Distribution of selected basidiomycetes in oceanic dwarf-scrub heaths in the Paamiut area, low arctic South Greenland

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Abstract

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The occurrence of 80 selected basidiomycetes (49 symbionts, 31 saprobionts) was investigated at seven sites in dwarf-scrub heaths in the Paamiut area (low arctic S Greenland). The sites are situated in the hyperoceanic zone (at the outer coast), in the oceanic zone (about 10-25 km from the outer coast) and in the suboceanic zone (more than 25 km from the outer coast). The number of species is larger in the oceanic than in the hyperoceanic zone, and there is a tendency for the proportion of symbionts to increase from the hyperoceanic zone and away from the coast. The total number of species indicates that the increase of symbionts in the oceanic zone is due to the larger number of *Cortinarius* and *Russula* species. Moreover, larger symbionts tend to dominate away from the coast. Observations from Paamiut peninsula (hyperoceanic zone) indicate that the number of saprobiontic species exceed the symbionts in the areas very close (< 3 km) to the ocean.

Four distributional groups can be segregated based on the distributions in the Paamiut area. A: species most frequent in the hyperoceanic zone (nine symbionts and fourteen saprobionts), B: indifferent species (nine symbionts and five saprobionts), C: species most numerous and frequent in the oceanic zone (twenty-four symbionts and six saprobionts) and D: species most frequent in the suboceanic zone (two saprobionts). *Cortinarius imbutus*, *Entoloma fernandae* and *Pholiota scamba* are new to the low arctic region.

Keywords: Greenland, Paamiut, low arctic, basidiomycetes, dwarf-scrub heaths, symbionts, saprobionts, distribution.

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Introduction

Lange (1957) demonstrated that the mycoflora in S and SW Greenland is rich and diverse. In Ivittuut he e.g. analysed a *Betula glandulosa* heath and found that the species density and numbers of individuals was fairly high – even compared to Danish conditions. He stressed that the mycoflora in oceanic (as opposed to continental) S and SW Greenland needed further studies.

The author moved to Paamiut in Greenland in 1978 and became fascinated by the rich mycoflora and the many taxonomical, ecological and distributional challenges the fungi raised. The mycoflora in ubiquitous dwarf-scrub heaths was studied intensively in the Paamiut area and compared with other areas. In the town area the composition of the basidiomycetes seemed to be similar to some of the sites near the ocean described by Lange (1957), while further inland it seemed to be rather different, and more like the Ivittuut area also described by Lange (1957).

The mycoflora of dwarf-scrub heaths is generally little known, because this habitat is rare in the Alps, where the mycoflora is well studied, and little has

