Lichens in the vicinity of Colesdalen, one of the "hot spots" of the Svalbard archipelago

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Abstract

This study summarizes the lichen diversity in the Colesdalen area of Svalbard, where a total of 234 species are known. Notably, 112 of these lichen species are reported for the first time in this region. Among them, the newly recorded species are *Arthonia granitophila*, *Ionaspis obtecta*, *Micarea denigrata*, *Poeltinula interjecta*, *Rhizocarpon infernulum*, *R. subgeminatum*, *Rinodina mniaroea* var. *cinnamomea*, *Sagedia zonata*, *Sarcogyne lapponica*, which are new to Svalbard. Furthermore, *Arthonia granitophila* and *Poeltinula interjecta* are documented for the first time in the Arctic. Additionally, 27 species have been identified as new to Nordenskiöld Land (Central Spitsbergen). The ecological conditions of the Colesdalen area, including its unique microhabitats and substrate availability, significantly influence the lichen biodiversity and site-dependent vegetation composition. This research contributes to the knowledge of local biodiversity of lichens and highlights how certain species can thrive beyond their typical ranges due to specific environmental factors – substrate, altitude, anthropogenic impact, distance from glaciers, humidity. Approximately half of the identified species are known only from the study area or from a few locations on Svalbard. This highlights the specificity of the natural conditions of the study area as well as the complex interactions between natural ecosystems and human-modified environments, emphasizing the importance of further study and documentation of Arctic lichens.

Key words: lichens, new records, Arctic, ecology, distribution, Nordenskiöld Land

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Introduction

The Svalbard archipelago is located in the Arctic Ocean between 76°26′ and 80°50′ N and 10° and 32° E. The climate is subarctic, significantly softened in the west by the warm Spitsbergen Current (part of the Gulf Stream). The average air temperature on the coast ranges from +4…+6°C (July) to -10…-14°C (January)[1]. Due to the influence of the Gulf Stream, winter temperatures in Svalbard are, on average, 20 degrees higher than in other places at comparable latitude. According to the accepted system of zonal division of the archipelago (Øvstedal et al. 2009), its territory is divided into two zones: the polar desert zone and the arctic tundra zone. The arctic tundra zone is further divided into northern arctic tundra and middle arctic tundra. It is believed that the polar desert zone includes areas with an average temperature of the warmest month below +3°C, while the northern arctic tundra has an average temperature within +3…+5°C, and the middle arctic tundra is +5…+7°C. The southern arctic tundra, which represents areas within +7…+9°C, is absent on Svalbard but may be represented by small areas inhabited by heat-loving species (for example, *Betula nana* L., *Campanula gieseckiana* Vest, *Calamagrostis purpurascens* R. Br.). One of these "hot spots" is the area located around Colesbukta and the former Russian mining settlement of Kolsbey. These conditions of slightly warmer local climate are ensured by both the geographical location in the interior of the Isfjorden and the fact that the area is located in a depression occupied by the large river Coleselva and surrounded by mountains. Thus, this area is protected from strong winds and is also swampy, most of it being a river valley. This undoubtedly has a significant impact on the microclimatic conditions of the region, as well as on vegetation (including lichen) cover. This paper is dedicated to exploring the peculiarities of the lichen cover in such favorable conditions for this Arctic archipelago.

Despite the potentially significant diversity, information on the lichens of the Colesbukta region has remained rather scarce until recently. For the Colesdalen area, 40 lichen species are listed in the Svalbard Lichen Database[2]. This database currently consists of a small number of specimens from the Botanical Museum, University of Oslo (O), Bergen Museum, University of Bergen (BG), and Tromsø Museum, University of Tromsø (TROM). Another 29 species are mentioned in the checklist of lichens of Svalbard (Øvstedal et al. 2009). A preliminary list of lichens for the area around the former settlement of Kolsbey, which included 121 species was published in 2018 (Konoreva and Chesnokov 2018). Therefore, we focused on detailed survey of lichen species in Colesdalen which resulted in this paper. Herewith, we report 112 species that are listed for the first time for the area. Moreover, a new species for Svalbard (*Stictis radiata*) was recently discovered near the Kolsbey settlement (Konoreva and Chesnokov 2024).

Material and Methods

This work is a part of a large-scale study conducted by the Avrorin Polar-Alpine Botanical Garden-Institute at the Kola Science Center RAS in Svalbard. The lichens were collected by the first author in the Colesbukta area in 2009 and 2015 (Fig. 1) from coastal rocks and stone rubble, at a seashore colony of birds (*Alle alle* L., *Larus argentatus* Pontoppidan, *L. marinus* L., *Rissa tridactyla* L.), a

waterlogged area, river and stream valleys, and various types of tundra. In total, about 1000 lichen specimens were collected, mainly terricolous and saxicolous species, as well as those growing on driftwood, plant debris, mosses, and bones.

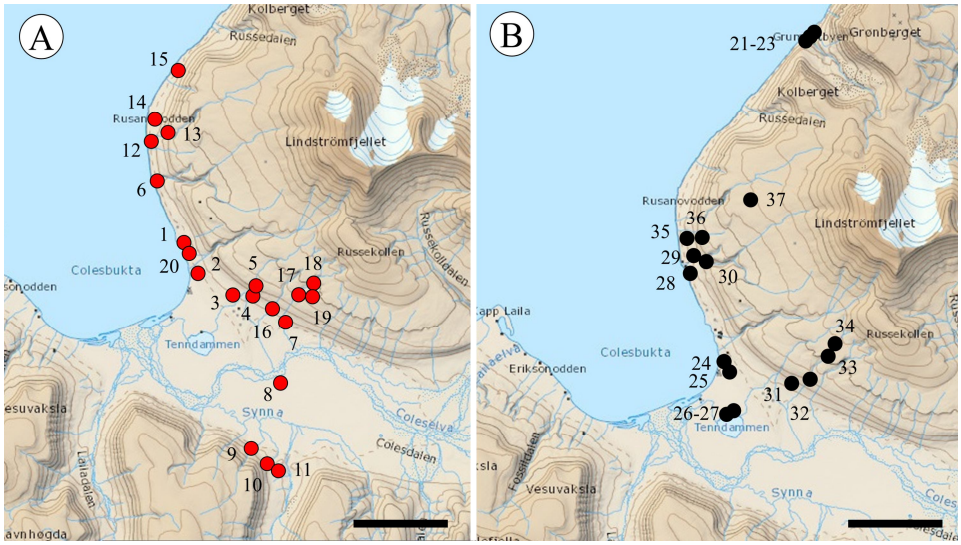


Fig. 1. Collection sites in the vicinity of Colesdalen in 2009 (A) and 2015 (B). Scale bar 2 km.

Morphological and anatomical features of the lichens were analyzed using standard light microscopy (binocular stereoscopic MBS-10 and Carl Zeiss Primo Star microscope) and chemical tests: K – 10% KOH, C – calcium hypochlorite, KC – K is applied, followed by C, Pd – alcohol solution of *p*-paraphenylenediamine, I – Iodine solution (Smith et al. 2009). For some specimens, thin layer chromatography (TLC) was performed in solvent system C (Orange et al. 2001). Voucher lichen specimens are deposited in the herbarium of the Avrorin Polar-Alpine Botanical Garden-Institute(KPABG).Some of the duplicate specimens were transferred to the herbarium of the Komarov Botanical Institute (LE). Photographs of the species were taken with a stereoscopic microscope Motic SMZ-171-LED with an attached MotiCam S6 camera. The geographical names and topographic bases for Fig. 1 are based on the topographic map of Svalbard[3]. The nomenclature of lichens mainly follows Westberg et al. (2021), with additions and changes published in several other studies (*e.g.* Lumbsch and Huhndorf 2010, Kondratyuk et al. 2020, Ekman 2023, Westberg et al. 2024).

