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Phytosociological aspects of Dryas integrifolia vegetation on moist-wet soil in Northwest Greenland

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with 4 tables and 9 figures

Abstract. This paper deals with the results of a phytosociological study according to the Braun-Blanquet approach of *Dryas integrifolia* vegetation on moist-wet soil in the Uummannaq District, Northwest Greenland. Soil chemical analyses comprise pH, conductivity, C/N-ratio and content of organic material, Ca^{2+}, Mg^{2+}, K^{+}, Na^{+} and phosphate (mg/100g soil).

Based on 49 relevés two associations and one community are distinguished, which were firstly described from the east coast of Greenland and so far only known from East Greenland. The Rhododendro-Vaccinietum microphylli Daniëls 1982 occurs on moist soil. A subass. campylietosum stellati nov. occurs mainly along lakes and rivulets and a subass. sphaerophoretosum globosi nov. is restricted to moist soil which dries out in summer. A north-western vicariant of the Saxifrago-Kobresietum simpliciusculae Daniëls & Fredskild in Fredskild 1998 mainly occurs on wet soil. A subass. ochrolechietosum frigidae nov. occurs on soil which partly dries out in summer and a subass. eriophoretosum angustifolii nov. occurs on permanent wet soil. An *Eriophorum angustifolium-Rhododendron lapponicum* community is confined to wet calcium- and magnesium-rich soil with permanent water supply.

Literature research shows, that all vegetation types can be considered widespread in most parts of Greenland. Multivariate analyses (DECORANA and CANOCO) confirm the vegetation typology and the decisive differential role of soil moisture conditions between the vegetation types, just as do the results of a transect study along a soil moisture gradient. The vegetation types are classified within a new hygrophytic-mesophytic Rhododendrenion lapponici suballiance of the alliance Dryadion integrifoliae Ohba ex Daniëls 1982, order Kobresio-Dryadetalia (Br.-Bl. 1948) Ohba 1974, class Carici-Kobresietea Ohba 1974. The synecological conception of the Dryadion integrifoliae and floristical differentiation against Caricion atrofusco-saxatilis vegetation (Caricetalia davallianae Br.-Bl. 1949, Scheuchzerio-Caricetea (Nordh. 1937) R. Tx. 1943) are reconsidered and stated more precisely. The high species richness of Rhododendro-Vaccinietum vegetation stands with a mean species number of 65 and 70 per plot of respectively 4 m^2 and 0.16 m^2 is discussed.

Keywords: Arctic, Caricion atrofusco-saxatilis, Dryadion integrifoliae, species richness, synecology, transect study.

Introduction

The North American Arctic species *Dryas integrifolia* (a. o. PORSILD 1947, HULTÉN 1959, PORSILD & CODY 1980) is considered a faithful species (Ch)

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of the alliance Dryadion integrifoliae Ohba ex Daniëls 1982 (see Ohba 1974, Daniëls 1982). The alliance belongs to the order Kobresio-Dryadetalia (Br.-Bl. 1948) Ohba 1974, class Carici-Kobresietea Ohba 1974. The conception and characterisation of this widely distributed circumpolar arctic-northern alpine class stem from Ohba (1974). The class comprises mainly cryoxerophytic grass heath and some dwarf shrub heath communities on weakly acidic-basic soil.

The class is subdivided into several regional orders. Contrary to Ohba (1974) we accept only the circumarctic order Kobresio-Dryadetalia (Br.-Bl. 1948) Ohba 1974 for the entire Greenland (cf. Daniëls 1982, 1994, see also Dierssen 1996).

In Greenland this order is represented by the North-American alliance Dryadion integrifoliae Ohba ex Daniëls 1982. This alliance is characterised by the faithful species *Dryas integrifolia* and *Pedicularis lanata* (Ohba 1974). Additionally diagnostic for the alliance are the diagnostic species (Ch and D) of the order and class as far as they occur in Greenland (cf. Table 2 and 3). For the order they include *Carex glacialis, C. misandra, C. nardina, C. scirpoidea, Pedicularis lanata* and *P. capitata* (all Ch), and *Cassiope tetragona* and *Rhododendron lapponicum* (both D), and for the class *Carex rupestris, Dryas octopetala* s.l., *Erigeron uniflorus, Gentiana tenella, Kobresia myosuroides, Pedicularis oederi, Potentilla crantzii, P. nivea, Tofieldia coccinea* (all Ch). Moreover *Saxifraga oppositifolia* and *Silene acaulis* are considered differential species, just as a number of microlichens (Daniëls 1982, 1994).

The alliance was firstly described from Southeast Greenland on the basis of only one association, the xerophytic Carici-Dryadetum integrifoliae Daniëls 1982, and two other vegetation types. The alliance was synecologically characterised as weakly acido- to basiphytic, meso- to xerophytic, and weakly chiono- to achionophytic (Daniëls 1982).

Actually *Dryas integrifolia* vegetation is much more common and diverse in northern and continental parts of Greenland (e.g. own unpublished material, Böcher 1954, 1963, Daniëls & Alstrup 1999, Daniels et al. 2000), such as in the poorly known Uummannaq District in Northwest Greenland (Lünterbusch 2002). However very few relevé-based publications with syntaxonomical and synecological interpretation exist so far from these regions (Ohba 1974, Daniëls 1982, 1994; see also Stumböck 1993, Fredskild 1998).

Although *Dryas integrifolia* mainly occurs in fell-field and heath vegetation on comparatively dry, neutral to basic soil (a.o. Böcher et al. 1978), the species seems to have a much broader ecological amplitude, since it is found in many other vegetation types and habitats (a. o. Gelting 1937, Böcher 1954, 1963, Jakobsen 1971, Daniëls 1982, Hart 1988, Batten & Svoboda 1993, Lünterbusch & Daniels 2000, 2001). The species is often reported from plant communities on moist-wet soil, e.g. in the Rhododendro-Vaccinietum Daniëls 1982 and e.g. in communities of the *Rhododendron-Carex amblyorhyncha* Type (Böcher 1954). Such communities have been (provisionally) classified in the mire and fen class Scheuchzerio-Caricetea (cf. DANIËLS 1982). In Northeast Greenland *Dryas octopetala* (incl. *integrifolia*) commonly occurs both in fen vegetation (Caricion atrofusco-saxatilis) on hygric soil and in Dryadion integrifoliae vegetation on mesic-xeric soil (FREDSKILD 1998). Also BARRET (1972) reports *Dryas integrifolia* from wetlands in Devon Island, Nunavut, Canada (a. o. "Caricetum stantis" and "Eriophoro-Salico-Agrostidetum latifoliae"). HART & SVOBODA (1993) observed a different growth-form in wet habitats.

On the other hand many diagnostic species of the class and order show less broad and different ecological amplitudes: e.g. *Tofieldia* species, *Carex capillaris* coll., *C. misandra* and *Rhododendron lapponicum* mainly occur on rather moist-wet soil; *Carex rupestris* and *C. nardina* mainly on dry soil (cf. BÖCHER 1954, 1963, OHBA 1974, BÖCHER et al. 1978).

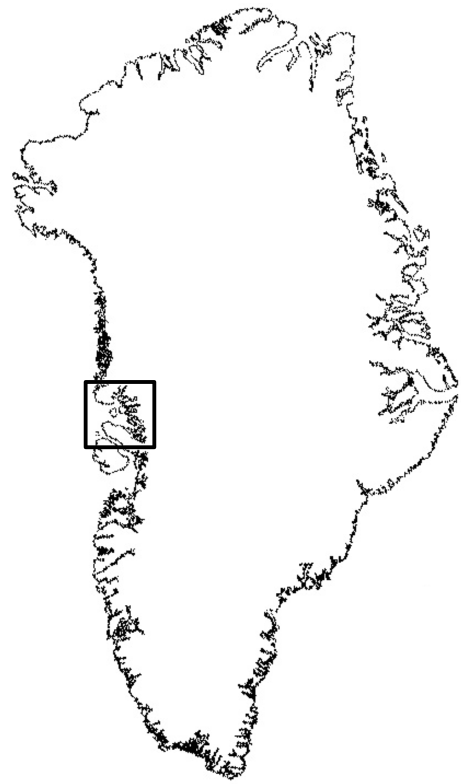
HOFMANN (1968), OHBA (1974) and DIERSSEN (1996) drew attention to problems of the floristical differentiation between Carici-Kobresietea vegetation (here Dryadion integrifoliae) and rich fen vegetation of the Scheuchzerio-Caricetea class (here Caricion atrofusco-saxatilis) in northern arctic regions. These syntaxa share a number of species, whereas even diagnostic species also can occur side by side in the same vegetation stand (cf. Table 3). This might be due to wet soil conditions due to stagnant water on the frozen subsoil (permafrost) after snow melt (Caricion atrofusco-saxatilis habitat), followed by desiccation in summer (Dryadion integrifoliae habitat). Also differences in height of only a few centimetres in substrate surface might cause different soil moisture conditions and enable species of both syntaxa to live side by side (cf. OHBA 1974, DIERSSEN 1996). Moreover both reduction of peat formation due to low precipitation and soil cryoturbation result into non acidic substrate conditions (habitat of both syntaxa).

This all allows a reconsideration of the floristical and synecological conception of the Dryadion integrifoliae against the Caricion atrofusco-saxatilis. The main purpose of the research presented here is a syntaxonomical and synecological evaluation of vegetation with *Dryas integrifolia* in Northwest Greenland on moist-wet soil. The results are based both on ample floristical comparisons of vegetation types and a detailed transect study of flora and vegetation along a pronounced soil moisture gradient. They aim to contribute to a better floristical and synecological conception of the Dryadion integrifoliae alliance and its associations in Greenland. Finally species richness will be shortly addressed.

Study area

The fieldwork was carried out in 1997 and 1998 in the Uummannaq District, between the Svartenhuk Peninsula in the North and the Nuussuaq Peninsula in the South (approximately between 70°15' N and 72° N, and 49°E–54° E). Thirteen localities have been studied (see Fig. 1, 2).

From a phytosociological point of view this District is poorly known (cf. FREDSKILD 1996, LÜNTERBUSCH 2002). From a bioecological point of



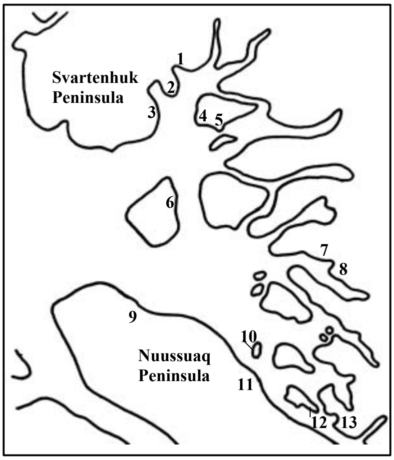


Fig 2. Map of the Uummannaq District with indication of the 13 research localities.

Fig. 1. Map of Greenland showing the location of the Uummannaq District.

view the region might be considered as transitional between the "Low Arctic" and "High Arctic" (sensu Bliss 1997, see also Fredskild 1996). Most of the District belongs to the "Southern Arctic Dwarf Shrub Zone" (Daniels et al. 2000, cf. CAVM Team 2003).

The landscape is mountainous and deeply cut by fjords. Glaciers and moraines are common. Geology is rather varied. In the eastern parts Precambrian gneiss covers extensive areas, bedrock in the western parts consists of basalt. However locally granite, marble, and cretaceous and tertiary sediments occur (Pulvertaft 1990) (see Fig. 3).

Climatological information about the entire region is scant. As can be seen from the climate diagram of the town of Uummannaq (Fig. 4) the climate might be characterised as arctic continental. Mean annual temperature is – 2.8° C. Precipitation is < 200 mm/year. July and August are very dry. A strong climatic gradient exists between the continental inland areas and the oceanic coastal parts of the District. Due to a semi-permanent glacial anticyclone system with high pressure on the central icecap, strong and dry foehn winds are commonly blowing from the icecap to the coast.

