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A contribution to lichen biota of the central part of Spitsbergen, Svalbard Archipelago

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Abstract: The present contribution to lichen-forming and lichenicolous biota of northernmost Billefjorden (Petuniabukta area, central Spitsbergen, Svalbard) contains 40 species of lichens. Four species: *Arthonia ligniariella*, *Candelariella lutella*, *Ochrolechia upsaliensis*, *Polyblastia pernigrata* are new for the Svalbard Archipelago.

Key words: Arctic, Spitsbergen, lichenized fungi, species distribution.

Introduction

The studies on lichen-forming and lichenicolous fungi in Svalbard Arctic Archipelago began at the end of XIX century (Fries 1867). A recent checklist of lichens and lichenicolous fungi of the area contains 597 species (Alstrup and Olech 1993; Elvebakk and Hertel 1996). However, the territory of Svalbard has not been investigated uniformly, as most of the species were collected in southern, western and north-western territories. According to Elvebakk and Hertel (1996), the best studied regions are: Bjørnøya (about 100 species), Sørkapp Land and Hornsund (nearly 480 species). From the west coast of Spitsbergen Island around 380 species are known, and from the north coast – 215 species (Lynge 1924, 1926; Nowak 1965; Hertel and Ullrich 1976; Hertel 1977; Haffellner 1982; Nimis 1985; Olech

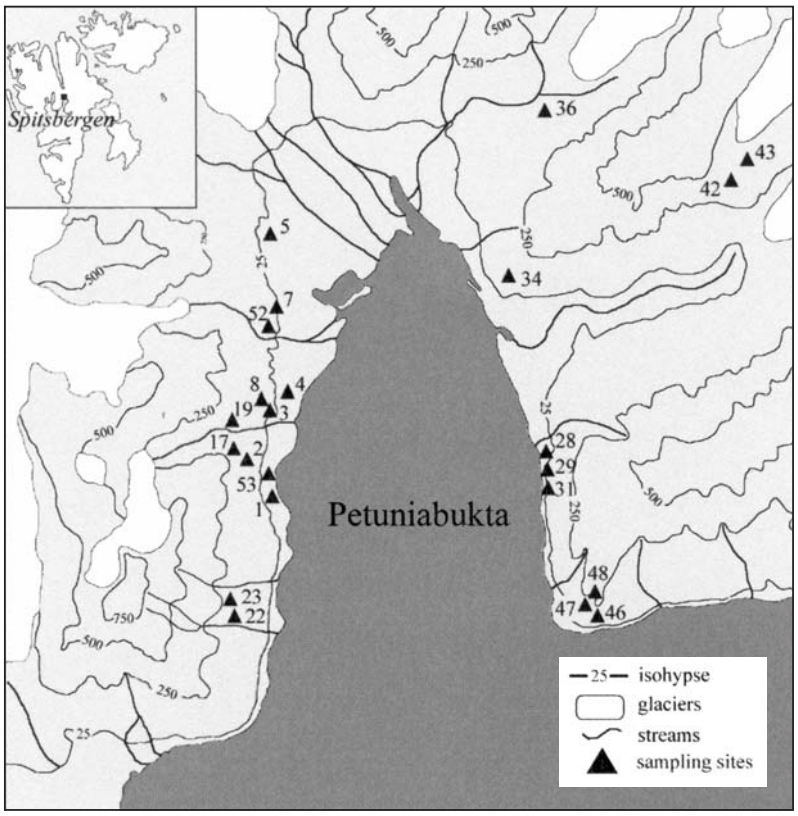

Fig. 1. Map of Petuniabukta area (central part Spitsbergen Island, Svalbard) showing location of the sampling sites.

1987, 1990). However, from the central part of Spitsbergen Island only ten species are reported: *Melanelia stygia* from Pyramiden area, *Nephroma arcticum* from Dickson Land, *Ochrolechia frigida* from Dirksbukta and seven species from Petuniabukta area (Fries 1867; Summerhayes and Elton 1928; Lynge 1938; Elvebakk 1984, Elvebakk and Hertel 1996; Osyczka and Węgrzyn 2008), which clearly does not reflect the real situation.

The central part of Spitsbergen is characterized by a more continental climate than the western and southern parts of the island (Hanssen-Bauer *et al.* 1990), thus we can expect here not only common species reported from other areas but probably other species characteristic of the territories with drier climatic conditions.