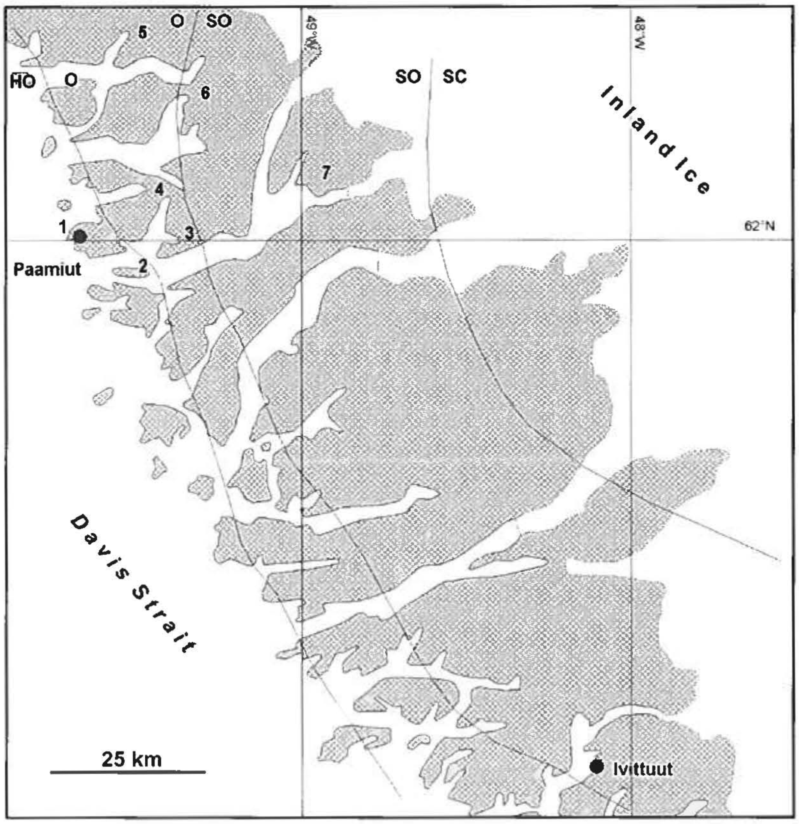

Fig. 1. Part of southwest Greenland showing Paamiut municipality with the studied sites and phytogeographic zones (after Feilberg 1984). Study sites: 1/ Paamiut, 2/ Kangilineq, 3/ Taartoq, 4/ Eqaluit, 5/ Qassit Kangerluarsua, 6/ Nerutusoq Avannarleq and 7/ Nigerlikasik. HO = hyperoceanic zone, O = oceanic zone, SO = suboceanic zone; SC = subcontinental zone (not included in the present study).

been published from the low arctic and alpine zones of Scandinavia and elsewhere.

The purpose of this paper is to investigate the distribution of basidiomycetes in dwarf-scrub heaths between three different phytogeographical zones in low arctic South Greenland.

The preparation of this paper would not have been possible without the inspiration from the works on the Greenlandic mycoflora of the late Morten Lange and Peter Milan Petersen, hence it is dedicated to them.

Material and methods

The study area is northern Paamiut municipality in South Greenland at app. 62° N (Fig. 1). It is within the low arctic zone and the average temperature for the warmest month, July, is 5.7° C in Paamiut town situated adjacent to the Davis Strait (Fredskild 1996). Further inland the summer temperatures increase, though no measurements are recorded. The precipitation in Paamiut town is fairly high, 851 mm annually (Fredskild *l.c.*), but there is a strong negative precipitation-gradient towards the inland and the Inland ice, about 45 km to the east. Three phytogeographical zones are recognized in the Paamiut area (Feilberg 1984). The area close to the Davis Strait is hyperoceanic, characterised by the absence of copses. When moving inland the area becomes oceanic and subsequently suboceanic (Fig. 1).

In the hyperoceanic zone poor heaths dominated by *Empetrum hermaphroditum* with *Salix herbacea* and *S. glauca* are abundant, whereas *Betula glandulosa* is absent to less common in "the coastal fringe" (= an app. three km wide belt along the coast) (Fig. 2), but fairly common elsewhere. In the oceanic zone the heaths become lusher and *B. glandulosa*, *Deschampsia flexuosa*, *Empetrum*, *Juniperus communis*, *Ledum groenlandicum* and *S. glauca* are common (Fig. 3). Especially in the suboceanic zone dry heaths dominated by *Cladonia* spp., *B. glandulosa* and *D. flexuosa* are common on sandy-gravely deposits and moraines (Fig. 4). Names of vascular plants are in accordance with Böcher *et al.* (1968). The bedrock is mainly acid gneiss (GGU 1976a, b).

Fig. 2. A slightly south sloping *Empetrum*-heath with *Betula glandulosa*, *Salix glauca*, lichens and mosses from study site 1, Paamiut, August 1998.

Fig. 3. A level, mesic fiord heath dominated by *Betula glandulosa*, mosses and lichens with e.g. *Inocybe lacera*, *Lactarius rufus* and *Russula* spp. from study site 4, Eqaluit, August 1994.

