

Funga Arctica & Alpina

volume 3

Smut Fungi & Tremelloids

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New taxa in this volume (*):

The new combination *Exidiopsis arctica* is made on page 340.

The new species *Tremella sibirica* is described on page 340.

Introduction

In this volume, we present keys, descriptions, macrophotos, microphotos and distribution maps for 106 species of smut fungi, 20 species of Exobasidiomycetes and 24 species of tremelloid fungi. For further information about the project, see volume 1.

Acknowledgements

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Materials and methods

This study is based on examination of specimens from the following reference collections: B – Botanischer Garten und Botanisches Museum Berlin, Germany; BPI – U. S. National Fungus Collections, Beltsville, Maryland, USA; C & CP – Natural History Museum of Denmark, University of Copenhagen, Denmark; DAOM – Canadian National Mycological Herbarium, Ottawa, Canada; E – Royal Botanic Garden Edinburgh, UK; GZU – Karl-Franzens-Universität Graz, Austria; H – University of Helsinki, Finland; H.M.K. – M. Kemler personal collection, Hamburg, Germany; K-M – Kew Fungarium, Royal Botanic Gardens, Kew, UK; LE – Komarov Botanical Institute, St. Petersburg, Russia; MA & MA-Fungi – Royal Botanic Garden, Madrid, Spain; O – Botanical Museum, University of Oslo, Norway; PRM – National Museum, Praha, Czech Republic; S – Swedish Museum of Natural History, Stockholm, Sweden; SOMF – Institute of Biodiversity and Ecosystem Research, Sofia, Bulgaria; UME – Umeå University, Sweden; UPS – Uppsala University, Sweden; W – Natural History Museum Vienna, Austria; WSP – Washington State University, Pullman, Washington, USA.

Dried specimens were examined using a stereo zoom microscope (for observation of sori) and light microscope (LM). For LM observations and measurements, spores were mounted in lactoglycerol solution (w : la : gl = 1 : 1 : 2) on glass slides, gently heated to boiling point to rehydrate the spores, and then cooled. The descriptions of spore length range of *Anthracoidea* species are in accordance with Denchev et al. (2020a: 11), as follows:

Spore length ranges	Length (μm)
very small	9-13
small	(11-)13-21
medium-sized	15-25(-27)
large	18-33(-40)

The description of the spore ornamentation of *Anthracoidea* species is in accordance with Denchev et al. (2013: 10), as follows:

smooth

punctate – with very low projections, up to 0.1 μm high

verrucose – with warts

- minutely verruculose – with warts 0.1-0.3 μm high
- moderately verruculose – with warts 0.3-0.5 μm high
- verrucose – with warts higher than 0.5 μm
- coarsely verrucose – with large irregular projections, higher than 0.5 μm (up to 2 μm high), apically flattened and slightly enlarged, densely situated, regularly or irregularly arranged. This ornamentation is characteristic of a group of *Anthracoidea* species, usually described as “echinate,” e.g., *A. intercedens*, *A. subinclusa*.

Abbreviations

EUROPE: AD – Andorra, AL – Albania, AT – Austria, BA – Bosnia and Herzegovina,

BG – Bulgaria, CH – Switzerland, CZ – Czech Republic, DE – Germany, ES – Spain, FI –

Finland, FR – France, IS – Iceland, IT – Italy, JAN – Jan Mayen, ME – Montenegro, MK –

North Macedonia, NO – Norway, PL – Poland, RO – Romania, RS – Serbia, RU – Russia, SE –

Sweden, SI – Slovenia, SK – Slovakia, Svalbard – Svalbard, UA – Ukraine.

ASIA: JP – Japan, KG – Kyrgyzstan, KZ – Kazakhstan, RU – Russia, TJ – Tajikistan, TM –

Turkmenistan, UZ – Uzbekistan.

NORTH AMERICA: AK – Alaska, CAN – Canada (AB – Alberta, BC – British Columbia, NL –

Newfoundland and Labrador, NT – Northwest Territories, NU – Nunavut, QC – Quebec,

YT – Yukon), GR – Greenland, USA – USA (CO – Colorado, ID – Idaho, MT – Montana, UT –

Utah, WY – Wyoming).

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In the descriptions of the included smut fungi, “spores” refers to teliospores.

Key to included species of smut fungi

Basidiomycota R.T. Moore

Fungi forming basidia bearing basidiospores. Basidia very diverse. Meiospores (basidiospores) external. Basidiomata present (typically macroscopic) or absent. Species typically mycelial, but some are dimorphic, with an anamorphic yeast or yeast-like stage. Cell walls multi-layered, composed of differently stained layers (dark-light-dark). Saprotrophic, parasitic or mycorrhizal.

Key to subphyla

- 1a. Cell wall carbohydrate composition with dominance of glucose and presence of xylose; basidiomata present, very diverse, mostly macroscopic, typically firm, sometimes soft and jelly-like; species holobasidiate or phragmobasidiate with longitudinal or oblique septa; teliospores absent; saprotrophic, parasitic or mycorrhizal **Agaricomycotina**, p. 29
- 1b. Cell wall carbohydrate composition different; basidiomata typically absent, rarely present; species holobasidiate or phragmobasidiate with transverse septa; teliospores typically present 2
- 2a. Cell wall carbohydrate composition with dominance of glucose and absence of xylose; basidiomata absent; in the arctic-alpine region, plant parasitic species (smut fungi) producing thick-walled teliospores in various organs of the host and showing a smut syndrome, sometimes teliospores embedded in the host tissue; or non-teliosporic parasitic species causing hypertrophy of plant tissue (*Exobasidium*); species holobasidiate or phragmobasidiate **Ustilaginomycotina**, p. 10
- 2b. Cell wall carbohydrate composition with dominance of mannose; basidiomata typically absent; in the region, plant parasitic species having complex life cycles with five distinct spore stages, some species with a shortened life cycle (rust fungi, see vol. 2); or plant parasitic species (smut fungi, Microbotryales) producing thick-walled teliospores in various organs of the hosts and showing a smut syndrome, sometimes with teliospores embedded in the host tissue; or exceptionally, a single saprotrophic species (*Saccosoma*) forming resupinate basidiomata on rotten wood; all species phragmobasidiate..... **Pucciniomycotina**

Pucciniomycotina R. Bauer, Begerow, J.P. Sampson, M. Weiss & Oberw.

An extremely diverse group of basidiomycetes in terms of morphology and ecology, consisting of plant parasitic species, asymptomatic members of the phylloplane, saprotrophs, parasites on insects and fungi, etc. Cell wall carbohydrate composition with dominance of mannose. Septal pores simple, without membrane caps. Basidiomata typically absent. Species phragmobasidiate or holobasidiate.

In the arctic-alpine region, including three groups of fungi: a) rust fungi (see vol. 2): obligate parasites on plants, having complex life cycles with five distinct spore stages, some species with a shortened life cycle, autoecious or heteroecious; b) smut fungi and Microbotryales: plant parasitic species producing thick-walled teliospores in various organs of the host and showing a smut

syndrome, sometimes with teliospores embedded in the host tissue; and c) a single saprotrophic species (*Saccosoma farinaceum*) forming resupinate basidiomata on rotten wood. All species phragmobasidiate with transverse septa.

Key to classes of Pucciniomycotina

- 1a. Basidiomata resupinate, corticioid; on rotten wood **Atractiellomycetes**
 1b. Basidiomata absent; plant parasitic species 2
- 2a. Species producing thick-walled teliospores and showing a smut syndrome (smut fungi); basidia with multiple production of sessile basidiospores.....**Microbotryomycetes**
 2b. Species having complex life cycles with five distinct spore stages (spermatia, aeciospores, urediniospores, teliospores, and basidiospores); some species with a shortened life cycle; autoecious or heteroecious; basidia producing sterigmate basidiospores..... **Pucciniomycetes** (rust fungi), see vol. 2

Atractiellomycetes R. Bauer, Begerow, J.P. Samp., M. Weiss & Oberw.

Basidiomycetes characterized by the presence of symplechosomes (organelles similar to dictyosomes of plants) consisting of a stack of platelike cisternae derived from the endoplasmatic reticulum. Basidiomata corticioid, coralloid, stipitate, capitate, stilboid or pycnidium-like. All species phragmobasidiate. Most species saprotrophic, rarely endophytic or mycorrhizal.

Only one order:

Atractiellales Oberw. & Bandoni

Characters as for the class.

Only one family in the region:

Phleogenaceae J. Weese

Only one genus in the region:

Saccosoma Spirin

Basidiocarps resupinate, thin to rather thick, non-gelatinised, arid, floccose to dense, white to cream-coloured. Hyphae clamped. Basidia four-celled, tubular-clavate, straight. Saprotrophs.

In the region, only one species, *Saccosoma farinaceum*, see p. 35.

Microbotryomycetes R. Bauer, Begerow, J.P. Samp., M. Weiss & Oberw.

A highly diverse class of basidiomycetes in terms of morphology and ecology, consisting of plant parasitic species, mycoparasites, and saprotrophs. Circumscribed as a highly supported clade in molecular phylogenetic reconstructions. At the ultrastructural level, characterised by simple septal pores and intranuclear metaphasic spindle pole bodies. Mycoparasites contain organelles, termed

colacosomes. Several taxa isolated as yeasts from the phylloplane or soil. Basidiomata typically absent, when present ranging from stilboid to pycnidoid.

In the arctic-alpine region including one order, comprised of species without basidiomata, producing thick-walled teliospores, and showing a smut syndrome (smut fungi), sometimes with teliospores embedded in the host tissue. Basidia with multiple production of sessile basidiospores.

Microbotryales R. Bauer & Oberw.

Species of this order have the lifestyle of smut fungi similar to that of phragmobasidiate species in Ustilaginomycetes, but are morphologically distinguishable from them by the lack of intracellular hyphae or haustoria. They are characterized by the presence of transversely septate basidia with multiple production of sessile basidiospores and only intercellular hyphae.

Key to families

- 1a. Spores embedded in the leaf tissue; smooth, hyaline;
on the high-arctic grass *Pleuropogon sabinei* **Ustilentylomataceae**, p. 9
- 1b. Sori in various organs (leaves, stems, inflorescences, flowers,
anthers, ovaries, capsules or seeds); spore mass powdery, rarely
semi-agglutinated or agglutinated; spores never embedded in leaf
tissue, ornamented (reticulate, verruculose, verruculose-reticulate
or striate) and pigmented (vinaceous, livid vinaceous or purple,
rarely pale yellowish brown to subhyaline); on dicots (Polygonaceae,
Caryophyllaceae, Montiaceae, Gentianaceae, Lentibulariaceae,
and Caprifoliaceae)..... **Microbotryaceae**

Microbotryaceae R.T. Moore

Characterized by the absence of pores in the mature septa. All species are plant parasitic fungi.

Microbotryum Lév.

Sori in leaves, stems, inflorescences, flowers, anthers, ovaries, capsules or seeds of host plants in dicotyledonous families. Spore mass powdery, rarely semi-agglutinated or agglutinated, pale to dark purplish brown. Spores solitary, surface variously ornamented (often reticulate, also verruculose, verruculose-reticulate or striate). Peridium, columella and capillitium-like threads absent in the sori. Sterile cells absent between the spores that are not catenulate. Spore germination results in phragmobasidia with successive production of sessile basidiospores, sterigmata absent.

In cold areas, many species occur on members of the knotweed family (Polygonaceae) and the pink family (Caryophyllaceae), more rarely on other families.

Key to species

- 1a. In flowers, stems, leaves or ovaries of Polygonaceae 2
- 1b. On other plant families 11
- 2a. In flowers of *Oxyria* ***M. vinosum***, p. 83
- 2b. On *Koenigia*, *Rumex* or *Bistorta*..... 3

3a.	In inflorescences, ovaries, stems or leaves of <i>Koenigia</i>	4
3b.	On <i>Rumex</i> or <i>Bistorta</i>	7
4a.	Sori in ovaries; spores verruculose; on <i>Koenigia islandica</i>	<i>M. picaceum</i> , p.69
4b.	Sori elsewhere.....	5
5a.	Sori mainly occurring in inflorescences (in swollen flowers, pedicels, and peduncles), sometimes in leaves; spores 10-18(-22) μm long, verruculose to verruculose-reticulate; on various species of <i>Koenigia</i>	<i>M. bosniacum</i> , p.45
5b.	Sori in stems or leaves; spores up to 10 μm long, rarely up to 13.5 μm ; spore wall striate	6
6a.	Sori in stems or leaves; spore wall finely striate; on <i>K. islandica</i>	<i>M. koenigiae</i> , p.55
6b.	Sori on the underside of leaves; spore wall with curved, anastomosing striae, resembling fingerprints; on various species of <i>Koenigia</i>	<i>M. piperi</i> , p. 73
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8b.	Spores 6-10.5 μm long.....	<i>M. warmingii</i> , p. 87
9a.	Sori in the inflorescences, destroying flowers and bulbils	<i>M. bistortarum</i> , p. 43
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10a.	Sori along the margins of leaves, occurring as a continuous 1-2 mm wide border, or as isolated groups of marginal pustules.....	<i>M. marginale</i> , p. 61
10b.	Sori occurring as rounded pustules, scattered or arranged in two rows along the median vein.....	<i>M. pustulatum</i> , p. 75
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14b.	On <i>Silene uralensis</i>	<i>M. savilei</i> , p. 77
15a.	On <i>Heliosperma</i>	<i>M. heliospermatis</i> , p. 51
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- 16a. On *Minuartia* *M. minuartiae*, p. 63
 16b. On other plants..... 17
- 17a. On *Silene acaulis* *M. silenes-acaulis*, p. 79
 17b. On other plants..... 18
- 18a. On *Silene uralensis* *M. arcticum*, p. 41
 18b. On other plants..... 19
- 19a. On *Silene vulgaris* or *Viscaria*..... 20
 19b. On *Stellaria*..... *M. stellariae*, p. 81
- 20a. Spore mass light (fawn), spores reticulate;
 on *Silene vulgaris* or *Viscaria* *M. lagerheimii*, p. 57
 20b. Spore mass dark purple, spores incompletely
 verruculose-reticulate; on *Silene vulgaris* *M. violaceoirregulare*, p. 85
- 21a. Sori in anthers of *Pinguicula* (Lentibulariaceae)..... 22
 21b. On plants from other families 24
- 22a. On *Pinguicula alpina*..... *M. alpinum*, p. 39
 22b. On other species of *Pinguicula*..... 23
- 23a. On *Pinguicula spathulata* or *P. villosa* *M. liroi*, p. 59
 23b. On *P. grandiflora*, *P. leptoceras*, *P. macroceras*, or *P. vulgaris* *M. pinguiculae*, p. 71
- 24a. Sori in anthers of *Scabiosa* (Caprifoliaceae) *M. intermedium*, p. 53
 24b. On plants from other families 25
- 25a. Sori in seeds of *Gentiana nivalis* (Gentianaceae)..... *M. nannfeldtii*, p. 65
 25b. Sori in seeds of *Claytonia* (Montiaceae) *M. claytoniae*, p. 47

Ustilentylomataceae R. Bauer & Oberw.

Characterized by the presence of simple pores in the mature septa, without membrane caps. The family consists of plant parasitic fungi and anamorphic yeast species.

Only one genus is included:

Ustilentyloma Savile

Sori in leaves of host plants in the grass family (Poaceae), forming spots on the leaf surface. Spores single, in loose or compact groups, embedded in the host tissue, not powdery, subhyaline or pale yellow. Resembles *Entyloma*, but spore germination of the *Ustilago*-type.

Only one species in the region, *Ustilentyloma pleuropoginis*, see p. 89.

Ustilaginomycotina Doweld

A diverse group of basidiomycetes in terms of morphology and ecology, consisting of plant parasites and anamorphic species. Cell wall carbohydrate composition with dominance of glucose and absence of xylose. Characterized by lack of parentheses at the pores, and presence of zones of host-parasite interactions with fungal deposits. Basidiomata absent.

In the arctic-alpine region including two groups of fungi: a) plant parasitic species (smut fungi) producing thick-walled teliospores in various organs of the host and showing a smut syndrome, sometimes with teliospores embedded in the host tissue; and b) non-teliosporic parasitic species (*Exobasidium*) on plants of the heather family (Ericaceae) and *Saxifraga* (Saxifragaceae), causing hypertrophy of plant tissue. Holobasidiate or phragmobasidiate.

Most of the smut fungi in Ustilaginomycotina have a dimorphic life cycle consisting of a saprobic haploid phase (yeast or yeast-like stage) and a parasitic dikaryotic phase when they form hyphae. The haploid phase is initiated by the formation of basidiospores on basidia and ends with the conjugation of compatible haploid cells to produce dikaryotic, infectious hyphae. The infection is systemic or local. Teliospores, developed on sporogenous hyphae and clustered in sori, are the most conspicuous structure of the smut fungi. Sporogenesis occurs in different organs, e.g. leaves, stems, inflorescences, flowers, anthers, ovaries, or seeds. Teliospore germination results in a phragmobasidium or holobasidium where formation of a diploid nucleus occurs, followed by meiosis and formation of haploid basidiospores. Homothallism in *Anthracoidea* is a variation of this general cycle.

For the life cycle of the non-teliosporic parasitic species, see *Exobasidium*, p. 24.

Key to classes

- 1a. Cellular host-parasite interaction with a local interaction zone; teliospores absent; parasitic on Ericaceae and *Saxifraga*, generally emerging on the underside of leaves **Exobasidiomycetes** (Exobasidiales), p. 24
- 1b. Plant parasitic species (smut fungi) producing thick-walled teliospores in various organs of monocotyledonous or dicotyledonous hosts (not on Ericaceae and *Saxifraga*) and showing a smut syndrome, sometimes with teliospores embedded in the host tissue 2
- 2a. Cellular host-parasite interaction with a local interaction zone **Exobasidiomycetes** (excluding Exobasidiales), p. 20
- 2b. Cellular host-parasite interaction with an enlarged interaction zone **Ustilaginomycetes**

Ustilaginomycetes R. Bauer, Oberw. & Vánky

Plant parasitic and teliosporic species characterized by cellular host-parasite interaction with an enlarged interaction zone. Teliospores occurring in various organs of monocotyledonous or dicotyledonous hosts, sometimes with teliospores embedded in the host tissue. Teliospores solitary, in pairs or in balls. Phragmobasidiate or holobasidiate.

Key to orders of Ustilaginomycetes

- 1a. Spores in balls composed of one to many central fertile spores, surrounded by a layer of sterile cells; exceptionally spores are single, but then in sori in seeds of crucifers (Brassicaceae)..... **Urocystidiales**
- 1b. Spores solitary, rarely in pairs or in balls; spore balls when present composed only of spores **Ustilaginales**, p. 13

Urocystidiales R. Bauer & Oberw. (“*Urocystidales*”)

Including species with enlarged interaction zones and septa with simple pores, but in some species the soral hyphae are without septal pores. The teleomorphic members are plant parasites on various plant families; seen in leaves, stems, roots, flowers or seeds as darker spots, stripes and swellings. In addition, several species are only known in their yeast state.

Spores in balls composed of one to many central fertile spores, surrounded by a layer of sterile cells; exceptionally spores are single, but then in sori in seeds of crucifers (Brassicaceae).

Anamorph state present or absent.

Key to families

- 1a. Sori in seeds of crucifers (Brassicaceae), replacing the seed with a pale brown, powdery spore mass; spores single..... **Glomosporiaceae**
- 1b. Sori formed on other plants of other families..... **Urocystidiaceae**

Glomosporiaceae Cif.

Sori occur in various parts of the infected plants. They are filled with masses of spore balls, or rarely the spores are single. The host spectrum includes plants from 16 families of dicotyledons, and host-parasite interaction is by intracellular hyphae; mature septa are poreless.

Only one genus occurs in the area:

Thecaphora Fingerh.

Sori in various organs of the host plant. Spores in spore balls, yellowish brown to dark reddish brown; spores rarely solitary. Spore balls loosely or firmly agglutinated, composed of few to many spores. Sterile cells absent. Spores variable in shape; spore wall thin, smooth or nearly so on the contact sides, thick and ornamented on the free side. Spore germination variable.

Only one species in the arctic-alpine area, with single spores, *T. thlaspeos*, p. 91.

Urocystidiaceae Begerow, R. Bauer & Oberw. (“*Urocystidaceae*”)

Characterized by the formation of spore balls (with sterile cells outside), pigmented teliospores, presence of a simple septal pore with two outer membrane caps and two inner, non-membranous plates closing the pore, and host-parasite interaction by haustoria.

Only one genus in the area:

Urocystis Rabenh.

Infection usually systemic. Sori in various organs of the host plant, mostly in leaves and stems, sometimes in flowers or seeds, less often on the base of stems or roots; forming dark brown or blackish brown streaks, spots, swellings or galls, containing a powdery mass of spore balls. Spore balls persistent, composed of one to many pigmented fertile spores surrounded by paler and smaller sterile cells. Spore germination holobasidiate. Anamorph present in some species.

Key to species based on host plant

- | | | |
|------|--|---------------------------------------|
| 1a. | On <i>Carex</i> | 2 |
| 1b. | On other genera | 3 |
| 2a. | Spore balls 18-34.5 µm long, composed of 1-2(-3) spores | <i>U. fischeri</i> , p. 101 |
| 2b. | Spore balls 25–50 µm long, composed of (1-)2-6(-9) spores..... | <i>U. littoralis</i> , p. 111 |
| 3a. | On <i>Juncus</i> | 4 |
| 3b. | On other genera | 5 |
| 4a. | (1-)2-10(-23) spores per ball..... | <i>U. junci</i> , p. 109 |
| 4b. | 1-5(-9) spores per ball..... | <i>U. tothii</i> , p. 121 |
| 5a. | On <i>Anticlea</i> or <i>Toxicoscordion</i> | <i>U. flowersii</i> , p. 103 |
| 5b. | On other genera | 6 |
| 6a. | On plants from the grass family (Poaceae)..... | 7 |
| 6b. | On plants from other families..... | 11 |
| 7a. | On <i>Anthoxanthum</i> | <i>U. roivainenii</i> , p. 117 |
| 7b. | On other genera of grasses..... | 8 |
| 8a. | On <i>Arctagrostis</i> , <i>Elymus</i> , <i>Leymus</i> , or <i>Pseudoroegneria</i> | <i>U. agropyri</i> , p. 93 |
| 8b. | On other genera of grasses..... | 9 |
| 9a. | On <i>Deschampsia</i> | <i>U. deschampsiae</i> , not included |
| 9b. | On other genera of grasses..... | <i>U. triseti</i> , p. 127 |
| 10a. | On plants from the primrose family (Primulaceae)..... | 11 |
| 10b. | On plants from other families..... | 12 |
| 11a. | On <i>Lysimachia europaea</i> | <i>U. trientalis</i> , p. 125 |
| 11b. | On <i>Primula matthioli</i> | <i>U. cortusae</i> , p. 99 |
| 12a. | On plants from the buttercup family (Ranunculaceae)..... | 13 |
| 12b. | On plants from the saxifrage family (Saxifragaceae)..... | 18 |
| 13a. | On <i>Aconitum</i> | <i>U. irregularis</i> , p. 107 |
| 13b. | On other genera | 14 |

14a. On <i>Callianthemum</i>	<i>U. callianthemi</i> , p. 97
14b. On other genera	15
15a. On <i>Ranunculus</i>	16
15b. On other genera	17
16a. (0-)1-3(-5) spores per ball.....	<i>U. ranunculi</i> , p. 115
16b. 1-5(-7) spores per ball.....	<i>U. nivalis</i> , p. 113
17a. On <i>Thalictrum</i>	<i>U. sorosporioides</i> , p. 119
17b. On <i>Trautvetteria</i>	<i>U. trautvetteriae</i> , p. 123
18a. On <i>Boykinia</i>	<i>U. alaskana</i> , p. 95
18b. On <i>Heuchera</i> or <i>Micranthes</i>	<i>U. heucherae</i> , p. 105

Ustilaginales Clinton

Characterized by the presence of a mature septum without a pore, and a host-parasite interaction through intracellular hyphae. Plant parasitic species occurring on Cyperaceae, Juncaceae, and Poaceae. Spores single, in pairs or in balls (composed only of spores). Spore germination with transversely septate basidia or with ramified hyphae.

Anamorph state present or absent.

Key to families

- 1a. Sori on species of Cyperaceae or Juncaceae, mainly in spikelets or flowers, rarely destroying the nutlets (*Moreaua*) or forming crusts on the leaf epidermis (*Orphanomyces*)..... **Anthracoideaceae**
- 1b. Sori on grasses (Poaceae), in leaves, leaf sheaths or stems, occasionally in the inflorescence axes or spikelets **Ustilaginaceae**, p. 20

Anthracoideaceae Denchev

Septa poreless. Host-parasite interaction through intracellular hyphae. Spore germination through transversely septate basidia or with ramified hyphae.

Parasitic on Cyperaceae and Juncaceae.

Key to genera

- 1a. Sori in spikelets or flowers of *Juncus* or *Luzula* (Juncaceae); spores single
 - 1b. Sori on plants from the sedge family (Cyperaceae)
 - 2a. Spores single.....
 - 2b. Spores in pairs or in balls
- | | |
|-------|--------------------------------|
| | <i>Stegocintractia</i> , p. 19 |
| | 2 |
| | 3 |
| | 5 |

- 3a. Sori external, seen as black crusts on the leaf epidermis of *Carex* *Orphanomyces*, p. 19
 3b. Sori occurring around aborted nuts of *Carex* and
Trichophorum cespitosum as globose hard bodies 4
- 4a. Spores with a thick-walled equatorial band and
 two thin-walled lighter polar areas *Planetella*, p. 19
 4b. Spores uniformly pigmented *Anthracoidea*, p. 14
- 5a. Sori in leaves of *Carex*, forming striae or irregular spots;
 spores joined in pairs *Schizonella*, p. 19
 5b. Sori destroying the nutlets of *Carex*; spores in balls *Moreaua*, p. 18

Anthracoidea Bref.

Sori in and around ovaries of cyperaceous plants (in the case of *Carex* scattered in female spikes or in female flowers of mixed spikes), usually partly hidden by the glumes; occurring as globose, subglobose, broadly ellipsoid or ovoid, black hard bodies composed of the remainder of the nut in the center and a spore mass around it; initially covered by a thin, white, greyish or silvery peridium of fungal cells, hyphae, and fragments of host cells, which ruptures to expose the spore mass. Spore mass initially firmly agglutinated, later powdery or semi-agglutinated on the surface, less often mature sori agglutinated on the surface and breaking into small, irregular pieces; composed only of teliospores, sterile cells absent. Spores formed singly, usually flattened, in plane view more or less regular in outline (orbicular, suborbicular or broadly ellipsoid) or more or less irregular, surrounded by a gelatinous sheath that breaks down at maturity. Spore wall unevenly or evenly thickened, rarely with pale thinner-walled polar regions, with or without protuberances, often with internal swellings and/or light-refractive areas, usually ornamented with warts, rarely punctate or smooth, a few species with coarse (up to 2 μm high) irregular ornaments, apically flattened and slightly enlarged. Spore germination results in a two-celled aerial basidium forming one or more basidiospores on each cell; basidiospores globose, subglobose, ovoid or cylindrical.

Anamorph present in some species.

Parasitic in the flowers and seeds of *Carex* including *Kobresia*, and in *Trichophorum* (*Scirpus*). The genus is large and complicated, occurring on one of the largest genera of monocots. Generally, we have not treated subspecies and varieties as hosts, but have included them under the principal host.

Anthracoidea caricis-albae on *Carex alba* is only found in the Alps, but at lower altitudes, and thus is not included.

Key to species based on host plant (arranged in sections and informally named clades, cf. Roalson et al. 2021). *For key to *Anthracoidea* not based on host, see p. 337.

- 1a. On *Trichophorum* *A. scirpi*, p. 197
 1b. On *Carex*..... 2
- 2a. On sect. *Acrocystis* (*C. deflexa*, *C. montana*, *C. pilulifera*, or *C. rossii*) *A. caricis*, p. 145
 2b. On other carices 3
- 3a. On species of the Annectens Clade 4
 3b. On other carices 5

- 4a. Spores medium-sized, 15-26 μm long; spore wall densely verruculose-echinulate; on *Carex diandra* *A. aspera*, p. 133
- 4b. Spores smaller, 13-22 μm long; spore wall echinate; on *C. cusickii*..... *A. fischeri*, p. 155
- 5a. On species of the Capitata Clade 6
- 5b. On other carices 9
- 6a. Spores large, 18-27(-30) μm long; on *C. bicolor*, *C. livida*, *C. panicea*, or *C. vaginata* *A. paniceae*, p. 185
- 6b. Spores smaller..... 7
- 7a. Spores minutely verruculose, warts up to 0.2(-0.3) μm high; spores medium-sized, (15.5-)17-23(-26) μm long; on *C. rupestris*..... *A. rupestris*, p. 193
- 7b. Spore wall in LM smooth 8
- 8a. Spores medium-sized, (16-)17-22(-23) μm long; on *C. nardina*..... *A. nardinae*, p. 181
- 8b. Spores smaller, (12.5-)13.5-19(-20) μm long; on *C. obtusata* *A. obtusatae*, p. 183
- 9a. On sect. *Chartotechium* (*Carex atrofusca*)..... *A. misandrae*, p. 179
- 9b. On other carices 10
- 10a. On sect. *Chordorrhizae* (*Carex chordorrhiza*)..... 11
- 10b. On other carices 12
- 11a. Spores medium-sized, 15-26 μm long; spore wall densely verruculose-echinulate..... *A. aspera*, p. 133
- 11b. Spores smaller, 13-22 μm long; spore wall echinate..... *A. fischeri*, p. 155
- 12a. On sect. *Chlorostachyae* (*Carex boecheriana*, *C. capillaris*, or *C. ledebouriana*)..... *A. capillaris*, p. 143
- 12b. On other carices 13
- 13a. On sect. *Clandestinae* (*Carex pediformis*) *A. irregularis*, p. 163
- 13b. On other carices 14
- 14a. On species of the Curvula Clade 15
- 14b. On other carices 16
- 15a. Spore wall uneven, 1.2-2 μm thick, at the angles up to 3.5 μm ; internal swellings and light-refractive areas present; on *C. baldensis* *A. baldensis*, p. 137
- 15b. Spore wall evenly thickened, 1.2-1.6(-2.0) μm thick; internal swellings and light-refractive areas absent; on *C. curvula*..... *A. curvulae*, p. 147
- 16a. On sect. *Cyperoideae* (*Carex ebenea*, *C. macloviana*, *C. phaeocephala*, or *C. preslii*)..... *A. verrucosa*, p. 207
- 16b. On other carices 17

17a. On sect. <i>Digitatae</i> (<i>Carex ornithopoda</i> subsp. <i>ornithopoda</i> and subsp. <i>ornithopodioides</i>).....	<i>A. irregularis</i> , p. 163
17b. On other carices	18
18a. On species of the Disticha Clade	19
18b. On other carices	21
19a. Spores very small, (8.5-)9.5-11.5(-12.5) μm long; spore wall depressed in 3-6 places where the wall is paler and thinner; on <i>C. enervis</i> or <i>C. maritima</i>	<i>A. pseudofoetidae</i> , p. 189
19b. Spores larger, up to 22 μm long; spore wall otherwise	20
20a. Spore wall echinate; spines up to 1.0 μm high; on <i>C. disticha</i>	<i>A. fischeri</i> , p. 155
20b. Spore wall minutely verruculose, warts up to 0.3 μm high; on <i>C. hoodii</i> ...	<i>A. verrucosa</i> , p. 207
21a. On species of the Echinata Clade	22
21b. On other carices	23
22a. Spore wall verrucose, spore profile affected; warts 0.5-0.7 μm high; on <i>C. foetida</i>	<i>A. foetidae</i> , p. 157
22b. Spore wall minutely verruculose, spore profile not affected; warts up to 0.15 μm high; on <i>C. echinata</i>	<i>A. kariii</i> , p. 165
23a. On sect. <i>Filifoliae</i> (<i>Carex elynoides</i>).....	<i>A. nardinae</i> , p. 181
23b. On other carices	24
24a. On species of the Flacca Clade.....	25
24b. On other carices	28
25a. Spores large, 18-31 μm long; on <i>C. flacca</i>	<i>A. pratensis</i> , p. 187
25b. Spores medium-sized, up to 25(-27.5) μm long	26
26a. Protuberances, internal swellings, and light-refractive areas absent; on <i>C. ferruginea</i>	<i>A. ferrugineae</i> , p. 151
26b. Protuberances, internal swellings, and light-refractive areas present.....	27
27a. Internal swellings 1-3(-4); on <i>C. firma</i>	<i>A. firmae</i> , p. 153
27b. Internal swellings 1(-2); on <i>C. sempervirens</i>	<i>A. sempervirentis</i> , p. 201
28a. On species of the Fuliginosa Clade	29
28b. On other carices	30
29a. Spores small, (14-)15-20(-21) μm long; minutely verruculose, warts up to 0.2(-0.3) μm high; on <i>C. fuliginosa</i> subsp. <i>misandra</i>	<i>A. altera</i> , p. 129
29b. Spores medium-sized, 17-26 μm long; minutely to moderately verruculose (occasionally verrucose), warts up to 0.5(-0.6) μm high; on <i>C. fuliginosa</i> subsp. <i>fuliginosa</i> or <i>C. fuliginosa</i> subsp. <i>misandra</i>	<i>A. misandrae</i> , p. 179

30a. On <i>Carex</i> sect. <i>Glareosae</i>	31
30b. On other carices	33
31a. Spores echinate; on <i>Carex canescens</i> , and hybrids, or <i>C. lapponica</i>	<i>A. fischeri</i> , p. 155
31b. Spores minutely verruculose or verruculose-echinulate.....	32
32a. Spore wall minutely verruculose, spore profile not affected; warts up to 0.15 μm high; on <i>C. brunnescens</i> , <i>C. canescens</i> , <i>C. heleonastes</i> , <i>C. lapponica</i> , <i>C. loliacea</i> , <i>C. marina</i> , and hybrids.....	<i>A. kari</i> , p. 165
32b. Spore wall verruculose-echinulate, spore profile affected; ornaments of very different size, 0.1-1.0 μm high; on <i>C. glareosa</i>	<i>A. aspera</i> , p. 133
33a. On species of the Hirta Clade	34
33b. On other carices	36
34a. Sori powdery on the surface; spores large-sized, 20-30 μm long; on <i>C. lasiocarpa</i> or <i>C. saxatilis</i>	<i>A. lasiocarpae</i> , p. 169
34b. Mature sori agglutinated on the surface, usually broken into small pieces; spores small, up to 20(-22) μm long	35
35a. Spore wall with 2-4 distinct internal swellings; on <i>C. atherodes</i> , <i>C. rostrata</i> , or <i>C. utriculata</i>	<i>A. americana</i> , p. 131
35b. Spore wall without internal swellings; on <i>C. rostrata</i> , <i>C. rotundata</i> , or <i>C. \timessaamica</i>	<i>A. inclusa</i> , p. 161
36a. On species of the Kobresia Clade.....	37
36b. On other carices	38
37a. Spores smooth in side view; spore wall with 1-3 internal swellings; on <i>C. borealipolaris</i> , <i>C. capillifolia</i> , <i>C. deasyi</i> , or <i>C. myosuroides</i>	<i>A. elyanae</i> , p. 149
37b. Spores minutely verruculose, warts up to 0.2(-0.3) μm high; internal swellings absent; on <i>C. alatauensis</i> , <i>C. kokanica</i> , or <i>C. simpliciuscula</i>	<i>A. lindebergiae</i> , p. 175
38a. On sect. <i>Limosae</i> (<i>Carex limosa</i> , <i>C. magellanica</i> subsp. <i>irrigua</i> , <i>C. rariflora</i> , and hybrids)	<i>A. limosae</i> , p. 173
38b. On other carices	39
39a. On species of the Microchaeta Clade (<i>Carex krascheninnikovii</i> , <i>C. microchaeta</i> subsp. <i>nesophila</i> , or <i>C. spectabilis</i>)	<i>A. atratae</i> , p. 135
39b. On other carices	40
40a. On sect. <i>Paniceae</i> (<i>Carex laxa</i>).....	<i>A. laxae</i> , p. 171
40b. On other carices	41
41a. On sect. <i>Phacocystis</i>	42
41b. On other carices	45

- 42a. Spores small, (12-)13-19.5(-21.5) μm long; spore wall with 1–4(–5) internal swellings, minutely verruculose; warts up to 0.2(-0.3) μm high *A. heterospora*, p. 159
- 42b. Spores medium-sized to large 43
- 43a. Spores medium-sized to large, (17-)19-25(-28) μm long; spore wall with 1–2 internal swellings, minutely verruculose, warts up to 0.2(-0.3) μm high *A. liroi*, p. 177
- 43b. Spores medium-sized; spore wall without internal swellings 44
- 44a. Spores 17-25 μm long; spore wall verrucose, warts up to 0.7 μm high *A. atratae*, p. 135
- 44b. Spores (16-)17-22(-23.5) μm long; spore wall moderately verruculose, warts up to 0.4(-0.5) μm high *A. bigelowii*, p. 139
- 45a. On sect. *Physoglochin* (*Carex dioica*, *C. parallela*, and hybrids) *A. turfosa*, p. 203
- 45b. On other carices 46
- 46a. On sect. *Psyllophorae* (*Carex pulicaris*) *A. pulicaris*, p. 191
- 46b. On other carices 47
- 47a. On sect. *Racemosae* 48
- 47b. On other carices 50
- 48a. Spores large, 20-30 μm long; on *Carex adelostoma*, *C. buxbaumii*, or *C. gmelinii* *A. buxbaumii*, p. 141
- 48b. Spores small or medium-sized 49
- 49a. Spores medium-sized, 17-25 μm long; spore wall without internal swellings, verrucose; warts up to 0.7 μm high; on *C. atrata* or *C. raynoldsii* *A. atratae*, p. 135
- 49b. Spores small, (15-)16-21.5 μm long; spore wall with 1–3 internal swellings, minutely verruculose, warts up to 0.3 μm high; on *C. norvegica* *A. savilei*, p. 195
- 50a. On *Carex kitaibeliana* *A. kitaibelianae*, p. 167
- 50b. On other carices 51
- 51a. On species of the Rhomboidales-Mitrata Clade (*Carex umbrosa* subsp. *umbrosa*, *C. umbrosa* subsp. *huetiana*, and hybrids) *A. umbrosae*, p. 205
- 51b. On sect. *Scirpinae* (*Carex scirpoidea*) *A. scirpoideae*, p. 199

Moreaua Liou & H. C. Cheng

Sori naked on the surface of inner floral organs, forming a black granular-powdery mass of spore balls. Spore balls composed of firmly adhering spores. Columella, peridium, and sterile cells lacking. Spores usually wedge-shaped, pigmented, reddish brown or blackish brown; spore wall thick on the free surface. Spore germination results in 4-celled phragmobasidia with sessile spores.

Only one species, *M. apicis*, see p. 209.

***Orphanomyces* Savile**

Sori external on the leaf surface of sedges (*Carex*), forming black, often confluent crusts. Mycelium systemic, perennial. Infected plants do not flower. Spores single or in loose balls, moderately large, with brown, coarsely sculptured walls.

Only one species, *O. arcticus*, see p. 211.

***Planetella* Savile**

Sori in female flowers of sedges (*Carex*), around aborted nuts, forming black hard bodies. Spores slightly flattened, with a thick-walled medium reddish brown equatorial band, and two thin-walled light yellow-brown polar areas. Spore germination unknown.

Only one species, *P. lironis*, see p. 213.

***Schizonella* J. Schröt.**

Sori occurring in leaves of the sedge family (Cyperaceae) as black, short or long, pustulate streaks with an agglutinated to powdery spore mass. Spores initially in pairs, arising by internal division of a mother cell, later separating into single spores. Spore germination of the *Ustilago*-type.

Key to species

- 1a. Spores light to medium yellow-brown; on *Carex myosuroides* *S. elyanae*, p. 215
 1b. Spores dark reddish brown; on other species of *Carex* *S. melanogramma*, p. 217

***Stegocintractia* M. Piepenbr.**

Infection systemic. Sori on plants from the rush family (Juncaceae), in all spikelets or around pedunculi of an infected inflorescence, forming a black agglutinated spore mass with a powdery surface. Young sori covered by a fungal peridium, sterile stroma lacking. Spores single, pigmented (brown), ornamented, without appendages.

Key to species

- 1a. On *Juncus* *S. lidii*, p. 221
 1b. On *Luzula* 2
- 2a. Spores verruculose-echinulate *S. hyperborea*, p. 219
 2b. Spores foveolate 3
- 3a. Spores (19.5-)20.5-28.5(-30) μm long *S. luzulae*, p. 223
 3b. Spores 13-21 μm long *S. spadicea*, p. 225

Ustilaginaceae Tul. & C. Tul.

Species with poreless septa and host-parasite interaction by intracellular hyphae. Spore germination with transversely septate basidia. Parasitic on grasses (Poaceae).

Only one genus is included here:

Ustilago (Pers.) Roussel

Parasitic on various genera of grasses. Sori in various vegetative or generative organs of the infected plant, at maturity bursting and exposing a usually powdery, sometimes agglutinated, blackish or olive brown spore mass. Sterile cells absent. Spores single, pigmented, usually ornamented. Spore germination results in phragmobasidia bearing lateral and apical spores or hyphae.

Key to species

- 1a. Spores 8.5-15(-16) μm long, echinulate *U. striiformis*, p. 231
- 1b. Spores larger 2
- 2a. Spores 14-19 μm long; spore wall echinate,
spines up to 1 μm high..... *U. calamagrostidis*, p. 227
- 2b. Spores 12-18 μm long; spore wall scrobiculate, with ornaments
ca. 1 μm high, their bases confluent into meandriform, often
interrupted ridges *U. scrobiculata*, p. 229

Exobasidiomycetes Begerow, Stoll & R. Bauer

Characterized by presence of cellular host-parasite interaction with local interaction zones without or with interaction apparatus. Teliosporic or non-teliosporic species. Members holobasidiate or phragmobasidiate.

In the arctic-alpine region two groups of fungi occur: plant parasitic species (smut fungi) producing thick-walled teliospores in ovaries of grasses and showing a smut syndrome, or species with teliospores embedded in the leaves of grasses or dicotyledonous hosts; and a group of non-teliosporic parasitic fungi comprising *Exobasidium* species on Ericaceae and *Saxifraga* (Saxifragaceae), usually appearing on the underside of leaves.

Members of *Exobasidium* cause localised infection, or so-called “systemic” infection, but systemic infections do not affect the whole plant and are not perennial. Nannfeldt (1981) coined the term “surculicolous” for this condition, which results in deformed, often etiolated shoots. Infections may be annual and circumscribed, i.e. surrounded by healthy tissue and dying away after the season. Circumscribed species may also cause “gall-apples,” which are round cm-large structures, at first greenish or whitish, then becoming pink or reddish. Hymenia occur on one or both sides of the leaves, forming white crusts covering the whole leaf surface or only the tissue between the veins. Basidiospores ellipsoid or cylindrical, in some species ultimately with 1 or more septa, sterigmata conic, often remarkably long. Basidia non-septate, variably 2-6 sterigmate, difficult to study in full length. Hyphae simple septate.

Key to orders of Exobasidiomycetes

- 1a. Non-teliosporic parasitic fungi on plants from the heather family (Ericaceae) and *Saxifraga*, forming etiolated and deformed shoots and/or colourful leaf spots **Exobasidiales**, p. 24
- 1b. Teliosporic parasitic fungi on plants from other families..... 2
- 2a. Sori in ovaries of grasses (Poaceae), filling them with a powdery mass of teliospores and sterile cells..... **Tilletiales**, p. 23
- 2b. Teliospores embedded in the leaves; spore mass not powdery 3
- 3a. Sori forming on the leaf surface spots with numerous spore balls appearing as minute dark brown raised dots; spore balls embedded in the host tissue, composed of a central mass of teliospores surrounded by a cortex of sterile cells **Doassansiales** p. 21
- 3b. Teliospores solitary or in groups, not agglutinated in balls..... 4
- 4a. Sori on dicotyledonous hosts..... **Entylomatales**, p. 22
- 4b. Sori on grasses **Georgefischeriales**, p. 22

Doassansiales R. Bauer & Oberw.

Infecting aquatic plants or plants growing in moist habitats, united by a suite of morphological, ultrastructural, and molecular characters. Sporulating in vegetative parts of the host, predominantly on leaves or petioles. The host spectrum is quite diverse, including lycopods (*Selaginella*), monocotyledons and dicotyledons.

Includes three families, but only one in the area:

Doassansiaceae R.T. Moore ex P.M. Kirk, P.F. Cannon & J.C. David

Species forming spore balls. Teliospores are hyaline or weakly pigmented. Teliospores germinate with holobasidia, often with sigmoid basidiospores. Species have intercellular hyphae that form local interaction zones with a complex interaction apparatus containing cytoplasmic compartments. Haustoria are absent. The septal pore is simple with two membrane caps without inner plates.

Only one genus occurs in the area:

Doassansia Cornu

Sori on leaves, petioles, or stems, forming pale green, yellowish or brownish areas with numerous spore balls embedded in the host tissue, appearing as minute brown dots. Spore balls persistent, composed of a central mass of teliospores surrounded by a more or less distinct cortex of sterile cells. Spore germination of the *Tilletia*-type.

Key to species

- 1a. On leaves of *Epilobium* ***D. epilobii***, p. 233
- 1b. On leaves of *Ranunculus hyperboreus* ***D. nearctica***, not included

Entylomatales R. Bauer & Oberw.

Having intercellular hyphae that form local host-parasite interaction zones with a simple interaction apparatus. Haustoria absent. Teliospores and interaction apparatus with homogeneous contents; the septal pore is simple with two membrane caps.

Only one family:

Entylomataceae R. Bauer & Oberw.

Parasites on many different lineages of dicotyledons. Sori in vegetative organs of the host, mostly in leaves and petioles, rarely in stems or roots, usually forming few to numerous spots, sometimes swellings or galls are formed by hypertrophic growth of host tissue.

Teliospores permanently embedded in the host tissue, singly or in irregular groups, hyaline, yellow or yellowish brown, and usually with a smooth, two-layered wall; very rarely the outer layer is tuberculate or torn apart into prismatic, pyramidal or coarse and irregular pieces; often with a hyaline gelatinous sheath. Spore germination of the *Tilletia*-type.

Only one genus in the arctic-alpine area:

Entyloma de Bary

Key to species

- | | | |
|-----|--|---------------------------------|
| 1a. | On plants from the daisy family (Asteraceae) | 2 |
| 1b. | On plants from other families | 4 |
| 2a. | On <i>Arnica</i> | <i>E. arnicale</i> , p. 235 |
| 2b. | On other genera | 3 |
| 3a. | On <i>Erigeron</i> | <i>E. erigerontis</i> , p. 237 |
| 3b. | On <i>Leontodon</i> or <i>Scorzoneroides</i> | <i>E. leontodontis</i> , p. 241 |
| 4a. | On <i>Polemonium</i> | <i>E. lapponicum</i> , p. 239 |
| 4b. | On <i>Ranunculus</i> | <i>E. microsporum</i> , p. 243 |

Georgefischeriales R. Bauer, Begerow & Oberw.

Parasitic, sporulating in vegetative parts of the host, mostly in leaves. Local interaction zones without interaction apparatus in intercellular hyphae, and poreless septa at maturity. Intracellular hyphae and haustoria are lacking. Additionally, this order includes some species that are known from the anamorphic stage only.

Only one family in the area:

Georgefischeriaceae R. Bauer, Begerow & Oberw.

Characterized by formation of holobasidia and ballistosporic propagules and loss of septal pores at maturity.

Only one genus in the area:

Jamesdicksonia Thirum., Pavgi & Payak

Mostly parasites on Poaceae and Cyperaceae. Sori occurring in leaves, leaf sheaths or stems as black spots, pustules or crusts.

Teliospores solitary or in groups, not agglutinated in balls, darkly pigmented, embedded in the host tissue or erumpent, not powdery, or occurring on the surface of the plant and powdery. Spore germination results in a holobasidium with ballistic basidiospores or secondary ballistospores.

Based on molecular phylogenetic analyses two asexual yeast species, isolated from plant surfaces, were recently added to the genus.

Only one species in the arctic-alpine area, *J. dactylidis*, p. 245

Tilletiales Kreisel

Characterized by having local interaction zones without interaction apparatus in intercellular hyphae, and a dolipore without pore caps, traversed by two tripartite, membranous, symmetrically arranged plates. Sori formed in the ovaries of the hosts.

Teliospores darkly pigmented and mostly ornamented, germinating with holobasidia, and producing an apical whorl of basidiospores.

Parasitic on various genera of grasses.

Only one family in the area:

Tilletiaceae Tul.

Characters as for the order.

Only one genus in the area:

Tilletia Tul. & C. Tul.

Infection systemic or local. Sori on host plants in the Poaceae, most commonly in the ovaries, which fill with a semi-agglutinated or powdery spore mass intermixed with sterile cells. In some species the sori form on leaves and culms as streaks. Peridium and columella lacking.

Teliospores single, medium-sized to large, usually ornamented (reticulate, cerebriform, verrucose, tuberculate or with cylindrical projections), rarely smooth, often enclosed in a hyaline gelatinous sheath. Sterile cells usually present between the spores, solitary, variously shaped, smooth, but also weakly or clearly ornamented, hyaline or slightly pigmented, naked or sheathed. Teliospore germination by means of an aseptate basidium (holobasidium) bearing terminal basidiospores which often conjugate in situ, giving rise to infection hyphae, blastospores and ballistospores (secondary sporidia); or basidiospores numerous, acicular, giving rise to infection hyphae without conjugation.

Only one species in the area: *Tilletia cerebrina*, p. 247

Exobasidiales Lindau

Characters as for the only family:

Exobasidiaceae P. Henn.

Characters as for the genus:

Exobasidium Woronin

Syn.: *Arcticomyces* Savile

Parasitic on dicotyledons, in the arctic-alpine area generally on Ericaceae, with one species on herbs of Saxifragaceae. Mycelia short-lived and localised to perennial, surculicolous, deforming the host, causing more or less hypertrophied leaf-spot galls, deformed shoots, or "witches' brooms," and mostly colouring the diseased parts red. Well-defined basidioma absent; superficial hymenia of cylindric to clavate basidia emerge from intercellular unspecialized hyphae, mostly on the undersides of leaves, at first as a whitish bloom of discrete fascicles of basidia, and then in some species turning into a chalk-white continuous felt powdered by the spores.