Investigated area and methods

The area of investigation called Petuniabukta is located in the centre of Spitsbergen Island in the northwestern part of Billefjorden (the place names of

Table 1

List of sampling sites in the Petuniabukta area and their description

Site	Exposure	Slope	Description of the sampling sites
1	East	5°	stabilized scree with soil, stones up to 10 cm
2	East	2°	stabilized scree with soil, stones up to 1 m
3	Southeast	3°	moss-dominated wetland, stones up to 20 cm, long-lasting snow cover
4	South	10°	snow bed
5	South-southeast	5°	old platform
7	horizontal surface	0°	old stabilized platform
8	horizontal surface	0°	old stabilized platform
17	Southeast	10°	slightly wet scree, with soil and stones up to 40 cm
18	Southeast	5°	scree with soil, stones up to 40 cm
19	East	10°	wet tundra, stones up to 50 cm
22	East	10°	polygonal soil, stones up to 30 cm
23	Southeast	10°	scree on the margin of snow bed, stones up to 30 cm
29	horizontal surface	0°	wind-exposed platform
31	West-southwest	3°	stabilized platform, stones up to 20 cm
34	Southwest	5°	extreme dryas-tundra, fine scree, polygonal soils
36	Northwest	10°	deglaciated area cca 1 km from the glacier, compact consolidated scree
42	North	10°	scree with soil, stones up to 30 cm
43	Northeast	10°	scree, stones up to 1.5 m
46	West-northwest	40°	fine scree, partly with soil, stones up to 5 cm
47	Northwest	30°	scree with soil, below the bird cliff, stones up to 10 cm
48	horizontal surface	0°	mountain top plateau, stones up to 20 cm
52	horizontal surface	0°	top of small ridge
53	Southeast	5°	dryas-tundra, stone polygons

Svalbard, 2003). The study region is characterized by low and gently sloping shores with flat terraces and cliffs around the bay. The valley is surrounded by decreasing glaciers: Ferdinand, Hørbye, *etc*. The climate is characterized by dry conditions in comparison with the western coast, and annual precipitation is only 200 mm (Hanssen-Bauer *et al.* 1990).

The lichens were collected on the western and eastern shores of Petuniabukta from the sea level to the edge of glaciers. During the Arctic expedition of Czech scientists in the summer 2008, more than 50 samples of lichens from plant debris, soil and mosses were collected by Jiří Košnar and Jan Gloser. Lichens were sampled at 23 sites in different vegetation types and additional sampling on stones, soil and rock was also performed (Table 1, Fig. 1).

The identification was carried out using the keys of Purvis *et al.* (1992), Golubkova *et al.* (1996), Thomson (1997), Moberg (2002), Andreev *et al.* (2003),

Khodosovtsev *et al.* (2004) and Smith *et al.* (2009). The basic nomenclature of lichens adopted in the article is that of Santesson *et al.* (2004). Vouchers are kept in the herbarium PRA (Institute of Botany, Academy of Science of the Czech Republic in Průhonice).

Results and discussion

As a result of our study, 40 species of lichens and lichenicolous fungi have been found. Among them four species (*Arthonia ligniariella*, *Candelariella lutella*, *Ochrolechia upsaliensis*, *Polyblastia pernigrata*) are reported from Svalbard for the first time (Appendix 1). Sampling sites differed in species richness; the richest localities were number 4 where 10 species were found, number 2 and 52 with eight species. Eight sampling sites were characterized only by one lichen species.

The most common species were *Fulgensia bracteata* (epigeic) and *Lecanora epibryon* (growing on plant debris) recorded in 9 sampling sites, 28 species were registered only once. The highest cover of lichens was found in site 31, where the projective cover reached 90% and was composed of six species. The lowest cover of lichens was found in sampling sites 17 and 19 (less than 2%).

About one third of the species collected in Petuniabukta are common on Svalbard. All determined species from the genera *Cladonia*, *Caloplaca* and *Collema*, occur also in all islands of this archipelago. Less common species, such as *Caloplaca tornoënsis*, *Mycobilimbia hypnorum* and *Agonimia gelatinosa*, are also widely distributed there, but they have been found mainly along the shores of bays (Elvebakk and Hertel 1996; Søchting *et al.* 2008). It is interesting that several species (e.g. *Caloplaca jungermanniae*, *Cladonia cariosa*, *C. pocillum*, *C. pyxidata*, *Collema tenax*, *Rinodina turfacea*), which were noted as common in other parts of Svalbard (Elvebakk and Hertel 1996) are sparsely found in the area of investigation.