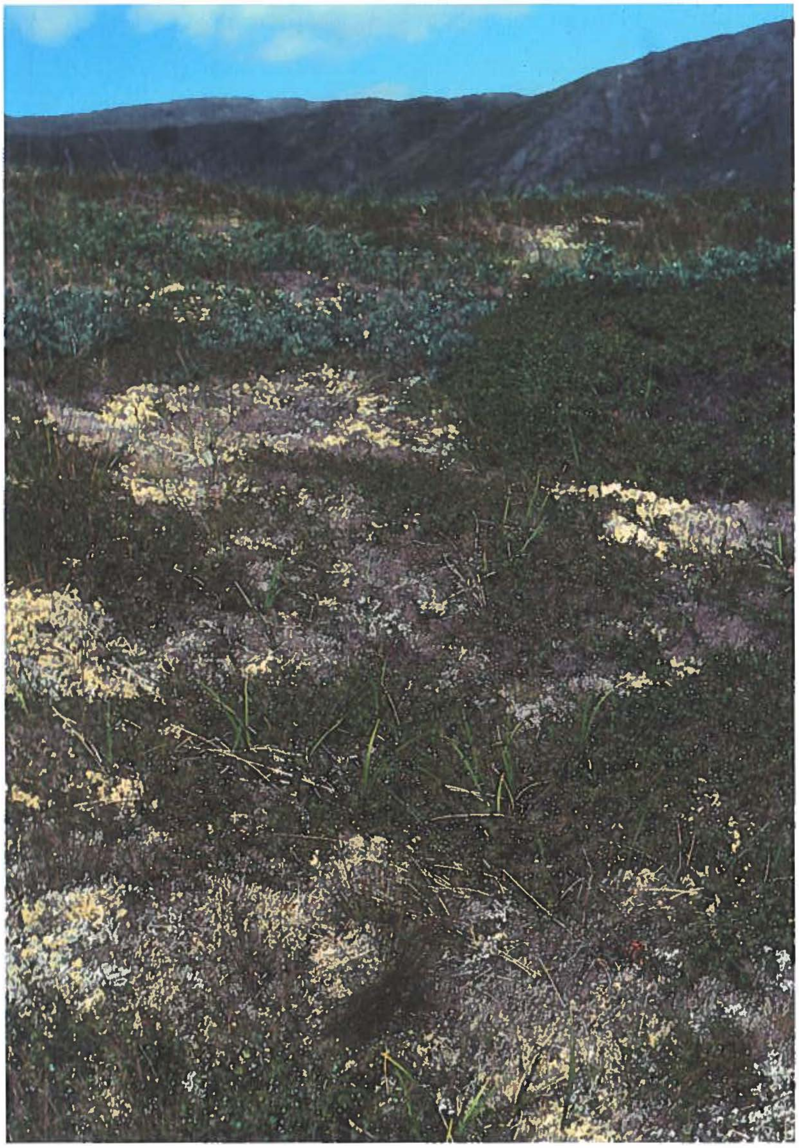

Fig. 4. A slightly south sloping dwarf-scrub heath dominated by lichens with clones of *Betula glandulosa* and *Salix glauca* from study site 7, Nigerlikasik, June 1995.

Dwarf-scrub heaths in seven sites within the study area (Fig. 1) were studied, preferably by repeated observations in the same places. Obvious differences in bedrock and more special soil features were noted. Observations were made on the vegetation, especially concerning the occurrence of ectomycorrhizal hosts, and the frequencies of the selected basidiomycetes were estimated. Listed after decreasing oceanity the sites are:

1. Paamiut peninsula (62° 00′ N, 39° 40′ W), around Paamiut town, hyperoceanic, distance to outer coast 0-8 km.
2. The eastern part of the island Kvaneø at the abandoned settlement Kangilineq (61° 57′ N, 49° 28′W), hyperoceanic, distance to outer coast 9-12 km.
3. Northern side of the fiord Taartoq (62° 01′ N, 49° 26′ W), oceanic, distance to outer coast 16-17 km.
4. At the head of Eqaluit (62° 03′ N, 49° 25′ W), oceanic, distance to outer coast 16-18 km.
5. At the head of Qassit Kangerluarsua (abbreviated Qassit) (62° 18′ N, 49° 22′ W), oceanic, distance to outer coast 25 km.
6. At the head of Nerutusoq Avannarleq (abbreviated Nerutusoq) (62° 12′ N, 49° 20′ W), suboceanic, distance to outer coast 25-28 km.
7. At the head of Nigerlikasik (62° 07′ N, 48° 53′ W), suboceanic, distance to outer coast 45 km.

Table 1. Number of visits to the study sites in the Paamiut area in the fungus season.