Spores hyaline, non-septate or in most species with one transverse median septum when mature or at least when germinating, rarely more. Basidia non-septate, (2-)4(-8)-sterigmate. Germinating with small lanceolate blastoconidia.

The genus is very common in arctic-alpine regions basically due to the strong representation of the host plants in these areas. The hotspot of the genus is probably in Japan, where ca. 30 species occur, many of them local.

The genus *Arcticomyces* is recognized by some authors as it occurs on Saxifragaceae, whereas the other species of *Exobasidium* occur on Ericaceae.

Nannfeldt (1981) used terms like circumscribed (surrounded by healthy tissue) and surculicolous (a terminal, more or less hyaline to whitish, greenish or pink shoot) to describe the distribution of the parasite in the host. He applied a narrow species concept, recognizing that each host species (or genus) has its own parasitic species. His concept is followed here, but many of the species are still rarely found and studied. He identified most of the material in Copenhagen (C) for his monograph of the European species.

Exobasidium canadense Savile and *E. dimorphosporum* Savile are poorly known and are not included.

Key to species

- | | | |
|-----|--|------------------------------|
| 1a. | On plants from the heather family (Ericaceae)..... | 2 |
| 1b. | On <i>Saxifraga</i> ; systemic, preventing flowering; annual shoots with hypertrophied, pale, pinkish to purplish leaves, eventually becoming white and powdery on the lower surface | <i>E. warmingii</i> , p. 287 |
| 2a. | On <i>Vaccinium vitis-idaea</i> | 3 |
| 2b. | On other species of Ericaceae..... | 5 |

- 3a. On splendidly red leaves, slightly enlarged and rounded; annual, shoots often fasciculate; basidia 2-sterigmate; spores $20-27 \times 6-11.5 \mu\text{m}$, never septate..... *E. splendidum*, p. 279
- 3b. On dwarf red plants or on plants with thickened red-green leaves; spores $9-19 \times 2-24 \mu\text{m}$; basidia 4-spored 4
- 4a. With conspicuous, strongly thickened leaf-spots or leaf-concavity galls (ca. 1 cm across), bright red above; spores $11-19 \times 2-4 \mu\text{m}$ *E. vaccinii*, p. 283
- 4b. Systemic; infected plants dwarfed, richly and spreadingly branched; leaves thin, flat and soft, bright red all over; spores $9-11 \times 2-4 \mu\text{m}$, eventually 1-septate *E. juelianum*, p. 263
- 5a. On *Vaccinium uliginosum* 6
- 5b. On other species of Ericaceae..... 8
- 6a. Forming markedly thickened leaf-spots (ca. 0.5 cm across), pale yellowish to pale red *E. pachysporum*, p. 271
- 6b. On modified shoots..... 7
- 7a. On scattered annual shoots; leaves mostly moderately enlarged, upper side pale to bright red, underside eventually covered by a dense, continuous, chalk-white hymenium; basidia 2-sterigmate; spores $16-23 \times 6.5-9 \mu\text{m}$, never septate..... *E. vaccinii-uliginosi*, p. 285
- 7b. Stems or major branch-complexes with only slight ramification; upperside of leaves pale green to reddish, underside eventually with a dense white hymenium between the veins; basidia 4-sterigmate; spores $9-15 \times 2.5-4 \mu\text{m}$, finally 1-septate..... *E. expansum*, p. 259
- 8a. On *Vaccinium myrtillus* 9
- 8b. On other species of Ericaceae..... 10
- 9a. Scattered annual shoots; leaves moderately enlarged, whitish to bright red above; basidia 2-sterigmate; spores $15-28 \times 6-10 \mu\text{m}$, never septate *E. aequale*, p. 249
- 9b. Systemic; leaves mostly enlarged and often with broadly revolute margins, pale green to (rarely) bright red; sometimes of normal size or even diminished and then bright red; basidia 4-sterigmate; spores $10-16 \times 1.5-4 \mu\text{m}$, eventually 1-septate..... *E. myrtilli*, p. 269
- 10a. On *Cassiope*..... 11
- 10b. On other genera 12

- 11a. Scattered annual shoots; leaves strongly enlarged (up to 10×6 mm), soft, thin and flat with revolute margin, triangular with distinct hastate base, blood red or greenish white above; hymenium exclusively hypophyllous; red pedicels, sepals and spots on the inside of the corolla throat (as opposed to green pedicels and sepals and no corollar spots).....*E. hypogenum*, p. 261
- 11b. Scattered annual shoots, initially greenish to pinkish white, eventually hymenium-clad all over; leaves deformed (up to 6×3 mm), soft and thick, only indistinctly set off from the stem.....*E. cassiopes*, p. 255
- 12a. On *Arctostaphylos* 13
- 12b. On other genera 14
- 13a. On *Arctostaphylos alpina*; annual shoots fasciculate; leaves (yellowish) white to blood red above*E. angustisporum*, p. 251
- 13b. On *A. uva-ursi*; fascicles often very rich and dense, of more or less erect dark blood red annual shoots; infected leaves with hyphal palisade in the lower epidermis only*E. uvae-ursi*, p. 281
- 14a. On *Rhododendron* (including *Ledum*) 15
- 14b. On other genera 17
- 15a. On *Rhododendron albiflorum* in North America *E. burtii*, p. 253
- 15b. On other species of *Rhododendron* 16
- 16a. Flowers white, with a strongly aromatic spicy smell; not forming cm-large gall-apples (formerly *Ledum*)..... *E. ledi* p. 267
- 16b. Flowers reddish, cm-large, with a somewhat aromatic smell; forming cm-large green or red gall-apples*E. rhododendri* p. 275
- 17a. On *Andromeda polifolia*; shoots scattered or gregarious, often sprouting from subterranean parts; diseased stems mostly thin with leaves strongly broadened, dark, often almost blackish purple above*E. karstenii*, p. 265
- 17b. On other species of Ericaceae..... 18
- 18a. On *Empetrum nigrum*; only in coastal regions in Alaska and Japan; shoots red.....*E. empetri*, p. 257
- 18b. On other species of Ericaceae..... 19
- 19a. On *Phyllodoce**E. phyllodoce*s, p. 273
- 19b. On *Chamaedaphne calyculata*.....*E. savilei*, p. 277

Keys to arctic-alpine smut fungi based on host plant family

- Asteraceae** (Daisy family: *Arnica*, *Erigeron*, *Leontodon*, *Scorzoneroides*)
Sori in leaves; spores single..... *Entyloma*, p. 22
- Brassicaceae** (Cabbage family: *Arabidopsis*, *Arabis*, *Cardamine*,
Draba, *Noccaea*)
Sori in seeds; spores single..... *Thecaphora*, p. 11
- Caprifoliaceae** (Honeysuckle family: *Scabiosa*)
Sori in anthers; spores single *Microbotryum*, p. 7
- Caryophyllaceae** (Pink family: *Arenaria*, *Heliosperma*, *Minuartia*,
Sagina, *Silene*, *Stellaria*, *Viscaria*)
Sori in flowers, anthers, or destroying the seeds; spores single *Microbotryum*, p. 7
- Cyperaceae** (Sedge family: *Carex*, *Trichophorum*)
- 1a. Sori as black crusts on the leaf surface..... *Orphanomyces*, p. 19
1b. Sori otherwise 2
- 2a. Sori in female flowers, around aborted nuts; spores single 3
2b. Sori elsewhere..... 4
- 3a. Spores with a thick-walled equatorial band and
two thin-walled polar areas..... *Planetella*, p. 19
3b. Spores without an equatorial band..... *Anthracoidea*, p. 14
- 4a. Sori destroying the nutlets; spores in balls formed of spores only *Moreaua*, p. 18
4b. Sori occurring in leaves as long striae between the veins; spores in pairs
or in balls 5
- 5a. Spores joined in pairs *Schizonella*, p. 19
5b. Spores in balls; spore balls composed of one to several fertile spores,
surrounded by a layer of sterile cells *Urocystis*, p. 12
- Gentianaceae** (Gentian family: *Gentiana*)
Sori in ovules, filling the capsules with a spore mass; spores single *Microbotryum*, p. 7
- Juncaceae** (Rush family: *Juncus*, *Luzula*)
- 1a. Sori in spikelets or flowers; spores single *Stegocintractia*, p. 19
1b. Sori in the interior of the culms or occurring in leaves as long striae
between the veins; spores in balls; spore balls composed of one to
several fertile spores, surrounded by a layer of sterile cells *Urocystis*, p. 12
- Lentibulariaceae** (Bladderwort family: *Pinguicula*)
Sori in anthers; spores single *Microbotryum*, p. 7

Montiaceae (Spring Beauty family: *Claytonia*)Sori in seeds; spores single *Microbotryum*, p. 7**Onagraceae** (Willowherb family: *Epilobium*)Sori in leaves; spores in balls composed of a central spore mass surrounded by a multi-layered cortex of sterile cells *Doassansia*, p. 21**Poaceae** (Grass family: many genera)

- 1a. Spores in balls; spore balls composed of one to several fertile spores, surrounded by a layer of sterile cells *Urocystis*, p. 12
- 1b. Spores solitary or in groups, not agglutinated in balls 2
- 2a. Sori occurring in leaves as linear or ovoid spots; spores embedded in the leaf mesophyll, not powdery 3
- 2b. Spore mass powdery 4
- 3a. Sori light yellowish brown; spores hyaline. On *Pleuropogon*..... *Ustilentyloma*, p. 9
- 3b. Sori forming greenish grey to blackish spots; spores yellowish to blackish brown..... *Jamesdicksonia*, p. 23
- 4a. Sori in ovaries; spores longer than 20 μm *Tilletia*, p. 23
- 4b. Sori occurring in leaves, leaf sheaths, or culms as streaks between the veins; spores small to medium-sized, up to 19 μm long *Ustilago*, p. 20

Polemoniaceae (Jacob's-ladder family: *Polemonium*)Sori in leaves and stems; spores single..... *Entyloma*, p. 22**Polygonaceae** (Knotweed family: *Bistorta*, *Koenigia*, *Oxyria*, *Rumex*)Sori in stems, leaves, flowers or inflorescences; spores single *Microbotryum*, p. 7**Primulaceae** (Primrose family: *Lysimachia*, *Primula*)Sori in leaves and stems, or destroying the seeds; spores in balls..... *Urocystis*, p. 12**Ranunculaceae** (Buttercup family: *Aconitum*, *Callianthemum*, *Ranunculus*, *Thalictrum*, *Trautvetteria*)

- 1a. Spores single, embedded in the in the host tissue, not powdery *Entyloma*, p. 22
- 1b. Spores in balls composed of one to several fertile spores, surrounded by a layer of sterile cells; mass of spore balls powdery *Urocystis*, p. 12

Saxifragaceae (Saxifrage family: *Boykinia*, *Heuchera*, *Micranthes*)Sori in leaves; spores in balls *Urocystis*, p. 12

Keys to included species of tremelloids

Agaricomycotina Doweld

Basidioma fleshy or resupinate, dry or gelatinous, agaricoid or if gelatinous of varying shape.

Basidia holobasidia or heterobasidia; if heterobasidiate, basidia at maturity either cruciate-septate or transversely septate. Hyphae with dolipores and cupulate parenthosomes.

Spores one-celled or septate.

Saprotrophic, parasitic, mycorrhizal or lichenized.

Two classes:

Key to classes

- 1a. Basidia septate lengthwise or diagonally; basidiocarps often soft and jelly-like **Tremellomycetes**
- 1b. Basidia not septate; basidioma generally firm, fleshy, leathery or woody Agaricomycetes, see vols. 4-7

Tremellomycetes Hibbett, Matheny & Manfr. Binder

Basidioma present or absent; if present gelatinous, of variable size (mm to cm), also parasitic inside other fungi; if absent then occurring as a yeast.

Spores hyaline, septate or non-septate. Basidia septate, lengthwise or diagonally. Hyphae with dry or gelatinous walls.

Saprotrophic on wood or debris, or parasitic on other fungi.

Four orders:

Key to orders

- 1a. Basidioma yellow to orange; basidia (1-)2(3)-sterigmate, cylindrical, with two prominent sterigmata **Dacrymycetales**, p. 31
- 1b. Basidioma of other colours, or if yellow then basidia septate 2
- 2a. Growing in or on other fungi; basidioma gelatinous, sometimes jelly-like, irregular **Tremellales**, p. 30
- 2b. Growing on dead organic matter **Auriculariales**, p. 32

Tremellales Fr.

Basidioma variable in shape, size and colour, soft to firm gelatinous.

Spores hyaline, thin-walled, sterigmata often pronounced.

Parasitic on other fungi, both asco- and basidiomycetes.

Two families:

Key to families of Tremellales

- 1a. Basidioma large, 2-10 cm, pale to dark brown, with large irregular lobes **Phaeotremellaceae**
- 1b. Basidioma large to small, of various shapes and colours, but not brown with large flat lobes **Tremellaceae**

Phaeotremellaceae Yurkov & Boekhout

Basidioma large, 2-10 cm, pale to dark brown, of large, irregular lobes.

Spores hyaline, thin-walled.

Parasitic.

Only one genus in the area:

Phaeotremella Rea

Only one species in the area, *P. foliacea*, p. 289.

Tremellaceae Fr.

Basidioma variable in shape, size and colour, soft to firm gelatinous.

Spores hyaline, thin-walled, sterigma often pronounced.

Parasitic on other fungi, both ascomycetes and basidiomycetes.

An anamorph state is present in some species.

Only one genus in the area:

Tremella Pers.

Basidioma or yeast state or both present, gelatinous, hyaline, white, yellow, orange, from ca. 1 mm to several cm.

Spores hyaline, globose to broadly ellipsoid, thin-walled, with distinct apiculus.

Anamorph yeast-like stage present in some species.

Parasitic on other fungi.

The largest group of species parasitizes lichenized fungi, and has evolved adaptations to a small size, sometimes losing its perfect stage and developing a more drought-resistant stage.

In recent years numerous new species were described especially through the work of P. Diederich et al. (2022), all parasitizing lichens. Only a few of them occur in Arctic areas, whereas a number are known from e.g. the Alps and the Pyrenees. Their names are treated in Diederich et al. (2022).

Although in principle belonging to this work, we have chosen not to include them, since they were treated recently in large detail by those authors.

Another large group of *Tremella* species occur on larger species of pyrenomycetes on wood, e.g. *T. pyrenophila* on *Valsaria*, *T. translucens* on *Lophodermium*, *T. karstenii* on *Colpoma*, *T. indecorata* on *Diatrype*, *T. globospora* on *Diaporthe*, and *T. exigua* on *Cucurbitaria*.

A third group occurs on stereoid fungi and *Dacrymyces*: *Tremella encephala* on *Stereum sanguinolentum*, *T. polyporina* on *Postia*, *T. versicolor* on *Aleurodiscus lividocaeruleus* and

Peniophora nuda, *T. mycophaga* and *T. simplex* on *Aleurodiscus amorphous*, *T. sibirica** on *Gloeocystidiellum leucoxanthum*, *T. obscura* on *Dacrymyces/Ditiola* and *T. separans* on *Dacrymyces stillatus*. Most likely, every species of *Tremella* is parasitic on another fungus, although the exact species is not always known.

Key to species of *Tremella*

- 1a. Basidioma absent; occurring as a parasite in *Dacrymyces* *T. penetrans*, p. 297
- 1b. Basidioma present..... 2

- 2a. Basidiocarp bright yellow, 1-10 cm *T. mesenterica*, p. 295
- 2b. Basidiocarp hyaline or whitish, < 1 cm 3

- 3a. On *Gloeocystidiellum leucoxanthum* on wood of deciduous trees *T. sibirica*, p. 299
- 3b. On pyrenomycetes on branches of *Juniperus* or deciduous branches 4

- 4a. On the pyrenomycete *Colpoma juniperi* on *Juniperus*..... *T. karstenii*, p. 293
- 4b. On the pyrenomycete *Diatrype* on *Salix* and other deciduous trees..... *T. indecorata*, p. 291

Dacrymycetales Henn.

Only one family is treated:

Dacrymycetaceae Bref.

Key to genera

- 1a. Spores (0-)3-7 septate, 15-20 µm long *Guepiniopsis*, p. 32
- 1b. Spores 0-3-septate, 10-15 µm long..... *Dacrymyces*

Dacrymyces Nees

Basidioma gelatinous, yellow to orange, from a few mm to several cm in size, disc-shaped, clavate, truncate, irregular or resupinate.

Spores non-septate or often septate, hyaline, thin-walled. Basidia characteristic, as probasidia developing two forked epibasidia.

Saprotrophic on wood.

An anamorph yeast-like stage is present in some species.

Key to species of *Dacrymyces*

- 1a. Basidioma stipitate *D. capitatus*, p. 301
- 1b. Basidiocarp sessile..... 2

- 2a. Basidiocarps often associated with an orange anamorph of conidia; spores with thick septa; generally on conifers, but also on *Betula* and *Salix* *D. stillatus*, p. 305
- 2b. Basidiocarps not associated with an anamorph; spores with thin septa; on *Betula*, *Alnus*, and *Salix* *D. lacrymalis*, p. 303

Guepiniopsis Pat.

Only one species in the area, *G. suecica*, p. 307.

Auriculariales J. Schröt.

Key to family and genus of unknown relationship

- 1a. Basidia produced laterally and terminally in compact clusters as short outgrowths on a main hypha, collapsing at maturity to form conspicuous withered involucre resembling brooms *Basidiodendron*, p. 34
- 1b. Basidia produced singularly or in groups or palisades, not leaving conspicuous involucre at base **Auriculariaceae**

Auriculariaceae Lindau

Basidioma gelatinous, rarely dry, of very variable shape, corticioid, stereoid, or jelly-like gelatinous, variously brown, grey, white or black.

Spores of various shape, subglobose to obovoid or allantoid, hyaline, thin-walled, often with granulose contents, repetitive. Cystidia absent, but gelatinous hyphal ends may be present.

Clamp connections present or absent. Hyphae generally narrow, dry or slightly gelatinous to strongly gelatinous.

Saprotrophic on wood.

Key to genera

- 1a. Basidioma a yellow-brown to brown dry crust 2
- 1b. Basidioma hyaline, gelatinous or if crust-shaped then whitish 3
- 2a. Basidioma 1-5 cm in diameter, ca. 1 mm thick, with coarse, mm-large scattered hyphal pegs; sharply delimited from the substrate *Heteroradulum*, p. 34
- 2b. Basidioma a several cm long, ca. 0.5 mm thick crust, \pm smooth, with effused margin *Sclerotrema*, p. 34
- 3a. Basidioma fleshy, discoid, turbinate or cerebriform; hyphidia absent *Exidia*, p. 33
- 3b. Basidioma resupinate, corticioid; hyphidia present; cystidia present in some species 4
- 4a. Basidioma gelatinous, hyaline or pink *Exidiopsis*, p. 33
- 4b. Basidioma dry, not hyaline, whitish grey *Alloexidiopsis*, p. 33

Alloexidiopsis L.W. Zhou & S.L. Liu

Only one species in the area, *A. calcea*, p. 309

Exidia Fr.

Basidioma distinctly gelatinous, hyaline, whitish, pale to dark brown or black, few to many cm long, irregular, turbinate, brain-like, crust-like, or of similar irregular shape.

Spores allantoid, thin-walled, granulose, hyaline, repetitive. Probasidia globose-ovoid, granulose, partitioning into 2-4 long epibasidia. Clamp connections present. Hyphae thin, 1-3 μm broad.

Cystidia absent.

Saprotrophic on wood.

Key to species

- 1a. Basidiocarp pale to dark brown 2
- 1b. Basidiocarp hyaline-whitish or black 4

- 2a. On *Salix*; basidiocarp 1-2 cm, soft gelatinous, obconical, contracted at base, partly transparent, pale to dark brown *E. recisa*, p. 315
- 2b. On *Betula*; basidiocarp up to several cm, firm gelatinous, almost crust-shaped 3

- 3a. Basidiocarp 1-2 cm, pulvinate, confluent at maturity, brown *E. repanda*, p. 317
- 3b. Basidiocarp \pm crust-shaped, tough gelatinous, pale brown to whitish *E. cartilaginea*, p. 311

- 4a. Basidiocarp dark grey to black, of several confluent pulvinate-globose parts, finally glandular-brain-like, tough gelatinous, 0.5-1 cm high, several cm long *E. glandulosa*, p. 313
- 4b. Basidiocarp hyaline-whitish; several confluent pulvinate-globose parts, irregular, 1-several cm long, up to 0.5 cm high *E. thuretiana*, p. 319

Exidiopsis Vuill.

Basidioma resupinate, slightly gelatinous to dry, pale coloured, brownish to pink or bluish.

Spores allantoid, thin-walled, hyaline, granulose, repetitive. Probasidia ellipsoid, separating into 2-4 epibasidia; epibasidia with long sterigmata. Clamp connections present, distinct. Hyphae not or only slightly gelatinized, 1-2 μm broad.

Saprotrophic on wood of deciduous shrubs.

Key to species

- 1a. Basidioma with pink or bluish notes; loose bundles of hyphae absent; spores allantoid, 4-5 μm broad *E. effusa*, p. 323
- 1b. Basidioma pale grey-brown, waxy-transparent; spores allantoid, 5-7 μm broad 2

- 2a. Loose bundles of hyphae present; dendrophyses present.....*E. arctica*, p. 321
 2b. Loose bundles of hyphae absent; dendrophyses absent.....*E. pallida*, p. 325

***Heteroradulum* Lloyd**

Only one species, *H. deglubens*, p. 327.

***Sclerotrema* Spirin & Malysheva**

Only one species, *S. griseobrunnea*, p. 329.

Unknown family

***Basidiodendron* Rick**

Basidioma resupinate, densely attached, gelatinous-waxlike, grey, 0.1-0.2 mm thick.

Spores subglobose, thin-walled, granulose, in congo red appearing distinctly grey, repetitive.

Probasidia ellipsoid, separating in four epibasidia. Gloeocystidia irregular to sac-shaped, resembling cystidia, with some pale brownish contents. Hyphidia absent. Hyphae indistinct, irregular.

On rotten wood of deciduous shrubs like *Salix*.

Key to species

- 1a. Spores obovoid, 7-11 × 6-8.5 μm.....*B. cinereum*, p. 333
 1b. Spores subglobose 2
- 2a. Spores 6.5-9 μm in diameter;*B. caesiocinereum*, p. 331
 2b. Spores 3-5 μm in diameter *B. eyrei*, p. 335

Saccosoma: Phleogenaceae: Atractiellales



Saccosoma farinaceum

HK 92.135e; C-F-153246; Switzerland

Saccosoma farinaceum (Höhn.) Spirin & K. Pöldmaa, including f. *alniviridis* Bourdot

Syn.: *Helicobasidium farinaceum* Höhn.; *Saccoblastia pinicola* Bourdot & Galzin;
Helicogloea farinacea (Höhn.) Rogers

Basidioma resupinate, corticioid, rather thick and waxy with effused margin, several cm long and broad, crème or beige, margin byssoid. **Spores** 11–17 × 8–12 µm, hyaline, broadly ellipsoid, repetitive, thin-walled. **Probasidia** sac-shaped, hanging, 30–60 × 10–15 µm; **metabasidia** hyaline, cylindric or narrowly clavate, 70–140 × 8–12 µm, with basal clamp connection, septate, 2–3–4-spored. **Hyphae** hyaline, thin-walled to slightly thick-walled, 3–5 µm broad, with clamp connections.

Habitat

A rare and poorly known species, seemingly preferring subalpine localities on *Alnus alnobetula* and *Pinus*.

Distribution

(Arctic)-alpine; North American–Eurasian; type 9; found in the Alps, the Pyrenees, the Tatras (1200 m), Russia (Chukotka, Kamchatka), and Canada (Yukon).



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum adenopetalae A. Chlebicki & M. Suková s.n.; PRM 907411; Kazakhstan

Microbotryum adenopetalae M. Lutz, Kemler & Chleb.

Infection systemic. **Sori** in deformed and swollen flowers, enclosed by calyx, destroying the anthers; ovary and styles aborted. Spore mass filling affected flower completely, pulverulent, dark purple.

Spores subglobose, globose, or broadly ellipsoid, $6-8(-9) \times 5.5-7.5(-8) \mu\text{m}$, light vinaceous, reticulate; meshes 5–7 per spore diameter, $(0.6-)0.8-1.0(-1.2) \mu\text{m}$ long, muri $0.3-0.5 \mu\text{m}$ high, interspaces smooth or finely rough.

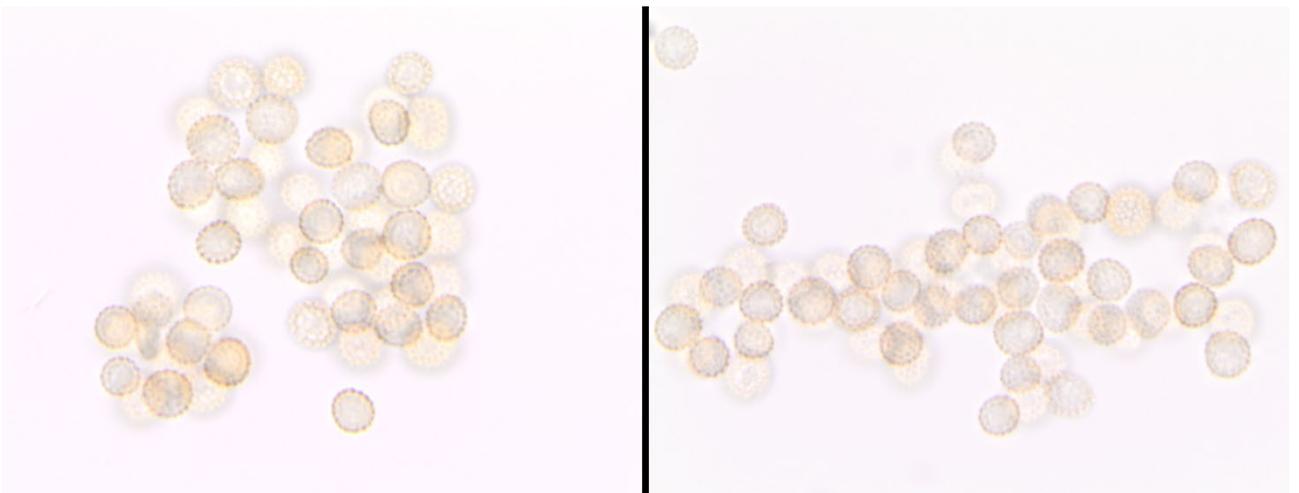
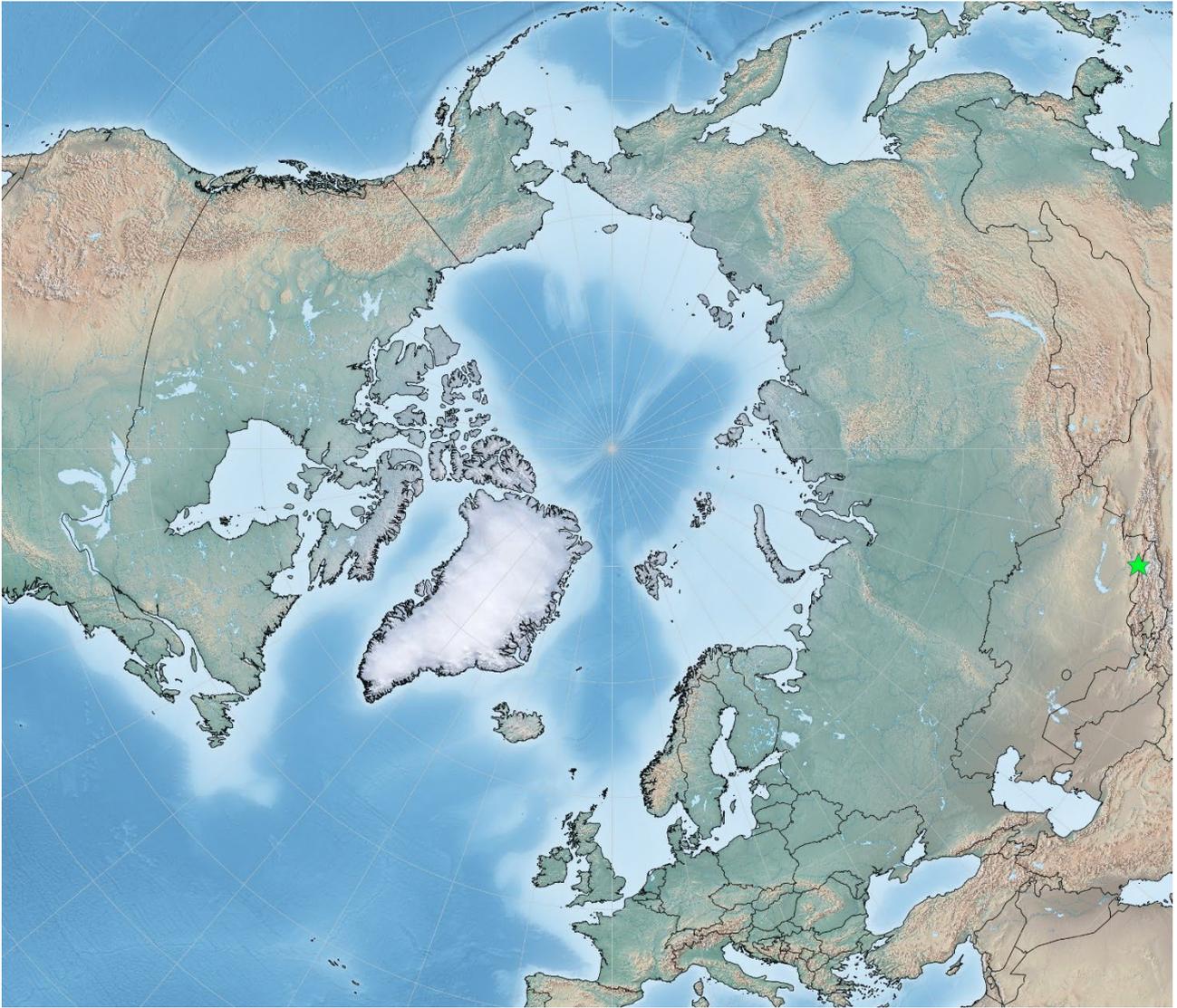
Habitats and host plants

Alpine rocky slopes.

Caryophyllaceae: *Silene adenopetala*.

Distribution

Alpine; Eurasian; type 15; found in alpine Tian Shan (KZ). Very rarely reported.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum alpinum J. I. Liro et al., *Mycoth. Fenn.* 515; MA-Fungi 29009; Finland

Microbotryum alpinum R. Ziegler, M. Lutz & Piątek

Infection systemic. **Sori** in the anthers of the infected flower; spore mass powdery, dark purple.

Spores globose, subglobose, or broadly ellipsoid, sometimes ovoid, (5–)6–9.5(–10.5) × (5–)5.5–8 μm, light to medium vinaceous, reticulate; spore wall (0.5–)1.0 μm thick, meshes (4–)5–7(–9) per spore diameter, polyhedral, interspaces smooth.

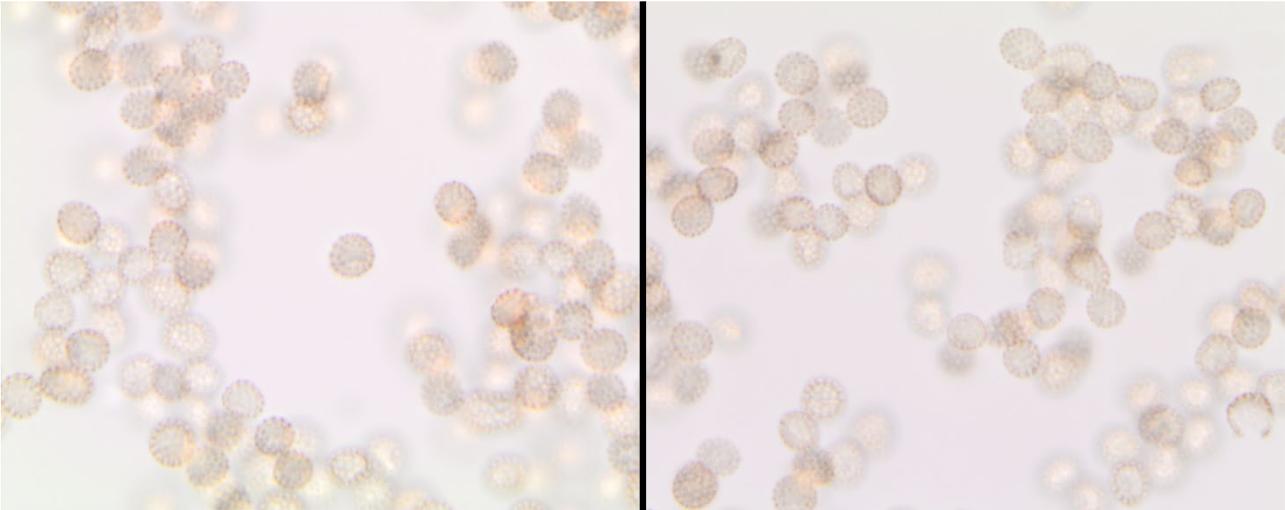
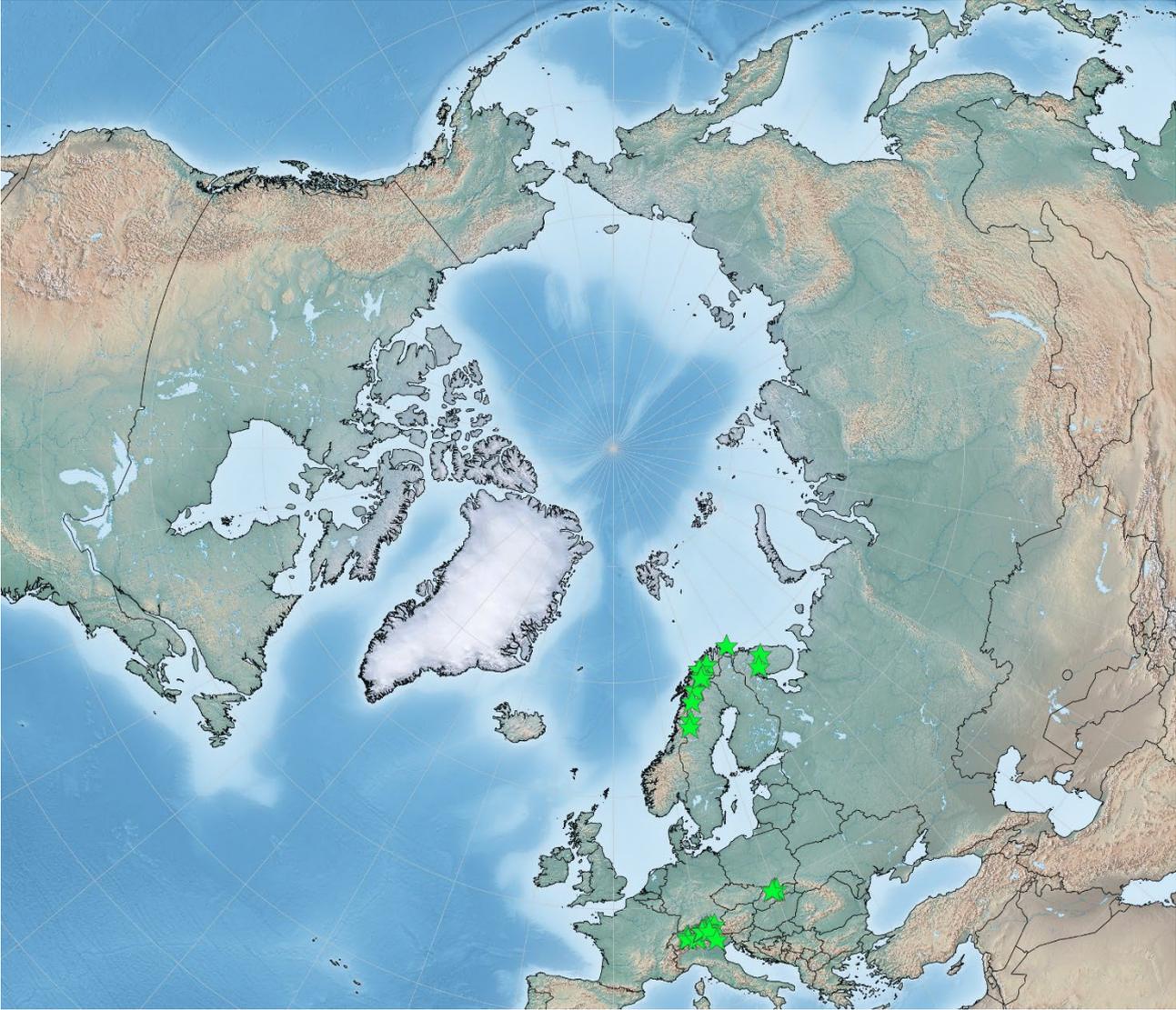
Habitats and host plants

Bogs and wet places in arctic, subarctic, and subalpine biomes; northern Europe and Central European mountains.

Lentibulariaceae: *Pinguicula alpina*.

Distribution

Arctic-alpine; Eurasian; type 9; found in arctic Norway and Russia, and in the alpine Scandinavian Mts. (NO, SE, FI), the Alps (DE, CH, AT, IT), the Tatras (PL, SK), and the Khibiny Mts. (RU). Common in the Scandinavian Mts, the Alps, and the Tatras.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum arcticum

D. B. O. Savile et al. 3925; DAOM 66883; Canada (NU)

Microbotryum arcticum T. Denchev, Denchev, Kemler & Begerow

Infection systemic. **Sori** in the considerably swollen anthers, filling the pollen sacs with a pulverulent, dark livid or livid vinaceous spore mass.

Spores subglobose, globose, broadly ellipsoid, or ovoid, sometimes ellipsoid or slightly irregular, (5–)5.5–7.5(–8.5) × (4.5–)5–6.5(–7.5) μm, pale vinaceous; spore wall reticulate, 0.8–1.3(–1.5) μm thick including reticulum, meshes 5–8(–9) per spore diameter, polyhedral or irregular, 0.3–1.0(–1.5) μm long, muri (15–)16–21(–23) on equatorial circumference, up to 0.4 μm high.

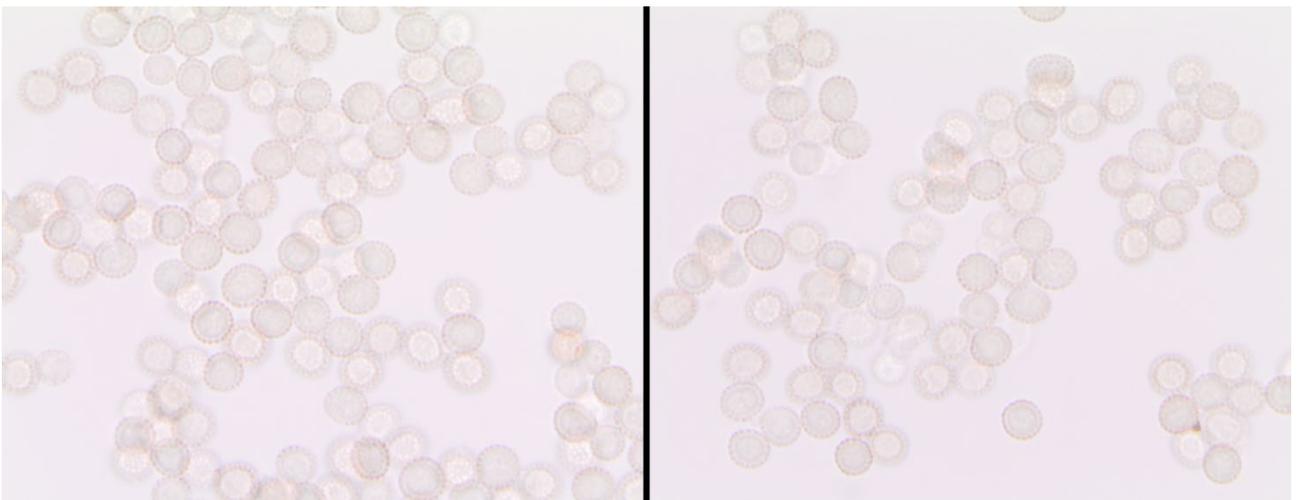
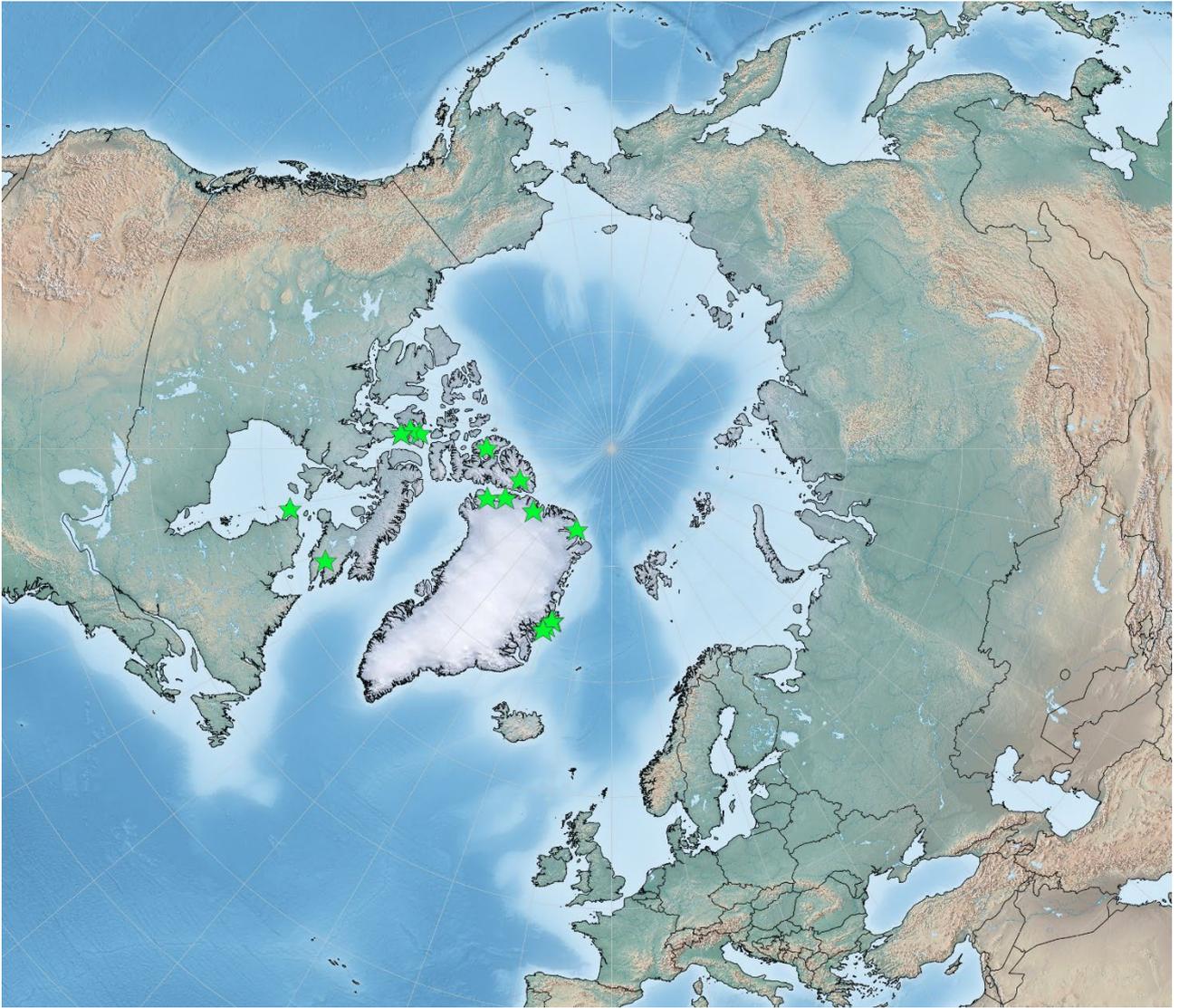
Habitats and host plants

Arctic tundra, gravelly and grassy places.

Caryophyllaceae: *Silene uralensis* subsp. *arctica*.

Distribution

Arctic; North American; type 12; found in arctic Canada (Nunavut), and Greenland. Rarely reported.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum bistortarum

SAE-2017.157-GR; C-F-107750

Microbotryum bistortarum (DC.) Vánky

Syn.: *Ustilago candollei* Tul. & C. Tul.; *U. inflorescentiae* (Trel.) Maire;
Sphacelotheca borealis (G.P. Clinton) Schellenb.; *S. polygoni-vivipari* Schellenb.

Infection systemic. **Sori** in all flowers of an infected plant; spore mass semi-agglutinated to powdery, dark reddish brown.

Spores subglobose, slightly irregular, broadly ellipsoid, ovoid, globose, or ellipsoid, (8.5–)9.5–15.5(–17) × (8–)9.5–13.5(–15) μm, medium vinaceous; spore wall 0.7–1.2 μm thick, moderately verruculose, warts up to 0.4(–0.5) μm high, spore profile affected. Immature hyaline spores with smooth or verruculose wall may be present.

Habitats and host plants

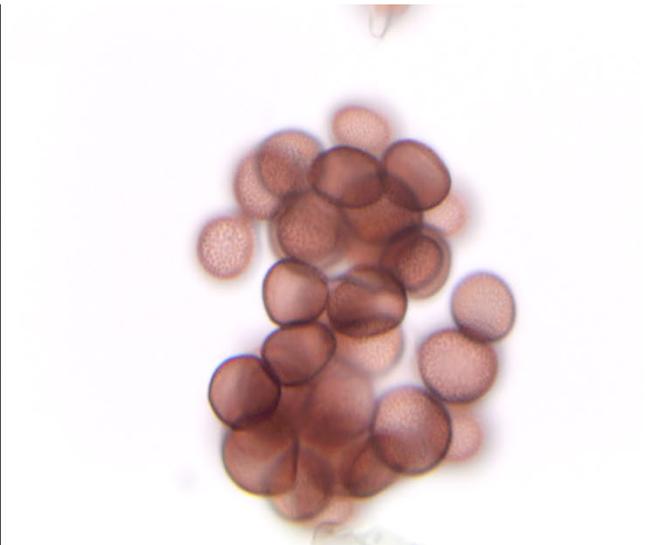
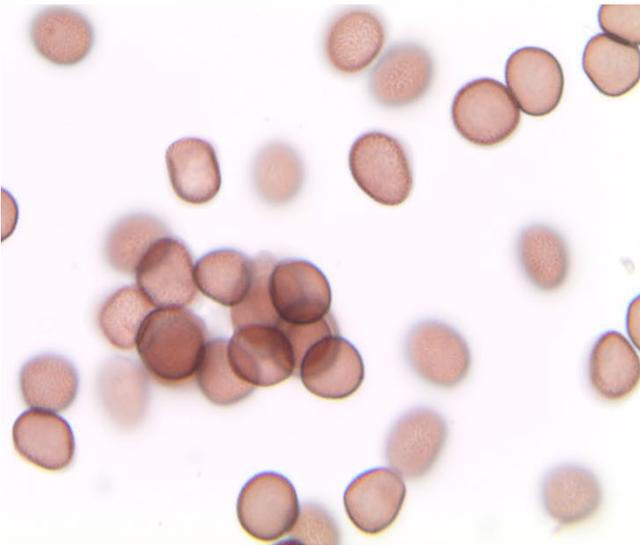
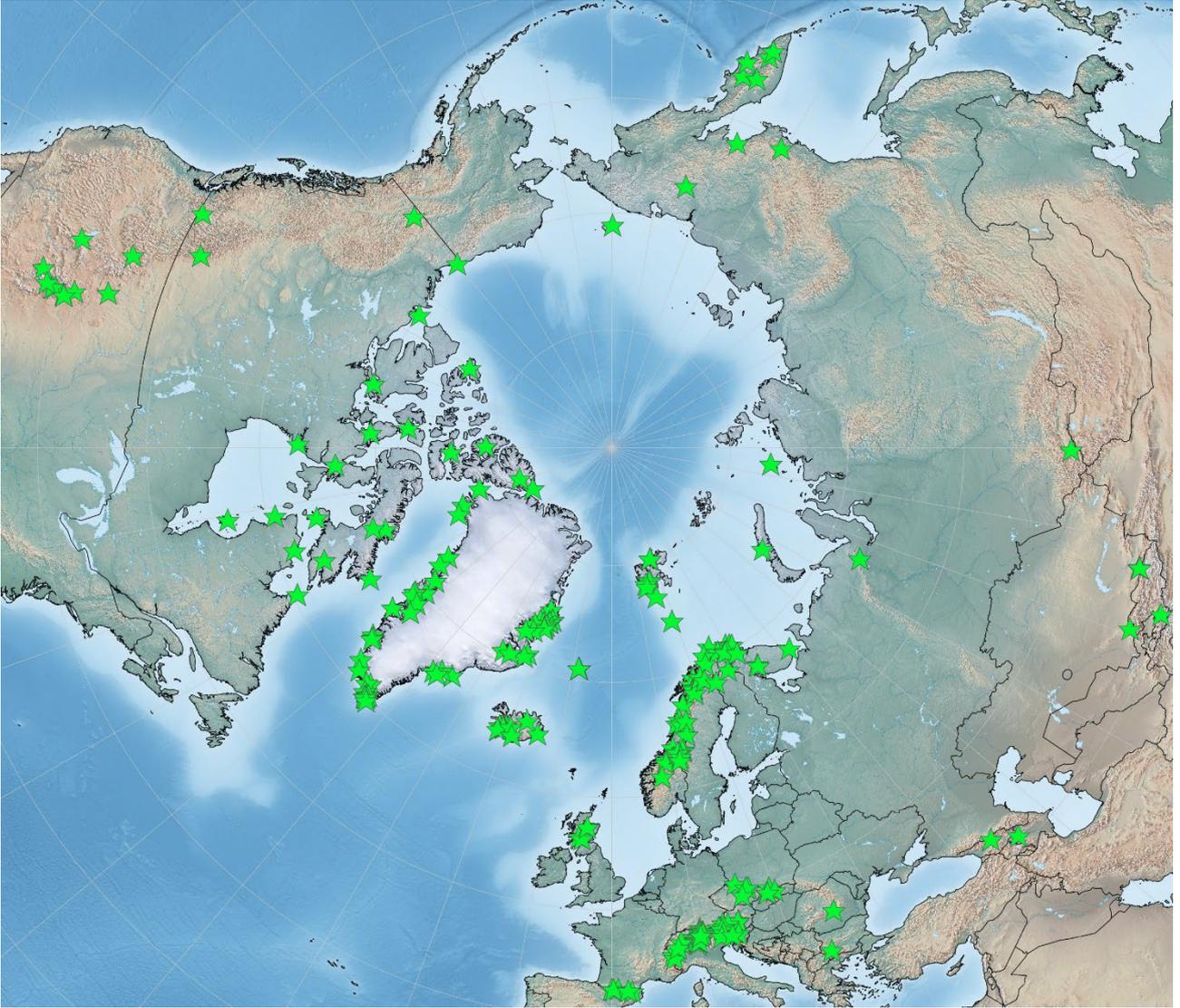
Arctic and alpine tundra and high mountains; around ponds, along streams, river terraces, moist rock crevices and moss-covered turf, moist subalpine woods and meadows, alpine slopes and meadows.