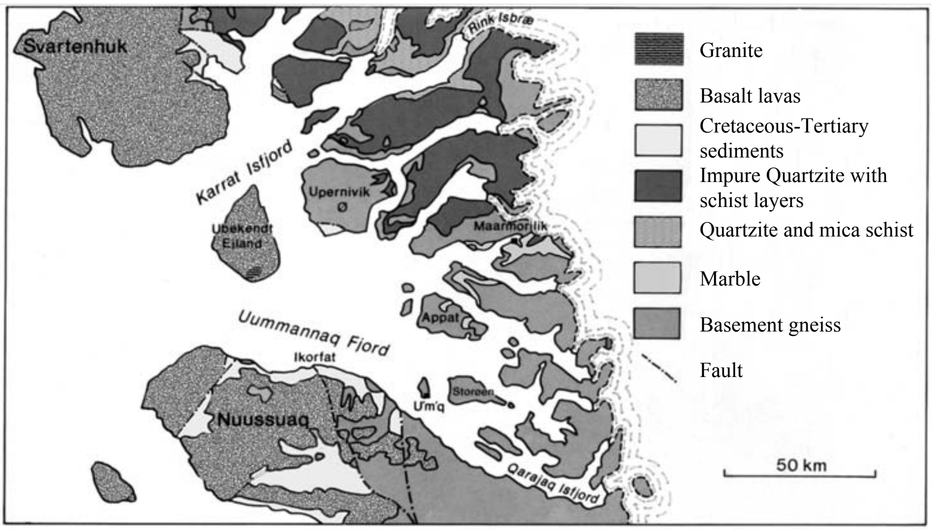


Fig. 3. Simplified geological map of the Uummannaq District (after PULVERTAFT 1990).

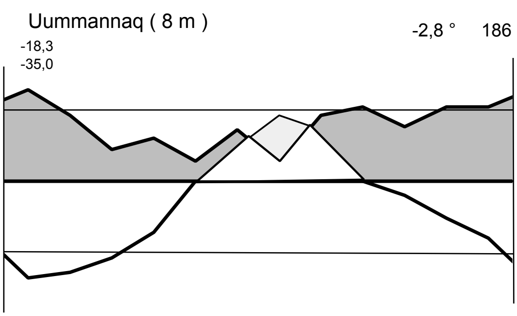


Fig. 4. Climatic diagram of the town of Uummannaq 70.69° N, 52.17° W (WALTER & LIETH 1960–1967).

Of the 2600 inhabitants 1200 live in small settlements scattered over the District and 1400 in the town of Uummannaq.

Methods

The *Dryas* vegetation was studied according to the Braun-Blanquet approach (cf. DIERSCHKE 1994). In total 49 relevés of 2×2 m^2 were made stemming from many localities scattered over the entire District (see Fig. 2).

The following cover-abundance scale was used:

r	1–2 individuals, cover < 5 %
+	3–10 individuals, cover < 5 %
1	10–100 individuals, cover < 5 %
2m	> 100 individuals, cover < 5 %
2a	cover 5–<12.5 %
2b	cover 12.5–<25 %
3	cover 25–<50 %
4	cover 50–<75 %
5	cover ≥ 75 %

Critical specimens, especially of bryophytes and lichens, have been identified in the laboratory using microscope and Thin Layer Chromatography (Culberson & Amman 1979).

For all relevés the following habitat factors were measured: altitude, aspect, inclination and depth of ground water if present. Wind shelter, snow cover in winter and water supply in spring and summer, were estimated in five categories: 1 (lowest) – 3 (intermediate) – 5 (highest).

Soil samples stem from the rhizosphere (3–10 cm) and were analysed according the AG Boden (1994).

All chemical analyses have been performed with soil material < 2 mm. Contents are expressed in mg/100g; electric conductivity in µS/cm. pH was measured in aqua dest. with an electric WTW device (solution 10 gram soil in 25 ml aqua dest. after 2 hours shaking). Conductivity was measured with a WTW conductivity meter in the same solution after adding 75 ml aqua dest. and one hour additional shaking.

Total N and total C contents for calculation the C/N-ratio have been measured with the Element Analysator (CHN-O-Rapid, HEREUS). Plant available P was measured photometrically through phosphor-molybdate complex according to the CAL Method (VDLUFA 1991).

The amount of the cations Ca^{2+}, Mg^{2+}, K^{+}, and Na^{+} was measured according to Trüby & Aldinger (1989): 2.5 gram soil were extracted with NH_4Cl. The contents of Na^{+} and K^{+} were measured by AAS and of the other cations by AAS 939 (UNICAM). The results of the habitat analyses are presented in the head of Tables 1 and 2.

In the synthetic research phase the programs TURBO(VEG) – Version 9.42, MEGATAB – Version 2.08 (Hennekes 1995, 1996, 1997) and Decorana (using default option) (Hill 1979, Ter Braak & Smilauer 2002) were used. Frequency classes follow Dierschke (1994).

The relationships between the relevés and environmental factors have been studied with CANOCO (CANOCO 4.5 software package) (Ter Braak & Smilauer 2002).

Biological distribution types (BDT) of the vascular plants follow Böcher (1975) in Fredskild (1996) (cf. Table 3). They include the following categories: A: Arctic, widespread; HA: High Arctic; AC: Arctic, continental; MA: Middle Arctic; L: Low Arctic; LO: Low Arctic, oceanic;

LC: Low Arctic, continental and B: Boreal. Geographical distribution types (GDT) are according to Hultén (1958, 1964, 1971) in Fredskild (1996) and include the categories: C: circumpolar; W: western (main occurrence in North-America); E: eastern (main occurrence in Eurasia) and A: amphi-atlantic.

Moreover a transect analysis along a soil moisture gradient was performed about 1 km east of the settlement of Nuugaatsiaq (Fig. 2, locality 5: 71°55'N, 53°10'W) in August 1998. Altitude is abt. 20 m NN. The geological substrate is graywacke (metagraywacke, Nûkavsak Formation (cf. Hendersson & Pulvertaft 1987).

The transect consisted of 21 contiguous vegetation plots of 0.4 × 0.4 m^2 along a line starting from a rivulet with wet fen vegetation and ending in a mesic lichen-rich dwarf shrub heath with *Dryas integrifolia.* Vegetation was recorded as explained above. If present, depth of ground water level was measured in cm (see further Table 1 and 4).

Diagnostic species of the Caricion atrofusco-saxatilis (incl. Caricetalia davallianae and Scheuchzerio-Caricetea) are principally derived from Dierssen (1996), those of the Dryadion integrifoliae (incl. Kobresio-Dryadetalia and Carici-Kobresietea) from Ohba (1974) (Table 3).

Nomenclature of vascular plants follows Böcher et al. (1978), lichens Santesson (1993), Musci Corley et al. (1981, 1991) and liverworts Grolle (1983). The code of phytosociological nomenclature was taken into account (Weber et al. 2001).

Results and discussion

1. Syntaxonomy and synecology of Dryas integrifolia vegetation on mesic-wet soil

(Table 1, 2 and 3; Fig. 5 and 6)

1.1. Rhododendro-Vaccinietum microphylli Daniëls 1982

Syn.: Lande à *Rhododendron lapponicum* (De Lesse 1952); vegetation with *Rhododendron lapponicum* of the *Rhododendron-Carex amblyorhyncha* and *Rhododendron lapponicum-Pedicularis lanata* Type (Böcher 1954); *Carex rupestris-Dryas* communities (Böcher 1963), *Dryas integrifolia* Soziation (Stumböck 1993)
(Table 1, ref. no. 1–26; Table 2, Vegetation type 1, 2, 3 and 4)

The Rhododendro-Vaccinietum is well differentiated in the Uummannaq District by the dominance of *Rhododendron lapponicum* (regional faithful species) and numerous more or less hygrophytic species, which are lacking in the *Dryas integrifolia* vegetation on dry soil (a.o. Carici-Dryadetum integrifoliae Daniëls 1982). They include a.o. *Campylium stellatum, Carex capillaris, C. misandra*, *Fissidens osmundoides, Meesia uliginosa*, *Myurella tenerrima*, *Oncophorus wahlenbergii, Pedicularis flammea*, *Tofieldia coccinea* and *T. pusilla* reflecting the hygrophytic character of the association.

Against the Saxifrago-Kobresietum (1. 2) and *Eriophorum angustifolium-Rhododendron lapponicum* community (1. 3) the association is differentiated by a group of mostly xerophytic species such as e.g. *Alectoria ochroleuca, Bryoria nitidula, Cladonia amaurocraea, C. borealis, Ochrolechia upsaliensis* and *Pertusaria coriacea* (Table 1: species group d1). This group reflects the xerophytic character of the vegetation. The association is negatively characterised by the absence of true hygrophytic species such as *Arctagrostis latifolia, Carex atrofusca, Catoscopium nigritum, Cyrtomnium hymenophylloides, Eriophorum angustifolium* ssp. *subarcticum, Juncus biglumis, J. castaneus, J. triglumis, Kobresia simpliciuscula,* and *Mnium thomsonii* (Table 1: species groups d2, d3, d7, d12, d13). Other constant companions are listed in Table 1 and 2.

The floristical similarity with the association stands from Southeast Greenland, from where the association was firstly described by Daniëls (1982), is high by many species in common (a.o. *Aulacomnium turgidum*, *Carex bigelowii*, *C. capillaris, Dryas integrifolia, Empetrum nigrum* ssp. *hermaphroditum*, *Fissidens osmundoides, Polygonum viviparum*, *Rhododendron lapponicum*, *Salix glauca* ssp. *callicarpaea*, *Sanionia uncinata*, *Tofieldia pusilla*, *Vaccinium uliginosum* ssp. *microphyllum*). *Rhododendron lapponicum, Carex capillaris* and *Fissidens osmundoides* were considered regional faithful species in Southeast Greenland. The Rhododendro-Vaccinietum was classified by Daniëls (1982) in the order Caricetalia davallianae (Scheuchzerio-Caricetea).

The vegetation has a compact, xeromorphic physiognomy and primarily contains dwarf shrubs, pleurocarpous mosses and fruticose lichens. The association was characterised as weakly acido- to neutrophytic, minerotraphent, mesotraphent, meso- to hygrophytic and weakly chiono- to weakly achionophytic. Soil conditions in the growing season are rather moist by more or less permanent melt water supply from higher sites, but later rather dry, due to desiccation of the upper soil surface. In Southeast Greenland the association is less well developed as in Northwest Greenland, and not common. It is generally found as small, band shaped phytocoenoses of a few tenths of square metres.

In the Uummannaq District the association occurs under the same synecological conditions: moist soil which dries out later in the year. Soil is shallow and weakly acidic to neutral and rich in organic material. Often the stands occur on small rocky terraces (ledges).

A subassociation sphaerophoretosum globosi subass. nov. (Table 1, ref. no. 1–18, Nomenclatoric type relevé: ref. no. 4) is in general restricted to drier sites in the northern part of the investigation area (Fig. 2: localities: 1, 2, 4, 5). Differential species are a.o. *Anthelia juratzkana*, *Gymnomitrion corallioides*, *Hypnum vaucheri*, *Pertusaria glomerata*, *P. panyrga*, and *Sphaerophorus globosus* (Table 1, species group d8).