Table 1 presents the names and coordinates of the localities. Description of the sites is presented in Supplementary Materials.

No.	Localities	Coordinate
1.	the vicinity of the Kolsbey settlement	78°07′15.9″N, 15°00′49.3″E
2.	the vicinity of the Kolsbey settlement	78°06′44.8″N, 15°01′59.8″E
3.	the vicinity of the Kolsbey settlement	78°06′34.6″N, 15°03′34.3″E
4.	the vicinity of the Kolsbey settlement	78°06′33.4″N, 15°04′43.3″E
5.	the vicinity of the Kolsbey settlement	78°06′39.1″N, 15°04′57.2″E
6.	near Rusanov's house	78°07′52.6″N, 14°59′15.4″E
7	Colesdalen	78°06′09.6″N, 15°06′52.3″E
8	Colesdalen	78°05′32.3″N, 15°06′34.9″E
9	Colesdalen	78°04′47.1″N, 15°04′48.6″E
10	Colesdalen	78°04′38.6″N, 15°05′39.0″E
11	Colesdalen	78°04′31.6″N, 15°06′09.8″E
12.	road to Grumant, the 1st terrace	78°08′16.6″N, 14°58′58.3″E
13.	road to Grumant, the 1st terrace	78°08′22.6″N, 15°00′18.0″E
14.	road to Grumant, the 1st terrace	78°08′30.3″N, 14°59′37.4″E
15.	road to Grumant, the 1st terrace	78°09′13.3″N, 15°00′34.6″E
16.	Colesdalen	78°06′26.2″N, 15°06′00.8″E
17.	Colesdalen	78°06′38.7″N, 15°07′49.7″E
18.	Colesdalen	78°06′46.2″N, 15°08′33.6″E
19.	Colesdalen	78°06′35.8″N, 15°09′11.2″E
20.	Kolsbey settlement	78°07′07.7″N, 15°00′54.8″E
21.	Grumant, near the coast	78°10′36.0″N, 15°06′45.2″E
22.	Grumant, sea shore	78°10′36.2″N, 15°06′57.7″E
23.	Grumant area	78°10′28.6″N, 15°06′35.2″E
24.	near the Coleselva estuary	78°06′43.3″N, 15°01′31.5″E
25.	Coleselva river floodplain	78°06′35.7″N, 15°01′52.9″E
26.	Colesdalen, lake shore Tenndammen	78°06′06.7″N, 15°01′51.4″E
27.	Colesdalen, lake shore Tenndammen	78°06′09.7″N, 15°02′07.2″E
28.	near Rusanov's house, 2nd seaside terrace	78°07′45.8″N, 14°59′40.9″E
29.	near Rusanov's house, stream	78°07′54.4″N, 14°59′47.9″E
30.	near Rusanov's house, stream	78°07′52.3″N, 15°00′18.7″E
31.	Coleselva river	78°06′27.6″N, 15°05′22.8″E
32.	Coleselva river	78°06′28.9″N, 15°06′24.8″E
33.	Coleselva river	78°06′45.5″N, 15°07′31.5″E
34.	Coleselva river, plateau near the Russekollen	78°06′56.5″N, 15°07′52.6″E
35.	road to Grumant, 2nd terrace	78°08′10.1″N, 14°59′22.5″E
36.	road to Grumant, 3rd terrace	78°08′08.0″N, 15°00′21.8″E
37.	road to Grumant	78°08′37.5″N, 15°03′11.7″E
38.	Colesdalen (Øvstedal *et al.* 2009, [2])	78°06′N, 15°03′E

Table 1. List of localities.

Results

As a result of this research, along with a summary of available herbarium data and literature, we have created a list of lichen species for the vicinity of Colesdalen. Today it includes 234 species. Of these, 112 species were identified in the study area for the first time, including ten species new to the Svalbard archipelago: *Arthonia granitophila*, *Ionaspis obtecta*, *Micarea denigrata*, *Poeltinula interjecta*, *Rhizocarpon infernulum*, *R. subgeminatum*, *Rinodina mniaroea* var. *cinnamomea*, *Sagedia zonata*, *Sarcogyne lapponica*. Notably, *Arthonia granitophila* and *Poeltinula interjecta* are reported here for the first time in the Arctic (Fig. 2A, B, D, E).

Additionally, the following 27 species are new to Nordenskiöld Land: *Alectoria gowardii*, *Amandinea cacuminum*, *Caloplaca stillicidiorum*, *Candelariella borealis*, *C. xanthostigma*, *Cladonia squamosa*, *Euopsis granatina*, *Hymenelia arctica*, *Hypogymnia austerodes*, *Lecanora orae-frigidae*, *Lecidella elaeochroma*, *Miriquidica nigroleprosa*, *Myriolecis torrida*, *Myriolecis zosterae* var. *palanderi*, *Peltigera extenuata*, *Peltigera praetextata*, *Placynthium asperellum*, *Polyblastia gothica*, *Porpidia crustulata*, *Protomicarea alpestris*, *Protothelenella sphinctrinoides*, *Rhizocarpon leptolepis*, *Rhizocarpon rittokense*, *Sagedia simoensis*, *Thelidium papulare*, *Thelignya lignyota*, *Xylographa parallela*. Furthermore, the following species were previously known only from the Colesdalen area: *Aspicilia supertegens*, *Lecanora formosa*, *Miriquidica deusta*, *Pertusaria sommerfeltii*, *Pyrenopsis furfurea* var. *terrigena*, *Thelenella sordidula*.

The following abbreviations and notation are in the list:
* – new to Colesbukta; ** – new to Nordenskiöld Land; ! – new to Svalbard

The list of species

**Acarospora fuscata* (Schrad.) Th. Fr. – 4, 20, 25, 36, on stone, on treated wood.
**Acarospora privigna* (Ach.) A. Scneid. – 11, 18, 29, on stone.
**Acarospora sinopica* (Wahlenb.) Körb. – 14, 22, on stone.
**Acarospora veronensis* A. Massal. – 21, on stone.
**Adelolecia kolaënsis* (Nyl.) Hertel & Rambold – 18, on stone.
***Alectoria gowardii* Lumbsch – 14, stone. Previously reported from Nordaustlandet – Innvika Bay (Konoreva and Chesnokov 2021), Barentsøya – Frankenhalvøya Peninsula (Konoreva and Chesnokov 2022) and Prins Karls Forland – among Thomsonfjella and Conquerorfjellet (Konoreva and Chesnokov 2023).
Alectoria nigricans (Ach.) Nyl. – 5, 14, 30, 32, 38, on mosses, on soil.
Allantoparmelia alpicola (Th. Fr.) Essl. – 4, 10, 30, on stone.
***Amandinea cacuminum* (Th. Fr.) H. Mayrhofer & Sheard – 14, 36, on wood, on stone.
**Amandinea punctata* (Hoffm.) Coppins & Scheid. – 4, 9, 12, 16, 17, 20, 24, 25, 26, 28, on wood, on driftwood, on stone, on branches of *Betula nana*, on treated wood.
Amundsenia approximata (Lynge) Søchting et al. – 10, on stone. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
**Arctomia delicatula* Th. Fr. – 32, on soil.
!*Arthonia granitophila* Th. Fr. (Fig. 2A, B) – 5, on stone. New to Arctic. This species has rounded to somewhat elongate apothecia, 0.1–0.3 mm in diam., true exciple well-developed, often found in shaded habitats on silicate rocks (Smith et al. 2009). Until recently, the species belonged to the genus *Melaspilea* Nyl., but phylogenetic analyses place the species in the Arthoniaceae (Frisch et al. 2014). It is a widely distributed species in Europe, but rarely reported (Smith et al. 2009, Liška 2010, Vondrák et al. 2010, Roux 2012, Westberg et al. 2021). This is the first time it has been reported for the Arctic.