Polygonaceae: *Bistorta* species: in arctic-alpine regions *Bistorta bistortoides*

(*Polygonum bistortoides*), *Bistorta elliptica* (*P. nitens*), *Bistorta officinalis* (*P. bistorta*, *B. major*), *B. plumosa* (*P. bistorta* subsp. *plumosum*), and *B. vivipara* (*P. viviparum*).

Distribution

Arctic-alpine; circumpolar; type 1; in arctic CAN (BC, YT, NT, NU, QC), GR, IS, Svalbard, JAN, NO and RU, and in the alpine Alaska-Yukon Ranges (CAN: YT), the Rocky Mts. (CAN, USA), NO including Dovre, SE, FI, the Khibiny Mts. (RU), the Alps (DE, FR, CH, AT, IT, SI), Sudetes (CZ), Tatras (PL, SK), Carpathians (RO), Pyrenees (FR, ES, AD), and Rila Mts. (BG), the Anyuy Range, Chersky Range, Kolyma Highlands, Kamchatka, and the Altai Mts. (RU), and Tian Shan (KZ, KG). A very common species; one of the most widespread smut fungi in the Arctic, where it is very often reported on *Bistorta vivipara*.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum bosniacum Oberwinkler et al., Vánky *Ustilagin.* 632; SOMF 19560; Italy

Microbotryum bosniacum (Beck) Vánky

Syn.: *Ustilago bosniaca* Beck; *Sphacelotheca bosniaca* (Beck) Maire; *S. alpina* Schellenb.

Infection systemic. **Sori** mainly in the inflorescence, in swollen flowers, pedicels, and peduncles; sometimes occurring in leaves as long fusiform swellings on the midrib, which split longitudinally. Sori initially covered by a whitish to brown peridium formed of host tissue and hyphae that ruptures irregularly to expose a purplish, powdery spore mass.

Spores variable in shape and size, globose, broadly ellipsoid, ovoid, pyriform, or irregularly elongate, $10\text{--}18\text{ (–}22) \times 9\text{--}15.5\ \mu\text{m}$, vinaceous; spore wall densely and finely verruculose to verruculose-reticulate.

Habitats and host plants

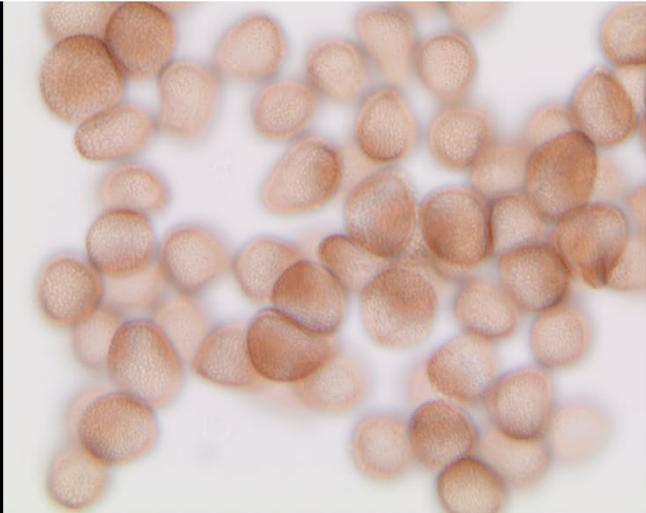
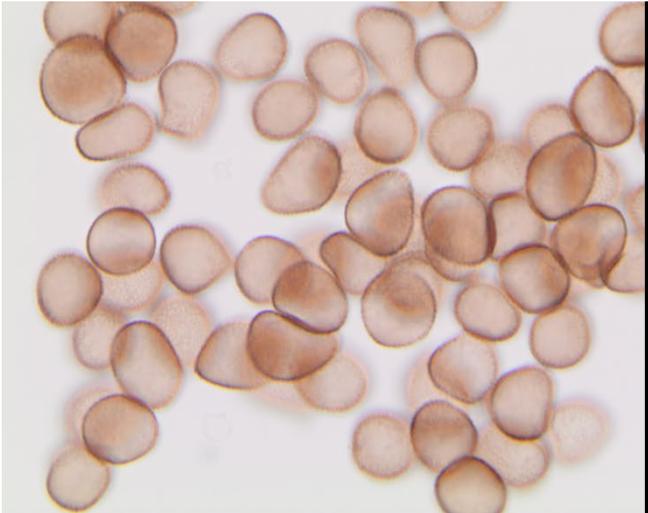
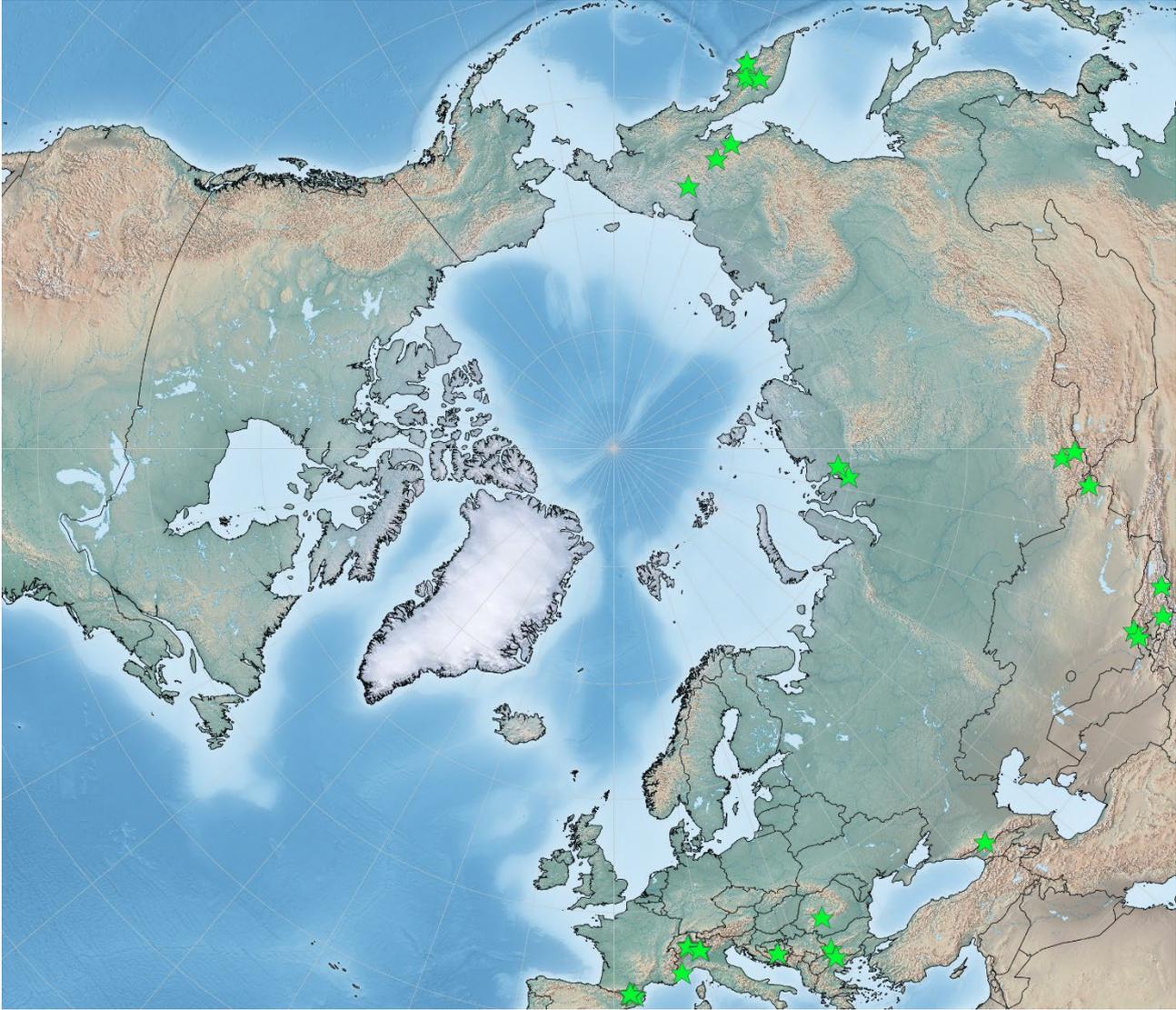
Forest margins, mountain slopes and valleys, steep subalpine grassy slopes; in tundra along sandy riverbanks, seashores, on rocky slopes.

Polygonaceae: *Koenigia*: in the arctic-alpine region *Koenigia alpina* (*Polygonum alpinum*),

Koenigia coriaria (*Polygonum coriarium*, *Polygonum bucharicum*), *Koenigia ocreata* (*Aconogonon ocreatum* var. *riparium*, *Polygonum laxmannii*), *Koenigia songarica* (*Polygonum songaricum*), and *Koenigia tripterocarpa* (*Polygonum tripterocarpum*).

Distribution

Arctic-alpine; Eurasian; type 9; found in arctic RU, and in alpine regions of the Alps (FR, CH, IT), Carpathians (RO), Pyrenees (FR, ES, AD), Dinaric Alps (BA), Mt. Vitosha, and the Rila and Pirin Mts. (BG), the Anyuy Range, Kolyma Highlands, Kamchatka, and the Sayan Mts. (RU), the Altai Mts. (RU, KZ), the Pamir-Alay Range (KG), and Tian Shan (KZ, UZ, KG). Common in some high mountains in central and southern Europe. Although it is a conspicuous species, it is probably an overlooked and more widespread smut fungus than currently known.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum claytoniae

B. Sullins & G. Zundel s.n.; W 1924-175; USA

Microbotryum claytoniae (Shear) Vánky

Syn.: *Ustilago claytoniae* Shear

Infection systemic. **Sori** in seeds, surrounding their remains with a purplish black, agglutinated to powdery spore mass.

Spores globose, subglobose, or broadly ellipsoid, 13–16(–19) × (12–)13–15(–17) μm, light purplish; spore wall even, 1.5–2.5(–3) μm thick, reticulate, 6–10 rounded meshes per spore diameter, muri 1–2(–2.5) μm high, in median view with blunt edges.

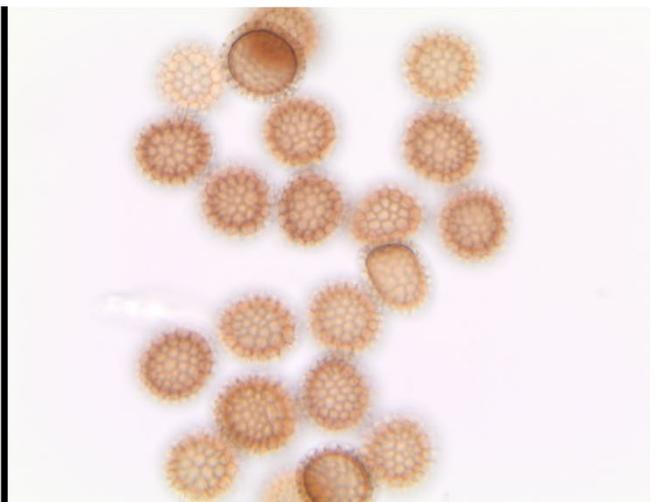
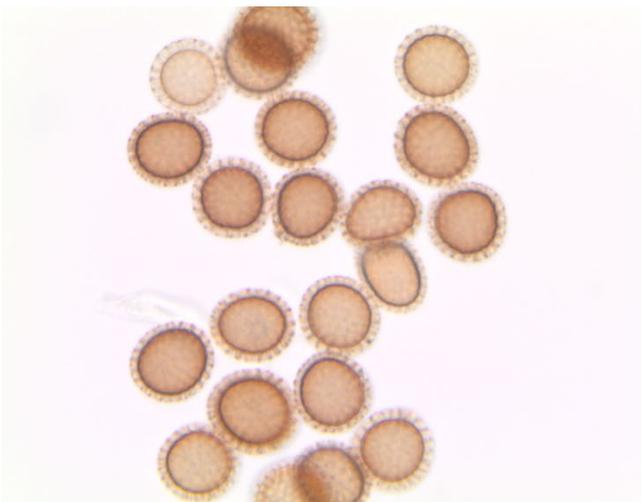
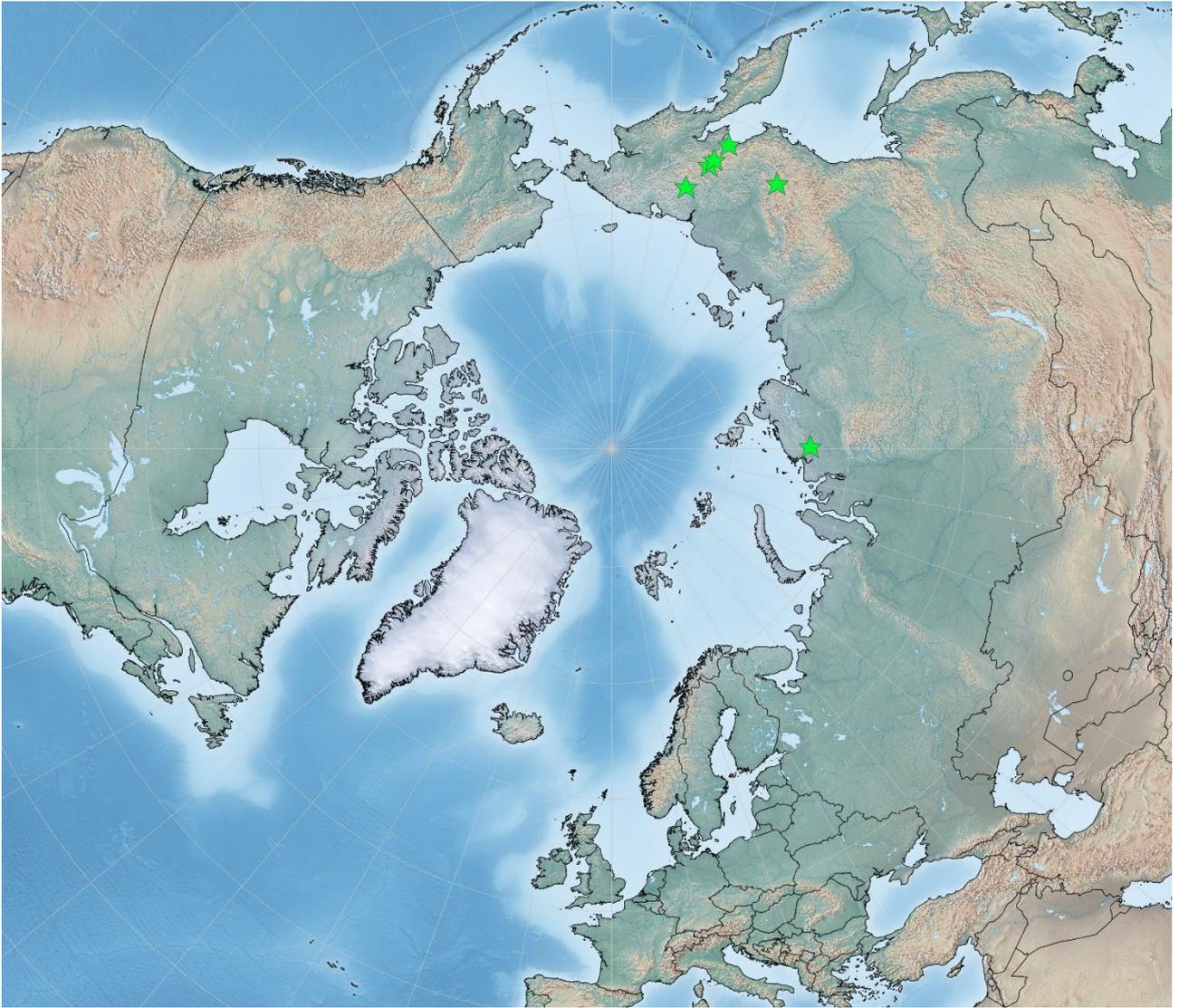
Habitats and host plants

Marshy ground in moss and lichen tundra and alder and birch thickets; snowbeds, rocks, and gravel; scree of mountain slopes.

Montiaceae: *Claytonia* species and *Montia linearis* (*Claytonia linearis*); in the arctic-alpine region *C. acutifolia* and *C. joanneana*.

Distribution

Arctic-alpine; Eurasian; type 9; found in arctic Russia, and in the alpine Anyuy Range, Kolyma Highlands, and Chersky Range (RU). Very rarely reported.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum goeppertianum

Microbotryum goeppertianum (J. Schröt.) Vánky

Syn.: *Ustilago goeppertiana* J. Schröt.

Infection systemic. **Sori** in leaves and petioles forming purplish round spots, sometimes occupying the whole leaf, less commonly in the flowers; spore mass semi-agglutinated to powdery, pale ochre or flesh-coloured.

Spores globose, subglobose, or broadly ellipsoid, 12–20 × 11–17 µm, hyaline to pale yellowish brown; spore wall 1.5–2 µm thick, very finely reticulate, 8–14 meshes per spore diameter, meshes 0.5–1.5 µm wide, muri 1–1.5 µm high, in median view the meshes appear as spines.

H. Roivainen 62; TROM 39212; Norway

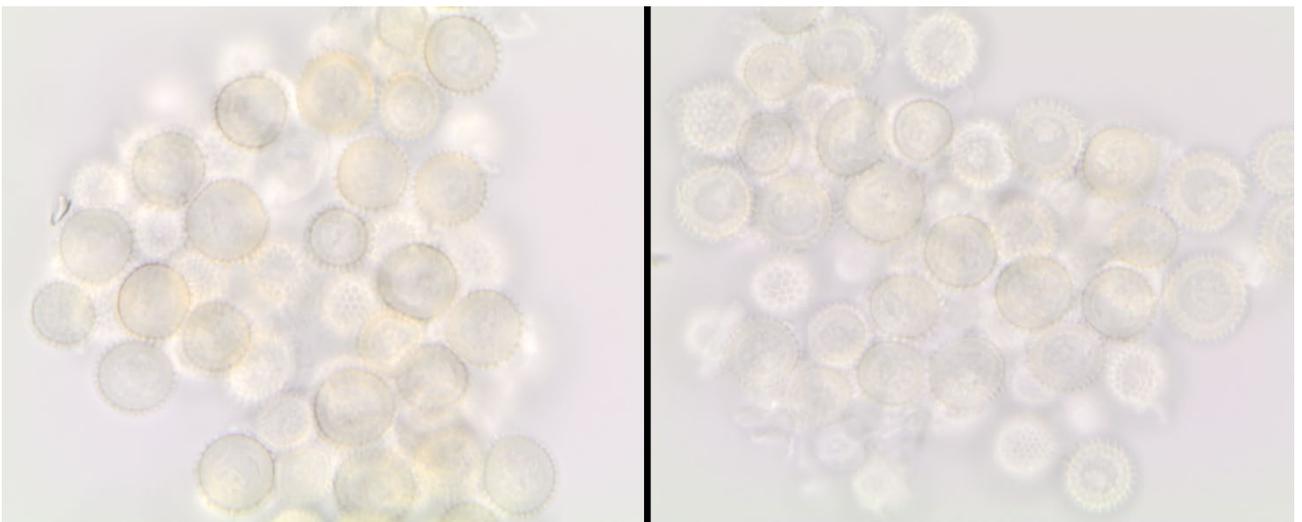
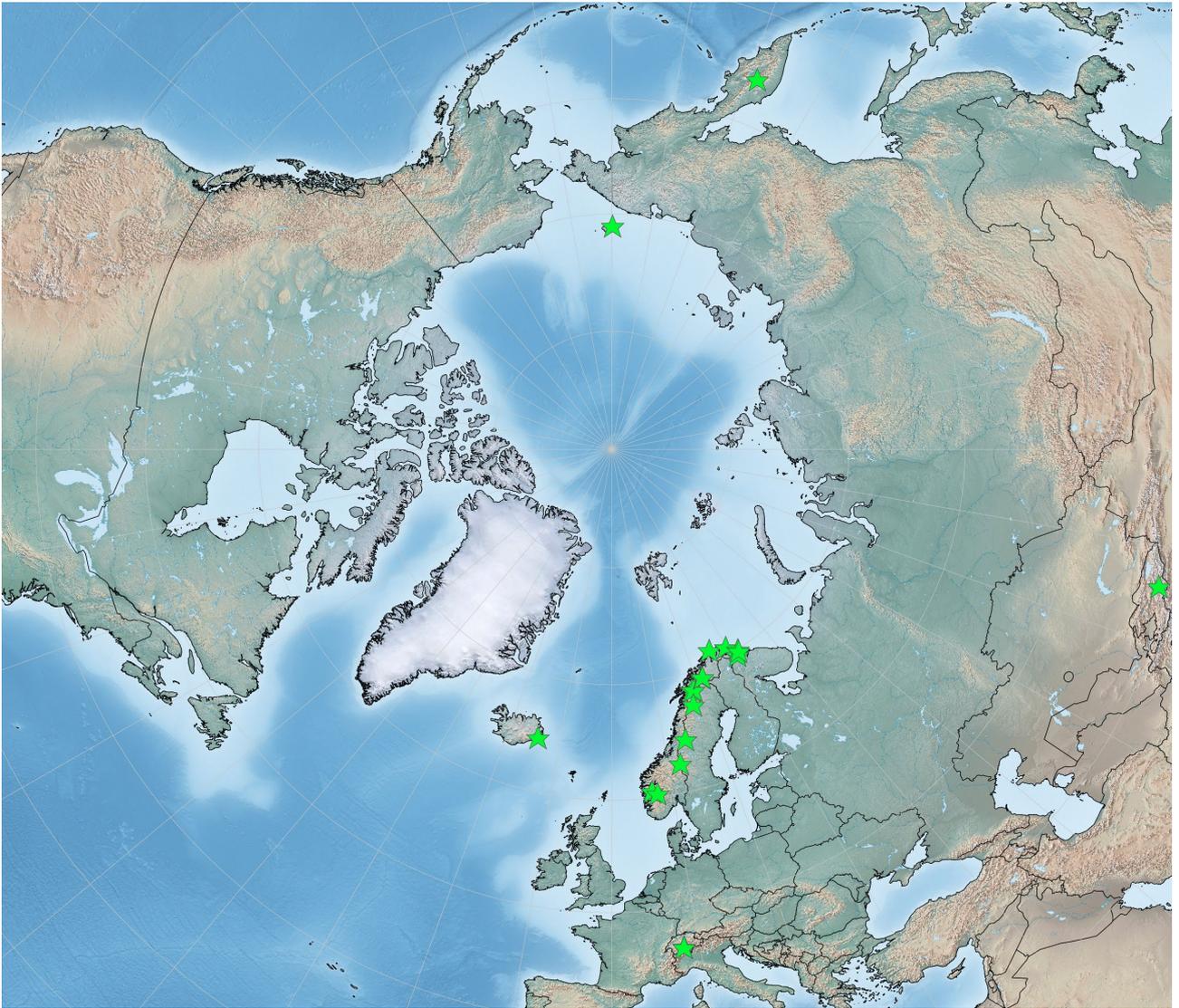
Habitats and host plants

Meadows, rock outcrops, alluvial habitats along rivers and streams in tundra and subalpine zones; high mountain vegetation.

Polygonaceae: *Rumex*: in the arctic-alpine region *Rumex acetosa*, *R. arifolius*, and *R. lapponicus* (*R. alpestris* auct. non Jacq.).

Distribution

Arctic-alpine; Eurasian; type 9; in arctic Iceland, Norway, and Russia, and in the alpine Scandinavian Mts. (SE, FI), Dovre (NO), the Alps (CH), Kamchatka (RU), and Tian Shan (KG). Very rarely reported.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum heliospermatis T. T. & C. M. Denchev 1979; SOMF 30382; Bulgaria

Microbotryum heliospermatis Piątek & M. Lutz (“*heliospermae*”)

Infection systemic. **Sori** in the considerably swollen anthers, filling the pollen sacs with a pulverulent, sepia or date brown spore mass.

Spores subglobose, globose, broadly ellipsoid, ovoid, slightly irregular, or ellipsoid, (5.5–)6–8.5(–9.5) × (5–)5.5–7.5(–8.5) μm, light livid vinaceous; spore wall reticulate, 0.8–1.3(–1.5) μm thick including reticulum, meshes 6–9(–11) per spore diameter, polyhedral or irregular, 0.3–1.0(–1.3) μm wide, muri 0.15–0.35 μm high.

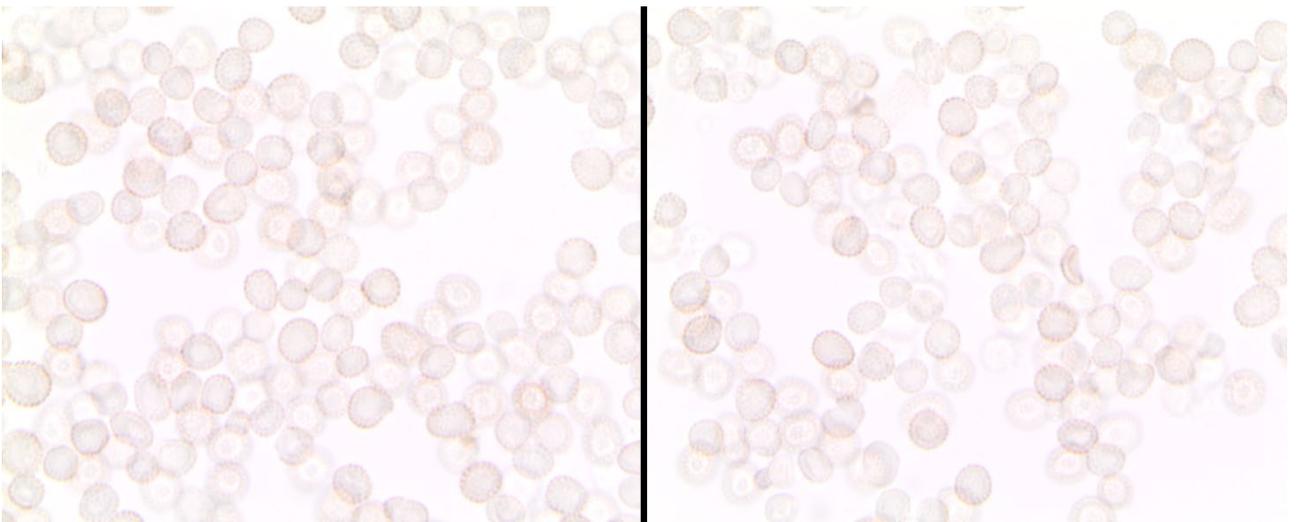
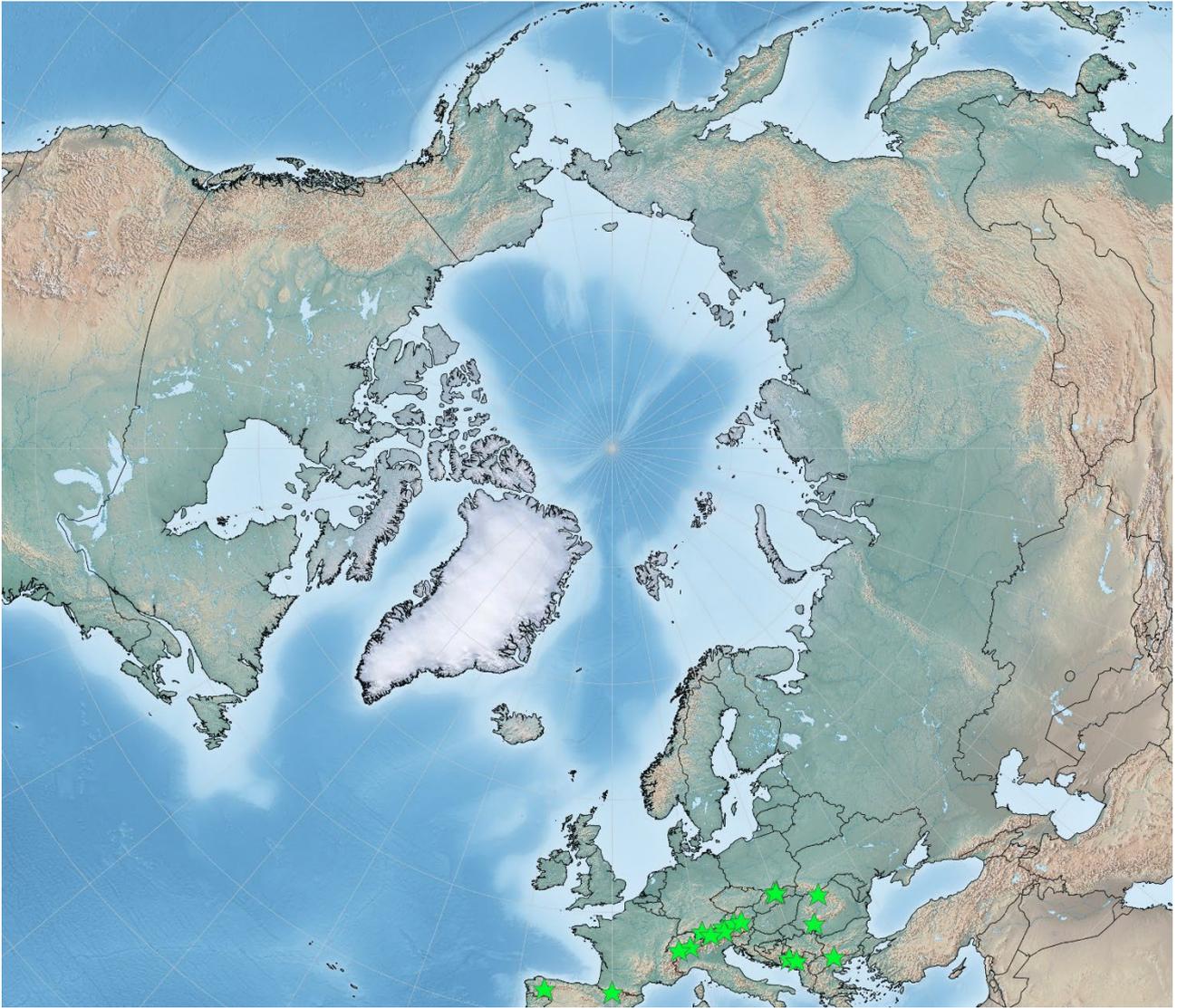
Habitats and host plants

High mountain vegetation, rocks, ravines, and boulders.

Caryophyllaceae: *Heliosperma pusillum* (*Silene pusilla*, *H. quadridentatum* auct.)

Distribution

Alpine; Eurasian; type 15; found in the Alps (DE, CH, AT), Tatras (PL, SK), Carpathians (RO), Pyrenees (FR), Cantabrian Mts. (ES), Dinaric Alps (ME), and Pirin Mts. (BG). Common.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum intermedium

T. T. & C. M. Denchev 1814; SOMF; Bulgaria

Microbotryum intermedium (J. Schröt.) Vánky

Syn.: *Ustilago intermedia* J. Schröt.

Infection systemic. **Sori** in anthers filling the flowers with a powdery, dark purple spore mass.

Spores globose, subglobose, broadly ellipsoid, or ovoid, 10–16(–20) × 9–14.5 μm, pale vinaceous; spore wall finely reticulate, 6–10 meshes per spore diameter, muri ca. 1 μm high, marginal wings not conspicuous.

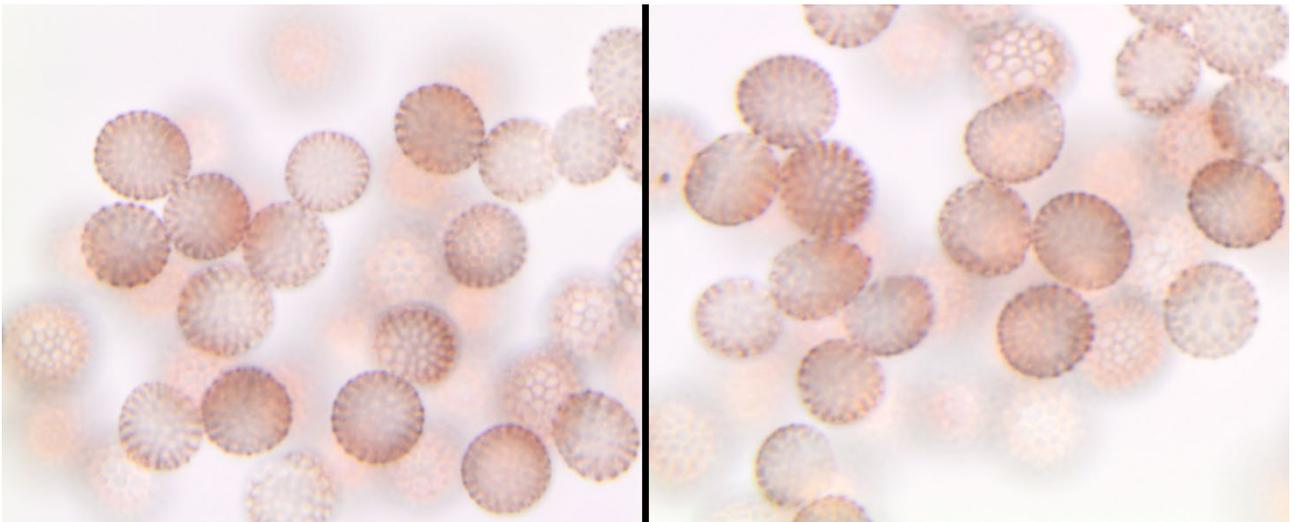
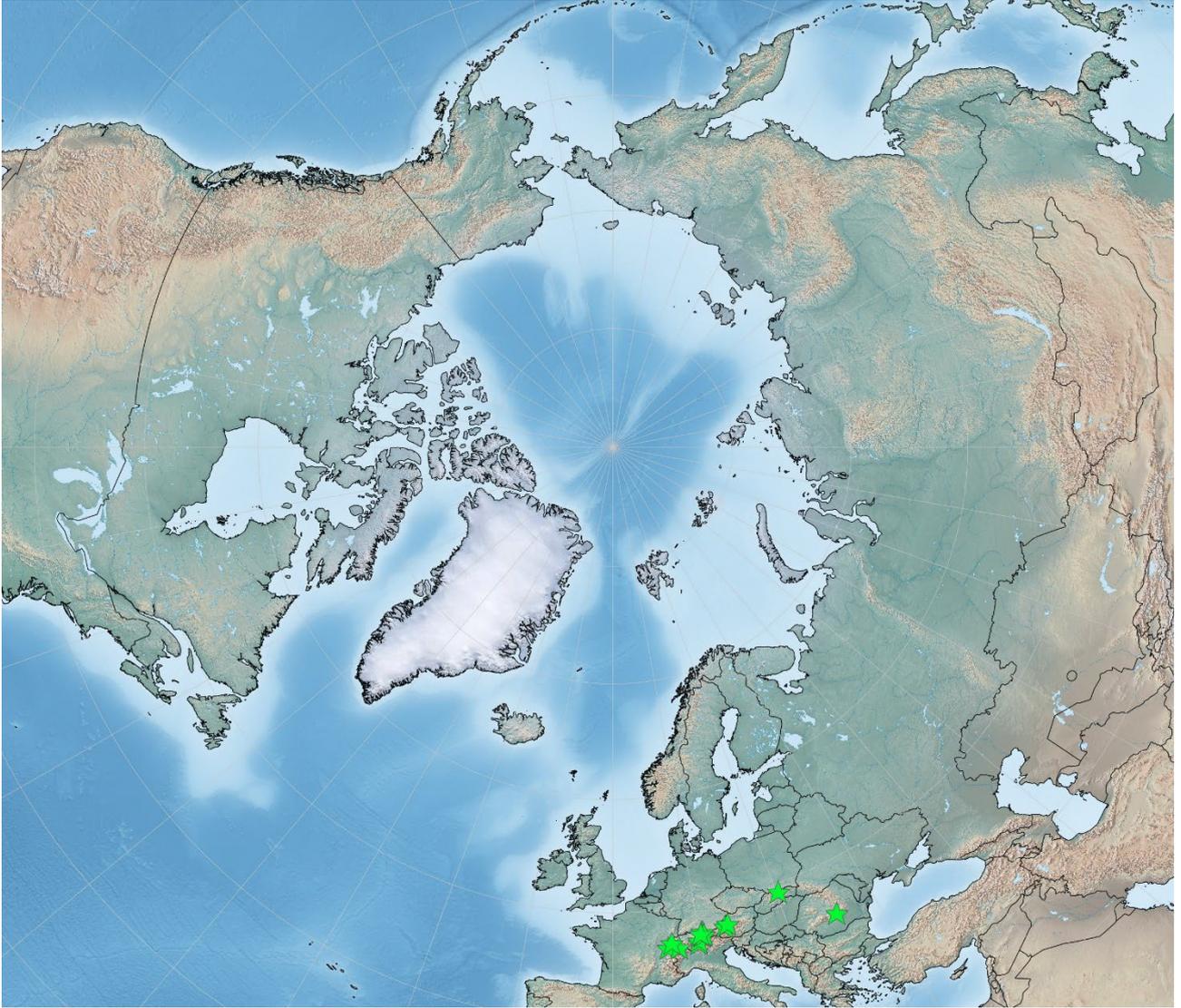
Habitats and host plants

High mountain vegetation, grassy and stony places.

Caprifoliaceae: *Scabiosa*: in the alpine region *S. columbaria* and *S. lucida*.

Distribution

Alpine; Eurasian; type 15; found in the Alps (DE, CH, AT), Tatras (SK), and Carpathians (RO). Rarely reported from the alpine region.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum koenigiae

E. Warming & T. Holm s.n.; C-F-102468 (type)

Microbotryum koenigiae (Rostr.) Vánky

Syn.: *Ustilago koenigiae* Rostr.

Infection systemic. **Sori** in the stem forming fusiform, broadly fusiform, reniform, crescent-shaped, or irregularly elongate bodies, or in leaves as irregular bodies that rupture irregularly, exposing a semi-agglutinated to pulverulent, dark reddish brown spore mass.

Spores variable in shape and size, subglobose, globose, ovoid, ellipsoid, or broadly ellipsoid, sometimes elongate, irregular, pyriform, or lacrymiform, (5–)6–9.5(–12) × (4.5–)5–7.5(–8.5) μm (single irregularly elongate spores can reach up to 13.5 μm in length), light to medium vinaceous; spore wall 0.8–1.2 μm thick, in some spores indistinctly two-layered, finely striate, striae up to 0.2 μm high.

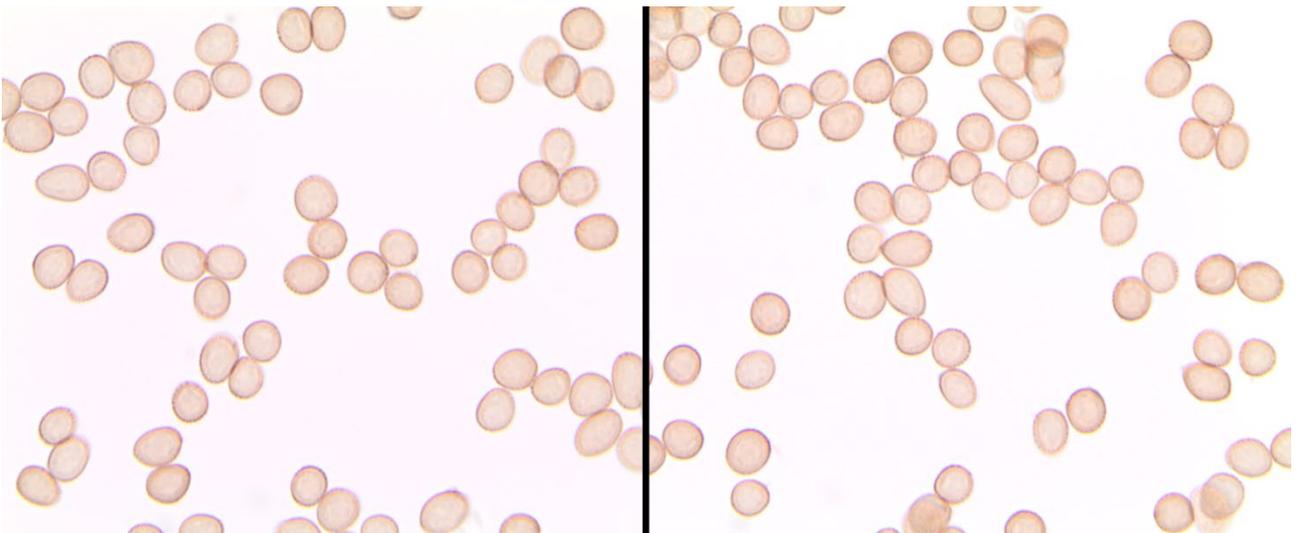
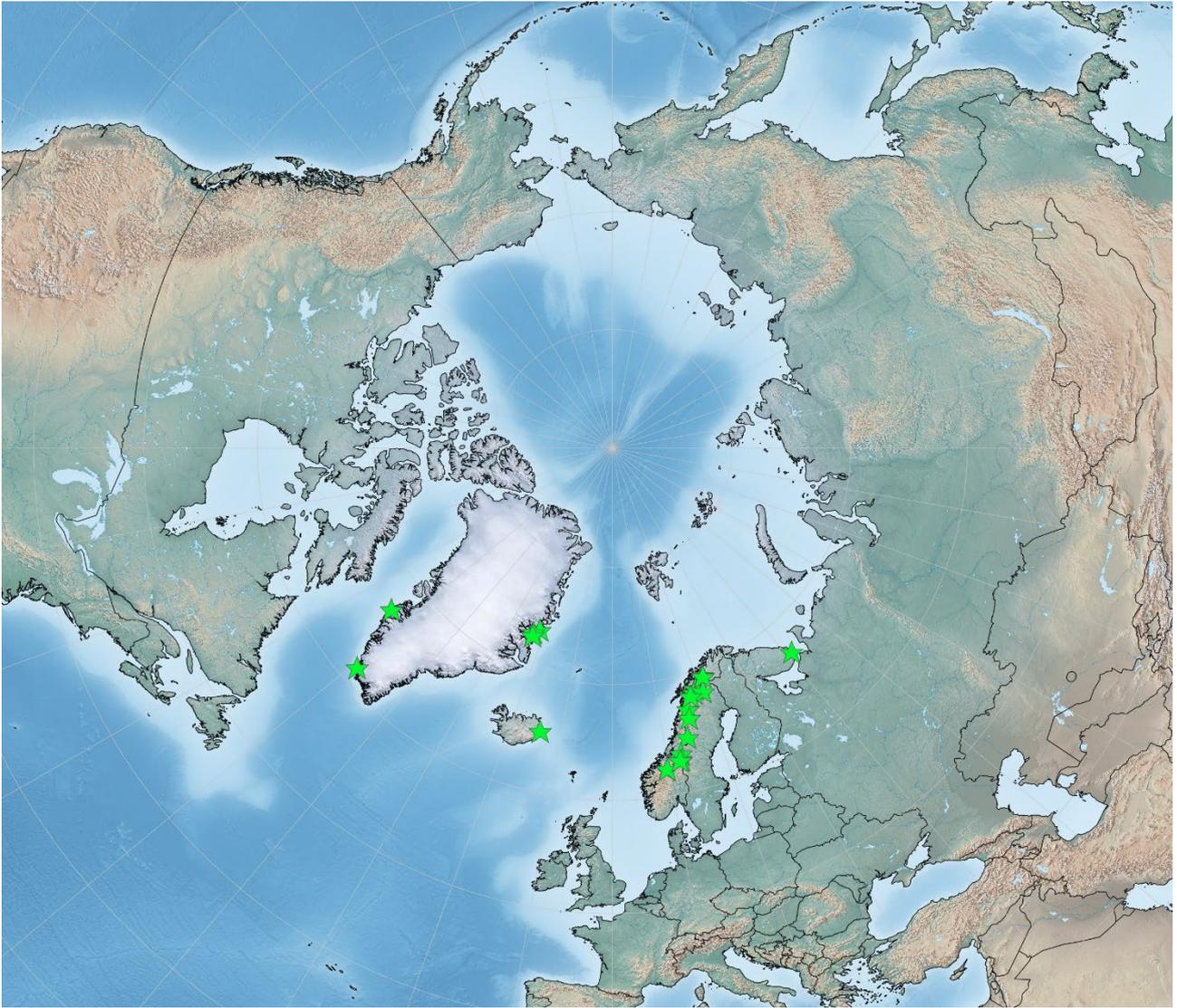
Habitats and host plants

Arctic tundra and alpine meadows with permanently moist gravel, especially around persistent snow patches near streams, ponds, and lakes.

Polygonaceae: *Koenigia* species; in the arctic-alpine region *Koenigia islandica*.

Distribution

Arctic-alpine; North American arctic, Eurasian arctic-alpine; type 4; in arctic Greenland, Iceland, and Russia, and in the alpine Scandinavian Mts. (NO, SE, FI) and Dovre (NO). In Greenland, Iceland, and Fennoscandia probably coextensive with *Koenigia islandica*.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum lagerheimii

I. Nordin 9255; UPS F-151316; Sweden

Microbotryum lagerheimii Denchev

Infection systemic. **Sori** in the considerably swollen anthers, filling the pollen sacs with a pulverulent, fawn-coloured spore mass.

Spores globose, subglobose, broadly ellipsoid, or ovoid, (5.5–)6–8.5(–9.5) × (5–)5.5–8(–8.5) μm, subhyaline with vinaceous tint; spore wall reticulate, 0.9–1.4 μm thick (including reticulum), meshes 5–8(–9) per spore diameter, polyhedral or irregular, 0.3–1.2 (–1.5) μm wide, muri up to 0.4 μm high.

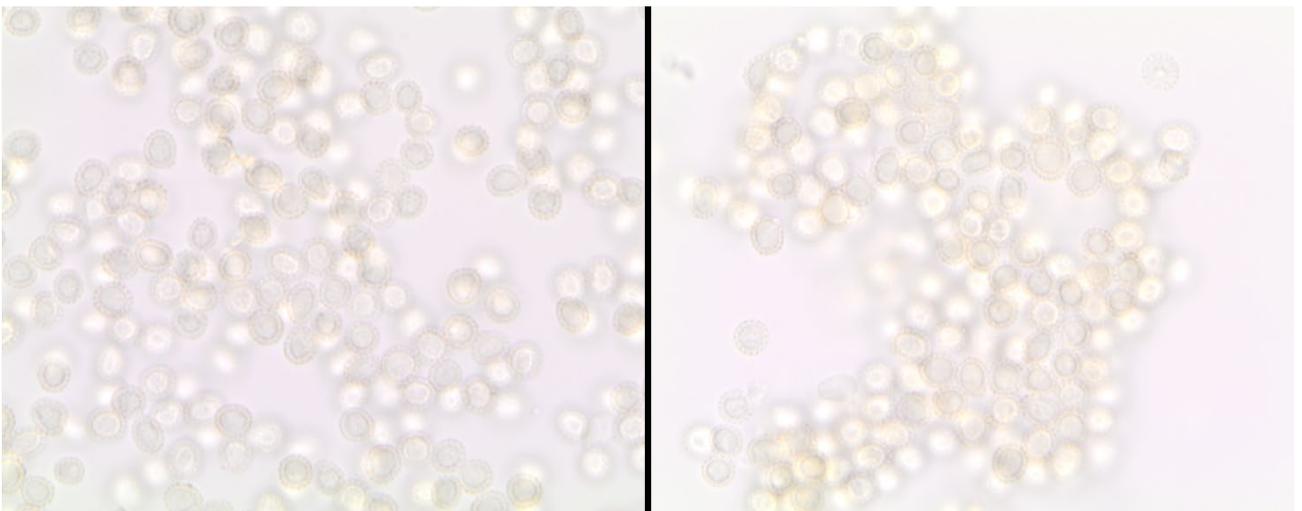
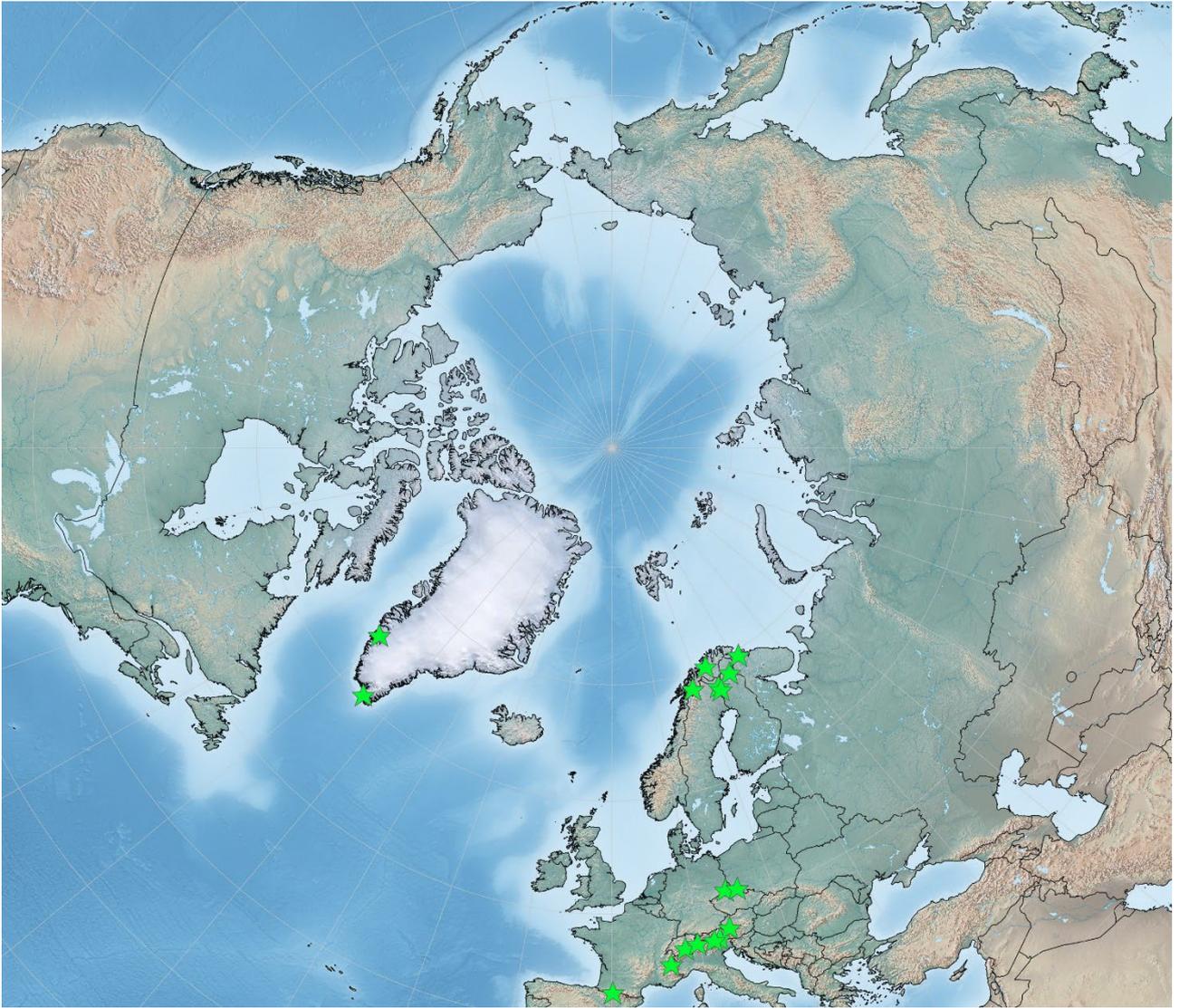
Habitats and host plants

Tundra, rocky barrens, gullies and river outwashes, grassy slopes, sea cliffs (*Viscaria alpina*); rocky slopes, dry grassland, stream gravel.

