L	..	..	..	..	..	..	..	1	..
Aulacomnium palustre ..		3	..	..	..	..	..	..	..	..
Polytrichum spec.		3	..	..	..	..	..	..	..	..
Cladonia ecmocyna		..	..	1	..	..	..	..	..	..
Polytrichum commune ...		..	..	..	..	..	..	1	..	..

Not recorded in the table are: *Agrostis borealis* in sample plot 7(+); *Cam panla gieseckiana* 8(+); *Festuca rubra* 1(+); *Poa alpina* 3(+); *Saxifraga caespitosa* 2(+); *Taraxacum croceum* 3(+); *Trisetum spicatum* 3(+); *Dicranum elongatum* 3(+); *Polytrichum juniperinum* 7(+); *Racomitrium canescens* 3(1); *Tritomaria quinquedentata* 3(1); *Cetraria islandica* 5(1); *Cladonia coccifera* 5(+); *Cl. gracilis* 8(+); *Psoroma hypnorum* 5(+).

taxa are *Salix herbacea* (co-dominant), *Polygonum viviparum*, *Luzula spicata*, *Poa glauca*, *Drepanocladus uncinatus*, *Pleurozium schreberi;* less frequent are for instance *Carex bigelowii*, *Cerastium alpinum*, *Oxyria digyna*, *Sedum rosea*, *Silene acaulis*, *Thalictrum alpinum* (cf. HADAČ, 1971b, p. 107–108).

distribution: The syntaxon has a sub to low-arctic distribution (Iceland, Southeast Greenland).

7.1.1.1.1. Subass. *ptilidietosum* subass.nov.

table 21.

composition:Regional (local?) differential taxa are *Ptilidium ciliare* (L.) HAMPE, *Cetraria crispa* (ACH.) NYL., *Stereocaulon* SCHREBER, *Cladonia rangiferina* (L.) WIGG., *Cl. mitis* SANDST., *Peltigera canina* (L.) WILLD. s.l. The community is in the district comparatively poor in taxa, the average number of taxa observed in one sample plot being 17, of which nearly 7 are phanerogams (cf. HADAČ, l.c.).

physiognomy: The predominantly bryochamaephytic and hemicryptophytic, partly chamaephytic community is as a rule stratified in (1) a dense, closed, 3 to 10 cm high bottom layer of cryptogams and also *Salix herbacea*, and (2) a fragmentary to more or less closed, 10 to 15 cm higher field layer of herbs, grasses, sedges and sometimes poorly thriving dwarf shrubs. It forms inconspicuous, dull, dirty yellowish green patches, which cover areas of 0,5 to 16 m^2 with soft, springy moss carpets.

synecology & habitat: The low-arctic and extreme oceanic, (aero-) hygrophytic, chionophytic, mesophotophytic to somewhat skiophytic, acidophytic and (oligotrafent to) mesotrafent community occurs in the Angmagssalik District in sheltered, damp and shady places on 5 to 60°

sloping, North-facing and thinly earth-covered screes near the coast between 30 and at least 75 m a.s.l. It is found characteristically in patches or strips below perpendicular to overhanging rocks over which water trickles and drips down ("Tropfregion"), or comparable, less distinctly characterizable habitats.

The substrate consists of a shallow, 20 to 35 (to rarely more than 60) cm thick deposits of humic, wet to moist, fine sandy to gravelly medium fine sand over and between the blocks of the scree. The sand is predominantly of colluvial origin, non-calcareous, more or less poor in minerals and derived mainly from weathered garnet gneiss or related rocktypes. The substrate is differentiated in an upper, 4 to 15 cm thick layer of raw humus or fibrous mosspeat, and a lower (0–)9 to 23 cm thick layer of peaty to humic sand.

The habitat is snow-covered from late September through June-July, and during the period of exposure practically continuously, though in diminishing degree supplied with water from the higher parts of the slope. Gravitational addition of soil material occurs irregularly.

The colorimetric pH of the rhizosphere ranges from $4^1/_4$ to 5 and averages 4.6.

succession & zonation: See 7.1.1. The unit occurs usually more or less spatially isolated on bare block screes, or above communities of the *Ranunculo-Salicetum herbaceae lophozietosum* somewhat further away from the rockwalls.

distribution: The unit is rare in the Angmagssalik District, but locally rather common (along the Blomsterdalen valley on the northern slopes of the Sømandsfjeldet; observed on Kulusuk and at Tasîlâlik); it occurs probably also elsewhere in oceanic localities in Southeast and possibly Southwest Greenland.

subdivision: The subassociation in the district can be subdivided according to the dominance in the bottom layer in:

(a) Variant of *Drepanocladus uncinatus* (table 21:2–5), characterized by the dominance of *D. uncinatus*, and

(b) Variant of *Pleurozium schreberi* (table 21:6–9), characterized by the dominance of *P. schreberi*.

The community represented by sample plot 1 in table 21 represents a probably atypical type; it was found in the overflow area of a mixed *Paludella* and *Calliergon sarmentosum* mire.

syntaxonomy & discussion: HADAČ (1971b, p. 106) has described the *Hylocomio-Salicetum herbaceae* from Southwest Iceland. He characterizes it according to the central European, original concepts of the Zürich-Montpellier school: "Its characteristic (viz. faithful) species are *Draba norvegica* and *Poa glauca* (opt.) and perhaps also *Timmia austriaca* and *Hypnum revolutum*". This definition applies only partially to the *S.*

herbacea-H. *splendens* community which occurs in the Angmagssalik District, and in my opinion belongs to the same association.

The characterization of this association must accordingly be altered, and is as such mentioned in the above. In this concept the Icelandic unit must be conceived as a subass. *rhytidiadelphetosum* (Hadač 1971) subass.nov., characterized by the differential taxa *Thalictrum alpinum*, *Draba norvegica*, *Armeria maritima*, *Rumex alpestris*, *Rhytidiadelphus squarrosus*, *R. loreus*. Irrespective of some variation in the composition of the field layer it is likely that this unit also occurs in suitable habitats in South Greenland.

In nearly identical environmental conditions as those of subass. *ptilidietosum* I observed a closely related *S. herbacea-H. splendens-P. schreberi* community with, for instance, *Carex bigelowii* in western Ireland (Croagham Mnt., Achill Island), which mainly differed in the floristic-phytogeographic composition of the field layer, it being rich in boreal, often sylvicolous taxa.

7.1.1.2. Ass. *Kiaerio-Salicetum herbaceae* ass.nov.prov.

table 22.

composition: Faithful taxa are *Kiaeria glacialis* (Berggr.) Hag. (= *Dicranum glaciale* Berggr., *D. molle* Wils., *D. arcticum* Schimp.) and *Psoroma hypnorum* (Vahl) Gray (both faithful within the alliance). Constant taxa are *Salix herbacea* (dominant in the field layer) and the cryptogams *Drepanocladus uncinatus*, *Polytrichum strictum*, *Lophozia alpestris*, *Cladonia ecmocyna*, *Cl. mitis*, *Stereocaulon paschale* s.l. On an average 13 taxa were observed in one sample plot, of which on an average nearly 3 are phanerogams.

physiognomy: The predominantly bryochamaephytic community is as a rule stratified in (1) a well developed, closed, 1 to 3 cm high bottom layer of cryptogams, (2) a 1 cm higher, more or less open to fragmentary lower field layer with *Salix herbacea*, and (3) a fragmentary to absent, 6 to 12 cm high upper field layer of herbaceous and graminoid plants. It forms not very striking, rather luxuriant patches, which cover small areas of 0.75 to 22 m^2 with soft, loose, dark green convex moss carpets.

synecology & habitat: The low-arctic and oceanic, (aero-)hygrophytic, chionophytic, mesophotophytic, (medium) acidophytic and (oligotrafent to) mesotrafent community occurs in the Angmagssalik District on North-facing screes near the coast up to at least 120 m a.s.l., in 0 to 20° sloping, sheltered, damp and shady drip areas ("Tropfregion") below steep to overhanging rocks.

The substrate consists of 11 to more than 50 cm deep deposits of humic, moist coarse colluvial sand over buried debris. The sand is more or less washed, non-calcareous and derived from various weathered rock

Table XXII

reference number		1	2	3	4
altitude (m)		80	120	80	120
inclination		0	20	10	10
orientation		N	NE	NW	N
total cover plants (in %)		100	90	95	95
cover phanerogams	–	3	35	40	5
– cryptogams	–	100	85	90	95
– litter	–	0	} 10	10	5
– open soil	–	0	}	0	0
maximum depth soil (cm)		>30	11	>50	18
pH rhizosphere		4 3/4	4 1/2	4 3/4	4 3/4
Salix herbacea	L	1	4	4	1
Kiaeria glacialis		5	5	5	4
Drepanocladus uncinatus		4	3	+	4
Psoroma hypnorum		+	2	3	..
Cladonia mitis		1	+	+	..
Polytrichum strictum		1	1	1	..
Cladonia ecmocyna		1	+	1	..
Lophozia alpestris		..	2	2	2
Stereocaulon paschale s.l.		1	+	..	+
Carex bigelowii	L	..	+	1	..
Cetraria crispa		..	+	+	..
Calliergon stramineum		+	..	..	+
Polygonum viviparum	A	..	1	..	+
Oncophorus wahlenbergi		..	..	..	4
Barbilophozia kunzeana		3	..	..	..
Sphagnum teres		2	..	..	..
Anthelia juratzkana		..	..	..	2
Conostomum tetragonum		..	..	..	2
Polytrichum alpinum		..	..	..	1
Poa arctica	A	..	..	+	..
Ptilidium ciliare		..	..	+	..
Peltigera spec.		..	+	..	..
Cladonia coccifera		..	+	..	..
fungus indet.		+	..	..	..
Chamaenerion latifolium	A	..	..	..	+
Ranunculus pygmaeus	A	..	..	..	+

types. The substrate is differentiated in a superficial, 2 to 9 cm thick layer of rather dry, light brown raw peat or humus, grading into a 0 to 9 cm thick transitional layer, which is in turn followed by a 2 to 7 cm layer of moist, dark to blackish brown amorphous greasy (sandy) peat, which passes into a subsoil of more or less humic to somewhat peaty sand.

The snow cover and the irrigation of the habitat corresponds to the conditions in which the *Hylocomio-Salicetum herbaceae* occurs in the

district, but the water supply is less plentiful and diminishes more rapidly.

The colorimetric pH of the rhizosphere ranges from $4^1/_2$ to $4^3/_4$ and averages 4.7.

succession & zonation: See 7.1.1.1.1. The community may also occur above various dwarf shrub communities.

distribution: The unit is not uncommon in the coastal areas of the district (southern part of the Angmagssalik Ø, Kulusuk; observed at Tasîlâlik); it occurs possibly also in suitable localities elsewhere in Southeast and Southwest Greenland.

syntaxonomy & discussion: The community described here is evidently, in particular synecologically related to the *Hylocomio-Salicetum herbaceae* and replaces said unit in drier localities. As such it should be classified in the *Antitrichio-Sedion roseae*, but in my opinion it can not be grouped satisfactorily in any of the known associations of that syntaxon. In consequence I describe it here as belonging to a new, provisional association. I expect that closely related *Kiaeria glacialis-Salix herbacea* communities also occur in Iceland and possibly in the Faroes and Fennoscandia.

Of the four sample plots in the table number 4 must be considered atypical.

7.1.2. All. *Stellaro-Oxyrion*[1] Gjaerevoll 1950.

syn.: Dwarf herb meadow poor in *calciphiles* Du Rietz 1942; *Saxifrago-Ranunculion nivalis* Nordh. 1943 p.p. (pro suball.).

The delimination and classification of the hygrophytic and chalicophytic, herbaceous *Stellaro-Oxyrion* has been discussed previously (p. 117–120). Conform to the concept of this syntaxon, as proposed by Du Rietz and Gjaerevoll and adopted here, also the *Luzulo-Ranunculetum glacialis* should be grouped in it. This leads to a clearer distinction between the thus herbaceous, chalicophytic *Stellaro-Oxyrion* and the ligneous, non-chalicophytic *Cassiopo-Salicion herbaceae*, which two syntaxa are for the rest particularly related because of the frequent similarity in the composition of the bottom layer and the short vegetation period.

The communities representing the alliance in the Angmagssalik District cover there small to comparatively large areas. They are presumably all semi-permanent pioneer communities, which are probably replaced by hygrophytic communities of the *Ranunculo-Oxyrion digynae*, rarely by communities of the *Antitrichio-Sedion roseae*, with increasing stabilisation of the substrate and accumulation of soil material.

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[1]) The syntaxon is presumably nomenclatorically better described as the *Saxifrago-Oxyrion*, as *Stellaro*-refers to the species name of *Saxifraga stellaris*.

Faithful taxa of the alliance are *Oxyria dygina* (L.) HILL., *Carex lachenalii* SCHKUHR. (also in 6.1.2.), *Deschampsia alpina* (R.) R. et S., *Saxifraga stellaris* L., *Juncus biglumis L.*, *Cardamine bellidifolia* L., *Minuartia biflora* (L.) SCH. et TH., *Cerastium cerastoides* (L.) BRITTON (also in 6), *Philonotis tomentella* MOL., *Pohlia commutata* SCHIMP. (also in 6.1.1.); the composition of the moss layer agrees partly with that of the *Cassiopo-Salicion herbaceae.* For further details, in particular on the synecology, the reader is referred to the introduction of the previous chapter. The alliance occurs in the alpine zone of North Europe and in Greenland.

7.1.2.1. Ass. *Oxyrietum triviale* BÖCHER 1933 em. NORDH. 1943.

syn.: *Oxyrietum* BÖCHER 1933; incl. *Oxyria digyna-synedria* LID 1964.

composition: Regional faithful taxon is *Oxyria digyna* (L.) HILL. The syntaxon is further characterized by the absence of true calciphytes. Noticeable accessory taxa include *Cerastium cerastoides*, *Epilobium anagallidifolium*, *Saxifraga stellaris*, *Veronica alpina* (GJAEREVOLL, 1956, p. 188, table 25; NORDHAGEN, 1943, table 48:7, 8).

distribution: boreal-alpine to arctic: Fennoscandia, Iceland, Greenland; presumably circumpolar.

7.1.2.1.1. Subass. *inops* subass.nov.

table 23.

composition: The unit is characterized by the absence of differential taxa and the general, comparative poverty in taxa. In the district constant taxa are *Luzula spicata* and *Poa alpina;* frequent are *Viscaria alpina*, *Silene acaulis* and *Stereocaulon* cf. *alpinum.* On an average I observed 7 taxa in one sample plot, of which on an average more than 5 are phanerogams.

physiognomy: The predominantly hemicryptophytic community is indistinctly stratified; it is possible to distinguish (1) a fragmentary to absent bottom layer with cryptogams, and (2) an open, 7 to 20 cm high field layer with herbaceous and graminoid plants. The community forms open, often extensive patches of vegetation, which are quite homogeneous and dominated by the conspicuous, evenly distributed, more or less purplish green dense clumps of *Oxyria* (fig. 51).

synecology & habitat: The low-arctic and oceanic, chionophytic, hygrophytic, minerotrafent and eutrafent, medium acidophytic to neutrophytic community occurs in the Angmagssalik District in more or less South-facing, 5 to 20° sloping moist snow-bed habitats mainly in the coastal areas up to at least 120 m a.s.l., especially in rather extensive tracts in loose sandy to gravelly, widened erosion gullies and also on moraines.



Fig. 51. Open *Oxyria dygina* community in early spring (*Oxyrietum triviale inops*); to the right a melting off, dirt-covered snowdrift which a few days before uncovered this community.
JGdM phot. VII. 1968.

The habitat is subjected to a supply of colluvial and niveo-aeolian sand and gravel, as well as to creep, erosion and deflation. The thus unstable, mobile substrate is usually more than 30(60) cm deep and undifferentiated. Its instability prevents the development of a well developed bottom layer.

The habitat is generally covered by deep snowdrifts in winter, which often do not disappear until middle to late July. Owing to irrigation of the substrate below the snow cover *Oxyria* is often already developing before it becomes free of snow. The site is irrigated by a very long-lasting, ample supply of melt and later also rainwater, which gradually decreases in the course of the summer. The substrate is freely drained owing to the local topography and its texture, so that even during the period of maximum irrigation at least the upper 1 to 3 cm of the substrate is dry. The mentioned phenomena involve a certain leaching as well as enrichment of the substrate in non-calcareous minerals. The colorimetric pH of the rhizosphere ranges from $4^1/_2$ to 7 and averages 5.5.

succession & zonation: See 7.1.2. The community borders usually on bare rock, bare mobile talus slides or on communities of the *Ranunculo-Oxyrion digynae* or of the *Caricetum bigelowii* in stable soils.

Table XXIII

reference number		1	2	3	4	5
altitude (m)		75	100		80	120
inclination		15	5	10	10	20
orientation		NE	S	S	W	SE
total cover plants (in %)		<10	5	10	3	10
cover phanerogams	–	>5	5	10	3	10
– cryptogams	–	<5	1	<1	0	0
– litter	–	5	2	10		<1
– open soil	–	90	95	90	98	90
pH rhizosphere		5	6	4 1/2	5 1/4	7
Oxyria digyna	A	2	1	2	1	1
Luzula spicata	L	+	1	+	+	+
Poa alpina	L	+	+	+	..	+
Viscaria alpina	L	..	..	+	+	+
Stereocaulon cf. alpinum		+	+	..	+	..
Silene acaulis	A	+	+	+	..	..
Cerastium alpinum	L	+	+	..	..	..
Agrostis borealis	L	+	..	+	..	..
Polytrichum piliferum		1	..	..	..	..
Desmatodon latifolius		1	..	..	..	..
Juncus trifidus	L	..	..	..	+	..
Minuartia biflora	L	..	+	..	..	..
Phleum commutatum	L	..	..	+	..	..
Ranunculus glacialis	?M	+	..	..	..	..
Crocynea neglecta		+	..	..	..	..
Dicranum spec. (†)		+	..	..	..	..
Pohlia nutans		+	..	..	..	..

distribution: The unit is common in the coastal areas (southern part of the Angmagssalik Ø and elsewhere), and rare in the inland of the district; it occurs also at Kangerdlugssuaq on the East coast (BÖCHER, 1933, p. 87, 93) and probably also on the West coast of Greenland.

syntaxonomy & discussion: GJAEREVOLL (1950a, 1956) divides the alpine Fennoscandian *Oxyria digyna* communities in three groups, which are classified in the non-calciphytic *Oxyrietum triviale*, the calciphytic *Oppositifolium* GJAEREVOLL 1950 (*Oppositifolio-Oxyrion* (DU RIETZ 1942) GJAEREVOLL 1950, syn. *Saxifrago-Ranunculion nivalis* NORDH. 1943 p.p.) and in the calciphytic *Ranunculo-Poietum alpinae* GJAEREVOLL 1956 (*Ranunculo-Poion alpinae* (DU RIETZ 1942) GJAEREVOLL 1950).

An examination of the published tables of analyses of *O. digyna* communities (for instance KALELA, 1939, table 49; NORDHAGEN, 1943, table 48:7, 8; GJAEREVOLL, 1956, table 25, 44, 47; BÖCHER, 1963, table 28:7–14) reveals in my opinion that the syntaxonomy of these com-

munities as proposed by GJAEREVOLL is still not completely satisfactory. If, as I do for the present, GJAEREVOLL's view is accepted, it appears that most of the *O. digyna* communities described in the literature belong to the two calciphytic associations mentioned previously.

The *O. digyna* communities in the Angmagssalik District belong presumably to the non-calciphytic *Oxyrietum triviale.* They are physiognomically fell-field communities, which are rather variable in composition. The most common of these communities is described here. Moreover, there occurs a community co-characterized by *Luzula confusa* and one with *Gnaphalium supinum.* Judging from this variability, I presume that these represent three variants of one subassociation, the subass. *inops* described here in the typical form.

The *Oxyrietum triviale* vicariates geographically with the alpine, central European *Oxyrietum digynae* (LÜDI 1921) BR.-BL. 1926 (*Androsacion alpinae* BR.-BL. 1926; cf. BRAUN-BLANQUET, 1948a, p. 41); ecologically it vicariates to some extend with the *Oppositifolium* GJAEREVOLL 1950 and the *Ranunculo-Poietum alpinae* GJAEREVOLL 1956 (in calcareous substrates).

7.1.2.2. Ass. *Deschampsietum alpinae* NORDH. 1943.

syn.: incl. *Aira alpina*-reichen Mooswiesen + ?*Carex lachenalii*-Wiese SAMUELSSON 1916.

composition: Regional, exclusive to selective faithful taxon is *Deschamspia alpina* (L.) R. et S.; the syntaxon can also be characterized by a combination of differential taxa consisting of *D. alpina*, *Cerastium cerastoides* (L.) BRITTON and *Carex lachenalii* SCHKUHR. (cf. NORDHAGEN, 1943, table 47; GJAEREVOLL, 1956, table 26).

distribution: See 7.1.2.1.

7.1.2.2.1. Subass. *anthelietosum juratzkanae* (NORDH. 1943) subass.nov.

syn.: *Deschampsia alpina-Anthelia*-sosiasjon NORDH. 1943.

table 24.

composition: Differential, more or less selective faithful taxa are *Anthelia juratzkana* (LIMPR.) TREVIS, *Conostomum tetragonum* (BRID.) LINDB., *Marsupella boeckii* MACV. Constant taxon is in the district *Polytrichum norvegicum;* elsewhere, in Fennoscandia, also *Salix herbacea*, *Saxifraga stellaris*, *Mniobryum albicans* (cf. NORDHAGEN, l.c.; GJAEREVOLL l.c. and 1950a, table 17). In the district the community is not rich in taxa; in one sample plot are on an average 8 taxa observed, of which on an average 2 are phanerogams.

physiognomy: The predominantly bryophytic (bryohemicryptophytic), concerning the phanerogams predominantly hemicryptophytic community is stratified in (1) a usually closed bottom layer of cryptogams, mainly hepatics, (2) a very open to absent lower field layer with *Salix*

Table XXIV

reference number		1	2	3
altitude (m)		120	120	120
inclination		0	0	0
orientation		–	–	–
total cover plants (in %)		75	70	70
cover phanerogams –		15	35	20
– cryptogams –		70	35	60
– litter –		5	15	10
– open soil –		25	20	25
pH rhizosphere		5	4 3/4	4 3/4
ground water level (cm)		+10	0	−10
Deschampsia alpina	L	3	4	3
Anthelia juratzkana		5	4	5
Polytrichum norvegicum		+	+	+
Scapania irrigua		+	+	..
Bryum cf. funkii		+	+	..
Drepanocladus exannulatus		..	2	..
Pohlia commutata		..	..	1
Cerastium cerastoides	L	+	..	..
Polygonum viviparum (juv.)	A	..	+	..
Salix herbacea	L	+	..	..
Saxifraga stellaris	L	+	..	..
Taraxacum croceum (juv.)	L	+	..	..
Bartramia ithyphylla		..	+	..
Marsupella boeckii		..	+	..
Pohlia spec.		..	..	+
Racomitrium fasciculare		..	+	..

herbacea, *Saxifraga stellaris*, and (3) a more or less open field layer with *Deschampsia alpina*. The community forms a conspicuous patch of vegetation of 100 m² in a single locality, consisting of a more or less coherent, shriveled greyish-blackish moss mat, in which the phanerogams, particularly the physiognomically dominant, several decimeters high *D. alpina* occur in clumps.

synecology & habitat: The northern alpine to low-arctic, more or less oceanic, chionophytic, (amphiphytic to) hygrophytic, mesotrafent and (medium) acidophytic community occurs in the Angmagssalik District in one locality, a shallow and rather wide, wet to moist cup-shaped depression in a late snow area.