**Arthrorhaphis alpina* (Schaer.) R. Sant. – 4, 29, 30, on soil.
Arthrorhaphis citrinella (Ach.) Poelt – 30, 31, 32, 38, on soil.
Aspicilia aliena (Zahlbr.) Oxner – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Aspicilia arctica (Lynge) Oxner – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Aspicilia supertegens Arnold – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
**Bacidina subfuscula* (Nyl.) S. Ekman – 2, on soil.
**Baeomyces carneus* Flörke – 27, 34, on soil. Rare in Svalbard. Most of the species finds belong to Nordenskiöld Land (Urbanavichene and Koroleva 2008, Øvstedal et al. 2009, Zhurbenko and Brackel 2013) and was once reported for Nordaustlandet (Konoreva and Chesnokov 2021).
Baeomyces rufus (Huds.) Rebent. – 2, 12, 34, on soil.
Biatora cuprea (Sommerf.) Fr. – 9, 38, on soil. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Biatora ementiens (Nyl.) Printzen – 38, on soil. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
**Biatora subduplex* (Nyl.) Räsänen ex Printzen – 5, 6, 9, 10, 13, 17, 25, 28, 29, 31, on soil, on wood.
**Blastenia ammiospila* (Wahlenb.) Arup et al. – 3, 24, 28, 31, on soil.
Brodoa oroarctica (Krog) Goward – 30, on soil. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
Bryocaulon divergens (Ach.) Kärnefelt – 14, on soil. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
**Bryonora castanea* (Hepp) Poelt – 34, on soil.
Bryonora septentrionalis Holt.-Hartw. – 27, 38, on soil.
Bryoplaca jungermanniae (Vahl) Søchting et al. – 4, 38, on soil.
Bryoplaca tetraspora (Nyl.) Søchting et al. – 2, 17, 25, 28, 31, 38, on plant debris, on soil, on mosses.
**Bryostigma lapidicola* (Taylor) S. Y. Kondr. & J.-S. Hur – 10, 17, 29, on limestone, on soil.
Buellia aethalea (Ach.) Th. Fr. – 16, 36, 38, on stone.
Buellia insularis Øvstedal – 38, on thallus *Pannaria hookeri* and *Vestergrenopsis* spp. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Buellia leptocline (Flot.) Körb. – 38, on perpendicular to overhanging, siliceous rock. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
**Buellia vilis* Th. Fr. – 17, on stone.
**Caloplaca caesiorufella* (Nyl.) Zahlbr. – 14, 34, on wood, on soil.
***Caloplaca stillicidiorum* (Vahl) Lynge – 16, 20, 24, 26, on soil, on wood, on treated wood. Rare in Svalbard. A poorly studied species. Reliably known locations are located on Barentsøya (Konoreva and Chesnokov 2022), Prins Karls Forland (Konoreva and Chesnokov 2023) and Nordaustlandet (Konoreva et al. 2024). Probably widely distributed throughout Svalbard and common, but is often confused with *Caloplaca cerina* (Hedw.) Th. Fr. So *Caloplaca cerina* grows on the bark of trees and shrubs, and *C. stillicidiorum* s. lat. growing on or near the ground on various substrata such as mosses, soil, plant debris, horns, bones and driftwood (Šoun et al. 2011).
**Calvitimela aglaea* (Sommerf.) Hafellner – 4, 25, on stone.
**Calvitimela melaleuca* (Sommerf.) M. P. Andreev – 4, on stone.

**Candelariella aurella* (Hoffm.) Zahlbr. – 11, on stone.
***Candelariella borealis* M. Westb. – 4, 10, 16, 30, 31, on soil. Rare in Svalbard. Previously the species was reported from several localities in Nordaustlandet (Konoreva et al. 2019, 2024, Konoreva and Chesnokov 2021) and Barentsøya (Konoreva and Chesnokov 2022).
Candelariella vitellina (Hoffm.) Müll. Arg. – 4, 5, 10, 14, 20, 21, 22, 25, 26, 28, 30, 36, on limestone, on driftwood, on wood, on stone, on treated wood.
**Candelariella xanthostigma* (Ach.) Lettau – 26, on driftwood. Previously reported from Horsund (Nowak 1965), Albert I Land – Bockfjorden (Hafellner 1982), Amsterdamøya (Øvstedal et al. 2009), Ny-Friesland – foothill of Mt. Heimdalkampen[2] and Nordaustlandet – Damflya (Konoreva et al. 2019), Storøya (Lynge 1939).
**Catapyrenium daedaleum* (Kremp.) Stein – 28, on soil.
**Cetraria aculeata* (Schreb.) Fr. – 9, 12, 17, 30, on mosses, on soil.
**Cetraria ericetorum* Opiz – 4, 28, 31, on soil.
Cetraria islandica (L.) Ach. – 4, 13, 25, 29, 30, 31, 32, 37, on soil.
**Cetraria muricata* (Ach.) Eckfeldt – 28, on plant debris.
Cetrariella delisei (Bory ex Schaer.) Kärnefelt & A. Thell – 9, 12, 27, 29, 37, on soil.
Cladonia amaurocraea (Flörke) Schaer. – 27, 28, 30, on soil.
Cladonia coccifera (L.) Willd. – 4, 17, 18, 27, 28, 29, 30, on soil.
Cladonia gracilis (L.) Willd. – 4, 8, 12, 13, 18, 23, 25, 27, 29, 33, 37, on wood, on soil.
Cladonia mitis Sandst. – 2, 9, 29, 37, on soil.
**Cladonia pocillum* (Ach.) Grognot – 21, on soil.
Cladonia pyxidata (L.) Hoffm. – 2, 4, 8, 10, 14, 17, 18, 25, 31, on soil, on wood.
***Cladonia squamosa* Hoffm. – 37, on soil.
Diploschistes muscorum (Scop.) R. Sant. – 21, on soil. Rare on Svalbard. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018) and Blomesletta (Øvstedal et al. 2009).
**Eiglera flavida* (Hepp) Hafellner – 1, 29, on stone, on concrete.
***Euopsis granatina* (Sommerf.) Nyl. – 9, 29, on stone. Rare on Svalbard. Previously reported from Albert I Land – Kobbefjorden (Øvstedal et al. 2009), Bockfjorden (Elvebakk and Hertel 1996) and Prins Karls Forland (Konoreva and Chesnokov 2023).
**Euopsis pulvinata* (Schaer.) Vain. – 29, on stone.
**Farnoldia jurana* (Schaer.) Hertel – 23, on limestone.
Flavocetraria nivalis (L.) Kärnefelt & A. Thell – 15, on soil among mosses. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
***Hymenelia arctica* (Lynge) Lutzoni – 9, 18, on stone.
***Hypogymnia austerodes* (Nyl.) Räsänen – 13, on stone.
!*Ionaspis obtecta* (Vain.) R. Sant. (Fig. 2C) – 9, on stone. The species is characterized by cracked-areolate, deep rust-red, matt thallus and abundant, ± sessile apothecia with thick dark rusty to black exciple and pale red disc (Smith et al. 2009). Thanks to its appearance it is easily distinguished from other species *Ionaspis* and *Hymenelia*. The closest locations of the species in the Arctic are known from Norway and the Murmansk Region (Kristinsson et al. 2010).
**Japewia tornoënsis* (Nyl.) Tønsberg – 9, 21, 23, on wood, on driftwood.
Lambiella impavida (Th. Fr.) M. Westb. & Resl – 38, on stone. Previously reported for the Colesbukta area as *Rimularia impavida* (Th. Fr.) Hertel & Rambold (Øvstedal et al. 2009).
Lambiella insularis (Nyl.) T. Sprib. – 38, on stone. Previously reported for the Colesbukta area as *Rimularia insularis* (Nyl.) Rambold & Hertel (Øvstedal et al. 2009).