Caryophyllaceae: *Silene*, *Viscaria*: in the arctic-alpine region *Silene vulgaris*, *Viscaria alpina* (*Lychnis alpina*), and *Viscaria vulgaris* (*L. viscaria*, *V. viscosa*).

Distribution

Arctic-alpine; North American arctic, Eurasian arctic-alpine, circumpolar; type 4; in arctic Greenland and Russia, and in the alpine Scandinavian Mts. (NO, SE, FI), the Alps (FR, CH, AT, IT), Erzgebirge (DE), Sudetes (PL), and Pyrenees (FR). Common.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum liroi

L. Ollila & H. Roivainen s.n.; SOMF 2706; Finland

Microbotryum liroi R. Ziegler, M. Lutz & Piątek

Infection systemic. **Sori** in the anthers of the infected flower; spore mass powdery, dark purple.

Spores globose, subglobose, or broadly ellipsoid, sometimes ovoid, (6–)7–9.5 × (5–)6–8(–8.5) μm, light to medium vinaceous, reticulate; spore wall (0.5–)1.0 μm thick, meshes 5–8 per spore diameter, polyhedral, interspaces smooth.

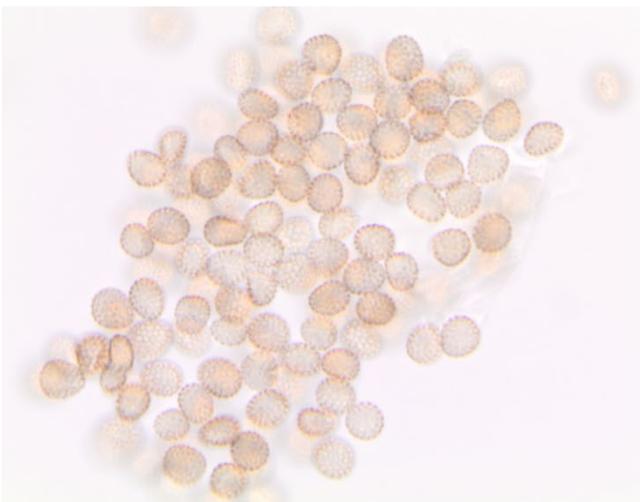
Habitats and host plants

Sphagnum bogs, along streams, turfy alpine tundra.

Lentibulariaceae: *Pinguicula spathulata* (*P. variegata*), and *P. villosa*.

Distribution

Arctic-alpine; Eurasian; type 9; in arctic Norway and Russia, and in the alpine Scandinavian Mts. (NO, SE, FI) and Dovre (NO). Probably the fungus is much more common, but it is rather inconspicuous and easily overlooked since the corolla lips of its host are purplish, making the spore mass hard to see.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum marginale

Microbotryum marginale (DC.) Vánky

Syn.: *Ustilago marginalis* (DC.) Lév.

Infection systemic. **Sori** along the margins of leaves as small pustules that usually coalesce early into a continuous, 1–2 mm wide border, or sometimes as isolated groups of marginal pustules covered by the epidermis that flakes away to expose the purplish, powdery spore mass.

Spores globose, subglobose, ovoid, or slightly irregular, 11–17(–20) × 10.5–14.5 µm, light to medium purple; spore wall ca. 0.5 µm thick, finely and densely verruculose, warts ca. 0.5 µm high.

J. L. Taylor JLT11048; K-M 192257; UK

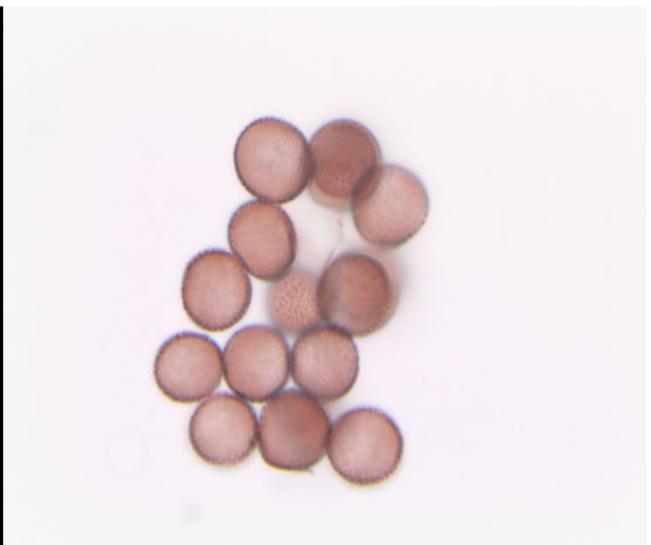
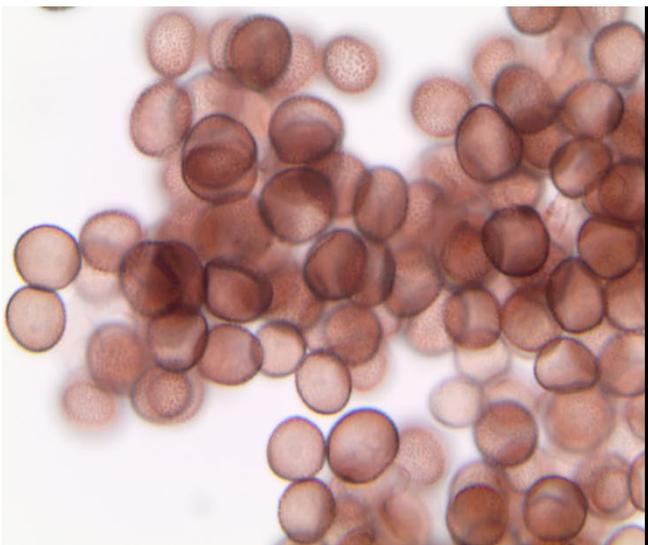
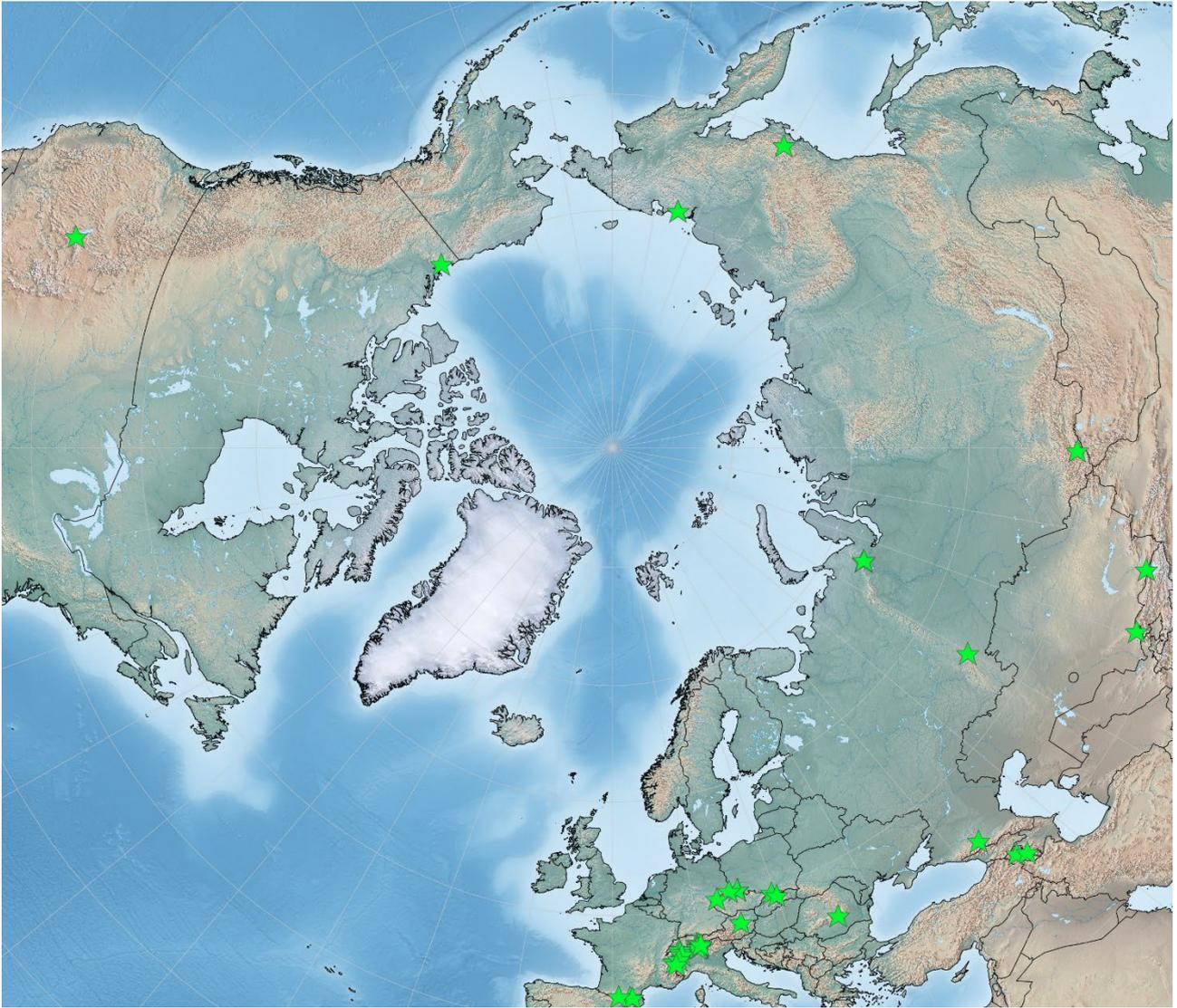
Habitats and host plants

Streambanks, ponds, along streams, river terraces, moist or swampy meadows, damp grassy places, alpine slopes, arctic tundra.

Polygonaceae: *Bistorta*: in the arctic-alpine region *Bistorta bistortoides* (*Polygonum bistortoides*), *Bistorta carnea* (*P. carneum*), *Bistorta elliptica* (*P. ellipticum*, *P. nitens*), *Bistorta officinalis* (*P. bistorta*, *B. major*), and *B. plumosa* (*P. bistorta* subsp. *plumosum*).

Distribution

Arctic-alpine; circumpolar; type 1; in arctic Canada (YT) and Russia, and in the alpine Rocky Mts. (USA: UT), the Alps (FR, CH, AT, IT), Erzgebirge (CZ), Sudetes (PL, CZ), Tatras (PL), Carpathians (RO), Pyrenees (FR, ES), Urals, Altai Mts., and the Chersky Range (RU), and Tian Shan (KZ, KG). Common.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum minuartiae

C. M. Denchev 04103; SOMF 30401; Bulgaria

Microbotryum minuartiae M. Lutz, Piątek & Kemler

Infection systemic. **Sori** in the considerably swollen anthers, filling the pollen sacs with a pulverulent, sepia or date brown spore mass.

Spores subglobose, globose, broadly ellipsoid, slightly irregular, ovoid, or ellipsoid, (6.5–)7.5–9(–10) × 6.5–8.5(–9.5) μm, light vinaceous; spore wall reticulate, 0.9–1.3 μm thick including reticulum, meshes (5–)6–8(–9) per spore diameter, polyhedral or irregular, 0.3–1.5(–2.0) μm wide, muri 0.2–0.4 μm high.

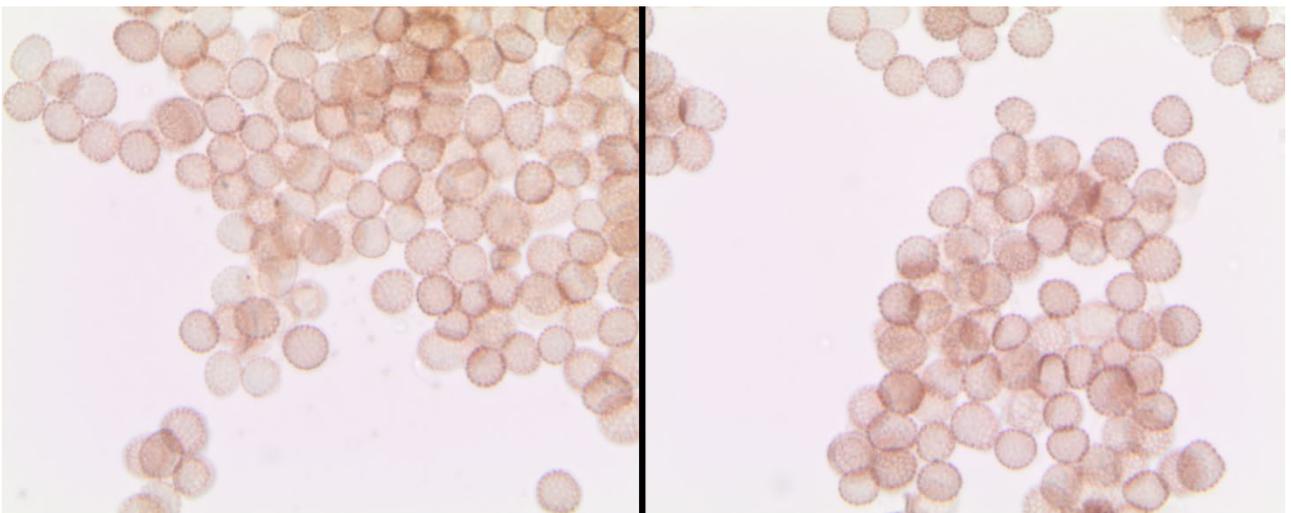
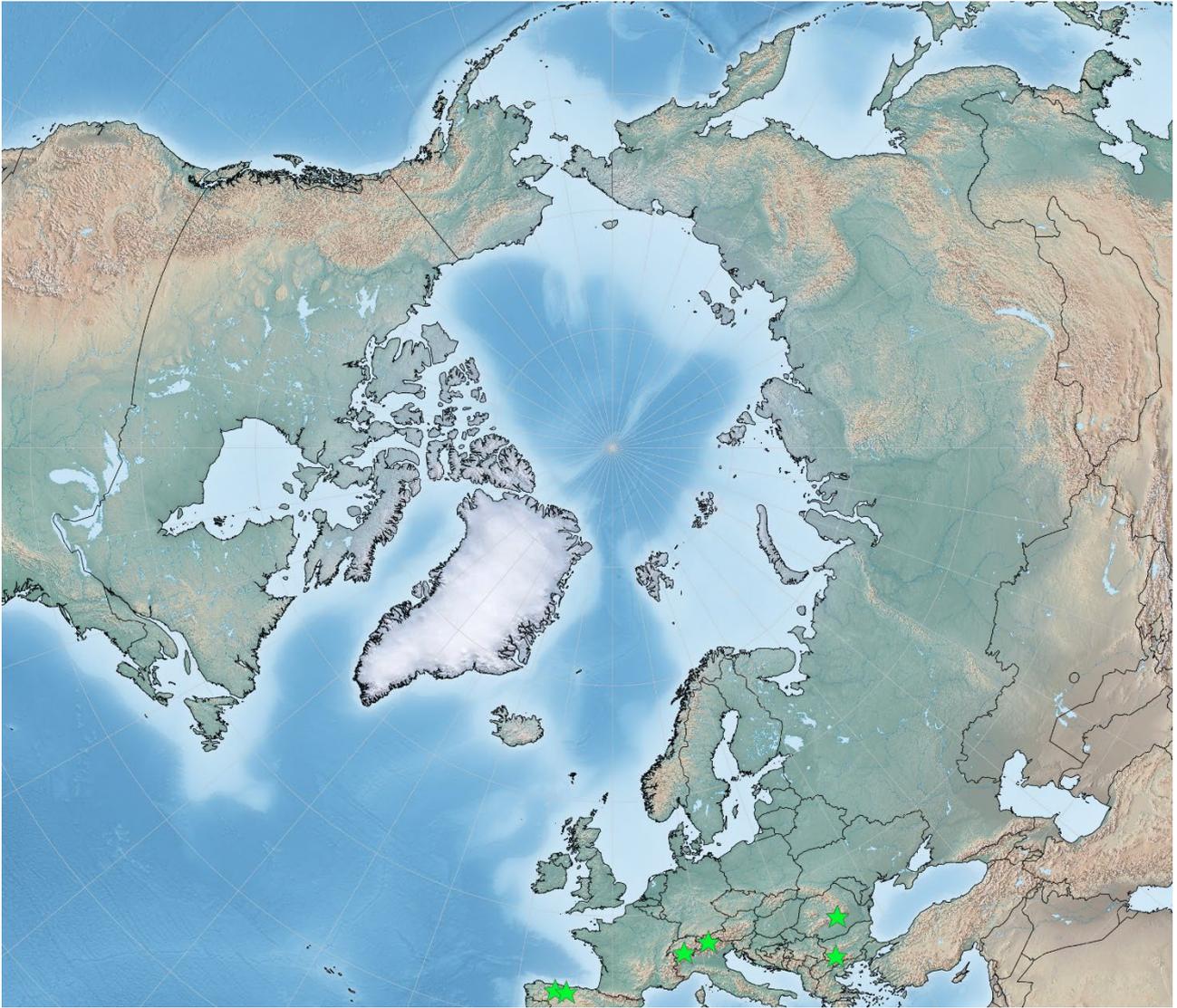
Habitats and host plants

Open silicate rocks with hasmophytic vegetation in high mountain ridges.

Caryophyllaceae: *Minuartia recurva*, *Sabulina villarii* (*Minuartia villarii*).

Distribution

Alpine; Eurasian; type 15; found in the Alps (CH, AT), Carpathians (RO), Cantabrian Mts. (ES), and Rila Mts. (BG). Rarely recorded.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum nannfeldtii

J. A. Nannfeldt 4717; UPS F-639565; Sweden

Microbotryum nannfeldtii (Liro) Vánky

Syn.: *Ustilago nannfeldtii* Liro

Infection systemic. **Sori** in ovules filling the capsules with a purplish black, powdery spore mass.

Spores globose, subglobose, or ellipsoid, 11–19 × 11–16 μm, light to medium vinaceous; spore wall reticulate, meshes (6–)7–9(–10) per spore diameter, variable in shape and size, polygonal to rounded, rarely incomplete, often thickened in the angles and punctate in the areolae, muri ca. 1 μm high.

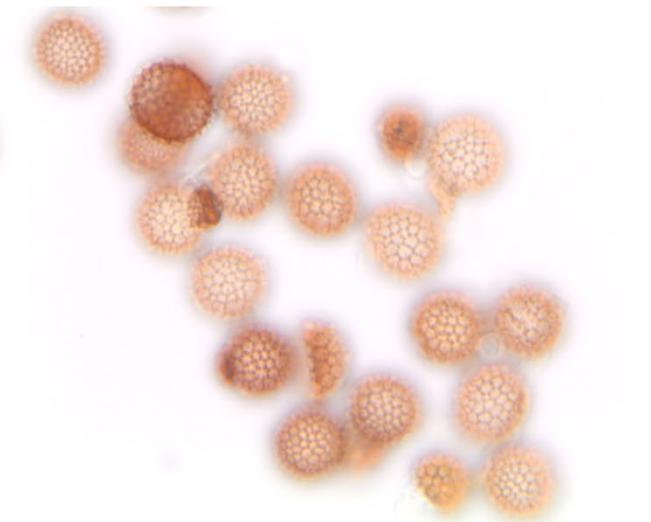
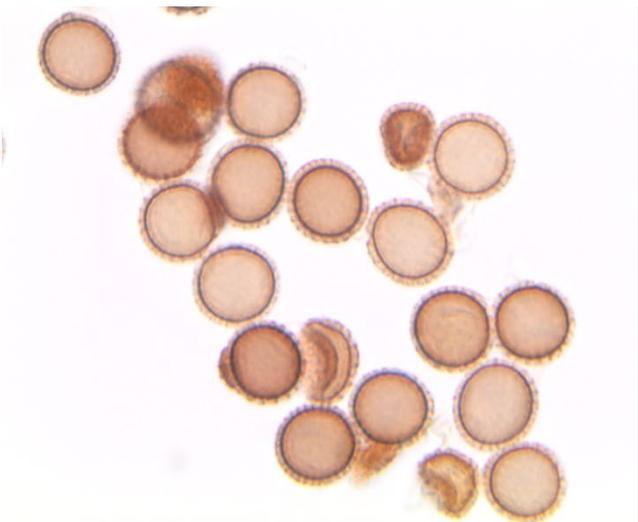
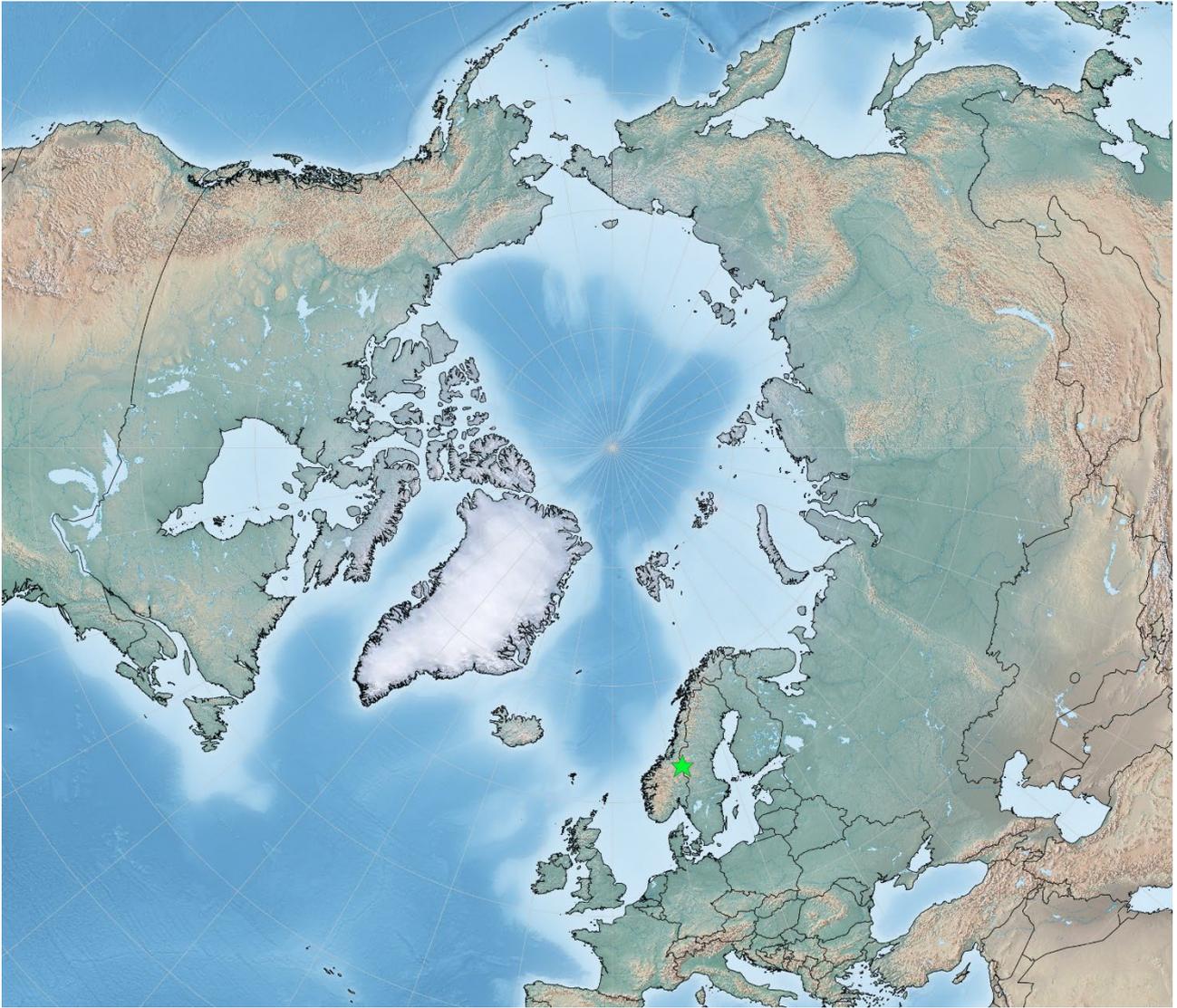
Habitats and host plants

Exposed rocky slopes in alpine regions.

Gentianaceae: *Gentiana nivalis*.

Distribution

Alpine; Eurasian; type 15; found in the Scandinavian Mts. (SE). Known only from the type collection.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum nivale

A. Hagen s.n.; O

Microbotryum nivale (Liro) Vánky

Syn.: *Ustilago nivalis* Liro; *Haradaea nivalis* (Liro) Denchev & H.D. Shin

Infection systemic, all capsules of an infected plant affected. **Sori** in ovules, filling the swollen capsules with a semi-agglutinated, dark reddish brown spore mass.

Spores subglobose, broadly ellipsoid, slightly irregular, globose, ovoid, or ellipsoid, (9.5–)10–13(–14) × (9–)9.5–11.5(–12.5) μm, light to medium vinaceous; spore wall reticulate, (1.5–)1.7–2.2(–2.4) μm thick including reticulum, meshes (5–)6–8(–9) per spore diameter, polyhedral or irregular, 0.5–1.7(–2.5) μm wide, with a hemispherical protuberance on the bottom, muri up to 0.9(–1.1) μm high. Immature hyaline spores may be present.

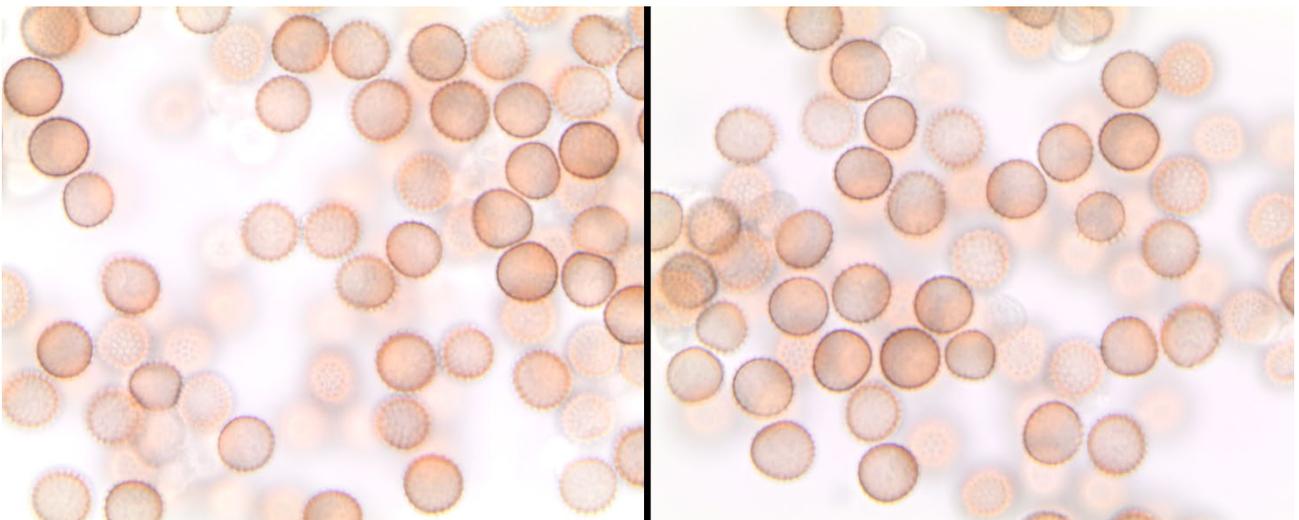
Habitats and host plants

Sandy or gravelly beaches, coastal rocks, alluvial plains, fresh glacial moraines, low swampy tundra, alpine areas.

Caryophyllaceae: *Sagina nivalis* (*Sagina intermedia*).

Distribution

Arctic; circumpolar; type 6; found in arctic Greenland and Svalbard. Very rarely reported.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum picaceum

Microbotryum picaceum (Lagerh. & Liro) Vánky

Syn.: *Ustilago picacea* Lagerh. & Liro

Infection systemic. **Sori** in ovaries, initially covered by a thin peridium that ruptures irregularly to expose the purplish black, powdery spore mass.

Spores globose, subglobose, ellipsoid, or slightly irregular, 11–18.5 × 11–15 µm, vinaceous, finely and densely verruculose; spore profile almost smooth to very finely wavy or serrulate. Hyaline, smooth, relatively thick-walled (1.5–2.5 µm) cells about the size of the spores, solitary or in groups, may be present between the spores.

K. A. Lye et al. 5416; HUV 20121; Norway

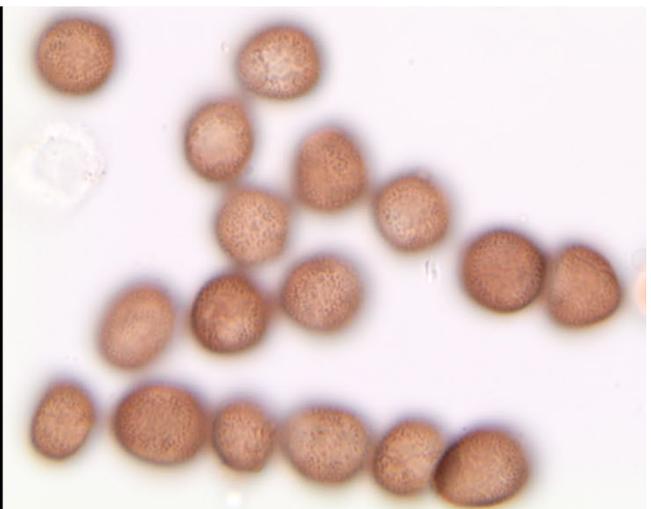
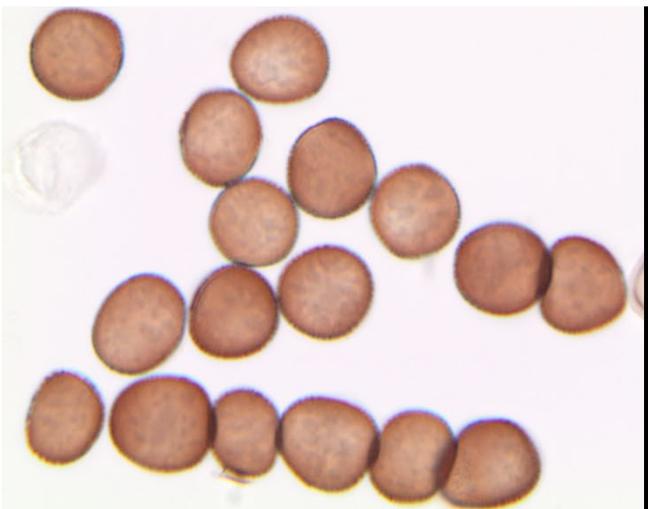
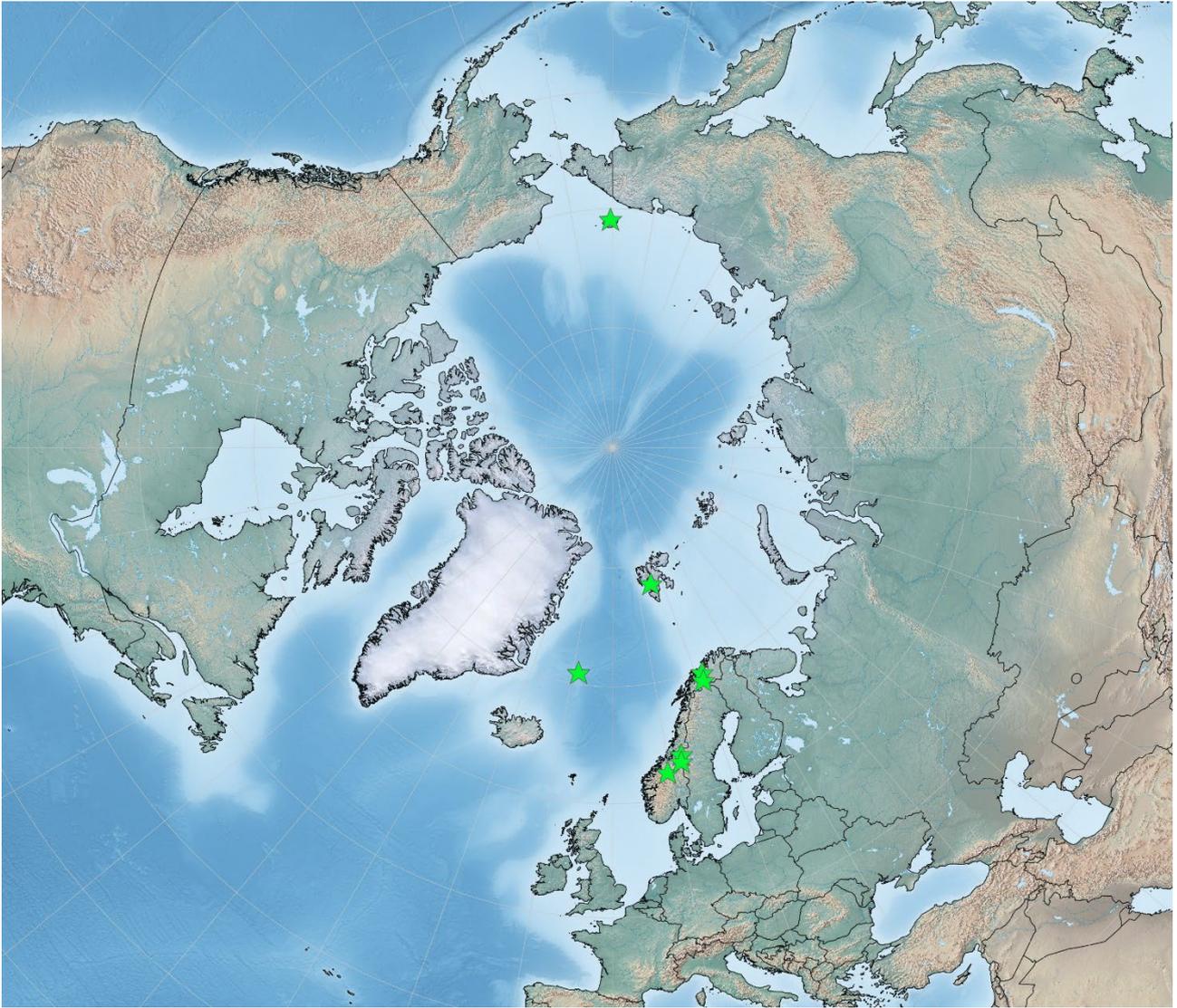
Habitats and host plants

Arctic tundra and alpine meadows with permanently moist gravel, especially around persistent snow patches near streams, ponds, and lakes.

Polygonaceae: *Koenigia*; in the arctic-alpine region *Koenigia islandica*.

Distribution

Arctic-alpine; Eurasian; type 9; found in arctic Svalbard, Jan Mayen, and Russia, and in the alpine Scandinavian Mts. (NO, SE, FI) and Dovre (NO). Very rarely reported.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum pinguiculae

Microbotryum pinguiculae (Rostr.) Vánky

Syn.: *Ustilago pinguiculae* Rostr.

Infection systemic. **Sori** in the anthers of the infected flower; spore mass powdery, dark purple.

Spores globose, subglobose, or broadly ellipsoid, (6–)7–9(–9.5) × 5.5–7.5(–8.5) μm, light to medium vinaceous, reticulate; spore wall ca. 1.0 μm thick, meshes 4–7 per spore diameter, polyhedral, interspaces smooth.

T. Vestergren s.n.; DAOM 237003; Sweden

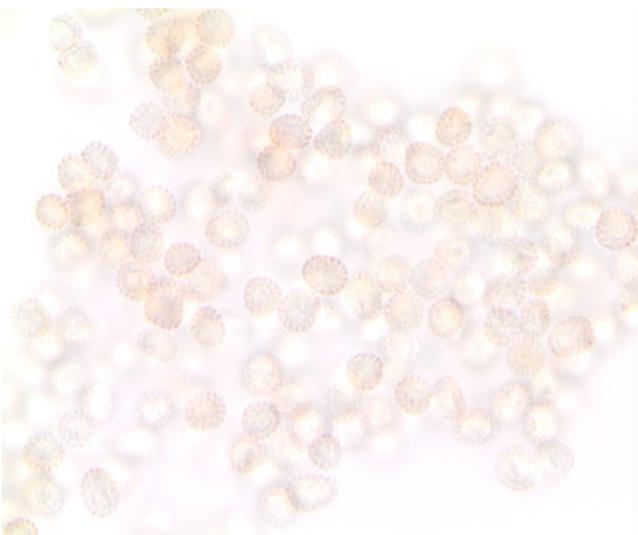
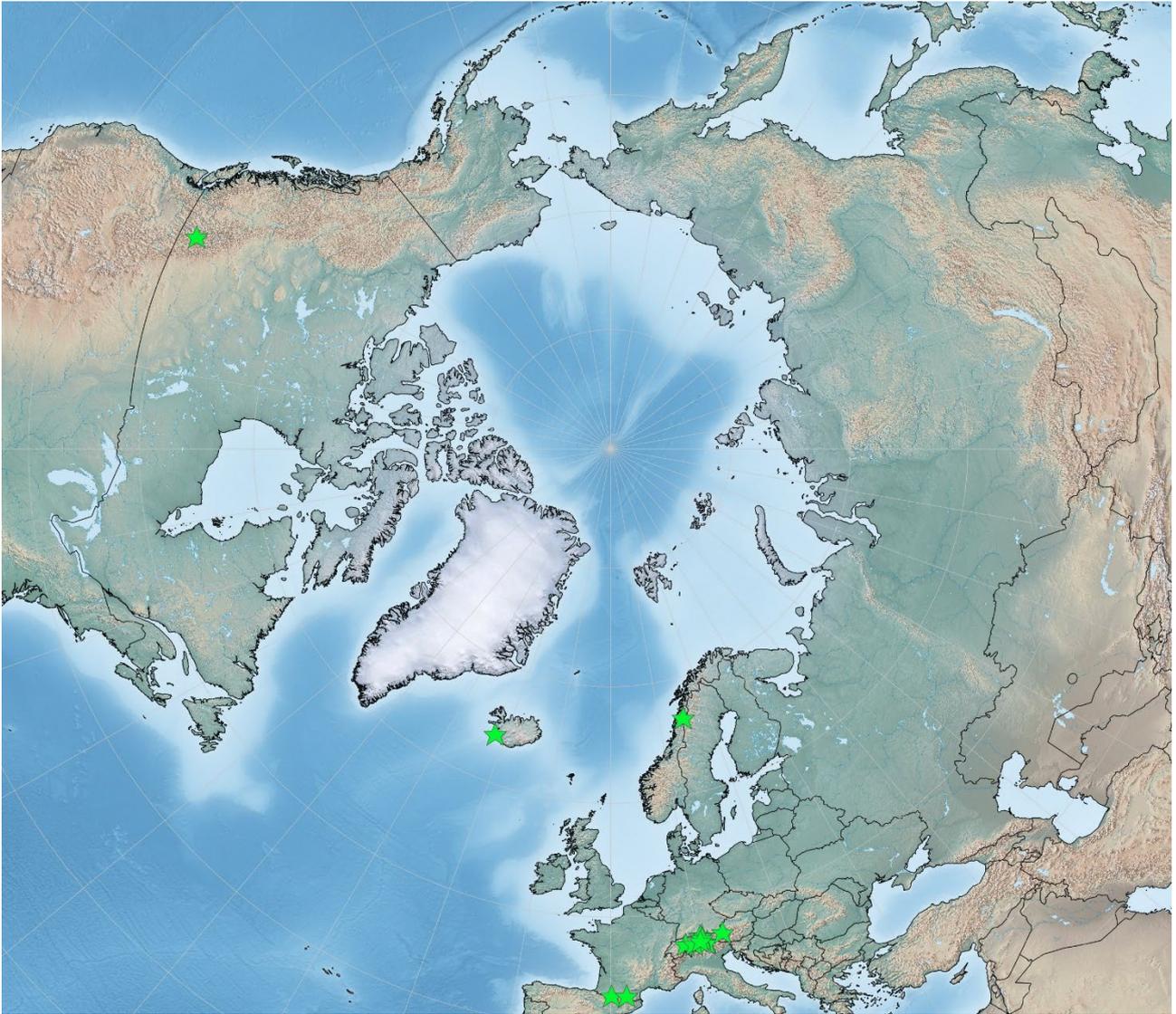
Habitats and host plants

Wet rocks and rock ledges, gravelly shores, wet gravelly open sites, bogs, wet meadows; acidic or calcareous areas.

Lentibulariaceae: *Pinguicula*: *P. grandiflora*, *P. leptoceras*, *P. macroceras*, and *P. vulgaris*.

Distribution

Arctic-alpine; circumpolar; type 5; found in arctic Iceland, and in the alpine Rocky Mts. (CAN: AB), the Scandinavian Mts. (NO), the Alps (DE, CH, AT), and the Pyrenees (FR). Rarely collected, but the smut fungus is rather inconspicuous and easily overlooked since the corolla lips of its hosts are violet or blue; probably the fungus is much more common.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum piperi F. Oberwinkler et al., Vánky *Ustilaginales* 641; SOMF 19569; Italy

Microbotryum piperi (G.P. Clinton) Vánky (“*piperii*”)

Syn.: *Ustilago piperi* G.P. Clinton; *Sphacelotheca polygoni-alpini* Cruchet;
Ustilago polygoni-alpini (Cruchet) Zundel

Infection systemic. **Sori** as pustules on the underside of leaves often confined to the leaf margin and more or less confluent, at first covered by the epidermis, which soon ruptures irregularly to release the umber or sepia, powdery spore mass. **Spores** variable in shape, globose, ovoid, irregularly rounded, broadly ellipsoid, ellipsoid, elongate, or occasionally pyriform or lacrymiform, (5–)6–9(–10) × (5–)5.5–7.5(–8) μm, light vinaceous; spore wall 0.6–1.0 μm thick, with curved anastomosing striae resembling fingerprints, striae up to 0.25 μm high.

Habitats and host plants

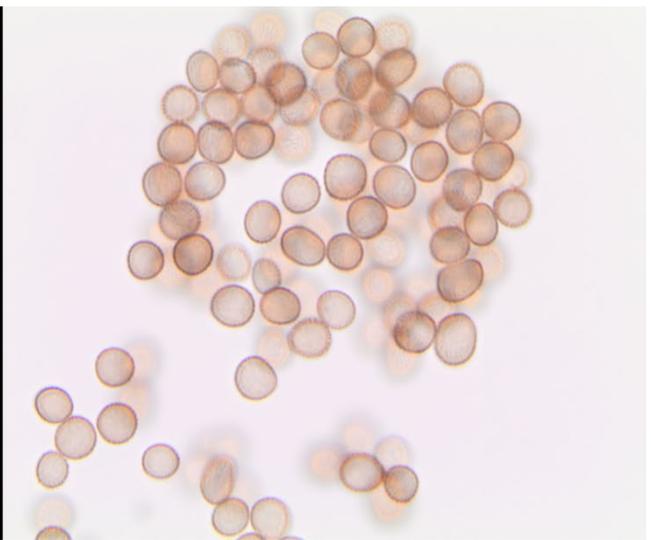
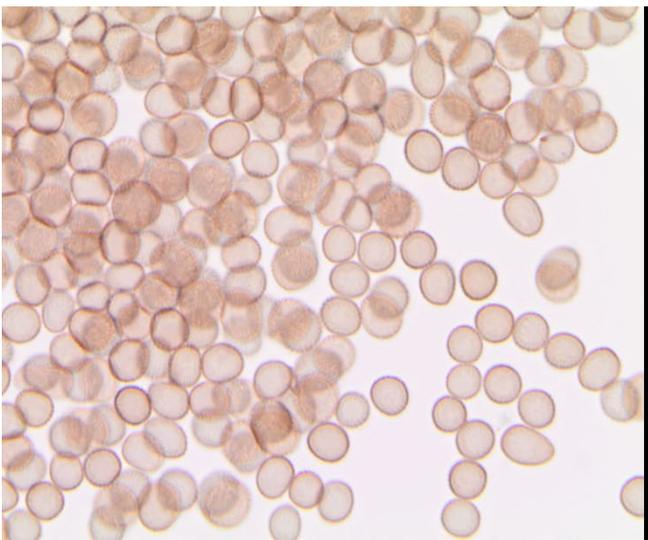
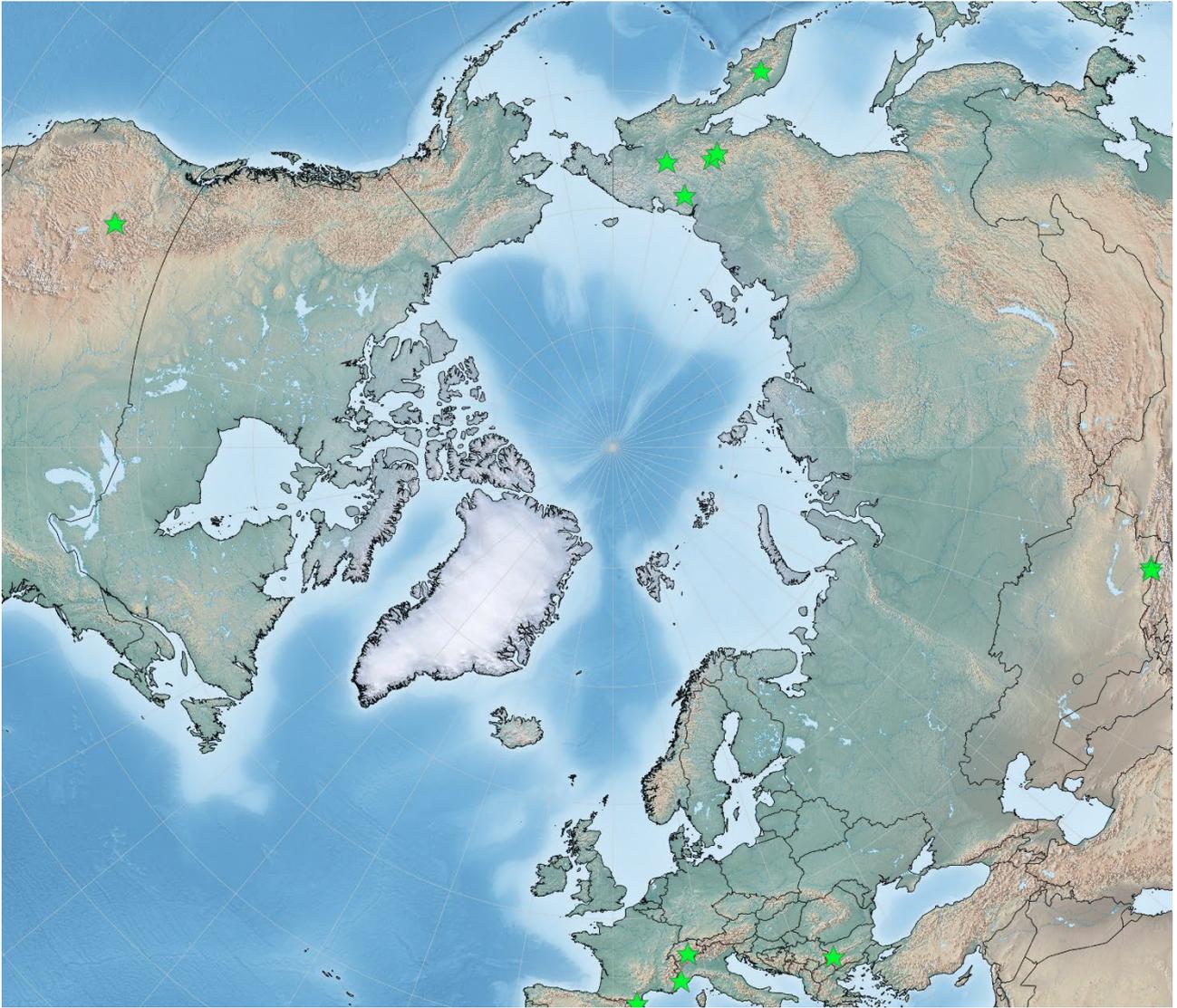
Forest margins, mountain slopes and valleys, alpine and subalpine grassy slopes,

tundra along sandy riverbanks, seashores, rocky slopes.

Polygonaceae: *Koenigia*: in the arctic-alpine region *Koenigia alpina* (*Polygonum alpinum*, *P. undulatum*), *Koenigia phytolaccifolia* (*P. phytolaccifolium*), *Koenigia songarica* (*P. songaricum*), and *Koenigia tripterocarpa* (*P. tripterocarpum*).

Distribution

Alpine; North American–Eurasian; type 7; found in arctic Russia, and in the alpine Rocky Mts. (USA: ID), the Alps (FR, IT), the Pyrenees (FR), Mt. Vitosha (BG), the Anyuy Range, Kolyma Highlands, and Kamchatka (RU), and Tian Shan (KZ). Very rarely reported.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum pustulatum

A. Hagen s.n.; O

Microbotryum pustulatum (DC.) R. Bauer & Oberw.