A variant of *Diapensia lapponica* (Table 1, ref. no. 1–7) is dominated by dwarf shrubs and fruticose lichens, whereas graminiods are sparse. Dif-

Table 2. Synoptic table of the vegetation types with indication of the diagnostic vascular plant species of the Dryadion integrifoliae and Caricion atrofusco-saxatilis in Greenland.

	diagnostic species Carici-Kobresietea	diagnostic species Scheuchzerio-Caricetea	**Vegetation type**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
			Number of relevés	7	6	5	8	6	11	3	3
			Mean altitude (m)	91	75	110	114	110	78	143	95
			Mean slope (degrees)	14	8,2	3,8	5,6	3	3,1	4,3	4,7
			Mean cover total (%)	94	82	84	93	87	86	98	97
			Mean cover herb layer (%)	71	59	67	77	77	73	70	65
			Mean cover moss layer (%)	44	31	27	41	30	37	82	83
			Mean cover litter layer (%)	3,4	4,5	6,2	11	9,5	7,5	4	4,7
			Mean height herb layer (cm)	3,9	7,7	4,6	4,8	5,3	6,9	5,7	8,7
			Mean height low herb layer (cm)	3	1,3	1	1,1	1,8	2,5	1	5,7
			Mean max. height herb layer (cm)	19	23	21	22	24	28	32	42
			Mean max. height crypt, layer (mm)	2,3	2,2	1,6	2,5	1,5	2,3	6	7,3
			Mean cover dwarf shrubs (%)	66	25	47	69	43	31	52	47
			Mean cover forbs (%)	1,1	2,3	1,4	1,1	3,7	2,3	2,3	1,3
			Mean cover graminoids (%)	4,1	35	22	13	40	46	27	23
			Mean wind shelter (1 - 5)	2,1	2,3	3,1	3,4	3,8	3,6	3,5	3,3
			Mean snow cover (1 - 5)	3,2	2,7	3,3	3,7	4,1	4	4,3	4
			Mean water supply spring (1 - 5)	3,4	3,2	3,7	3,9	4,8	5	5	5
			Mean water supply summer (1 - 5)	2,8	2,5	3,2	3,5	3,8	4,4	4,5	4,5
			Mean soil depth in cm	17	14	15	20	15	23	27	30
			Mean soil displacement (1-5)	1,8	2,1	2,7	2,9	2,3	2,4	2,2	2
			Mean carbonate (0 - 5)	0,3	0,5	0,2	0,5	0	0,6	1,3	0,7
			Mean pH	6	6,2	6,1	6,3	6,4	6,6	7,1	6,9
			Mean conductivity in µS/cm	34	30	33	63	79	72	83	44
			Mean humus	13	7,9	7,5	16	28	14	21	20
			Mean C/N-ratio	17	17	15	18	15	16	14	14
			Mean C absolute (%)	5,2	3,2	3,6	8,2	14	6	8,2	7
			Mean N absolute (%)	0,3	0,2	0,2	0,5	1	0,4	0,6	0,5
			Mean K^{+} in mg/100g soil	11	19	7,4	23	30	13	22	27
			Mean Na^{+} in mg/100g soil	8,5	18	31	34	33	28	17	32
			Mean Mg^{2+} in mg/100g soil	36	27	26	41	69	39	89	132
			Mean Ca^{2+} in mg/100mg	166	85	125	133	288	216	335	279
			Mean phosphate in mg/100g	1,5	1,5	1,2	2,3	2	1,9	1,9	2
			Mean species number vascular plants	14	14	14	14	17	20	17	18
			Mean species number lichens	32	35	38	26	13	9,4	4	7,3
			Mean number acrocarpous mosses	11	9,8	14	11	7,5	9,1	9,3	10
			Mean species number pleurocarpous mosses	4	2,2	2,8	5,4	4,3	5,6	6	6,3
			Mean species number liverworts	4,1	4	3,6	3,3	1,7	2,8	3	4,7
			Mean total number of species	65	64	72	60	43	47	39	47
d1:			Bryoria nitidula	V	V	V	V	I	.	.	.
			Alectoria ochroleuca	V	V	IV	V	I	+	1	.
			Alectoria nigricans	IV	V	III	III	.	I	.	.
			Ochrolechia upsaliensis	IV	IV	V	III	I	.	.	.
			Pannaria praetermissa	III	II	III	V	I	.	.	.
			Hypnum revolutum	IV	I	I	IV	.	.	.	.
			Pohlia cruda	IV	V	IV	III	I	.	.	.
			Cladonia pyxidata	V	V	V	II	I	I	.	1
			Cladonia borealis	V	V	III	II	.	.	.	.
			Racomitrium lanuginosum	V	III	V	II	.	+	.	.
			Ceratodon purpureus	III	V	II	II	.	.	.	.
			Psoroma hypnorum	III	II	I	II	.	.	.	1
			Candelariella spec.	II	II	III	II	I	.	.	.
			Cladonia arbuscula ssp. mitis	V	V	II	II	I	+	.	1
			Rinodina turfacea	III	IV	III	II	.	+	.	1
			Stereocaulon alpinum	V	III	III	II	.	.	1	2
			Caloplaca ammiospila	IV	V	V	II	I	+	.	1
			Pertusaria coriacea	III	V	II	II	I	+	.	.
	x		Carex nardina	III	II	II	I	I	+	.	.
			Luzula confusa	III	I	IV	II	I	+	.	.
d2:	x	x	Carex misandra	II	.	I	II	V	V	2	.

Tab. 2 (cont.)

		x	Juncus triglumis	.	.	.	.	II	IV	1	.
			Saxifraga aizoides	.	.	.	.	I	II	1	.
		x	Carex atrofusca	.	.	.	.	I	II	1	.
			Armeria scabra ssp. sibirica	.	.	.	I	II	I	.	.
d3:			Orthothecium chryseon	.	.	.	.	.	+	1	3
			Philonotis tomentella	.	.	.	.	.	.	1	1
			Barbilophozia quadrilobata	.	.	.	I	.	+	1	2
			Cinclidium stygium	.	.	.	.	.	+	1	2
		x	Pinguicula vulgaris	.	.	.	.	.	+	1	2
			Mnium thomsonii	.	.	.	I	.	+	2	.
d4:	x		Carex rupestris	V	V	V	V	V	V	.	.
			Cetraria nivalis	V	V	V	V	V	IV	1	.
			Caloplaca tiroliensis	III	III	IV	V	IV	II	.	2
			Cephaloziella arctica	V	V	IV	V	I	IV	.	.
	x		Silene acaulis	IV	IV	IV	II	V	IV	.	.
			Cetraria cucullata	V	V	IV	V	II	III	1	.
			Cetraria islandica ssp. crispiformis	V	V	IV	IV	III	II	.	.
			Carex bigelowii	V	I	IV	III	III	III	1	1
			Cetraria muricata	IV	V	V	V	III	III	.	.
			Thamnolia vermicularis v. subul.	V	V	V	V	IV	III	2	1
			Ochrolechia frigida	V	V	V	V	V	II	1	1
			Rinodina roscida	I	III	II	III	III	II	.	.
			Lepraria neglecta	III	I	I	I	II	.	.	.
			Physconia muscigena	I	IV	V	V	II	I	.	.
			Megaspora verrucosa	.	III	III	IV	III	I	.	.
			Ochrolechia frigida f. lappuensis	II	I	.	IV	I	.	.	.
d5:			Cladonia pocillum	.	.	V	V	V	V	1	1
	x		Pedicularis flammea	.	.	II	II	IV	IV	2	2
d6:	D		Saxifraga oppositifolia	I	.	I	III	IV	II	.	.
			Distichium capillaceum	.	I	.	IV	III	III	1	2
			Campylium stellatum	.	II	.	IV	IV	IV	2	2
	x	x	Tofieldia pusilla	III	.	.	III	V	III	3	3
			Luzula arctica	III	.	.	II	I	II	.	1
			Myurella julacea	I	.	II	V	V	V	3	1
d7:			Tomentypnum nitens	II	.	.	III	I	IV	3	3
		x	Kobresia simpliciuscula	.	.	.	I	IV	IV	2	1
			Hypnum bambergeri	II	.	.	II	II	V	3	1
			Blepharostoma trichophylla	.	.	.	II	II	III	2	2
			Equisetum arvense	.	.	.	II	.	II	2	3
			Orthothecium strictum	I	.	.	II	IV	III	3	2
		x	Equisetum variegatum	.	.	.	I	II	II	3	1
			Scapania gymnostomophila	.	I	.	I	II	III	2	1
		x	Carex rariflora	.	.	.	.	I	I	1	1
			Salix arctica	.	.	.	.	I	I	2	1
d8:			Sphaerophorus globosus	V	V	IV	.	.	.	.	.
			Gymnomitrion corallioides	III	V	V	.	.	.	.	.
			Anthelia juratzkana	III	IV	IV	.	.	+	.	.
			Cladonia amaurocraea	V	V	V	II	.	.	.	.
			Cladonia stricta	II	III	III	I	I	I	.	.
	x		Tofieldia coccinea	III	III	V	.	.	III	.	.
			Pertusaria glomerata	I	I	III	.	.	.	.	.
			Hypnum vaucheri	I	III	IV	.	.	.	1	.
			Pertusaria panyrga	II	III	III	II	.	.	.	.
d9:			Polytrichum juniperinum	V	I	.	.	.	.	.	.
			Diapensia lapponica	V	.	I	.	.	.	.	.
			Lecidea diapensiae	IV	.	.	.	.	.	.	.
			Peltigera malacea	III	.	.	I	.	.	.	.
			Cladonia rangiferina	III	.	.	I	.	.	.	.
			Hylocomium splendens	III	.	.	I	.	.	.	1
			Dicranum cf. groenlandicum	IV	II	.	.	.	.	.	.
			Stereocaulon paschale	III	I	.	.	.	.	.	.
			Cladonia gracilis	III	I	.	.	.	.	.	.
			Caloplaca spec.	III	.	.	.	.	.	.	.
			Ochrolechia androgyna	III	.	.	.	.	+	.	.
			Dactylina ramulosa	III	.	.	.	.	.	.	.
			Rhytidium rugosum	III	I	II	.	.	+	.	.
			Ptilidium ciliare	III	.	I	II	.	.	.	1

Tab. 2 (cont.)

		Barbilophozia hatcheri	III	.	.	II	.	.	1	.
d10:		Cladonia macroceras	III	III	.	.	I	I	.	.
	x	Kobresia myosuroides	.	V	.	II	.	+	.	.
		Cerastium alpinum	.	IV	.	II	.	.	.	.
		Buellia geophila	.	IV	.	I	.	.	.	.
		Draba spec.	.	III	.	.	.	.	.	.
		Parmelia omphalodes	.	III	I	.	.	.	.	.
		Polytrichum alpinum	.	V	III	.	.	I	.	1
d11:		Hierochloe alpina	.	III	III	I	.	+	.	.
		Festuca brachyphylla	.	III	II	I	.	.	.	.
		Campylopus schimperi	II	I	V	II	.	I	.	.
		Hypogymnia austerodes	.	IV	IV	IV	.	.	.	.
		Japewia tornoensis	I	III	II	II	.	.	.	.
		Tortula ruralis	.	II	I	II	.	.	.	.
		Rinodina olivaceobrunnea	.	I	I	II	.	.	.	.
		Gyalecta foveolaris	I	.	III	II	.	.	.	.
		Dicranum cf. muehlenbeckii	I	I	II	IV	.	.	.	.
		Caloplaca tetraspora	.	.	IV	I	.	.	.	1
		Racomitrium heterostichum	.	.	III	.	.	.	.	.
		Rinodina mniaraea v. mniaraea	I	II	I	II	I	.	.	.
d12:	x	Carex scirpoidea	I	.	I	I	IV	I	.	.
		Cyrtomnium hymenophylloides	II	.	.	I	IV	+	1	1
		Empetrum nigrum ssp. hermaphroditum	I	.	.	II	III	I	1	3
		Oncophorus wahlenbergii	III	I	.	II	IV	I	1	1
		Myurella tenerrima	II	.	I	III	III	.	.	.
		Meesia uliginosa	III	.	I	II	V	II	3	1
	x	Carex gynocrates	.	.	.	.	II	.	.	1
		Chamaenerion latifolium	.	.	.	I	II	.	.	.
d13:	x	Carex stans	.	.	.	.	.	II	1	1
	x	Eriophorum angustifolium ssp. subarcticum	.	.	.	.	.	IV	3	3
	x	Juncus castaneus	.	.	.	.	II	V	2	.
	x	Arctagrostis latifolia	.	.	.	.	.	III	1	3
		Catoscopium nigritum	.	.	.	.	.	III	3	1
d14:		Scorpidium turgescens	.	.	.	.	.	II	.	.
		Euphrasia frigida	.	.	.	.	.	II	.	.
	x	Juncus biglumis	.	.	.	.	.	III	.	.
		Trichostomum arcticum	.	.	I	I	.	III	1	.
d15:		Aulacomnium palustre	.	.	.	.	.	.	.	2
		Cyrtomnium hymenophyllum	.	.	.	.	.	.	.	2
		Meesia triquetra	.	.	.	.	.	+	.	2
others	x	Dryas integrifolia	V	V	V	V	V	V	3	3
	D	Rhododendron lapponicum	V	V	V	V	V	V	3	2
		Vaccinium uliginosum ssp. microphyllum	V	V	IV	V	V	IV	3	3
		Bryum spec.	IV	V	III	V	IV	V	3	3
		Polygonum viviparum	V	V	V	V	V	V	3	3
	x	Pedicularis lanata	V	I	I	II	III	I	2	3
		Ditrichum flexicaule	III	.	V	V	IV	V	3	2
		Salix glauca ssp. callicarpaea	II	V	V	IV	III	V	.	1
		Tortella tortuosa (arctica)	II	II	IV	V	III	III	2	.
		Lecanora epibryon	III	II	IV	IV	IV	II	1	1
		Fissidens osmundoides	III	II	III	I	IV	IV	.	1
		Lecidea spec.	II	IV	IV	IV	II	I	.	.
		Distichium spec.	II	II	IV	I	II	II	2	1
		Tortella fragilis	I	III	II	III	III	II	1	.
		Caloplaca cerina	I	III	IV	II	II	II	1	.
		Encalypta spec.	I	III	I	II	I	.	2	.
		cf. Platydictya jungermannioides	I	.	I	II	IV	I	1	.
		Aulacomnium turgidum	V	I	II	IV	.	I	.	3
		Betula nana	V	I	.	IV	II	II	1	3
		Lophozia spec.	I	II	I	II	.	I	1	2
	D	Cassiope tetragona	III	.	.	II	.	I	1	3
		Pyrola grandiflora	III	.	.	II	.	.	.	3
		Microlichen indet.	II	.	III	I	.	II	.	.
		Solorina bispora	I	I	I	.	I	III	.	.
		Bryum spec. (cuculate)	I	.	II	.	II	II	.	1
		Cephalozia spec.	III	I	.	II	.	+	.	1
		Hymenostylium recurvirostrum	.	.	.	II	I	II	.	.