	Paamiut	Kangilineq	Taartoq	Eqaluit	Qassit	Nerutusoq	Nigerlikasik
1978-1988	145	22	3	30	1	0	1
1990-2000	75	2	19	48	8	8	2
2002	4	1	0	1	2	4	3
Total	224	25	22	79	11	12	6

These sites were visited several times during my stay in Paamiut (Table 1).

In total 80 species of basidiomycetes (basidiolichens not included) were selected for this study (Table 2). These include mainly easily recognizable species, but some species difficult to identify, less known or preferring other habitats are also included when searched for a sufficient number of times or sites to establish their frequency of occurrence. All species were studied in detail and dried material will be or is already deposited in Botanical Museum in Copenhagen (C). The biology of most of the species is well known regarding whether they are symbionts or saprobionts. However, for a few this aspect is yet not settled with certainty. *Clavulina coralloides* is treated here as an ectomycorrhizal symbiont, cf. Tedersoo *et al.* (2003), and the *Hygrocybe* species are most likely saprobionts (Griffith *et al.* 2002). All *Entoloma* species are here regarded as saprobionts although some may be symbionts (Noordeloos 2004).

Fructification is used as a measure of frequency as follows: Common ≥ 9 observations (single or separated groups of basidiocarps apparently representing a single mycelium) in one visit, occasional = 5-9 observations in one visit, rare ≤ 5 observations in total. Frequencies between the two latter categories are indicated as rare/occasional. The species are divided in two size groups, viz. large (> 5 cm in cap diameter or height for club fungi) and small species (< 5 cm in diameter/height).

The collections were mainly identified by me. Some of them have been published by Bendiksen *et al.* (1993), Borgen (1983, 1998a, b), Borgen and Arnolds (2004), Brandrud (1998), Elborne and Knudsen (1990), Jeppson (in print), Knudsen and Borgen (1982, 1987 and 1992), Lamoure *et al.* (1982), Lange (1955, 1957), Noordeloos (1984) and Petersen (1977). Many unpublished records are moreover included in a database of Greenland records at the Botanical Museum in Copenhagen.

Distribution patterns were analysed for the selected species: Species are included when they occur in at least two sites in the same zone, have different frequency in two zones, or are common or occasional in a single zone. Exceptionally, a few species have the same frequency in two of the zones, e.g. *Cortinarius paragaudis*. Such are referred to a distribution pattern based on the zone in which they are estimated to be most frequent.

Specific names are fully quoted if they are missing in Hansen and Knudsen (1992) or can be misinterpreted, this applies to: *Amanita groenlandica* Bas ex. Knudsen and T. Borgen, *A. mortenii* Knudsen and T. Borgen, *Cortinarius caperatus* (Pers.) Fr. (= *Rozites caperatus* (Pers.: Fr.) P. Karst.), *C. durus* P.D. Orton (cf. Brandrud 1998), *C. disjungendus* P. Karst. (cf. Brandrud *et al.* 1998), *C. imbutus* Fr. sensu Brandrud *et al.* 1998 (= *C. aff. evernius* (Fr.: Fr.) Fr. in Borgen 1998a), *C. paragaudis* Fr. subsp. *paragaudis* sensu Brandrud *et al.* 1992, *C. umbilicatus* P. Karst. (= *C. adalbertii* J. Favre ex M.M. Moser cf. Moser *et al.* 1995, *C. subtorvus* Lamoure sensu Petersen 1977 in part), *C. venustus* P. Karst. (= *C. calopus* P. Karst. cf. Brandrud *et al.* 1996), *L. sp. 1* (= *L. subcircellatus* Kühner sensu Knudsen and Borgen 1982 non Kühner 1975a), *L. torminosulus* Knudsen & T. Borgen, *Lactarius utilis* (Weinm.) Fr. (= *L. musteus* Fr. sensu Knudsen and Borgen 1982 *non al.*), *Leccinum atrostipitatum* A.H. Sm., Thiers & Watling, *L. sp. 1* (an unidentified species from the *holopus*-complex with pinkish white, then brownish buff pileus and soft, unchanging context, known to us for many years), *Russula citrinochlora* Singer (cf. Knudsen and Borgen 1992), *R. decolorans* (Fr.) Fr. (non sensu Lange 1957), *R. groenlandica* Ruotsalainen & Vauras (= *R. claroflava* Grove var. *viridis* Knudsen & T. Borgen 1992), *R. medullata* Romagn. sensu Kühner 1975b, *R.*