Syn.: *Uredo bistortarum* var. *pustulata* DC. (“*U. bistortarum* α *pustulata*”);
Ustilago pustulata (DC.) G. Winter

Infection local. Sori in leaves as yellowish brown to dark vinaceous, round, blister-like pustules, 1–4 mm in diameter, often larger by fusion, scattered or often arranged in two rows along the median vein, initially covered by the epidermis that later ruptures, disclosing a semi-agglutinated to powdery, dark reddish brown mass of spores.

Spores subglobose, broadly ellipsoid, slightly irregular, ovoid, globose, or ellipsoid, (12–)13–18(–20) × (11–)12–16(–17) μm, medium vinaceous; spore wall 0.7–1.3 μm thick, moderately verruculose, warts up to 0.4(–0.5) μm high, spore profile affected.

Habitats and host plants

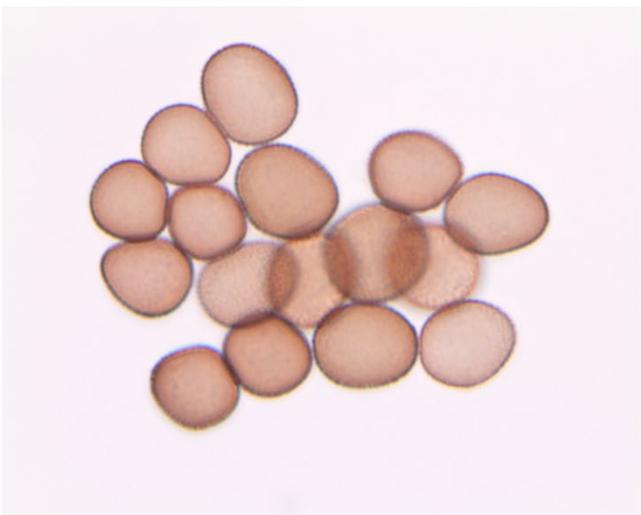
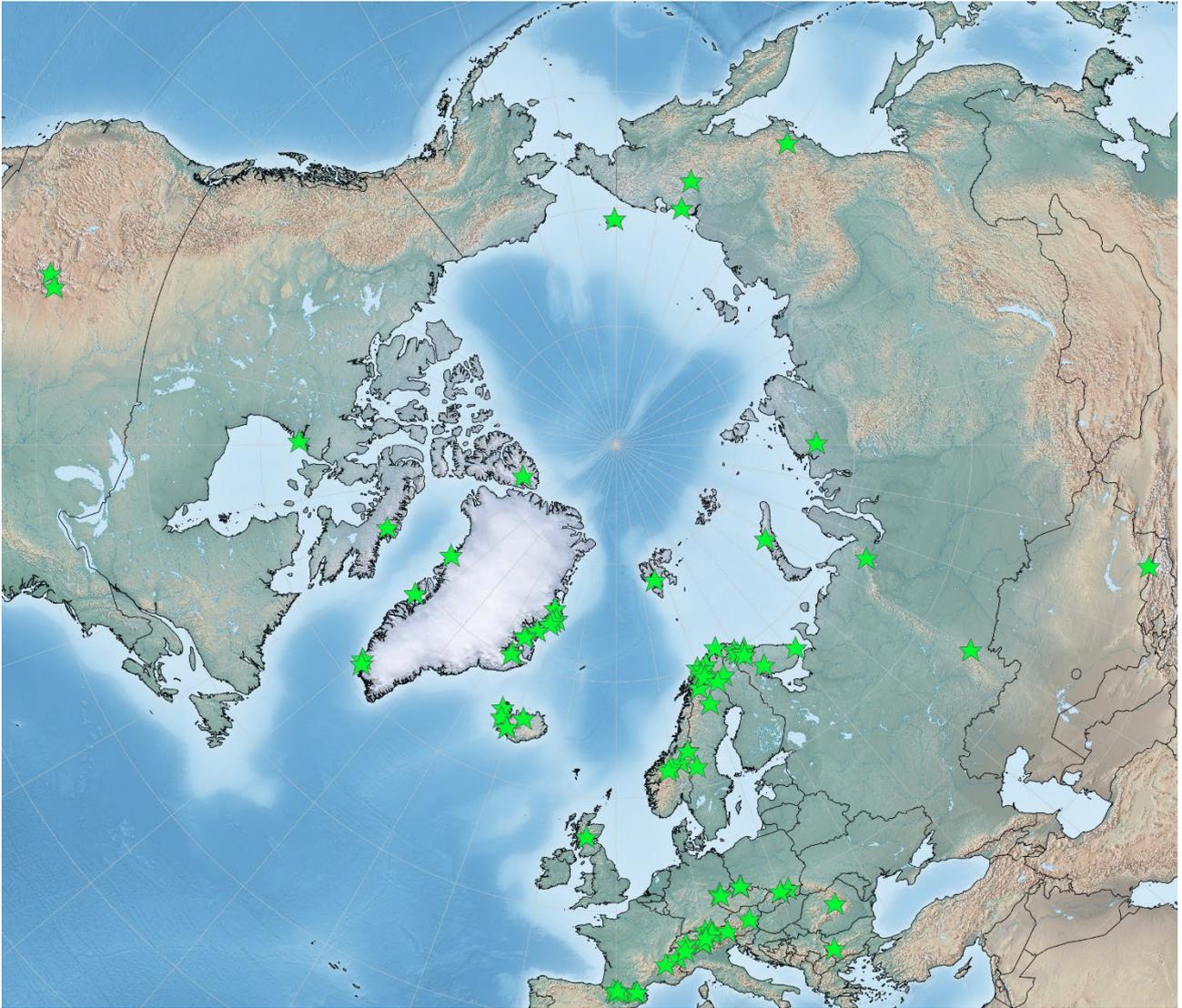
Tundra and mountains; around the margins of ponds, along streams, river terraces, moist meadows, moist rock crevices and moss-

covered turf, moist subalpine woods and meadows, alpine meadows and slopes.

Polygonaceae: *Bistorta*: in the arctic-alpine region *Bistorta elliptica* (*Polygonum ellipticum*, *P. nitens*), *Bistorta officinalis* (*P. bistorta*, *B. major*), and *Bistorta vivipara* (*P. viviparum*).

Distribution

Arctic-alpine; circumpolar; type 1; in arctic CAN (NU), GR, IS, Svalbard, NO, and RU, and in the alpine Rocky Mts. (USA-CO), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Khibiny Mts. (RU), the Alps (DE, FR, CH, AT, SI), Erzgebirge (DE, CZ), Sudetes (PL, CZ), Tatras (PL, SK), Carpathians (RO), and Pyrenees (FR, ES), Mt. Vitosha (BG), the Urals, and the Anyuy and Chersky Ranges (RU), and Tian Shan (KZ, KG). Common.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum savilei

D. B. O. Savile et al. 3925; DAOM 66883; Canada (NU)

Microbotryum savilei Denchev

Infection systemic. **Sori** in deformed and swollen flowers, enclosed by corolla (petals remain within closed calyx), affecting anthers and filaments, stamens may or may not be completely destroyed, ovary and styles aborted. Calyx of infected flowers erect and closed at throat, broadly ovoid or very broadly ovoid. Spore mass filling affected flower completely, enclosed by corolla, pulverulent, dark livid or dark purple.

Spores subglobose, globose, or broadly ellipsoid, sometimes ellipsoid, (5.5–)6–9(–10) × (5–)5.5–8(–9) μm, light vinaceous; spore wall reticulate, 1.0–1.7(–2.0) μm thick including reticulum, meshes (4–)5–8(–9) per spore diameter, polyhedral or irregular, 0.4–1.8(–2.5) μm long, muri (15–)16–20(–22) on equatorial circumference, up to 0.4(–0.5) μm high.

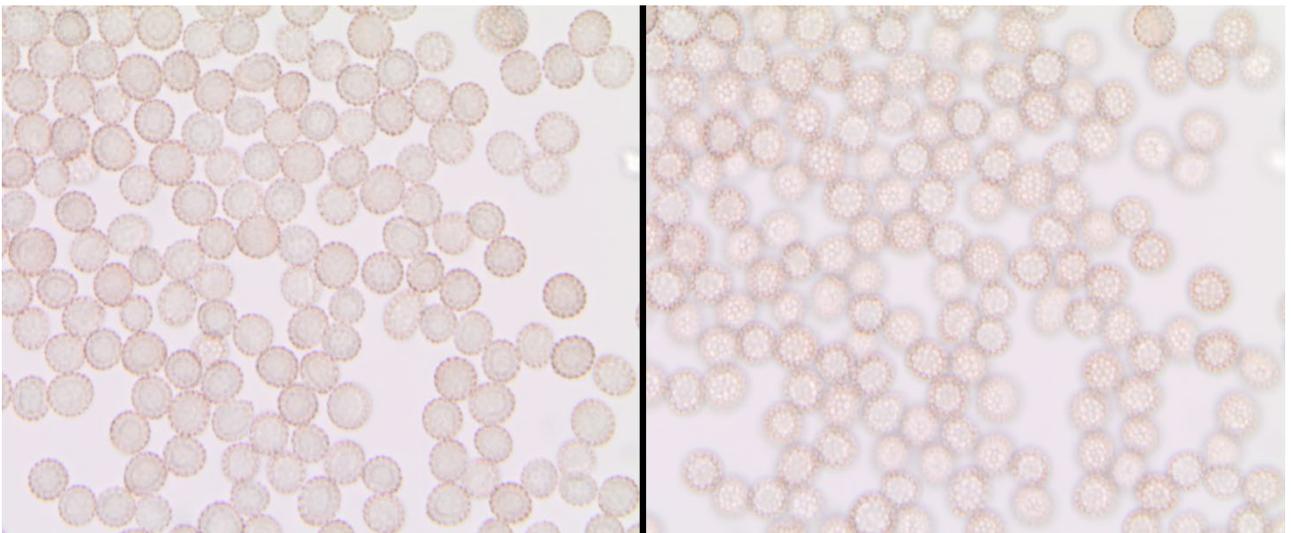
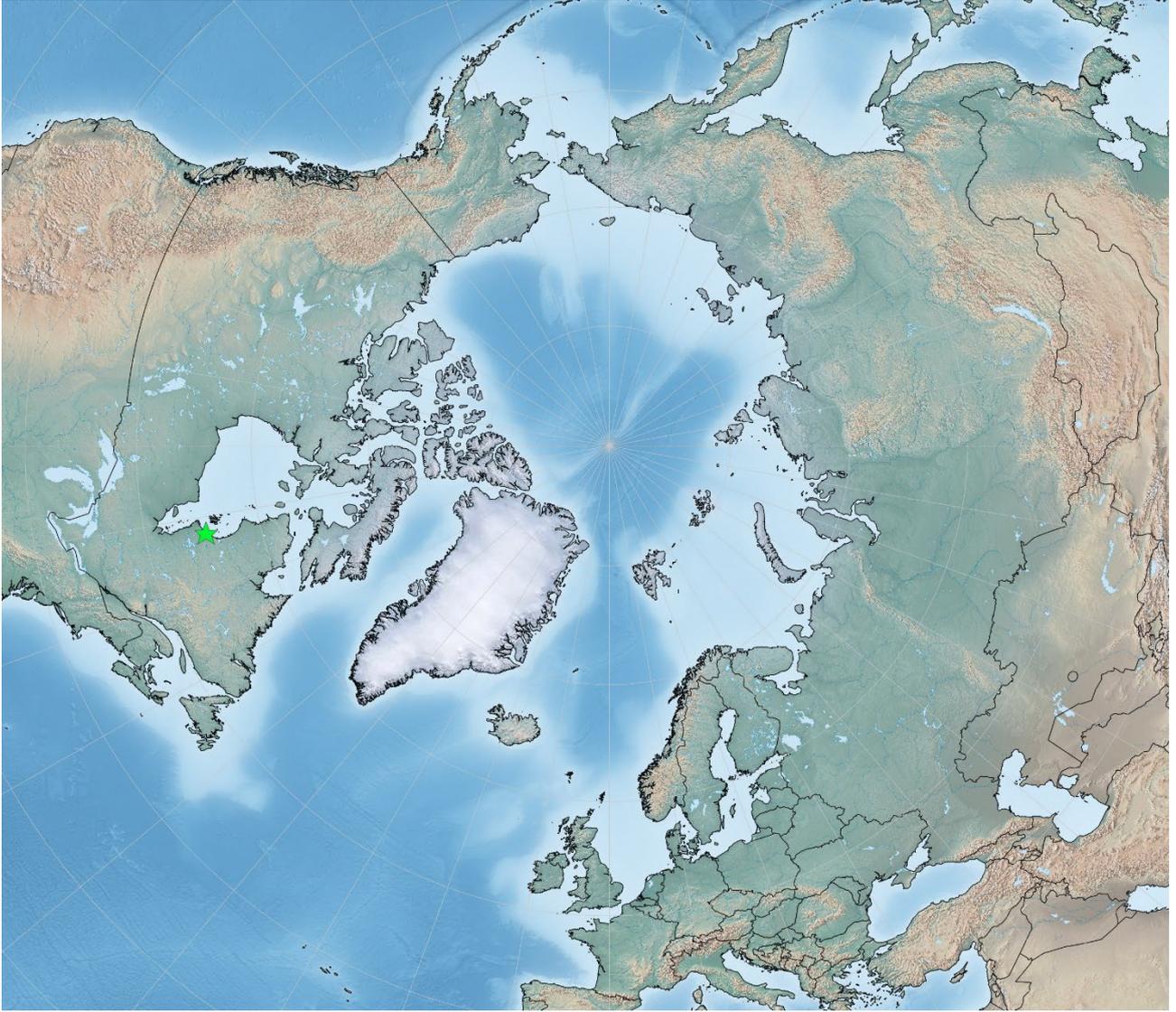
Habitats and host plants

Arctic tundra, gravelly and grassy places.

Caryophyllaceae: *Silene uralensis* subsp. *arctica*.

Distribution

Arctic; North American; type 12; found in arctic Canada (NU). Known only from the type locality.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum silenes-acaulis

H. H. Bruun; C-NHMD001862328

Microbotryum silenes-acaulis M. Lutz, Piątek & Kemler

Infection systemic. **Sori** in the considerably swollen anthers, filling the pollen sacs with a pulverulent, vinaceous spore mass.

Spores subglobose, globose, broadly ellipsoid, or ovoid, sometimes ellipsoid, (5.5–)6–9(–9.5) × (5–)5.5–7.5(–8.5) μm, light vinaceous; spore wall reticulate, 0.9–1.4 μm thick including reticulum, meshes (4–)5–8(–9) per spore diameter, polyhedral or irregular, 0.3–1.6(–2.0) μm wide, muri up to 0.4 μm high.

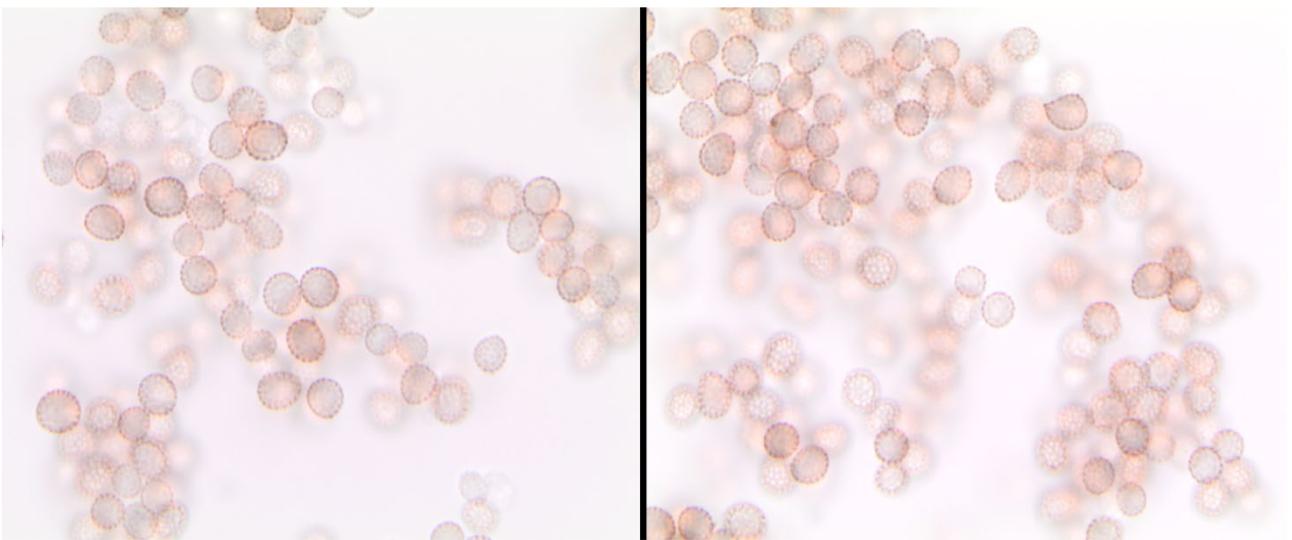
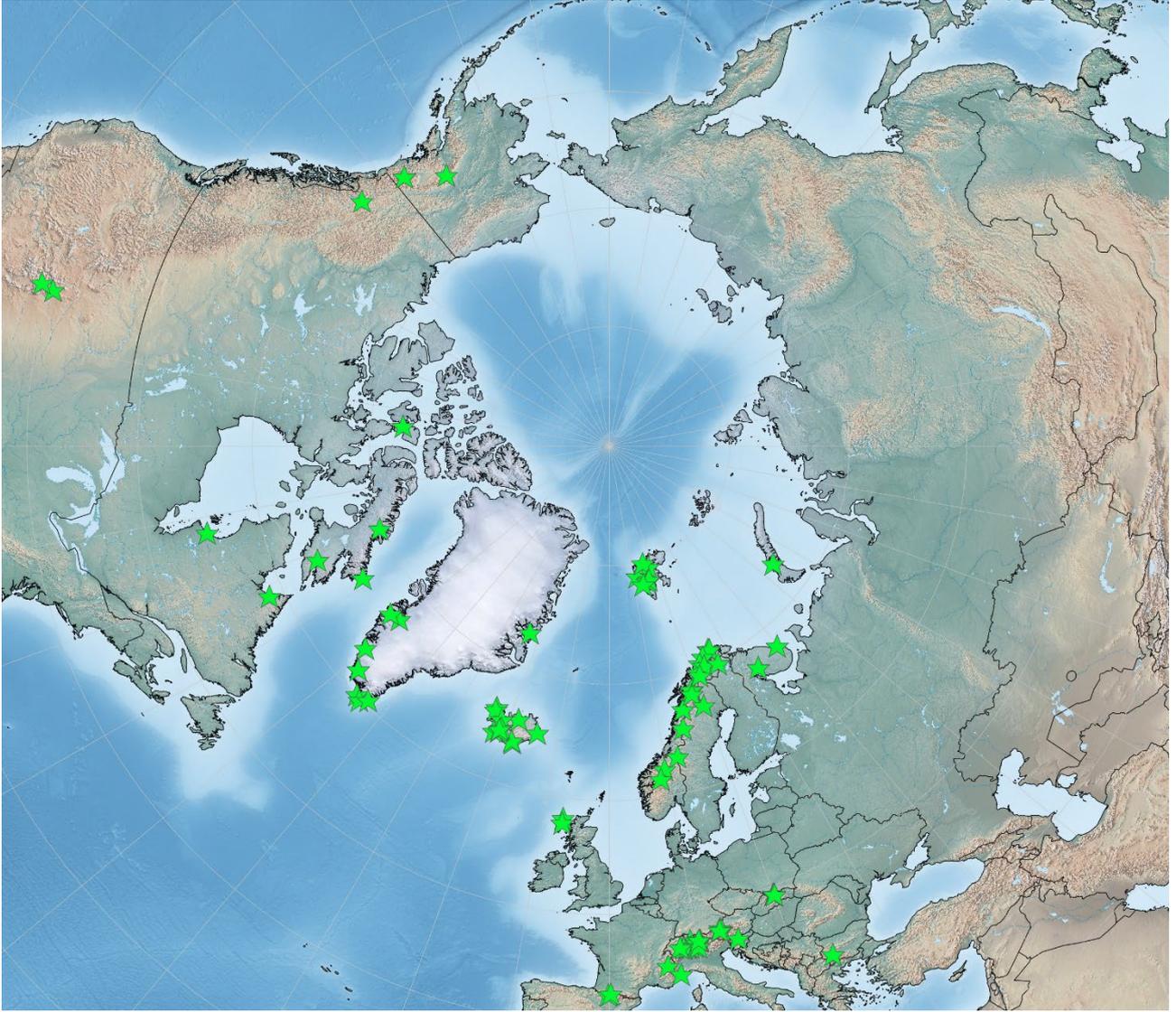
Habitats and host plants

Arctic tundra and in high mountains, gravelly, often wet places, rocky ledges.

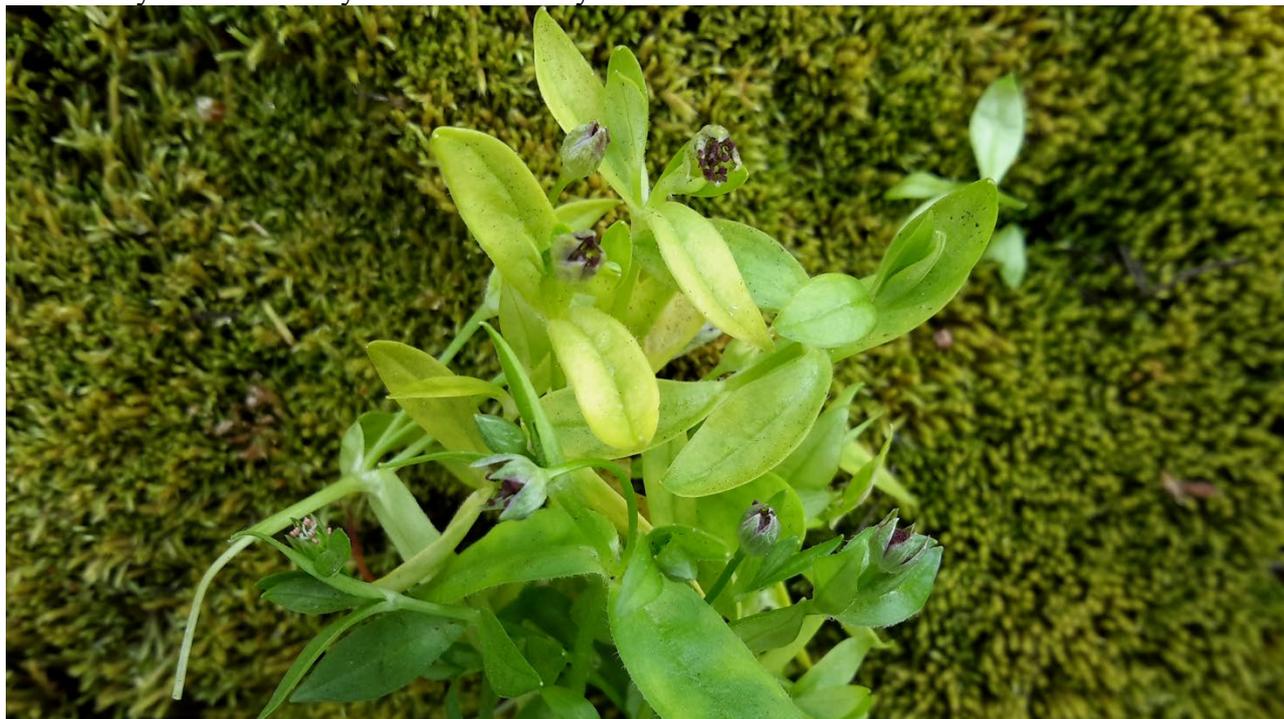
Caryophyllaceae: *Silene acaulis*.

Distribution

Arctic-alpine; circumpolar; type 1; in arctic CAN (NU, QC), GR, IS, Svalbard, NO, and RU, and in the alpine Alaska-Yukon Ranges (AK and CAN: YT), the Rocky Mts. (USA: CO), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Khibiny Mts. (RU), and the Alps (DE, FR, CH, AT, IT), Tatras (PL, SK), Carpathians (RO), Pyrenees (FR), and Rila Mts. (BG). Rather common; in Greenland, Iceland, Svalbard, and Fennoscandia coextensive with *Silene acaulis*.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum stellariae

HK 16.196; C-F-108447

Microbotryum stellariae (Sowerby) G. Deml & Oberw.

Syn.: *Ustilago stellariae* (Sowerby) Liro; *U. violacea* var. *stellariae* (Sowerby) Savile

Infection systemic. **Sori** in the considerably swollen anthers, filling the pollen sacs with a pulverulent, dark reddish brown spore mass.

Spores subglobose, globose, broadly ellipsoid, ovoid, ellipsoid, or slightly irregular, 5–8.5(–9.5) × (4.5–)5–7(–8) μm, light vinaceous; spore wall reticulate, 0.9–1.3 μm thick including reticulum, meshes (5–)6–9(–10) per spore diameter, polyhedral or irregular, 0.3–1.4(–2.0) μm wide, muri up to 0.4 μm high.

Habitats and host plants

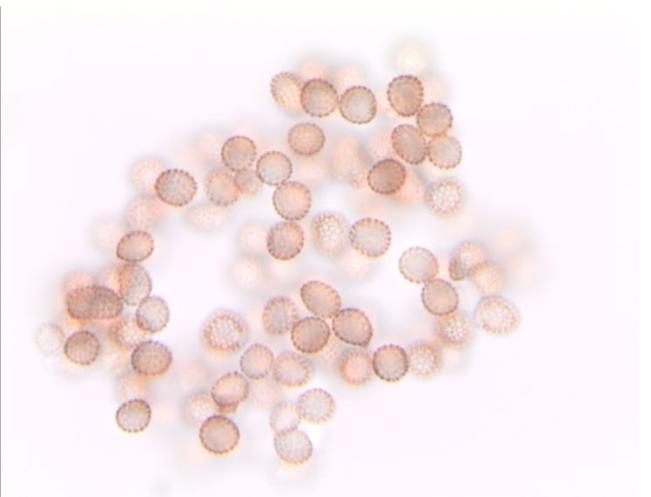
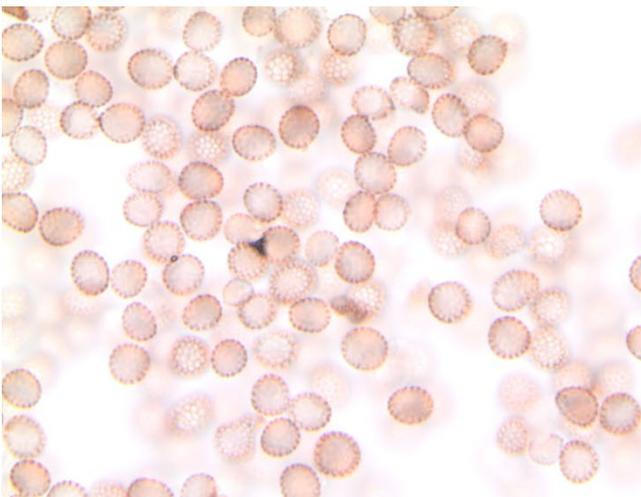
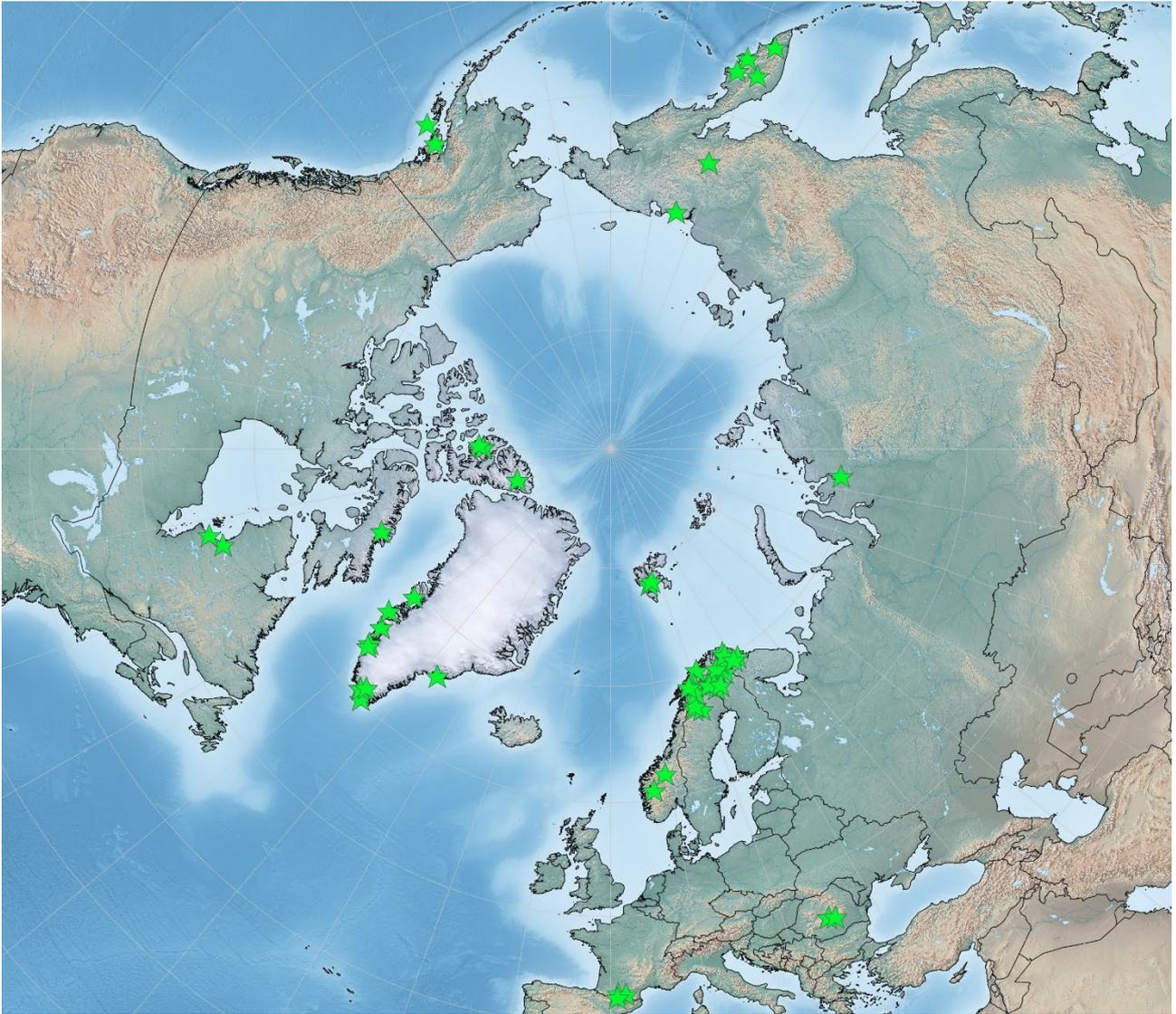
Arctic tundra and in high mountains; damp places, often in snow-patches, meadows, river and stream banks, shores of lakes and streams, terraces by rivers.

Caryophyllaceae: *Arenaria* spp., *Cerastium* spp., *Stellaria* spp.: in the arctic-alpine region *Arenaria biflora*, *A. ciliata*, *A. multicaulis* subsp. *moehringioides* (*A. moehringioides*),

Stellaria borealis, *S. calycantha*, *S. crassipes*, *S. edwardsii*, *S. eschscholtziana*, *S. graminea*, *S. laeta*, *S. longifolia*, *S. longipes* (*Stellaria ciliatosepala*, *S. monantha*), *Stellaria peduncularis* (*S. longipes* var. *peduncularis*), and hybrids (*S. calycantha* × *longifolia*, *S. graminea* × *longifolia*).

Distribution

Arctic; North American–Eurasian; type 4; found in arctic AK, CAN (NU, QC), GR, Svalbard, NO, and RU, and in the alpine Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Carpathians (RO), Pyrenees (ES), Kolyma Highlands, and Kamchatka (RU). Common in the Canadian Arctic and Greenland, and rather common in the north of Fennoscandia. In the other European areas, collections of this fungus on *Stellaria* are from forests or non-alpine grasslands. In Europe rarely reported on *Arenaria*. Rarely reported on *Stellaria* from the Russian Arctic and Far East.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum vinosum

HK 17.012; C-F-104902

Microbotryum vinosum (Tul. & C. Tul.) Denchev

Syn.: *Ustilago vinosa* Tul. & C. Tul.

Infection systemic, all flowers of an inflorescence affected. **Sori** in the four perianth segments of each flower, swelling them considerably and filling them with a pulverulent, vinaceous spore mass. Ovaries and anthers remain intact.

Spores globose, subglobose, ovoid, or broadly ellipsoid, sometimes ellipsoid, $6.5\text{--}9.5\text{--}(10.5) \times (5.5\text{--})6.5\text{--}8\text{--}(9) \mu\text{m}$, light vinaceous; spore wall reticulate, $0.9\text{--}1.4 \mu\text{m}$ thick including reticulum, meshes $(5\text{--})6\text{--}9\text{--}(10)$ per spore diameter, polyhedral or irregular, $0.4\text{--}1.7\text{--}(2.0) \mu\text{m}$ wide, muri up to $0.5 \mu\text{m}$ high.

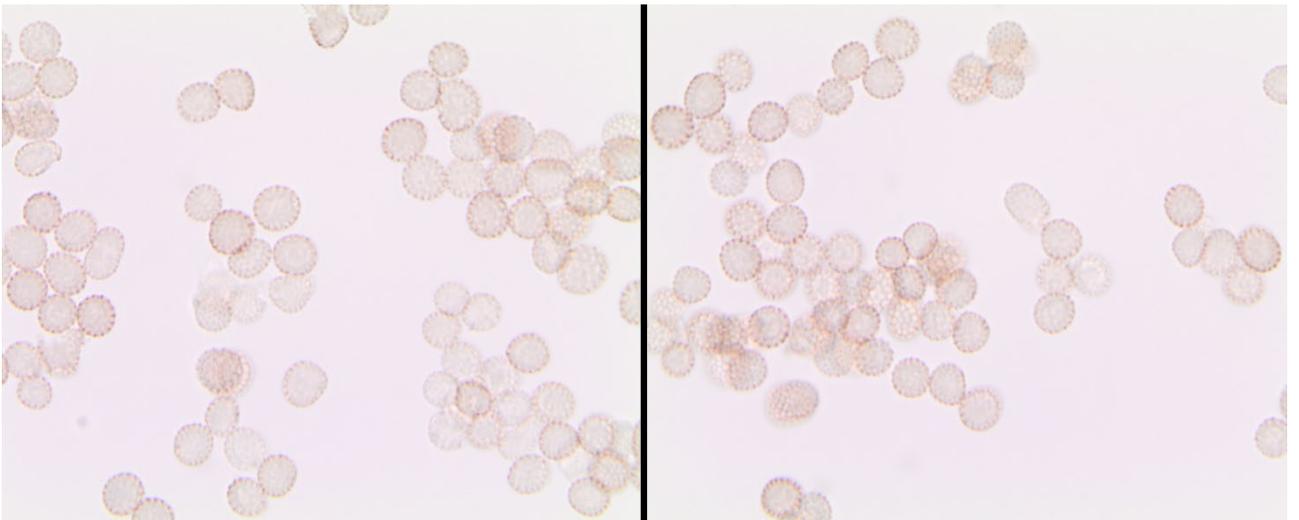
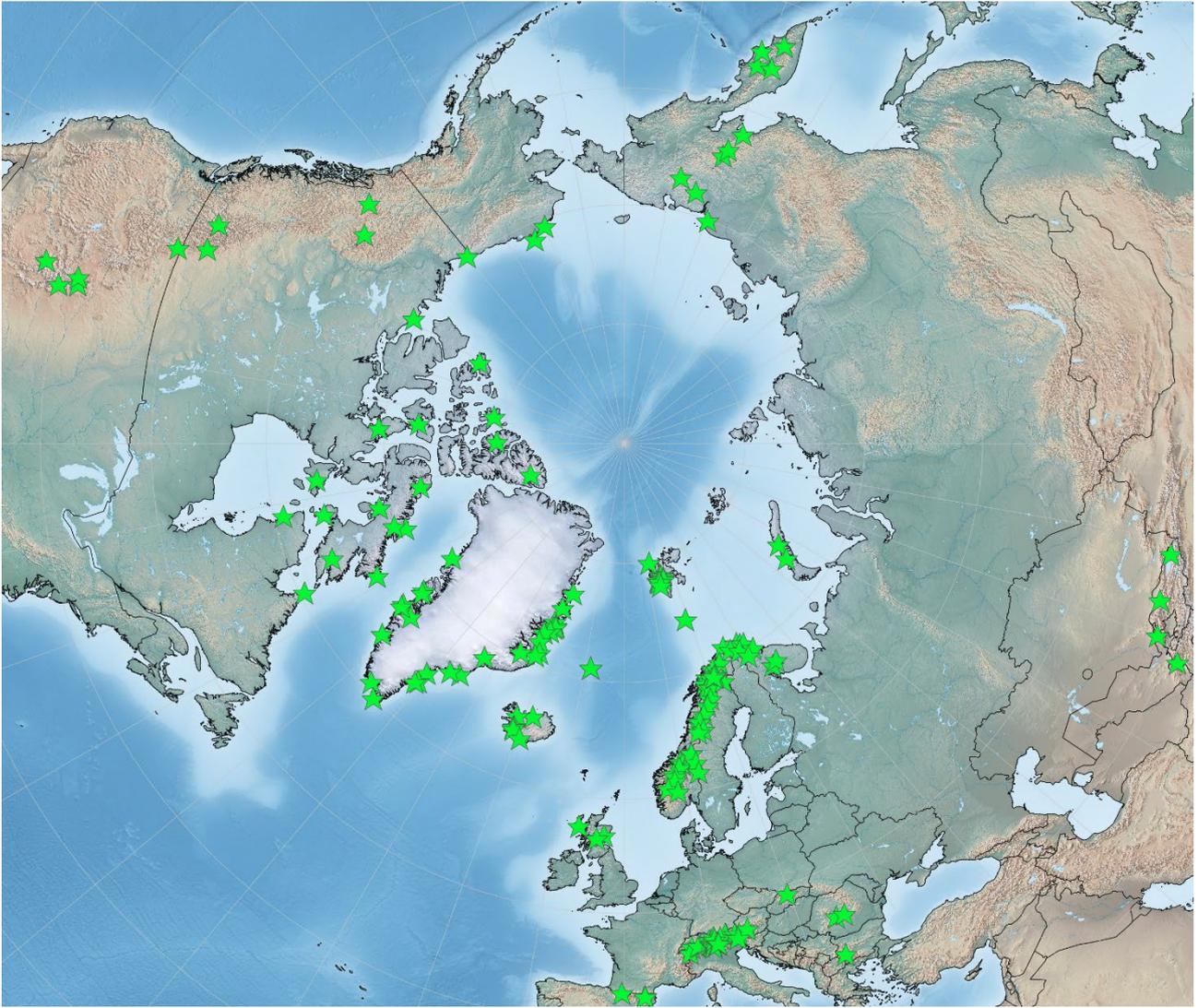
Habitats and host plants

Arctic tundra and in high mountains; early melting snowbeds and zones of snow accumulation, alpine meadows, gravel bars, mudflats, scree slopes, crevices in rock outcrops, beside streams.

Polygonaceae: *Oxyria digyna*.

Distribution

Arctic-alpine; circumpolar; type 1; in arctic AK, CAN (YT, NT, NU, QC), GR, IS, Svalbard, JAN, NO, and RU, and in the alpine Alaska-Yukon Ranges (CAN: YT), the Rocky Mts. (CAN: BC, AB; and USA: MT, WY, CO), the Scandinavian Mts. (NO, SE), Dovre (NO), the Khibiny and Lovozero Mts. (RU), the Alps (CH, AT, IT), Tatras (PO, SK), Carpathians (RO), and Pyrenees (FR, ES), the Rila Mts. (BG), the Anyuy Range and Kolyma Highlands (RU), Tian Shan (UZ, KG), and the Pamir Mts. (TJ). Rather common; one of the most widespread smut fungi in the Canadian Arctic, Greenland, Iceland, Svalbard and Jan Mayen, Fennoscandia, and the Russian Arctic. Common in a number of temperate high mountains.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum violaceoirregulare

W. Dietrich 425/94; GZU 000335987; Austria

Microbotryum violaceoirregulare (Brandenb. & Schwinn) G. Deml & Oberw.

Syn.: *Ustilago violaceoirregularis* Brandenb. & Schwinn

Infection systemic. **Sori** in the anthers, filling the pollen sacs with a pulverulent, dark purple spore mass.

Spores globose, subglobose, ovoid, or broadly ellipsoid, $6.5\text{--}10 \times 5.5\text{--}8 \mu\text{m}$, light purple; spore wall irregularly and incompletely verruculose-reticulate, with warts and spines which often are connected by low ridges, forming an irregular and incomplete reticulum.

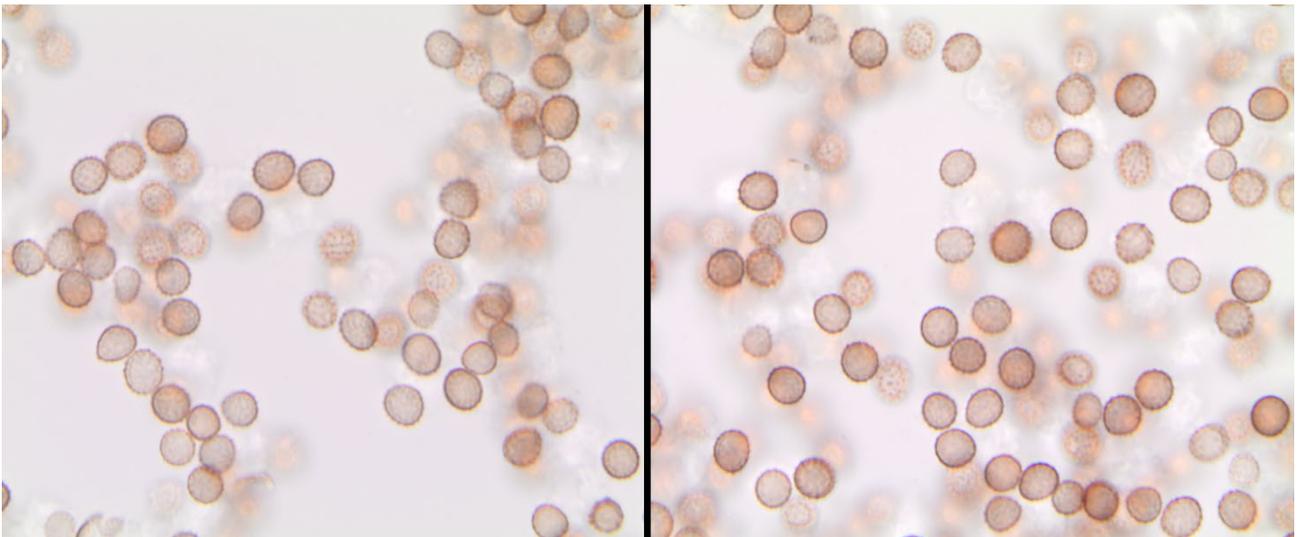
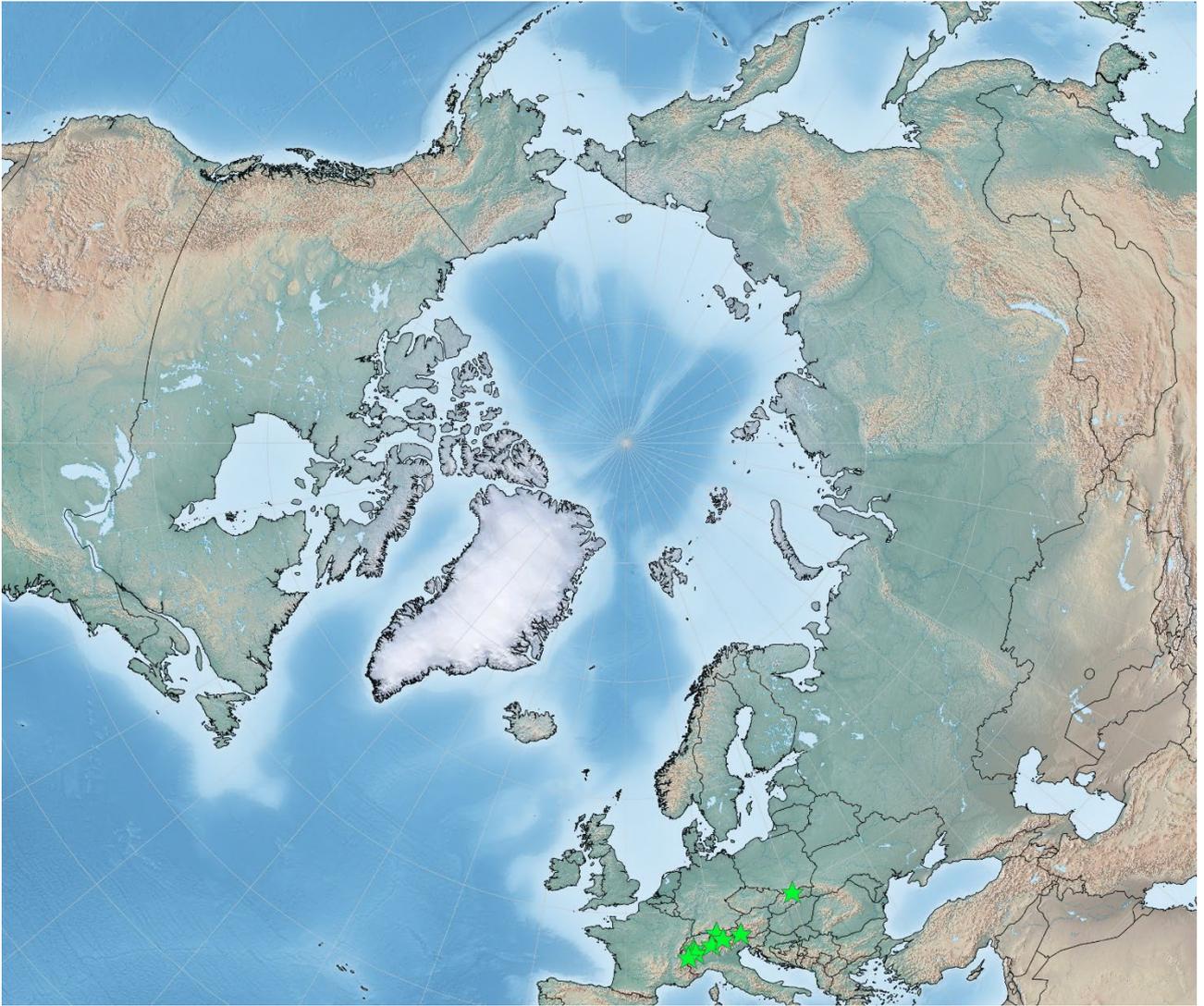
Habitats and host plants

Meadows, pastures, grassy slopes.

Caryophyllaceae: *Silene vulgaris*.

Distribution

Alpine; Eurasian; type 15; found in the Alps (DE, CH, AT, IT) and the Tatras (SK). Very rarely reported.



Microbotryum: Microbotryaceae: Microbotryales



Microbotryum warmingii

G. Vannes s.n.; TROM 39223; Norway

Microbotryum warmingii (Rostr.) Vánky

Syn.: *Ustilago warmingii* Rostr.

Infection systemic. **Sori** in leaves and flowers. In leaves especially along leaf margins as more or less extensive, purple, pustulous areas. Infected flowers are destroyed, filled with a pale purplish, powdery spore mass.

Spores globose, subglobose, or ovoid, occasionally irregular, 6–10.5 × 6–9 μm, subhyaline to pale vinaceous; spore wall finely reticulate, 6–9 meshes per spore diameter, muri 0.5–1 μm high, in median view appearing as low blunt projections.

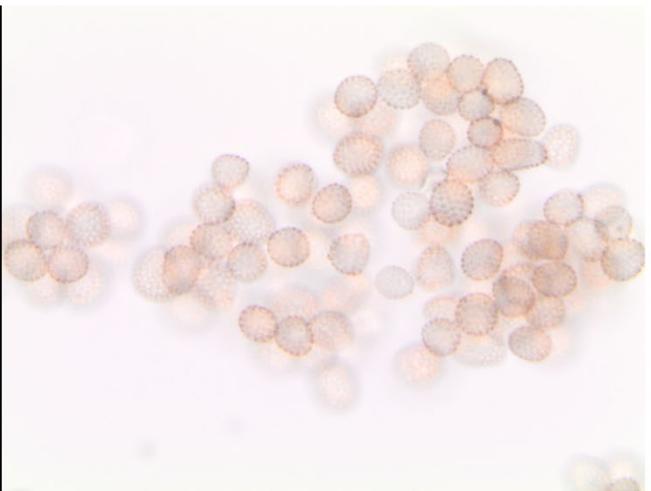
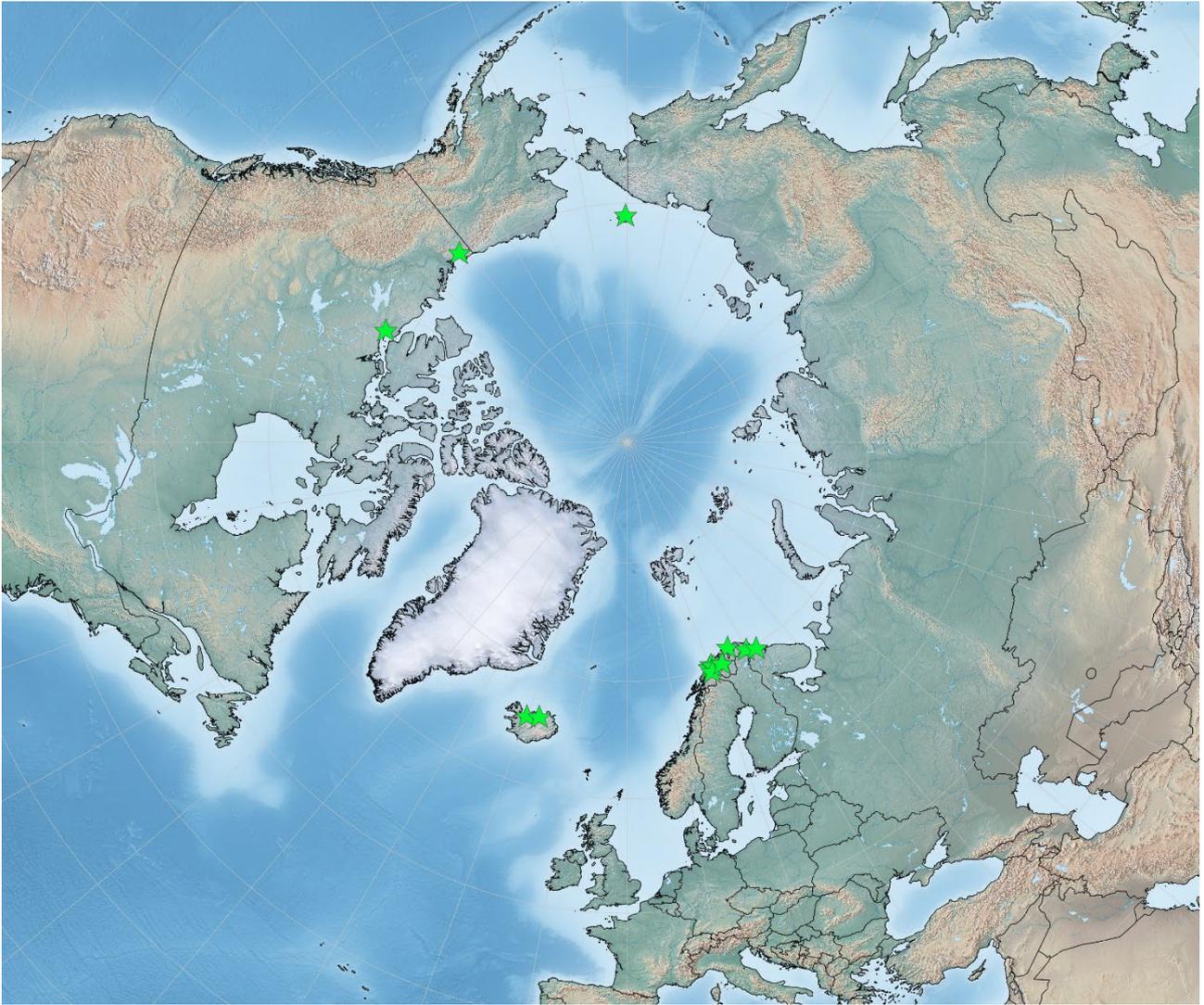
Habitats and host plants

Lakeshores, riverbanks, margins of streams, wet meadows and pastures, damp woodland; seashore meadows.