Tab. 2 (cont.)

	Sanionia uncinata	II	.	.	I	.	I	.	1
	Caloplaca saxifragarum	I	III	.	I	I	+	.	.
	Encalypta rhaptocarpa	.	I	II	II	.	II	.	.
	Lopadium pezizoideum	III	II	I	I	.	+	.	.
	Pedicularis lapponica	II	.	.	I	II	+	1	.
	cf. Odontoschisma elongatum	.	I	I	I	.	II	1	1
	Cetrariella delisei	II	.	I	I	.	+	.	.
	Odontoschisma macounii	I	.	.	I	II	I	.	1
	Amblystegium serpens	I	II	.	II	I	+	.	.
	Poa glauca	.	III	.	II	I	+	.	.
	Brachythecium spec.	.	II	II	I	.	+	.	.
	Peltigera didactyla	I	III	.	I	.	+	.	.
	Peltigera aphthosa	II	.	I	I	I	.	.	1
	Pseudocalliergon turgescens	.	.	.	I	.	II	1	1
	Bacidia bagliettoana	.	I	I	I	.	.	.	2
	Salix herbacea	.	.	I	I	.	I	.	1
	Anastrophyllum minutum	II	III	.	I	.	.	.	.
	Cladonia ecmocyna	I	I	I	I	.	.	.	1
	Saelania glaucescens	I	I	I	I	.	+	.	.
	Pedicularis hirsuta	I	.	I	I	.	.	1	1
	Polyblastia sendtneri	.	.	.	I	.	+	1	.
	Baeomyces carneus	II	I	II	.	.	.	.	.
	Tayloria lingulata	.	.	.	I	.	+	1	1
	Cladonia spec.	II	I	.	.	I	+	.	.
	Poa arctica	.	I	.	I	I	+	.	.
	Pertusaria dactylina	III	II	.	.	.	.	.	.
	Distichium inclinatum	.	.	.	I	II	I	.	.
	Luzula spicata	I	II	.	I	.	.	.	.
	Dicranum fuscescens	II	II	.	.	.	.	.	.
	Barbula spec.	.	II	I	.	.	+	.	.
	Thuidium abietinum	II	.	I	I	.	.	.	.
	Collema spec.	.	.	I	II	.	.	1	.
	Dicranum spadiceum	.	.	I	II	.	.	.	.
	Lecanora zosterae	.	.	I	I	I	+	.	.
	Drepanocladus spec.	.	.	.	.	.	II	.	3
	Leproloma vouauxii	.	I	II	.	.	.	.	.
	Cladonia cariosa Atr. + Homosek.	.	I	I	.	.	+	.	1
	Micarea turfosa	.	.	.	I	II	+	.	.
	Scapania spec.	I	I	I	I	.	.	.	.
	Cornicularia divergens	.	.	.	II	I	.	.	.
	Pohlia spec.	.	I	I	.	.	+	.	.
	Bryoerythrophyllum recurvirostrum	.	.	I	II	.	.	.	.
	Stellaria longipes coll	.	II	.	.	.	+	.	.
	Tetraplodon mnioides	I	.	I	.	.	+	.	.
	Leptogium gelatinosum	.	.	.	.	.	+	.	1
	Lepraria lobificans	.	II	I	.	.	.	.	.
	Cladonia dahliana	.	.	.	I	I	+	.	.
	Schistidium apocarpum (frigidum)	.	.	I	I	.	.	.	.
	Bartramia ithyphylla	.	II	I	.	.	.	.	.
	Scorpidium scorpioides	I	.	.	.	.	+	.	1
	Lecidea cf. caesioatra	.	.	I	I	I	.	.	.
D	Carex supina ssp. spaniocarpa	.	.	II	I	.	.	.	.
	Leciophysma finmarkicum	.	.	II	I	.	.	.	.
	Lophozia rutheana	.	.	.	.	I	.	1	1
	Oncophorus virens	.	.	.	I	I	+	.	.
x	Carex glacialis	.	I	.	.	.	.	.	.
	Hepaticae indet.	I	.	I	.	I	.	.	.
	cf. Leskeaceae	.	.	.	.	.	II	.	.
	Pertusaria bryontha	I	I	I	.	.	.	.	.
	Arthrorhaphis citrinella	I	I	I	.	.	.	.	.
	Cladonia cariosa Atran. + Norstict.	II	.	.	I	.	.	.	.
	Peltigera rufescens	.	I	.	I	.	+	.	.
	Phaeorrhiza nimbosa	.	II	.	I	.	.	.	.
	Dicranum spec.	I	.	I	.	.	+	.	.
	Cladonia cariosa s. str.	I	.	I	.	.	.	.	.

Table 3. Table showing the presence and range of cover/abundance values of the diagnostic vascular plant species of the Dryadion integrifoliae and Caricion atrofusco-saxatilis (according to Ohba 1974, Daniëls 1982, 1994 and Dierssen 1996) in the vegetation types (cf. Table 1, 2). Biological (BTD) and geographical (GDT) distribution types are indicated.

		Vegetation type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
		Number of relevés	7	6	5	8	6	11	3	3		
diagnostic species Carici-Kobresietea												
	diagnostic species Scheuchzerio-Caricetea										BDT	GDT
x		*Dryas integrifolia*	V 1/2b	V +/2a	V 2b/4	V +	V +/3	V 2m/4	3 3	3 2a/3	AC	w
D		*Rhododendron lapponicum*	V +/2a	V +/2b	V +/2b	V r/2a	V +/2a	V r/2a	3 +/2a	2 2a/3	AC	w
x		*Pedicularis lanata*	V r/+	I r/+	I +	II r/+	III +	I +	2 +	3 +	AC	w
x	x	*Tofieldia pusilla*	III r/1	.	.	III +/1	V r/1	III r/1	3 +/1	3 1/2m	L	c
D		*Cassiope tetragona*	III +	.	.	II +/3	.	I r/+	1 +	3 +	AC	c
x	x	*Carex misandra*	II r/+	.	I r	II r/+	V r/3	V +/2a	2 1/2a	.	AC	c
x		*Silene acaulis*	IV r/1	IV r/1	IV +/1	II r/+	V r/2a	IV r/1	.	.	A	c
x		*Carex rupestris*	V +/2a	V 2m/3	V 2a/3	V +/3	V +/3	V +/3	.	.	AC	c
x		*Carex nardina*	III r/1	II +	II +/2a	I r	I +	+ +	.	.	AC	a
x		*Tofieldia coccinea*	III r/+	III +/1	V +/1	.	.	III +/1	.	.	AC	w
D		*Saxifraga oppositifolia*	I 1	.	I r	III r/1	IV r/1	II r/1	.	.	A	c
x		*Carex scirpoidea*	I +	.	I 1	I	IV +	I +/1	.	.	L	w
x		*Carex glacialis*	.	I +	.	.	.	.	.	.	AC	c
x		*Kobresia myosuroides*	.	V +/4	.	II 2a/4	.	+ 1	.	.	LC	c
x		*Carex capillaris coll.*	.	I r/+	II +	II +/1	III r/1	IV r/2m	1 +	.	L	c
D		*Carex supina s. spaniocarpa*	.	.	II +/1	I +	.	.	.	.	LC	w
x		*Pedicularis flammea*	.	.	II +/1	II +	IV +/1	IV +/1	2 +	2 r/+	L	w
	x	*Equisetum variegatum*	.	.	.	I 1	II r/2m	II +/1	3 +/2m	1 2m	L	c
	x	*Kobresia simpliciuscula*	.	.	.	I 2m	IV 2a/3	IV +/2b	2 1	1 r	LC	c
	x	*Juncus triglumis*	.	.	.	.	II r/1	IV +/2m	1 1	.	A	c
	x	*Juncus castaneus*	.	.	.	.	II +	V r/2m	2 +	.	MA	c
	x	*Carex atrofusca*	.	.	.	.	I r	II r/2a	1 +	.	MA	c
	x	*Carex rariflora*	.	.	.	.	I 2b	I +/2b	1 +	1 2a/3	L	c
	x	*Carex gynocrates*	.	.	.	.	II r/+	.	.	1 1	LC	w
	x	*Juncus biglumis*	.	.	.	.	.	III +/2m	.	.	A	c
	x	*Arctagrostis latifolia*	.	.	.	.	.	III +/2a	1 +	3 +/1	HA	c
	x	*Carex stans*	.	.	.	.	.	II r/2a	1 2a	1 1	HA	c
	x	*Eriophorum angustif.* ssp. *subarct.*	.	.	.	.	.	IV +/3	3 +/4	3 1/3	B	c
	x	*Pinguicula vulgaris*	.	.	.	.	.	+ +	1 +	2 +	B	a

ferential species are a.o. *Dactylina ramulosa*, *Diapensia lapponica*, *Hylocomium splendens*, *Lecidea diapensiae*, *Ochrolechia androgyna* and *Polytrichum juniperinum* (Table 1, species group d9). It is found in wind exposed sites on slightly acidic to neutral soil near the sea.

A variant of *Kobresia myosuroides* (Table 1, ref. no. 8–13) is often dominated by graminoids especially *Kobresia myosuroides* and *Carex rupestris*, and occurs on small hill tops exposed to dry foehn winds. Differential species are a.o. *Buellia geophila*, *Cerastium alpinum* and *Kobresia myosuroides* (see Table 1, species group d10).

A typical variant (Table 1, ref. no. 14–18) occurs in intermediate sites.

A subassociation campylietosum stellati subass. nov. (Table 1, ref. no. 19–26, Nomenclatoric type relevé: ref. no. 22) occurs mainly along lakes and rivulets on fresh and moist soil and is floristically closely related to the Saxifrago-Kobresietum (see 1.2). This subassociation is very common all over the District.

The association is widely distributed in most parts of Greenland, with the exception of the northernmost regions. The presumed distribution area is confined to the middle and southern arctic dwarf shrub- and arctic shrub zones (Daniels et al. 2000, cf. also Fredskild 1996) in Greenland and eastern Canada (cf. Polunin 1948).

In Southeast Greenland the association is rather rare, not so in the Uummannaq District, where the association covers extensive areas.