The substrate is unstable owing to solifluction and frost-heaving; erosion is of minor importance. It consists of colluvial, partly niveo-aeolian erosion material of grades ranging from medium fine sand to stones, and is covered by a 0,2 to 0,5 cm thick moss mat. The substrate

is not differentiated, only a layer of a few millimeters below the moss is more or less distinctly rich in humus.

The locality is snow-covered from early autumn to middle-late June, while a snow drift nearby against the slope of the depression may persist until late July. It is irrigated with meltwater for a rather long time. During and some time after the period of meltwater supply and following rainy periods the substrate is oversaturated to up to at least 10 cm deep flooded with water, owing to the spatial isolation of the site which can drain only via a threshold-like overflow. Desiccation may happen when the irrigation stops for some time, but is restricted to the very upper soil layers and the moss mat.

The colorimetric pH of the rhizosphere ranges from $4^3/_4$ to 5.

succession & zonation: See 7.1.2. The community occurs in the centre of a depression surrounded by tussocky *Salix herbacea-Anthelia juratzkana* and farther away from the centre by *Ranunculo-Salicetum herbaceae* communities; in the lower parts of the sandy-gravelly slopes around the depression occurs fell-field vegetation, including open *Oxyrietum triviale* communities.

distribution: In the district the community is only observed in one locality (Elvbakker); it occurs more or less rarely in Scandinavia (Samuelsson, 1916, p. 71–74; Nordhagen, 1943, p. 291; Gjaerevoll, 1950a, p. 431 and 1956, p. 194). The association also is represented by other units both in Scandinavia (Gjaerevoll, l.c.) and in West Greenland (Böcher, 1963, p. 244).

syntaxonomy & discussion: The description of the community as given here should be considered with some reserve, as it concerns a single occurrence in which three sample plots were studied. This scarce information indicates that it represents a more or less impoverished type of the subassociation as known in Scandinavia. From the table 24 and the cited literature it appears that the association is floristically and ecologically related to both the *Cassiopo-Salicion herbaceae* and the *Mniobryo-Epilobion hornemanni*. According to Nordhagen (l.c.) and Gjaerevoll (1956, p. 189) the association in Scandinavia replaces the calciphytic *Phippsietum algidae-concinnae* on soils poor in lime.

7.1.2.3. Ass. *Caricetum rufinae* Nordh. (1928) 1943.

syn.: incl. *Carex rufina*-Schneeboden Tengwall 1920, *Anthelia-Cesia*-reiche *Carex rufina*-Ass. Nordh. 1928, *Carex rufina-Salix herbacea*-Soz. Nordh. 1936, *Carex rufina*-Rasen Br.-Bl. 1951, *Carex rufina*-soc. Böcher 1963.

composition: Regional faithful taxon is *Carex rufina* Drej. Constant taxa are for instance *Carex lachenalii*, *Eriophorum scheuchzeri*, *Salix*

herbacea; the composition of the bottom layer is very variable (see the discussion).

distribution: Alpine North Europe (Scandinavia, Iceland) and low-arctic East and West Greenland, amphi-atlantic.

7.1.2.3.1. Subass. *calliergetosum sarmentosi* (GJAEREVOLL 1956) subass. nov. prov.

syn.: *Carex rufina-Calliergon sarmentosum*-soc. GJAEREVOLL 1956.

This northern-alpine to low-arctic and oceanic, medium acidophytic, chionophytic, hygrophytic, minerotrafent and mesotrafent community was observed in the Angmagssalik District in a single locality on Kulusuk, near Kap Dan, at 10 m a.s.l., where the stand representing it covered abt. 300 m². The data of the single sample plot studied there are: cover plants (total) 40 %, -phanerogams 15 %, -cryptogams 30 %, -litter 10 %, -open soil 60 %; ground water level -5,5 cm; pH rhizosphere 5; soil profile: 0–1,5 cm greyish brown-, 1,5–60 cm light brown coarse alluvial sand, 60–? cm debris.

composition:

Carex lachenalii	L	+	*Bryum* spec.....		+
Carex rufina	L	2	*Calliergon sarmentosum*		3
Eriophorum scheuchzeri	A	+	*Dicranum fuscescens*.....		+
Anthelia juratzkana		2	*Drepanocladus exannulatus* ..		+

The stand occurs on the sandy, wet, irrigated level shore of a lake in a local meltwater discharge system, below a long persistent snowdrift which supplies most of the required moisture (cf. GJAEREVOLL, 1956, p. 203–205).

7.1.2.3.2. Subass. *drepanocladetosum exannulati* (GJAEREVOLL 1956) subass. nov.prov.

syn.: *Carex rufina-Drepanocladus purpurascens*-soc. GJAEREVOLL 1956.

This community corresponds synecologically closely to the previous one. It was also observed in the Angmagssalik District in one locality on Kulusuk, near Kap Dan, at 20 m a.s.l. The observed stand is small, abt. 6 m², and in consequence presumably somewhat atypical. The data of the analysis of the single sample plot are: cover plants (total) almost 100 %, -phanerogams 40 %, -cryptogams 95 %, -litter 0 %, -loose gravel 2 %; ground water level -30 cm; pH rhizosphere $4^3/_4$; soil profile: (1,5–0 cm moss), 0–4 cm raw moss peat, 4–10 cm amorphous, black, greasy peat, 10–11 cm sandy brown peat, 11 to more than 60 cm greyish black, somewhat fine sandy, amorphous greasy peat.

composition:

Carex rufina	L	4	*Polytrichum commune*		3
Calliergon stramineum .		4	*Scapania irrigua*		1
Drepanocladus exannulatus		4	*Scapania* spec. (?)		3–4

The stand occurs projecting as a lobe into a wet, miry and peat-filled depression which is until late in the early summer covered by a snow drift; in the rest of the depression occurs a mosaic of *Calliergon* communities (cf. GJAEREVOLL, 1956, p. 205–206).

syntaxonomy & discussion: Most of the *C. rufina* communities described in the literature are characterized by the dominance of small, oligotrafent hepatics, viz. *Anthelia juratzkana* and usually also *Marsupella varians*, in the bottom layer (cf. SAMUELSSON, 1916, p. 49–50; NORDHAGEN, 1928, table 309, 1936, p. 48 and 1943, table 43; GJAEREVOLL, 1950, table 5 and 1956, table 28). These communities form a well delimited type which can be described as a *C. rufina-Anthelia juratzkana* sociation or a subass. *anthelietosum juratzkanae* of the *Caricetum rufinae.*

Noticeably more rare seem to be the *C. rufina* communities characterized by a bottom layer dominated by more or less mesotrafent pleurocarpous musci, viz. alternating *Calliergon sarmentosum* (GJAEREVOLL, 1956, table 27:I–III; this publication), Drepanocladus revolvens (BÖCHER, 1963, table 32:16) or *Drepanocladus exannulatus* (GJAEREVOLL, 1956, table 27:IV–V; this publication). These communities are mutually closely related, and I consider the information referred to above too poor to ensure their classification. Consequently I have described the vegetation types treated in the foregoing as provisional subassociations, as I am not completely convinced that these three types should not be variants of a single subassociation.

The *Caricetum rufinae* is floristically and synecologically related to the *Salicetalia herbaceae*, the *Caricion curto-nigrae* and the *Myricarietalia germanicae.*

7.1.2.4. Ass. *Luzulo-Ranunculetum glacialis* NORDH. 1943.

syn.: *Ranunculus glacialis*-Heiden SAMUELSSON 1916, *Ranunculus glacialis*-Schneeboden TENGWALL 1920, *Ranunculetum glacialis* GJAEREVOLL 1950; incl. *Anthelia-Cesia*-reiche *Ranunculus glacialis*-Ass. and *Anthelia-Cesia*-reiche *Luzula arcuata*-Ass. NORDH. 1928, *Luzula spicata-synedria* LID 1964.

This on p. 120 and 189 referred to syntaxon is also represented in the Angmagssalik District, though I have seen only fragments (fig. 52). In particular I observed communities which correspond to the *R. glacialis-Anthelia juratzkana-Gymnomitrium varians-*, the *R. glacialis-Stereocaulon paschale-* and the *Luzula confusa-Anthelia Juratzkana-Gymnomitrium*

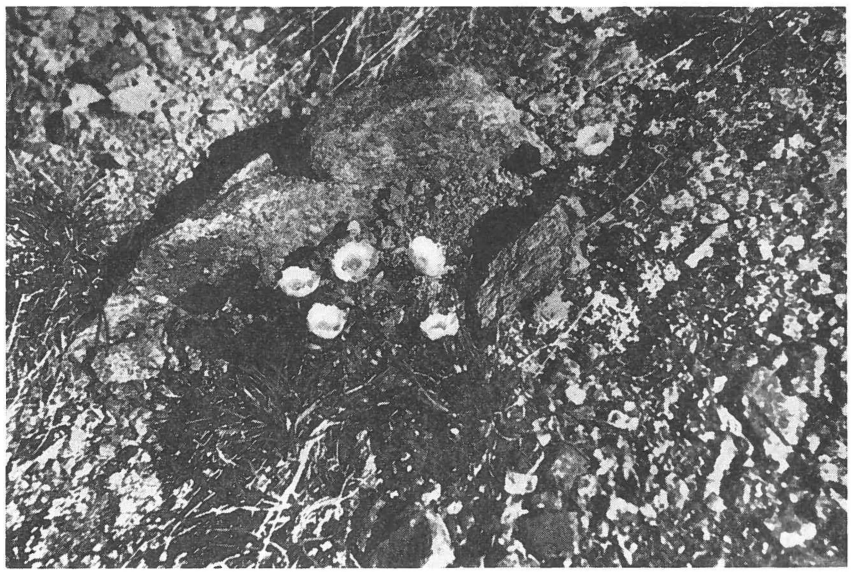


Fig. 52. Fragmentary stand of the *Luzulo-Ranunculetum glacialis* in very mobile soil. JGdM phot. VII. 1966.

varians sociations described by GJAEREVOLL (1956, p. 136–148; cf. also NORDHAGEN, 1928, p. 313–314 and 1943, p. 271–283.

These northern alpine and low-arctic, chionophytic, hygrophytic, chalicophytic, medium acidophytic (GJAEREVOLL, 1956, p. 147–148), more or less minerotrafent and oligotrafent to mesotrafent communities occur in the Angmagssalik District from shortly above sea level up to at considerable altitudes, on North-facing debris slopes in the inland and coastal areas; viz. in mobile, more or less gravelly to stony, undifferentiated, wet to moist substrates poor in humus, which are subjected to prolonged irrigation, creep and sliding as well as to strong weathering; namely in rather steep erosion gullies and along temporary meltwater beds. The intense mechanical weathering and the high mobility of the substrate and its coarse texture are presumably the cause of the fragmentary development of these communities in the district.

The association and communities belonging to it have been described for instance by CLEVE (1901, p. 26), SAMUELSSON (1916, p. 50–52), TENGWALL (1920, p. 398), NORDHAGEN (l.c.), GJAEREVOLL (l.c.); a related vegetation type is mentioned by BÖCHER from West Greenland (BÖCHER, 1954, p. 128).

7.1.A. Ass. *Taraxaco-Cystopteretum fragilis* ass.nov.

syn.: incl. *Cystopteris fragilis-Synedria* LID 1964.

table 25.

Table XXV

reference number		1	2	3	4	5
altitude (m)		70	70	130	90	40
inclination		0	60	40	0	60
orientation		S	S	S	S	SW
total cover plants (in %)		100	100	80	100	70
cover shrub	–	0	10	0	0	0
– herbs	–	100	100	80	100	65
– cryptogams	–	0	5	<1	<1	10
– litter	–	50		60	>75	80
pH rhizosphere		4½	4½	5½	5	5
maximum depth soil (cm)		14	36	26	>60	28
Cystopteris fragilis	B	5	4	5	6	5
Taraxacum croceum	L	2	2	2	2	2
Epilobium angustifolium	B	3	3	3	1	..
Sibbaldia procumbens	L	+	2	..	+	1
Oxyria digyna	A	..	..	2	+	1
Carex bigelowii	L	..	+	1	+	..
Sedum rosea	L	4	4	..	..	..
Gnaphalium norvegicum	L	2	1	..	..	..
Bartsia alpina	L	1	1	..	..	..
Hieracium alpinum	L	1	2	..	..	..
Salix herbacea	L	..	1	..	+	..
Campanula gieseckiana	L	..	1	2	..	..
Tortula norvegica		..	..	+	..	2
Polygonum viviparum	A	2	..	..	..	..
Salix glauca	L	..	2	..	..	..
Thalictrum alpinum	L	..	..	2	..	..
Polytrichum juniperinum		..	..	..	..	2
Phleum commutatum	L	1	..	..	..	..
Plagiothecium denticulatum		..	1	..	..	..
Pohlia nutans		..	1	..	..	..
Poa alpina	L	..	..	1	..	..
Polystichum lonchitis	L	..	..	1	..	..
Leucorchis albida	L	..	..	1	..	..
Epilobium hornemanni	L	..	..	..	1	..
Poa arctica	A	+	..	..	..	..
Euphrasia firgida	L	..	+	..	..	..
Gnaphalium supinum	L	..	+	..	..	..
Draba alpina	H	..	..	..	+	..
Stereocaulon spec.		..	..	..	+	..
Desmatodon latifolium		..	..	..	..	+
Luzula spicata	L	..	..	..	..	+
Poa glauca	A	..	..	..	..	+

composition: Exclusive to selective faithful taxon is *Cystopteris fragilis* (L.) BERNH. ssp. *dickieana* (SIM.) HYL. Constant to very frequent taxa are *Taraxacum croceum*, *Chamaenerion angustifolium*, *Sibbaldia procumbens* and *Oxyria digyna*. On an average in one sample plot occur 11.4 taxa, of which on an average 10 are phanerogams.

physiognomy: The predominantly hemicryptophytic community is usually stratified in (1) a poorly developed to absent bottom layer with cryptogams, and (2) a well developed, 17 to 43 cm high closed field layer; sometimes the field layer can be divided in an upper layer with *Cystopteris*, *Taraxacum*, *Chamaenerion*, and a lower one with *Euphrasia*, *Ghaphalium supinum*, *Sibbaldia*. The community forms vivid light green fern-vegetation of usually limited extent, which occurs in the form of narrow belts which are quite conspicuous in the usually barren surroundings of the typical habitat.

synecology & habitat: The low-arctic and oceanic, chionophytic, mesophytic to hygrophytic, chalicophytic to somewhat chasmophytic, eutrafent and medium acidophytic community occurs in the Angmagssalik District in the coastal areas on South-facing, 0 to 60° inclined slopes between 40 and 130 m a.s.l., in seasonally wet habitats. It is found usually in narrow strips of vegetation along steep rocks, keeping close to the base of the rock wall over which until far into summer water oozes down. It occurs also fragmentarily on rock ledges and in crevices and clefts in rock, in shallow accumulated soil.

The substrate is humid, humic, niveo-aeolian and colluvial, predominantly medium fine sandy and 5 to more than 60 cm deep. It is usually for the greater part covered with a $1^1/_2$ to 3 cm thick litter layer. Below this one finds a 1 to 8 cm thick layer of raw humic to fibrous peaty sand, which gradually passes into a subsoil of coarse debris.

The habitat is snow-covered all winter and becomes free of snow in early June. It is irrigated by water which oozes down from above during and for some time following the melting period and periods of rain. During summer the substrate can dry out to a considerable extent. The irrigation involves presumably enrichment of the substrate in, partly basic, minerals.

The colorimetric pH of the rhizosphere ranges from $4^1/_2$ to $5^1/_2$ and averages 4.9.

succession & zonation: The unit represents presumably a semi-permanent stage in the succession. Stands of this unit occur usually closest to the rock; lower downward they are followed by communities of the *Ranunculo-Oxyrion digynae* or by barren talus slopes.

distribution: The unit occurs locally in the coastal areas of the district (Elvbakker, Sermilikvejen-Vegas Fjeld, Tasîlâlik, Kulusuk).

syntaxonomy & discussion: *Cystopteris fragilis* coll. occurs in Southeast Greenland according to KRUUSE (1906, p. 285) and BÖCHER

(1938, p. 52) along the foot of cliffs, in herb fields mostly in process of formation, in screes, and in shrub and dwarf shrub heaths. It occurs for instance in the Wiedemann Fjord on basaltic debris, often as a species "forming an association", as does *Sedum annuum* closer to the steep terrace walls (BÖCHER, 1933, p. 49).

These occurrences of *C. fragilis* probably refer for the greater part to the northern ssp. *dickieana*. Elsewhere in Greenland occurs *C. fragilis* in particular in willow scrub (cf. BÖCHER, 1954, 1963, div. pp.).

In alpine, central Europe one finds the sspp. *fragilis*, *dickieana* and *alpina* HARTM. (= *C. regia* (L.) DESV.). The latter is there considered to be characteristic of the calciphytic and chalicophytic *Thlaspeion rotundifolii* BR.-BL. 1926 (*Thlaspeetea rotundifolii*) and also of the calciphytic and chasmophytic *Potentillion caulescentis* BR.-BL. 1926 (*Asplenietea rupestris* BR.-BL. 1934; cf. BRAUN-BLANQUET, 1948b, p. 39; RUNGE, 1969, p. 28; OBERDORFER, 1970, p. 67). The occurrence of the two other subspecific taxa there does not seem to be clearly associated with certain syntaxa.

Characteristic of the non-calciphytic *Taraxaco-Cystopteretum fragilis* described here is the ssp. *dickieana*, sometimes presumably mixed with sterile hybrids with the ssp. *fragilis* (cf. BÖCHER *et al.*, 1966, p. 47). Mainly because of its synecology this syntaxon should be grouped in the *Androdacetalia alpinae*. It is related to the non-calciphytic, chalicophytic and eutrafent *Veronico-Poion glauca* NORDH. 1942 (cf. NORDHAGEN, 1943, p. 544) and as such also somewhat to the *Sedo-Thymion drucei*. On the other hand it shows also some resemblance to the fern-communities of seasonally wet, eroded slopes of the chionophytic, oligotrafent *Cryptogrammo-Athyrion alpestris* NORDH. 1936 (cf. p. 117, 118).

Considering the above facts and the lack of information on related communities, I prefer to group the association for the present in the order *Androsacetalia alpinae* and to refrain from grouping it in a certain alliance.

7.1.B. Note

To the order *Androsacetalia alpinae*, and presumably to the alliance *Antitrichio-Sedion roseae*, belongs also a more or less fragmentary *Sedum rosea-Coptis trifoliata-Salix herbacea* community with as noteworthy components *Bartsia alpina*, *Carex bigelowii*, *Chamaenerion latifolium*, *Polygonum vivipartum*, *Sibbaldia procumbens*, *Taraxacum croceum*, which is more or less rich in cryptogams (bryophytes). This low-arctic, more or less oceanic, chiono- and hygrophytic, eutrafent and more or less acidophytic community was not studied in detail, as homogeneous, comparatively extensive stands were not observed. It occurs in particular at low altitudes on the southern part of the Angmagssalik Ø (in particular on the western slopes of the Sømandsfjeldet) on more or less sunny slopes, in moist to wet, humic to peaty coarse sandy (to gravelly) colluvial soil, at the foot of steep to perpendicular rocks over which water seeps down.



Fig. 53. *Sedum rosea-Coptis trifoliata-Salix herbacea* community in the drip zone ("Tropfregion") at the base of a steep rock wall.
JGdM phot. VII. 1968.

They form usually a narrow strip of vegetation close to the rock, often in mosaic with fragmentary communities of the *Ranunculo-Oxyrion digynae*, and fade gradually into wet to moist *Vaccinium uliginosum* heath farther away from the rock (fig. 53).

7.2. Order *Myricarietalia germanicae* G. BR.-BL. 1931.

syn.: *Epilobietalia fleischeri* MOOR 1958.

The syntaxon comprises pioneer communities and semi-permanent succession stages in dynamic environments in sandy to gravelly, calcareous or non-calcareous, basic to acid, minerotrophic and (mesotrophic to) eutrophic substrates along the shores of, on banks in, and on deltas of glacier rivers and mountain streams, where they are more or less regularly inundated which involves sedimentation, closer setting of the soil particles and (sometimes) erosion, which phenomena after emersion of the habitat can be followed by the substrate drying out of with subsequent deflation. These communities usually show the observer a scala of different life-forms. They occur in the alpine to montane areas of Central and North Europe and in Greenland, and are characterized by the following faithful taxa: *Epilobium dodonaei* VILL., *Hieracium piloselloides* VILL., *Calamagrostis pseudophragmites* (HALL. f.) KOEL. et *neglecta* (EHRH.) G., M. et S. (also in 5.1.).

7.2.1. All. *Calamagrostion neglectae* NORDH. 1936.

The plant communities of dynamic, comparatively unstable habitats on more or less stabilized, viz. owing to flooding more or less consolidated, coarse sandy to gravelly alluvial deposits along mountain and glacier streams and in the precincts of valley-glaciers are in montane to alpine Central and Northern Europe grouped in the *Myricarietalia germanicae*. Their habitat is characteristically subjected to inundation with each large freshet, involving a variable, considerable supply of sediments and frequently (partial) destruction of the plant cover.

In central Europe there belong to this order the *Epilobion fleischeri* G. BR.-BL. 1931 (Alps, Carpathians: montane-subalpine) and the *Glaucion flavi* BR.-BL. 1947 (southern Cevennes: montane). In northern Europe at higher altitudes it is represented by the subalpine, periglacial, chionophytic, more or less neutrophytic and presumably (little or) non-calciphytic *Calamagrostion neglectae* NORDH. 1936.

The *Calamagrostion neglectae* is a little known syntaxon, in as far as I can judge from the to me accessible literature. In consequence I group the communities described hereafter with some reservation in this alliance. These communities are semi-permanent and will, when the environment becomes stabilized, presumably gradually be replaced by *Salix glauca* scrub.

The alliance has several taxa in common with the *Parvocaricetea*, particularly with the *Caricion bicolori-atrofuscae* (cf. also ARWIDSSON, 1943, p. 135–137). To the alliance I also think that the "pure" *Eriophorum scheuchzeri* communities previously grouped in the *Eriophorion scheuchzeri* and the "pure" *Deschampsia alpina* communities (cf. 7.1.2.2.) which occur in the habitat described above as characteristic of the *Calamagrostion neglectae* belong.