Polygonaceae: *Rumex*; in the arctic-alpine region *Rumex arcticus* and *R. longifolius* (*R. domesticus*).

Distribution

Arctic-alpine; circumpolar; type 6; in arctic CAN (YT, NU), IS, NO, and RU, and in the alpine Scandinavian Mts. (NO). Common in Iceland and Norway, very rare in the Canadian Arctic, the Yukon, and the Russian Arctic.



Microbotryum: Ustilentylomataceae: Ustilentyloma



Ustilentyloma pleuropogonis

D. B. O. Savile 4316B; DAOM 92913; Canada (NU)

Ustilentyloma pleuropogonis Savile

Infection systemic. **Sori** in leaves, forming elongate, scattered, light yellowish brown, 0.5–2 mm long spots on the leaf surface.

Spores embedded in the mesophyll, broadly ellipsoid or irregularly polygonal, rarely orbicular to suborbicular, 10–21.5 × 8–15 μm, hyaline; spore wall smooth.

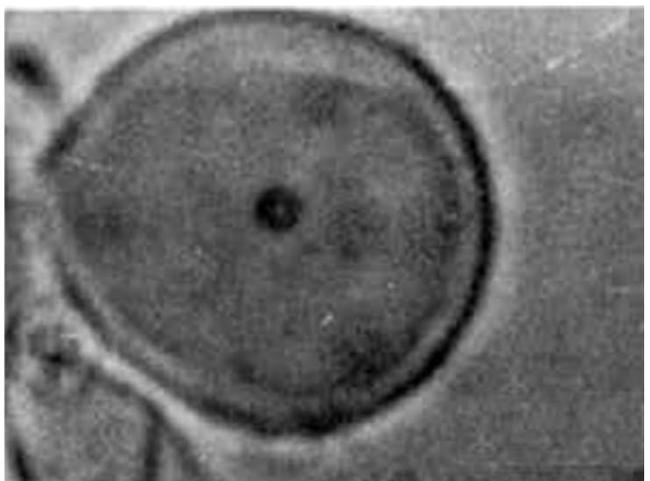
Habitats and host plants

Open wet places; around lakes, ponds, marshy areas, and riverbanks.

Poaceae: *Pleuropogon sabinei*.

Distribution

Arctic; North American; type 12; the host is widely distributed in arctic areas, but the species is only known from high arctic areas in Greenland and Canada.



Thecaphora: Glomosporiaceae: Urocystidales



Thecaphora thlaspeos

L. Jonsell 6221; S-F30022; Sweden

Thecaphora thlaspeos (Beck) Vánky

Syn.: *Ustilago thlaspeos* (Beck) Lagerh.; *Tothiella thlaspeos* (Beck) Vánky

Infection systemic. **Sori** in seeds, beginning at the funiculus, gradually replacing the entire seed with a pale brown or light yellow-brown, dusty, rather inconspicuous spore mass that is released when the silique opens.

Spores single, not in balls, broadly ellipsoid, subglobose, ovoid, or irregular, 10–20.5 × (8–)10–16 μm (including the ornaments), pale yellowish brown; spore wall 0.5–1.0 μm thick, with irregularly arranged, coarse warts, tubercles, or elongate ornaments, 0.5–1.0 μm high; the ornaments are denser and higher (1.5–2.5 μm) on one of the sides.

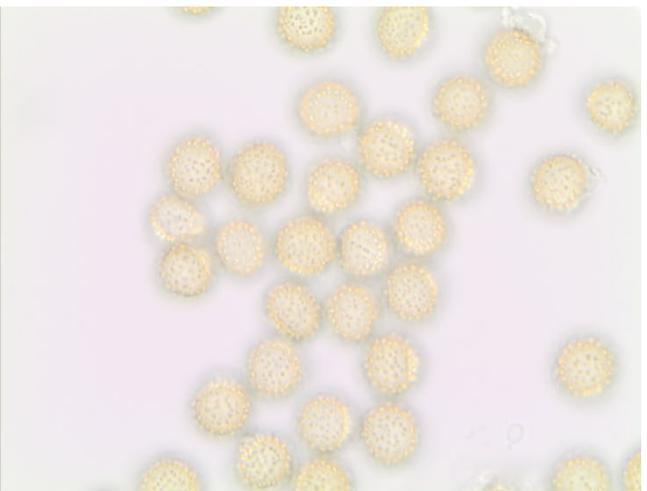
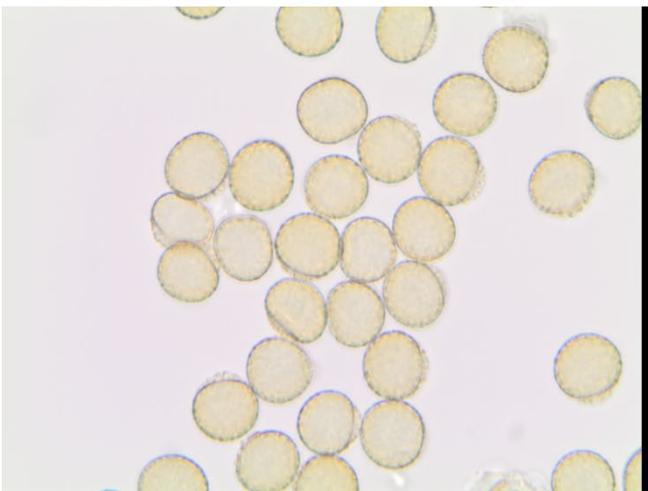
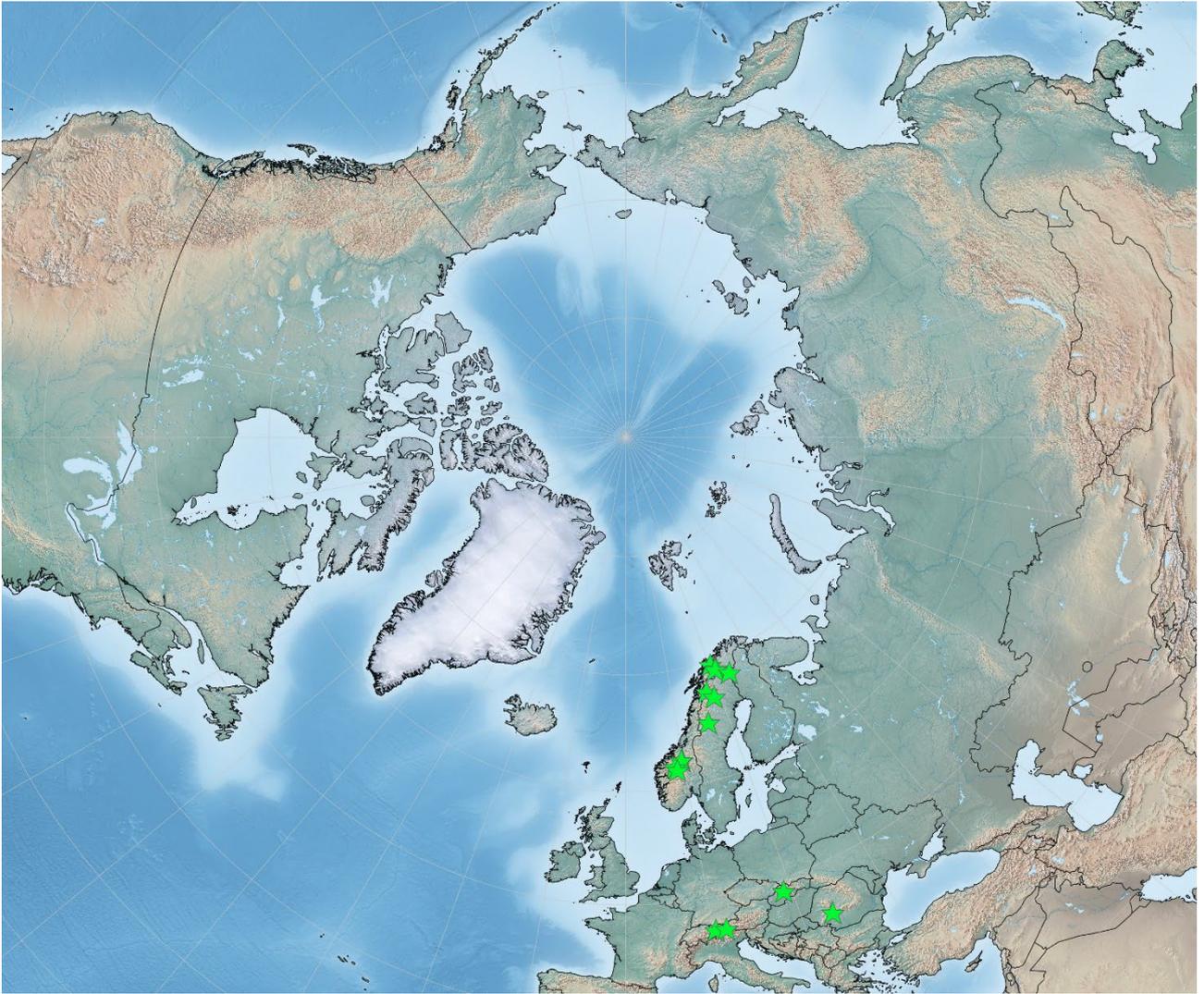
Habitats and host plants

Tundra, along streams, moist montane rocks and gravel, snowbeds, sand and gravel flats or beaches; alpine rocks, slopes, and gravel.

Brassicaceae: *Alyssum*, *Arabidopsis*, *Arabis*, *Cardamine*, *Draba*, *Erysimum*, and *Noccaea*; in the alpine region *Arabidopsis lyrata* subsp. *petraea* (*Cardaminopsis petraea*), *Arabis alpina*, *Arabis sagittata*, *Cardamine bellidifolia*, *Draba aizoides*, *Draba alpina*, *Draba incana*, *Draba norvegica*, and *Noccaea caerulescens* (*Thlaspi alpestre*).

Distribution

Eurasian alpine; type 15; found in the alpine Scandinavian Mts. (NO, SE, FI), Dovre (NO), and the Alps (AT, IT), Tatras (SK), and Carpathians (RO). Rarely collected in the study area, probably overlooked. Outside of the study area, host plants of this smut fungus are confined to sparsely vegetated areas, roadsides, dry slopes in lowlands, seminatural habitats, scrubs, forests, and non-alpine grasslands.



Urocystis: Urocystidaceae: Urocystidales

*Urocystis agropyri* sensu lato

HK 18.089; C-F-111316

Urocystis agropyri (Preuss) A.A. Fisch. Waldh.

Infection systemic. **Sori** found in leaves as long striae between the veins, initially covered by the epidermis that later ruptures, disclosing a powdery, blackish brown mass of spore balls.

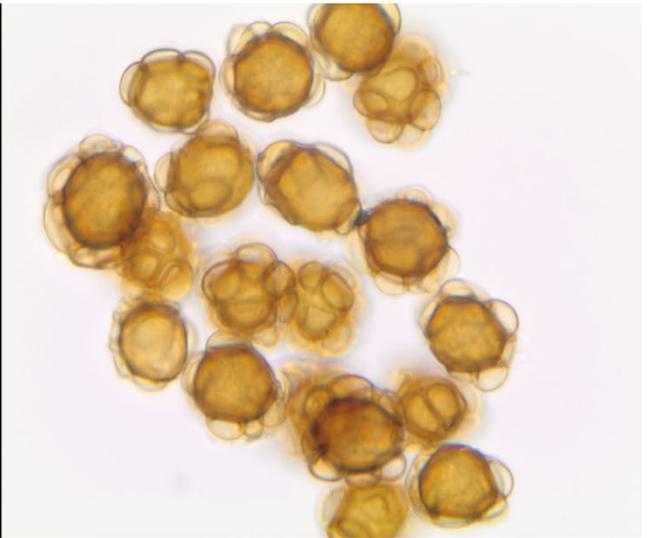
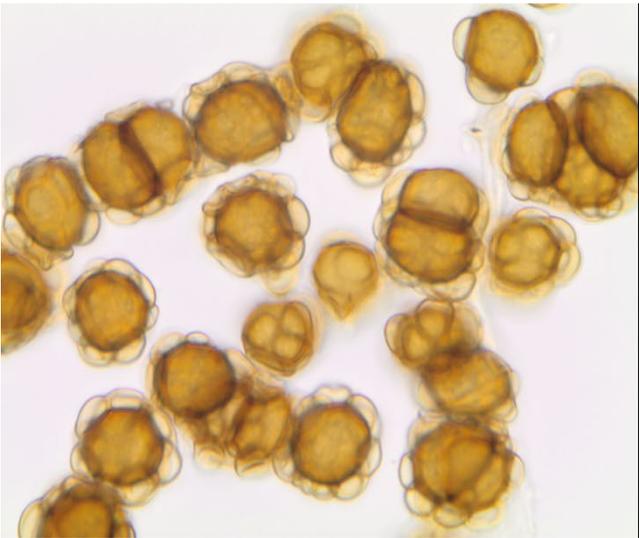
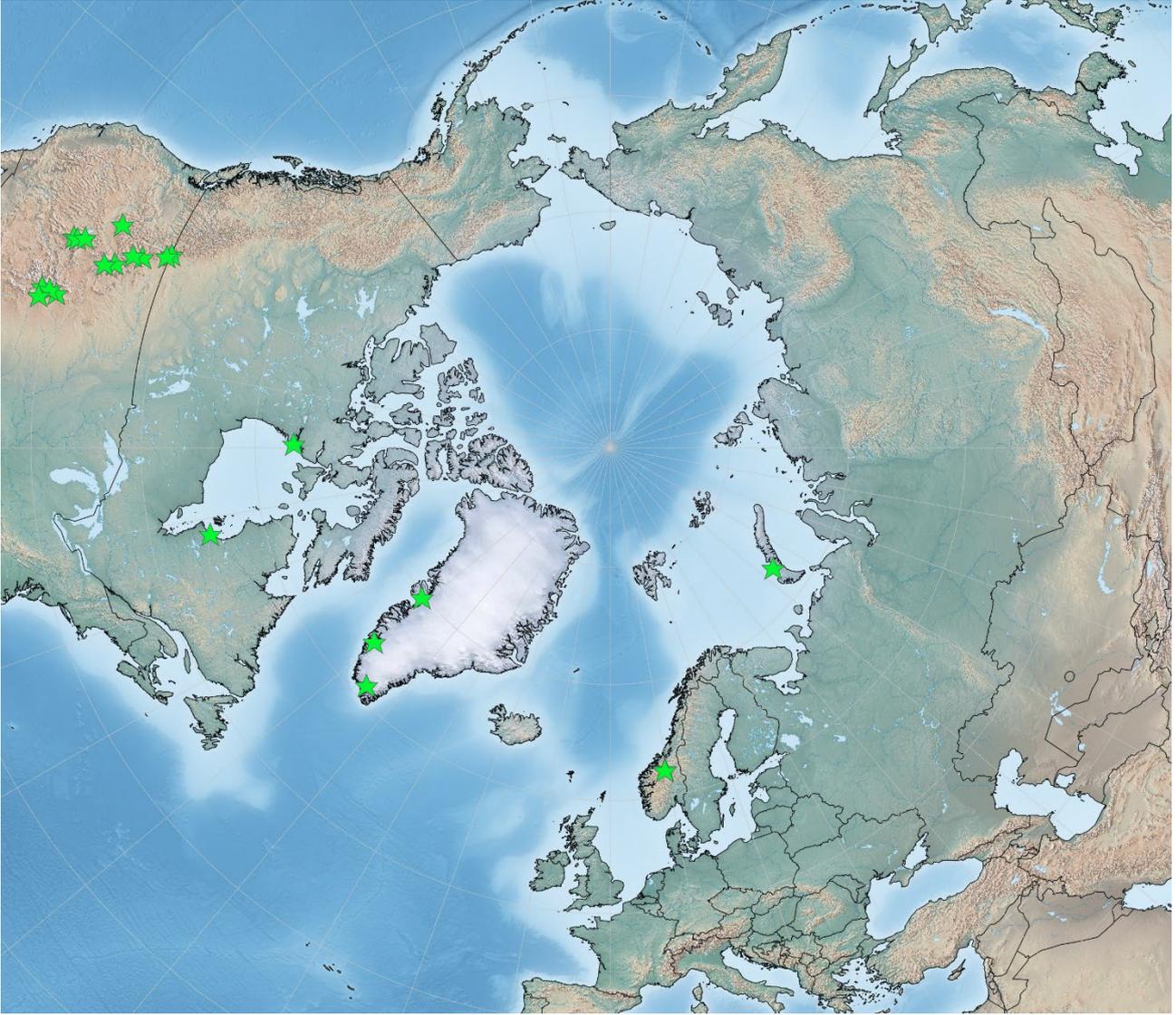
Spore balls irregular, broadly ellipsoid, subglobose, ovoid, or ellipsoid, composed of 1–2(–3) central spores surrounded by a discontinuous to almost continuous layer of sterile cells, (17–)18.5–24(–25) × (14–)15–19(–20) μm (with 1 spore), (20–)21–28(–30.5) × (17–)18–22(–23) μm (with 2 spores). **Sterile cells** broadly ellipsoid, suborbicular, irregular, ellipsoid, or ovoid, sometimes collapsed, (3–)4–11(–12) μm long, pale yellowish to light yellowish brown; cell wall on the side distal to the spores 0.5–0.8 μm thick, on the side proximal to the spores thicker, 0.7–1.0 μm. **Spores** subglobose, broadly ellipsoid, irregular, ovoid, or ellipsoid, often slightly flattened in one or few places, (12–)13–17.5(–18.5) × (10–)11–14.5(–15.5) μm, medium reddish brown; spore wall slightly unevenly thickened, 0.7–1.0 μm thick.

Habitats and host plants

Pastures, waste areas, around riverbanks, open woodlands, seashores.

Poaceae: a wide range of hosts in *Agropyron*, *Arctagrostis*, *Elymus*, *Leymus*, *Psathyrostachys*, *Pseudoroegneria*, and *Thinopyrum*: in the arctic-alpine region *Arctagrostis latifolia*, *Elymus canadensis*, *Elymus glaucus*, *E. macrourus* (*Roegneria borealis*), *Elymus smithii* (*Agropyron smithii*), *Elymus violaceus* (*Agropyron latiglume*, *Agropyron pauciflorum*, *A. subsecundum*, *A. trachycaulum*), *Leymus arenarius* (*Elymus arenarius*), *Leymus mollis* (*Elymus mollis*), *Leymus villosissimus* (*Elymus mollis* subsp. *villosissimus*), and *Pseudoroegneria spicata* (*Agropyron inerme*, *A. spicatum*).

Distribution Cosmopolitan; type 1; found in arctic CAN (NU, QC), GR, and RU, and in the alpine Rocky Mts. (CAN: AB; and USA: ID, MT, WY, UT, CO) and Dovre (NO).



Urocystis: Urocystidaceae: Urocystidales



Urocystis alaskana

D. V. Baxter s.n.; BPI 195244; Alaska

Urocystis alaskana Zundel

Infection systemic. **Sori** on the abaxial side of the leaves and petioles forming pustules, chiefly along the veins, ovoid or elongate, 3–6 mm long, initially covered by the epidermis that ruptures to expose a powdery, blackish brown mass of spore balls.

Spore balls irregular in shape, chiefly 20–50 × 15–40 μm, composed of 1–6 spores surrounded by an incomplete layer of sterile cells. **Sterile cells** subglobose, ellipsoid to slightly irregular, with flattened contact sides, 7–16 μm long, yellowish brown; cell wall 1–2(–2.5) μm thick, smooth; contents granular. **Spores** subglobose, ovoid, ellipsoid, elongate, or irregular, with flattened contact sides, 15–25 × 12–20 μm, yellowish to reddish brown; spore wall even, 1–1.5 μm thick.

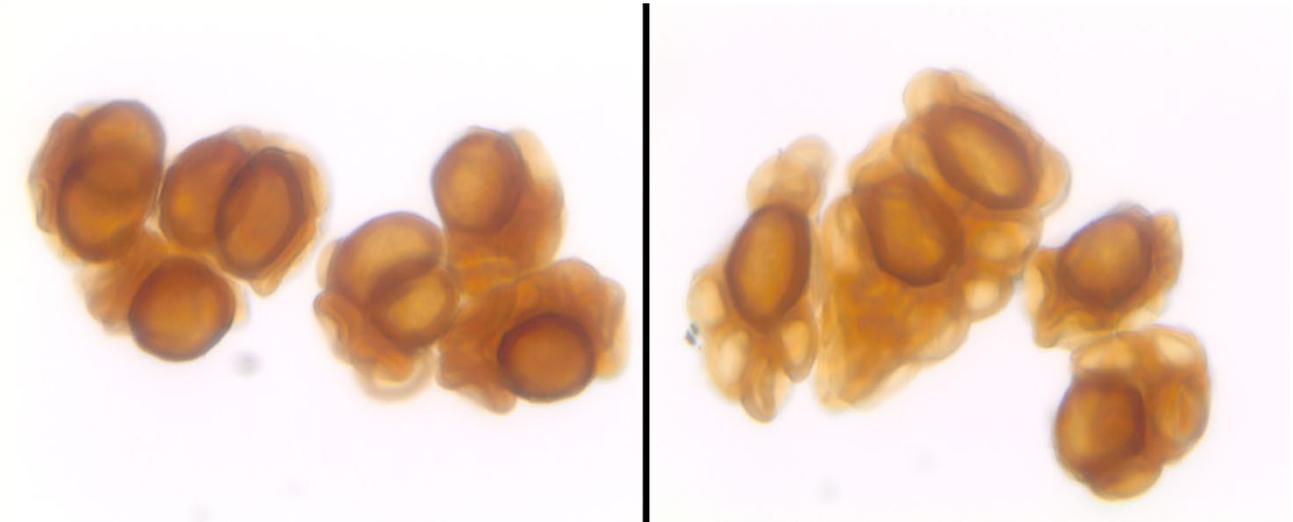
Habitats and host plants

Streamside gullies, snowbeds, grasslands, and meadows, in open or partially shaded *Salix* thickets.

Saxifragaceae: *Boykinia*: in the arctic region *Boykinia richardsonii*.

Distribution

North American arctic; type 12; found in arctic Alaska. Very rarely reported. On *Boykinia richardsonii* known only from the type locality.



Urocystis: Urocystidaceae: Urocystidales



Urocystis callianthemi

A. A. Domashova s.n.; LE 43569; Kyrgyzstan

Urocystis callianthemi Domashova

Syn.: *Tuburcinia callianthemi* Massenot;

Urocystis callianthemi (Massenot) Kochman & T. Majewski

Infection systemic. **Sori** occurring in leaves and petioles as isolated or grouped pustules initially covered by the epidermis, which ruptures to expose a powdery, black mass of spore balls.

Spore balls globose to ovoid, 16–40 × 14–30 μm, pale reddish brown, composed of (0–)1–3(–5) spores surrounded by an incomplete layer of sterile cells. **Sterile cells** variable in form and size, 4–13 μm long, yellowish to pale reddish brown; cell wall thin, more or less even, smooth, collapsed when dry.

Spores globose, ovoid, or irregular, 11–16 × 10–14 μm, yellowish to pale reddish brown; spore wall smooth.

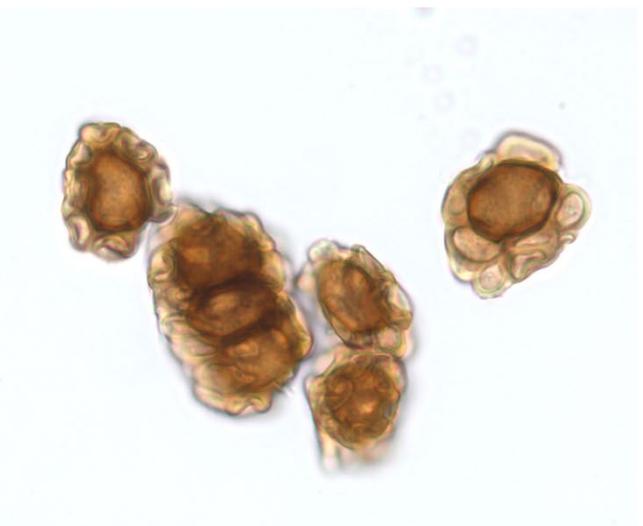
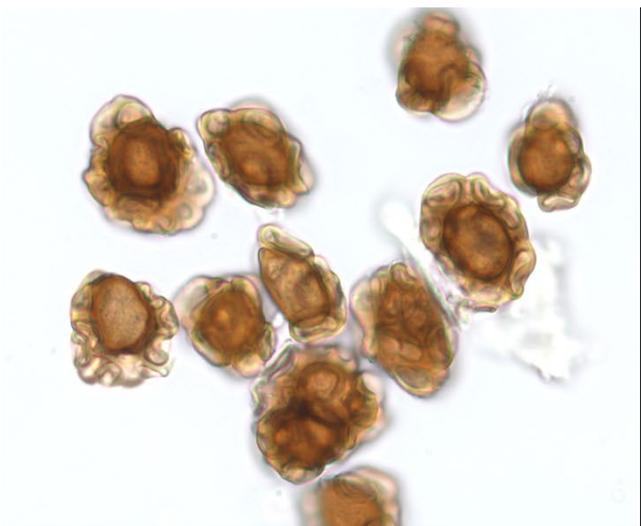
Habitats and host plants

Grassy slopes and valleys in high mountains.

Ranunculaceae: *Callianthemum alatavicum*, *C. coriandrifolium*.

Distribution

Eurasian alpine; type 15; found in alpine regions of the Alps (FR, IT) and Tian Shan (KG). Very rarely reported.



Urocystis: Urocystidaceae: Urocystidales



Urocystis cortusae

K. Vánky, Ustilaginales 295; SOMF 17946; Slovakia

Urocystis cortusae (Liro) Schwarzman

Syn.: *Tuburcinia cortusae* Liro

Infection systemic. **Sori** destroying the seeds and filling the capsules with a powdery, blackish brown mass of spore balls; at maturity the capsules open at the apex and the spore mass becomes scattered.

Spore balls globose, subglobose, or irregular, (24–)30–50(–64) × (20–)24–36(–50) μm, composed of 1–7(–8) spores surrounded by a discontinuous to continuous, single or in part double layer of sterile cells. **Sterile cells** subglobose, ovoid, or irregular, 5.5–14.5(–16) × 3–9.5 μm, yellow to pale yellowish brown; cell wall 0.8–2.5 μm thick, smooth. **Spores** globose, subglobose, ovoid, or irregular, 11–20(–28) × 11–16 μm, medium brown; spore wall ca. 0.8 μm thick, smooth.

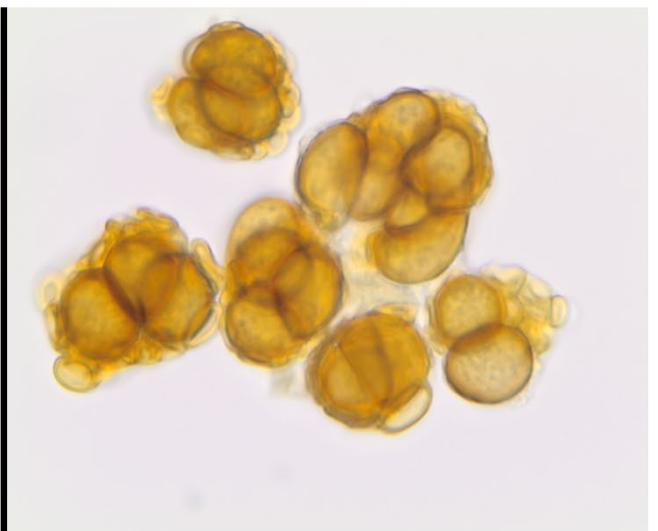
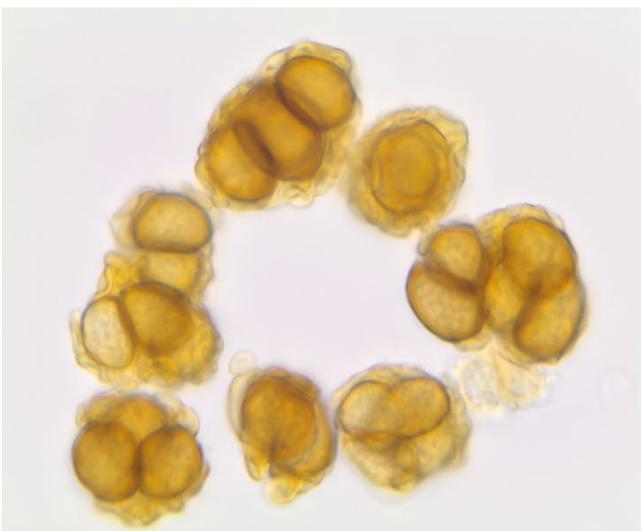
Habitats and host plants

Moist woodlands, mountain meadows, around streams.

Primulaceae: *Primula matthioli*.

Distribution

Eurasian; type 9; found in arctic Russia, and in the alpine Tatras (SK) and Tian Shan (UZ, CN). Very rarely reported.



Urocystis: Urocystidaceae: Urocystidales



Urocystis fischeri

J. I. Liro & H. Roivainen s.n.; SOMF 2696; Finland

Urocystis fischeri Körn.

Infection systemic. **Sori** occurring in leaves as long striae between the veins, initially covered by the epidermis that later ruptures, disclosing a semi-agglutinated, very dark reddish brown mass of spore balls.

Spore balls irregular, subglobose, ovoid, broadly ellipsoid, or ellipsoid, composed of 1–2(–3) central spores surrounded by a continuous, sometimes almost continuous layer of sterile cells, 18–34.5 × 17–25.5 μm.

Sterile cells usually irregular, sometimes broadly ellipsoid, ellipsoid, or ovoid, collapsed, 5–9.5(–11.5) μm long, medium yellowish brown to medium reddish brown; cell wall on the side distal to the spores 0.5–0.7 μm thick, on the side proximal to the spores thicker, 0.8–1.2 μm, smooth.

Spores subglobose, broadly ellipsoid, slightly irregular, or ovoid, sometimes cuneate, sometimes slightly flattened in one to a few places, (13–)14–18.5(–20.5) × (11–)12–15.5(–16.5) μm, medium or dark reddish brown; spore wall slightly unevenly thickened, 0.8–1.4 μm thick, smooth.

Host plants and habitats

Grasslands close to the sea, low and medium altitude hay meadows, mountain habitats, subalpine and alpine grasslands.

Cyperaceae: a polyphagous smut fungus, recorded on 28 species of *Carex*; in the arctic-alpine region *Carex atrata*, *Carex bigelowii*, *Carex capillaris*, *Carex caryophylllea*, *Carex ericetorum*, *Carex flacca*, *Carex fusca*, *Carex lasiocarpa*, *Carex lyngbyei*, *Carex membranacea*, *Carex nigra*, *Carex panicea*, *Carex pallescens*, *Carex rostrata*, and *Carex subspathacea*.

Distribution

Arctic-alpine; type 1; found in arctic GR, IS, and RU, and in the alpine Rocky Mts. (USA: MT, WY, CO), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Alps (DE, FR, CH, AT), the Tatras (SK), and Tian Shan (KG). Common.

Urocystis: Urocystidaceae: Urocystidales



Urocystis flowersii

Urocystis flowersii Garrett

Sori in leaves, mostly on the lower surface, forming ellipsoid or broadly fusiform pustules, 1.5–5 mm long, initially lead-coloured, covered by the epidermis that ruptures longitudinally to expose the blackish brown, agglutinated mass of spore balls.

Spore balls subglobose, ovoid, broadly ellipsoid, or ellipsoid, often elongate or irregular, composed of (2–)4–25 or more central spores, surrounded by an incomplete or complete layer of sterile cells, 25–85 × 20–60 µm. **Sterile cells** suborbicular, broadly ellipsoid to ellipsoid, often with a flattened contact side, 7–13.5 µm long, pale yellowish brown; cell wall 1.5–3.5 µm thick, smooth. **Spores** subglobose, broadly ellipsoid, ovoid, or irregular, sometimes cuneate, 12–20(–28) × 9.5–16 µm, yellowish brown; spore wall evenly thickened, ca. 0.5 µm thick, punctate.

S. Flowers s.n.; BPI 182115; USA (Utah)

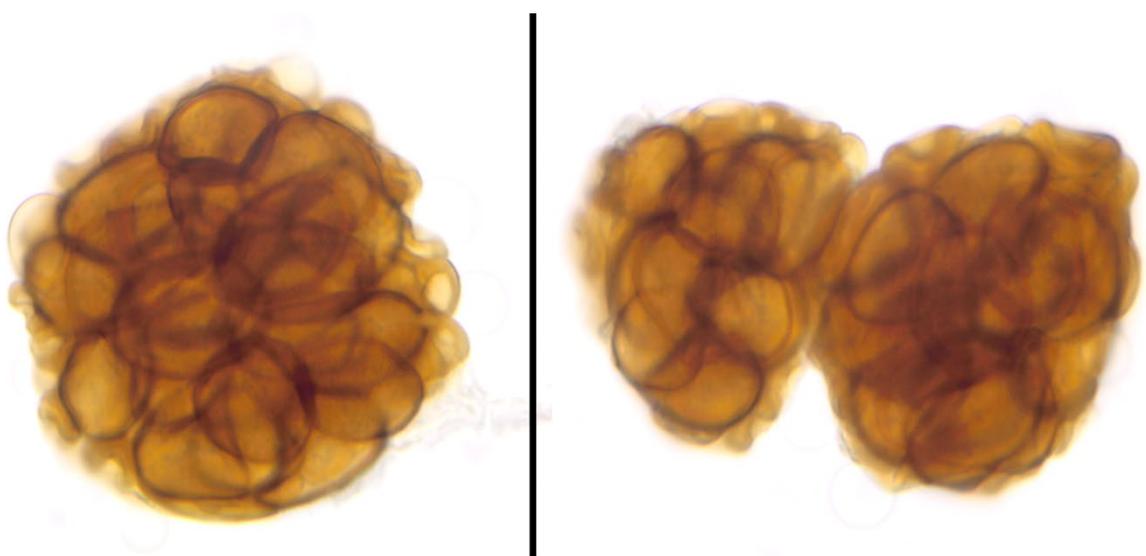
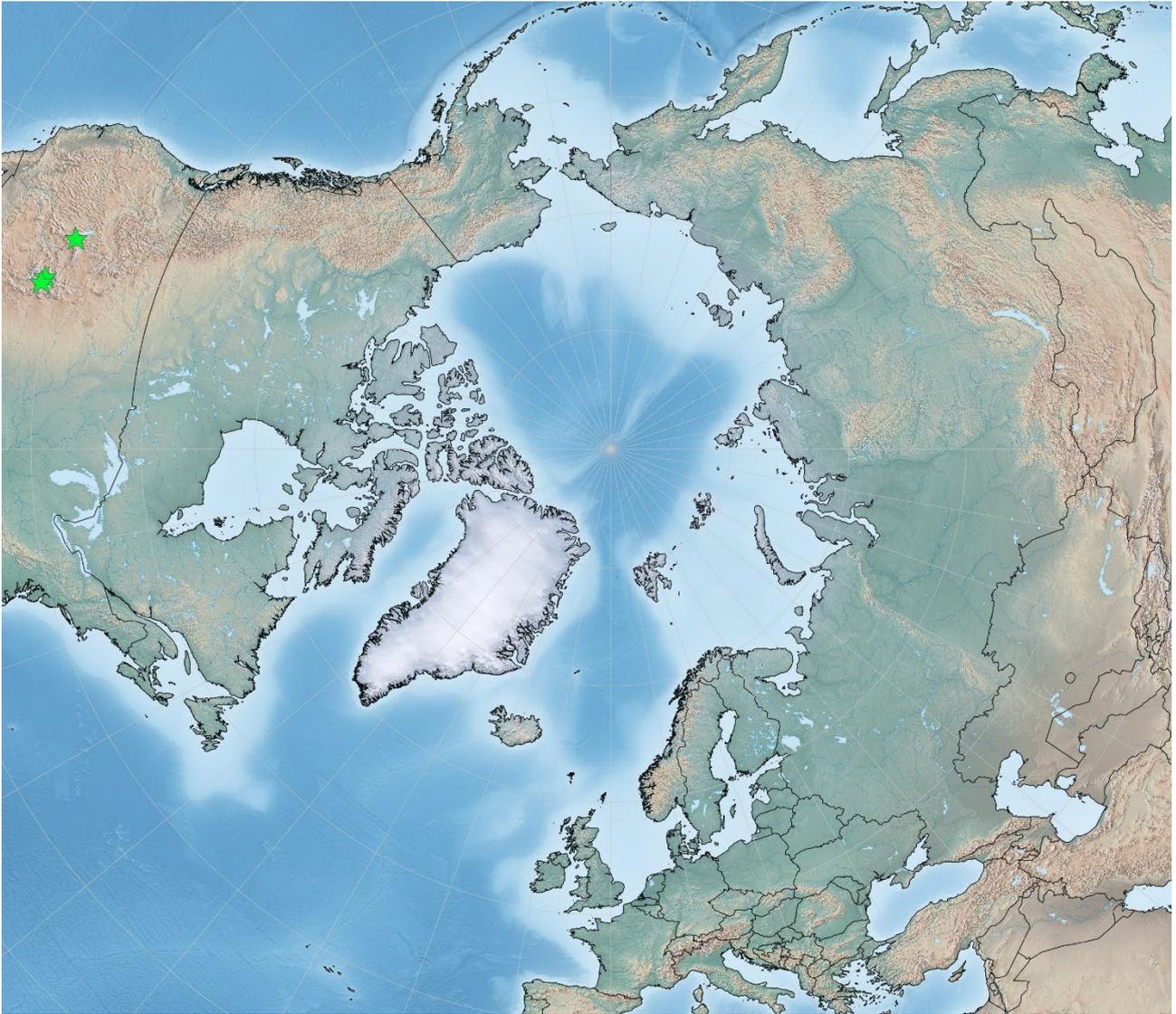
Habitats and host plants

Moist grasslands, meadows, lake shores, rocky slopes.

Melanthiaceae: *Anticlea elegans* (*Zigadenus elegans*), *Toxicoscordion venenosum* var. *gramineum* (*Zigadenus gramineus*).

Distribution

North American alpine; type 14; found in the alpine Rocky Mts. (USA: UT, CO). Very rarely collected.



Urocystis: Urocystidaceae: Urocystidales



Urocystis heucherae

Urocystis heucherae Garrett

Infection systemic. **Sori** in leaves forming pustules, in petioles and stems producing swellings and distortion; initially covered by the epidermis, which ruptures irregularly to expose a semi-agglutinated to powdery, black mass of spore balls.

Spore balls composed of (1–)2–10(–14) spores and an incomplete layer of sterile cells, subglobose, ellipsoid, elongate, or irregular, 20–50(–55) × 14–40 μm, reddish brown. **Sterile cells** subglobose, ellipsoid, or irregular, 5.5–14 μm long, yellowish brown; cell wall 0.5–1.2 μm thick, smooth. **Spores** subglobose, ovoid, ellipsoid, or irregular with one or several flattened sides, 11–17(–19) × 10–14 μm, dark reddish brown; spore wall 1.0–1.8 μm thick.

A. O. Garrett 3378; BPI 182154B; USA (Utah)

Habitats and host plants

Rocky mountain habitat types, rock outcrops in valleys, foothills, canyon walls, subalpine and alpine slopes.

Saxifragaceae: *Heuchera parvifolia*,
Micranthes tolmiei (*Saxifraga tolmiei*).

Distribution

North American alpine; type 14; found in the alpine Intermountain West (CAN: BC) and Rocky Mts. (USA: UT). Very rarely collected; probably overlooked.



Urocystis: Urocystidaceae: Urocystidales



Urocystis irregularis

K. Vánky et al., *Ustilaginales* 237; SOMF 17956; Norway

Urocystis irregularis (G. Winter) Săvul.

Syn.: *Tuburcinia irregularis* (G. Winter) Liro

Infection systemic. **Sori** on the abaxial side of leaves, occurring on petioles and stems as pustules, sometimes confluent, or in the veins as long swellings, initially covered by the epidermis that ruptures to expose a powdery, black mass of spore balls.

Spore balls composed of 1–7(–9) central spores and a few to sometimes many peripheral sterile cells forming an incomplete layer, subglobose to irregular, of various sizes, 22–52(–64) × 20–35(–40) μm. **Sterile cells** globose, semi-lunate, ovoid, or irregular, 7–20 × 5.5–12 μm, pale yellowish brown; cell wall 0.8–1.0 μm thick, smooth. **Spores** mostly irregularly elongate, sometimes broadly ellipsoid or subglobose, 13–24 × 9.5–16(–20.5) μm, medium reddish brown; spore wall 1–1.5 μm thick, smooth to punctate or with irregular small thickenings on the free surface.

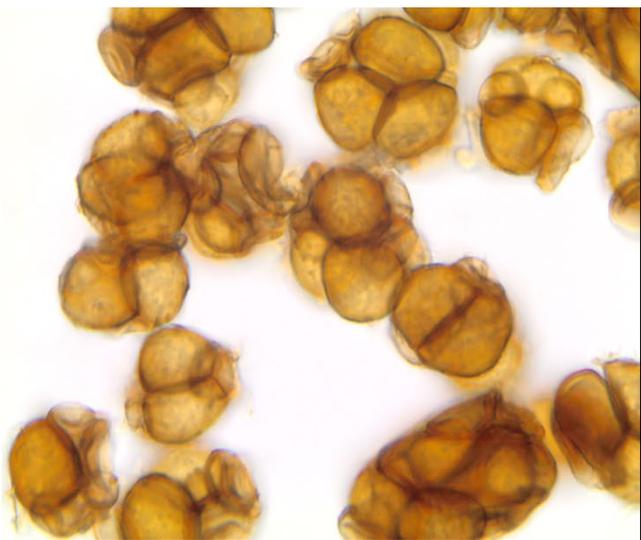
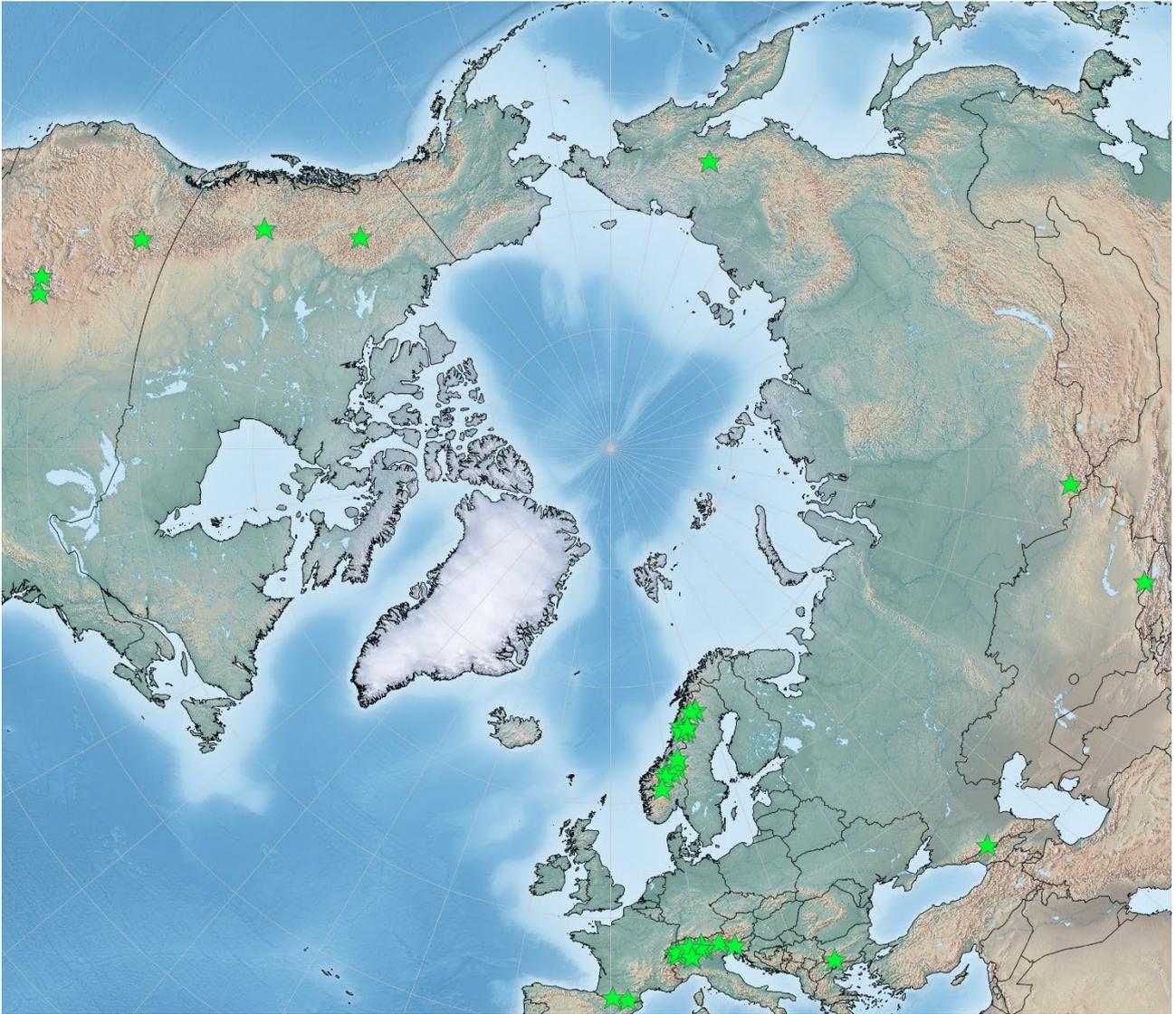
Habitats and host plants

Meadows, along streams, creeks, and in other wet areas; thickets, woods, subalpine and alpine rocky slopes; riverbanks in the alpine zone.

Ranunculaceae: *Aconitum* spp.: in the region *Aconitum anthora*, *Aconitum columbianum*, *Aconitum delphiniifolium*, *A. lamarckii*, *A. lycoctonum*, *A. napellus*, *A. septentrionale* (*A. excelsium*), *A. soongaricum*, or *A. vulparia*.

Distribution

Alpine; type 7; found in the Alaska-Yukon Ranges (CAN: YT), the Rocky Mts. (CAN: BC and USA: MT, CO), Scandinavian Mts. (NO, SE), Dovre (NO), Alps (CH, IT, SI), Pyrenees (FR), Rila Mts. (BG), Caucasus, Kolyma Highlands, and Altai Mts.(RU), and Tian Shan (KZ). Common on *Aconitum septentrionale* in Norway and Sweden, but very rarely reported from the rest of the alpine region.



Urocystis: Urocystidaceae: Urocystidales



Urocystis junci

A. Wennström, Vánky Ustilaginales 1041; SOMF; Sweden

Urocystis junci Lagerh.

Syn.: *Tuburcinia junci* (Lagerh.) Liro

Infection systemic. **Sori** in the interior of the culms, often spirally twisted, to 15 cm long, rupturing longitudinally and exposing a granular-powdery, blackish brown mass of spore balls.

Spore balls variable in shape and size, broadly ellipsoid to ellipsoid, globose, or irregular, $15.5\text{--}78 \times 15\text{--}53 \mu\text{m}$, composed of (1)2–10(–23) spores completely invested by sterile cells. **Sterile cells** suborbicular, broadly ellipsoid, ellipsoid, or irregularly elongate, $5.5\text{--}14.5\text{--}16.5 \mu\text{m}$ long, light reddish brown, often collapsing when dry; cell wall ca. $1 \mu\text{m}$ thick, smooth. **Spores** broadly ellipsoid, subglobose, ovoid, or slightly irregular, $11\text{--}16\text{--}19.5 \times 9.5\text{--}13 \mu\text{m}$ in diameter, reddish brown; spore wall ca. $1 \mu\text{m}$ thick, smooth.