Species richness is very high. On average 65 species occur in a relevé. In the 5 relevés of the typical variant of the subassociation sphaerophoretosum we found between 61 and 83 species (on average 72). As far as we could trace this is the highest average species number in relevés of 4 m^2 ever found in the Arctic.

1.2. Saxifrago-Kobresietum simpliciusculae Daniëls et Fredskild in Fredskild 1998

(Table 1, ref. no. 27–43; Table 2, Vegetation types 5 and 6)

This association was firstly described from Northeast Greenland as a middle-arctic, meso-hygrophytic grassland association on rich soil (Fredskild 1998). It is characterised by the Northeast Greenlandic endemic *Saxifraga nathorstii* (local faithful species) and *Braya purpurascens*. Preferential regional faithful species are *Carex atrofusca*, *C. parallela* (not known from the Uummannaq District), *Saxifraga aizoides*, *Kobresia simpliciuscula* and *Pedicularis flammea*. Species with high abundance include *Carex atrofusca*, *C. misandra*, *C. parallela*, *C. rupestris*, *C. scirpoidea*, *Dryas octopetala* (s.l.), *Equisetum variegatum*, *Eriophorum triste*, *Juncus biglumis*, *J. triglumis*, *Kobresia simpliciuscula*, *Minuartia stricta*, *Pedicularis flammea*, *Polygonum viviparum*, *Saxifraga aizoides*, *S. nathorstii*, *S. oppositifolia*, *Salix arctica*, *Silene acaulis*, *Vaccinium uliginosum* ssp. *microphyllum* etc. and cryptogams such as *Bryoerythrophyllum recurvirostre*, *Campylium stellatum*, *Cyrtomnium hymenophylloides*, *Distichium capillaceum*, *Ditrichum flexicaule*, *Encalypta longicollis*, *Hypnum bambergeri*, *Meesia uliginosa*, *Scorpidium turgescens* and *Tortella fragilis*. Fredskild (1998) described the association stands as a "strange mixture of fen plants with dry ground plants".

We consider the vegetation stands of the Uummannaq District (Table 1, ref. no. 27–43) a Northwest Greenlandic vicariant of this association: area-differential species (cf. Daniëls 1985) are *Carex gynocrates* (LC, W) and *Pedicularis lanata* (AC, W). In Northeast Greenland the association contains several species which are absent in West Greenland, such as e.g. the endemic *Saxifraga nathorstii* (however its probable progenitors *S. oppositifolia* and *S. aizoides* are abundant (Böcher 1941, 1983) along the west coast of Greenland) and *Carex parallela* (Fredskild 1996), whereas *Rhododendron lapponicum* is lacking in the association stands (Fredskild 1998).

Both vicariants share a big number of prominent species, indicating similar habitats (a.o. *Pedicularis flammea, Juncus triglumis, J. castaneus, Tofieldia pusilla, Carex scirpoidea, Kobresia simpliciuscula, Carex misandra, C.*

rupestris, C. capillaris, Saxifraga oppositifolia and *Dryas octopetala* s.l., which includes *D. integrifolia*).

In the Uummannaq District the Saxifrago-Kobresietum is differentiated against the Rhododendro-Vaccinietum by the species mentioned above (Table 1: species groups d2 and d7) and against the *Eriophorum angustifolium-Rhododendron lapponicum* community (1.3) (Table 1, ref. no. 44–49) by species of groups d2 and d4 (Table 1).

The Saxifrago-Kobresietum occurs on slightly sloping sites in small wind sheltered depressions often near rivulets where the vegetation is strongly supplied with melt water in spring. The vegetation stands show a small scale pattern of low hummocks due to tussocks and cushions (*Carex misandra, C. capillaris, Dryas integrifolia)*, and permanent wet-moist shallow hollows. Typical species on the small hummocks are a.o. *Cetraria cucullata*, *C. muricata*, *C. nivalis*, and *Thamnolia vermicularis* v. *subuliformis*. In the hollows fen species such as *Scorpidium turgescens* and *Meesia uliginosa* occur. Compared with the Rhododendro-Vaccinietum, shows the Saxifrago-Kobresietum a micro-pattern of dry grassland, dwarf shrub heath and fen species, but due to the permanent wetter soil conditions (in the hollows) the latter group is stronger represented. Thus the association is more hygrophytic (see also the DCA in Fig. 5). The field layer is primarily dominated by graminoids, whereas that of the Rhododendro-Vaccinietum is dominated mostly by dwarf shrubs. The pH values vary between 5.6 and 7.8.

The Saxifrago-Kobresietum is found over the entire Uummannaq District. Its entire distribution range in Greenland is not known yet. Presumably the association is locally distributed in the middle- and southern arctic dwarf- and shrub zones (Daniels et al. 2000, cf. also Fredskild 1996, 1998).

A subassociation ochrolechietosum frigidae subass. nov. (Table 1, ref. no. 27–32, Nomenclatoric type relevé: ref. no. 28) occurs on soil which dries out in summer and is differentiated by a.o. *Carex scirpoidea*, *Cyrtomnium hymenophylloides* (Table 1: species group d12), and *Ochrolechia frigida* (Table 1: species group d4). A subassociation eriophoretosum angustifolii nov. (Table 1, ref. no. 33–43, Nomenclatoric type relevé: ref. no. 42) occurs on permanent wet soil; differential species are a.o. *Arctagrostis latifolia*, *Catoscopium nigritum*, *Eriophorum angustifolium* and *Juncus biglumis* (Table 1: species groups d13 and d14).

Species richness varies between 32 and 64. Mean species number per relevé is respectively 43,3 in subass. ochrolechietosum and 47 in subass. eriophoretosum.

1.3. Eriophorum angustifolium-Rhododendron lapponicum community

(Table 1, ref. no. 44–49; Table 2, Vegetation types 7 and 8)

This is a fen vegetation on permanent wet soil with high cover values of *Dryas integrifolia* and a well developed moss layer (cover 70–95 %) dominated by *Tomentypnum nitens* (cover often 25–75 %) and *Catoscopium nigritum*. It is closely related to the Saxifrago-Kobresietum (1. 2), but differentiated by *Barbilophozia quadrilobata*, *Cinclidium stygium*, *Mnium thomsonii*, *Orthothecium chryseon*, *Philonotis tomentella* and *Pinguicula vulgaris* (Table 1, species groups d3 and d15). Although many fen species occur, dwarf shrubs such as *Dryas integrifolia*, *Rhododendron lapponicum*, *Vaccinium uliginosum* ssp. *microphyllum* and *Salix arctica* are abundant. *Dryas integrifolia* does not show its normal cushion growth-form. It grows prostrate with short stolons between the moss carpets (cf. Hart & Svoboda 1993).

The community occurs on very calcium- and magnesium-rich soils (basalts, marbles) with a permanent strong water supply during the whole season.

A vicarious vegetation type named *Eriophorum triste-Rhododendron* community was described by Fredskild (1998) from Northeast Greenland.

A typical subtype (Table 1, ref. no. 44–46) and a *Aulacomnium turgidum* subtype (Table 1, ref. no. 47–49), with more dwarf shrub heath species such as *Betula nana*, *Cassiope tetragona* and *Pyrola grandiflora*, and *Aulacomnium palustre*, *Cyrtomnium hymenophyllum* and *Meesia triquetra* (Table 1: species group d15), might be distinguished.

Total species number varies from 35 to 53 species per relevé (mean 43).

1.4. Remark

The results of the multivariate analyses (Fig. 5 and 6) clearly confirm the floristical and synecological differences between the vegetation types.

2. Species distribution and richness along a soil moisture gradient

(Table 4, Fig. 7, 8, 9)

The transect begins in a moss- and sedge-rich fen („grass-mire“) along a small rivulet and is ending in a lichen-rich dwarf shrub heath with *Rhododendron lapponicum* (Fig. 7). It passes three vegetation types of different syntaxonomical status. Although the size of the plots is small (0.16 m^2) it is nevertheless possible to identify the syntaxonomical status of these stands (community fragments) (see Table 4).

The soil moisture gradient is very clear (cf. Fig. 8): wet-dry, while pH increases from 5.5 up to 6.3. Of course snow cover duration and wind shelter decrease in the same direction.

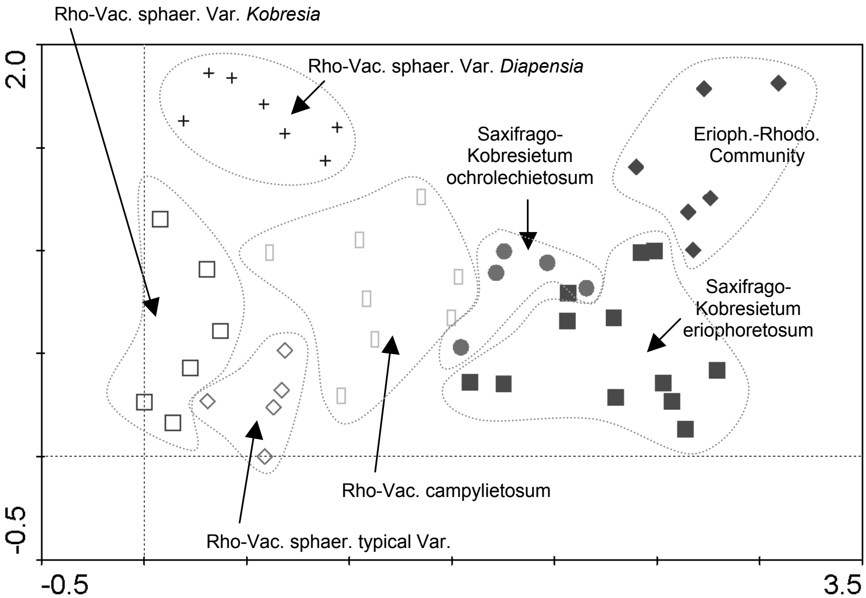


Fig. 5. DCA-diagram of the relevés of Table 1 (Eigenvalue x-axis 0.46; y-axis 0.21).

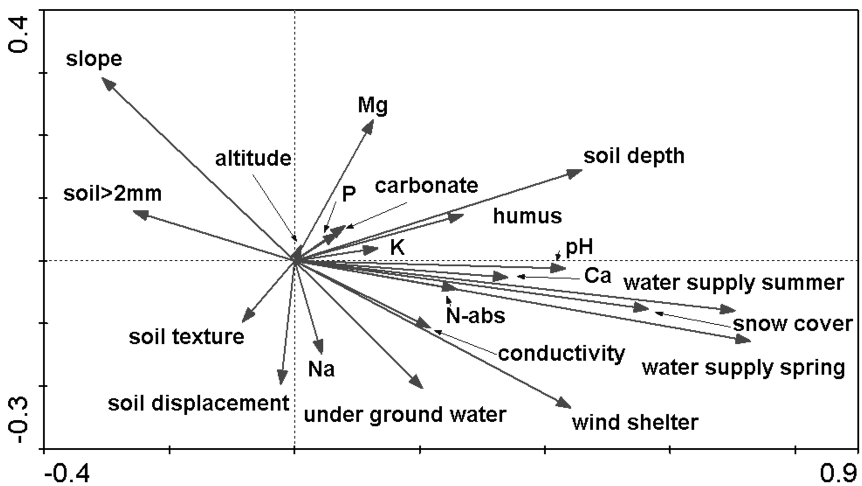


Fig. 6. CCA-diagram of the relevés of Table 1 (Eigenvalue x-axis 0.44; y-axis 0.2).

In the bed of the streamlet a species-poor Equiseto-Caricetum rariflorae de Molenaar 1976 is found with a field layer dominated by *Carex rariflora* and mainly pleurocarpous mosses in the water (Table 4, relevé numbers 1–4, see also Fig. 7 and 9). The transect relevés of this vegetation type are species-poor and contain in total only 14 to 21 species on 0.16 m^2.

Table 4. Vegetation table of the 21 relevés according their sequence in the transect.