Faithful taxa of the alliance are *Calamagrostis neglecta* (EHRH.) G., M. et S., *Lactuca sibirica* (L.) BENTH., *Aongstroemia longipes* (SOMMERF.) B. S. G., *Blasia pusilla* L., *Bryum pallens* SW. et *purpurascens* (R. BR.) B. S. G., *Dicranella riparia* (LINDB.) MÅRT. et NYHOLM, *Ditrichum* TIMM. div. spp., *Pohlia* HEDW. (viz. the propaguliferous spp., sect. *Pohliella* LOESKE). Differential taxa are *Juncus arcticus*, *J. castaneus*, (*Deschampsia alpina*), *Eriophorum scheuchzeri*, *Philonotis tomentella*, *Racomitrium canescens*, *Scapania lapponica*, *Solonostoma*.

7.2.1.1. Ass. *Pohlio-Caricetum rufinae* ass.nov.

table 26:1–11.

composition: Faithful taxa are *Carex rufina* DREJ. (exclusive; also in *Stellaro-Oxyrion*) and *Pohlia gracilis* (SCHLEICH.) LINDB. (selective). Constant taxa are *Calamagrostis neglecta*, *Juncus castaneus*, *Aong-*

Table XXVI

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13
altitude (m)		130	120	15	15	1	1	2	2	30	2	1½	1	2
total cover plants (in %)		80	85	50	45	35	25	45	40	35	35	15	30	15
cover phanerogams –		15	10	10	35	10	5	40	30	35	20	15	30	15
– cryptogams –		75	80	50	30	30	20	10	15	1	15	22	5	1
– litter –		0	0	0	0	0	0	0	0	0	0	0	0	0
– open soil –		20	15	50	55	75	80	80	80	80	80	95	75	90
pH rhizosphere		7	7	7	7	6¾	6¾	6¾	6¾	6¾	6¾	6¾	6¾	6½
ground water level (-cm)		18	10	8	15	28	25	23	26	5	24	15	5	5
Carex rufina	L	2	1	+	3	1	+	2	2	2	2	2	..	..
Pohlia gracilis		4	5	2	3	3	4	2	2	+	2	1	+	+
Pohlia commutata												..	..	..
Pohlia ludwigii		..	..	..	..			..	..	..	..	..	..	..
Bryum pallens		+	1	1	1	1	1	1	1	+	2	+	+	+
Bryum purpurascens														
Calamagrostis neglecta	B	..	..	..	..	1	1	3	2	2	2	1	3	3
Juncus castaneus	L	..	..	2	2	..	..	3	3	3	1	1	..	..
Aongstroemia longipes		+	+	+	1	+	+	..	+	+	..	..	+	..
Blasia pusilla		+	+	2	+	+	+	+	1	..	..	..	..	..
Juncus arcticus	L	..	..	..	3	2	1	..	+	..	2	..	..	..
Equisetum variegatum	L	..	..	..	+	..	+	+	..	+	..	..	+	..
Carex bigelowii	L	..	+	..	..	..	..	+	+	..	+	..	..	..
Salix glauca (juv.)	L	..	..	+	+	+	..	+	..	..	..	..	..	..
Salix herbacea	L	+	+	..	..	..	+	+	..	..	..	..	..	+
Eriophorum scheuchzeri	A	1	+	..	..	..	..	+	..	..	..	+	2	..
Deschampsia alpina	L	+	+	..	+	..	..	..	..	..	..	+	+	..
Philonotis tomentella		1	+	2	+	..	1	..	..	+	..	..	+	..
Solonostoma pumilum		+	..	2	+	+	..	..	..	..	..	..	..	+
Scapania lapponica		4	2	2	3	..	..	..	..	..	..	..	..	..
Pertusaria oculata		1	+	+	+	..	..	..	..	..	..	..	..	..
Cephalozia ambigua		+	+	+	+	..	..	..	..	..	..	..	..	..
Cephalozia arctica		+	+	+	+	..	..	..	..	..	..	..	..	..
Anthelia juratzkana		+	1	+	..	..	..	..	..	..	..	..	..	..
Drepanocladus exannulatus		+	2	+	..	..	..	..	..	..	..	..	..	..
Scapania irrigua		..	1	1	..	..	..	..	..	..	..	..	..	..
Carex lachenalii	L	+	1	..	..	..	..	..	..	..	..	..	..	..
Lephalozia bicuspidata		+	+	..	..	..	..	..	..	..	..	..	..	..
*Lachnea scutellata**		+	..	..	+	..	..	..	..	..	..	..	..	..
Ditrichum cf. *pusillum*		+	+	..	..	..	..	..	+	..	..	..	..	..
Juncus biglumis	A	..	+	+	..	..	..	..	..	..	..	..	..	..
Chamaenerion latifolium	A	..	..	+	+	..	..	..	..	..	..	..	..	..
Oxyria digyna	A	..	..	+	+	..	..	..	..	..	..	..	..	..
Sagina saginoides	L	..	+	..	..	..	+	..	..	..	..	..	..	..
Bryum cf. *affine*		..	..	..	+	..	..	..	1	+	..	..	..	..
Oncophorus virens		..	2	..	..	..	..	..	..	..	..	..	..	..

Not recorded in the table are, all with "+": *Cerastium cerastoides* in sample plot 2; *Epilobium anagallidifolium* 2; *Koenigia islandica* 9; *Phippsia algida* 2; *Ranunculus pygmaeus* 2; *Saxifraga stellaris* 2; *Calliergon sarmentosum* 2; *C. stramineum* 9; *Catoscopium nigritum* 9; *Drepanocladus revolvens* 9; *Dr. uncinatus* 1; *Mniobryum albicans* 4; *Solonostoma pusillum* 3; *fungi* (2 spec.) 3.

* see note on p. 71.

stroemia longipes, *Bryum pallens*, *B. purpurascens*, *Blasia pusilla*, *Philonotis tomentella*, *Pohlia commutata*.

On an average 16 to 17 taxa are observed in one sample plot, of which on an average 6 are phanerogams; in general the numbers of taxa per sample plot are rather variable.

physiognomy: The predominantly hemicryptophytic, partly geophytic and as regards the cryptogams bryochamaephytic and bryohemicryptophytic community is stratified in three layers; (1) a fragmentary to closed, dense, a few millimeters to 1 cm high bottom layer of cryptogams (bryophytes), (2) an usually less than 10(15) cm high, open, predominantly graminoid lower field layer with for instance *Carex rufina*, *C. bigelowii*, and (3) a 20 to 27 cm high, open, predominantly graminoid upper field layer as a rule dominated by *Calamagrostis neglecta*, *Juncus arcticus*, *J. castaneus*.

It usually covers extensive tracts, of 10 to frequently many hundreds of square meters with alluvial meadow vegetation, which is variable in appearance; see for details the subunits.

synecology & habitat: The low-arctic, chionophytic, hygrophytic and tropohydrophytic, neutrophytic, minerotrafent and (mesotrafent to) eutrafent, non-calciphytic periglacial community occurs in the Angmagssalik District in latish snow areas in the coastal areas and especially in the inland, between 1 and at least 130 m a.s.l., on open, level parts of extensive, sandy outwash plains and deltas of meltwater streams, as a rule less than 2 m above the water level in the nearby fjord or lake in which the glacier and meltwater streams drain.

The glaciofluvial substrate consists of a superficial, up to 10 cm thick, layered deposit of silty, fine sandy sediments, and of a many tens of meters thick subsoil of coarse sandy to gravelly deposits. No pedological differentiation was observed.

As regards the stability the environment is intermediate between those of the two following associations in the district. It is covered by snow presumably from September–October through June. In early summer it is subjected to shallow inundation, which involves sedimentation and limited displacement of previously deposited material. Later in summer the water level falls to depths between –5 and –28 cm below the ground surface. The uppermost, a few centimeters thick layer of the substrate becomes subsequently dried out and subjected to limited deflation.

The colorimetric pH of the rhizosphere is abt. $6^3/_4$ to 7.

succession & zonation: With gradual rising and stabilization of the substrate the community is presumably replaced by the *Calamagrosto-Ditrichetum* and by *Salix glauca* scrub. If the habitat becomes less stable and more dynamic because of changes in the local physiography involving more intense sedimentation, erosion and deflation, as well as desiccation,

it is replaced by the *Calamagrostetum neglectae*. The stands of the community are found bordering upon stands of the *Calamagrosto-Ditrichetum* or *Salix glauca* scrub on slightly higher, level ground, often also on communities of the *Calamagrostetum neglectae* or *Salix* scrub on low hummocks, diminutive dunes or ridges.

distribution: The community is rather common in the inland and very rare in the coastal areas of the district (see the subunits); it occurs probably also in suitable localities elsewhere in East and West Greenland.

syntaxonomy & discussion: The syntaxon is related to the *Caricetum rufinae* (*Stellaro-Oxyrion*, 8.1.2.3.), mainly because of the constant occurrence of the chionophytic *Carex rufina* and *Pohlia commutata* in both. It differs from the association mentioned in the further composition of both the field and the bottom layer, in which the synecological differences between the two syntaxa is expressed. These differences are fundamentally the same as those between the *Myricarietalia germanicae* and the *Androsacetalia alpinae*, and concern mainly the dynamics and instability of the environment (mobility of the substrate, flooding, sedimentation, deflation, soil texture).

Floristically and synecologically related communities have been described from alpine areas in central and northern Europe. FAEGRI (1933, p. 72 and table 10:1–6) describes a *Pohlia gracilis*-Soz. with *Eriophorum scheuchzeri*, *Deschampsia alpina* and *Philonotis fontana* from Central Norway.

HERZOG (1912, p. 243) and GIACOMINI (1939, p. 59, 113) report from the southern Central Alps several bryophyte communities, such as an association of *Pohlia gracilis-Blasia pusilla* with *Aongstroemia longipes*, an association of *Pohlia ludwigii*, and an association of *Pohlia gracilis-Philonotis tomentella* with *A. longipes*.

7.2.1.1.1. Subass. *scapanietosum lapponicae* subass.nov.

table 26:1–4.

composition: Differential taxa are *Scapania lapponica* (ARN. et C. JENS). STEPH. (=*Jungermania globulifera* C. JENS., *Lophozia jensenii* KM; presumably identical with *S. obcordata* (BERGGR.) S. ARN. (K. DAMSHOLT, personal communication), *Cephalozia ambigua* MASS., *Cephaloziella arctica* BRYHN & DOUIN and *Pertusaria oculata* (DICKS.) TH. FR.; to some extent also *Anthelia juratzkana*, *Drepanocladus exannulatus* (var. *purpurascens*), *Scapania* cf. *irrigua*. The unit is rich in taxa: on an average 25 taxa are observed in one sample plot, of which on an average one third are phanerogams.

physiognomy: See 7.2.1.1.; the bottom layer is as a rule well developed, more or less open to closed, the upper field layer is often comparatively poorly developed. The appearance of the community is

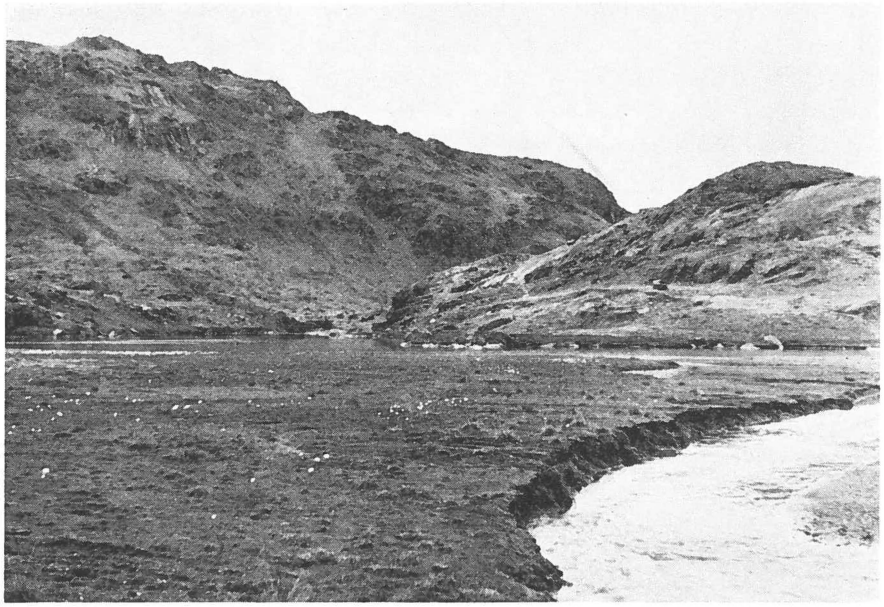


Fig. 54. The coastal variant of *Eriophorum scheuchzeri* of the *Pohlio-Caricetum rufinae* subass. *scapanietosum lapponicae*.
JGdM phot. IX. 1969.

to a large extent determined by the dark, brownish to greenish bottom layer; to this dull physiognomy is further contributed by the brownish green of the field layers.

synecology & habitat: See 7.2.1.1. The community occurs in the district in the coastal areas on open, extensive, level deltas of meltwater streams in lakes, a few decimeters above the water level in these waters (fig. 54). In the inland it occurs on open, small to extensive, level to very slightly sloping wet outwash deposits on levelled valley floors usually close to the snouts of the present glaciers, viz. in front of arcuate recessional moraines on fan-like spread sandrs of mixed outwash and ice-contact drift; sometimes it occurs also more or less fragmentary inside such embarkments (glacier snout basins, precincts).

The substrate consists of sorted, near the surface silty to fine sandy, deeper down not silty-fine sandy, fluvioglacial coarse sand and fine gravel. The superficial (0)$3^1/_2$ to 10 cm is stratified and consists of a few millimeters to 6 cm thick layers of graded material, sometimes with enclosed 2 to 10 mm thick humic strata.

The environment is comparatively stable. The shallow, quiet inundation in early summer involves sedimentation of small quantities of rather fine mineral material but no erosion. The courses of the nearby meltwater channels are rather stable and erosion is restricted to their shores.

The habitat of this unit is moister than any of the other units of the alliance in the district. After emerging of the habitat the ground water level sinks to depth between–8 and–18 cm in August–September, while the bottom layer prevents desiccation of the not (over-)saturated soil layers.

The colorimetric pH of the rhizosphere is 7.

succession & zonation: See 7.2.1.1.

distribution: The community is rare in the coastal and inland areas of the district (valleys between the Ymers Bjerg and the Præstefjeld and the Ymers Bjerg and the Sømandsfjeldet on Angmagssalik Ø, and in the valley at the head of the Tasîlaq).

subdivision: The syntaxon is in the district represented by two local variants:

(a) Variant of *Eriophorum scheuchzeri* (table 26:1, 2), the oceanic variant characterized by the taxon mentioned and *Salix herbacea.*

(b) Variant of *Juncus castaneus* (table 26:3, 4), the continental variant characterized by *Juncus castaneus* and *J. arcticus.*

7.2.1.1.2. Subass. *calamagrostetosum neglectae* subass.nov.

table 26:5–11.

composition: Differential taxon is *Calamagrostis neglecta* (EHRH.) G., M. & S. The syntaxon is further characterized by being comparatively poor in taxa, in particular in cryptogams. On an average 12 taxa are observed in one sample plot, of which on an average half are phanerogams.

physiognomy: See 7.2.1.1. The bottom layer is usually poorly developed, open to fragmentary; the upper field layer is usually comparatively well-developed. The community forms open, light grayish green alluvial meadows, which resemble in appearance open stands of the *Calamagrosto-Ditrichetum* (p. 212).

synecology & habitat: The community is in the district continental in distribution. It occurs near sea level on open, level, extensive fluvioglacial deposits filling up former glacier troughs, and extending as deltas into the fjord at present filling the deeper part of these troughs. It occurs there in particular in slight depressions on open sand flats at the transition from the higher, stabilized part where the *Calamagrosto-Ditrichetum* occurs, to the unstable zone of the tidal flat, namely near the upper limit of the (occasional) influence of the episodic fluctuations of the fjord water level (fig. 55). On this part of the deltas is the gradually stabilized system of the meltwater streams with the accompanying phenomena of sedimentation and erosion degenerated by the leveling effect of the irregular flooding with fjord water on the geomorphology. The community occurs also in comparable conditions along glacier lakes more centrally on such outwash plains.



Fig. 55. The outer part and tidal flat of the delta at the head of Qíngertivaq fjord with communities of the *Pohlio-Caricetum rufinae* and the *Calamagrostetum neglectae*. FJAD phot. VII. 1969.

The substrate consists of ungraded, sandy to gravelly deposits, covered by a 4 to 9 cm thick series of ($^1/_2$) 1 to 7 cm thick (silty to) fine sandy layers of sediment, which are partly coloured brightly blue owing to oxygen deficiency. The soil surface is usually more or less rippled.

The environment is comparatively unstable. The habitat is subjected to inundation by meltwater in early summer, and by occasional fresh to slightly brackish fjord water in the vegetative period during exceptionally high tides. This involves sedimentation of fine sand and limited erosion. During the period of emerging of these parts of the deltas the habitat serves as shallow channels through which the water flows off. In the middle of August the ground water level is found between 5 and 28 cm depth, usually below 20 cm depth. The uppermost part of the substrate is then rather dry and subjected to limited deflation.

The colorimetric pH of the rhizosphere is abt. $6^3/_4$ to 7.

succession & zonation: See 7.2.1.1.

distribution: The community occurs here and there in the inland of the district (delta at the head of the Qíngertivaq, North of the Cassiopefjeld in the valley in the extension of that fjord, fragmentary also at the head of the Tasîlaq; possibly also at Sieraq and Tuno).

subdivision: Two local variants can be distinguished:

(a) Variant of *Pohlia ludwigii* (table 26:5, 6), characterized by the

dominance of said bryophyte in the bottom layer and by the absence of *Carex bigelowii*.

It occurs in superficially medium fine sandy substrates in slightly more unstable, dynamic conditions than the following variant.

(b) Variant of *Juncus castaneus* (table 26:7–11), characterized by the (co-) dominance of this rush and *C. neglecta* in the upper field layer and the presence of *Carex bigelowii*. It occurs in superficially silty to fine sandy substrates in slightly less unstable and dynamic conditions.

7.2.1.2. Ass. *Calamagrostetum neglectae* NORDH. 1928.

syn.: *Calamagrostis neglecta*-Wiese KALELA 1939; incl. nackte *Calamagrostis neglecta*-Soz. and ?nackte *Juncus arcticus*-Soz. ARWIDSSON 1943, *Calamagrostis neglecta*-synedria LID 1964.

table 26:12, 13.

composition: Regional, preferent faithful taxon is *Calamagrostis neglecta* (EHRH.) C., M. et S., presumably also *Racomitrium canescens* (HEDW.) BRID. The syntaxon is further negatively characterized. It is comparatively poor in taxa; the cryptogams in particular are qualitatively and quantitatively poorly represented.

physiognomy: The hemicryptophytic, elsewhere in particular also geophytic community is in the district stratified in (1) a very open to fragmentary bottom layer of bryophytes, and (2) a rather open, 30 to 36 cm high graminoid field layer dominated by *C. neglecta*. Elsewhere the field layer can often be subdivided in a lower and an upper layer (cf. NORDHAGEN, 1928, p. 337; KALELA, 1939, p. 305). It forms rather open, elsewhere also rather dense, light greyish-purplish green alluvium meadows, which cover in the district small areas of up to 40 m^2 (fig. 56).

synecology & habitat: The northern subalpine to low-arctic, more or less chionophytic, hygrophytic and tropohydrophytic, neutrophytic, minerotrafent and eutrafent community occurs in the Angmagssalik District in the inland, below 2 m a.s.l. on the outer parts of fluvioglacial deltas at the heads of fjords; especially in the upper zone of the tidal flat and the adjoining higher, unstable parts of such deltas, where the braided, stabilized stream system becomes degenerated and subjected to the tidal influences of the water in the fjord. The plant cover in this zone belongs mainly to this community and is chiefly restricted to low, flattened, loose sandy dunes and banks (fig. 55, 56). The community occurs also along the shores of glacier streams in the valleys in the extension of such deltas, and fragmentarily along lake shores.

The substrate consists of layered, sometimes superficially fine gravelly, predominantly (medium fine to) coarse sandy deposits, occasionally with thin buried raw humic layers.



Fig. 56. *Calamagrostis neglecta* community (7.2.1.2.) on low sand dunes lining the tidal flat of the delta at the head of Qíngertivaq fjord.
JGdM phot. VII. 1969.

The environment is unstable and dynamic. The habitat is subjected to flooding by fresh water in early summer in the melting period, and during the entire vegetation period to occasional inundation in varying extent by fresh water and slightly brackish fjord water. Sedimentation is restricted to the comparatively coarse grades. Erosion occurs, but is rather limited in effect. In summer the ground water level sinks to depths of at least –75 cm. The substrate becomes then superficially dried out and subjected to deflation, in particular owing to katabatic winds and storms, and, during periods of intense insolation, whirlwinds.

The interaction between the mentioned environmental factors and the relatively sparse plant cover results in the formation of bare spreads of coarse sand and gravel, of very shallow and at the surface silty-fine sandy depressions (on the lower part of the delta devoid of vegetation, higher up with stands of the *Pohlio-Caricetum rufinae*), of wide, shallow streambeds, and of 1 to 2 ft. high, oblong and flattened, coarse sandy dunes. Said dunes are often slightly concave owing to secondary deflation. Such diminutive dunes occur also laterally along the tidal flats and are there also covered with stands of this community.

The colorimetric pH of the rhizosphere is abt. $6^1/_2$ to $6^3/_4$.

succession & zonation: The community occurs as a pioneer on loose sandy banks in the upper zones along the tidal flats and along glacier streams. Sometimes it alternates in the time with *Honckenya peploides*

var. *diffusa* stands, more frequently it is preceded by the *Pohlio-Caricetum rufinae*, in particular the subass. *calamagrostetosum* (see also 7.2.1.). It occurs spatially isolated or bordering upon lower situated communities of the *Pohlio-Caricetum rufinae*.

distribution: The community is rather common in the inland of the district (at the heads of the Qîngertivaq and the Tasîlaq, possibly also at Sieraq and Tuno; see also KRUUSE, 1912, p. 249). A *C. neglecta* community with a fragmentary bottom layer dominated by *Racomitrium canescens* (cf. NORDHAGEN, 1928, p. 337) is found in the valley at the head of the Tasîlaq along glacier streams. The association is also represented elsewhere in Greenland (BÖCHER, 1954, p. 250; BÖCHER & LÆGAARD, 1962, p. 171), in Fennoscandia (NORDHAGEN, l.c.; KALELA, l.c.; ARWIDSSON, 1943, p. 137), and on Jan Mayen (LID, 1964, p. 71), presumably also in Iceland.

syntaxonomy & discussion: The described community is not always clearly distinguishable from related vegetation types preceding it, as intermediate types are not uncommon; this applies especially to the *Pohlio-Caricetum rufinae* (7.2.1.1.2.a.). The general composition of the syntaxon is variable (see the cited literature). As recent, detailed investigations of this unit are scarce, I will confine myself to mentioning the representation of the association in the Angmagssalik District and the description of the concerned community, and not go further into detail on the composition and possible subdivision of the association.