violaceoincarnata Knudsen & T. Borgen (= *R. sphagnophila* Kauffm. var. *heterosperma* Singer sensu Lange 1957 in part), *Hygrocybe biminiata* Kühner (cf. Borgen and Arnolds 2004), *H. conica* (Scop.: Fr.) P. Kumm. var. *aurantiolutea* T. Borgen & Arnolds and *Entoloma olidum* Noordeloos & T. Borgen.

Results

In total, 204 species of basidiomycetes were identified from the study sites including 121 symbionts and 83 saprobionts (Table 3). Among these, 80 species were selected for an analysis of their distribution among the phytogeographical zones of the Paamiut-area (Table 3). In Table 2 all selected species are listed and their occurrence at the different study sites indicated. Most species were found in the oceanic zone where almost all of the selected symbionts were recorded. Particularly species of the genera *Cortinarius* and *Russula* were numerous in the oceanic zone: exemplified by the site at Qassit, where these two genera accounted for 20 out of 38 symbiontic species (and among the selected species 13 out of 24 species) in a well delimitated heath.

In all three phytogeographical zones the number

Table 2. Selected basidiomycetes in dwarf-scrub heaths in low arctic S Greenland. Study sites: P = Paamiut, K = Kangilineq, T = Taartoq, E = Eqaluit, Q = Qassit, Ne = Nerutusoq, Ni = Nigerlikasik. Frequency: c = common, o = occasional, r = rare, oc = the frequency vary between occasional and common, ro = frequency in between rare and occasional, x = frequency not recorded, . = only in other indigenous habitats, + = in other site(s) in the zone in question. Habitat (potential mycorrhizal host): 1 = *Betula*, 2 = *Betula* and *Salix*, 3 = *Salix*. Distr. (Distributional group): A = hyperoceanic species, B = indifferent species, C = oceanic species, D = suboceanic species. Size: L = frequently exceeding 5 cm in diameter, s = mostly < 5 cm in diameter. [1]Older records covering other habitats as well. [2]Species in bold types are from a lichen-heath in Qassit, see text. [3]Also recorded at altitudes more 200 m than above sea level.

	Hyperoceanic			Oceanic		Suboceanic		Habitat	Distr.	Size
Symbionts	P	K	T	E	Q[2]	Ne	Ni			
Amanita										
fulva			o	o	**r**			1, 2	C	L
groenlandica[3]	c	x	r	o	**o**	ro	x	1, 2, 3	A	L
mortenii[3]	+r		c	c	**r**			1, 2	C	L
nivalis	o	.	r	r	**r**	x	x	1, 2, 3	A	s
Boletus										
subtomentosus[3]	r	r	o	o	r	r		1, 2	C	L
Clavulina										
coralloides	r			r				2, 3		s
Cortinarius										
caperatus[3]	r		c	c	**c**	r		1, 2	C	L
raphanoides[3]	r		c	o	**o**	o	r	1, 2, 3	C	L
delibutus[3]	r		o	o	**o**	r	o	1, 2, 3	C	sL
fennoscandicus[3]	r	r	c	c	**c**	c	o	1, 2	C	L
septentrionalis[3]	o		c	c	**o**	x	o	1, 2	C	L
durus[3]	r		r	ro				1, 2	B	L
porphyropus[3]	ro	r	o	ro	r		o	1, 2, 3	B	L
agathosmus[3]	r	r	o	o	**c**	r		1, 2	C	L
alboviolaceus[3]			o	r	r	r		1, 2	C	L
disjungendus			r	r				1, 2	C	L
imbutus[3]			ro	ro	**r**	r		1, 2	C	L
ionophyllus[3]				ro	**o**	r		1, 2	C	L
obtusus[3]	c		o	oc	**ro**	x	x	2, 3	A	s
paragaudis[3]	r		r	r	r	r		1, 2	C	s
umbilicatus	ro							3	A	s
venustus			r					2		s

Table 2. Continued.