An interesting find is *Ochrolechia upsaliensis* reported earlier from Fosterøyane and Diksbukta (Spitsbergen) by Summerhayes and Elton (1928), but later Elvebakk (1996) corrected it as misidentified specimens of *O. frigida*. In Scandinavia both species occupied similar habitats and grow on soil crusts, mosses and plant debris (Santesson *et al.* 2004) but they differ markedly in the size of ascospores (*O. upsaliensis* has ascospores 55–75 × 26–38 µm, *O. frigida*: 25–40 × 15–26 µm) and the diameter of apothecia (smaller in *O. upsaliensis*) (Kopachevskaja *et al.* 1971). Our find suggests that *Ochrolechia upsaliensis* prefers drier and more continental localities in Spitsbergen, which were so far less surveyed than other places (especially west coast).

Another new species for Svalbard, *Polyblastia pernigrata,* is found in North Siberia, East Chukotka, North America, but was missing in polar regions of Europe (Kristinsson *et al.* 2006). Our results suggest that the species has a circumpolar distribution. *Candelariella lutella*, widespread in North America (North Alaska, Cen-

tral Canadian Arctic) and North Siberia, is known in Europe only from Scandinavia where it is common. The species is reported from Scandinavia as corticolous, usually growing on bark of *Alnus incana* (Santesson 1993); in Petuniabukta area, it was found on the thallus of *Parmelia saxatilis*.

For two species our finds in Petuniabukta represent the first discovery in Arctic localities. *Arthonia ligniariella* is broadly distributed in British Isles but rarely reported from Scandinavia (province Härjedalen, Sweden; Santesson 1993). *Candelariella reflexa* has a wide distribution throughout Europe and occurs also in Southern Hemisphere (Chile, Tasmania), but it was not known from Arctic regions (Purvis *et al.* 1992). Our sample of this species is characterized by an insignificant thallus with several apothecia of 0.2–0.3 mm in diameter. During next field trip we intend to collect more samples for further investigation.

Another interesting record from our study is the occurrence of a typically epilithic species, *Thelidium minutulum*, on soil crust. This species is usually found on the mica schist and limestone (Purvis *et al.* 1992).

The total number of 40 lichen species found on soil crust and plant debris in the central part of Spitsbergen could be regarded as a preliminary information for this area. We can expect also high diversity of epilithic lichen biota which were not yet studied.

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Appendix 1

The checklist of lichen-forming and lichenicolous fungi of the Petuniabukta area found during this exploration. Species marked by an asterisk (*) are new for Svalbard Arctic Archipelago.

1. ***Agonimia gelatinosa*** (Ach.) Brand and Diederich; sampling site 2, on naked earth, *leg*. Jiří Košnar. Known from Lovénberget, Wahlenbergfjorden (Fries 1867), Bjørnøya (Lynge 1926), Sørkapp Land (Olech 1990), Hornsund (Nowak 1965), Bockfjorden (Hafellner 1982). Widespread in Europe, N. America, subantarctic islands (Smith *et al.* 2009).

2. ****Arthonia ligniariella*** Coppins; sampling site 43, *leg*. Jiří Košnar.
Distribution in the world: W. Europe, British Is., Scandinavia (Smith *et al.* 2009).

3. ***Caloplaca cerina*** (Ehrh. ex Hedw.) Th. Fr.; sampling sites 43, 53, *leg*. Jiří Košnar.
Common species on Svalbard (Elvebakk and Hertel 1996). World distribution: Europe, Africa, Asia (Smith *et al.* 2009), S. America (Calvelo and Liberatore 2002), Australasia (McCarthy 2010).

4. ***Caloplaca jungermanniae*** (Vahl) Th.Fr.; sampling site 2, *leg*. Jiří Košnar.
Common species in Svalbard (Elvebakk and Hertel, 1996). Widely distributed in Arctic regions: North Siberia (Yamal, Taimyr Peninsula, Anabar-Olenyek, Chukotka East, Kanin-Pechora), N America (N Alaska, Central and North Canadian Arctic, West Hudsonian), Greenland, Arctic islands (Severnaja and Novaya Zemlya, Novosibirskie, Wrangel and Beringian Islands and Franz-Josef Land). Known in Scandinavia (Santesson *et al.* 2004).

5. ***Caloplaca tornoënsis*** H.Magn.; sampling site 31, *leg*. Jiří Košnar.
In Svalbard is known from Reindalen (Søchting and Olech 1995), (Elvebakk and Hertel 1996), Sabine Land, Sassendalen, Gjelhallet (Søchting *et al.* 2008). World distribution: N. America, Greenland, Siberia and Scandinavia (Magnusson 1944; Hansen *et al.* 1987; Søchting and Olech 1995; Søchting *et al.* 1992, 2008; Santesson *et al.* 2004).