7.2.1.3. Ass. *Calamagrosto-Ditrichetum* ass.nov.

table 27.

composition: Faithful taxa are *Dicranella riparia* (LINDB.) MÅRT. & NYHOLM (exclusive), *Ditrichum* TIMM. (D. cf. *pusillum* (HEDW.) BRITT.; exclusive) and *Anthelia juratzkana* (LIMPR.) TREV. (selective within the alliance). Constant taxa are *Calamagrostis neglecta*, *Carex bigelowii*, *Salix herbacea*, *Calliergon stramineum*, *Drepanocladus exannulatus* , *Pohlia commutata*, *Cephalozia ambigua*, *Cephaloziella arctica*, *Scapania irrigua*, *Sc. lapponica* (cf. 7.2.1.1.1.). On an average slightly over 15 taxa are observed in one sample plot, of which on an average 12 are cryptogams. In particular many of the hepatics are distinctly chionophytic.

physiognomy: The predominantly bryochamaephytic and partly bryohemicryptophytic community is stratified in (1) a 1 to 3 cm high, closed, compact bottom layer of cryptogams (bryophytes), (2) an abt. 1 cm higher, open to fragmentary lower field layer with *Salix herbacea*, sometimes also *Equisetum*, and (3) a 19 to 34 cm high, open to rather closed graminoid upper field layer with *Calamagrostis neglecta* and *Carex bigelowii*. It covers extensive areas with pale yellowish-green vegetation,

Table XXVII

reference number		1	2	3	4	5	6	7
altitude (m)		15	2	2	2	2	2	2
total cover plants (in %)		100	95	100	100	100	100	100
cover phanerogams –		2	25	35	40	25	20	20
– cryptogams –		100	80	90	95	95	95	95
– litter –		–	20	20	–	–	20	–
pH rhizosphere		7	5	6¼	5½	5	6½	6½
ground water level (-cm) (below surface moss layer)		13	>15	18	29	24	13	17
Calamagrostis neglecta	B	..	1	2	4	3	3	3
Salix herbacea	L	+	3	3	1	+	+	+
Carex bigelowii	L	+	2	2	2	+	..	..
Ditrichum cf. *pusillum*		5	4	5	2	6	3	2
Scapania lapponica		1	1	3	2	2	4	3
Cephalozia ambigua		3	1	2	4	3	4	+
Cephaloziella arctica			3		1	4	3	
Anthelia juratzkana		3	4	2	1	+	+	+
Pohlia commutata		1	3	2	2	+	2	..
Pohlia cuculata		..		..	..	..	..	..
Drepanocladus exannulatus		..	+	3	2	+	1	6
Scapania irrigua		..	+	1	1	+	+	+
Dicranella riparia		..	+	+	4	1	..	..
Calliergon stramineum		..	..	1	..	1	1	3
Bryum pallens/purpurascens		2	..	..	..	..	+	+
Carex rariflora		..	..	+	..	+	..	..
Philonotis tomentella		3	+	2	..	..	..	..
Drepanocladus uncinatus		..	..	2	..	1	..	..
Corallorhiza trifida	B	..	+	+	..	..	..	..
Oncophorus virens		+	..	..	..	..	..	+
Cephalozia bicuspidata		..	..	+	1	..	..	..
Pertusaria oculata		..	1	..	..	..	..	..
fungus		..	+	..	..	+	..	..
Blasia pusilla		..	+	..	..	..	..	..
Cephalozia lammersiana		..	+	..	..	..	..	..
Calliergon sarmentosum		..	..	..	..	..	+	..
Lophozia alpestris		..	..	..	+	..	..	..
Solonostoma pumilum		+	..	..	..	..	..	..
Equisetum variegatum	L	+	..	..	..	..	..	..
Polygonum viviparum	A	+	..	..	..	..	..	..
Salix glauca (juv.)	L	+	..	..	..	..	..	..
Chamaenerion latifolium	A	+	..	..	..	..	..	..

which especially at a distance strikes the observer as grassy or meadow-like (fig. 57).

synecology & habitat: The low-arctic, chionophytic, hygrophytic and more or less tropohydrophytic, neutrophytic, minerotrafent and



Fig. 57. The *Calamagrosto-Ditrichetum* on the delta at the head of Qíngertivaq fjord. FJAD phot. VII. 1969.

mesotrafent to eutrafent periglacial community occurs in the Angmagssalik District in the inland at 2 to 15 m a.s.l. on open, flat banks on extensive fluvioglacial plains and deltas; namely on the higher, stabilized parts of these, out of reach of the unstable, dynamic conditions near the glacier snouts as well as out of reach of the influence of the open water along the outer margin of the deltas at the head of the fjords where these plains occur, as a rule more than 2 m above the mean water level in these fjords.

The substrate consists of many tens of meters thick sediments. The braided channel system of the glacier streams is comparatively stable here, no longer continuously and rigorously changing courses. This area is regularly flooded each early summer. In apparently quiet water on the high, level banks, each year recently a 1 to 10(20) mm thick layer of graded sediment is deposited, consisting of predominantly silty-fine sandy to silty-coarse sandy material; a part of this material is presumably also of aeolian origin. Erosion is restricted to the shores and beds of the streams, deflation does not take place. To a depth of (0)12 to 22 cm the soil profile shows a series of 0,5 to 2(4) cm thick, alternating layers of bluish or brownish-grey, mineral or humic to somewhat peaty silt and silty sand; deeper down it shows considerably thicker layers of coarse sandy to gravelly deposits.



Fig. 58. *Corallorhiza trifida* in a community of the *Calamagrosto-Ditrichetum* on the delta at the head of Qíngertivaq fjord, the only known station of this orchid in East Greenland.
JGdM phot. VII. 1969.

The environment is comparatively stable. The habitat is covered with snow all winter, and becomes free of snow in late June. After the very shallow inundation the ground water level sinks to depths between 13 and 29 cm in the middle of July through early August. The non-saturated soil below the moss layer remains continuously rather moist.

The colorimetric pH of the rhizosphere ranges from 5 to 7 and averages 6.

succession & zonation: The syntaxon seems to present a semi-permanent community in the district. See further 7.2. It borders closer to the present glaciers on open *Stereocaulon* communities on higher, mobile, gravelly to stony substrates. On the other side, towards the fjord, it borders upon stands of the *Pohlio-Caricetum rufinae* and of the *Calamagrostetum neglectae.*

distribution: The unit is rather common in the inland of the Angmagssalik District (at the heads of the Qíngertivaq and the Tasîlaq, possibly also at Sieraq and Tuno). It occurs probably also in suitable localities elsewhere in Greenland and possibly Iceland and Fennoscandia.

syntaxonomy & discussion: From the areas of the faithful and constant taxa the syntaxon may be expected to occur also outside the Angmagssalik District. The syntaxon is floristically and synecologically related to the *Salicetalia herbaceae.*

Chapter VI

Grass heaths

By the term grass heath one generally understands xerophytic to mesophytic vegetation in stable, comparatively unfertile, humic and acid soils, and dominated by low graminoid plants. Dwarf shrub heaths comprise, in contrast, vegetation dominated by low ligneous plants, mainly *Ericaceae*, in, for the rest, the same conditions.

In Central Europe these two groups of heath vegetation are classified in distinctly separated higher syntaxa.

The alpine grass heaths of the Alps and Pyrenees are usually classified in the order *Caricetalia curvulae* BR.-BL. 1926 of the class *Juncetea trifidi* HADAČ apud KLIKA & HADAČ 1944 (syn.: *Caricetea curvulae* BR.-BL. 1948), whereas the corresponding dwarf shrub heaths are grouped in the *Vaccinio-Piceetalia* BR.-BL. 1926 in the class *Vaccinio-Piceetea* BR.-BL. 1939 (cf. BRAUN-BLANQUET, 1948a, 1948b; BRAUN-BLANQUET, SISSINGH & VLIEGER, 1939; BRAUN-BLANQUET, PALLMANN & BACH, 1954; OBERDORFER, 1957). The alpine grass and dwarf shrub heaths of the Tatra are, on the other hand, grouped by KRAJINA (1934) and HADAČ (1956) in one single order, the *Caricetalia curvulae* BR.-BL. 1926 em. KRAJINA 1934, but in separate alliances (see also HADAČ, 1962).

The non-alpine grass and dwarf shrub heaths of central and northwest Europe are classified in separate orders, which are grouped in one class, the *Nardo-Callunetea* PREISING 1949 (cf. PREISING, 1949; SCHUBERT, 1960; WESTHOFF & DEN HELD 1969).

In Fennoscandia the classification of the alpine grass and dwarf shrub heaths is based on criteria which in particular emphasize the floristic composition of the communities in relation to the environment, namely persistence and depth of the snow cover in winter, and factors correlated with that phenomenon, more so than on floristic-structural similarity and differences as in Central Europe. This results in a classification of these two groups of heath vegetation in units where they are kept separated at a comparatively low syntaxonomical level.

NORDHAGEN (1936, 1943; cf. also KALLIOLA, 1939) groups the chionophytic grass heaths in the alliance *Nardo-Caricion bigelowii* NORDH. 1936, which he considers to belong to the *Salicetalia herbaceae* BR.-BL. 1926. The anemophytic ("chinophobous") grass heaths he groups in the *Juncion trifidi* (scandinavicum) KRAJINA 1934 em. NORDH. 1936, which he considers to belong to the *Caricetalia curvulae* BR.-BL. 1926 em. KRAJINA 1934. According to NORDHAGEN the chionophytic dwarf shrub heaths should be classified in the *Phyllodoco-Vaccinion myrtilli* NORDH. 1936 and the anemophytic ones in the *Loiseleurio-Vaccinion uliginosi*

Br.-Bl. 1926 (syn.: *Loiseleurio-Arctostaphylion* Kalliola 1939), which two alliances, in his opinion, are to be grouped in one order, the *Vaccinio-Piceetalia* Br.-Bl. 1939 (syn.: *Rhodoretalia ferruginei* Br.-Bl. 1939; see the above). This classification has been generally accepted until its recent revision by Dahl (1957).

Dahl (l.c., p. 85–167) considers it — in Rondane, Norway — difficult to accept a separation of the various types of grass and dwarf shrub heath even at the level of alliance, in consequence of his elaboration of Nordhagen's floristic-ecological approach to their classification. He arrives at grouping the chionophytic (or seasonally wet), relative mesophytic grass as well as such dwarf shrub heaths in a new order, the *Deschampsio-Myrtilletalia* Dahl 1957, which is divided in three alliances, viz. a *Phyllodoco-Vaccinion myrtilli* Nordh. 1936 em. Dahl 1957 (low alpine, medium chionophytic dwarf shrub and related grass heath communities), a *Deschampsio-Anthoxanthion* (Du Rietz 1942) Dahl 1957 (low alpine, more extreme chionophytic grass heaths) and a *Nardo-Caricion bigelowii* Nordh. 1936 em. Dahl 1957 (low and middle alpine, seasonally wet grass heaths with a variable snowcover and often frozen in ice in winter). This *Deschampsio-Myrtilletalia* should presumably be grouped in the *Juncetea trifidi.*

Dahl (l.c.), on the contrary, classifies the anemophytic, "chinophobous", xerophytic grass and dwarf shrub heaths in a single, new alliance, the *Arctostaphylo-Cetrarion nivalis* (*Loiseleurio-Vaccinion uliginosi* Br.-Bl. 1926 + *Juncion trifidi* (*scandinavicum*) Krajina 1934 em. Nordh. 1936 p.p.), which also belongs to the *Juncetea trifidi.*

The grass and dwarf shrub heaths in Greenland have mainly been studied by Böcher (1933, 1954, 1963). Böcher does not apply the classification system of the Zürich-Montpellier school. He groups these heaths in complexes or groups of plant communities on the basis of ecogeographical criteria, approaching Dahl's classification, or on the basis of the physiognomy, floristic composition and ecology, approaching the central European classification (Böcher 1954, respectively 1963).

In the Angmagssalik District anemophytis grass heaths are mainly represented by very open *Juncus trifidus* communities, which physiognomically should be described as barrens or fell-fields. They are not directly comparable with the more or less closed *Juncus trifidus* grass heaths described from alpine Fennoscandia by, for instance, Dahl (1957), Nordhagen (1928, 1943) and Resvoll-Holmsen (1920). These fell-field communities are not described here. They, and the other fell-field communities, have been studied by H. F. Ferwerda; his studies will presumably be published in the near future.

Chionophytic grass heaths are represented in the district by the two associations described below. These heaths are common in the

coastal areas of the district, in particular on sandy slopes they may cover comparatively very extensive tracts, for instance, along the northern side of the Blomsterdalen valley. They are very conspicuous in the field, forming low and dense, extensive, yellowish green meadows or grassy slopes.

In my opinion these chionophytic grass heaths belong evidently to the *Nardo-Caricion bigelowii* NORDH. 1936. DAHL's division of this alliance in a *Deschampsio-Anthoxanthion* and a *Nardo-Caricion bigelowii* with a more restricted concept may be justifiable in comparatively continental areas, but, as DAHL reflected himself (DAHL, l.c. p. 129) seems not to fit the conditions in more oceanic areas. In consequence it is not accepted in the present study. I agree with DAHL that the *Nardo-Caricion bigelowii* s.l. should be grouped in his *Deschampsio-Myrtilletalia* together with the related dwarf shrub communities of the *Phyllodoco-Vaccinion myrtilli.* The order is presumably most "naturally" classified in the *Juncetea trifidi.*

In calcareous areas in the alpine to subalpine regions of central and northern Europe and in the Arctic the *Juncetea trifidi* is replaced by various communities of the *Elyno-Seslerietea* BR.-BL. 1948 ("Alpin-nordische neutro-basophile Urwiesen" or "-Trockenrasen", "Alpin-subalpine Kalksteinrasen"), which is to some extent also related to the *Koelerio-Corynephoretea.* This class comprises two phytogeographically differentiated orders (cf. BRAUN-BLANQUET 1949, p. 20), the central European *Seslerietalia coeruleae* BR.-BL. 1926 (syn.: *Elyno-Seslerietalia* NORDH. 1936) and the Fennoscandian-Arctic *Elyno-Dryadetalia* BR.-BL. 1949. The *Elyno-Dryadetalia* in turn comprises at least two alliances, the *Kobresio-Dryadion* NORDH. (1935)1943 (incl.: *Caricion nardinae* NORDH. 1935, *Elynion bellardii* (*boreo-arcticum*) NORDH. 1936, *Dryadion octopetalae* KALLIOLA 1939; xerophytic grass (sedge) and dwarf shrub heath communities) and the *Potentillo-Polygonion vivipari* NORDH. 1936 (mesophytic meadow communities).

The communities representing the *Kobresio-Dryadion* in the Angmagssalik District will be described and discussed by F. J. A. DANIËLS in a future publication in this series dealing with dwarf shrub heath vegetation.

The *Potentillo-Polygonion vivipari* is very rare in the district, and will be treated briefly here (see 9.). For details, see NORDHAGEN (1936, p. 35–43) and KALLIOLA (1939, p. 119, 132–137).

8. Class *Juncetea trifidi* HADAČ apud KLIKA & HADAČ 1944.

syn.: *Caricetea curvulae* BR.-BL. 1948.

This class comprises (open to) closed, mesophytic to xerophytic grass and dwarf shrub heath communities in sandy to stony, very acid,

(more or less) humus-rich and oligotrophic soils in the arctic and alpine areas of Europe and in Greenland. They are dominated by graminoid hemicryptophytes, partly also by chamaephytes, and vicariate with the lowland to subalpine, partly closely related *Nardo-Callunetea* PREISING 1949.

Faithful taxa are, with the exception of several taxa also characteristic of the *Nardo-Callunetea* communities at high altitudes, *Juncus trifidus* L., *Hieracium alpinum* L., *Anemone vernalis* L., *Euphrasia minima* JACQ., *Antennaria dioica* (L.) GAERTN. ssp. *borealis* CAMUS, *Sesleria disticha* (WULF) PERS.; also in the *Sedo-Thymion drucei: Luzula spicata* (L.) DC., *Viscaria alpina* (L.) DON. (cf. BRAUN-BLANQUET 1949; HADAČ 1956, 1962; and others).

8.1. Order *Deschampsio-Myrtilletalia* DAHL 1957.

See for a brief characteristic the introduction to this chapter. The communities of the order occur in stable, frequently more or less podzolidized, comparatively deep, sandy, non-calcareous soils covered with snow in winter until spring or early summer and underneath the snow often covered with ground ice; in spring the soils are wet because of irrigation by meltwater, later they become dried out to a various extent, to become more or less wet again in the autumn due to snow and rainfall in periods with alternating frost and thaw.

Faithful taxa are: *Phyllodoce coerulea* L., *Lycopodium alpinum* L., *Nardus stricta* L., *Orthocaulis floerkei* BUCH, *Lecidea uliginosa* (SCHRAD.) NYL.; preferent are for example *Deschampsia flexuosa* (L.) TRIN., *Vaccinum myrtillus* L., *Moerckia blyttii* (MOERCH) BROCK., *Cladonia uncialis* (L.) HOFFM., *Stereocaulon paschale* (L.) HOFFM., *Lecidea granulosa* (EHRH.) SCHAER., *L. rufofusca* ANZI.

The syntaxon occurs in the alpine and subarctic parts of North Europe and in sub and low-arctic Greenland. It vicariates with the alpine, central European *Caricetalia curvulae* BR.-BL. 1926 em. KRAJINA 1934 (*Caricetalia curvulae* BR.-BL. 1926 + *Vaccinio-Piceetalia* BR.-BL. 1939 pro min. p.), to some extent also with the lowland to subalpine *Nardetalia* (OBERDORFER, 1949) PREISING 1949 of the boreal and temperate, atlantic to subcontinental parts of Europe (cf. 8; DAHL, 1957).

8.1.1. All. *Nardo-Caricion bigelowii* NORDH. 1936 (sub. nom. *Nardeto-Caricion rigidae*).

syn.: *Deschampsio-Anthoxanthion* DU RIETZ 1942; *Nardo-Caricion bigelowii* NORDH. 1936 em. DAHL 1957 + *Deschampsio-Anthoxanthion* (DU RIETZ 1942) DAHL 1957.

For details see above. Faithful taxa (mainly preferent-selective) of this seasonally wet, mesophytic to xerophytic and hemicryptophytic graminoid syntaxon are: *Nardus stricta* L., *Anthoxanthum odoratum* L. ssp. *alpinum* LÖVE, *Deschampsia atropurpurea* (WBG.) SCHEELE, *Agrostis*

Table XXVIII

reference number		1	2	3	4	5	6
altitude (m)		50	20	20	15	80	30
inclination		5	10	0	5	0	5
orientation		S	S	SSE	SE	–	N
total cover plants (in %)		100	100	80	100	100	100
cover phanerogams	–	50	70	60	70	60	65
– cryptogams	–	80	70	60	75	80	70
– litter	–	15	20	50	40		15
– open soil	–	0	0	0	0	0	0
pH rhizosphere		4 3/4	4 3/4	4 3/4	4 3/4	4 1/2	4 1/4
Hieracium alpinum	L	2	4	2	4	4	4
Carex bigelowii	L	4	2	4	3	4	4
Cerastium alpinum	L	+	+	+	1	+	3
Luzula spicata	L	+	+	+	+	..	+
Salix herbacea	L	2	3	+	..	2	2
Polygonum viviparum	A	1	2	1	+	+	..
Stereocaulon paschale s.l.		2	4	4	5	3	1
Cladonia ecmocyna		3	+	1	2	3	3
Cladonia mitis		2	+	1	1	2	1
Cetraria islandica		1	1	1	2	+	2
Drepanocladus uncinatus		3	2	3	1	1	+
Barbilophozia hatcheri		..	+	3	2	3	2
Cladonia rangiferina		..	+	+	1	2	2
Dicranum scoparium		..	1	..	1	3	3
Cetraria crispa		+	..	..	1	1	1
Festuca vivipara	L	1	1	1	+	..	..
Cladonia gracilis		2	+	1	+	..	..
Aulacomnium palustre		4	4	..	..	..	..
Peltigera canina s.l.		1	+	..	..	..	..
Cladonia coccifera		+	+	..	..	..	..
Poa alpina	L	1	..	..	2	+	+
Peltigera aphthosa		+	..	..	..	+	1
Campanula gieseckiana	L	..	1	2	+	..	..
Chamaenerion angustifolium	B	..	+	2	+	..	..
Taraxacum croceum	L	..	..	1	+	..	..
Thalictrum alpinum	L	..	1	1	..	..	..
Potentilla crantzii	L	..	+	+	..	..	..
Polytrichum juniperinum		1	..	..	..	1	..
Polytrichum alpinum		1	..	..	..	..	+
Agrostis borealis	L	..	..	..	..	+	..
Antennaria canescens	L	..	..	..	..	+	..
Carex capitata	?L	..	..	1	..	..	..
Deschampsia alpina	L	..	..	..	..	+	..
Poa arctica	A	..	..	+	..	..	..
Sedum rosea	L	1	..	..	..	..	..
Silene acaulis	A	..	..	..	..	..	+

(continued)

Table XXVIII (continued)

reference number		1	2	3	4	5	6
Trisetum spicatum	A	+	..	..	..	..	..
Lophozia alpestris		2	..	..	..	..	..
Ptilidium ciliare		..	..	..	..	..	2
Cladonia lepidota		1	..	..	..	..	..

Not recorded in the table are: *Bryum elegans* in sample plot 6(+); *Desmatodon latifolium* 1(+); *Hylocomium splendens* 2(+); *Racomitrium canescens* 1(+); *Tortula ruralis* 2(+); *Cetraria delisei* 1(+).

borealis HARTM., *Carex brunnescens* (PERS.) POIR., *C. lachenalii* SCHKUHR., *C. bigelowii* TORR. (syn.: *C. rigida* GOOD), *Luzula frigida* (BUCH.) SAM., *L. wahlenbergii* RUPR., *Cetraria delisei* (BORY) FRIES (cf. 8. and 8.1.; also NORDHAGEN, 1936, 1943; GJAEREVOLL, 1956).

The area of the alliance is restricted to the alpine-subarctic areas of Northern Europe and sub to low-arctic Greenland. In the Angmagssalik District in more chionophytic, hygrophytic and eutrophic conditions it is replaced by the *Ranunculo-Oxyrion digynae* (6.1.2.).

8.1.1.1. Ass. *Hieracio-Caricetum bigelowii* ass.nov.

tabl 28.

composition: Faithful taxa (or differential taxa combination) are (is) *Hieracium alpinum* L., *Stereocaulon paschale* (L.) HOFFM., both optimal; differential taxa as regards the *Caricetum bigelowii* are *Festuca vivipara*, *Dicranum scoparium*, *Drepanocladus uncinatus*, *Cladonia ecmocyna*, *C. gracilis*, *C. mitis*, *C. rangiferina*. *Carex bigelowii* is dominant or codominant. Boreal taxa such as *Nardus stricta*, *Anthoxanthum odoratum* are absent, except *Chamaenerion angustifolium*. Accessory taxa with a high frequency of occurrence are *Cerastium alpinum*, *Luzula spicata*, *Polygonum viviparum*, *Salix herbacea*, *Cetraria crispa*, *C. islandica*, *Barbilophozia hatcheri*.

Many of the observed taxa are mesotrafent to oligotrafent, in particular the cryptogamic ones. The syntaxon is rich in taxa, on an average the number of taxa observed in one sample plot is abt. 22.5 of which on an average 10 are phanerogams. Cryptogams, especially lichens, are qualitatively and quantitatively prominent.

physiognomy: The predominantly hemicryptophytic, partly also geophytic community is stratified in two layers: (1) a several centimeters high, dense bottom layer dominated by lichens, bryophytes and *Salix herbacea*, and (2) a rather closed, 19 to 28 cm high field layer dominated by *H. alpinum* and *C. bigelowii*.