Symbionts	Hyperoceanic P	K	Oceanic T	E	Q[2]	Suboceanic Ne	Ni	Habitat	Distr.	Size
Inocybe										
calamistrata			r					2		s
Lactarius										
dryadophilus[3]	ro		r	r			r	3	A	L
glyciosmus[3]	o	c[1]	o	c	oc	o	oc	2	B	s
repraesentaneus[3]	ro		o	ro	r		o	2, 3	B	L
rufus[3]	o	r	c	c	c	c		2	C	L
sp. 1[3]	r	r	ro	o	ro	r		1, 2	C	s
torminosulus[3]	r	.	r	r		x	x	2, 3	B	L
trivialis					r			2		L
vietus[3]			r	r	r	r		1, 2	C	L
utilis[3]			o	ro	ro			1, 2	C	L
Leccinum										
atrostipitatum			c	c	c	o	r	1, 2	C	L
rotundifoliae	c	oc	x	x		o		1, 2	A	L
sp. 1	c	x	o	c	c	x	x	2	B	L
variicolor			r	r		r		2	C	L
Paxillus										
involutus			r	o	oc	c		1, 2	C	L
Russula										
citrinochlora	o[1]	o[1]		x	r			2, 3	A	s
claroflava	o	r	o	c	c	c	o	1, 2	C	L
consobrina[3]			ro	r				1, 2	C	L
decolorans				r				2		L
delica	r			r		r		2, 3	A	L
emetica[3]	r	o	o	o	c	x	x	2	C	L
groenlandica[3]	o	r	o	o	r	x	r	2	B	L
medullata	o	r[1]	ro	o	ro	o	o	2, 3	B	L
nitida	c	c[1]	x	o	c	x	o	2	A	s
violaceoincarnata	o	ro	ro	o	r	o	r	1, 2, 3	B	L
Coltricia										
perennis				r				2		s
Thelephora										
caryophyllea			r					2		s

Saprobionts	P	K	T	E	Q	Ne	Ni	Distr.	Size
Clitocybe									
clavipes[3]	r		r	ro	r		r	C	L
diatreta[3]	[1]c	[1]o	ro	x	oc	o	x	A	s
ditopa[3]				r					s
gibba	r		r				r	A	s
vibecina[3]	[1]oc	[1]o	x	x	c	r	.r	A	s
Collybia									
cirrata[3]	c[1]	x	x	c[1]	c	x	x	B	s
Cystoderma									
amianthinum[3]	c[1]	x	x	x	o	x	x	B	s
granulosum[3]	r		r			o	o	D	s
Hygrocybe									
biminiata[3]	c	c	r	o	r	r	+r	A	s
cinerella	ro	o		+r				A	s

Table 2. Continued.

	P	K	T	E	Q	Ne	Ni	Distr.	Size
citrinopallida	c	c	r	r	.r		r	A	s
conica var.									
aurantiolutea	o		r	r	r	r		A	L
lilacina	o	o[1]		r		r		A	s
salicis-herbaceae	o	.	r	o	r	ro		B	s
xanthochroa	r		r	r	r			B	s
Marasmius									
androsaceus	r		x	o	o	c		D	s
kallioneus	ro		r					A	s
Saprobionts									
Mycena									
megaspora	c	x	c	c	c	c	x	B	s
Omphaliaster									
asterosporus[3]			r	r		r	r	C	s
borealis[3]	o	ro	r	ro	o[1]			A	s
Entoloma									
cetratum						r			s
fernandae				c				C	s
fuscotomentosum	o		r	r				A	s
olidum			r	r	r	r		C	L
vinaceum[3]			r	r	r			C	s
Rhodocybe									
hirneola[3]	.r			r					s
Pholiota									
scamba			r	r				C	s
Stropharia									
alpina	o						r	A	s
Lycoperdon									
nigrescens	r								s
Clavaria									
argillacea[3]	c	x	r	r		r		A	s
Ramariopsis									
subarctica	o	x		r				A	s

of symbionts was higher than the number of saprobionts (Table 3), while the proportion of saprobionts was highest in the hyperoceanic zone (Table 3).