Lecanora atrosulphurea (Wahlenb.) Ach. – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Lecanora bicincta Ramond – 11, 12, 16, 28, 29, 38, on stone. Rare on Svalbard. Previously reported for the Nordenskiöld Land – Colesbukta area (Øvstedal et al. 2009), Dickson Land – Pyramiden Settlement (Konoreva 2011a) and Nordaustlandet (Konoreva et al. 2024).
Lecanora cenisia Ach. – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
**Lecanora epibryon* (Ach.) Ach. – 21, on soil.
Lecanora formosa (Bagl. & Carestia) Knoph & Leuckert (=*Lecidea tuberculifera* H. Magn.) – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Lecanora intricata (Ach.) Ach. – 14, 17, 28, on stone.
***Lecanora orae-frigidae* R. Sant. – 9, on wood.
Lecanora polytropa (Ehrh. ex Hoffm.) Rabenh. – 4, 5, 14, 15, 18, 20, 21, 22, 23, 25, 26, 28, 30, 36, on stone, driftwood, on treated wood.
Lecanora rupicola (L.) Zahlbr. – 30, 38, on stone.
Lecanora swartzii (Ach.) Ach. – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
**Lecidea atrobrunnea* (Ramond ex Lam. & DC.) Schaer. – 14, 25, on stone.
**Lecidea auriculata* Th. Fr. – 4, 18, 36, on stone.
Lecidea confluens (Weber) Ach. – 38, on stone. Previously reported for the Colesbukta area[2].
**Lecidea lapicida* var. *pantherina* Ach. – 10, 29, 36, on stone.
**Lecidea praenubila* Nyl. – 14, stone.
Lecidea silacea (Hoffm.) Ach. – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
**Lecidea tessellata* Flörke – 14, stone.
**Lecidella effugiens* (Nyl.) Knoph & Hertel – 14, stone. Rare in Svalbard. Only reported in Nordenskiöld Land, mainly from Isfjorden (Øvstedal et al. 2009) and once reported for Sveagruva (Elvebakk and Hertel 1996).
***Lecidella elaeochroma* (Ach.) M. Choisy – 9, on wood.
**Lecidella euphorea* (Flörke) Hertel – 6, 20, 26, on driftwood, on treated wood.
Leciophysma finmarkicum Th. Fr. – 38, on soil. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
**Lendemeriella exsecuta* (Nyl.) S.Y. Kondr. – 4, on stone.
**Lendemeriella tornoensis* (H. Magn.) S. Y. Kondr. – 21, on soil.
Lepraria gelida Tønsberg & Zhurb. – 5, 13, 21, on soil. TLC: alectorialic and porphyrilic acids.
Lepraria lobificans Nyl. – 38, on soil.
Lepraria neglecta (Nyl.) Lettau – 13, 18, 31, on soil.
Leptogium saturninum (Dicks.) Nyl. – 21, on mosses over rocks. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
Lichenomphalia alpina (Britzelm.) Redhead et al. – 12, on soil. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
Lichenomphalia umbellifera (L.:Fr.) Redhead et al. – 2, 35, on soil among mosses. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
Lobaria linita (Ach.) Rabenh. – 2, 12, 15, 17, 27, 29, 34, on soil, on mosses.
**Lopadium coralloideum* (Nyl.) Lynge – 22, 27, 28, 31, 32, 34, on soil.
**Lopadium pezizoideum* (Ach.) Körb. – 13, 28, 29, 30, 31, on soil.

Megalaria jemtlandica (Th. Fr. & Almq.) Fryday – 38, on soil. Previously reported for the Colesbukta area[2].
**Megaspora verrucosa* (Ach.) Hafellner & V. Wirth – 10, 17, 20, 23, 31, 33, on soil, on mosses, on treated bridge timber.
Melanelia hepatizon (Ach.) A. Thell – 4, 18, 28, 31, 32, on soil and stones.
!*Micarea denigrata* (Fr.) Hedl. – 15, on treated wood. The specimen is characterized by dark convex apothecia, scattered areoles, the presence of gyrophoric acid, a light hypothecium and 0-1-septate spores. A common and widespread species in the boreal zone. Typically found in forest communities. In addition, *M. denigrata* is a very successful primary colonizer of treated wood. It can often be found on gates, fence posts and rails, garden furniture, picnic tables and seats, window frames of greenhouses, wooden roof tiles (shingles), telegraph poles, *etc*. (Coppins 1983).
**Micarea incrassata* Hedl. – 8, 18, 27, on soil.
Miriquidica deusta (Stenh.) Hertel & Rambold – 38, on stone. It is known only from Colesbukta area (Øvstedal et al. 2009).
**Miriquidica griseoatra* (Flot.) Hertel & Rambold – 16, on stone.
***Miriquidica nigroleprosa* (Vain.) Hertel & Rambold – 4, 25, on stone.
Miriquidica picea Øvstedal – 38, on stone. Previously known from Colesbukta and Nordaustlandet (Øvstedal et al. 2009).
Montanelia disjuncta (Erichsen) Divakar et al. – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Myriolecis dispersa (Pers.) Śliwa et al. – 21, 26, on limestone. Sørkapp, but probably overlooked (Øvstedal et al. 2009).
***Myriolecis torrida* (Vain.) Śliwa et al. – 1, on concrete surface.
Myriolecis thuleana (Poelt) Śliwa et al. – 20, on the wood of bridge. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
**Myriolecis zosterae* (Ach.) Śliwa et al. – 2, 20, on wood.
***Myriolecis zosterae* var. *palanderi* (Vain.) Śliwa – 20, on treated wood and bridge timber. Previously reported for the Barentsøya (Konoreva and Chesnokov 2022) and Nordaustlandet (Konoreva et al. 2024). Probably widespread on Svalbard and in the Arctic, but not well understood to date (Śliwa 2007). Rare.
Myriospora molybdina (Wahlenb.) M. Westb. – 21, on stone.
**Myriospora smaragdula* (Wahlenb. ex Ach.) Nägeli ex Uloth – 21, on stone.
Nephroma arcticum (L.) Torss. – 28, on mosses.
Nephroma expallidum (Nyl.) Nyl. – 4, 17, 28, 34, 38, on plant debris, on soil.
Ochrolechia androgyna (Hoffm.) Arnold – 38, on mosses. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Ochrolechia frigida (Sw.) Lynge – 2, 4–6, 8–10, 12, 14, 16–18, 21–25, 27–31, 34, on mosses, on wood, on soil.
Ochrolechia grimmiae Lynge – 30, 31, on dead *Racomitrium lanuginosum* (Hedw.) Brid.
**Orphniospora moriopsis* (A. Massal.) D. Hawksw. – 4, on stone.
**Pannaria hookeri* (Borrer ex Sm.) Nyl. – 30, on stone, on soil.
Parmelia omphalodes (L.) Ach. – 14, 31, on stone and wood. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
Parmelia saxatilis (L.) Ach. – 14, 28, on stone, on mosses.
Parmelia skultii Hale – 14, 31, on mosses.
**Parvoplaca tiroliensis* (Zahlbr.) Arup et al. – 2, 5, 9, 16, 24, 28, 30, 31, 33, on mosses, on plant debris, on soil, on branches of *Betula nana*, on dead thallus of *Peltigera praetextata*, on *Salix* sp.