Fig. 59. The *Hieracio-Caricetum bigelowii* along the inner part of Kong Oscars Havn at the entrance to Sermilikvejen valley.
JGdM phot. VIII. 1968.

It forms dense, occasionally more or less open, yellow to glaucous green grass heaths with a dull, grayish undertone owing to the lichens in the bottom layer, and dominated from afar by the bright, pale yellow flowers of *H. alpinum* (fig. 59).

synecology & habitat: The low-arctic, more or less oceanic, (xerophytic to) mesophytic, somewhat mesotrafent to oligotrafent, and little minerotrafent, (extreme to) medium acidophytic, chionophytic community occurs in the Angmagssalik District in the coastal areas up to at least 80 m a.s.l. It covers limited to extensive tracts on exposed, usually not distinctly orientated level to slightly sloping (up to 10°), usually somewhat convex or hummocky sites or low ridges in valleys of streams or brooks, sometimes in dry valleys which serve as overflow of isolated lakes or ponds (fig. 59), or associated with higher, moist slopes, in deep sandy soils.

The substrate consists of predominantly fluviatile, partly presumably also niveo-aeolian and (secondarily) colluvial medium fine to coarse sandy, stratified deposits of 33 to usually 100 cm depth or more. It is due to eluviation presumably poor in nutrients. Superficially it is very rich in humus to peaty, deeper down it consists of more or less humic to mineral sand occasionally containing thin, buried peaty layers. It is

covered by a 3 to 10 cm thick, loose, airy layer of raw humus and litter. The rhizosphere is not deep, several plants such as *H. alpinum* and *Polygonum viviparum* root mainly in the raw humus layer.

The snow cover is thin but continuous during the whole winter. It is laid in early autumn and melts off from late May to the middle of June. In spring the substrate is irrigated by local melt water and by ground water supply from the higher parts of the valleys and their slopes. Later on it dries out gradually, which process is limited by prolonged subterraneous water supply, the protection offered by the 1 to $2^1/_2$ cm thick moss layer and the raw humus and litterlayer, and by the often comparatively limited insolation owing to local physiography. Ground water was never reached in profile-pits of 50 cm depth which were dug in middle to late August, whereas the soil was always found to be quite moist.

The colorimetric pH at 5 to 10 cm depth varies from $4^1/_4$ to $4^3/_4$ and is on an average abt. 4.6.

succession & zonation: The course of the succession is not clear. The zonation is very variable. In general the stands occur below less chionophytic dwarf shrub heaths, lichen heaths or fell-field vegetation, and above more chionophytic communities of the *Salicetalia herbaceae.*

distribution: The syntaxon is not very common in the Angmagssalik District (Blomsterdalen, Sermilikvejen valley). I have not found directly comparable vegetation descriptions from elsewhere in or outside Greenland. The syntaxon seems thus to be more or less endemic or to have its centre of optimal development in Southeast Greenland, comparable with the *Caricetum bigelowii.*

syntaxonomy & discussion: The syntaxon shows some affinity to the more or less medium chionophytic and seasonally wet communities of northern alpine Europe as mentioned on p. 235, in particular considering the development of the bottom layer and the ecology. It differs on the other hand in the general floristic and phytogeographical composition especially of the field layer, to the same extent as the *Caricetum bigelowii* (see p. 236, (a) and (b)). These differences and the floristic and ecological differences with the *Caricetum bigelowii* justify in my opinion the distinction of a separate association, which needs further research.

Hieracium alpinum appears to attain a comparatively high frequency of occurrence (50 %) in the *Polytricho-Caricetum bigelowii* Dahl 1957, namely in the "facies" *caricetosum brunnescentis* Dahl 1957; in all other northern alpine and arctic, northern atlantic grass heaths dominated or codominated by *C. bigelowii* it is rare or absent.

In less stable substrate of mainly colluvial origin and subjected to creep and/or superficial wind erosion in summer I observed more open, more or less fell-field-like, fragmentary stands of the community.

8.1.1.2. Ass. *Caricetum bigelowii* BÖCHER 1933 em.nov.

syn.: non *Carex rigida*-Ass. NORDH. 1928, non *Caricetum bigelowii* GJAEREVOLL 1950.

table 29.

composition: Faithful taxa are *Carex bigelowii* TORR., *Taraxacum croceum* DAHLST., *Chamaenerion angustifolium* (L.) SCOP., *Campanula gieseckiana* VEST, *Bryum elegans* NEES (all preferent-selective, possibly best to be taken as a differential taxa combination). Boreal graminoid taxa are absent (cf. 8.1.1.1.). Frequent accessory taxa are for instance *Cerastium alpinum* (constant), *Luzula spicata*, *Polygonum viviparum*, *Poa alpina*, *Salix herbacea*, *Cetraria islandica.*

The number of taxa recorded per sample plot varies considerably. The syntaxon is in consequence heterotonous; the subunits, in contrast, have a high degree of homotony. In particular bryophytes and lichens are quantitatively rare.

physiognomy: The predominantly hemicryptophytic, to a considerable extent also geophytic and chamaephytic community is stratified in 2 to 4 layers, in (1) an, owing to the high rate of niveo-aeolian sedimentation, usually fragmentary developed bottom or moss layer, (2) an absent to variably developed, not always distinctly differentiated, low undergrowth layer with *Salix herbacea*, (3) a well-developed, dense field layer or lower field layer dominated by *Carex bigelowii*, and (4) an absent to variably developed, not always distinct higher field layer of tall, well thriving herbs such as *Chamaenerion angustifolium*, *Campanula gieseckiana*, *Taraxacum croceum.* The general appearance of the different units of the syntaxon is that of yellow to glaucous green, dense meadows.

synecology & habitat: The low-arctic and more or less oceanic, xerophytic to mesophytic, mesotrafent, (extreme to) medium chionophytic, extreme to medium acidophytic community occurs in the Angmagssalik District in particular in the coastal areas where it covers extensive tracts, but also in the inland, up to at least 550 m a.s.l. on predominantly South-facing, 5 to 25° (to 60°) sloping, deep sandy slopes.

The substrate consists of niveo-aeolian (sometimes partly fluviatile) sand deposits of (mostly) over 60 cm depth. A distinct macro-soil profile is not developed. It is intermediately rich in minerals and superficially more or less humic.

The habitat is continuously snow-covered during the whole winter; the depth of the snow cover varies. Water supply is mainly restricted to the period of snow melt (May–June) and rainy periods. The water sinks quickly to considerable depth owing to the coarse texture of the soil.



Fig. 60. The northern slope of Blomsterdalen. High on the slope *Salix glauca* scrub in shallow soil, lower *Carex bigelowii* grass heath in deep sandy soil which, in the lower right corner of the picture, is affected by erosion.
JGdM phot. VII. 1968.

The soil is consequently dry during most of the vegetative period. The ground water is moving, mostly at comparatively great depth, viz. in early summer already below 60 to 75, usually even below 150 m depth.

The environment is more or less dynamic; it is subjected to annually variable, discontinuous sedimentation of niveo-aeolian sand and allochtonous vegetative material during the thaw period in spring; occasionally it can be subjected to limited solifluction.

The colorimetric pH at 5 to 10 cm depth varies, presumably depending on the rate of sedimentation, from 4 to $5^1/_2$; at greater depths it decreases to values less than 4.

succession & zonation: The community is usually found bordering upon *Salix glauca* scrup on shallower soil, which presumably precedes the syntaxon in the succession. Between the scrub and the meadows there is often a narrow zone of low, greyish lichen vegetation, dominated by various *Cladonia (Cladina)* species.

distribution: The association is common in the Angmagssalik District; it also occurs more to the North and South of it, probably more or less fragmentarily and also here and there, presumably not optimally developed in the middle West Greenland (Böcher, 1933, p. 51–54, p. 60 and 1963, p. 149).

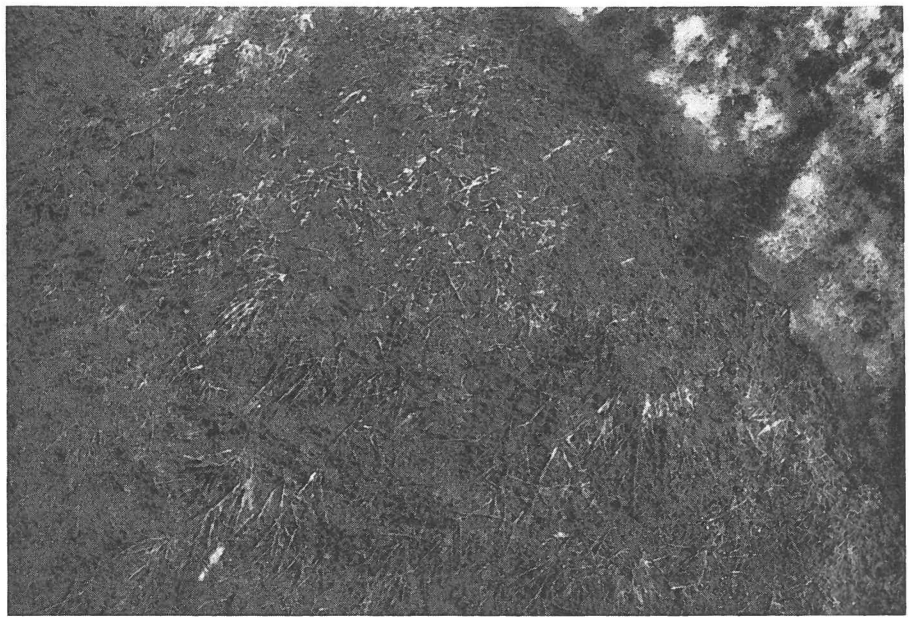


Fig. 61. Niveo-aeolian material covering *Carex bigelowii* grass heath, left behind by the melting snow cover which is still partly seen in the upper right corner of the picture.
JGdM phot. VI. 1968.

subdivision: The subdivision is primarily based on floristic differences correlated with differences in depth and persistence of the snow cover, secondarily on similar characteristics correlated with the depth of the substrate and the water supply.

syntaxonomy & discussion: See p. 235–236.

8.1.1.2.1. subass. *chamaenerietosum angustifolii* (BÖCHER 1933) subass.nov.

syn.: *Caricetum rigidae* BÖCHER 1933.

table 29:1–13.

composition: Differential taxa are *Campanula gieseckiana*, *Chamaenerion angustifolium*, *Cerastium alpinum*, *Luzula spicata*, *Taraxacum croceum*, *Cetraria islandica*, *Bryum elegans*, *Stereocaulon paschale* s.l. Rare, and quantitatively poorly represented are more chionophytic, moisture-indicating taxa such as *Salix herbacea*, *Polytrichum juniperinum*. The syntaxon is usually rich in taxa, on an average there are abt. 15 taxa in one sample plot, of which on an average 9 are phanerogams.

physiognomy: See the association. The community is stratified in 2 to 3 layers, in (1) an usually poorly or fragmentarily developed bottom layer of bryophytes and lichens which covers 0 to 25 %, (2) a well-developed, dense, 10 to 20 cm high lower field layer dominated by *C. bigelowii*,



Fig. 62. Soil profile below *Carex bigelowii* grass heath (8.1.1.2.1.); depth of the pit about 1.75 m.
JGdM phot. VII. 1969.

and (3) a (more or less) open, often poorly differentiated, up to 40 cm high upper field layer with tall herbs and grasses (*C. angustifolium*, *C. gieseckiana*, vigorously flowering *T. croceum*, *Poa alpina*). It forms conspicuous, very extensive "grass-slopes" (cf. BÖCHER, 1933, p. 51) or grass heaths, of a characteristic yellow-green which turns to (greenish) yellow in late summer, physiognomically more or less dominated by the various tall herbs (fig. 60, 64; cf. NORDENSKIÖLD, 1885; KRUUSE, 1912, p. 248).

synecology & habitat: The medium chionophytic community occurs in the coastal area up to 550 m a.s.l.; it is in particular well-developed in the surroundings of Angmagssalik between 10 and 150 m elevation. It is characteristic of South-facing, 5 to 20° (to 30°) sloping, extensive, deep sandy slopes and subjected to a variable, often high rate of supply of sand.

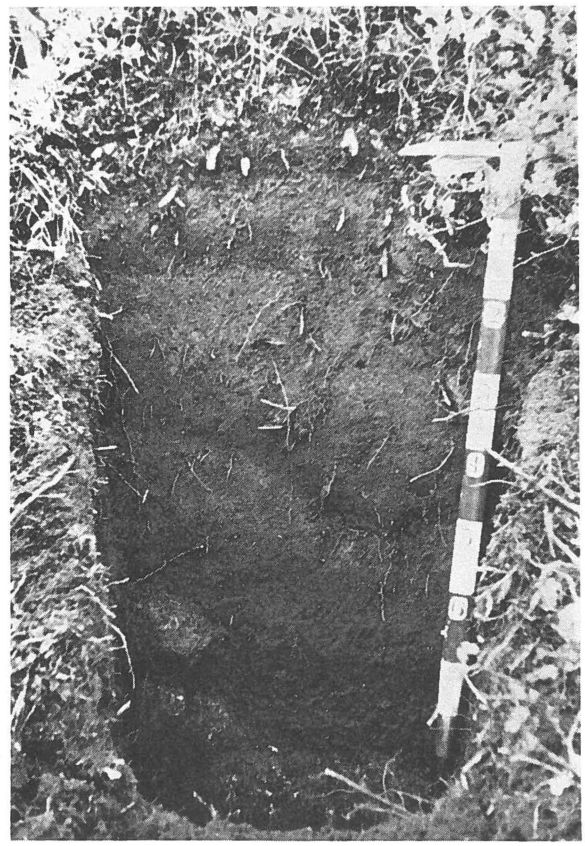


Fig. 63. Soil profile below *Salix glauca* scrub; depth of the pit about 0.90 m. FJAD phot. VII. 1969.

The snow cover is thin, but continuous during the whole winter. Usually it is not thicker than 20 cm, though on exception considerably thicker. It covers the slopes from early autumn, and under alternating thaw and frost the upper layer freezes together to a 5 to 10 cm thick icy crust or "harst" under which the snow re-crystallizes to coarse-grained, loose "corn" or "buckshot" snow; sometimes old harsts are buried by fresh snow, on top of which a new harst can develop (cf. also KRUUSE, 1912, p. 246). The snow melts away from early May, and has disappeared already for the greater part in early to middle June (cf. also KRUUSE, l.c., p. 63).

The substrate consists of more than 60 cm, usually more than 2 m thick deposits of niveo-aeolian, coarse to medium fine sands very poor in fines. This material is mainly derived from weathered charnockitic granulite rocks and is especially rich in hypersthene. The soil profile shows in general a distinct stratification in layers of a few centimeters thickness,

to a depth of more than 1 m, presumably caused by discontinuous sedimentation (fig. 61, 62). A distinct differentiation in pedogenetic horizons is absent, but in the soil layers at the surface there are a series of repeated, deeper down readily obscured micro-A(B)C-profiles. The ground is usually covered by a thin layer of recently deposited loose sand mixed with allochtonous vegetative material and autochtonous litter. The humus content of the soils decreases gradually with increasing depth. At greater depth, usually below 1 m depth, the soil profile appears to resemble the profile commonly found below *Salix glauca* scrub on comparable niveo-aeolian soils of less than 50 to 100 cm thickness, viz. by the occurrence of 5 to more than 10 cm thick very compact brown to blackish humic layers alternating with lighter coloured, less humic strata (fig. 63).

The substrate is superficially dry owing to the texture and the spatially isolated occurrence of these sandy slopes as regards higher areas which potentially might supply ground water. Moving ground water occurs at great depths presumably at least until early to mid-summer, as moisture indicating vegetation (*Ranunculo-Oxyrion digynae*) commonly is found at the foot of these slopes where the ground water comes closer to the surface and the soil remains moist until that time. On 29 June 1969 I dug a profile-pit to a depth of 2.30 m and reached moving ground water there at a depth of slightly over 1.50 m.

The roots of the sedges form a coherent sod to a depth of abt. 35 cm; individual roots may reach a depth of 50 to 135 cm.

At present the process of sedimentation is still active, but in many places the meadows are affected by strong wind erosion which causes deep, regressing holes and gullies often secondarily worn by temporary, spatial concentration of melt water discharge, and in which deep snowdrifts accumulate in winter (see fig. 60).

The colorimetric pH at 5 to 10 cm depth below the ground surface varies from 4 to 5 and is on an average abt. 4.7.

zonation & succession: A common zonation is given above (cf. also p. 227). In secondary erosion holes open, chionophytic *Oxyria digyna* vegetation may develop, while *C. bigelowii* may invade along the comparatively little steep edges. The soil profiles suggest a course of succession similar to the spatial zonation from fell-field on shallow soils, followed by *Salix glauca* scrub on moderately deep soil, followed by a succession stage dominated by lichens, ending with this type of vegetation on deep soils.

distribution: The community is locally very common in the southern part of the Angmagssalik Ø around the Kong Oscars Havn and also at Tasîlâlik, where it represents one of, if not the most extensive non-ligneous vegetation types (not considering the mires and fell-fields). It occurs also at Kangerdlugssuaq on the East coast and here and there in

middle west Greenland (BÖCHER, 1933, p. 53, 1954, p. 60 and 1963, p. 149).

subdivision: There is, in particular physiognomically, a sometimes distinct variation in this vegetation type. This is caused by the alternating optimal occurrence of otherwise common, more or less constant taxa under certain environmental conditions. Since this variation is mostly of a quantitative nature and the differences in environment underlying this are slight, I prefer to distinguish the subunits of this syntaxon as variants. This results in a subdivision into:

(a) a variant of *Campanula gieseckiana* (table 29:1–5; fig. 64), the least eutrafent, minerotrafent and mesophytic type, which is characterized by a comparatively well developed moss layer, both quantitatively and qualitatively comparatively rich in lichens, and the preferent occurrence of *Campanula gieseckiana*. It occurs commonly along the edge above erosion holes in deep, dry soil. In this variant I also group a more or less initial type from the summit of the Sømandsfjeldet (table 29:1).

(b) a variant of *Luzula spicata* (table 29:6–9), an intermediary type on comparatively steep sloping soils which are superficially occasionally somewhat affected by creep. *Dicranum scoparium* is also characteristic.

(c) a variant of *Taraxacum croceum* (table 29:10–13; fig. 50), the most eutrafent, least xerophytic type. It occurs in particular at the higher parts of the slopes, occasionally also at the lower parts, where the water supply is comparatively the largest (as indicated for instance by the occurrence of *Oxyria*, *Viola*) and where there is comparatively much supply of niveo-aeolian sand. *T. croceum* does not thrive so well in the other two variants, where most plants are more or less dwarfed and do not flower.

8.1.1.2.2. Subass. *salicetosum herbaceae* subass.nov.

table 29:14–18.

composition: Differential taxa are *Salix herbacea*, *Polygonum viviparum*, *Polytrichum juniperinum*, all more or less selective. The syntaxon is comparatively intermediately rich in taxa, on an average there are almost 12 taxa in one sample plot, of which on an average more than 8 are phanerogams.

physiognomy: The predominantly geophytic and chamaephytic, partly also hemicryptophytic community is stratified in 2 to 3 layers, in (1) a poorly developed, open bottom layer of bryophytes and lichens, (2) a variably developed, not always distinct, up to 6 cm high undergrowth layer composed of *Salix herbacea*, and (3) a well developed, closed field layer of mostly graminoid plants from 10 to 26 cm high.



Fig. 64. Variant of *Campanula gieseckiana* of the *Caricetum bigelowii* subass. *chamaenerietosum angustifolii*.
JGdM phot. VII. 1968.

The general appearance differs little from that of the previous type. It has a darker undertone and tall herbs, when present, are less well thriving and changing the general physiognomy. It resembles 6.1.2.3.1. (cf. fig. 47).

synecology & habitat: The mesophytic, mesotrafent community occurs in the district in the coastal and inland areas up to 130 m elevation, on predominantly Southwest-facing, 5 to 25° sloping, flat to slightly concave, sometimes more or less hummocky parts of slopes of consolidated debris (old block fields) covered with more than 80(120 to 150?) cm deep deposits of mainly niveo-aeolian, medium fine to coarse sand.

The snow cover is presumably somewhat deeper and longer persistent than over the previous subassociation.

The litter is usually differentiated in a lower, comparatively compact layer of mostly autochtonous *S. herbacea* litter on the moss layer (cover 50 % or more) and an open, loose litter layer of *C. bigelowii* plant rests on top of this (cover 20 to 50 %). The annual supply of sediments is considerable, and partly buries the litter and the cryptogams; also the stolons of the sedge and the creeping stems of the willow are usually found relatively deeply buried.

The substrate is not clearly differentiated in horizons. Superficially it is commonly rich in humus, deeper down it is poor in humus and fines.

Table XXIX

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
altitude (m)		550	30	80	60	80	55	130	80	50	100	80	120	30	120	125	95	130	60	510	480	150	500
inclination		5	5	15	5	10	10	15	10	20	5	5	5	15	5	10	25	5	0	20	15	10	10
orientation		E	S	S	S	S	SSE	SW	S	SW	SW	S	S	SE	SW	SW	SW	S	S	SW	SW	SE	SW
total cover plants (in %)		60	50	80	75	75	70	60	75	75	100	70	80	75	70	100	80	90	100	60	90	65	90
cover phanerogams	–	50	45	75	60	65	70	60	75	75	100	70	80	75	70	100	80	90	95	55	90	75	90
– cryptogams	–	25	5	10	25	25	5	1	5	5	5	1	0	5	2	10	1	5	15	1	0	0	1
– litter	–	30	30	30	30	70	30	35	50	40	25	60	30	20	50	50	60	50	–	50	90	90	60
– open soil	–	20	30	10	15	0	10	10	0	0	0	0	30	15	–	0	0	0	0	0	0	0	0
pH rhizosphere	–	4 1/4	5	4 1/2	4 3/4	4 3/4	–	4 3/4	4 3/4	4 3/4	4 3/4	5	4	4 3/4	5 1/2	5	4 1/2	4 1/4	4 1/4	–	5 1/2	4 1/4	4 1/2
Carex bigelowii	L	4	3	4	4	5	5	4	4	4	5	4	4	5	5	5	5	6	6	5	6	6	6
Cerastium alpinum	L	2	2	1	2	+	+	1	+	2	1	1	1	..	..	..	..	+	+	..	..	..	..
Chamaenerion angustifolium	B	..	..	2	2	2	1	1	4	3	3	3	2	..	2	1	..	..	..	..	..	..	..
Campanula gieseckiana	L	1	3	4	2	2	1	+	+	..	1	..	+	..	..	..	..	..	..	..	..	..	..
Luzula spicata	L	+	1	1	1	..	3	2	2	3	..	..	..	1	..	..	..	..	..	+	..	..	..
Taraxacum croceum	L	..	+	1	+	+	+	2	+	1	3	3	2	4	1	3	+	..	..	..	..	..	..
Salix herbacea	L	2	..	..	..	..	..	..	+	..	+	..	..	..	4	5	4	4	2	1	1	+	..
Polygonum viviparum	A	1	..	..	..	..	..	..	+	2	2	..	..	..	+	2	+	1	4	..	..	..	..
Cetraria islandica		+	1	1	2	+	1	+	..	+	..	1	..	+	..	..	..	..	..	..	..	..	..
Stereocaulon paschale s.l.		2	+	1	..	+	+	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cladonia mitis		+	+	+	+	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Peltigera canina s.l.		+	..	+	+	..	+	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..
Cladonia ecmocyna		2	..	+	+	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bryum elegans		+	1	1	+	..	+	+	..	..	..	+	..	+	..	..	..	..	..	..	..	..	..
Barbilophozia hatcheri		+	+	+	2	4	1	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Dicranum scoparium		+	1	..	..	..	1	+	+	+	..	..	..	..	..	..	..	..	+	..	..	..	..
Thalictrum alpinum	L	..	+	..	..	+	..	..	4	..	2	1	..	..	..	..	..	..	..	..	..	..	..
Drepanocladus uncinatus		..	..	..	..	..	..	..	+	1	1	..	..	..	..	..	+	..	..	..	..	..	..
Poa alpina	L	..	..	..	+	..	..	..	+	..	..	2	1	..	..	..	..	..	+	+	+	..	..
Polytrichum juniperinum		..	..	..	..	..	..	..	+	+	..	..	..	..	+	2	+	+	+	(+)	..	..	..
Poa arctica	A	..	..	..	..	+	..	..	..	1	..	..	..	..	+	+	+	..	..	+	+	..	..
Sibbaldia procumbens	L	..	..	..	..	..	..	..	..	..	..	..	..	..	+	+	+	..	..	+	..	..	..
Bryum capillare		..	..	..	..	..	..	..	..	..	1	..	..	..	+	+	+	..	..	..	..	..	..