Ref. no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**
Exposition (°)										225	225	225	225	225	225	225	225	225	225		
Slope (°)										1	1	1	1	1	1	1	2	1	1		
Cover total in %	30	100	95	99	100	99	90	65	80	95	95	99	99	80	85	80	85	75	90	80	95
Cover herb layer in %	5	85	70	60	70	45	35	45	60	40	85	80	80	60	80	60	40	50	70	50	60
Cover moss layer in %	25	60	70	80	80	85	60	20	25	65	20	35	50	10	10	25	60	30	40	45	60
Cover litter in %	0	0	0	0	2	1	1	5	5	3	10	3	5	15	10	15	3	25	15	15	5
Mean height herb layer in cm	4	12	10	10	10	10	8	10	9	4	8	5	4	4	3	3	3	2	3	2	3
Max. height in cm	10	23	15	32	21	19	17	20	16	17	20	20	28	26	20	8	9	7	7	8	19
Moss layer height in cm	2	6	7	7	9	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cover of dwarf shrubs in %	0	5	5	1	7	3	1	2	3	1	5	5	30	50	65	45	20	35	45	35	25
Cover of herbs in %	0	1	1	1	1	2	1	1	1	2	1	2	2	3	10	2	1	2	6	3	2
Cover of graminoids in %	5	85	85	60	65	40	35	45	60	40	80	75	55	10	7	15	20	15	20	15	35
Wind shelter (1-5)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3
Snow cover (1-5)	5	5	5	5	5	5	5	5	5	5	4,5	4,5	4	4	4	4	3	3	3	3	3
Water supply spring (1-5)	5	5	5	5	5	5	5	5	5	4,5	4,5	4,5	4,5	4	4	3,5	3	3	3	3	3
Water supply summer (1-5)	5	5	5	5	5	5	4,5	4,5	4	4	4	4	4	4	3,5	3,5	3	3	3	3	3
Soil depth in cm	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	17	18	23	27	22	23
Depth of water table (cm)	-9	0	0	0	2	3	4	9	10	12	15	16	16	16	18	20	25	25	25	25	25
Soil displacement (1-5)	1	1	1	1	1	1	1	3	3	2	2	1,5	1,5	3	1,5	2	2	1,5	1,5	1,5	1,5
pH		5,5			5,7							6,2			6,2				6,3		
Species number vascular plants	2	5	5	7	8	11	9	12	12	12	13	14	13	11	9	8	9	10	9	10	11
Species number mosses	12	12	12	14	11	13	20	15	18	19	21	26	13	18	16	20	18	14	13	17	21
Species number lichens	0	0	0	0	1	1	5	17	9	21	18	17	4	7	10	15	25	26	26	25	38
Total number of species	**14**	**17**	**17**	**21**	**20**	**25**	**34**	**44**	**39**	**52**	**52**	**57**	**30**	**36**	**35**	**43**	**52**	**50**	**48**	**52**	**70**
	Equiseto-Caricetum rariflorae				transitional stands			Saxifrago-Kobresietum simpliciusculae eriophoretosum									Rhododendro-Vaccinietum sphaerophoretosum				
Calliergon sarmentosum	2b	+																			
Scorpidium scorpioides	+	+																			
Eriophorum scheuchzeri	+	2a	+																		
Calliergon trifarium	2m	+	2b	2a																	
Cinclidium stygium	2m	2b	2m	2m																	
Cinclidium arcticum	+	+	+	+																	
Philonotis tomentella	+	+	+		+	+															
Catoscopium nigritum	2m	2b	3	4	3	2b	2m														
Drepanocladus intermedius	2a	3	2b	2a	1	3	2b	+													
Carex rariflora	2a	5	4	4	3	2b	r			2a	2b	1	r								
Pseudocalliergon turgescens	2m	+	2b	2a	1	2a	2m							+	+	+					
Meesia uliginosa	+	+	+	+	2a	+	+		2m	+	2m	+				1	1	r			
Campylium stellatum	+	2a	2a		2a	2a	+			+	1		3	2a	1						r
Hypnum bambergeri	+		+	+		+	+	1	1	2m	2a	2m	+	+	+	+				1	+
Meesia triquetra		+	+	+		+	2a														
Eriophorum angustifolium		+		+	1	2a	1	2a	2a	1	1	2a	2b	1							

Polygonum viviparum	r	1	1	1	1	1	1	1	2m	1	1	1	1	1	1	1	1	1	1	+
Salix glauca ssp. callicarpea	+		+	+	+	r	+					+	+	+						+
Distichium spec. (vegetative)		+	+	+	+	2m	+	2m	2a	2a	3	2a	1	1	2m	2a	2a	3	2a	2a
Arctagrostis latifolia		r	1	1	2a	1	+	+	1	2a	+	+	r							
Juncus castaneus			+	+	+	+	1	1	1	+										
Juncus biglumis			r		+	+	+		+	+										
Bryum spec (cucullate)			+	+	2a	2b		1			+		+							
Ditrichum flexicaule			+		+	2a	2m	2a	2m	2a	2m	1	+	1	1	1	1	+	+	+
Bryum spec.			+		+	+		+	2m	1	2m	2m	2m	1	2m	2m	2m	+	+	+
Blepharostoma trichophyllum			+					+												+
Kobresia simpliciuscula				1	2a	2b	3	3	2a	2a	+	+								
Pedicularis flammea				+	+		+	r		+	+	+			r	r	+			
Myurella julacea				1	+	+	+	+	+	2m	2m	2m	+	+	+	+	+	+	+	
Orthothecium strictum				+		1	+	+	+	+	+	+			+	+	+	+	+	+
Scapania gymnostomophila				+			1		+	+	+		1		+		+	+	+	+
Cladonia macroceras				+	+	+	+									+	+	+	+	+
Juncus triglumis					1	1	1	1	+	1	+									
Odontoschisma macounii						+		+	+	+	+			+						
Fissidens arcticus						+	+	+	+	+				+	+					
Rinodina olivaceobrunnea						+	+			+	+						+	+		
Tortella fragilis						+					+		+							+
Myurella tenerrima						+	+								r				+	+
Cephaloziella spec.						2m	+	2m	+	2m	+	+	+	+	+	+	+			r
Cladonia pocillum						1	1	1	+	1	+		+	+	1	1	+	+	r	r
Tortella tortuosa						2m	1	1	1		+	+	+		+	+	+	+		1
Ochrolechia frigida						+	1	+	1	1	+		+	+	+	1	1	2m	2a	2m
Caloplaca tiroliensis						+	+		+	+			+	+	+	1	+		1	1
Parmelia omphalodes							2m	+										+		
Cladonia amaurocraea							+		1	+	+									
Solorina bispora							r		+				1		+	1	1			
Aulacomnium turgidum							+		2a	1	r	2m	2m			1			+	
Dryas integrifolia							+	+	+	+	r	+	2b	4	2b	+	3	+	+	+
Cetraria muricata							r	1	+	+		+			r	2m	2a	2m	2m	2a
Rhododendron lapponicum							+	r	+	2a	2a	2a	+	+	r	2a	+	2a	2a	r
Thamnolia vermicularis v. subuliformis							r	r	+	r	+	+				1	1	1	2m	2m
Cetraria cucullata							r	+	+	+	2m	1			r	1	+	+	1	1
Lecanora epibryon							r	1	+	+	1			+	+	1	2a	2m	+	1
Rinodina turfacea							r		1		+		+	+	+	+	+	+	+	+
Silene acaulis							+				+		+	2a	+		+	2a	+	r
Caloplaca cerina							r		r		+			+	+		+			1
Megaspora verrucosa							r			+			+	+		+	+	+		+
Cladonia pyxidata							+		+	+	+					+	+	+	+	r
Pohlia cruda								+			+	+								
Cladonia stricta								+	+				+							
Amblystegium serpens								+	1	+			1							
Carex misandra								+			+	+		+						
Polytrichum alpinum								1		+	+		1	r	+					
Hymenostylium recurvirostrum								+	+	+				+	+	+				

Tab. 4 (cont.)

Oncophorus wahlenbergii			+	+	+	+			+	+	+				
Tofieldia coccinea			+	+	2a	2a	1	+	r	r	+	+	2a	2a	2b
Carex rupestris				+	2a	3	2b	2b	2a	2b	2b	2b	2b	2b	2a
Cetraria islandica ssp. crispiformis				3	+	+				+	2m	2m	2a	2a	2a
Racomitrium lanuginosum				+	+	1						+	+	+	+
Cetraria nivalis				+							1	2m	2m	2m	2a
Cladonia arbuscula s mitis				+							+		r	+	+
Pertusaria bryontha				+							+		+	+	
Alectoria nigricans				+									1		1
Hypogymnia austerodes				+									+	1	+
Platydictya jungermannioides				+		+									
Sphaerophorus fragilis				r		+									
Buellia punctata					+	+									
Cephalozia bicuspidata					+	+		+	+	2m					
Caloplaca ammiospila					r	+					+	+		+	+
Alectoria ochroleuca					+	1					+		+	+	+
Lecidea spec.					+	+					1	+	+	1	+
Distichium capillaceum (fruiting)					+	+					+		+		+
Bryoria nitidula					+						+		1	2a	1
Physconia muscigena					+						+				+
Peltigera aphthosa						+	+								
Sanionia uncinata						r	+	+	+						
Schistidium apocarpum						r			+	+					
Ceratodon purpureus						+				+					
Vaccinium uliginosum ssp. microphyllum		+				+	2b	2b	2b	2b	2a	+	2b	2b	2b
Campylopus schimperi						+					+	+	+	+	+
cf, Odontoschisma elongatum						+						+	1	+	+
Tomentypnum nitens							+	1			+				
Rinodina roscida									+	+		+			+
Polyblastia gelatinosa									+	+					+
Buellia geophila									+				+		+
Baeomyces rufus										r		+			+
Encalypta rhaptocarpa										+	2m				
Collema spec.										+					+
Lecanora cf, dispersa										+			+		
Cyrtomnium hymenophylloides											1	+	+		
Carex nardina											+	r		+	+
Pedicularis lanata											+	+	+	+	+
Japewia tornoensis											+	+		+	+
Pertusaria coriacea											+	+		1	1
Hypnum spec.											+	+			
Dactylina ramulosa												+	+		1
Saxifraga oppositifolia													+	+	
Sphaerophorus globosus													+	1	1
Anthelia spec. (vegetative)													+	+	1
Cetrariella delisei													+	+	+

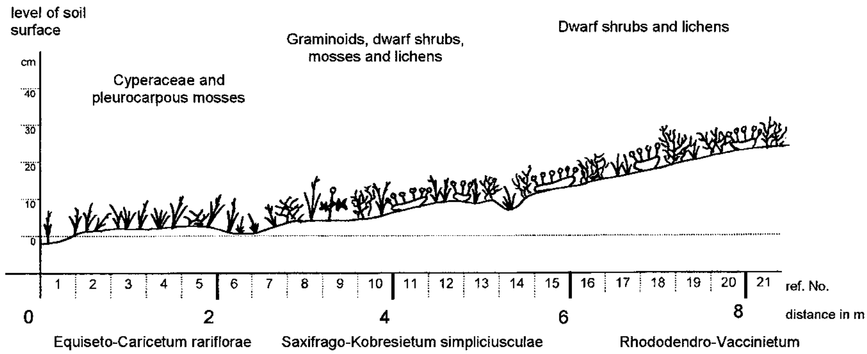


Fig. 7. Vegetation profile of the transect. X-axis sequence of the relevés along the transect with indication of the vegetation types and distance in m. Y-axis level of soil surface above water level in cm (cf. Table 4).

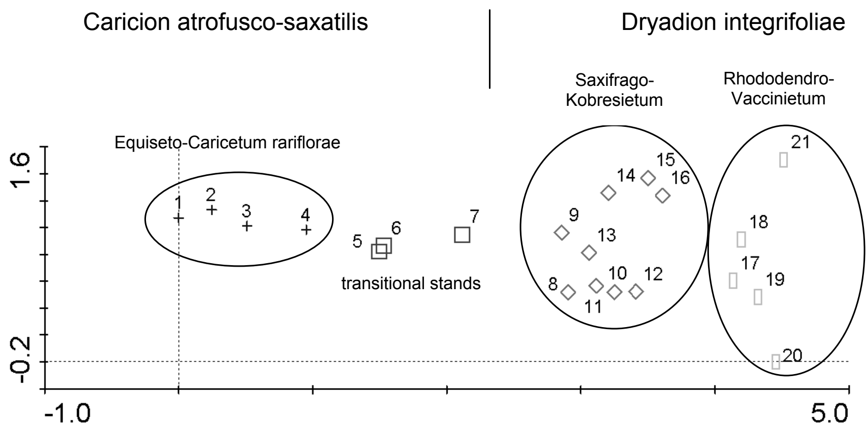


Fig. 8. DCA-diagram of the transect relevés (cf. Table 4) (Eigenvalue x-axis 0.65; y-axis 0.15).