Peltigera aphthosa (L.) Willd. – 2, 21, 25, 38, on soil.
Peltigera canina (L.) Willd. – 2, 5, 8, 12, 27, 29, 34, on soil, on mosses.
Peltigera didactyla (With.) J. R. Laundon – 8, 16, on soil.
****Peltigera extenuata** (Nyl. ex Vain.) Lojka – 2, on soil. Rare in Svalbard. Previously reported for Oskar II Land – Zeppelinfjellet (Breuss 2017), Nordaustlandet – Floraberget (Czernyadjeva et al. 2020), Barentsøya – Frankenhalvøya (Konoreva and Chesnokov 2022).
Peltigera lepidophora (Nyl. ex Vain.) Bitter – 38, on soil. Previously reported for the Colesbukta area[2].
Peltigera leucophlebia (Nyl.) Gyeln. – 2, 17, 21, 35, on mosses and soil.
***Peltigera lyngei** Gyeln. – 2, 8, 22, 29, 33, on soil.
Peltigera malacea (Ach.) Funck – 2, 4, 8, 17, 28, 29, 31, on soil.
****Peltigera praetextata** (Flörke ex Sommerf.) Zopf – 16, on soil. Rare in Svalbard. Previously reported for Sørkapp Land (Elvebakk and Hertel 1996), Oskar II Land – Brøggerhalvøya[2].
Peltigera rufescens (Weiss) Humb. – 5, 25, on soil.
Peltigera scabrosa Th. Fr. – 8, 27, 33, 38, on soil.
Peltigera scabrosella Holt.-Hartw. – 38, on soil. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Peltigera venosa (L.) Hoffm. – 13, 15, on soil.
***Pertusaria geminipara** (Th. Fr.) C. Knight ex Brodo – 12, 13, 18, 25, 27, 29, 30, 31, 34, on soil, on mosses.
Pertusaria oculata (Dicks.) Th. Fr. – 8, 10, 23, 29, 30, on soil.
Pertusaria sommerfeltii (Flörke ex Sommerf.) Fr. – 38, on dead twig of *Betula nana*. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Phaeophyscia sciastra (Ach.) Moberg – 15, on stone. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
Phaeorrhiza nimbosa (Fr.) H. Mayrhofer & Poelt – 30, on soil. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
***Physcia caesia** (Hoffm.) Fürnr. – 21, 24, on stone.
Physcia dubia (Hoffm.) Lettau – 2, 20, 22, 26, on driftwood, on treated bridge timber.
Physconia muscigena (Ach.) Poelt – 5, 14, 28, 38, on plant debris, on mosses.
Pilophorus cereolus (Ach.) Hellb. – 37, on stone.
Pilophorus dovrensis (Nyl.) Timdal et al. – 2, 4, 19, 30, 34, 38, on soil.
Placopsis gelida (L.) Linds. – 2, 37, on stone.
****Placynthium asperellum** (Ach.) Trevis. – 10, 29, 30, on limestone, on stone.
!*Poeltinula interjecta* (Leight.) Hafellner (Fig. 2 D, E) – 14, on stone. The species is characterized by lirellate, simple or forked to subgyrose-contorted apothecia, a scaly pale green-grey thallus, and 1-septate colourless ascospores (old ascospores are brown) narrowed at the septum, grows on vertical surfaces of silicate rocks (Smith et al. 2009). Widely distributed in Europe and North America. This is the first time it has been reported for the Arctic.
****Polyblastia gothica** Th. Fr. – 32, on soil. Rare in Svalbard. Mainly known from Nordaustlandet (Konoreva et al. 2024) and Prins Karls Forland (Konoreva and Chesnokov 2023). Also the species is mentioned for Liefdefjorden[2].
Polycauliona candelaria (L.) Frödén et al. – 20, 21, 26, on stone.
****Porpidia crustulata** (Ach.) Hertel & Knoph – 7, 12, on stone. Rare in Svalbard. Previously reported from Sørkapp Land (Elvebakk and Hertel 1996).
Porpidia flavicunda (Ach.) Gowan – 9, on stone.

**Porpidia hydrophila* (Fr.) Hertel & A. J. Schwab – 18, on stone. Rare in Svalbard. Previously reported for the Adventdalen[2].
Porpidia melinodes (Körb.) Gowan & Ahti – 9, 10, 18, 28, 38, on stone.
Porpidia superba (Körb.) Hertel & Knoph – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
***Protomicarea alpestris* (Sommerf.) McCune – 30, on soil.
Protopannaria pezizoides (Weber) P. M. Jørg. & S. Ekman – 4, 9, 17, 18, 19, 27, 33, 34, on soil.
**Protoparmelia badia* (Hoffm.) Hafellner – 13, 16, 25, 30, 36, on stone.
**Protothelenella sphinctrinoidella* (Nyl.) H. Mayrhofer & Poelt – 8, 21, on soil.
***Protothelenella sphinctrinoides* (Nyl.) H. Mayrhofer & Poelt – 8, 9, on soil. Scatered in Svalbard.
Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw. – 10, 14, 17, 18, 29, on stone, on mosses.
Pseudephebe pubescens (L.) M. Choisy – 14, 18, on stones. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
Psoroma hypnorum (Vahl) Gray – 2, 3, 4, 5, 17, 24, 27, 28, 31, 32, 34, on soil.
**Psoroma tenue* var. *boreale* Henssen – 2, 9, 16, 31, on branches of *Betula nana*, on soil.
Pyrenopsis furfurea var. *terrigena* Th. Fr. – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
**Rhexophiale rhexoblephara* (Nyl.) Hellb. – 9, 28, on soil.
**Rhizocarpon anaperum* (Vain.) Vain. – 18, on stone.
Rhizocarpon atroflavescens Lynge – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
Rhizocarpon bolanderi (Tuck.) Herre – 38, on stone. Rare in Svalbard. The species is known from Colesbukta, Billefjorden (Øvstedal et al. 2009) and Nordaustlandet (Konoreva et al. 2024).
**Rhizocarpon badioatrum* (Flörke ex Spreng.) Th. Fr. – 23, 29, on stone, driftwood.
Rhizocarpon copelandii (Körb.) Th. Fr. – 10, 18, 38, on stone.
**Rhizocarpon expallescens* Th. Fr. – 18, on stone.
**Rhizocarpon ferax* H. Magn. – 5, 18, 31, on stone.
Rhizocarpon geminatum Körb. – 14, 26, 31, 38, on stone.
Rhizocarpon geographicum (L.) DC. – 4, 5, 10, 11, 14, 16, 18, 25, 26, 28, 29, 31, 36, 37, on stone.
**Rhizocarpon grande* (Flörke ex Flot.) Arnold – 5, 14, on stone.
**Rhizocarpon hochstetteri* (Körb.) Vain. – 26, 28, on stone.
!*Rhizocarpon infernulum* (Nyl.) Lynge – 18, on stone. The species belongs to the *Rhizocarpon hochstetteri*-group and is characterized by a thin, areolate, brown or grey thallus, black, flat, slightly convex apothecia, 0.3-0.4 mm in diameter, with a thick exciple (up to 30 μm), epihymenium usually with aeruginose to blue-black pigment and hyaline 1-septate ascospores (Fryday 2002). Morphologically very similar to *R. hochstetteri* from which it differs in the smaller size of its apothecia and ascospores (according to Fryday 2002) apothecia *R. hochstetteri* – 0.6-1.0(-1.2) mm in diam., *R. infernulum* – 0.3-0.4(-0.5) mm in diam.; ascospores *R. hochstetteri* – 21-24(-28) × (8.5-)10-12 μm, *R. infernulum* – 14-18(-19) × 7-8.5 μm). The species is currently known from Great Britain, Greenland and Bering Island (Fryday 2002). Apparently, the species is much more widespread in Arctic and is probably often confused with *R. hochstetteri*.
Rhizocarpon intermediellum Räsänen – 16, 38, on stone.
**Rhizocarpon jemtlandicum* Malme – 4, on stone.