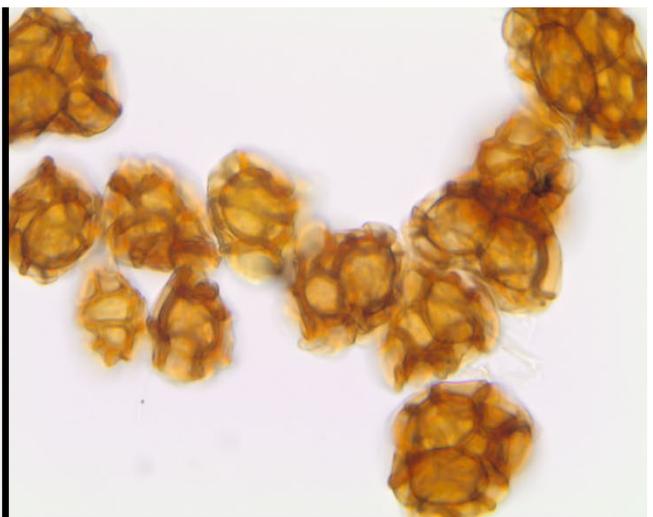
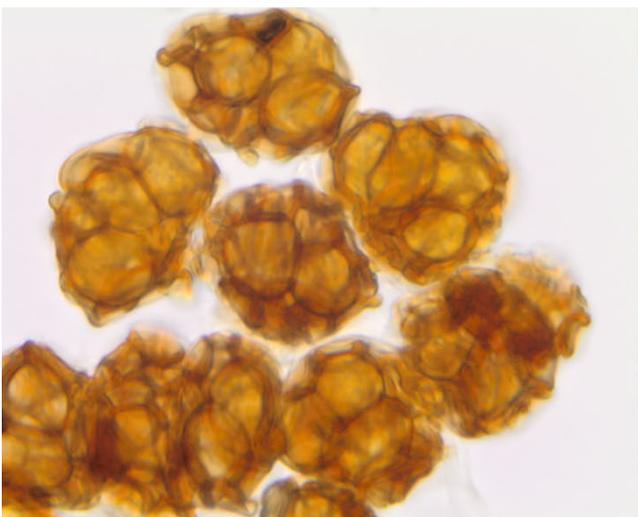
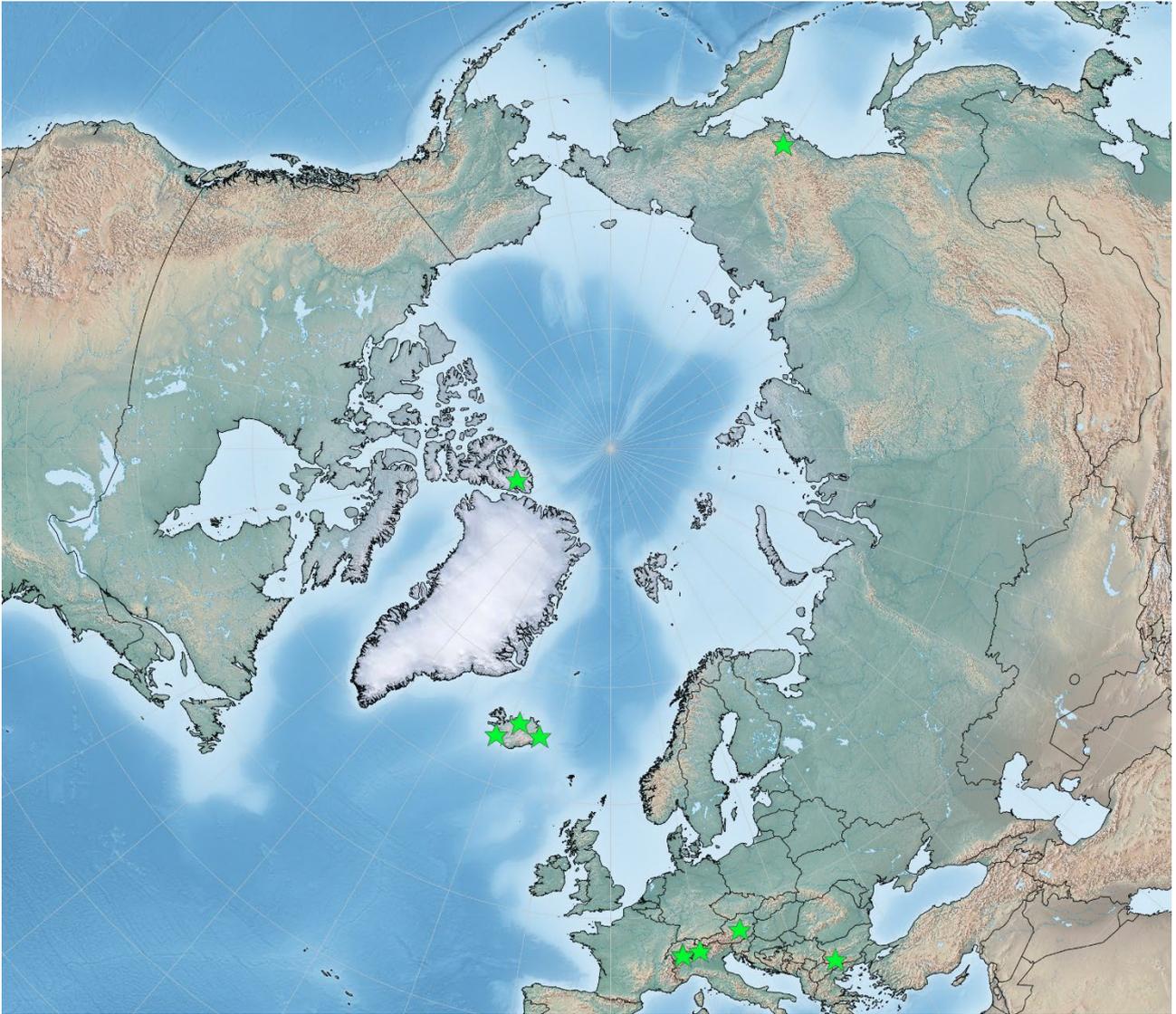
Habitats and host plants

Shores; wet tundra; stream banks, wet meadows, fens, marshes; wet gravel and open rocky slopes, or on the borders of lakes and streams in the alpine zone.

Juncaceae: *Juncus*: in the arctic-alpine region *Juncus arcticus*, *J. biglumis*, and *J. filiformis*.

Distribution

North American arctic–Eurasian; type 4; found in arctic Canada (NU) and Iceland, and in alpine regions of the Alps (CH, AT), the Tatras (PL), the Rila Mts. (BG), and the Chersky Range (RU). Very rarely reported.



Urocystis: Urocystidaceae: Urocystidales



Urocystis littoralis

Urocystis littoralis (Lagerh.) Zundel

Syn.: *Tuburcinia littoralis* (Lagerh.) Liro

Infection systemic. **Sori** occurring in leaves as long, often confluent, lead-coloured striae, initially covered by the epidermis, which ruptures longitudinally to expose a powdery, blackish brown mass of spore balls.

Spore balls globose to ellipsoid, 25–50 × 25–40 µm, composed of (1–)2–6(–9) spores completely invested by sterile cells. **Sterile cells** variable, 5–12 µm long, yellow, collapsed when dry; cell wall smooth, on the side proximal to the spores 1–1.5 µm thick, on the side distal to the spores thinner. **Spores** irregular, subglobose, or broadly ellipsoid, 13–18(–20) × 11–15 µm, reddish brown; spore wall smooth.

G. Lagerheim s.n.; W 1971-0029724; Norway

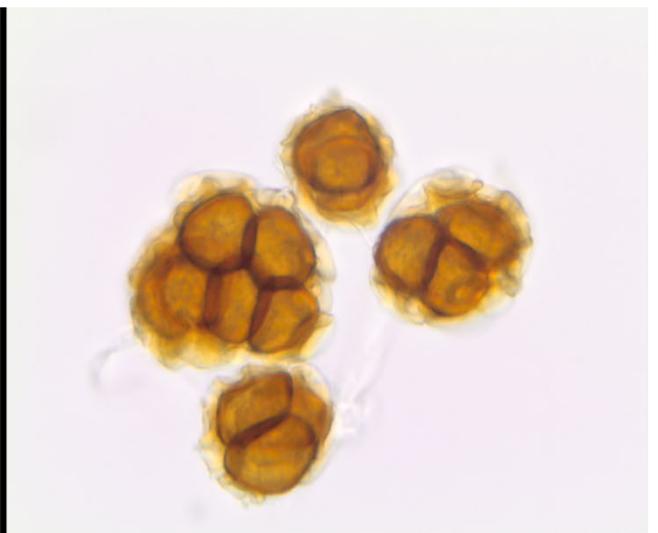
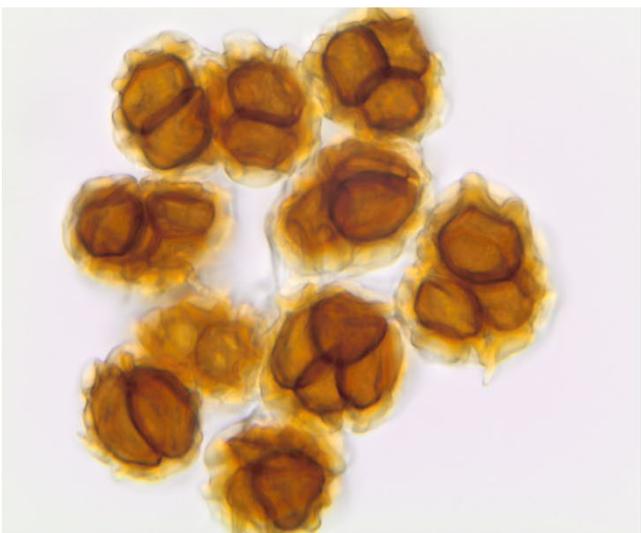
Habitats and host plants

Sandy, gravelly, or rocky places; beaches, dunes, fens; mostly near the coasts; inland on mountains in Norway.

Cyperaceae: *Carex maritima*.

Distribution

Eurasian alpine; type 15; found in the alpine Scandinavian Mts. (Norway). Extremely rare.



Urocystis: Urocystidaceae: Urocystidales



Urocystis nivalis

E. Rostrup s.n.; C-F-102479

Urocystis nivalis (Liro) Zundel

Syn.: *Tuburcinia nivalis* Liro; *T. murashkinskyi* Cif.; *Urocystis murashkinskyi* (Cif.) Zundel

Infection systemic. **Sori** in stems and leaves, forming swellings, initially covered by the epidermis which later ruptures irregularly, disclosing a powdery, blackish brown mass of spore balls.

Spore balls usually irregular, composed of 1–5(–7) central spores surrounded by few sterile cells, sterile cells sometimes lacking, 16.5–28 × 11.5–21 μm (with 1 spore), 21–32 × 14–24.5 μm (with 2 spores), 24–37 × 18–29 μm (with 3 spores), 27–41 × 21–31 μm (with 4 spores). **Sterile cells** usually irregular, sometimes broadly ellipsoid, suborbicular, ellipsoid, or ovoid, collapsed, (6–)7–15.5(–17) μm long, medium yellowish brown or medium reddish brown; cell wall on the side distal to the spores 0.5–0.8 μm thick, on the side proximal to the spores thicker, 0.8–1.3 μm, smooth. **Spores** irregular, subpolyhedral, subglobose, broadly ellipsoid, ellipsoid, elongate, or ovoid, (12–)13.5–21.5(–23.5) ×

(10.5–)11.5–15.5(–17) μm, medium reddish brown; wall slightly unevenly thickened, 0.8–1.5 μm thick.

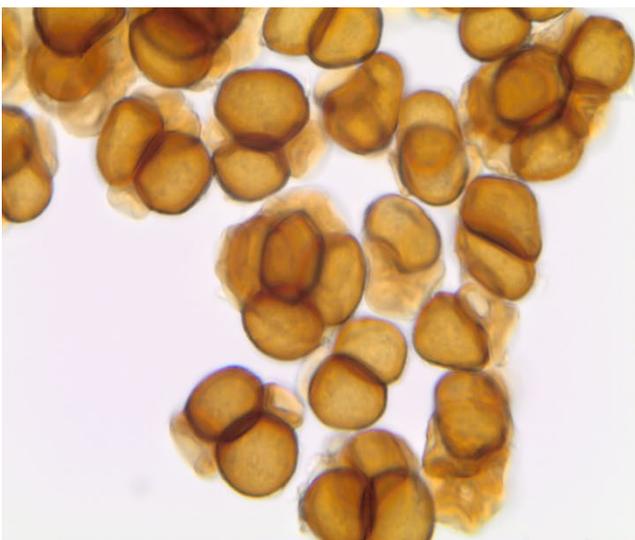
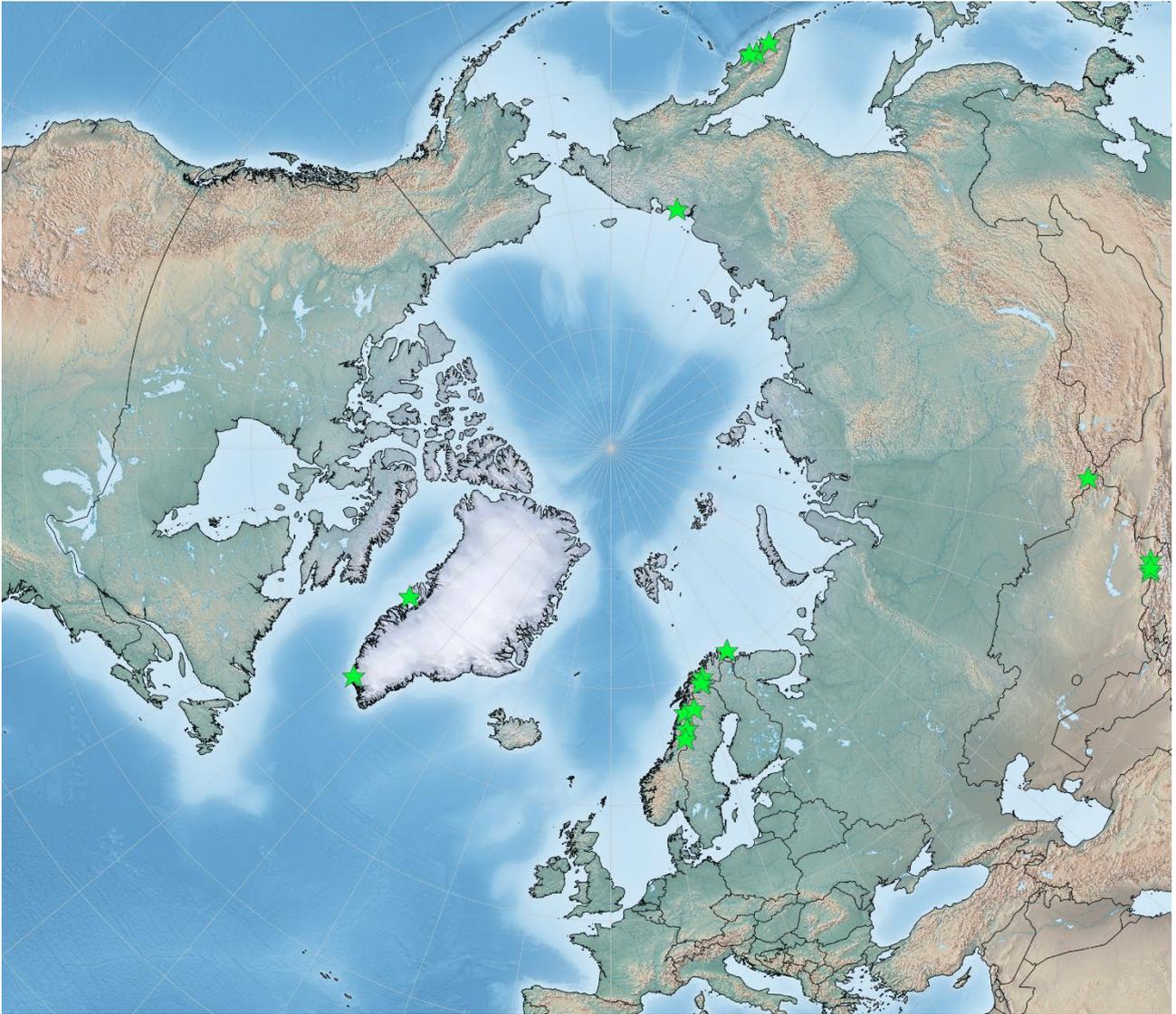
Habitats and host plants

Meadows, streambanks; wet or dry alpine meadows, often around late snowbeds.

Ranunculaceae: *Ranunculus acris* subsp. *acris*, *R. acris* subsp. *pumilus*, *R. affinis*, *R. albertii*, *R. altaicus* (*R. frigidus*), *R. nivalis*, *R. pygmaeus*, *R. sulphureus*, and *R. trautvetterianus*.

Distribution

North American arctic–Eurasian; type 4; found in arctic GR, NO, and RU, and in the alpine Scandinavian Mts. (NO, SE, FI), Kamchatka and the Altai Mts. (RU), and Tian Shan (KZ). Rarely recorded.



Urocystis: Urocystidaceae: Urocystidales



Urocystis ranunculi

S. Tóth, Vánky *Ustilaginales* 159; SOMF 17968; Hungary

Urocystis ranunculi (Lib.) Moesz

Syn.: *Tuburcinia ranunculi* (Lib.) Liro

Infection systemic. **Sori** in leaves, petioles, and stems, occasionally in pedicels or sepals, forming conspicuous pustules of various shape and size, initially covered by the epidermis that ruptures to expose a powdery, black mass of spore balls.

Spore balls globose, elongate, or irregular, 14–36(–44) × 12–28 μm, composed of (0–)1–3(–5) spores and a few peripheral sterile cells, or sterile cells may be lacking. **Sterile cells** globose, ovoid, or irregular, 6.5–16.5 μm in length, pale yellowish brown; cell wall 1–1.5 μm thick, smooth. **Spores** broadly ellipsoid, subglobose, ovoid, or irregular, 12–24 × 10–16.5 μm, light to dark reddish brown; spore wall ca. 1 μm thick, smooth.

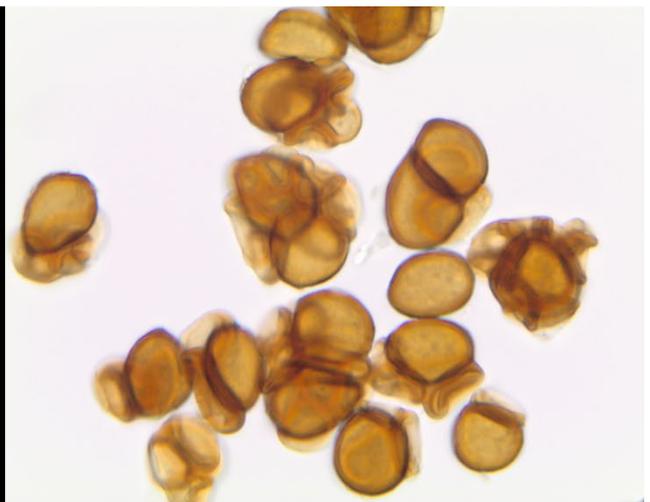
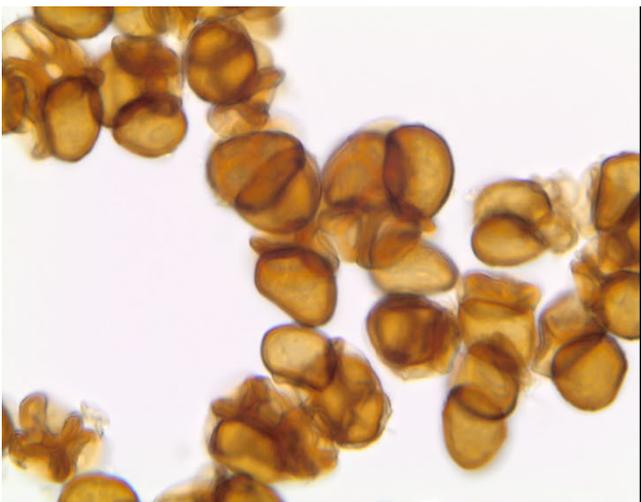
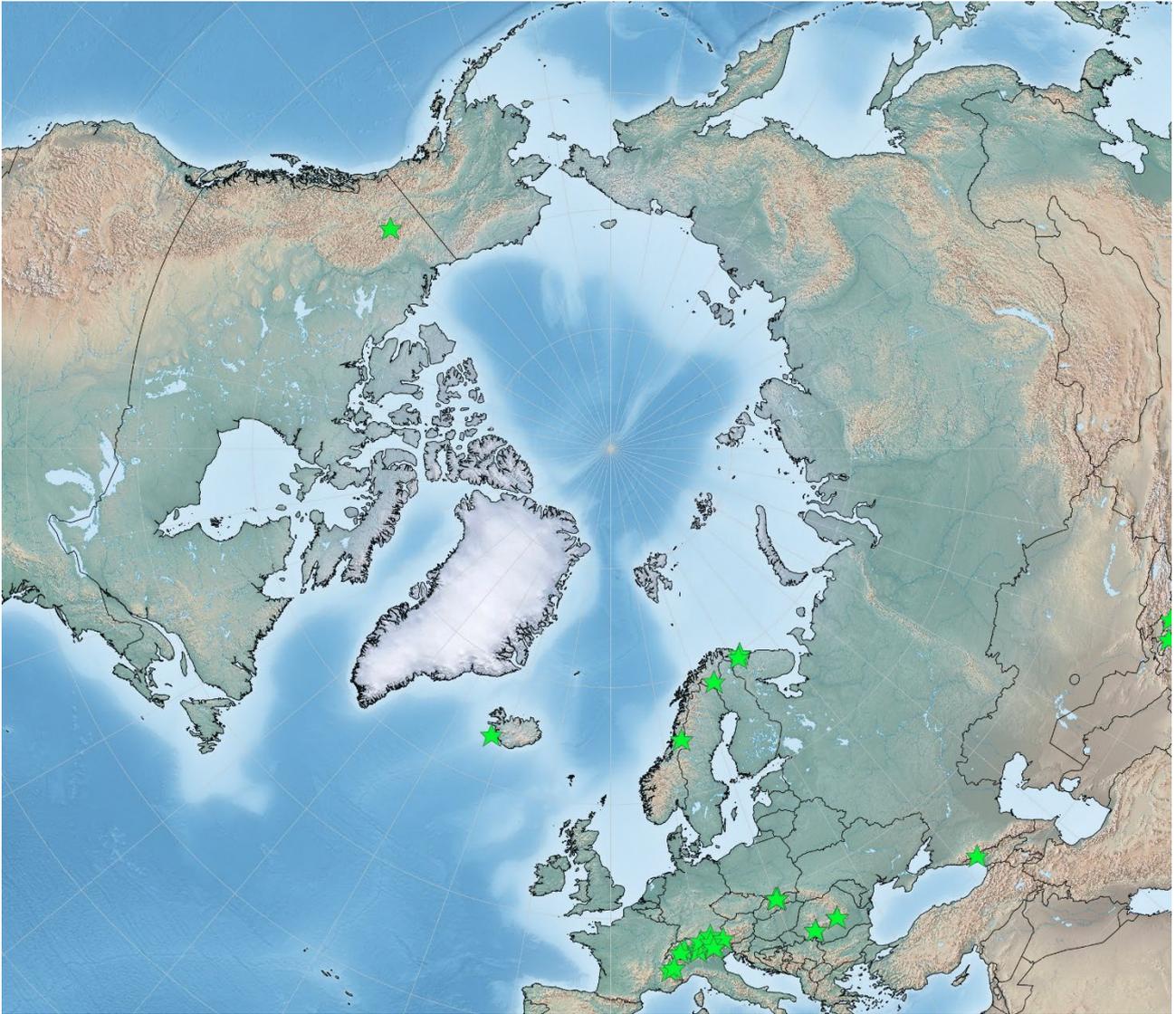
Habitats and host plants

Meadows and pastures; wetlands; in the alpine zone in grassy or stony slopes, along streams, and near melting snow.

Ranunculaceae: on many species of *Ranunculus*; in the arctic-alpine region *Ranunculus acris* (*R. stevenii*), *R. alpestris*, *R. breyninus* (*R. oreophilus*), *R. carpaticus*, *R. glacialis*, *R. grandiflorus*, *R. hyperboreus*, *R. montanus*, *R. nivalis*, *R. platanifolius*, *R. polyanthemos*, *R. pseudomontanus*, *R. songaricus*, and *R. villarsii*.

Distribution

Cosmopolitan; type 5; found in arctic IS and RU, and in the alpine Alaska-Yukon Ranges (CAN: YT), the Scandinavian Mts. (NO, FI), the Alps (DE, FR, CH, AT, IT), Tatras (PL, SK), Carpathians (RO), and the Pamir-Alay Range (KG). Common.



Urocystis: Urocystidaceae: Urocystidales



Urocystis roivainenii J. I. Liro & H. Roivainen, *Mycoth. Fenn.* 788; CP1031441; Finland

Urocystis roivainenii (Liro) Zundel

Syn.: *Tuburcinia roivainenii* Liro

Infection systemic. **Sori** occurring in leaves, sheaths, and culms as long, blackish brown streaks.

Spore balls globose to ovoid, 20–40 × 18–30 μm, composed of 1–3(–8) spores completely invested by a layer of sterile cells. **Sterile cells** subglobose, 7–16 μm long, pale yellowish brown, collapsed in old specimens. **Spores** globose to subangular, 14–18(–20) × 10.5–16 μm, yellowish brown.

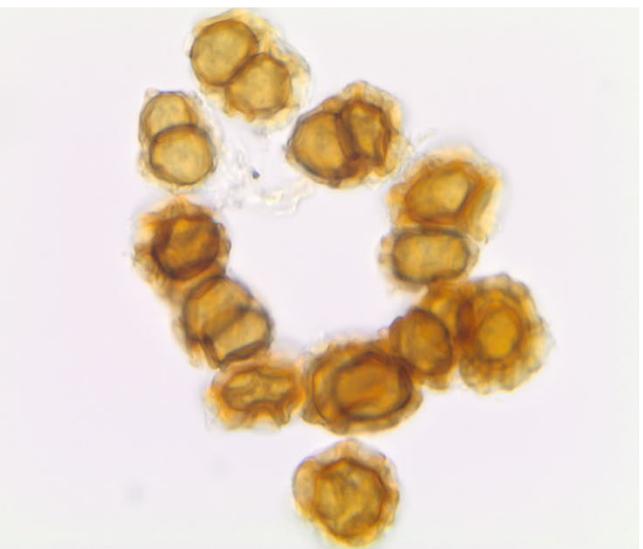
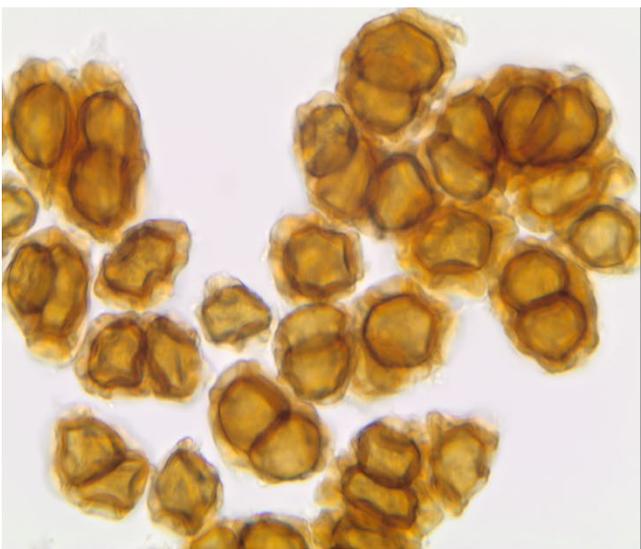
Habitats and host plants

Meadows, grassland, forest edges, ridges or ledges.

Poaceae: *Anthoxanthum odoratum*.

Distribution

Eurasian alpine; type 15; found in the alpine Scandinavian Mts. (SE, FI) and Dovre (NO). Only a few occurrences within the native host range.



Urocystis: Urocystidaceae: Urocystidales



Urocystis sorosporioides

HK 18.254; C-F-111318

Urocystis sorosporioides Körn. ex Fuckel

Syn.: *Tuburcinia sorosporioides* (Körn. ex Fuckel) Liro

Infection systemic. **Sori** in petioles and stems, forming up to 1 cm long, usually fusiform swellings, or in leaves, forming irregular swellings, initially covered by the epidermis that later ruptures irregularly to disclose a powdery, blackish brown mass of spore balls.

Spore balls irregular, broadly ellipsoid, subglobose, ellipsoid, ovoid, or elongate, (13.5–)17–43(–60) × 13–43 μm, composed of (1–)2–9(–14) central spores and a completely or almost completely investing layer of peripheral sterile cells. **Sterile cells** usually irregular, sometimes broadly ellipsoid, suborbicular, ellipsoid, or ovoid, collapsed, (4.5–)5.5–12.5(–14) μm long, light or medium yellowish brown, smooth. **Spores** irregular, subglobose, broadly ellipsoid, ellipsoid, elongate, or ovoid, sometimes cuneate, (8.5–)9.5–21 × (7.5–)8–15(–17) μm, medium reddish brown; spore wall smooth to rugulose.

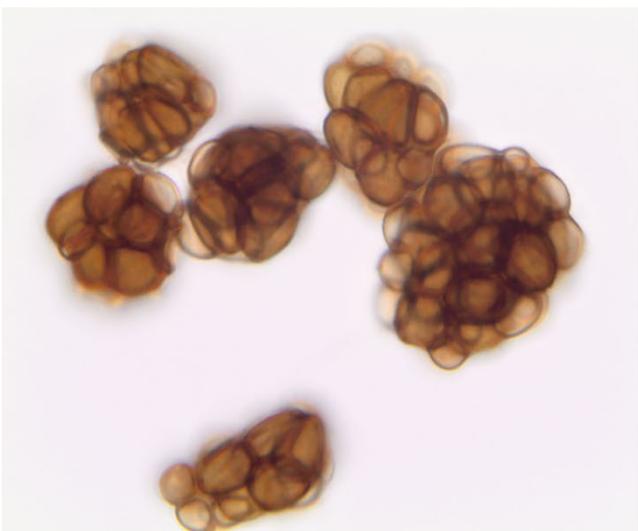
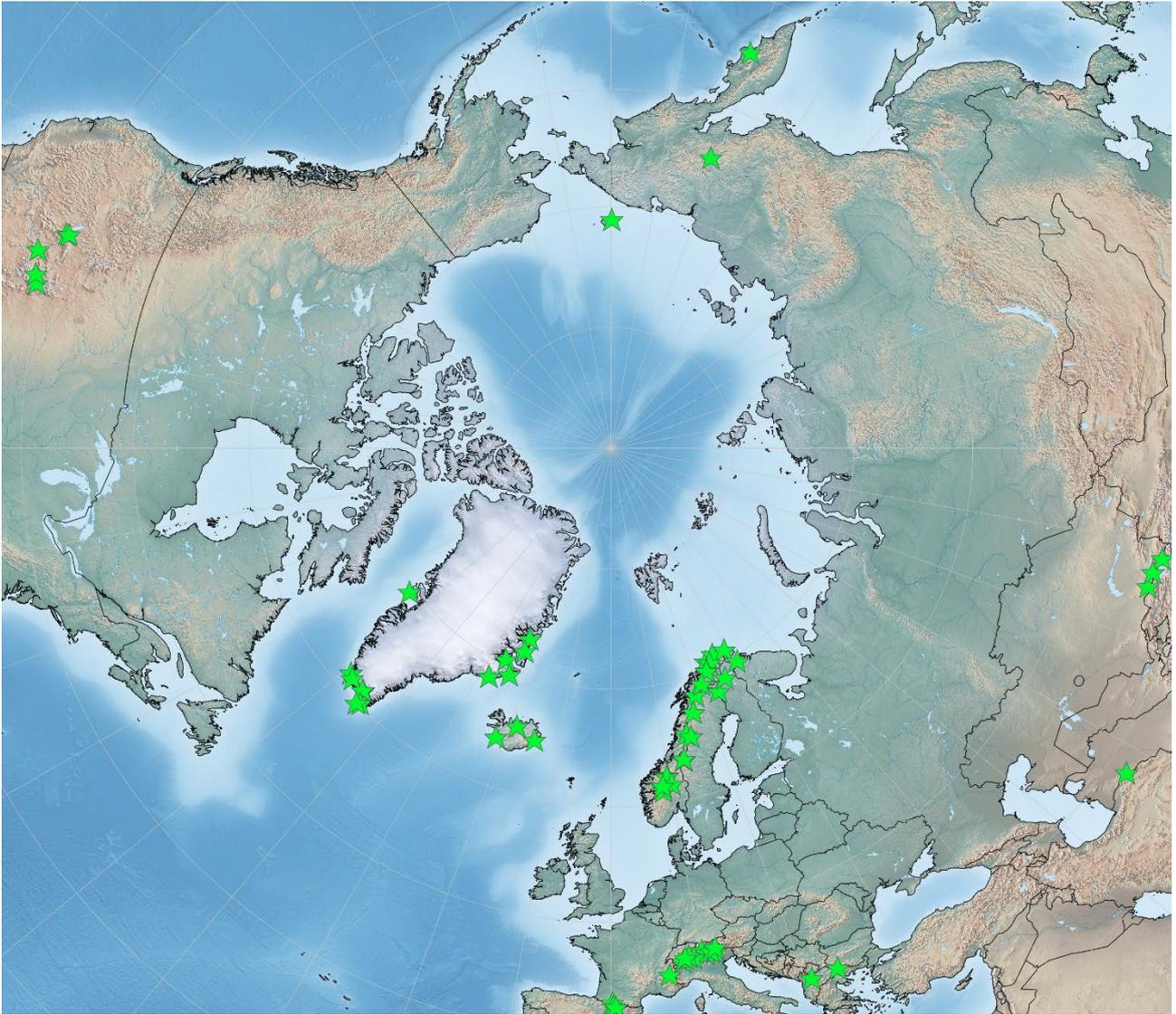
Habitats and host plants

Meadows, damp thickets, bogs; willow, birch, and spruce-fir communities; forest margins; damp rocky ledges and slopes.

Ranunculaceae: *Thalictrum*: in the arctic-alpine region *Thalictrum alpinum*, *T. aquilegiifolium*, *T. flavum*, *T. fendleri*, *T. foetidum*, *T. minus* sensu lato including subsp. *elatum* (*T. kemense*) and subsp. *saxatile* (*T. saxatile*, *T. olympicum*), *T. simplex*, and *T. sparsiflorum*.

Distribution

Arctic-alpine; type 1; found in arctic GR, IS, NO, and RU, and in the alpine Rocky Mts. (USA: UT, CO), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Alps (FR, CH, IT), the Pyrenees (FR, ES), Mt. Korab (MK), the Pirin Mts. (BG), the Kolyma Highlands and Kamchatka (RU), Kopetdag (TM), and Tian Shan (KZ, KG). Common.



Urocystis: Urocystidaceae: Urocystidales

*Urocystis tothii*

A. Hagen s.n.; O

Urocystis tothii VánkySyn.: *Urocystis lagerheimii* var. *obscura* (Liro) Zundel

Infection systemic. **Sori** occurring in leaves as long striae between the veins, initially covered by the epidermis that later ruptures, or in the interior of the culms, which later rupture longitudinally to expose a powdery, very dark reddish brown mass of spore balls.

Spore balls irregular, broadly ellipsoid, subglobose, ovoid, or ellipsoid, composed of 1–5(–9) central spores surrounded by a continuous layer of sterile cells, 14–24 × 13.5–20 μm (with 1 spore), 19–27.5 × 16–22 μm (with 2 spores), 22–31 × 17.5–25 μm (with 3 spores), 25–39 × 22–30 μm (with 4 spores).

Sterile cells usually irregular in outline, collapsed, 4–13 μm long, medium yellowish brown or medium reddish brown; cell wall 0.6–1.0 μm thick; rugulose. **Spores** subglobose, irregular, broadly ellipsoid, ovoid,

or ellipsoid, sometimes cuneate, often slightly flattened in one to a few places, (10–)11–16.5(–17.5) × (9.5–)10–13(–14) μm, medium or dark reddish brown; spore wall slightly unevenly thickened, 0.9–1.3 μm thick.

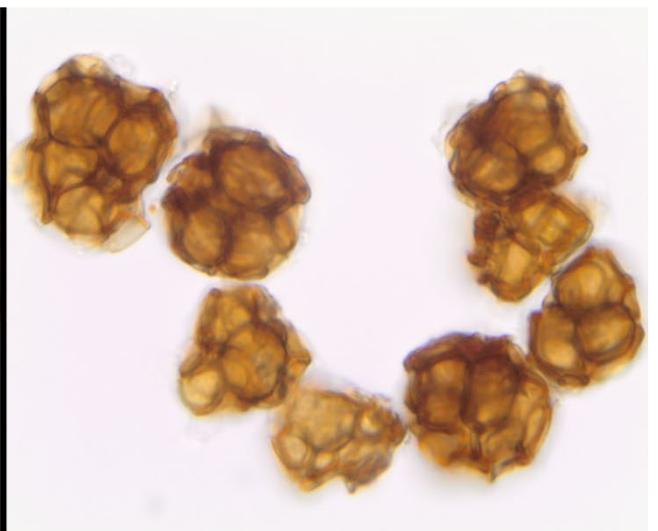
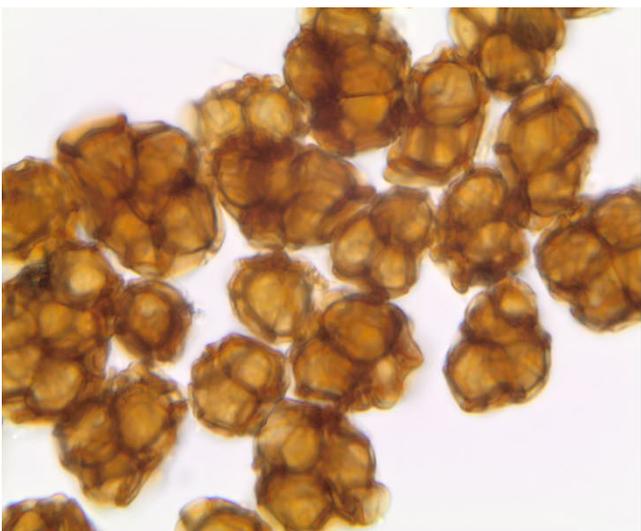
Habitats and host plants

Wet tundra and mossy margins of ponds and streams, wet gravel, and open rocky slopes.

Juncaceae: *Juncus* species; in the arctic region *Juncus biglumis*.

Distribution

North American arctic; type 12; found in arctic Greenland. Reported only once from the arctic-alpine region. Very rarely collected outside this region, probably overlooked.



Urocystis: Urocystidaceae: Urocystidales



Urocystis trautvetteriae Calder & MacKay 30353; DAOM 145082; Canada (BC, isotype)

Urocystis trautvetteriae Vánky

Infection systemic. **Sori** occurring as blister-like swellings, usually on the abaxial side of the leaves or on the petioles and stems, from 1 mm to 3 cm or longer by confluence, initially covered by the epidermis that ruptures irregularly to expose a powdery, blackish brown mass of spore balls.

Spore balls globoid, ovoid, or irregular, 20–45 × 20–35 μm, composed of (0–)1–4(–5) central spores and an incomplete or rarely complete peripheral layer of sterile cells, or sterile cells lacking. **Sterile cells** ovoid, elongate, or irregular in outline, 8–21(–25) μm long, yellowish brown; cell wall (1–)1.5–2.5(–3) μm thick, smooth. **Spores** ovoid, subglobose, slightly irregular, or elongate, 13.5–21(–25) × 12–16 μm, reddish brown; spore wall ca. 1 μm thick, smooth.

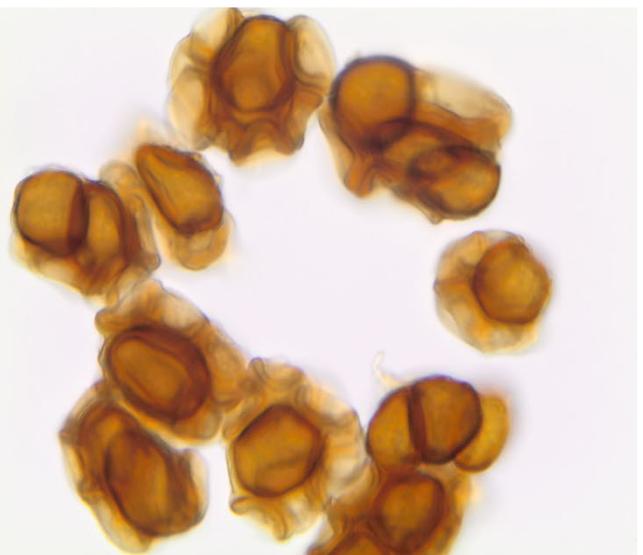
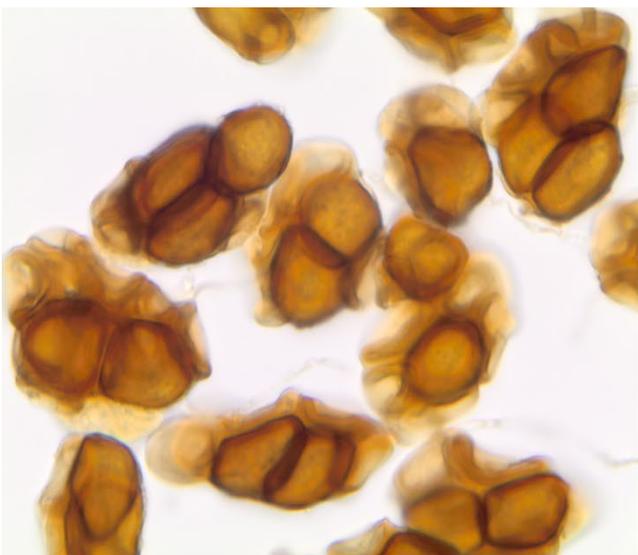
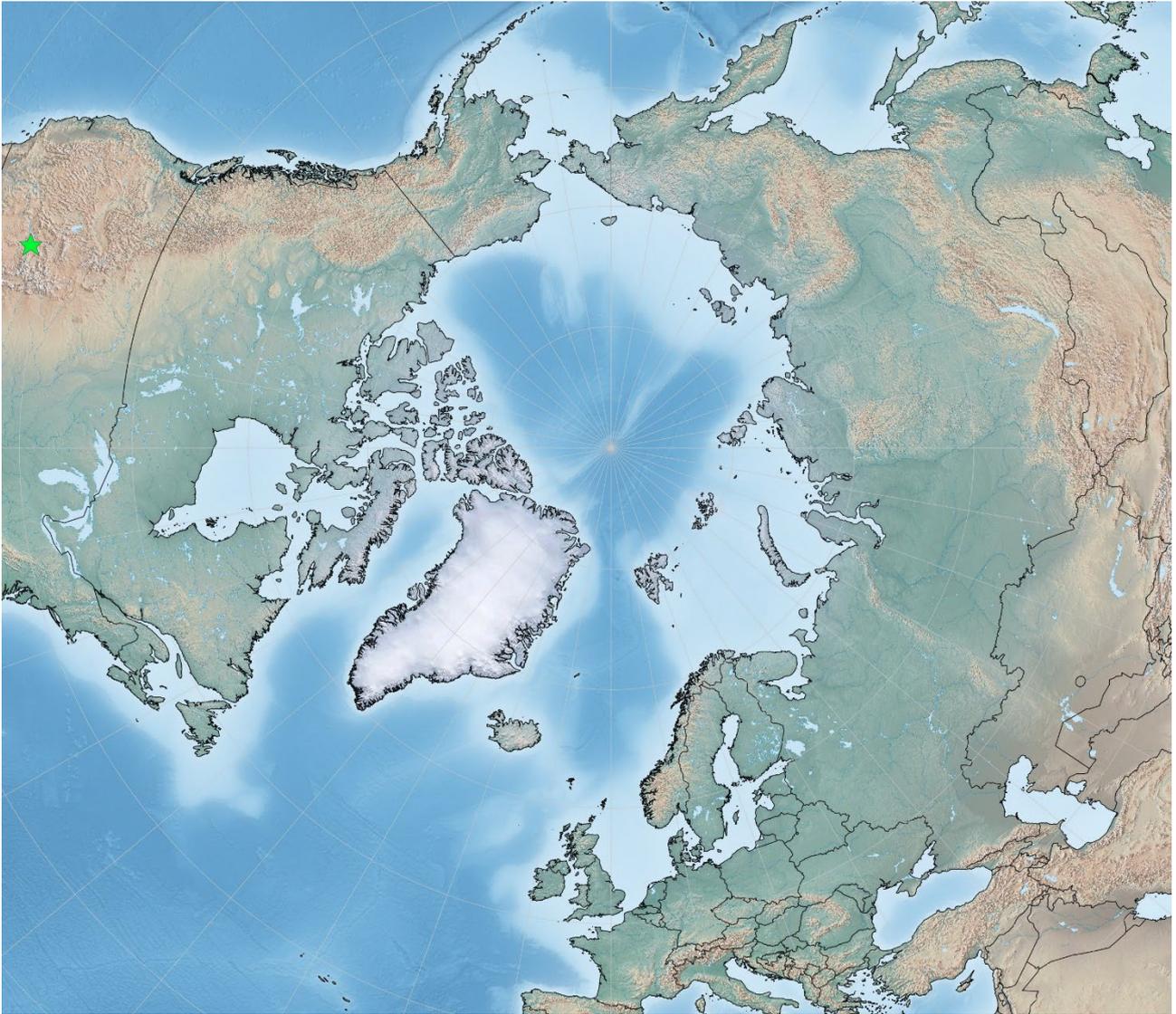
Habitats and host plants

Stream banks, bogs, western spruce-fir forests and subalpine meadows.

Ranunculaceae: *Trautvetteria caroliniensis* (*T. caroliniensis* var. *occidentalis*, *T. grandis*).

Distribution

North American alpine; type 14; found in the Rocky Mts. (CAN: BC, USA: UT). Very rarely recorded.



Urocystis: Urocystidaceae: Urocystidales



Urocystis trientalis

K. Vánky, Ustilaginales 308; SOMF 17976; Sweden

Urocystis trientalis (Berk. & Broome) B. Lindeb.

Syn.: *Tuburcinia trientalis* Berk. & Broome

Infection systemic. **Sori** occurring in leaves, petioles, and stems as small, sometimes confluent, irregular, lead-coloured pustules, containing an initially agglutinated, later granular-powdery, black mass of spore balls.

Spore balls subglobose, ovoid, irregular, or elongate, 40–80 × 28–70 µm, dark reddish brown, opaque, composed of 6–50 or more central spores and peripheral sterile cells usually irregularly arranged in an incomplete to complete layer. **Sterile cells** variable in shape, 6–18 µm long; cell wall 0.7–2 µm thick, pale brown, smooth. **Spores** globose, ovoid, elongate, or irregular, 12–20 × 10–15 µm, dark reddish brown, smooth.

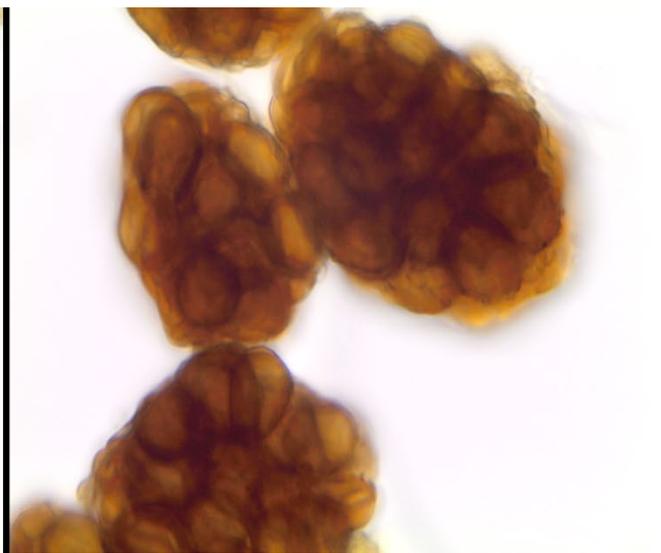
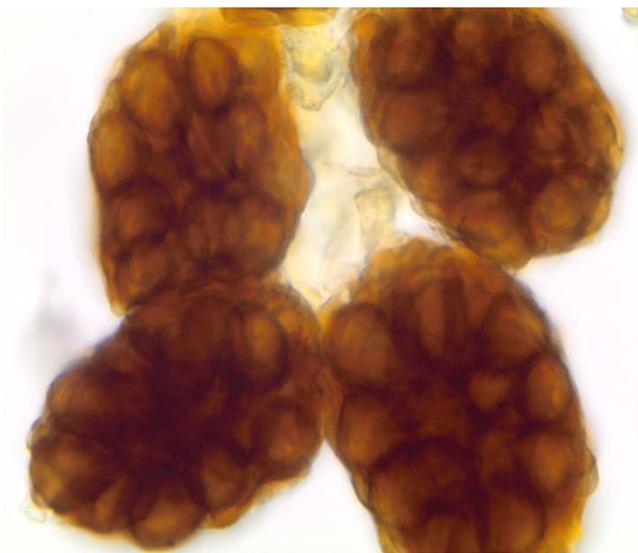
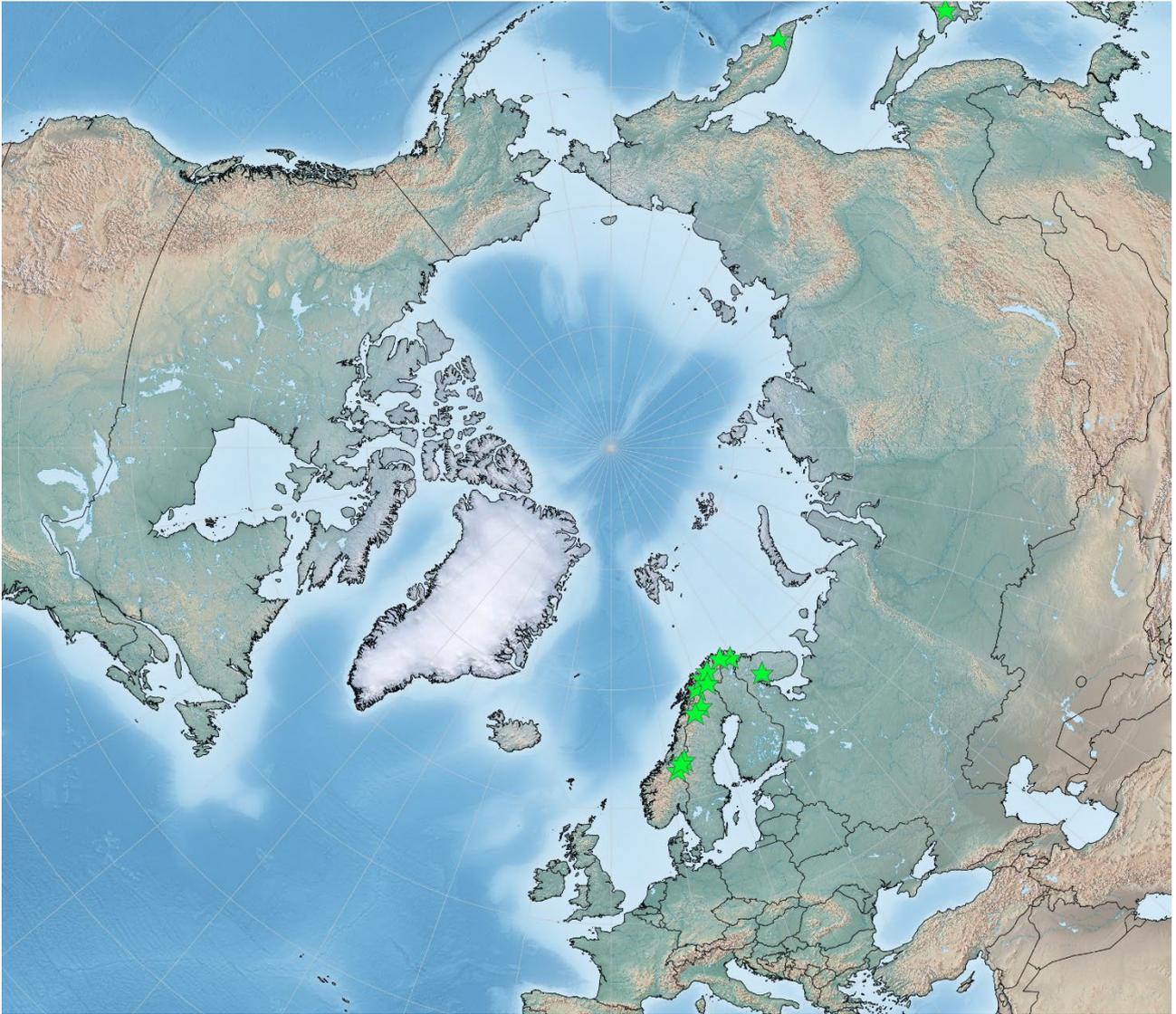
Habitats and host plants

Wet tundra; moist to wet coniferous forests, stream banks, moist open meadows, *Sphagnum* bogs and swamps.