Molenaar (1976) attributed the Equiseto-Caricetum rariflorae to the alliance Caricion atrofusco-saxatilis Nordh. 1943. Due to the permanent wet (flooding included) soil conditions all diagnostic species of the Dryadion integrifoliae and its higher syntaxa are absent. Dwarf shrubs are lacking.

With decreasing soil humidity the species combination changes and the plots are dominated by *Arctagrostis latifolia*, *Eriophorum angustifolium* (s.l.), *Juncus* species (*castaneus*, *biglumis*, *triglumis*), and *Kobresia simpliciuscula*. Also dwarf shrubs such as *Dryas integrifolia* and *Rhododendron lapponicum* show up now. These plots clearly represent the Saxifrago-Kobresietum simpliciusculae (Table 4, relevé numbers 8–16). Typical are small hollows with fen species (*Arctagrostis latifolia*, *Juncus castaneus*, *J.*

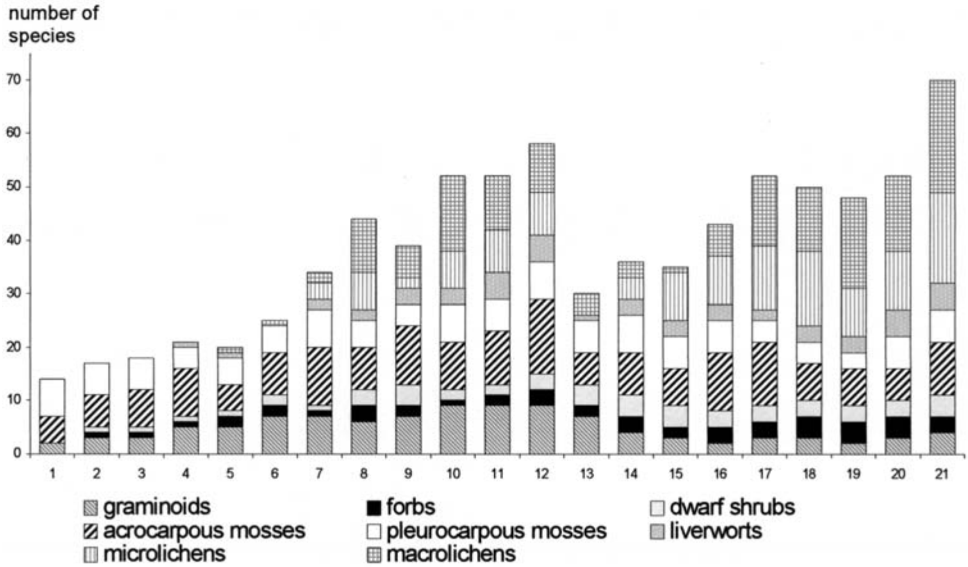


Fig. 9. Sum of species numbers of the different components of the transect relevés (cf. Table 4).

biglumis, *J. triglumis*, *Kobresia simpliciuscula*, *Meesia uliginosa)* and low hummocks of low tussock and cushion species of drier habitats (a.o. *Dryas integrifolia, Carex misandra, Carex rupestris*, *Rhododendron lapponicum, Silene acaulis* and *Tofieldia coccinea);* and numerous cryptogams such as *Caloplaca tiroliensis*, *Cladonia pocillum*, *Distichium*, *Ditrichum flexicaule*, *Hymenostylium recurvirostre*, *Megaspora verrucosa*, *Myurella tenerrima*, *Pohlia cruda*, *Tortella fragilis*, *T. tortuosa* and several cryptogams typical for dry soil conditions such as *Cetraria cucullata*, *C. muricata*, *Cladonia amaurocrea*, *C. pyxidata*, *Parmelia omphalodes*, *Thamnolia vermicularis subuliformis* etc. These plots represent the Saxifrago-Kobresietum simpliciusculae eriophoretosum. Species richness is relatively high: 30–57 on 0.16 m^2, probably due to the different microhabitats.

When the water table is more than 25 cm under the soil surface, non-acidic fen species are absent. The dwarf shrubs *Dryas integrifolia*, *Rhododendron lapponicum* and *Vaccinium uliginosum* ssp. *microphyllum* become dominant, just as *Carex rupestris*. The number of lichen species increases more and more when soil moisture decreases. The relevé numbers 17–21 represent the Rhododendro-Vaccinietum microphylli sphaerophoretosum globosi typical variant. Typical Dryadion integrifoliae species such as *Carex nardina* and *Pedicularis lanata* show up now.

Species density is very high. Relevé 21 contains 70 species (see Table 4 and Fig. 9).

The results of this transect analysis (cf. Fig. 8) confirm the results obtained by the ample comparison of vegetation types (typological and synecological analyses).

The delimitation between the non-acidic Caricion atrofusco-saxatilis and Dryadion integrifoliae vegetation in the transect is clearly marked by absence/presence of the diagnostic species *Carex rupestris*, *Dryas integrifolia*, *Rhododendron lapponicum*, *Silene acaulis* and *Tofieldia coccinea*, but additionally also by *Vaccinium uliginosum* and very many cryptogams (see Table 4; cf. differential species in Table 1 and 2).

The wettest plots show the lowest species numbers, due to the absence of lichens. When the substrate becomes drier the absolute number of the mosses keeps more less the same, but decreases procentually (see Fig. 9). The whole transect of 8.40 m contains at least 144 plant taxa (with exclusion of species on stones).

3. Conception of the Dryadion integrifoliae

Contrary to Daniëls (1982) and Fredskild (1998) who grouped the Rhododendro-Vaccinietum and Saxifrago-Kobresietum simpliciusculae in the Caricion atrofusco-saxatilis, both associations and the *Eriophorum angustifolium-Rhododendron lapponicum* community, are attributed now to the Dryadion integrifoliae. This is evident from Table 3. The Rhododendro-Vaccinietum contains all Ch and D species of the Dryadion integrifoliae, whereas those of the Caricion atrofusco-saxatilis are lacking. Moreover presence and cover/abundance values of most diagnostic species are high.

The Saxifrago-Kobresietum simpliciusculae, in particular the subass. eriophoretosum, contains diagnostic species of both alliances in an equal amount and the same applies to the *Eriophorum angustifolium-Rhododendron lapponicum* community. In the Saxifrago-Kobresietum the Dryadion integrifoliae species (e.g. *Carex capillaris, C. rupestris, Dryas integrifolia, Pedicularis flammea, Rhododendron lapponicum, Silene acaulis*) are much stronger represented (both in presence and cover/abundance values) than those of the Caricion atrofusco-saxatilis (*Eriophorum angustifolium* ssp. *subarcticum, Juncus castaneus, J. triglumis, Kobresia simpliciuscula*). The same applies in a lesser degree for the *Eriophorum-Rhododendron* community (Table 3). Nevertheless *Dryas integrifolia*, *Pedicularis lanata* (Ch Dryadion integrifoliae), *P. flammea* and *Rhododendron lapponicum* occur in all three vegetation types, whereas none of the Caricion atrofusco-saxatilis species do so.

The Rhododendro-Vaccinietum, Saxifrago-Kobresietum and *Eriophorum angustifolium-Rhododendron lapponicum* community (and the Arctagrostio-Eriophoretum Daniëls et Fredskild in Fredskild 1998 from Northeast Greenland, Fredskild (1998)), which all occur on wet-moist soil but with different soil moisture regimes, are grouped within a new meso-hygrophytic suballiance Rhododendrenion lapponici (Holotypus Rhododendro-Vaccinietum Daniëls 1982). This suballiance is differentiated against the rest of the Dryadion integrifoliae by *Carex misandra*, *C. capillaris*, *Cassiope tetragona*, *Cyrtomnium hymenophylloides*, *Fissidens osmundoides*, *Meesia uliginosa*, *Oncophorus wahlenbergii*, *Pedicularis flammea*, *Platydicta jungermannioides*, *Rhododendron lapponicum*, *Rhytidium rugosum*, *Tofieldia pusilla* and *T. coccinea*.

Consequently the Dryadion integrifoliae Ohba ex Daniëls 1982 is subdivided now in a typical suballiance with the Carici-Dryadetum Daniëls 1982 as Holotypus and some other communities on relatively dry soil, and the suballiance Rhododendrenion lapponici with the associations and community dealt with above. The synecological conception of the alliance in regards to soil moisture is broader now. The alliance comprises hygro-xerophytic vegetation types of temporarily wet-moist, mesic and dry, non-acidic soils.

The results of the multivariate analyses (Fig. 5, 6, and 8) clearly show that most probably soil moisture regime is the most decisive factor responsible for the differentiation of the vegetation types and species sequence along the transect. When soil wetness becomes permanent, character and differential species of the Carici-Kobresietea class, Kobresio-Dryadetalia order and Dryadion alliance vegetation disappear being substituted by those of the Scheuchzerio-Caricetea class, Caricetalia davallianae order and Caricion atrofusco-saxatilis alliance.

The syntaxonomical identification of stands with a mixture of diagnostic species of both syntaxa groups might be difficult in some cases as was reported in the introductory chapter. Indeed, in community types of the Rhododendrenion suballiance, diagnostic Scheuchzerio-Caricetea, Caricetalia davallianae, Caricion atrofusco-saxatilis species occur (such as *Juncus triglumis, J. castaneus, J. biglumis, Carex rariflora, C. atrofusca, C. stans, C. gynocrates, Eriophorum angustifolium, Arctagrostis latifolia* and some bryophytes e.g. *Campylium stellatum* (Table 1, 2 and 3). Thus in the syntaxonomical identification of vegetation stands with Dryadion and Caricion species and in the floristical delimitation between the two alliances, the woody species *Dryas integrifolia, Rhododendron lapponicum* and *Cassiope tetragona* are attributed an high diagnostic, decisive value, together with *Carex rupestris, Silene acaulis* and a number of xerophytic volume lichens. They are absent in the true wet arctic fen and mire vegetation, which are dominated by graminoid species in particular sedges, rushes and bryophytes (cf. Dierssen 1996).

Many diagnostic species of the Carici-Kobresietea class and lower syntaxa show in the Uummannaq District a very broad ecological amplitude. They also occur, even with high abundance/cover values, under wet soil conditions (Table 3). Obviously these taxa are highly competitive in an arctic continental climate regime. Most of these species belong to an Arctic continental biological distribution type and nearly half of them show a western distribution, e.g. the Ch species of the alliance *Dryas integrifolia* and *Pedicularis lanata* (cf. Table 3). This means that the North American Dryadion integrifoliae shows zonal features. It is widely distributed in the drier northern arctic regions. The Carici-Dryadetum Daniëls 1982 is considered the zonal vegetation of the eastern northern arctic dwarf shrub zone of the North American continent (Daniels et al. 2000, CAVM Team 2003).

The diagnostic species of the Scheuchzerio-Caricetea (here Caricion atrofusco-saxatilis) are mostly circumpolar without clear tendency regarding their biological distribution types (Table 3). Contrary to the Carici-Kobresietea species their distribution primarily depends on edaphical factors, i.e. very wet soil conditions. Thus this vegetation type shows azonal features.