****Rhizocarpon leptolepis** Anzi – 14, 31, on stone. Rare in Svalbard. Previously reported for the Barentsøya (Konoreva and Chesnokov 2022). Reported for the second time for Svalbard.
***Rhizocarpon reductum** Th. Fr. – 4, on stone.
****Rhizocarpon rittokense** (Hellb.) Th. Fr. – 18, on stone.
Rhizocarpon saanaense Räsänen – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
!*Rhizocarpon subgeminatum* Eitner – 28, on stone. The species belongs to the *Rhizocarpon obscuratum*-group (Fryday 2000) and is characterized by an areolate brown thallus and 2-spore asci with hyaline muriform ascospores (Ihlen 2004). It occurs in the slightly and markedly oceanic sections mainly in the nemoral and boreonemoral zones, occasionally in the southern boreal zone (Ihlen 2004, Smith et al. 2009).
Rhizocarpon viridiatrum (Wulfen) Körb. – 38, on stone. Reported only from the Colesbukta area[2].
Rhizoplaca melanophthalma (DC.) Leuckert & Poelt – 14, 20, 21, 26, on stone, wood.
Rinodina archaea (Ach.) Arnold – 38, on driftwood. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
***Rinodina calcigena** (Th. Fr.) Lynge – 29, on stone.
!*Rinodina mniaroea* var. *cinnamomea* Th. Fr. – 31, on soil. This variety is clearly distinguished from *Rinodina mniaroea* var. *mniaroea* (Ach.) Körb. by the presence of yellow to orange medulla (anthraquinones) (Mayrhofer and Moberg 2002). *Rinodina mniaroea* is a common species in Svalbard (Øvstedal et al. 2009).
***Rinodina olivaceobrunnea** C. W. Dodge & G. E. Baker – 2, 9, 15, 16, 24, 25, 27, 28, 30, 31, 33, on plant debris, on wood, on branches of *Betula nana*, on soil, on *Salix* sp., on mosses.
***Rinodina turfacea** (Wahlenb.) Körb. – 6, 9, 14, 16, 17, 21, 32, on wood, on branches of *Betula nana*, on soil.
***Rostania ceranisca** (Nyl.) Otálora et al. – 5, 29, on soil.
Rusavskia elegans (Link) S. Y. Kondr. & Kärnefelt – 1, 2, 4, 14, 15, 20, on treated bridge timber, on concrete.
Rusavskia sorediata (Vain.) S.Y. Kondr. & Kärnefelt – 26, 38, on stone.
****Sagedia simoensis** (Räsänen) A. Nordin et al. (Fig. 2F) – 25, on stone. Rare in Svalbard. Previously reported for the Heer Land – Sydøstkysten (Øvstedal et al. 2009).
!*Sagedia zonata* Ach. (Fig. 2G) – 18, 28, on stone. The species is morphologically variable, as indicated by the large number of synonyms (Nordin et al. 2007). It is characterized by a grayish areolate thallus, sometimes radially zonate on the periphery, and lecideine apothecia with a blackish rim. The species is a widespread in high mountains of the South and North Europe (*e.g.* Roux 2012, Nimis et al. 2018, Westberg et al. 2021), Asia (Kinalioglu and Aptroot 2017, Paukov and Alverdiyeva 2024) and Russia (Urbanavichus 2010).
!*Sarcogyne lapponica* (Ach. ex Schaer.) K. Knudsen & Kocourk. (Fig. 2H, I) – 14, 20, on stone, on driftwood, on treated wood. The species is characterized by a dark red-brown, fissured-areolate to scaly thallus and numerous apothecia immersed in the thallus with an uneven warty disc and a crenulated margin. It grows on silicate rocks in open areas, and can grow on wood (Smith et al. 2009). The specimen found on the rock has a weak thallus under the apothecia, whereas the specimens from the wood have a well-developed squamous thallus. For a long time the species was considered within the genus *Polysporina*, but after the revision of lichenicolous *Polysporina* was placed in

Sarcogyne (Knudsen and Kocourková 2008). Currently the species is known from northern Europe (Knudsen and Kocourková 2008, Westberg et al. 2021).
**Schaereria fuscocinerea* (Nyl.) Clauzade & Cl. Roux – 29, on stone.
Solorina bispora Nyl. – 32, on soil. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
Solorina crocea (L.) Ach. – 4, 18, 23, 27, 33, 34, 37, on soil.
**Solorina spongiosa* (Ach.) Anzi – 32, on soil. The species grew together with crustose lichen species such as *Polyblastia gothica*, *Psoroma hypnorum* and *Rinodina turfacea*.
Sphaerophorus fragilis (L.) Pers. – 14, on stone. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2018).
Sphaerophorus globosus (Huds.) Vain. – 14, 27, 30, on mosses, on soil.
Sporastatia testudinea (Ach.) A. Massal. – 3, 4, 30, 36, 38, on stone.
Stereocaulon alpinum Laurer – 2, 4, 8, 9, 12, 13, 15, 16, 17, 18, 29, 30, 32, 34, 36, 37, on mosses, on soil.
**Stereocaulon arcticum* Lynge – 18, 37, on soil. TLC: atranorin and stictic acid. Morphologically, the species is very similar to *Stereocaulon arenarium* (L. I. Savicz) I. M. Lamb, from which it differs in the composition of secondary metabolites: *S. arenarium* contains atranorin and porphyrilic acid (Pd+ pale yellow or Pd–), *S. arcticum* – atranorin, stictic acid, and small amounts of norstictic acid (Pd+ orange) (Lamb 1977). The closest known locations in the Arctic are Jan Mayen and Greenland (Lamb 1972, 1977).
**Stereocaulon botryosum* Ach. – 9, 18, 30, on soil.
**Stereocaulon glareosum* (Savicz) H. Magn. – 18, 19, 34, on soil.
**Stereocaulon rivulorum* H. Magn. – 2, 5, 8, 9, 10, 26, 34, on soil.
Stictis radiata (L.) Pers. – 16, 31, on branches of *Betula nana*, on *Salix* sp. Rare in Svalbard. Previously reported for the Colesbukta area (Konoreva and Chesnokov 2024).
Tephromela atra (Huds.) Hafellner – 12, 14, 25, 38, on stone.
Tetramelas insignis (Nägeli ex Hepp) Kalb – 2, 3, 4, 6, 10, 12, 14, 15, 17, 22, 25, 26, 27, 28, 33, 34, 38, on soil, on driftwood, on wood, on mosses.
Thamnolia vermicularis (Sw.) Schaer. – 4, 25, 29, 30, 31, on soil, on mosses.
Thelenella sordidula (Th. Fr.) H. Mayrhofer – 38, on stone. Previously reported for the Colesbukta area (Øvstedal et al. 2009).
***Thelidium papulare* (Fr.) Arnold – 2, on stone.
***Thelignya lignyota* (Wahlenb.) P. M. Jørg. & Henssen (Fig. 2J) – 11, on stone. Rare in Svalbard. The species was known from Hornsund, Sørkapp Land (Elvebakk and Hertel 1996) and Kjellstrømdalen (Øvstedal et al. 2009).
**Toniniopsis bagliettoana* (A. Massal. & De Not.) Kistenich & Timdal – 29, 31, on soil.
Tremolecia atrata (Ach.) Hertel – 4, 9, 14, 18, 22, 25, 26, 28, 31, on stone.
Umbilicaria cylindrica (L.) Delise ex Duby – 10, 13, 15, 21, on stone.
Umbilicaria hyperborea (Ach.) Hoffm. – 9, 10, 27, 30, 37, on stone.
**Umbilicaria lyngei* Schol. – 21, on stone.
Umbilicaria proboscidea (L.) Schrad. – 21, 30, 31, 32, 37, on stone.
Umbilicaria torrefacta (Lightf.) Schrad. – 4, 12, 28, on stone.
Usnea sphacelata R. Br. – 4, 14, 16, 18, 29, 30, 31, on stone.
Xanthomendoza borealis (R.Sant. & Poelt) Søchting et al. – 14, 21, on wood.
***Xylographa parallela* (Ach.:Fr.) Fr. – 15, on wood. Rare in Svalbard. The species was previously reported from Trygghamna (Konoreva 2011b).