This is even more pronounced if localities very close to the ocean (< 3 km), "the coastal fringe", are considered. Here saprobionts exceed the symbionts in number of species, and a few species were almost exclusively recorded here: *Marasmius kallioneus*, *Entoloma fuscotomentosum*, *Stropharia alpina* and *Lycoperdon nigrescens*.

Based on the selected species four distributional patterns can be segregated (Table 2):

Group A. Most frequent in the hyperoceanic zone. Symbionts (N = 9): *Amanita groenlandica*, *A. nivalis*, *Cortinarius obtusus*, *C. umbilicatus*, *Lactarius dryadophilus*, *Leccinum rotundifoliae*, *Russula citrinochlora*, *R. delica* and *R. nitida*. Saprobionts (N = 14): *Clitocybe diatreta*, *C. gibba*, *C. vibecina*, *Hygrocybe biminiata*, *H. cinerella*, *H. citrinopallida*, *H. conica* var. *aurantiolutea*, *H. lilacina*, *Marasmius kallioneus*, *Omphaliaster borealis*, *Entoloma fuscotomentosum*, *Stropharia alpina*, *Clavaria argillacea* and *Ramariopsis subarctica*.

Group B. Indifferent species with the same frequency in the hyperoceanic, the oceanic and suboceanic zones. Symbionts (N = 9): *Cortinarius durus*, *C. porphyropus*, *Lactarius glyciosmus*, *L. repraesentaneus*, *L. torminosulus*, *Leccinum sp. 1*, *Russula groenlandica*, *R. medullata* and *R. violaceoincarnata*. Sa-

Table 3. Distribution of sapro- and symbiont species between the three phytogeographical zones in the Paamiut area. HO = hyperoceanic, O = oceanic, SO = suboceanic.

	HO		O		SO		All	
Selected species	number	%	number	%	number	%	number	%
Symbionts	32	57	48	63	34	64	49	61
Saprobionts	24	43	28	37	19	36	31	39
Total	56	100	76	100	53	100	80	100
	HO		O		SO		All	
All species	number	%	number	%	number	%	number	%
Symbionts	71	53	100	62	52	61	121	59
Saprobionts	63	47	61	38	33	39	83	41
Total	134	100	161	100	85	100	204	100

probionts (N = 5): *Collybia cirrata, Cystoderma amianthinum, Hygrocybe salicis-herbaceae, H. xanthochroa* and *Mycena megaspora*.

Group C. Most frequent in the oceanic zone. Symbionts (N = 24): *Amanita fulva, A. mortenii, Boletus subtomentosus, Cortinarius caperatus, C. raphanoides, C. delibutus, C. fennoscandicus, C. septentrionalis, C. agathosmus, C. alboviolaceus, C. disjungendus, C. imbutus, C. ionophyllus, C. paragaudis, Lactarius rufus, L. sp. 1, L. utilis, L. vietus, Leccinum atrostipitatum, L. variicolor, Paxillus involutus, Russula claroflava, R. consobrina* and *R. emetica*. Saprobionts (N = 6): *Clitocybe clavipes, Omphaliaster asterosporus, Entoloma fernandae, E. olidum, E. vinaceum* and *Pholiota scamba*.

Group D. Most frequent in the suboceanic zone. Saprobionts (N = 2): *Cystoderma granulosum* and *Marasmius androsaceus*.

There was a marked difference in fruitbody size among the symbiontic species in the distribution groups. The group A species are generally small, with only 50 % characterised as 'large', and the species in group B and C are generally much larger, with 80 to 90% characterised as 'large'.

Some of the species were recorded in the low arctic region for the first time: *Cortinarius imbutus, Entoloma fernandae* and *Pholiota scamba*.

Discussion

The proportion of saprobiontic basidiomycetes is generally low in the Paamiut area. This is in accordance with other studies from Greenland, and is explained by wind exposure and a high saturation deficit in the air making mosses and litter-layer unsuitable substrates for saprobionts (Petersen 1977). However, this effect seems to be reduced in the hyperoceanic Paamiut peninsula, where a relatively high proportion of saprobionts is found. The reason must be the high amount of precipitation and the frequent periods with fog and mist during June and July, making conditions for particularly the saprobionts more suitable, for example by less desiccation of the litter-layer.