6. ****Candelariella lutella*** (Vain.); Räsänen close to sampling site 4, *leg*. Jan Gloser. World distribution: Europe (Scandinavia), Asia (north Siberia) and N. America (N. Alaska, Central Canadian Arctic) (Kristinsson *et al.* 2006).
7. ***Candelariella*** cf. ***reflexa*** (Nyl.) Lettau; sampling site 48, *leg*. Jiří Košnar. Cosmopolitan species (Santesson *et al.* 2004; Smith *et al.* 2009).
8. ***Catillaria*** cf. ***contristans*** (Nyl.) Zahlbr.; close to sampling site 4, *leg*. Jan Gloser. World distribution: Europe, Iceland (Smith *et al.* 2009), Antarctica (Øvstedal and Lewis Smith 2001), Australasia (McCarthy 2010).
9. ***Cetrariella delisei*** (Bory ex Schaer.) Kärnefelt and Thell; sampling sites 4, 8, on soil *leg*. Jiří Košnar and Jan Gloser. World distribution: Europe, New Zealand (Smith *et al.* 2009), S. America (Calvelo and Liberatore 2002), widely distributed in Arctic regions (Kristinsson *et al.* 2006).
10. ***Cladonia cariosa*** (Ach.) Spreng.; sampling site 43, *leg*. Jiří Košnar.
    Common species on Svalbard (Lynge 1938; Nowak 1965; Olech 1990; Elvebakk and Hertel 1996). World distribution: throughout Arctic regions (Kristinsson *et al.* 2006), Europe, Macaronesia, N. Africa, Asia (Smith *et al.* 2009), S. America (Calvelo and Liberatore 2002).
11. ***Cladonia pocillum*** (Ach.) Grognot; sampling site 4, *leg*. Jiří Košnar and Jan Gloser.
    Common species on Svalbard (Elvebakk and Hertel 1996). World distribution: Europe, Africa, Asia (Smith *et al.* 2009), S. America (Calvelo and Liberatore 2002), Antarctica (Øvstedal and Lewis Smith 2001), Australasia (McCarthy 2010), common in Arctic regions (Kristinsson *et al.* 2006).
12. ***Cladonia pyxidata*** (L.) Hoffm.; sampling site 18, *leg*. Jiří Košnar.
    Common species on Svalbard (Elvebakk and Hertel 1996). World distribution: Europe (Smith *et al.* 2009), S. America (Calvelo and Liberatore 2002), Australasia (McCarthy 2010).
13. ***Collema*** cf. ***callopismum*** A. Massal.; sampling site 52, *leg*. Jiří Košnar. World distribution: Scandinavia (Santesson *et al.* 2004), England, Arctic regions extending to C. America (Kristinsson *et al.* 2006; Smith *et al.* 2009).
14. ***Collema ceraniscum*** Nyl.; close to sampling site 4, *leg.* Jan Gloser.
    Common species on Svalbard (Elvebakk and Hertel 1996). World distribution: Scotland, (Smith *et al.* 2009), Scandinavia (Santesson *et al.* 2004), Arctic regions (Kristinsson *et al.* 2006).
15. ***Collema*** cf. ***limosum*** (Ach.) Ach.; sampling site 42, *leg*. Jiří Košnar.
    World distribution: Europe (British Is.), N. America, Africa, Asia (China).
16. ***Collema tenax*** (Sw.) Ach. em. Degel.; sampling site 2, *leg*. Jiří Košnar.
    Common in Svalbard (Elvebakk and Hertel 1996). Cosmopolitan species (Smith *et al.* 2009), known from Antarctica (Øvstedal and Lewis Smith 2001) and S. America (Calvelo and Liberatore 2002).
17. ***Collema*** sp.; sampling sites 2 and 31, *leg*. Jiří Košnar.
18. ***Dactylospora urceolata*** (Th.Fr.) Arnold; sampling site 18, on thallus of *Lecanora epibryon* on plant debris, *leg*. Jiří Košnar. Distributed in Fennoscandia (Santesson *et al.* 2004). In Arctic region known from West Greenland (Kristinsson *et al.* 2006).
19. ***Flavocetraria nivalis*** (L.) Kärnefelt and Thell; sampling sites 4, 18, on soil *leg*. Jiří Košnar and Jan Gloser. Common species on Svalbard (Hertel and Ullrich 1976; Elvebakk and Hertel 1996). Very common in Arctic regions of Northern Hemisphere (Kristinsson *et al.* 2006), known from S. America (Calvelo and Liberatore 2002), New Guinea (Smith *et al.* 2009).
20. ***Fulgensia bracteata*** (Hoffm.) Räsänen; sampling sites 2, 3, 4, on soil, *leg*. Jiří Košnar and Jan Gloser. Common in Svalbard (Elvebakk and Hertel 1996). Possibly circumpolar species: Polar Ural, Severnaya Zemlya, Chukotka, N. Alaska, Scandinavia (Santesson *et al.* 2004; Kristinsson *et al.* 2006; Smith *et al.* 2009), known from Australasia (McCarthy 2010).