4. Species richness

Böcher (1954) reports from West Greenland (61–62° N) in one relevé of 1 m² of a *Salix uva-ursi* sociation (Loiseleurio-Diapension (Br.-Bl., Siss. et Vlg. 1939) Daniëls 1982) 69 species (including at least 10 species on stones). According to Hobohm (2000) Böchers relevé probably contained so far the highest species number ever found on very small areas on earth. This species number was surpassed by Bültmann & Daniëls (2001), who found on 0.25 m² 73 species (in a disturbed Cladonietum mitis Krieger 1937 lichen vegetation) in Southeast Greenland. They found 62 species in a vegetation stand with *Dryas integrifolia* (Caloplacetum tiroliensis Kalb 1970) in Southeast Greenland. However both relevés are not published yet. Gelting (1955) reported from Disko Island 30 species in 0.1 m² in a lichen-rich *Dryas integrifolia* vegetation (Dryadion integrifoliae).

Also the *Dryas integrifolia* vegetation of the Uummannaq District is very rich in species (cf. Table 1, 2 and 4).

In the 49 relevés (Table 1) of 4 m² mean number of species is 55.4 (vascular plants 16.2; acrocarpous mosses 10, pleurocarpous mosses 4.6; liverworts 3.3; lichens 21.3). Species number normally varies between 45 and 70 (epiphytes and epilithic species excluded).

Mean species number in the subtypes of the Rhododendro-Vaccinietum is much higher, than in the subtypes of the Saxifrago-Kobresietum and *Rhododendron-Eriophorum* community (Table 1, 2, 3). In the 26 relevés (Table 1) of the Rhododendro-Vaccinietum mean species number is 64.6, comprising 31.9 lichens, 14.1 vascular plants and 18.6 mosses (11.1 acrocarpous, 3.8 pleurocarpous and 3.7 liverworts). The 5 relevés of the typical variant of the subassociation sphaerophoretosum contain 61–83 species (mean 72). Relevé number 18, Table 1 contains 83 species and this number is the highest species number for relevés of 4 m² we could trace for the Arctic.

Also on a size of 0.16 m² the Rhododendro-Vaccinietum sphaerophoretosum contains a rather high number of species. So we found in one relevé in the transect 70 species (Table 4, ref. no. 21). It is also obvious from the transect study that species richness in permanent wet sites (Equiseto-Caricetum rariflorae) is rather low (14–21 species) (cf. Table 4 and Fig. 9). This is connected with the absence of lichens, which can not thrive under such wet conditions.

Dryas integrifolia vegetation stands on temporarily moist-wet soil generally have more species than vegetation of permanent wet sites. Vascular plants, lichens, bryophytes (acrocarpous, pleurocarpous and liverworts) show different diversity optima. Vascular plant richness is highest in permanent wet sites, whereas lichen richness is highest in mesic and dry sites (up to 50 species per relevé) and lowest (< 10 species) in wet sites. The number of pleurocarpous mosses is high in mesic – wet sites and low at dry sites. Species numbers of acrocarpous mosses and liverworts do not show a clear response to soil moisture.

The high species numbers and the occurrence of rare cryptogam species in vegetation types belonging to the Carici-Kobresietea is explained by Dierssen (1996) by a low population density and productivity in continental arctic climate reducing likely the interspecific competition and allowing species with low potential of spreading to occupy suitable niches over a long time.

Due to the young landscape and harsh environmental conditions number and size of vascular plants are strongly reduced in arctic regions, whereas the small bryophytes and lichens are far more numerous, since more species of the latter groups are better adapted to such conditions. It is also obvious, that the smaller the plants are, the more species can occur together in a small sized plot. However also small scale temporarily abiotic heterogeneity (e.g. small height differences of substrate surface and differences in soil conditions) and biotic heterogeneity (due to litter and different structures e.g. growth- and life form (cf. "plant functional type") of the plants involved) enhance species richness, just as the omnipresence of disturbance and stress, which creates small gaps and suppresses dominance. Through these all, many niches exist and allow many plants to live close together on a small surface (cf. Bültmann & Daniëls 2001, cf. Dierssen 2000).

We think, that in particular biotic heterogeneity in Dryadion integrifoliae vegetation is high and that this strongly contributes directly and indirectly to the creation of many niches and consequently to the high species richness of the vegetation on the studied scales of 4 m^2 and 0.16 m^2.

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Appendix Table 1

Ref. no. 1: *Kiaeria* cf. *starkei* 2m, *Bryonora castanea* +, *Cetraria commixta* +, Musci indet. +, *Cladonia pleurota* +, *Pohlia nutans* +; ref. no. 2: *Lepraria* spec. 1; ref. no. 3: *Ochrolechia inaequatula* +, *Cladonia chlorophaea* s.str. +; ref. no. 4: *Cetraria commixta* +, *Baeomyces rufus* +, *Stereocaulon condensatum* +, *Psora rubiformis* +; ref. no. 5: *Bacidia* spec. +, *Arthrorhaphis* spec. +, *Parmeliella triptophylla* +, *Caloplaca jungermannia* +, *Rinodina* spec. +, *Dactylina arctica* +, *Pertusaria oculata* +; ref. no. 6: *Gymnomitrion concinnatum* +; ref. no. 7: *Racomitrium canescens* s.l. 1, *Dibaeis baeomyces* +, *Caloplaca* cf. *sinapisperma* +, *Huperzia selago* r; ref. no. 8: *Pertusaria geminipara* 2a, *Stereocaulon arenarium* 2m, *Diploschistis muscorum* 1, *Isopterygiopsis pulchella* +; ref. no. 9: *Pertusaria geminipara* 1, *Stereocaulon condensatum* +, *Lecanora* spec. +, *Saxifraga* spec. r; ref. no. 10: *Buellia papillata* +, *Leproloma cacuminum* +, *Peltigera* spec. +, *Tortula* cf. *norvegica* 1, *Arthrorhaphis* spec. r, *Saxifraga tricuspidata* r; ref. no. 11: *Stereocaulon rivulorum* +, *Melandrium triflorum* +, *Parmelia sulcata* +; ref. no. 12: *Candelariella aurella* 1, *Campylium polygamum* +; ref. no. 13: *Lecanora* spec. 2m, *Ochrolechia* spec. 1, *Cnestrum alpestre* 1, *Candelariella* cf. *aurella* 1, *Stereocaulon rivulorum* +, *Draba nivalis* +, *Cladonia alaskana* +, *Campanula uniflora* +, *Bryum argenteum* +, *Bacidia* cf. *microcarpa* +, *Antennaria* spec. +; ref. no. 14: *Pertusaria* spec. 2m, *Caloplaca epiphyta* +, *Cladonia* cf. *galindezii* +, *Micarea melaena* +, *Cetraria islandica* ssp. *islandica* +, *Cladonia macrophyllodes* +; ref. no. 15: *Tortula norvegica* 1, *Baeomyces rufus* +, *Catapyrenium cinereum* +, *Arthrorhaphis alpina* +; ref. no. 16: *Caloplaca epiphyta* +, *Pohlia andalusica* +, *Parmelia saxatilis* +, *Orthotrichum* spec. +; ref. no. 17: *Pohlia andalusica* 2m, *Micarea assimilata* 1, *Parmelia saxatilis* +, *Catapyrenium cinereum* +, *Stereocaulon arenarium* +, *Cetraria nigricacens* +, *Conostomum tetragonum* +, *Brodoa oreoarctica* +, *Saxifraga paniculata* r; ref. no. 18: *Cetraria nigricacens* 1, *Biatora subduplex* 1, *Pertusaria* spec. +, *Collema ceraniscum* +, *Peltigera leu-*

cophlebia +, *Leptogium* spec. +, *Nephroma expallidum* +, *Caloplaca* cf. *fulvolutea* +, *Phaeophyscia constipata* +, *Pseudephebe pubescens* r; ref. no. 19: *Cladonia bellidiflora* +; ref. no. 20: *Cladonia fimbriata* 2m, *Lepraria* spec. +, *Bryonora castanea* +, *Cnestrum glaucescens* +; ref. no. 21: *Caloplaca jungermannia* 1, *Cladonia phyllophora* 1, *Buellia papillata* +, *Festuca* spec. +, *Dicranum acutifolium* +, *Parmeliopsis ambigua* +, *Ledum palustressp.decumbens* r; ref. no. 22:, *Placynthiella* spec. 2m, cf. *Pleurocladula albescens* 2m, *Collema ceraniscum* 1, *Carex norvegica* +, *Cladonia acuminata* +; ref. no. 23: *Stereocaulon alpestre* 1, *Solorina* spec. +, *Eurhynchium pulchellum* +, *Papaver radicatum* coll. +, *Calamagrostis purpurascens* +; ref. no. 24: *Cnestrum alpestre* +; ref. no. 25: *Orthothecium* spec. 1, *Solorina spongiosa* 1, *Carex norvegica* r; ref. no. 26: *Orthothecium rufescens* 1, *Biatora subduplex* +, *Bacidia* spec. +, *Solorina saccata* +, *Toninia sedifolia* +, *Fulgensia bracteata* r; ref. no. 27: *Artemisia borealis* r; ref. no. 28: Musci indet. +, *Polyblastia terrestris* +; ref. no. 30: *Orthothecium rufescens* 2a, *Biatora subduplex* +, *Placynthiella* cf. *uliginosa* +; ref. no. 31: *Solorina saccata* +, *Lophozia wenzelii* +, *Massalongia carnosa* +, *Drepanocladus revolvens* +, *Cetraria ericetorum* +; ref. no. 33: *Cirriphyllum cirrosum* 1, *Festuca* spec. +, *Polytrichum piliferum* +; ref. no. 34: *Luzula multiflorassp.frigida* +, *Leptogium* cf. *lichenoides* +; ref. no. 35: *Solorina* spec. +, *Pannaria pezizoides* +, *Drepanocladus* cf. *brevifolius* +, *Draba bellii* +, *Minuartia rossii* +, *Calypogeia* spec. +; ref. no. 36: *Fissidens arcticus* 1, *Timmia bavarica* +, *Bryum neodamense* +, *Pedicularis* spec. +; ref. no. 37: *Timmia norvegica v. excurrens* 1, *Orthothecium* spec. +, *Cladonia acuminata* +, *Parmeliella triptophylla* +, *Ditrichum* spec. +; ref. no. 38: *Poa pratensis* coll. 1, *Minuartia stricta* +, *Minuartia* spec. r; ref. no. 40: *Carex saxatilis* 2b, *Leptogium* spec. +, *Collema* cf. *bachmanniana* +; ref. no. 41: *Dichodontium pellucidum* +, *Fissidens arcticus* r; ref. no. 42: *Biatora sphaeroides* +; ref. no. 43: *Lophozia* cf. *ventricosa* +; ref. no. 45: *Carex lachenalii* 1; ref. no. 46: *Salix* spec. 1; ref. no. 47: *Leptogium* cf. *tenuissimum* +, *Luzula multiflora* ssp. *frigida* r; ref. no. 48: *Kiaeria glacialis* 1, *Peltigera* cf. *retivoveata* +, *Marsupella* spec. +; ref. no. 49: *Salix* spec. 2a, *Plagiomnium medium* 1, *Aneura pinguis* r.

Appendix Table 4

Ref. 3: *Salix arctica +;* ref. 7: *Dichodontium pellucidum +;* ref. 8: *Encalypta spec.* +, *Oncophorus virens* +, cf. *Amphidium lapponicum* +, *Cladonia borealis* r; ref. 9: *Betula nana* r, *Salix herbacea* r; ref. 10: *Bacidia bagliettoana* +; ref. 11: *Lophozia grandiretis* 1; ref. 14: *Pedicularis hirsuta* r; ref. 17: *Catapyrenium cinereum* r, *Candelariella* spec. r, *Cephalozia* spec. +; ref. 18: *Pseudephebe pubescens* +, *Cetraria commixta* +, *Caloplaca saxifragarum* +; ref. 20: *Gymnomitrion corallioides* +, *Brachythecium turgidum* +, *Caloplaca jungermannia* +, *Micarea turfosa* +, *Cephalozia* cf. *lunulifolia* +, *Pohlia* spec. r; ref. 21: *Lopadium coralloideum* 1, *Stereocaulon alpinum* r, *Luzula arctica* r, *Bryum argenteum* +, *Cnestrum* cf. *alpestre* +, *Hypnum revolutum* +, *Gyalecta foveolaris* +, *Dicranum* cf. *muehlenbeckii* +, *Biatora subduplex* +, *Cladonia* spec. +, *Cetraria nigricacens* +.