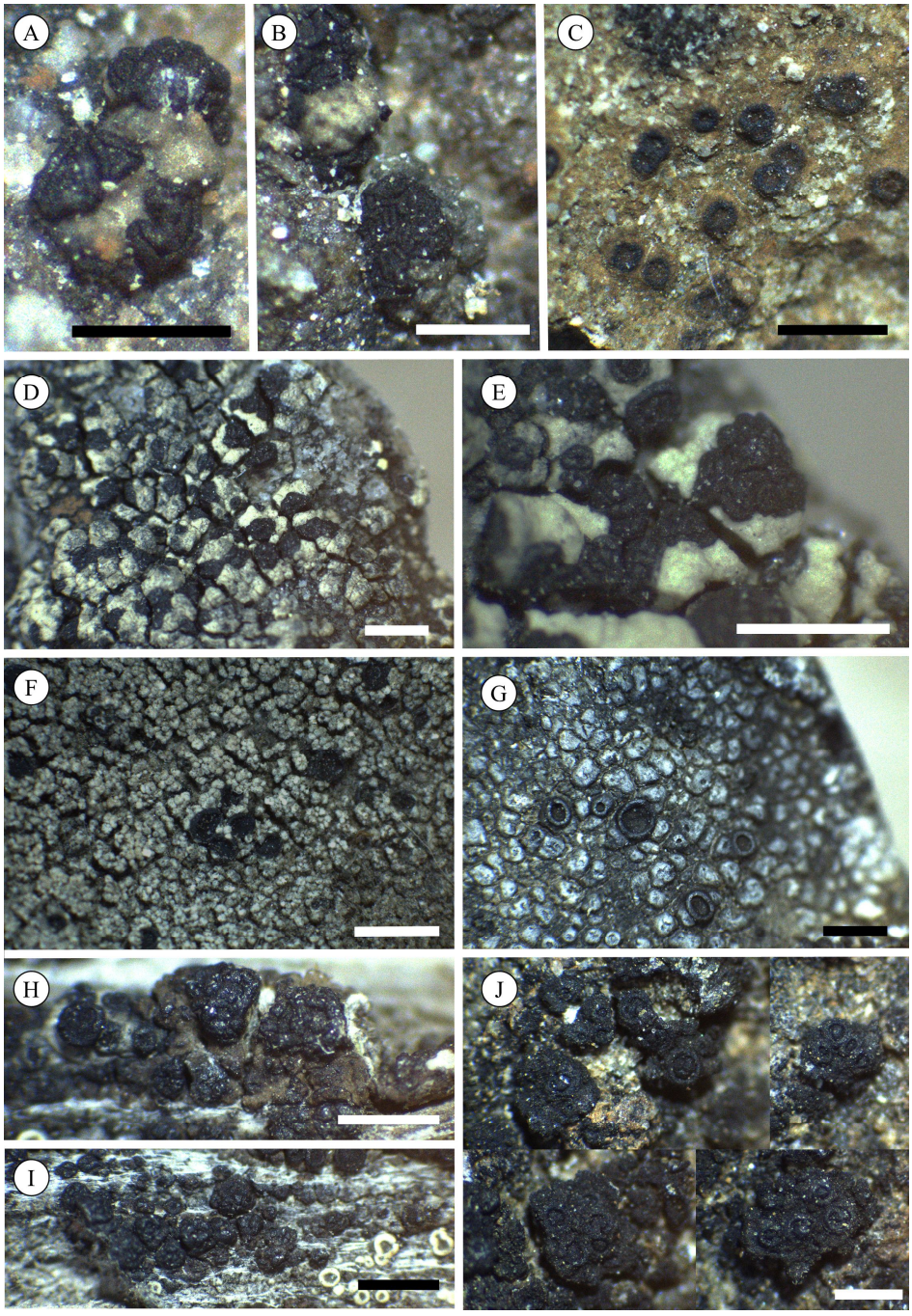


Fig. 2. New and rare species from the vicinity of Colesdalen: A, B – *Arthonia granitophila*, C – *Ionaspis obtecta*, D, E – *Poeltinula interjecta*, F – *Sagedia simoensis*, G – *Sagedia zonata*, H, I – *Sarcogyne lapponica*, J – *Thelignya lignyota*. Scale bar: A, B – 0.6 mm, C–E, G–I – 1 mm, F – 2 mm, J – 0.7 mm.

Discussion

Of the species identified, 124 are rare or scattered across the archipelago. The significant number of species known only from the study area or from a few localities on Svalbard (approximately half of the identified species) allows us to obtain confirmation of the assumptions about the high specificity of habitat conditions. For example, *Micarea denigrata*, discovered for the first time on the Svalbard archipelago, is generally not typical for the Arctic. According to the Panarctic Lichen Checklist (Kristinsson et al. 2010), this species is known in the Arctic from only three localities: the Kola Peninsula (where it is found in the forest zone), Central Canadian Arctic, and West Greenland – regions that are not primarily tundra areas. The main range of *Micarea denigrata* lies outside the Arctic, where it is widely represented in the forest and forest-steppe zone. The presence of suitable substrates (such as wood) and favorable microhabitat conditions contribute to these local habitats outside its main range. Similar distribution features characterize another species discussed in our earlier paper, *Stictis radiata* (Konoreva and Chesnokov 2024). The high humidity of the area, along with suitable substrate (decaying wood and plant debris of small shrubs), allows lichen species typical for forest ecosystems to extend their range further North into the Arctic.

The considerable humidity and mildness of the microclimatic conditions in the vicinity of Colesdalen are confirmed by the presence among rare and scattered species of a large number of foliose and fruticose lichens, preferring damp habitats. Notable examples include *Cladonia mitis*, *Leptogium saturninum*, *Nephroma arcticum*, *Peltigera collina*, *P. didactyla*, *P. lepidophora*, *P. leucophlebia*, *P. lyngei*, *P. malacea*, *P. praetextata*, *P. scabrosella*, *Pilophorus dovrensis*. Many of these species have their main range outside the Arctic, being widespread in the boreal zone but scattered within Arctic regions. Among the rare crustose species, many are difficult to identify and poorly visible (especially in the field). Their rarity is often due to insufficient study, for example, *Acarospora privigna*, *Aspicilia arctica*, *Caloplaca caesiorufella*, *Hymenelia arctica*, *Lecidea confluens*, *Myriolecis dispersa*, *M. torrida*, *Rhizocarpon copelandii*, *R. leptolepis*, *R. reductum*, *Thelignya ligniota* and others. Additionally, there is a group of crustose species confined to waterlogged communities characterized by a high density of small shrubs and plant debris, as well as substrates containing available calcium. This group includes species such as *Catapyrenium daedaleum*, *Diploschistes muscorum*, *Euopsis granatina*, *E. pulvinata*, *Lecanora bicincta*, *Phaerrhiza nimbosa*, *Psoroma tenue* var. *boreale*, *etc*.