21. ***Gyalecta foveolaris*** (Ach.) Schaer.; sampling sites 18, 22, *leg*. Jiří Košnar.
On Svalbard known from Miseryfjellet on Bjørnøya (Lynge 1926), Ny-Ålesund (Hertel 1977), Hornsund (Olech 1987), Kulmrabben on Sørkapp Land (Olech 1990). World distribution: Europe, Iceland, N. and C. America (Santesson *et al.* 2004), Greenland, Central Canadian Arctic (Kristinsson *et al.* 2006).

22. ***Lecanora epibryon*** (Ach.) Ach.; sampling sites 5, 7, 8, 18, 31, 42, 48, 52, 53, on plant debris and mosses, *leg*. Jiří Košnar.
Common species on Svalbard (Elvebakk and Hertel 1996). This species has a circumpolar distribution: Antarctica (Øvstedal and Lewis Smith 2001), known from Australasia (McCarthy 2010), South America (Calvelo and Liberatore 2002).

23. ***Lecanora hagenii*** (Ach.) Ach.; sampling sites 2, 43, on plant debris, *leg*. Jiří Košnar.
On Svalbard is known from Hornsund, Sorgfjorden, Lovénberget, Lomfjorden (Fries 1867), Sørkapp/ Hornsund (Lynge,1924), Depothamna/Depotøya at Nordaustlandet (Santesson 1939), Bockfjorden (Hafellner 1982), Hornsund (Olech 1987), Sørkapp Land (Olech 1990) as var. *lithophila* known from South America (Calvelo and Liberatore 2002). Cosmopolitan species (Smith *et al.* 2009).

24. ***Lepraria*** cf. ***lobificans*** Nyl.; sampling site 18, on soil, *leg*. Jiří Košnar. Widespread and often abundant species in the world (Smith *et al.* 2009).

25. ***Micarea incrassata*** Hedl.; sampling site 29, on soil, *leg*. Jiří Košnar.
On Svalbard known from Bjørnøya (Lynge 1926) and Ny-Ålesund (Hertel 1977). World distribution: Arctic regions (Kristinsson *et al.* 2006), Scotland, Fennoscandia, N. America, subantarctic islands (Santesson *et al.* 2004; Smith *et al.* 2009), Australasia (McCarthy 2010).

26. ***Mycobilimbia hypnorum*** (Lib.) Kalb and Hafellner, in Wirth; sampling site 52, on mosses, *leg*. Jiří Košnar. On Svalbard known from several places (Elvebakk and Hertel 1996): Bjørnøya (Lynge 1926), Hornsund (Nowak 1965), Sørkapp Land (Olech 1990), Kongsfjorden (Nimis 1985), Amsterdamøya (Hertel and Ullrich 1976) and Bockfjorden (Hafellner 1982). World distribution: British Isles, Continental Europe, Macaronesia, Asia, Africa, subantarctic islands (Smith *et al.* 2009), North Siberia, Western Hudsonian (Kristinsson *et al.* 2006), Australasia (McCarthy 2010).

27. ****Ochrolechia upsaliensis*** (L.) A. Massal.; sampling site 2, on plant debris, *leg*. Jiří Košnar.
Recorded from Fosterøyane and Diksbukta by Summerhayes and Elton (1928), but was rejected by Elvebakk (1996) as misidentified specimens of *O. frigida*. World distribution: Fennoscandia (Santesson *et al.* 2004), Asia (Caucasus, Kamchatka), N. and S. America (Kristinsson *et al.* 2006; Calvelo and Liberatore 2002).