Table XXIX (continued)

reference number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Hieracium alpinum	L	..	..	..	+	+	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Trisetum spicatum	A	..	..	..	..	..	..	..	..	+	..	+	..	..	+	..	..	..	..	+	..	..	..
Oxyria digyna	A	..	..	..	..	..	..	..	..	..	2	3	..	..	1	+	..	..	..	..	..	..	..
Brachythecium reflexum		..	..	..	..	+	..	..	+	..	..	..	..	..	+	..	..	..	..	..	..	..	..
Thymus drucei	B	..	1	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Erigeron uniflorus	L	..	+	+	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Carex scirpoidea	L	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Festuca vivipara	L	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Juncus trifidus	L	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Minuartia biflora	L	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phleum commutatum	L	..	..	..	..	..	..	..	..	+	..	..	..	+	..	..	..	..	..	..	..	..	..
Phyllodoce coerulea	L	..	..	..	..	..	..	..	..	..	..	..	..	..	+	+	..	..	..	..	..	..	..
Poa glauca	A	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
Potentilla crantzii	L	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	..	..	1	..	..	..	..
Stellaria calycantha	B	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..
Veronica fruticans	L	..	..	..	..	..	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Viola palustris	B	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..
Viscaria alpina	L	+	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Aulacomnium palustre		..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	1	..	..	..	..
Desmatodon latifolium		..	..	+	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Pohlia nutans		..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Polytrichum commune		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
Polytrichum piliferum		1	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tortula norvegica		..	..	+	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..
Tortula ruralis		..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lophozia alpestris		..	..	..	..	..	..	..	..	+	+	..	..	..	..	..	..	..	..	..	..	..	..
Cetraria crispa		2	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cladonia coccifera		..	..	..	..	..	+	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..
Cladonia gracilis		..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..
Cladonia pyxidata		..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cladonia uncialis		..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Peltigera aphthosa		..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	+	..	..	..	..

Ground water percolates diffusely down through the soils on the higher slopes, gradually diminishing in quantity after mid-summer. It sinks in places quite deep, and below this community the flow seems to be more or less concentrated by subsoil properties and the general physiography in subterraneous channels. These run sometimes audibly through the interspaces in the buried course debris.

The upper part of the soil is irrigated for some time in early summer, later on it is well drained and aerated owing to the sandy texture and the phenomenon described previously. Moving ground water is reached from 40 cm depth (June) to 60–75 cm depth (July).

The colorimetric pH at 5 to 10 cm depth varies from $4^1/_4$ to $5^1/_2$ and is on an average abt. 4.7.

zonation & succession: The community occurs usually surrounded by *Salix glauca* scrub on comparatively shallow soil, rarely in patches in communities of the above described subassociation. It is probably the first community of the *Caricetum bigelowii* developing in places, where this association under conditions of discontinuous sedimentation succeeds communities of the *Ranunculo-Oxyrion digynae*, namely the *Ranunculo-Salicetum herbaceae*, or *Salix glauca* scrub.

distribution: The syntaxon occurs in particular in the inland but also in the coastal areas of the Angmagssalik District (Qingertívaq, Elvbakker-Blomsterdalen; observed also elsewhere); it occurs probably also elsewhere in low-arctic East and West Greenland.

subdivision: A division of the unit on the basis of these five sample plots seems premature but there is a considerable variation.

8.1.1.2.3. Subass. *inops* subass.nov.

table 29:19–22.

composition: The syntaxon is floristically only negatively characterized by the absence of differential taxa; it is very poor in taxa, on an average not more than 4 taxa occur in one sample plot, of which more than three are phanerogams.

physiognomy: The predominantly geophytic community consists of only one well-developed vegetational layer, viz. a 26 to 32 cm (to 50 cm) high graminoid field layer; a fragmentary moss layer with bryophytes and an also fragmentary undergrowth layer or lower field layer composed of *Salix herbacea* and *Sibbaldia procumbens* occurs occasionally.

It looks like dense, luxuriant yellow to glaucous green meadows, which usually cover less extensive tracts than the subass. *chamaenerietosum angustifolii.*

synecology & habitat: The chionophytic community occurs mostly in the inland up to at least 510 m elevation, in the coastal areas mainly at lower altitudes as more or less fragmentary regeneration phases in

wind-eroded holes in the subass. *chamaenerietosum angustifolii* (cf. p. 229). It is found in South-facing, 10 to 20° sloping sheltered sites, on sandy, sometimes hummocky erosion slopes or more or less stabilized screes.

The snow cover is comparatively deep and long persistent.

The substrate consists of a 30 to more than 60 cm deep, somewhat unstable layer of humic, loose, mixed niveo-aeolian and partly secondarily colluvial, predominantly coarse (to medium fine) sand deposits over more or less stabilized old block screes. It is often somewhat island-like elevated with regard to the surroundings, owing to the holding of allochtonous sand. The substrate is wet during the melting period and subjected to limited solifluction, later on it dries out considerably and is then well drained and aerated.

The colorimetric pH at 5 to 10 cm depth varies from $4^1/_4$ to $5^1/_2$ and is on an average $4^3/_4$.

zonation & succession: The community borders generally upon *Salix glauca* scrub, communities of the *Salicetalia herbaceae*, or on open gravelly to stony slopes. It probably succeeds these communities or can probably also occur as a (secondary) pioneer community on bare soil.

distribution: The unit is possibly endemic in Southeast Greenland (Tasîlaq, Qîngertivaq, Ikâsaulaq; fragmentary near Angmagssalik).

syntaxonomy & discussion: Grass heaths in which *Carex bigelowii* is prominent are widely spread in northern Europe. These northern alpine vegetation types are extensively studied namely in Fennoscandia and in Scotland. These studies show that they are related to the Greenlandic *Caricetum bigelowii*. However, there are considerable floristic, phytogeographical and ecological differences.

The extreme chionophytic and seasonally wet *Caricetum bigelowii-lachenalii* Nordh. 1943 nom.mut. (Nordhagen, 1943, p. 250–255; Gjaerevoll, 1949, p. 49–55, 1950a, p. 392–395 and 1956, p. 63–81) and the group of related, less chionophytic and seasonally wet syntaxa to which belong for example the so-called *Caricetum bigelowii* Gjaerevoll 1950 (Gjaerevoll, 1950a, p. 396–397), *Polytricheto-Caricetum bigelowii* Dahl 1957 (Dahl, 1957, p. 162–166, 287, 289, and cited references), *Polytricheto-Caricetum bigelowii* sensu McVean & Ratcliffe 1962 (McVean & Ratcliffe, 1962, p. 72–73), *Carex rigida*-Ass. Nordh. 1928 (Nordhagen, 1928, p. 305–309), *Dicraneto-Caricetum bigelowii* (Poore, 1955) McVean & Ratcliffe 1962 (Poore, 1955; McVean & Ratcliffe, 1962, p. 73–74), *Deschampsio-Dicranetum fuscae* Dahl 1957 (Dahl, 1957, p. 134–135), *Carex rigida*-Wiese Kalela 1939 (Kalela, 1939, p. 279), *Cetrario islandicae-Caricetum bigelowii* Hadač, 1971c, p. 208), *Carex bigelowii*-synedria (Lid, 1964, p. 75), are grass heaths from the alpine to subarctic regions of North Europe which differ from the low-arctic *Caricetum bigelowii* in:

(a) the general phytogeographical composition of the field layer, independent of the ecology, by the occurrence of such boreal taxa — which reach commonly into the Subarctic but are absent in the true Arctic — as *Anthoxanthum odoratum*, *Deschampsia atropurpurea*, *D. flexuosa* (which reaches into the southern part of the low-arctic), *Festuca ovina*, *Rumex acetosa*, *Solidago virgaurea*, *Trientalis europea*, *Vaccinium myrtillus* (see the previous cited literature); in the bottom or moss layer, for example, *Cladonia alpestris* occurs. Absent are, in contrast, *Campanula gieseckiana*, *Chamaenerion angustifolium*, and in the bottom layer *Bryum elegans;*

(b) the floristic composition, independent of (a) but correlated with differences in ecology, in particular of the moss layer which is usually both quantitatively and qualitatively considerably better developed. In the field layer occur as ecologically differential taxa *Agrostis borealis*, *Deschampsia caespitosa*, *Luzula wahlenbergii*, *Vaccinium vitis-idaea*, in the moss layer a large number of taxa such as for instance *Dicranum fuscescens*, *Polytrichum alpinum*, *Pleuroclada albescens*, *Ptilidium ciliare*, *Cetraria delisei*, *Cladonia bellidiflora*, *C. ecmocyna*, *C. gracilis*, *C. rangiferina*, *C. sylvatica*, *Nephroma arctica.* These taxa indicate a distinctly more chionophytic and (seasonally) wet habitat.

I consider these differences, in particular those mentioned under (b), of enough importance to follow BÖCHER (1933, p. 51–54) and to regard the *Caricetum bigelowii* as an independent, separate low-arctic and Greenlandic association. If it is related at all, then it is closely so to and also vicarious with the *Polytricheto-Caricetum bigelowii* DAHL 1957 and the *Cetrario islandicae-Caricetum bigelowii* HADAČ 1971 prov. from alpine Norway.

The criteria on which I base the subdivision of the syntaxon are mentioned on p. 226.

Very characteristic of the syntaxon, also physiognomically, is the occurrence of *Chamaenerion angustifolium.* This widely spread taxon does not produce fertile seeds in Greenland (PORSILD, 1935 cited by BÖCHER, 1938, p. 142). In the *Caricetum bigelowii* in the Angmagssalik District I only observed vegetative plants (cf. BÖCHER, l.c.). Sometimes, in sheltered and sunny places it develops flower buds in late August, but the plants wither in September before these open. The taxon occurs here at its northern limit in East Greenland (BÖCHER, 1938, fig. 142) and has presumably spread so far North during warmer times.

9. Class *Elyno-Seslerietea* Br.-Bl. 1948.

This syntaxon is in most respects comparable with the *Juncetea trifidi* (8.), which it replaces in calcareous areas.

Faithful taxa of this class are listed among others by Braun-Blanquet (1948b, 1969) and by Oberdorfer (1957, 1970); faithful in the greater part of the area of the syntaxon are: *Kobresia myosuroides* (Vill.) Fiori et Paol., *Carex ornithopoda* Willd. (var. *castanea* Murb.), *C. rupestris* All., *C. atrata* L., *Silene acaulis* (L.) Jacq., *Dryas octopetala* L. et *D. integrifolia* M. Vahl.

9.1. Order *Elyno-Dryadetalia* Br.-Bl. 1949.

syn.: *Seslerietalia coeruleae* Br.-Bl. 1926 sensu Nordh. (1936) 1943 p.p.

See for details the *Elyno-Seslerietea*, the introduction to this chapter and compare also the non-calciphytic *Deschampsio-Myrtilletalia* Dahl 1957 (8.1.), with which the order vicariates ecologically in otherwise the same geographical area; it occurs also in Alaska. Geographically it vicariates with the alpine, central European *Seslerietalia coeruleae* Br.-Bl. 1926. It is floristically and ecologically more or less related to the *Sedo-Poietalia glaucae* (10.1.).

Faithful taxa are *Arnica alpina* (L.) Olin., *Carex nardina* E. Fries, *C. glacialis* Mack., *Cassiope tetragona* (L.) D. Don., *Draba nivalis* Liljebl., *Oxytropis lapponica* (Wahlenb.) Gaud., *Rhododendron lapponicum* (L.) Wahlenb. and possibly several others (cf. Bringer, 1961; Gjaerevoll, 1954; Kalliola, 1939; Nordhagen, 1928, 1935, 1936, 1943, 1955).

9.1.1. All. *Potentillo-Polygonion vivipari* Nordh. 1936.

This alliance is considered to comprise mesophytic, herb-rich meadow communities dominated by hemicryptophytes, in comparatively deep, stable, basic to neutral and sometimes medium acid, mesotrophic to eutrophic, calcareous substrate which is more or less sloping and moist to seasonally wet, and in winter covered with snow which melts off more or less early in spring. The syntaxon vicariates geographically with the *Caricion ferrugineae* Br.-Bl. 1931 (*Seslerietalia coeruleae;* alpine Central Europe) and ecologically more or less with the *Nardo-Caricion bigelowii* (*Juncetea trifidi, Deschampsio-Myrtilletalia*)

Faithful taxa are: *Polygonum viviparum* L., *Potentilla crantzii* (Cr.) G. Beck., *Thalictrum alpinum* L., *Trollius europaeus* L., *Viola biflora* L., *Saussurea alpina* (L.) DC., *Cerastium alpinum* L., *Poa arctica* R. Br., *P. alpina* L., *Astragalus frigidus* (L.) A. Gray, *Draba alpina* L.,

which are partly differential as regards the other, chamaephytic alliance of the order (*Kobresio-Dryadion* NORDH. (1936)1943), partly selective faithful in general.

9.1.1.1. *Potentilla crantzii-Carex scirpoidea* community.

table 32:1.

In the Angmagssalik District the *Potentillo-Polygonion vivipari* is observed to be represented by one, low-arctic, somewhat chionophytic to anemophytic, mesophytic, medium acidophytic, (eutrafent to) mesotrafent, chomophytic community, which occurs with a single stand in the inner part of Blomsterdalen on a ledge along a nearly perpendicular rockwall exposed to the South. It is irrigated by water oozing down from the higher slope during and after the snow melt period and by rainfall, but also from time to time subjected to strong desiccation. The patch of soil on the ledge is maximally 14 cm deep and consists of medium-fine to coarse sand intensely interwoven with the roots of the plants. The substrate originates from washed down material, derived from disintegrating charnockitic granulite rock. For additional data see the head of the table.

Similar vegetation types are described by BÖCHER (1954, p. 203, table 22: 12, 13, ± 8, and 1963, p. 230, table 25:16, 17) from Southwest and middle West Greenland, as dry herb slope or dry herbaceous vegetation in shallow soil of which he gives one pH measurement (6.5.). Comparing his data with mine I suspect that these vegetation types can be united in a separate association (a "*Potentillo-Caricetum scirpoideae*"), but I consider the material for the time being too heterogeneous and scarce to express a conslusive opinion.

In 1966 MR. DANIËLS observed an apparently related *Carex scirpoidea-Agrostis borealis* "meadow", with as conspicuous taxa *Antennaria canescens*, *Bartsia alpina*, *Hieracium alpinum*, *Polygonum viviparum* and *Trisetum spicatum*, at about 500 m a.s.l. on a 20 to 40° inclined, South-facing slope along the Tasîlaq valley (Tasîlap kua).

Chapter VII

Xerophytic talus-slide and rock vegetation

The more or less closed, xerophytic and thermophytic pioneer communities on dry, more or less stabilized, silicious and oligotrophic to sometimes rich in bases sandy to gravelly shallow soils or intensively weathering rocks which are subjected to extreme temperature fluctuations and extreme desiccation and which occur in the temperate, lowland to alpine regions of Europe, are grouped in the *Koelerio-Corynephoretea*

KLIKA apud KLIKA & NOVAK 1941 ("Sand- und Felsgrus-Trockenrasen", "Sandrasen und Felsgrus-Fluren").

The concept of this syntaxon varies with the different authors. According to recent views it comprises the *Corynephoretalia* R. TÜXEN 1933 em. 1962 (subatlantic communities of drift sand in central and western Europe), the *Festuco-Sedetalia* (*acris*) R. TÜXEN 1951 (communities of stabilized, slightly humic sand in central and northern Europe below the subalpine zone), and the *Sedo-Scleranthetalia* BR.-BL. 1955 (communities of debris and gravel in central Europe, mainly at high altitudes; see the discussion and the cited literature in WESTHOFF & DEN HELD, 1969, p. 145–160).

In Norway we find in the subalpine region corresponding chalicophytic and thermophytic communities on talus-slides poor in calcium. These are brought together in the *Veronico-Poion glaucae* NORDH. 1942, which alliance is not grouped in a higher syntaxon (NORDHAGEN, 1943, p. 544–566). This unit is related to a group of chasmophytic to chomophytic, thermophytic communities which occur in the same region and which are brought together in the *Saxifragion cotyledonis* NORDH. (1936) 1943. This alliance is far less characteristically developed than the corresponding chasmophytic units in Central Europe (NORDHAGEN, 1943, p. 568–569) being poor in obligate chasmophytes. Nevertheless, it is grouped by NORDHAGEN in the *Androsacetalia vandellii* BR.-BL. 1926 (NORDHAGEN, 1936, p. 12–13 and 1943, p. 570–573). In calcareous areas the *Saxifragion cotyledonis* is replaced by the *Asplenion viridis* NORDH. 1936 (*Potentilletalia caulescentis* BR.-BL. 1926); both mentioned orders are classified in the same class, the *Asplenietea rupestris* BR.-BL. 1934.

In Greenland there are sub to low-arctic, oceanic, xerophytic and thermophytic talus-side and rock communities, which are clearly related to the Scandinavian *Veronico-Poion glaucae* (BÖCHER, 1933, p. 49 and 1954, p. 48; NORDHAGEN, 1943, p. 552). Whereas NORDHAGEN (l.c.) distinguishes between talus-slide vegetation (*Veronico-Poion glaucae*) and rock vegetation (*Saxifragion cytoledonis*), BÖCHER (1954, p. 48) considers a sharp distinction between groups of chalicophytic and chasmophytic plant communities imperative in Greenland as well as in Norway. BÖCHER's chalicophytic to chasmophytic, usually distinctly chomophytic *Veronica fruticans-Sedum annuum* Type (hereafter described as the *Sedo-Thymion drucei*, see 10.1.1.), though phytogeographically a more arctic unit than the mentioned Scandinavian alliances, is in fact synecologically and floristically intermediate between these.

The *Veronico-Poion glaucae*, the *Sedo-Thymion drucei* and the *Saxifragion cotyledonis* should, following NORDHAGEN's view, be considered impoverished, northern-sub (to low) alpine and low-arctic representatives of different higher, temperate European syntaxa, viz. the

Koelerio-Corynephoretea and the *Asplenietea rupestris*, whereas they should be grouped in a single higher unit when BÖCHER's opinion is accepted. The absence of therophytes (see 10.1.1.2., discussion) and of "obligate" chasmophytes, and the common floristic-phytogeographical differences with respect to the related central European syntaxa, as well as the mutual floristic and synecological similarity, are in my opinion strong arguments against the classification of these syntaxa in widely separated groups and in favour of BÖCHER's view. Therefore I propose to unite these three in a new order, the *Sedo-Poietalia glaucae* ordo nov.

The *Sedo-Poietalia glaucae* should be grouped in the *Koelerio-Corynephoretea*, on account of the general synecology and the presence of many taxa faithful of that class, viz. mostly cryptogams such as *Cladonia pyxidata* (L.) HOFFM. (i.c. the var. *chlorophaea* FLK.), *Peltigera polydactyla* (NECK.) HOFFM., *Ceratodon purpureus* (HEDW.) BRID., *Polytrichum piliferum* HEDW. It is differentiated from the other orders in this syntaxon by the absence of their faithful taxa, the absence of therophytes, the phytogeographical composition, and differential taxa such as *Campanula gieseckiana* VEST, *Luzula spicata* (L.) DC., *Sedum rosea* (L.) SCOP., *Bryum elegans* NEES and others. Faithful taxa of the *Sedo-Poietalia glaucae* are *Poa glauca* M. VAHL, *Sedum annuum* L., *Veronica fruticans* JACQ., *Thymus drucei* RONN. em. JALAS (local), *Festuca ovina* L. incl. *F. vivipara* (L.) SM., *Cerastium alpinum* L. The area of the order comprises the sub to low-alpine and low-arctic regions of Fennoscandia and Greenland, presumably also of Iceland and N. America.

The *Sedo-Poietalia glaucae* is related to the *Elyno-Dryadetalia* BR.-BL. 1948 (9.), communities representing early stages in the development of the *Ranunculo-Oxyrion digynae* (cf. for instance 6.1.2.2.1.) and the *Caricetum bigelowii* (8.1.1.2.); transitions and intermediate communities seem to be not uncommon.

To the also related, chasmophytic *Asplenietea rupestris* BR.-BL. 1934 (cf. BRAUN-BLANQUET, 1948; OBERDORFER, 1957; WESTHOFF & DEN HELD, 1969) I consider as belonging only the communities exclusively restricted to crevices and fissures in rocks. These are in Greenland apparently only represented by more or less fragmentary fern communities namely with *Woodsia* and *Asplenium* species. In the Angmagssalik District such strictly chasmophytic taxa occur in my opinion merely individually without forming real communities.

10. Class *Koelerio-Corynephoretea* KLIKA apud KLIKA et NOVAK 1941.

syn.: *Corynephoretalia* R. TÜXEN 1933, *Corynephoretea* BR.-BL. et R. TÜXEN 1934; *Festuco-Brometea* BR.-BL. et R. TÜXEN 1943 sensu auct. p.p., *Brometo-Corynephoretea* SISSINGH et WESTHOFF 1946 p.p., *Festuco-Sedetea* OBERDORFER 1957 prov., *Sedo-Scleranthetea* BR.-BL. 1955 em.

OBERDORFER 1961 apud KRAUSCH 1962, *Caricetea arenariae* DOING 1963 + *Xerobrometo-Sedetea* DOING 1963 p.p.; incl. *Bryotherogramineteа* PIGNATTI 1953.