Thus, the species diversity of lichens in the Colesdalen area was formed under the influence of specific local conditions, as indirectly indicated by geobotanists (*e.g.* Brosø 1997, Engelskjøn and Spjelkavik 1999, Alsos et al. 2003, 2004), noting the atypical vegetation of this area compared to neighboring territories, including increased moisture and, consequently, a significant amount of plant debris, rotting wood from former settlement structures and mining activities, as well as driftwood. Another important factor is the presence of accessible calcium in the soil and rocks, which makes it possible for calciphilous species to settle here. These conditions are suitable for the northward expansion of lichen species whose main range is outside the Arctic, as well as some of boreal species. However, this does not necessarily indicate a general trend towards the penetration of boreal species into Arctic communities. The statement is valid only for small areas, “hot spots”, formed under specific air temperature and relative air humidity, and decaying organic matter

availability. There are several such localities on Svalbard, that require more detailed study, since this allows us to supplement the biota of the archipelago, as well as to identify species that are found on Svalbard far beyond their main range. We previously reported the discovery of *Sarcosagium campestre* (Fr.) Poetsch & Schied. near the Pyramiden settlement (Konoreva 2014). This species settled on a specific substrate (a compost heap in a barnyard), and such specific micro-habitat conditions allowed this boreal species to exist here far beyond its main range. However, over a long period of research, we have never had the opportunity to discover this species outside of a single and specific locality created by man. The same is true for some of the other species we present in this paper. The combination of natural micro-conditions and those related to anthropogenic acivities over the period of the settlement′s existence and the mine′s operation make it possible for a number of species to exist even though we usually do not encounter them in the Arctic or do it just rarely. For lichens, this highlights the importance of microenvironments and the availability of suitable substrate. Svalbard is very diverse in terms of climatic microconditions, vegetation cover, and geology. All this is due to the complex history of the geological formation of the archipelago, the uneven influence of the Gulf Stream on its territory, its significant length from north to south, its intricately indented coastline and the diversity of its relief. The influence of various factors (substrate, altitude, anthropogenic impact, distance from glaciers, humidity, *etc*.) on the distribution of lichens has been repeatedly noted in our paper for other regions of the Arctic (*e.g.* Konoreva 2014, Evdokimov et al. 2022, Kholod and Konoreva 2022, Kholod et al. 2024, Konoreva and Chesnokov 2024). Here we want to emphasize the importance of micro-conditions and the presence of substrate for lichens, as well as the need for careful study of individual areas of the archipelago, including by lichenologists, given the enormous diversity of its natural conditions.

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[2] Svalbard Lichen Database (SLD)
http://www.nhm2.uio.no/botanisk/nxd/sval_L/sld_e.htm

[3] TopoSvalbard
https://toposvalbard.npolar.no/

Supplementary Materials

No.	Localities	Coordinate	Altitude	Collection date
1.	the vicinity of the Kolsbey settlement, grass tundra	78°07′15.9″N, 15°00′49.3″E	23 m	29 VII 2009
2.	the vicinity of the Kolsbey settlement, remains of wooden and concrete structures on the coast	78°06′44.8″N, 15°01′59.8″E	11 m	29 VII 2009
3.	the vicinity of the Kolsbey settlement, moss-horsetail swamp	78°06′34.6″N, 15°03′34.3″E	74 m	29 VII 2009
4.	the vicinity of the Kolsbey settlement, stone scattering among the willow-moss tundra	78°06′33.4″N, 15°04′43.3″E	165 m	29 VII 2009
5.	the vicinity of the Kolsbey settlement, top of the hill, moss-grass tundra	78°06′39.1″N, 15°04′57.2″E	190 m	29 VII 2009
6.	the vicinity of the Kolsbey settlement, a piece of wood near Rusanov's house	78°07′52.6″N, 14°59′15.4″E	17 m	29 VII 2009
7.	Colesdalen, moss-sedge bog by the river	78°06′09.6″N, 15°06′52.3″E	35 m	30 VII 2009
8.	Colesdalen, moss-sedge bog on the other side of the river from settlement	78°05′32.3″N, 15°06′34.9″E	6 m	30 VII 2009
9.	Colesdalen, turfed stone scattering	78°04′47.1″N, 15°04′48.6″E	65 m	30 VII 2009
10.	Colesdalen, stone scattering	78°04′38.6″N, 15°05′39.0″E	58 m	30 VII 2009
11.	Colesdalen, rocks on the slope at the foot of the hill	78°04′31.6″N, 15°06′09.8″E	51 m	30 VII 2009
12.	road to Grumant, the 1st terrace, moss-willow tundra	78°08′16.6″N, 14°58′58.3″E	6 m	31 VII 2009
13.	road to Grumant, the 1st terrace, river canyon, wet rocks	78°08′22.6″N, 15°00′18.0″E	147 m	31 VII 2009
14.	road to Grumant, the 1st terrace, moss-grass-willow tundra on a slope	78°08′30.3″N, 14°59′37.4″E	40 m	31 VII 2009
15.	road to Grumant, the 1st terrace, remains of wooden structures	78°09′13.3″N, 15°00′34.6″E	19 m	31 VII 2009
16.	Colesdalen, slopes with *Betula nana*	78°06′26.2″N, 15°06′00.8″E	85 m	1 VIII 2009
17.	Colesdalen, moss-willow slope	78°06′38.7″N, 15°07′49.7″E	212 m	1 VIII 2009
18.	Colesdalen, stream canyon, wet rocks at base	78°06′46.2″N, 15°08′33.6″E	271 m	1 VIII 2009
19.	Colesdalen, abandoned road overgrown with sedges	78°06′35.8″N, 15°09′11.2″E	277 m	1 VIII 2009
20.	Kolsbey settlement, driftwood on the shore	78°07′07.7″N, 15°00′54.8″E	5 m	2 VIII 2009
21.	Grumant, near the coast, rocks with mosses and stone outcrops	78°10′36.0″N, 15°06′45.2″E	142 m	2 VIII 2015
22.	Grumant, sea shore, 2nd seaside terrace	78°10′36.2″N, 15°06′57.7″E	201 m	2 VIII 2015

23.	Grumant area, riverside	78°10′28.6″N, 15°06′35.2″E	122 m	2 VIII 2015
24.	the vicinity of the Kolsbey settlement, near the Coleselva estuary, swampy area	78°06′43.3″N, 15°01′31.5″E	46 m	5 VIII 2015
25.	Coleselva river floodplain, slope to the river, above the swamp, *Cassiope tetragona* on a slope among grass and moss areas	78°06′35.7″N, 15°01′52.9″E	17 m	5 VIII 2015
26.	Colesdalen, lake shore Tenndammen, willow-moss community	78°06′06.7″N, 15°01′51.4″E	11 m	5 VIII 2015
27.	Colesdalen, lake shore Tenndammen, spots with moss and willow	78°06′09.7″N, 15°02′07.2″E	10 m	5 VIII 2015
28.	the vicinity of the Kolsbey settlement, road to Grumant, near Rusanov′s house, 2nd seaside terrace, community with *Betula nana*, *Dryas*, polar willow and cereals	78°07′45.8″N, 14°59′40.9″E	66 m	5-6 VIII 2015
29.	the vicinity of the Kolsbey settlement, a stream near Rusanov's house, stone scatterings along the stream	78°07′54.4″N, 14°59′47.9″E	114 m	6 VIII 2015
30.	the vicinity of the Kolsbey settlement, a stream near Rusanov's house, stream, a scattering of stones at the ridge	78°07′52.3″N, 15°00′18.7″E	144 m	6 VIII 2015
31.	Coleselva river slope, stone scattering	78°06′27.6″N, 15°05′22.8″E	130 m	7 VIII 2015
32.	Coleselva river terrace slope, a hollow covered with stone scatterings	78°06′28.9″N, 15°06′24.8″E	183 m	7 VIII 2015
33.	Coleselva river terrace slope, on the slope near the snowfield, mossy tundra with *Ranunculus* sp.	78°06′45.5″N, 15°07′31.5″E	273 m	7 VIII 2015
34.	Coleselva river terrace slope, plateau near the mountain Russekollen, moss-willow-sedge tundra	78°06′56.5″N, 15°07′52.6″E	320 m	7 VIII 2015
35.	the vicinity of the Kolsbey settlement, road to Grumant, 2nd terrace	78°08′10.1″N, 14°59′22.5″E	87 m	8 VIII 2015
36.	the vicinity of the Kolsbey settlement, road to Grumant, 3rd terrace, stone scattering	78°08′08.0″N, 15°00′21.8″E	229 m	8 VIII 2015
37.	the vicinity of the Kolsbey settlement, road to Grumant, swampy lowland on the terrace	78°08′37.5″N, 15°03′11.7″E	342 m	8 VIII 2015
38.	Colesdalen (Øvstedal et al. 2009, [1])	78°06′N, 15°03′E	25-50 m	1933-2002

Table SM1. List of localities.