28. ***Parmelia saxatilis*** (L.) Ach.; sampling site 4, on soil, *leg*. Jan Gloser.
According to Elvebakk and Hertel (1996), a very common species in Svalbard. World distribution: cosmopolitan species (Smith *et al.* 2009). Antarctica (Øvstedal and Lewis Smith 2001), S. America (Calvelo and Liberatore 2002).

29. ***Peltigera malacea*** (Ach.) Funck; sampling site 47, on soil, *leg*. Jiří Košnar.
Common species on Svalbard (Lynge 1938; Elvebakk and Hertel 1996). Widespread in the N. Hemishere from temperate to Arctic regions (Smith *et al.* 2009), known from S. America (Calvelo and Liberatore 2002).

30. ***Physconia muscigena*** (Ach.) Poelt; sampling site 46, on mosses, *leg*. Jiří Košnar.
Very common species on Svalbard (Elvebakk and Hertel 1996). World distribution: Arctic regions (Santesson *et al.* 2004; Kristinsson *et al.* 2006), Antarctica (Øvstedal and Lewis Smith 2001).

31. ****Polyblastia pernigrata*** (Nyl.) Zahlbr.; sampling site 31, on plant debris and mosses, *leg*. Jiří Košnar. Distributed in the North Asia (Anabar, E. Chukotka) (Kristinsson *et al.* 2006).

32. ***Polyblastia terrestris*** Th. Fr.; sampling site 7, on soil, *leg*. Jiří Košnar.
From Svalbard is known in Bjørnøya (Lynge 1926), Hopen (Lynge 1939), Bockfjorden (Hafellner 1982). World distribution: N. Wales, Scotland, Ireland (Smith *et al.* 2009), Fennoscandia (Santesson *et al.* 2004), Arctic regions (Kristinsson *et al.* 2006).

33. ***Rinodina roscida*** (Sommerf.) Arnold; sampling site 43, on decaying plants, *leg*. Jiří Košnar.
On Svalbard is well known from scattered localities (Magnusson 1947; Hafellner 1982). World distribution: Fennoscandia (Santesson *et al.* 2004), Arctic regions (Kristinsson *et al.* 2006), N. and S. America (Calvelo and Liberatore 2002; Moberg 2002).

34. ***Rinodina turfacea*** v. ***turfacea*** (Wahlenb.) Körb.; sampling sites 8, 43, 48, on decaying plant and mosses, *leg*. Jiří Košnar. It is a common species on Svalbard (Elvebakk and Hertel 1996). World distribution: Arctic and Alpine Europe, Arctic Canada and Siberia, N. and S. America (Calvelo and Liberatore 2002; Moberg 2002; Santesson *et al.* 2004; Kristinsson *et al.* 2006).

35. ***Stereocaulon arcticum*** Lynge; sampling site 19, on soil, *leg*. Jan Gloser.
Common species on Svalbard (Elvebakk and Hertel 1996), widely distributed in the Arctic regions (Santesson *et al.* 2004; Kristinsson *et al.* 2006).

36. ***Stereocaulon rivulorum*** H. Magn.; sampling site 4, on soil, *leg*. Jan Gloser.
Common species on Svalbard (Elvebakk and Hertel 1996), widely distributed in the Arctic regions (Santesson *et al.* 2004; Kristinsson *et al.* 2006).

37. ***Thamnolia vermicularis*** (Sw.) Schaer; sampling site 1, on earth, *leg*. Jan Gloser.
It was recorded in south-west Svalbard (Nowak 1965; Hertel and Ullrich 1976; Elvebakk and Hertel 1996). Cosmopolitan species: Europe (arctic-alpine habitats), Asia, N. and S. America, Australia, New Zealand (Calvelo and Liberatore 2002; Smith *et al.* 2009; McCarthy 2010).

38. ***Thelidium minutulum*** Körb.; sampling site 4, on soil, *leg*. Jiří Košnar.
World distribution: Europe, N. America (Alaska, Central Canadian Arctic, West Hudsonian), Asia (Santesson *et al.* 2004; Kristinsson *et al.* 2006; Smith *et al.* 2009).

39. ***Thelocarpon epibolum*** Nyl.; sampling site 4, on decaying thallus of lichens and soil.
Known from Sørkapp Land (Alstrup and Olech 1993). World distribution: Europe (Norway Arctic, British Isles), N. America (Ellesmere), North Asia (Anabar), West and East Greenland (Kristinsson *et al.* 2006; Smith *et al.* 2009).

40. ***Verrucaria*** sp.; sampling site 31, on soil crust, *leg*. Jiří Košnar.