The class comprises open to closed pioneer communities dominated by hemicryptophytes and partly rich in therophytes in somewhat unstable sandy soils or on strongly weathering rocks. This substrate is subjected to extreme temperature fluctuations and strong desiccation and is oligotrophic to eutrophic, sometimes calcareous, medium acid to neutral-basic. The communities grouped in this syntaxon occur in the lowland and alpine areas of Europe and in Greenland.

Faithful taxa are *Potentilla argentea* L., *Rumex acetosella* L. (*in casu R. tenuifolius* (WALLR.) LÖVE), *Scleranthus perennis* L., *S. polycarpus* (L.) TORN., *Trifolium arvense* L., *Veronica verna* L., *V. dillenii* CRANTZ, *Cladonia foliacea* (HUDS.) WILLD., *C. furcata* (HUDS.) SCHRAD., *C. pyxidata* (L.) FRIES var. *chlorophaea* FLK., *Peltigera polydactyla* (NECK.) HOFFM., *Ceratodon purpureus* (HEDW.) BRID., *Polytrichum piliferum* HEDW., *Racomitrium canescens* (HEDW.) BRID.; also of the *Festuco-Brometea* BR.-BL. & R. TÜXEN 1943 em. R. TÜXEN 1961 for instance *Festuca ovina* L. s. str. (cf. BRAUN-BLANQUET & R. TÜXEN, 1943; KRAUSCH, 1962; OBERDORFER, 1957; WESTHOFF & DEN HELD, 1969, and studies cited there).

10.1. Order *Sedo-Poietalia glaucae* ordo nov.

See for details the introduction to this chapter.

10.1.1. All. *Sedo-Thymion drucei* (BÖCHER 1954) all.nov.

syn.: *Veronica fruticans-Sedum annuum* type BÖCHER 1954; ? incl. *Juncus trifidus-Minuartia groenlandica* type BÖČHER 1954 pro min. p.

In the terminology of BÖCHER (1954) the term (vegetational) type may nearly be the same as suballiance in the classification system of the Zürich-Montpellier school (BÖCHER, l.c., p. 10). In the particular example of his *Veronica fruticans-Sedum annuum* type it is in my opinion justified to consider this type an separate alliance, because of its autostacy with respect to the related northern and central European syntaxa as well as regards related syntaxa in Greenland (cf. the *Juncus trifidus-Loiseleuria-Veronica fruticans* complex, BÖCHER 1954). For the derivation of the name of this alliance I have not adopted BÖCHER's designation, but replaced the name of the in Greenland more chalicophytic *Veronica fruticans* by the more characteristic chomophytic *Thymus drucei;* for the geographical variation of the ecology of *Th. drucei* see p. 246. The syntaxon is only known from Greenland; it occurs probably also in Iceland.

The communities which represent the *Sedo-Thymion drucei* in the district are rather rare, though locally common, and cover small to very

small areas. This occurrence is presumably explained by the observed preference for more or less chomophytic habitats and mineral-rich, charnockitic and diabasic parent material of the soil. They are thermophytic pioneer communities, which are with increasing accumulation and stabilization of soil material succeeded by the *Caricetum bigelowii*, at least in this district.

The alliance there is related to certain communities of the *Ranunculo-Oxyrion digynae*, in particular to the subass. *polystichetosum lonchitis* of the *Alchemilletum alpinae* (6.1.2.2.1.), as well as to the *Potentillo-Polygonion vivipari* (9.1.1.1.).

Faithful and differential taxa of the alliance are, more or less arranged according to decreasing fidelity, *Sedum annuum* L., *Saxifraga aizoon* JACQ. var. *neogaea* BUTTERS, *Thymus drucei* RONN. em. JALAS, *Veronica fruticans* JACQ., *Woodsia ilvensis* (L.) R. BR., *Fimbriaria ludwigii* (SCHWAEGR.) LIMPR., *Ceratodon purpureus* (HEDW.) BRID., *Selaginella rupestris* (L.) SPRING em. UNDERWOOD, *Saxifraga tricuspidata* TOTTB., *Draba norvegica* GUNN., *Potentilla tridentata* AIT., *Viscaria alpina* (L.) G. DON., *Luzula spicata* (L.) DC., *Cerastium alpinum* L. ssp. *lanatum* (LAM.) ASCH. et GRAEBN., *Saxifraga nivalis* L., *S. tenuis* (WBG.) H. SM.

10.1.1.1. Ass. *Luzulo-Thymetum drucei* ass.nov.

syn.: *Thymus drucei* sociation BÖCHER 1954 n.n.

table 30.

composition: Faithful taxon is *Thymus drucei* RONN. em. JALAS (= *Th. arcticus* (E. DUR.) RONN., *Th. praecox Opiz* ssp. *arcticus* (E. DUR.) JALAS, *Th. serpyllum* L. ssp. *arcticus* (E. DUR.) HYL.) which is preferent to selective faithful and which probably should be combined with *Carex bigelowii* and *Salix herbacea* (both selective to exclusive faithful within the alliance) to constitute a regional differential taxa combination. Constant taxa are *Luzula spicata*, *Viscaria alpina*, *Stereocaulon*, *Cetraria islandica*, *Cladonia pyxidata*, *Cl. mitis*, *Bryum elegans*.

The community in the district is rather rich in taxa, on an average 19 taxa were observed in one sample plot; the number of cryptogams per sample plot is on an average close to the number of phanerogams. The general composition shows relationship to the *Caricetum bigelowii*.

physiognomy: The predominantly hemicryptophytic, partly also chamaephytic and geophytic community is more or less distinctly stratified in (1) an usually more or less open bottom layer with cryptogams, dominated by lichens, (2) an open to more or less closed lower field layer or undergrowth of low herbs, dominated by *Thymus drucei* (fig. 65), and (3) an open to more or less closed upper field layer of graminoid and tall herbaceous taxa of various heights.

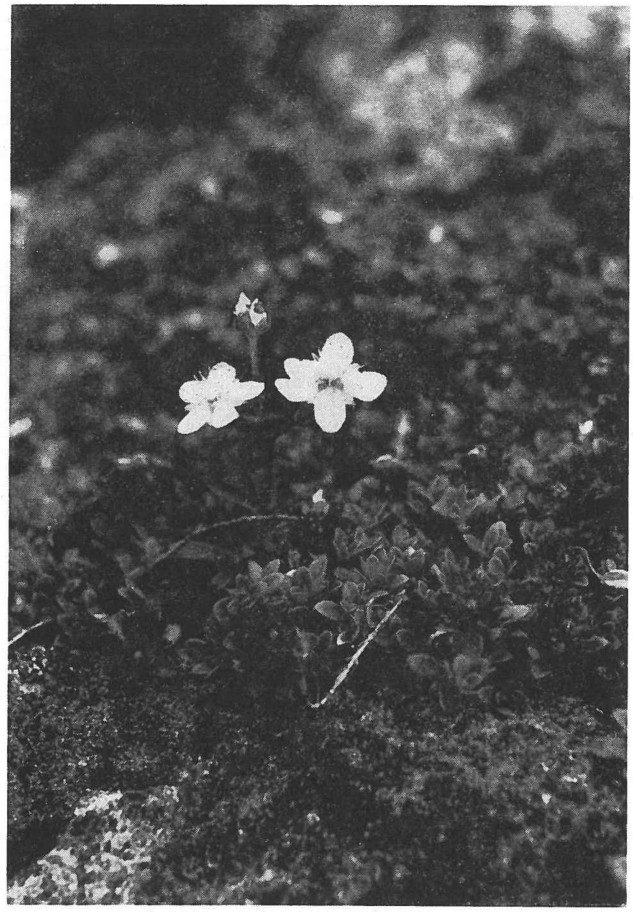


Fig. 65. *Potentilla tridentata* in a community belonging to the *Luzulo-Thymetum drucei*. JGdM phot. VII. 1968.

The community forms more or less closed, low herbaceous stands of a greyish-green with a light purplish shimmer owing to the abundant flowers of *Thymus* and *Viscaria*.

synecology & habitat: The low-arctic, more or less oceanic, medium acidophytic and chionophytic, mesophytic to xerophytic and thermophytic, eutrafent to mesotrafent and chomophytic to chalicophytic "Trockenrasen" community in the Angmagssalik District occurs in the coastal areas between 20 to abt. 550 m a.s.l., namely in sunny, sheltered habitats on South-facing ledges and local, South-facing, more or less stabilized talus slides and sandy slopes.

The 10 to 30° sloping, dry, slightly humic substrate consists predominantly of coarse to medium fine angular sand of colluvial and partly also niveo-aeolian origin, derived from weathered hypersthene-bearing

Table XXX

reference number		1	2	3	4	5	6	7	8	9
altitude (m)		90	50	20	120	20	20	25	635	30
inclination		10	30	30	15	15	30	15	10	25
orientation		S	SW	S	SW	S	S	S	S	SW
total cover plants (in %)		75	60	60	70	85	60	<70	55	80
cover phanerogams		50	45	40	60	>80	60	<70	<50	80
– cryptogams –		25	15	40	25	10	5	1	15	2
– litter –		25	40	10		<1	10	20	10	10
– open soil –		10	10	40	>35	20	<45	30	20	<5
pH rhizosphere		$4^1/_2$	$5^3/_4$	5	$4^3/_4$	5	5	5	$4^1/_2$	$4^3/_4$
maximum depth soil (cm)		13	>60	50	28	50	25	80	60	49
Thymus drucei	B	4	4	3	3	5	4	4	4	5
Luzula spicata	L	1	1	3	2	3	3	+	1	+
Carex bigelowii	L	..	1	1	3	1	1	2	2	..
Viscaria alpina	L	+	+	+	..	+	2	+	..	1
Stereocaulon paschale s.l.		2	1	3	2	+	+	+	2	..
Cetraria islandica		+	1	..	+	2	1	+	+	1
Cladonia pyxidata		..	+	+	+	..	+	+	+	+
Cladonia rangiferina		+	+	1	+	..	..	..	..	..
Cladonia coccifera		..	+	1	2	..	..	..	..	..
Cladonia uncialis		1	..	+	+	..	..	..	..	..
Desmatodon latifolium		1	..	+	+	..	..	..	..	+
Cladonia mitis		1	1	2	+	+	+	..	..	..
Cladonia ecmocyna		1	2	..	+	+	+	..	..	..
Bryum elegans		..	1	+	+	+	1	+	..	..
Festuca vivipara	L	+	..	..	..	+	..	+	+	3
Trisetum spicatum	A	+	..	..	..	+	1	..	+	1
Chamaenerion angustifolium	B	..	+	..	..	3	2	1	..	+
Salix herbacea	L	..	..	1	..	+	..	1	+	+
Cerastium alpinum	L	..	..	2	..	+	+	+	+	+
Juncus trifidus	L	..	..	..	2	..	+	1	1	1
Poa alpina	L	..	..	..	+	1	+	+	2	..
Poa arctica	A	..	..	..	..	+	1	2	+	+
Tortula norvegica		..	..	..	..	+	..	+	1	..
*Peltigera**		2	..	..	+	..	..	..	+	+
Campanula gieseckiana	L	..	..	..	2	3	..	..	..	1
Cetraria crispa		1	..	1	..	..	..	..	+	..
Saxifraga caespitosa	A	+	..	1	..	..	..	..	..	..
Ceratodon purpureus		+	+	..	..	..	..	..	..	..
Sedum annuum	L	..	..	..	..	..	..	+	..	..
Silene acaulis	A	..	..	1	..	..	..	..	1	..
Festuca brachyphylla	A	..	..	+	..	..	..	..	..	+
Agrostis borealis	L	..	..	..	+	..	..	..	+	..
Taraxacum croceum	L	..	..	..	..	+	..	..	+	..
Woodsia ilvensis	L	3	..	..	..	..	..	..	..	..
Cetraria nivalis		..	..	1	..	..	..	..	..	..

* predominantly *P. malacea*.

anorthositic or charnockitic granulite rocks. It is 13 to 80 cm deep, more or less consolidated, loose, and undifferentiated or stratified in $^1/_2$ to 2 cm thick layers of uniform texture varying in humus content.

In winter the habitat is covered with a layer of snow of a few decimeters thickness and a superficial icy crust. This cover melts off early in spring. Local meltwater and rainy periods irrigate the substrate for some time afterwards, otherwise the substrate is subjected to strong desiccation In late June 1969 only the deeper substrates were found to be moist below -30 to -50 cm depth.

The colorimetric pH of the rhizosphere ranges from $4^1/_2$ to $5^1/_4$ and averages abt. 5.

succession & zonation: See 10.1.1. The stands of the syntaxon occur either isolated on shelves and ledges, or below a narrow zone of *Salix glauca* espalier-scrub along the foot of rock outcrops. In the latter case they are found above rock outcrops, open rocky ground or *Carex bigelowii* grass heaths.

distribution: The community is rather common to locally rare in suitable habitats in the coastal areas of the district (southern part of the Angmagssalik Ø, Kulusuk); it occurs also elsewhere in Greenland (cf. KRUUSE, 1912, for instance p. 101; BÖCHER, 1938, p. 168–170 and 1954, p. 52). The general area is probably restricted to the southern half of Greenland.

subdivision: Correlated with floristical differences between the individual stands are differences in stability and depth of the substrate and the rate of sedimentation. These differences are more or less gradual and suggest the existance of two variants:

(a) Variant of *Cladonia* (table 30:1–4), with the differential taxa *Cladonia rangiferina*, *Cl. coccifera*, *Cl. uncialis*, *Cl. mitis*, *Cl. ecmocyna*, *Desmatodon latifolius*. The cryptogams are qualitatively and quantitatively comparatively prominent. The variant is characteristic of ledges and shelves, where it occurs spatially isolated. The substrate is comparatively unstable and shallow, usually not very deep. It consists of loose, dry, slightly humic sand without differentiation and is subjected to sliding.

(b) Variant of *Poa* (table 30:5–9), with the differential taxa *Poa arctica*, *Poa alpina*, *Trisetum spicatum*, *Festuca vivipara*, *Chamaenerion angustifolium*. Cryptogams are subordinated. The variant is character-

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Not recorded in the table are: *Carex scirpoidea* in sample plot 3(+); *Draba nivalis* 3(+); *Draba norvegica* 8(+); *Hieracium alpinum* 4(+); *Hieracium hyparcticum* 4(+); *Polygonum viviparum* 8(+); *Bryum inclinatum* 7(+); *Bryum pendulum* 4(+); *Dicranum elongatum* 1(+); *Dicranum scoparium* 5(+); *Grimmia* spec. 4(+); *Lophozia* spec. 2(+); *Marsupella* spec. 4(+); *Polytrichum juniperinum* 3(+); *Polytrichum piliferum* 1(+).

istic of terraced sandy talus slopes with rock outcrops, where it occurs associated with *Salix glauca* espalier-scrub and *Carex bigelowii* grass heaths. The substrate is comparatively stable and deep, on an average abt. 50 cm, subjected to limited solifluction, and usually distinctly stratified owing to discontinuous sedimentation.

syntaxonomy & discussion: *Thymus drucei* has a boreal to low-arctic, eastern amphi-atlantic distribution (HULTÉN, 1958, p. 94). The taxon occurs in the Scottish Highlands in somewhat related vegetation types (MCVEAN & RATCLIFFE, 1962, p. 84–85). In Ireland it occurs in quite different communities on limestone, together with e.g. *Sesleria*, *Antennaria hibernica*, *A. dioica*, *Dryas octopetala* (cf. BRAUN-BLANQUET & TÜXEN, 1952, p. 317, 319–325; IVIMEY-COOK & PROCTOR, 1966, p. 242–244, 247–251). I have not found referrences to the synecological behaviour of the taxon in Iceland and in central Norway (where it is rare).

10.1.1.2. Ass. *Fimbriario-Sedetum annui* ass.nov.

syn.: ? *Sedum annuum* sociation BÖCHER 1954.

table 31.

composition: Faithful taxa are *Sedum annuum* L. (more or less exclusive), *Fimbriaria ludwigii* (SCHWAEGR.) LIMPR. (= *Asterella ludwigii* (SCHWAEGR.) UNDERW.; exclusive-selective), *Ceratodon purpureus* (HEDW.) BRID. (idem), *Cetraria crispa* (ACH.) NYL. (preferent to selective). Constant taxa are *Cerastium alpinum*, *Luzula spicata*, *Poa alpina*, *Viscaria alpina*, *Bryum elegans*, *Cetraria islandica*, *Desmatodon latifolius*.

The community is rich in taxa, on an average more than 22 taxa occur in one sample plot; the number of cryptogams observed per sample plot is as a rule slightly higher than the number of phanerogams.

physiognomy: The hemicryptophytic, partly chamaephytic community is stratified in (1) a more or less well developed bottom layer with bryophytes and lichens, (2) a rather open to more or less well developed lower field layer with low herbs such as *Sedum annuum*, *Thymus drucei*, *Viscaria alpina*, and (3) a very open to more or less closed upper field layer with tall herbs such as *Luzula spicata*, *Poa alpina*, *Trisetum spicatum*, *Chamaenerion angustifolium*.

The community forms inconspicuous, more or less open to rather closed, small stands, which at a short distance appear to be dominated by the shining, light yellow-green of the pretty succulent *Sedum* and by its usually abundant pale-yellow flowers.

synecology & habitat: The low-arctic, more or less oceanic, medium chionophytic, mesophytic to xerophytic and thermophytic, acidophytic to neutrophytic, eutrafent to mesotrafent, chalicophytic to chomophytic pioneer-community occurs in the Angmagssalik District in sunny, sheltered, South-facing habitats, in unstable, loose, very shallow soil



Fig. 66. *Sedum annuum* in flower.
JGdM phot. VII. 1969.

laid bare by erosion and solifluction. It is found in the coastal areas between 20 and at least 60 m a.s.l., in the inland from 80 to at least 450 m a.s.l.; on the 30 to 50° sloping, central and posterior bare part of micro-terraces formed by erosion and solifluction lobes over bedrock, on open, thin earth tongues over bedrock outcrops, and on shelves and ledges.

The snow cover corresponds with the snow cover over the *Luzulo-Thymetum drucei.*

The substrate consists of 4 to 31 cm thick, usually abt. 10 cm thick deposits of loose, incoherent, humic, gravelly, coarse and medium fine sandy angular material of colluvial origin. It is rich in minerals being derived from charnockitic and diabasic rocks (see 10.1.1.1.), and shows no macrodifferentiation. In spring it is very wet owing to irrigation by meltwater, which causes erosion and sliding of the soil material. Later on it dries out strongly, but during and after periods of rain it becomes wet again for a short time. The substrate is quickly and strongly warmed and cooled by the alternating periods of insolation and radiation.

The colorimetric pH of the rhizosphere ranges from $4^1/_2$ to $6^1/_4$ and averages abt. 5.

succession & zonation: See 10.1.1. The community occurs usually associated with mesophytic to xerophytic *Carex bigelowii*, *Salix glauca*

and/or *Thymus drucei* stands; such types will presumably succeed this type when the substrate becomes deeper and/or more stabilized.

distribution: The community is locally common in the Angmagssalik District (Blomsterdalen, Torssukátak, Qíngertivaq-Qáqarssuaq,-Falkefjeld) in suitable habitats. It occurs also elsewhere in low-arctic Greenland (BÖCHER, 1954, p. 52, and 1963, p. 99). Possibly also in Iceland and Fennoscandia.

subdivision: The composition of the unit is somewhat variable, which phenomenon appears to be correlated with variation in the stability of the substrate, acidity of the rhizosphere and development of a litter layer. As these differences are gradual I propose a subdivision in variants.

(a) Initial phase (table 31:1), which is poor in taxa and dominated by seedlings of *Sedum annuum.*

(b) Variant of *Trisetum spicatum* (table 31:2–5), characterized by the differential *Trisetum spicatum*, *Saxifraga cernua*, *Cladonia mitis.* This variant occurs in the coastal and inland areas on comparatively coarsely textured substrate covered with a comparatively poorly developed litter layer. The substrate consists predominantly of unstable, sliding detritus from disintegrating rock which is presumably comparatively rich in minerals and which has a higher pH.

(c) Variant of *Fimbriaria ludwigii* (table 31:6–10), characterized by the differential taxa *Fimbriaria ludwigii*, *Viscaria alpina*, *Chamaenerion*

Table XXXI

reference number		1	2	3	4	5	6	7	8	9	10
altitude (m)		20	260	450	80	60	40	80	30	40	40
inclination		30	30	30	50	30	45	40	30	45	30
orientation		S	S	W	W	S	SW	S	S	S	S
total cover plants (in %)		60	50	60	75	60	60	70	60	75	85
cover dwarf shrub	–	0	0	2	0	2	1	<1	0	<2	<1
– herbs	–	45	15	25	60	40	35	40	50	50	<50
– cryptogams	–	25	40	35	25	25	40	40	20	50	<60
– litter	–	0	0	5	0	5	15	20	10	15	15
– open soil	–	60	50	40	30	50	40	40	50	30	15
pH rhizosphere		4½	5¾	5	6¼	5	4½	4½	4¼	4½	4¾
maximum depth soil (cm)		9½	9	<10	22	14	16	31	17	26	15
Thymus drucei	B	..	..	+	2	+	+	1	+	..	1
Sedum annuum	L	4	2	3	4	4	2	2	3	4	3
Fimbriaria ludwigii		..	+	+	+	..	2	1	2	3	3

(continued)

Table XXXI (continued)

reference number		1	2	3	4	5	6	7	8	9	10
Luzula spicata	L	1	1	1	1	1	2	2	4	3	3
Cetraria islandica		+	1	+	+	+	+	+	+	+	+
*Peltigera**		3	+	+	+	1	+	+	+	+	+
Desmatodon latifolius		+	1	+	+	+	+	+	+	+	1
Ceratodon purpureus		+	..	+	+	+	+	..	+	+	+
Bryum elegans		1	+	+	..	2	3	+	3	4	4
Cerastium alpinum	L	2	+	1	+	..	+	1	+	..	+
Poa alpina	L	2	1	..	2	1	1	..	+	..	+
Salix glauca	L	..	..	1	..	+	+	+	..	1	+
Cetraria crispa		+	1	2	+	+	..	+	+	..	..
Stereocaulon paschale s.l.		..	2	2	..	1	+	3	..	+	..
Cladonia mitis		..	1	1	+	+	..	+	..	..	..
Trisetum spicatum	A	..	+	+	+	1	..	..	..	..	..
Saxifraga cernua	A	..	+	1	+	..	..	..	..	..	..
Encalypta rhabdocarpa		..	..	+	2	..	..	..	..	..	..
Carex bigelowii	L	..	..	+	..	2	..	..	..	..	..
Viscaria alpina	L	+	+	..	..	1	1	1	1	1	2
Cladonia fimbriata		+	..	..	..	2	2	1	+	..	..
Bryum inclinatum		..	..	..	..	+	+	3	+	1	..
Chamaenerion angustifolium	B	..	..	..	..	+	2	+	1	3	+
Festuca brachyphylla	A	..	..	..	..	..	1	..	..	+	1
Cladonia prim. thallus		..	..	2	..	..	..	..	+	2	+
Cladonia pyxidata		..	3	..	2	..	..	..	..	+	+
Pohlia nutans		..	..	+	+	..	1	..	..	+	..
Saxifraga nivalis	A	..	..	1	+	..	..	..	..	+	..
Solorina crocea		..	..	+	..	+	..	+	..	..	..
Tortula norvegica		..	..	..	1	+	..	+	..	..	..
Minuartia rubella	A	..	+	..	+	..	..	..	..	..	..
Bryum argenteum		..	+	..	+	..	..	..	..	..	..
Cladonia ecmocyna		..	..	+	..	..	+	+	..	..	..
Poa arctica	A	..	..	..	..	..	1	..	..	2	..
Taraxacum croceum	L	..	..	..	..	..	1	..	..	..	+
Polytrichum piliferum		..	..	..	..	..	+	..	..	..	+
Psoroma hypnorum		..	..	..	..	..	+	+	..	..	..
Empetrum hermaphroditum	L	..	..	..	..	1	+	..	..	..	..
Poa glauca	A	..	..	..	1	..	+	..	..	..	..
Sedum rosea	L	..	..	..	+	..	+	..	..	..	..