However, the relatively high proportion of saprobionts in the hyperoceanic zone could also be explained by the absence of symbionts, particularly seem the large species like *Russula* and *Cortinarius* to avoid this zone particularly very close to the ocean in "the coastal fringe". Perhaps due to a low frequency of suitable mycorrhizal hosts, but probably also because the growth season in the hyperoceanic zone is shorter and relatively cold due to a delayed spring and much more fog and cloudy weather.

The composition of the basidiomycetes in the oceanic and suboceanic zones is quite similar to Lange's (1957) description of dry heaths in Ivittuut dominated by *B. glandulosa*: "Large, fleshy agarics ... and smaller forms, tolerant to desiccation", e.g. *Cortinarius caperatus, Lactarius rufus, Russula claroflava, Marasmius androsaceus, Mycena megaspora* and *Xeromphalina cauticinalis*.

The rather few species recorded during my studies in the suboceanic zone may be biased, because my search effort was low and the growth seasons when the sites were visited were mediocre, particularly in

Nigerlikasik (Table 1). More species probably occur here, particularly compared to other dry sites as Qassit and Ivittuut (outside my study area). However, the low number of saprobionts is probably real, as illustrated by the fact that only two species of *Mycena* were recorded in the suboceanic zone (seven and eight were found in the hyperoceanic and oceanic zones).

Studies outside the Paamiut area (partly based on Lange 1955, 1957; Petersen 1977 and Lamoure *et al.* 1982) do not comprise all phytogeographical zones, and the proportions between symbionts and saprobionts are not necessarily comparable as species selection was based on occurrences in Paamiut area. However, in Nuuk (app. 64° N, hyperoceanic and suboceanic zones) and Sisimiut areas (app. 66° N, hyperoceanic and oceanic zones) the number of A species and their distributions seems to be similar to the Paamiut area. The largely same number of B species in all areas confirms the indifferent occurrence. The C species appear to be fewer and less common in the hyperoceanic, than in the oceanic and suboceanic zones. The distributions of the D species are inconclusive.

A species like *Stropharia alpina* is definitely a group A species being almost restricted to the hyperoceanic zone of Paamiut. In other parts of Greenland it has been recorded in similar hyperoceanic sites further north in Nuuk and Sisimiut municipalities. However, it has also been recorded from inland sites (in dry continental areas), but here always at high altitude moist sites (Lange 1955, collections at C). Its preference for hyperoceanic conditions is underlined by the fact that it also occurs in Iceland and the Faroe Islands (Lange 1980).

Lactarius dryadophilus is classified as a group A species, because it is most frequent in site 1. It has, however, preference for base-rich soil (Knudsen and Lamoure 1993), and thus widespread at site 1 due to many basaltic dykes, and very limited in the other sites. This seems also to be the case for *Russula delica* and *Clitocybe gibba* (Lange 1955, Petersen 1977, unpublished information at C). Both species are widely distributed in Greenland but do not show oceanic preferences elsewhere.

The results from the oceanic and suboceanic zones in the Paamiut area are comparable to results from low oroarctic, fairly oceanic dwarf-scrub heath sites at Kilpisjärvi, North Finland (Ohenoja and Metsänheimo 1982, Metsänheimo 1987). The proportions of symbionts are similar, as are the dominating genera, except for the much higher number of *Inocybe* species (Bendiksen and Ohenoja, unpubl.).

Most of the selected species from my study sites also occur in low alpine sites in Scandinavia (Natural History Museum at the University of Oslo, Hansen and Knudsen 2000, Jacobsson 1984, Ohenoja 1996, Bendiksen and Ohenoja unpubl.). However, a few species: *Amanita mortenii*, *Cortinarius disjungendus*, *C. imbutus*, *C. ionophyllus* and *Pholiota scamba* are, so far, only known from arctic-alpine habitats in Greenland, although they occur in boreal or temperate lowland habitats.

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