Not recorded in the table are: *Antennaria canescens* in sample plot 10(+); *Campanula gieseckiana* 7(+); *Cystopteris fragilis* 4(+); *Draba norvegica* 2(+); *Juncus trifidus* 8(+); *Kobresia myosuroides* 2(+); *Saxifraga aizoon* 2(+); *S. caespitosa* 3(+); *S. tenuis* 2(+); *Silene acaulis* 3(+); *Thalictrum alpinum* 5(+); *Woodsia glabella* 2(+); *W. ilvensis* 4(+); *Bartramia ithyphylla* 2, 6(+); *Hypnum revolutum* 2(+); *Lophozia* spec. 5, 8(+); *Pohlia cruda* 2(+); *Cladonia coccifera* 2, 9(+); *Cl. gracilis* 2(1); *Cl. uncialis* 7(+); *Cornicularia muricata* 4(+).

* predominantly *P. malacea*.

angustifolium, *Bryum elegans*, *B. inclinatum*. This variant is only observed in the coastal area. The substrate is comparatively rich in fines, predominantly primarily of mixed niveo-aeolian and colluvial origin and secondarily subjected to erosion and solifluction. It is presumably comparatively poor in minerals, the litter layer is usually well developed and the rhizosphere reacts comparatively acid.

syntaxonomy & discussion: *Sedum annuum* has an eastern amphi-atlantic distribution (HULTÉN, 1958, p. 90). In Central Europe it is a faithful taxon of the *Sedo-Scleranthion* BR.-BL. 1949. In Scandinavia it occurs in the *Veronico-Poion glaucae* NORDH. 1943, the *Saxifragion cotyledonis* NORDH. 1936 and also rarely in the *Kobresio-Dryadion* NORDH. 1936 (cf. NORDHAGEN, 1943, p. 550–574).

BÖCHER mentions the occurrence of a *Sedum annuum* sociation in South Greenland (BÖCHER, 1954, p. 52) and of a similar vegetation type in middle West Greenland (BÖCHER, 1963, p. 99), which are closely related to, and presumably should be grouped in, the *Fimbriario-Sedetum annui*.

Some earlier botanists have observed that the taxon is an annual, sometimes biennial (KNABEN, 1954), but recently KNABEN (l.c.) has experimentally shown that *S. annuum* is, at least in Norway a biennial plant and not a annual one. This evidently also applies to its life-cycle in the Angmagssalik District, where in nearly every stand one finds a generation of small, not flowering seedlings (cf. KNABEN, l.c., fig. 1a) side by side with a generation of flowering individuals of the preceding year (cf. KNABEN, l.c., fig. 1b), and with defoliated, dead plants which germinated two years previously (see also fig. 66).

The thallose hepatic *Fimbriaria ludwigii* has a more or less circumpolar, northern subalpine to alpine area (MÜLLER, 1951–1958, p. 357).

10.1.1.3. Ass. *Sedo-Saxifragetum neogaeae* ass.nov.

table 32:2–9.

composition: Faithful taxon is *Saxifraga aizoon* JACQ. (= *S. paniculata* MILL.) var. *neogaea* BUTTERS; differential within the alliance are: *Campanula gieseckiana* VEST, *Carex scirpoidea* MICHX. and *Sedum rosea* (L.) SCOP. More or less constant or conspicuous accessory taxa are e.g. *Thymus drucei*, *Luzula spicata*, *Cerastium alpinum*, *Euphrasia frigida*, *Saxifraga nivalis*, *Potentilla crantzii*, *Silene acaulis*.

The community is rich in taxa, on an average in one sample plot abt. 27 taxa are observed. In general the number of recorded taxa is variable, which is mainly due to the highly variable number of cryptogams in dependence on the stability of the habitat and the density of the plant



Fig. 67. Community of the *Sedo-Saxifragetum neogaeae* on a ledge of a diabase dyke along Torssukátak fjord.
FJAD phot. VII. 1969.

cover. The average numbers of observed phanerogams and cryptogams in one sample plot are in the ratio of 5 to 1–7.

physiognomy: The predominantly hemicryptophytic, to a considerable extent also chamaephytic community is not clearly stratified. With some reservations it is possible to discern (1) a very variably developed, fragmentary to well-developed bottom layer of bryophytes and lichens, and (2) an open to closed field layer of phanerogams, indistinctly divided in an upper layer with *Saxifraga aizoon* var. *neogaea*, *Campanula gieseckiana*, *Trisetum spicatum*, *Sedum rosea*, *Cerastium alpinum* and others, and a lower layer with *Thymus drucei*, *Sedum annuum*, *Woodsia ilvensis*, and others.

The plant cover is usually homogeneous only over comparatively large areas. Limited stands or small areas are often more or less heterogeneous, as the plant cover is composed of a small-scale mosaic of small clusters of plants of one taxon, which is probably explained by the rather intense competition (cf. NORDHAGEN, 1943, p. 573) and the variable environmental conditions.

The community forms striking, usually small patches of often richly flowering, colourful "alpine garden" (fig. 67).

Table XXXII

reference number		1	2	3	4	5	6	7	8	9
altitude (m)		130	550	100	275	560	100	100	250	250
inclination		60	15	35	20	35	60	70	50	35
orientation		SW	SW	S	SE	W	S	S	S	S
total cover plants (in %)		80	65	<70	55	60	80	70	80	15
cover dwarf shrubs	–	0	<1	5	0	0	0	0	<1	0
– herbs	–	80	65	50	40	60	30	45	30	8
– cryptogams	–	<5	<1	25	15	1	70	60	50	7
– litter	–	<40	<10	15	0	10	15	10	0	
– open soil	–	5	30	20	55	35	10	25	20	<95
pH rhizosphere		5¼	5¼	6	4½	5¼	6	5½	4¼	5
maximum depth soil (cm)		14	30	18	9	24	8	14	8	6
Thymus drucei	B	..	5	2	1	2	1	3	1	1
Saxifraga aizoon	L	..	+	1	1	3	2	2	2	+
Sedum rosea	L	1	+	1	2	1	+	2	2	1
Cerastium alpinum	L	..	1	1	1	+	+	+	+	+
Carex scirpoidea	L	4	3	2	1	2	..	1	+	+
Campanula gieseckiana	L	3	2	2	2	+	+	1	..	+
Luzula spicata	L	+	1	+	+	..	+	+	+	+
Peltigera aphthosa		+	+	+	+	..	1	1	+	..
Cladonia mitis		..	..	+	+	..	+	1	2	..
Silene acaulis	A	..	..	+	+	1	+	..	..	+
Trisetum spicatum	A	1	1	+	+	+	..	..	..	..
Euphrasia frigida	L	..	+	2	+	+	..	..	..	..
Potentilla crantzii	L	4	+	1	2	+	1	..	..	..
Polygonum viviparum	A	1	1	1	..	1	+	..	..	..
Bryum elegans		+	+	+	..	+	..	..	..	..
Saxifraga nivalis	A	..	..	..	..	..	1	+	+	+
Saxifraga oppositifolia	A	..	..	..	..	..	..	+	1	1
Juncus trifidus	L	..	..	..	..	+	..	+	+	+
Cladonia pyxidata		..	..	1	..	..	..	+	2	+
Marsupella cf boeckii		..	..	..	..	+	+	+	+	2
Stereocaulon paschale s.l.		..	..	1	+	..	1	4	2	+
Festuca vivipara	L	..	..	..	1	+	..	..	1	1
Polytrichum alpinum		..	..	..	+	+	..	..	2	1
Polytrichum piliferum		..	..	1	2	..	4	..	..	..
Poa alpina	L	+	+	1	..	..	..	..	..	+
Sedum annuum	L	..	..	..	1	..	+	+	..	..
Woodsia ilvensis	L	..	..	..	+	..	2	1	..	..
Veronica alpina	L	..	..	1	..	..	+	+	..	..
Desmatodon latifolius		..	+	..	1	..	2	..	..	..
Cetraria crispa	..	..	..	+	..	..	..	+	+	..
Racomitrium canescens		..	..	..	+	..	..	..	+	+
Pohlia nutans		..	..	..	+	+	..	+	..	..
Dicranum scoparium		..	..	1	..	+	..	+	..	..
Erigeron uniflorus	L	+	..	+	..	..	..	1	..	..
Bartsia alpina	L	1	..	+	..	..	..	..	..	+

(continued)

Table XXXII (continued)

reference number		1	2	3	4	5	6	7	8	9
Thalictrum alpinum	L	2	+	2	..	..	..	..	..	+
Antennaria canescens	L	..	..	+	..	..	..	..	..	+
Saxifraga caespitosa	A	..	..	..	+	..	+	..	..	..
Agrostis borealis	L	+	..	..	..	..	+	..	..	..
Cladonia coccifera		..	..	..	..	..	+	..	1	..
Cladonia uncialis		..	..	..	..	..	..	+	..	+
Aulacomnium turgidum		..	..	..	..	..	..	..	1	+
Blindia acuta		..	..	..	..	..	..	..	+	1
Pohlia cruda		..	..	..	..	..	..	..	+	+
Bartramia ithyphylla		..	..	+	..	..	..	..	..	+
Tortella fragilis		..	..	..	..	+	+	..	..	..
Polytrichum juniperinum		+	..	..	..	..	..	+	..	..
Vaccinium uliginosum	L	..	+	..	..	..	..	..	+	..
Solorina crocea		..	..	..	..	..	+	..	..	+
Fimbriaria ludwigii		..	..	+	..	..	1	..	..	..
Peltigera canina s.l.		..	..	2	..	..	..	+	..	..
Taraxacum croceum	L	2	..	..	..	..	..	..	..	..
Oxyria digyna	A	1	..	..	..	..	..	..	..	..
Botrychium lunaria	B	1	..	..	..	..	..	..	..	..
Salix glauca	L	..	..	1	..	..	..	..	..	..
Cetraria islandica		..	..	1	..	..	..	..	..	..
Encalypta vulgaris		..	..	..	1	..	..	..	..	..
Tortella tortuosa		..	..	..	..	..	..	2	..	..
Myurella julacea		..	..	..	..	..	..	..	2	..
Dicranum elongatum		..	..	..	..	..	..	..	2	..
Amphidium lapponicum		..	..	..	..	..	..	..	1	..
Empetrum hermaphroditum	L	..	..	+	..	..	..	..	..	..
Erigeron eriocephalus	M	..	+	..	..	..	..	..	..	..
Juniperus nana	B	..	..	+	..	..	..	..	..	..
Poa arctica	A	..	..	..	..	+	..	..	..	..
Poa glauca	A	..	..	..	..	..	..	..	+	..
Saxifraga cernua	A	..	..	..	..	+	..	..	..	..
Saxifraga tenuis	A	..	..	..	..	..	..	+	..	..
Sedum villosum	B	..	..	..	..	..	..	..	..	+
Amblystegium serpens		..	..	..	..	..	..	+	..	..
Bryum argenteum		..	..	..	..	..	+	..	..	..
Bryum capillare		..	..	..	..	..	..	+	..	..
Bryum pendulum		..	..	..	..	..	..	+	..	..
Distichium capillare		..	..	..	..	+	..	..	..	..
Gymnomitrium coralloides		..	..	..	..	..	..	..	..	+
Philonotis tomentella		..	..	..	..	..	+	..	..	..
Plagiothecium denticulatum		..	..	+	..	..	..	..	..	..
Saelania glaucescens		..	..	..	..	..	..	..	+	..
Schistidium apocarpum		..	..	..	..	..	..	+	..	..
Cladonia ecmocyna		..	..	+	..	..	..	..	..	..
Cladonia spec.		..	..	+	..	..	..	..	..	..
Stereocaulon denundatum		..	..	..	+	..	..	..	..	..

synecology & habitat: The low-arctic, little-chionophytic, mesophytic to xerophytic and thermophytic, acidophytic to neutrophytic, eutrafent to mesotrafent, chomophytic (to chalicophytic) community in the Angmagssalik District occurs very locally, at low elevations in the coastal areas (100 to 260 m a.s.l.) up to considerable altitudes in the inland (100 to 560 m a.s.l.), on exposed, sunny, South-facing slopes; viz. in 15 to 70° sloping, shallow soil on ledges, on shelves, along the margin of bluffs, and on similar, projecting flat surfaces on the sides of steep rocks, beetling cliffs and mountain slopes; also, but more rarely, in gullies in steep rocky slopes.

The substrate is 6 to maximum 30 cm deep, not differentiated, rich in humus, strongly interwoven to almost felty with roots, well aerated and drained, and subjected to extreme desiccation and temperature fluctuations. It consists of residual and colluvial, on exception partly aeolian, angular debris, in which the grades of coarse sand and gravel dominate. This material is petrochemically rich in often basic minerals (non-quartzo-feldspathic minerals and amphibolite) but poor in calcite, being derived from disintegrating metabasic, tertiary, dolorite or diabase intrusions and ultrabasic hypersthenite dykes.

During winter the habitat is often temporarily without snow cover. In summer it is only irrigated by direct rainfall and indirectly to a very limited degree by seepage of melt and rainwater.

The colorimetric pH of the rhizosphere ranges from $4^1/_4$ to 6 and averages 5.2.

succession & zonation: The community represents a pioneer community, which in spatially isolated terrestrial habitats (ledges etc.) is (semi-) permanent, and in not spatially isolated habitats presumably is succeeded by *Salix glauca* scrub or *Carex bigelowii* grass heath with which it occurs in association there.

distribution: The community is rather rare in the district (Blomsterdalen, Qíngertivaq-Qáqarssuaq), though locally common (Torssukátak). It occurs presumably also elsewhere in the southern half of Greenland, perhaps also in suitable habitats in Iceland and Northeast Canada.

subdivision: In the district two types of the *Sedo-Saxifragetum neogaeae* occur, which is probably explained by edaphic variation. I prefer to treat these types as variants, as this factor has not been quantitatively studied, since the composition partly depends on the competition which causes a micro-mosaic pattern interfering with the germination of "late-arrivals" (see paragraph composition), and since the data were obtained in three localities only.

(a) Variant of *Euphrasia frigida* and *Trisetum spicatum* (table 32:2–5). Differential taxa: *E. frigida*, *T. spicatum*, *Bryum elegans*, *Potentilla crantzii*, *Campanula gieseckiana*. Cryptogams are in particular quantitatively subordinate. This variant is more characteristically

chomophytic than the other one, and occurs consequently more spatially isolated. For water supply it depends mainly on direct supply by rainfall.

(b) Variant of *Saxifraga nivalis* and *S. oppositifolia* (table 32:6–9). Differential taxa: *S. nivalis*, *S. oppositifolia*, *Juncus trifidus*, *Marsupella* (cf.) *boeckii*, *Stereocaulon*, *Cladonia pyxidata*. Cryptogams are qualitatively and quantitatively prominent. The variant occurs in chomophytic and chalicophytic conditions, and in consequence spatially less isolated from the occurrence of other vegetation types. The water supply of the habitat is comparatively long, due to seepage of water from the higher parts of the slopes.

syntaxonomy & discussion: The amphi-atlantic *S. aizoon* JACQ. is a very complex taxon, variable especially in the central and southern European mountains, less so in the western part of its area. In Greenland, Iceland and N. America it is represented by the var. *neogaea* BUTTERS, while the northern European (Norwegian) forms fall within the range of variation of *S. aizoon* in Central Europe (HULTÉN, 1958, p. 44; NORDHAGEN, 1965).

In the Angmagssalik District the *Sedo-Saxifragetum neogaeae* is principally a chomophytic to chalicophytic syntaxon. Fragmentary communities belonging to the association are occasionally observed in chasmophytic conditions.

The syntaxon vicariates to some extent with the more exclusively chasmophytic *Saxifraga cotyledon-Sedum rosea* sosiasjon NORDH. 1943 (*Saxifragion cytoledonis* NORDH. (1936) 1943) which is found in the sub to low-alpine regions of Norway. The Scandinavian *Saxifragion cotyledonis* in turn more or less vicariates with the chasmophytic, alpine central European *Androsacion vandellii* BR.-BL. 1926. (*Androsacetalia vandellii* BR.-BL. 1926). The Scandinavian alliance is to some extent also related to the *Veronico-Poion glaucae* and the *Potentillo-Polygonion vivipari* NORDH. 1936 (*Elyno-Seslerietea* BR.-BL. 1948; NORDHAGEN, 1943, p. 573; BÖCHER, 1954, p. 48).

The northern Norwegian *S. aizoon* var. *glabrata* (LAEST.) HYL. (= ssp. *laestadii* NEUM.) occurs in chalicophytic vegetation types which apparently belong to the *Kobresio-Dryadion* NORDH. 1943 (*Elyno-Seslerietea*); the chasmophytic, southern Norwegian *S. aizoon* cf. var. *montana* ENGL. et IRMSCH. communities belong presumably to the *Saxifragion cotyledonis* (cf. NORDHAGEN, 1965).

In alpine Central Europe the various varieties of *S. aizoon* occur in communities belonging to the *Potentilletalia caulescentis* BR.-BL. 1926 (*Asplenietea rupestris* BR.-BL. 1934), the *Thlaspietea rotundifolii* BR.-BL. 1926, and the *Elyno-Seslerietea* BR.-BL. 1948 (cf. BRAUN-BLANQUET, 1948b; OBERDORFER, 1970).

See also the introduction to this chapter.

10.1.A. Note.

In the Angmagssalik District occurs also a vegetation type which should be grouped in the *Sedo-Poietalia*, but which could not be studied in detail because of logistic arrangements made beforehand:

10.1.A.a. *Rumex acetosella-Carex scirpoidea-Veronica fruticans*-community.

This low-arctic, slightly continental, little chionophytic, (xerophytic to) mesophytic and thermophytic, neutrophytic, mesotrafent to eutrafent, chomophytic to chalicophytic community occurs at comparatively high altitudes on exposed, sunny, South-facing slopes in localities with "better rocks" (diabase for instance) in the inland of the district (Torssukátak, Qíngertivaq-Qáqarssuaq), in sliding, shallow tongues or lobes of undifferentiated, more or less gravelly erosion material over sloping rock surfaces and on strongly weathering rocks.

The data of the single sample plot studied are: locality Qíngertivaq-Qáqarssuaq, 460 m a.s.l., inclination 40°, orientation SW; area 2m²; cover plants (total) 15–20 %, -phanerogams more than 15 % (12 cm high), -cryptogams less than 5 %, -open gravel 75 %, -rock 10 %; substrate: depth 10–17 cm, mobile, undifferentiated, gravelly to coarse sandy, dry; pH rhizosphere 5¼; composition:

Carex scirpoidea	L	1⁺	*Trisetum spicatum*	A	+
Cerastium alpinum	L	+	*Veronica fruticans*	L	1
Erigeron uniflorus	L	+			
Hieracium alpinum	L	+	*Bartramia ithyphylla*		+
Luzula spicata	L	+	*Bryum* spec. (sterile)		+
Rumex acetosella	B	1⁺	*Cladonia* spec. (*prothallus*)		+
Saxifraga nivalis	A	+	*Fimbriaria ludwigii*		1
Sedum rosea	L	+	*Pohlia drummondi*		+
Silene acaulis	A	+	*Polytrichum piliferum*		+
Taraxacum croceum	L	+	*Stereocaulon* spec.		+

A more or less related community from South Greenland has been described by BÖCHER (1954, table 6:2).

10.2. Order *Sedo-Scleranthetalia* BR.-BL. 1955.

syn.: *Sempervivo-Sedetalia albi* TH. MÜLLER 1961.

10.2.1. *Sedum acre* community.

The occurrence of *Sedum acre* L., in Greenland is restricted to the Angmagssalik District, where it occurs in cracks and fissures in rocks by the sea and in old seaweed deposits on the beach, in several localities (KRUUSE, 1906, p. 245; BÖCHER, 1938, p. 110, fig. 52).



Fig. 68. Sedum acre community between blocks and in earth-filled cracks in gray gneiss rock at Sarfaq, Torssukátak fjord; on the rocks epilithic *Umbilicaria* communities.
JGdM phot. VII. 1969.

At Sarfaq in the inner Torsukátak (Tunok) fjord it occurs slightly above MHW level on Southwest to West-facing, 2 m high cliffs, in dense patches in earth-filled cracks in the rock. It is found associated with such taxa as *Cerastium alpinum*, *Festuca rubra*, *Poa alpina*, *Sedum rosea*, *Viscaria alpina*, *Ceratodon purpureus*, *Tortella tortuosa*, *Cetraria crispa*, *Cladonia gracilis*, *C. pyxidata* var. *chlorophaea*.

The data of one analyzed sample plot are: Sarfaq in Torssukátak, at 1 m a.s.l.; inclination 0–5°, orientation SW; area 3 m²; cover plants (total) 40 %, -phanerogams 20 % (18 cm high), -cryptogams 25 %, -open, bare rock 60 %; substrate: depth maximally 25 to 30 cm (in the cracks), undifferentiated, gravelly to coarse sandy colluvial material derived from weathering grey gneiss, dry; pH rhizosphere 5½; composition:

Saxifraga caespitosa	A	2	*Cetraria crispa*		2
Sedum acre	B	2	*Cladonia coccifera*		1
Cerastium alpinum	L	+	*Cladonia gracilis*		1
Cochlearia groenlandica	A	+	*Cladonia pyxidata* var. *chlorophaea*		1
Empetrum hermaphroditum	L	+			
Festuca rubra	B	+	*Tortella toruosa*		1

Honckenya peploides var. *diffusa*	L	+	*Cetraria nivalis*		+
Oxyria digyna	A	+	*Drepanocladus uncinatus*		+
Sedum rosea	L	+	*Ptilidium ciliare*		+
			Tortula ruralis		+

This low-arctic, little chionophytic to anemophytic, xerophytic and thermophytic, somewhat halophytic, mesotrafent to eutrafent, somewhat nitrophytic, chasmophytic community represents presumably a low-arctic counterpart of the boreal-atlantic *Sedum acre-album* communities known from similar habitats in e.g. the inner Oslofjord, South Norway, in particular of the type dominated by *S. acre* and described by SUNDING as a "*Sedetum acris*" (SUNDING, 1965, p. 34–35; RUBERS *et al.*, 1971, p. 6). For lack of more data I can not classify this plant community and confine myself to grouping it for the present as a community in the *Sedo-Scleranthetalia.*

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