Primulaceae: *Lysimachia*: in the alpine region *Lysimachia europaea* (*Trientalis europaea*, *Trientalis arctica*).

Distribution

Eurasian alpine; type 9; found in the alpine Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Khibiny Mts. and Kamchatka (RU), and Hokkaido (JP).



Urocystis: Urocystidaceae: Urocystidales



Urocystis triseti

A. Hagen s.n.; O

Urocystis triseti (Cif.) Zundel

Syn.: *Tuburcinia triseti* Cif.

Infection systemic. **Sori** occurring in leaves as long striae between the veins, initially covered by the epidermis that later ruptures to disclose a powdery, blackish brown mass of spore balls.

Spore balls irregular, broadly ellipsoid, subglobose, ovoid, or ellipsoid, composed of 1–4(–6) central spores surrounded by a continuous, sometimes almost continuous layer of sterile cells, 16–40 × 14.5–30 μm.

Sterile cells usually irregular, sometimes broadly ellipsoid, ellipsoid, suborbicular, or ovoid, collapsed, (5–)6–12(–14) μm long, medium yellowish brown to medium reddish brown; cell wall on the side distal to the spores 0.5–0.7 μm thick, on the side proximal to the spores thicker, 0.7–1.2 μm; cell wall punctate. **Spores** irregular, broadly ellipsoid, subglobose, ovoid, ellipsoid, or cuneate, often slightly flattened in a few places, (10.5–)11.5–17.5(–18.5) ×

(9.5–)10.5–13.5(–14.5) μm, medium reddish brown; spore wall slightly unevenly thickened, 0.8–1.3 μm thick.

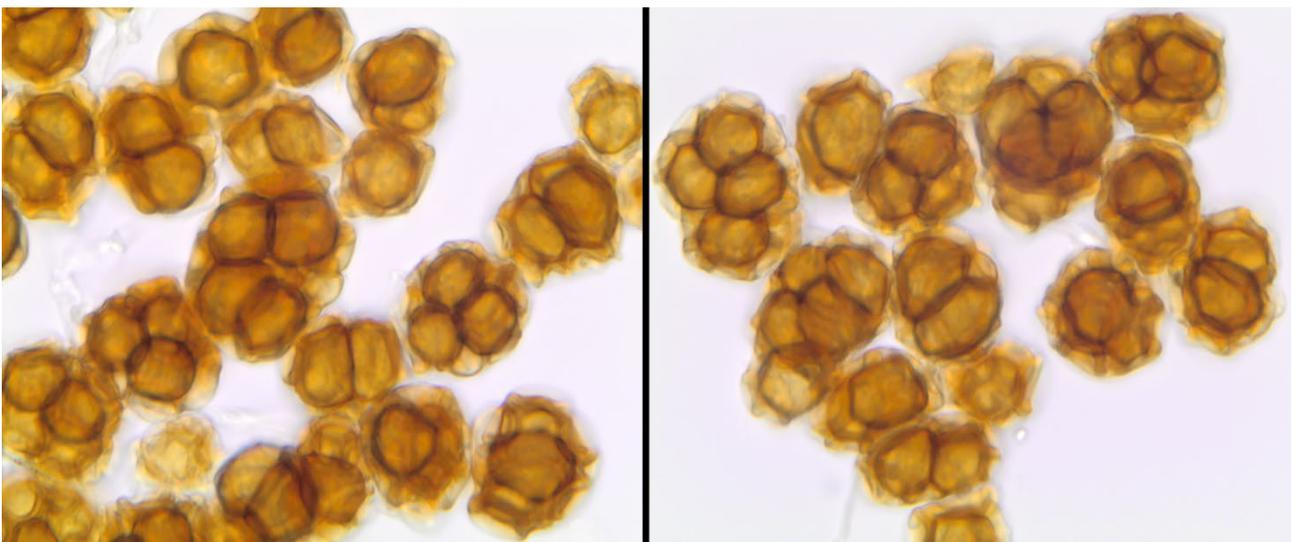
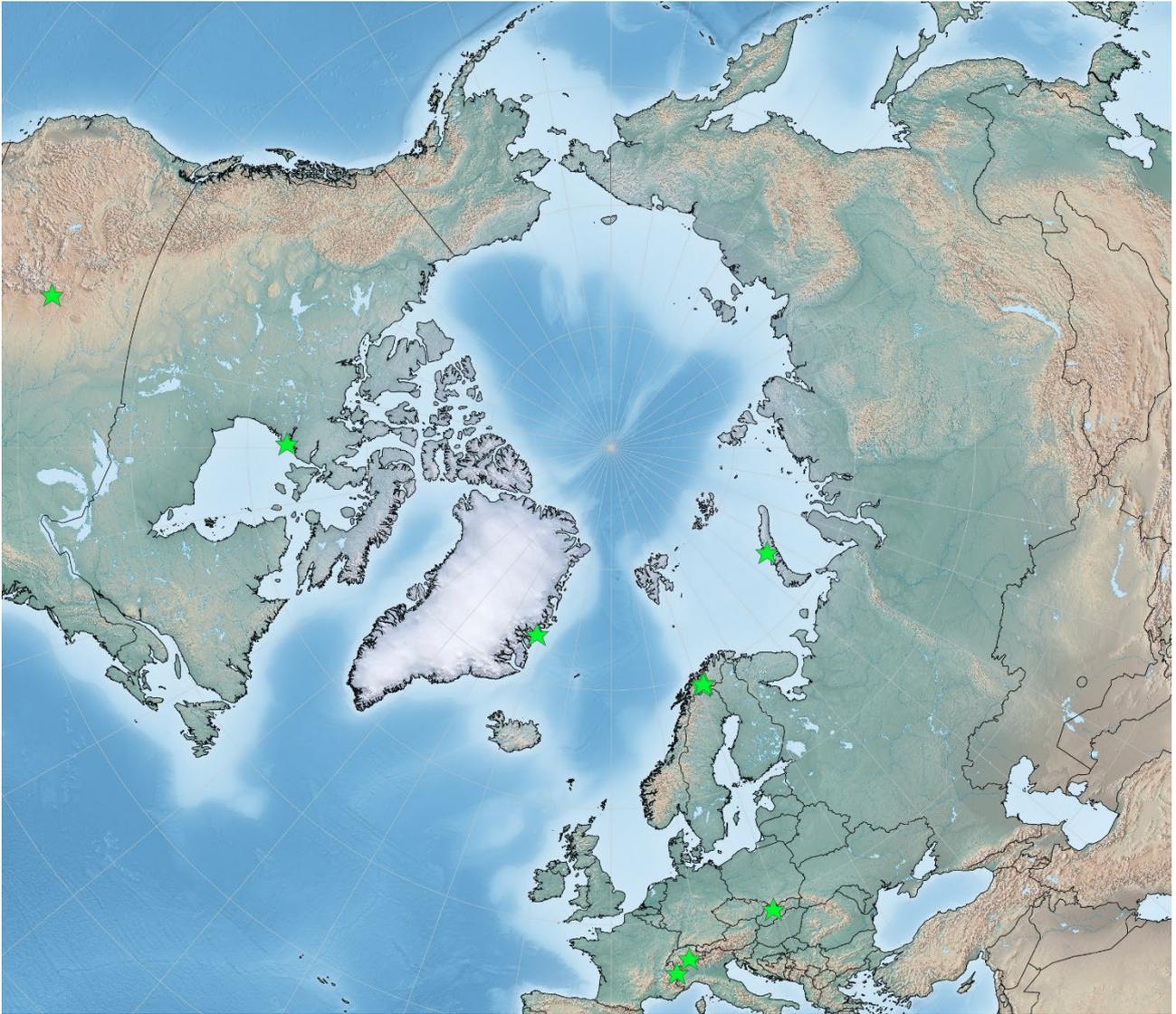
Habitats and host plants

Moist meadows and forests, and on rock ledges, tundra slopes, and screes.

Poaceae: *Koeleria spicata* (*Trisetum spicatum*, *Trisetum spicatum* var. *maidenii*, *Trisetum subspicatum*), *Trisetum alpestre*, and *Trisetum flavescens* (*Trisetum pratense*).

Distribution

Arctic-alpine; type 1; found in arctic CAN (NU), GR, and RU, and in the alpine Rocky Mts. (USA: WY), the Scandinavian Mts. (FI), the Alps (FR, CH), and the Tatras (SK). Very rarely reported.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea altera

Anthracoidea altera Nannf.

Infection local. **Sori** in some female flowers, occurring around aborted nuts as ovoid, broadly ellipsoid, or ellipsoid hard bodies, 1.0–1.5 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small, flattened, in plane view irregularly rounded, irregularly subpolygonal, broadly ellipsoid, or suborbicular, sometimes with a small protuberance, (14–)15–20(–21) × (12.5–)13.5–17(–18) μm, in side view 9–12 μm thick, medium reddish brown; spore wall slightly unevenly thickened, 0.8–1.4(–1.6) μm thick, sometimes with 1–2(–3) weak internal swellings, sometimes with light-refractive areas, surface minutely verruculose, warts up to 0.2(–0.3) μm high, spore profile not affected or very slightly affected. Spore germination of

P. Gelting s.n.; C-NHMD001862570

the *Anthracoidea*-type, resulting in a two-celled basidium producing short and ovoid basidiospores.

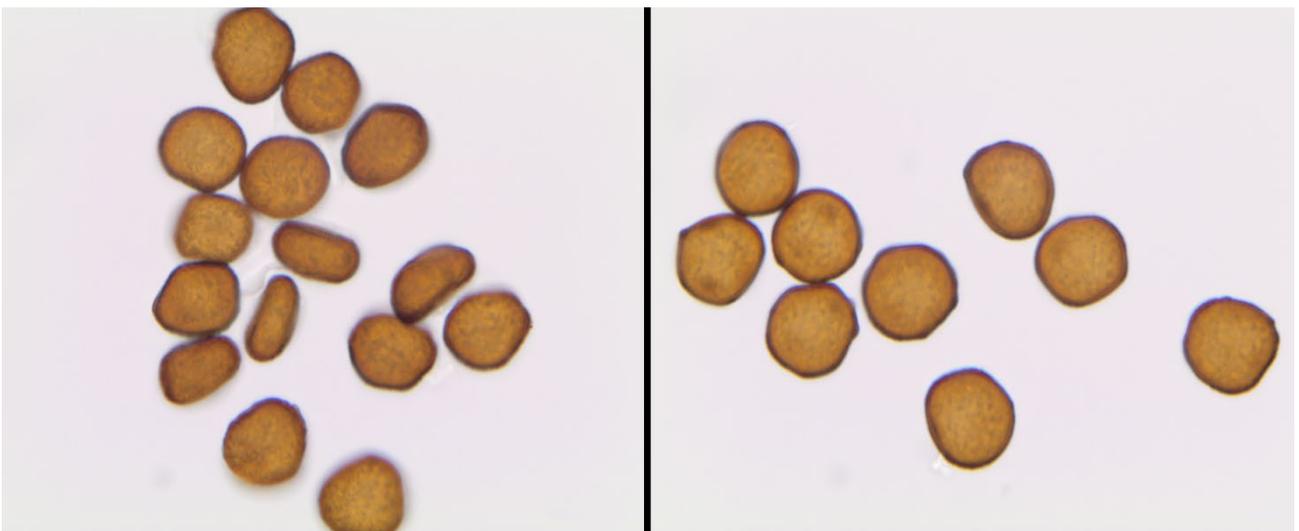
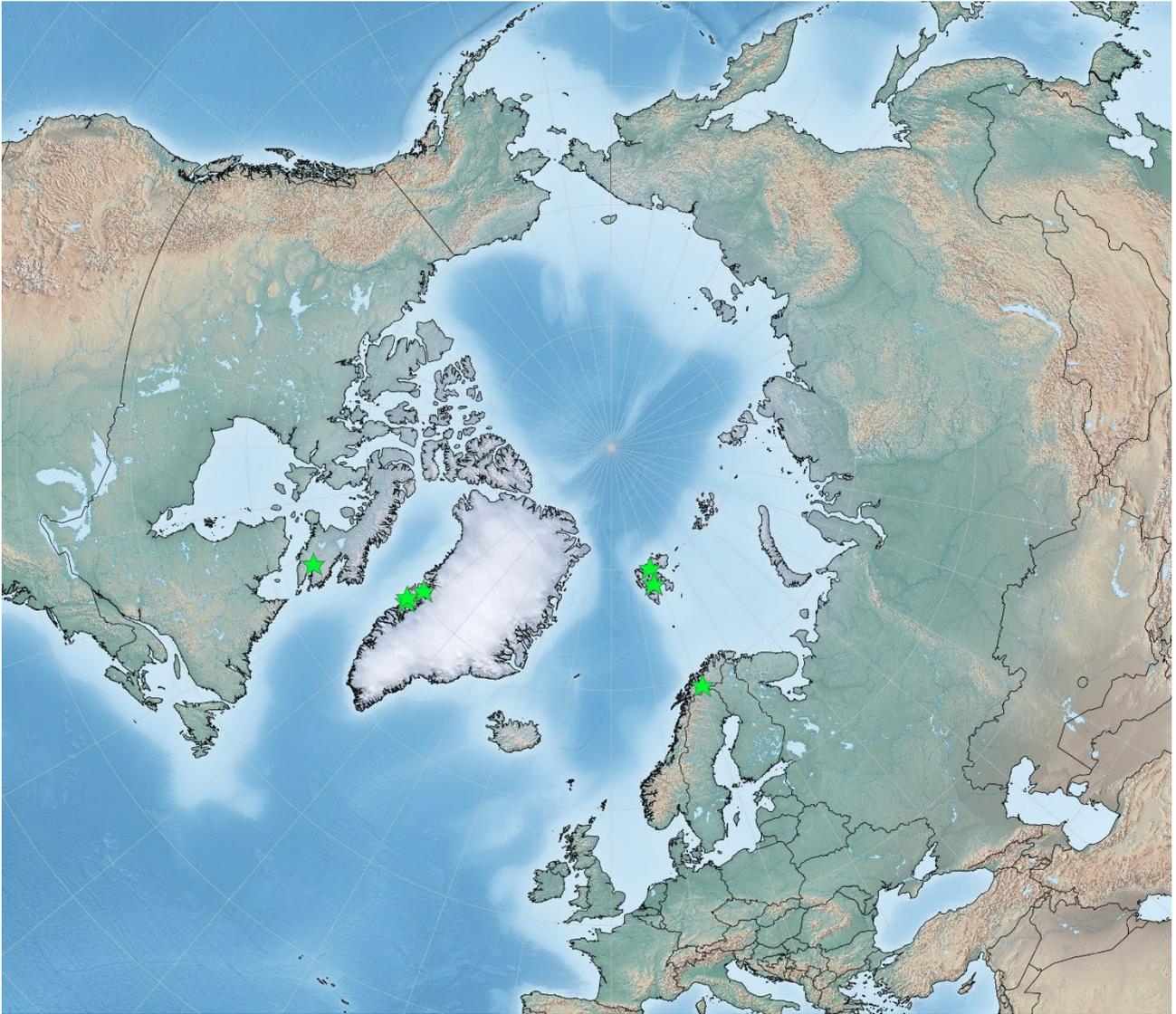
Habitats and host plants

Tundra, sedge meadows, rock ledges, stream sides, wet stony places.

Cyperaceae: Fuliginosa Clade of *Carex*: *C. fuliginosa* subsp. *misandra* (*C. misandra*).

Distribution

North American arctic–Eurasian; type 6; found in arctic CAN (NU), GR and Svalbard, and in the alpine Scandinavian Mts. (FI). A rare species, known only from a few localities, although the host plant is considered frequent in the Arctic.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea americana Berbee & Gruhn, Vánky Ustilag. 651; SOMF 19759; USA (CA)

Anthracoidea americana (Nannf. & B. Lindeb.) Kukkonen

Syn.: *Cintractia americana* Nannf. & B. Lindeb.

Infection local. **Sori** in some female flowers, occurring around aborted nuts as globose or ovoid hard bodies, 2.0–3.0 mm long, initially covered by a thin greyish peridium. Mature sori break into small pieces.

Spores small, only slightly flattened, in plane view suborbicular, broadly ellipsoid, or subangular, 12–20(–22) × 10–18(–20) μm, medium reddish brown; spore wall evenly thickened, 1.0–1.5 μm thick, with 2–4 distinct internal swellings, surface verrucose, covered with easily detaching 0.5–1 μm high warts, spore profile affected. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium producing short subglobose or ovoid basidiospores.

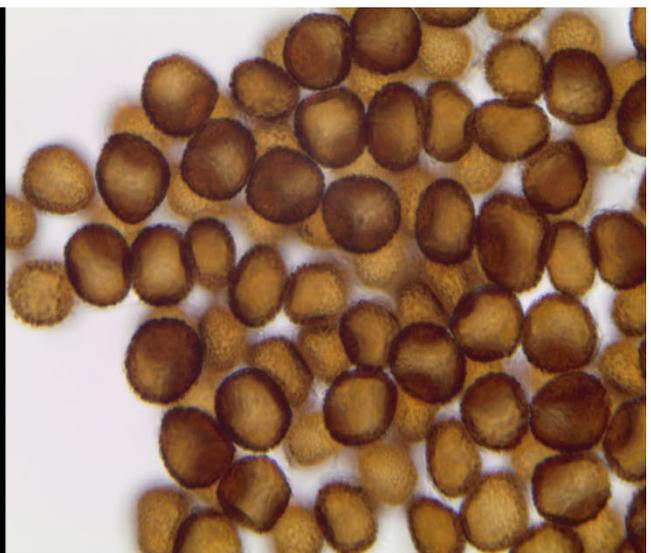
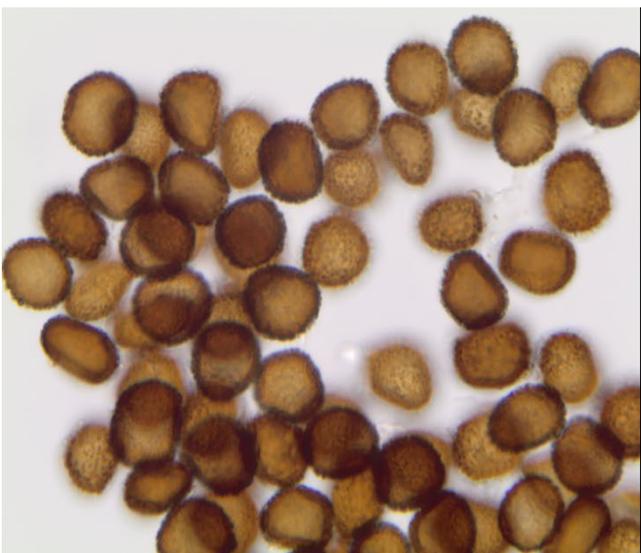
Habitats and host plants

Sedge meadows, swamps, bogs and bog pools, fens; lake and stream shores.

Cyperaceae: Hirta Clade of *Carex*; in the alpine region *Carex atherodes*, *Carex rostrata*, and *Carex utriculata* (*C. rhynchophysa*).

Distribution

North American alpine; type 14; found in the alpine Alaska-Yukon Ranges (AK; CAN: YT) and the Rocky Mts. (USA: MT, WY).



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea aspera K. Vánky & T. Vánky, Ustilaginales 204; SOMF 17844; Sweden

Anthracoidea aspera (Liro) Kukkonen

Syn.: *Cintractia aspera* Liro; *C. scabra* Syd.

Infection local. **Sori** in some female flowers, around aborted nuts as globose hard bodies, initially covered by a thin greyish peridium.

Spores medium-sized, slightly flattened, in plane view suborbicular, broadly ellipsoid, irregularly rounded, or irregularly subpolygonal, $15\text{--}26 \times 13\text{--}21 \mu\text{m}$, medium reddish brown; spore wall unevenly thickened, $2.5\text{--}4.0 \mu\text{m}$ thick, internal swellings 0–4, variable in conspicuousness, often with light-refractive areas, surface densely verruculose-echinulate, ornaments of very different size, $0.1\text{--}1.0 \mu\text{m}$ high, spore profile affected. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium producing 8–20 μm long, teardrop-shaped basidiospores.

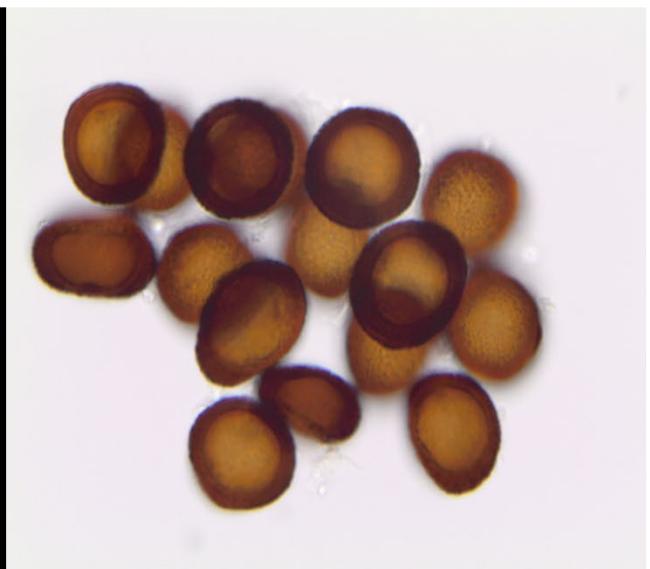
Habitats and host plants

Fens, bogs, sedge marshes, usually in very wet sites, often in shallow water; (*Carex glareosa*) salt marshes and gravelly seashores.

Cyperaceae: *Carex* sect. *Chordorrhizae*: *Carex chordorrhiza* (principal host); Annectens Clade: *Carex diandra*; *Carex* sect. *Glareosae*: *Carex glareosa*.

Distribution

North American alpine–Eurasian; type 5, found in arctic Russia, and in the alpine Alaska-Yukon Ranges (CAN: YT), the Rocky Mts. (USA: WY), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Kola Peninsula, the Khibiny Mts., Kamchatka, the Kolyma Mts., and Altai (RU). Common in northern Fennoscandia; very rarely reported from Russia and arctic-alpine North America.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea atratae E. T. Bartholomew, Fungi Columbiani 4908; NY; USA (MT)

Anthracoidea atratae (Savile) Kukkonen

Syn.: *Cintractia atratae* Savile

Infection local. **Sori** in some female flowers, around aborted nuts as globose hard bodies, initially covered by a persistent, silvery peridium, later powdery on the surface.

Spores medium-sized, flattened, in plane view suborbicular, broadly ellipsoid, or slightly angular, $17\text{--}25 \times 14\text{--}20\text{--}(22)$ μm , in side view $10\text{--}14$ μm wide, reddish brown; spore wall even, $1\text{--}2$ μm thick, no internal swellings, surface verrucose, warts rather large (up to 0.7 μm high and 1.0 μm across), in part fusing into distinct dots, forming a labyrinthiform pattern with light-refractive streaks between the warts. Spore germination of the *Proceres*-type, resulting in a two-celled basidium producing $42\text{--}96$ μm long, cylindrical basidiospores.

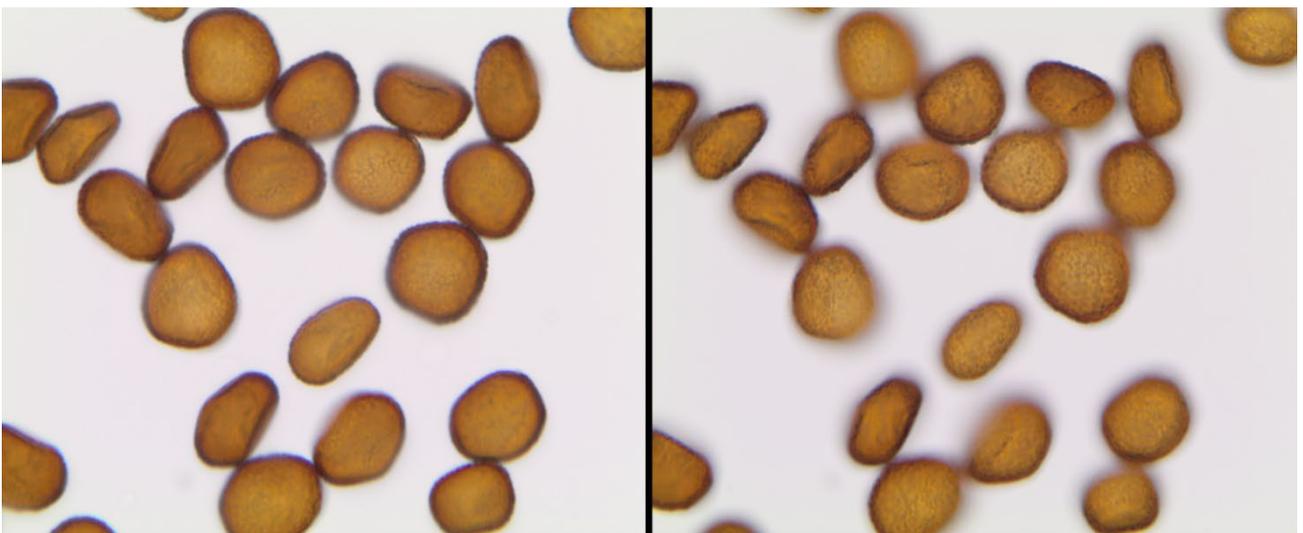
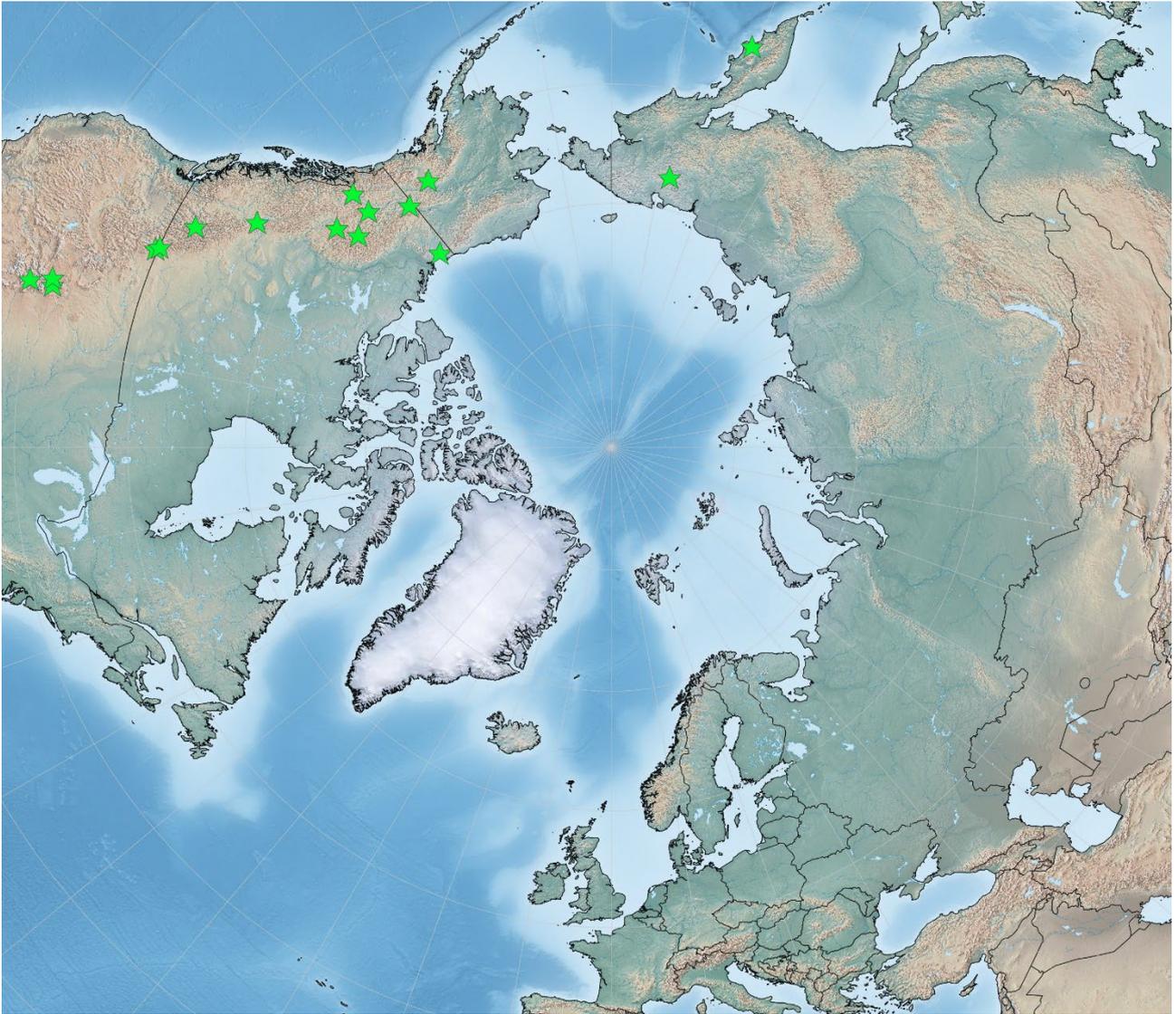
Habitats and host plants

Arctic tundra; willow scrub, moist rock ledges; marshes, shores, and other wet open places; subalpine and alpine meadows.

Cyperaceae: *Carex*: in the arctic-alpine region in *Carex* sect. *Racemosae*: *Carex atrata* and *Carex raynoldsii*; in *Carex* sect. *Phacocystis*: *Carex podocarpa* (*Carex montanensis*); and in *Carex* sect. *Microchaeta*: *Carex krascheninnikovii*, *Carex microchaeta* subsp. *nesophila* (*C. nesophila*), and *C. spectabilis*.

Distribution

North American alpine–Eurasian; type 7; found in arctic Russia, and in the alpine Alaska-Yukon Ranges (AK; CAN: YT), the Rocky Mts. (CAN: BC, AB; and USA: MT, WY, CO), and Kamchatka (RU).



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea baldensis K. Vánky et al., Ustilaginales 452; SOMF 18762; Switzerland

Anthracoidea baldensis Vánky

Infection local. **Sori** in some female flowers, occurring around aborted nuts as globose or ovoid hard bodies, 2.0–3.5 mm long, initially covered by a thin greyish peridium and hidden by the utricule. Later the utricule splits longitudinally and the peridium flakes away, exposing a black, agglutinated spore mass.

Spores medium-sized, flattened, in plane view suborbicular or angular, 17–21.5(–23) × 13.5–20 μm, in side view 9.5–12 μm wide, medium reddish brown; spore wall uneven, 1.2–2 μm thick, at the angles up to 3.5 μm, light-refractive areas often present, and sometimes also 1–2 weak internal swellings, surface moderately verruculose, warts 0.3–0.4 μm high, sometimes partly fusing and often arranged in short rows or groups. Spore germination unknown.

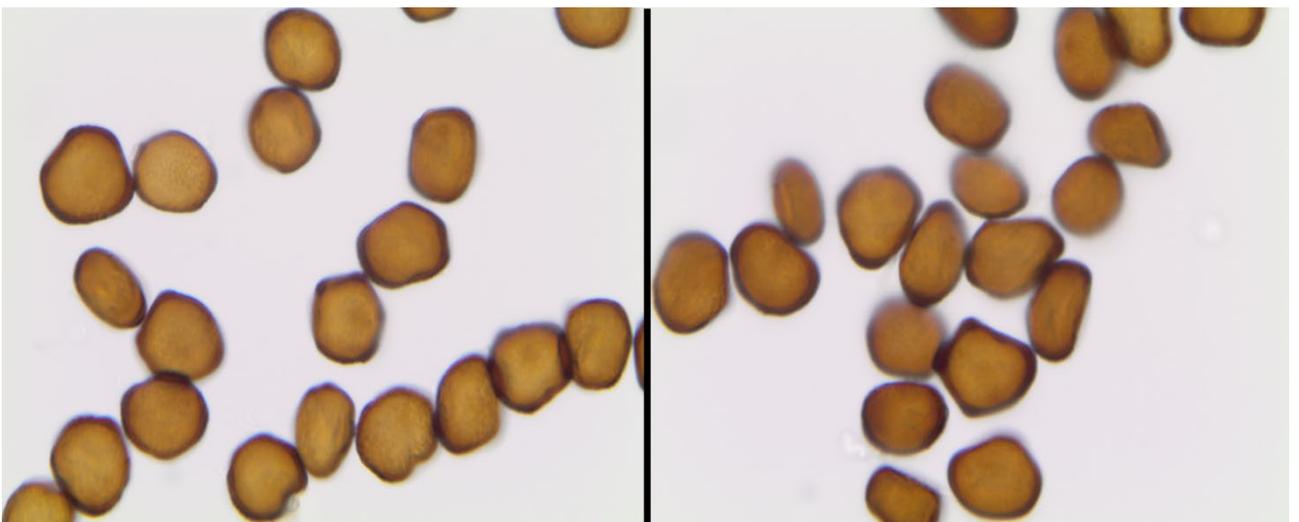
Habitats and host plants

Arctic-alpine calcareous grassland in the subalpine and alpine belts of the Alps.

Cyperaceae: *Carex baldensis*.

Distribution

Eurasian alpine; type 15; found in the Alps (CH). Extremely rare.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea bigelowii

K. Vánky, Ustilaginales 252; SOMF 17879; Sweden

Anthracoidea bigelowii Nannf.

Syn.: *Cintractia limosa* var. *minor* Savile

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose to ovoid hard bodies, 0.8–1.5 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view suborbicular, broadly ellipsoid, irregularly rounded, or ovoid, (16–)17–22(–23.5) × (14.5–)15.5–20(–21) μm, in side view 10.5–13.5 μm thick, medium or dark reddish brown; spore wall slightly unevenly thickened, 1.0–1.7(–2.0) μm thick, without internal swellings, light-refractive areas, or protuberances, moderately verruculose, warts up to 0.4(–0.5) μm high, spore profile affected. Spore germination of the *Proceres*-type, resulting in a two-celled basidium producing long cylindrical basidiospores.

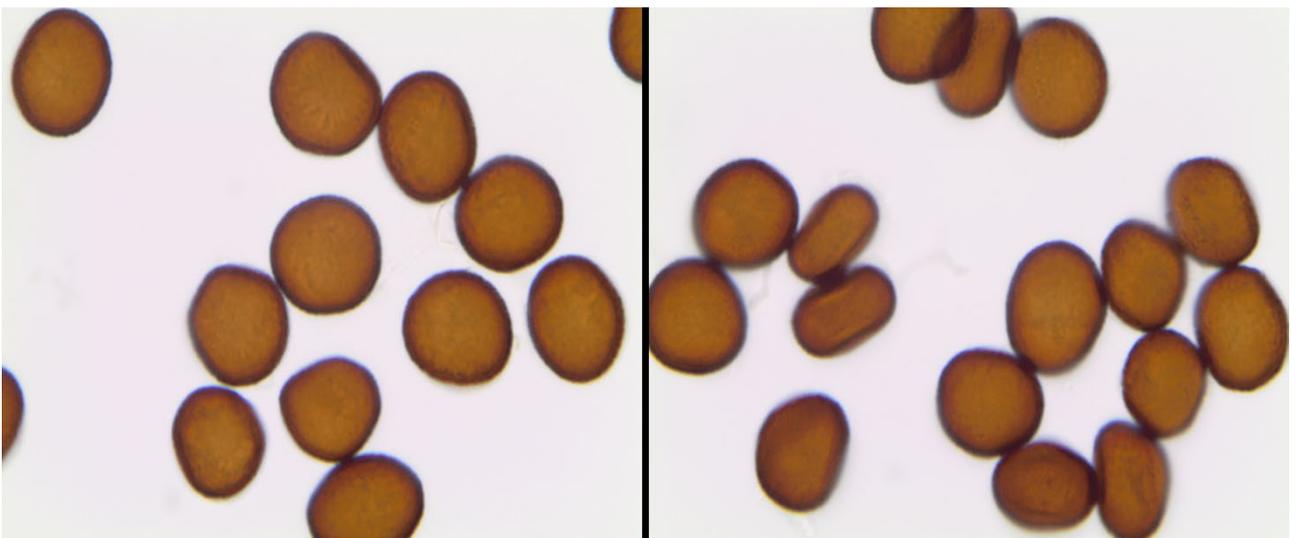
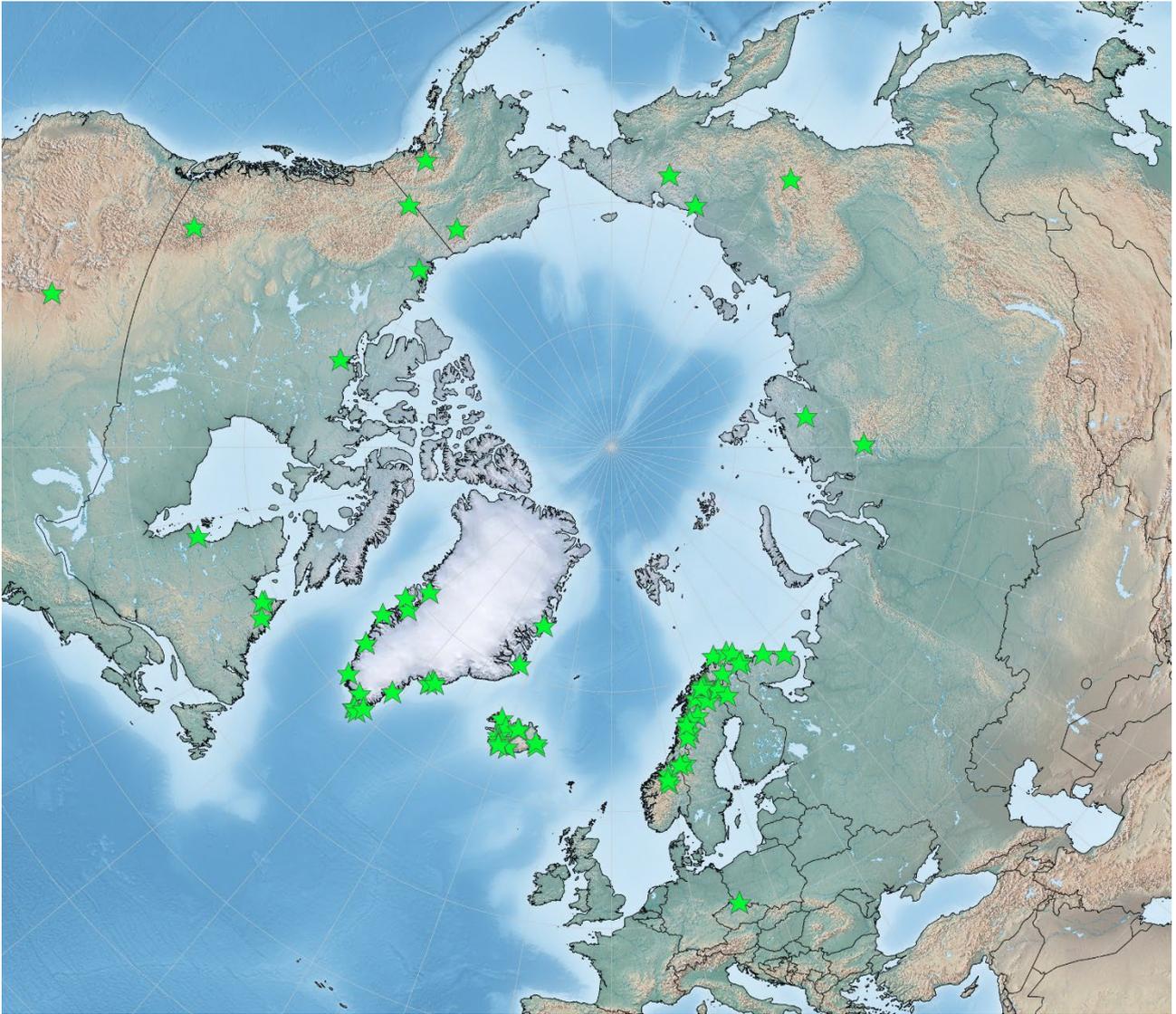
Habitats and host plants

Dry to moist alpine or arctic tundra; wet subalpine and alpine meadows.

Cyperaceae: *Carex* sect. *Phacocystis*: *Carex bigelowii*, *C. concolor*, *C. scopulorum*, and hybrids of *C. bigelowii*.

Distribution

Arctic-alpine; type 1; found in arctic CAN (NT, NU, QC, NL), GR, IS, NO, and RU, and in the alpine Alaska-Yukon Ranges (AK; and CAN: YT), the Rocky Mts. (CAN: BC; and USA: WY), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Sudetes (PL, CZ), the Putorana Plateau, and the Upper Kolyma Highlands (RU). Widespread in the region; in Greenland, Iceland, Fennoscandia and arctic Russia coextensive with *C. bigelowii*.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea buxbaumii K. Vánky, Vánky Ustilaginales. 205; SOMF 17845; Sweden

Anthracoidea buxbaumii Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose or broadly ellipsoid black hard bodies, 2.0–4.0 mm long, when young covered by a thin whitish peridium, later becoming exposed; spore mass of the mature sori powdery on the surface.

Spores large, flattened, in plane view mainly irregularly angular or broadly ellipsoid, $20\text{--}30 \times 16\text{--}24\text{--}(27) \mu\text{m}$, in side view $12\text{--}15 \mu\text{m}$ thick, medium to dark reddish brown; spore wall evenly thickened, $1.0\text{--}2.5 \mu\text{m}$ wide, with 1–3(–4) internal swellings, light-refractive areas lacking, minutely or moderately verruculose, warts $0.1\text{--}0.5 \mu\text{m}$ high, often forming small groups or short rows. Spore germination of the *Proceres*-type resulting in a 2-celled basidium, $250\text{--}300 \mu\text{m}$ long, producing one basidiospore on each cell; basidiospores cylindrical, straight or slightly curved, $42\text{--}92\text{--}(98) \times 3\text{--}6 \mu\text{m}$.

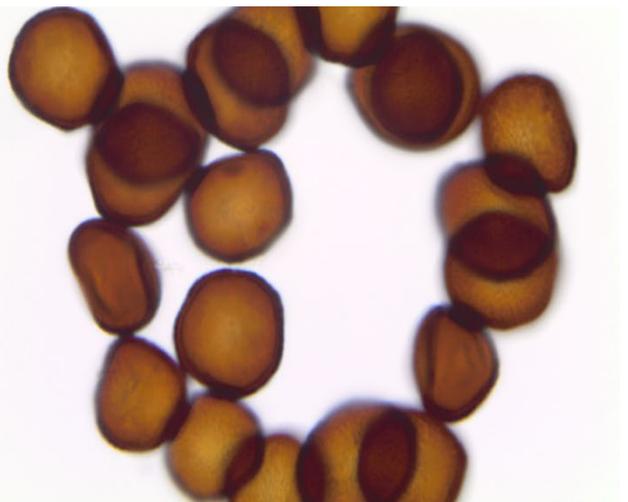
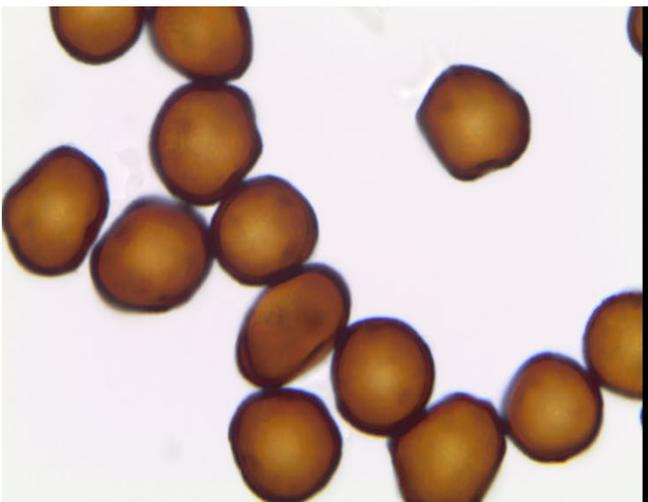
Habitats and host plants

Wet meadows, marshes, fens; subarctic bogs; coastal cliffs, beach meadows, sand dunes.

Cyperaceae: *Carex*: in the arctic-alpine region in *Carex* sect. *Racemosae*: *Carex adelostoma* (*Carex buxbaumii* subsp. *alpina*, *Carex buxbaumii* subsp. *mutica*) (principal host), *Carex buxbaumii* (*Carex polygama*) (principal host), and *Carex gmelinii*.

Distribution

Arctic-alpine; type 1; found in arctic CAN (QC) and RU, and in the alpine Rocky Mts. (CAN: BC), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Khibiny Mts. (RU), the Alps (CH), and Kamchatka (RU). In Fennoscandia very common (on *Carex adelostoma* and *Carex buxbaumii*); in the rest of the region very rarely reported.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea capillaris

P. Alanko, Vánky Ustilaginales 801; SOMF 20916; Norway

Anthracoidea capillaris Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose, ovoid, or broadly ellipsoid hard bodies, (0.3–)1.0–2.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small, flattened, in plane view irregularly rounded, angular, suborbicular, broadly ellipsoid, or ovoid, occasionally with a protuberance, (14.5–)15.5–21.5(–22) × (12–)14–17.5(–20) μm, in side view 9.5–12.5 μm thick, medium or dark reddish brown; spore wall unevenly thickened, 1.0–2.5(–4.0) μm thick, thickest at the angles and protuberances, often with 1–4(–5) usually prominent internal swellings, light-refractive areas sometimes present, surface minutely verruculose to almost smooth, spore profile not affected, warts up to 0.2 μm high, usually solitary, sometimes partly confluent, forming short rows or small groups. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium, 120–170 μm long, with apical cell 40–70 × 3.5–4.5 μm, producing 2 or 3

basidiospores on each cell; basidiospores ellipsoid, ovoid, or obovoid, 5–14 × 2.5–6 μm.

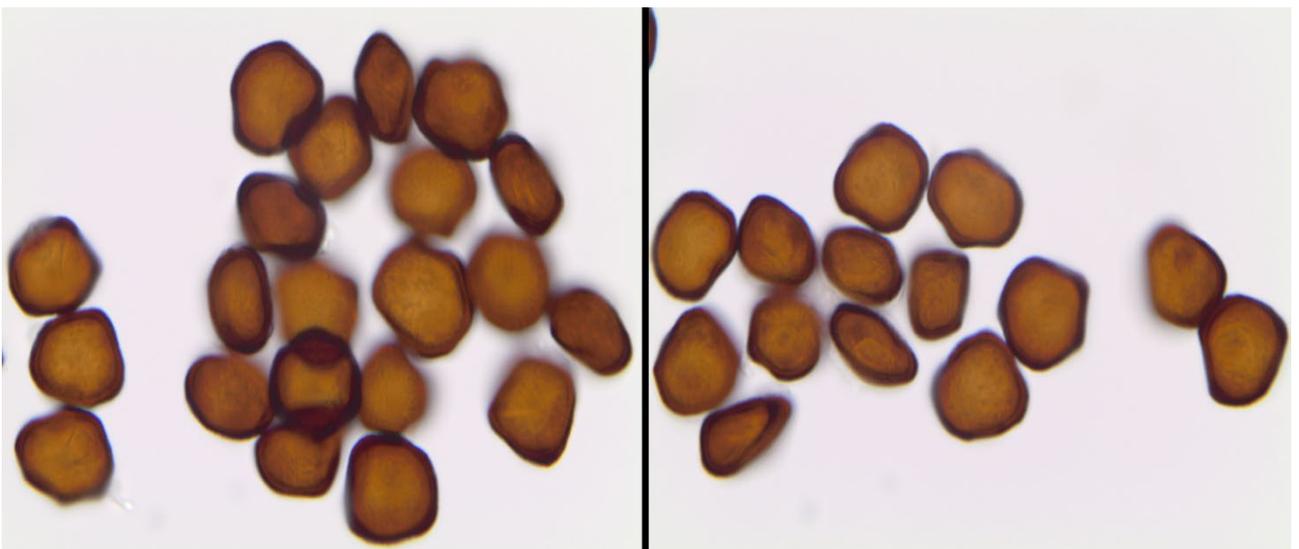
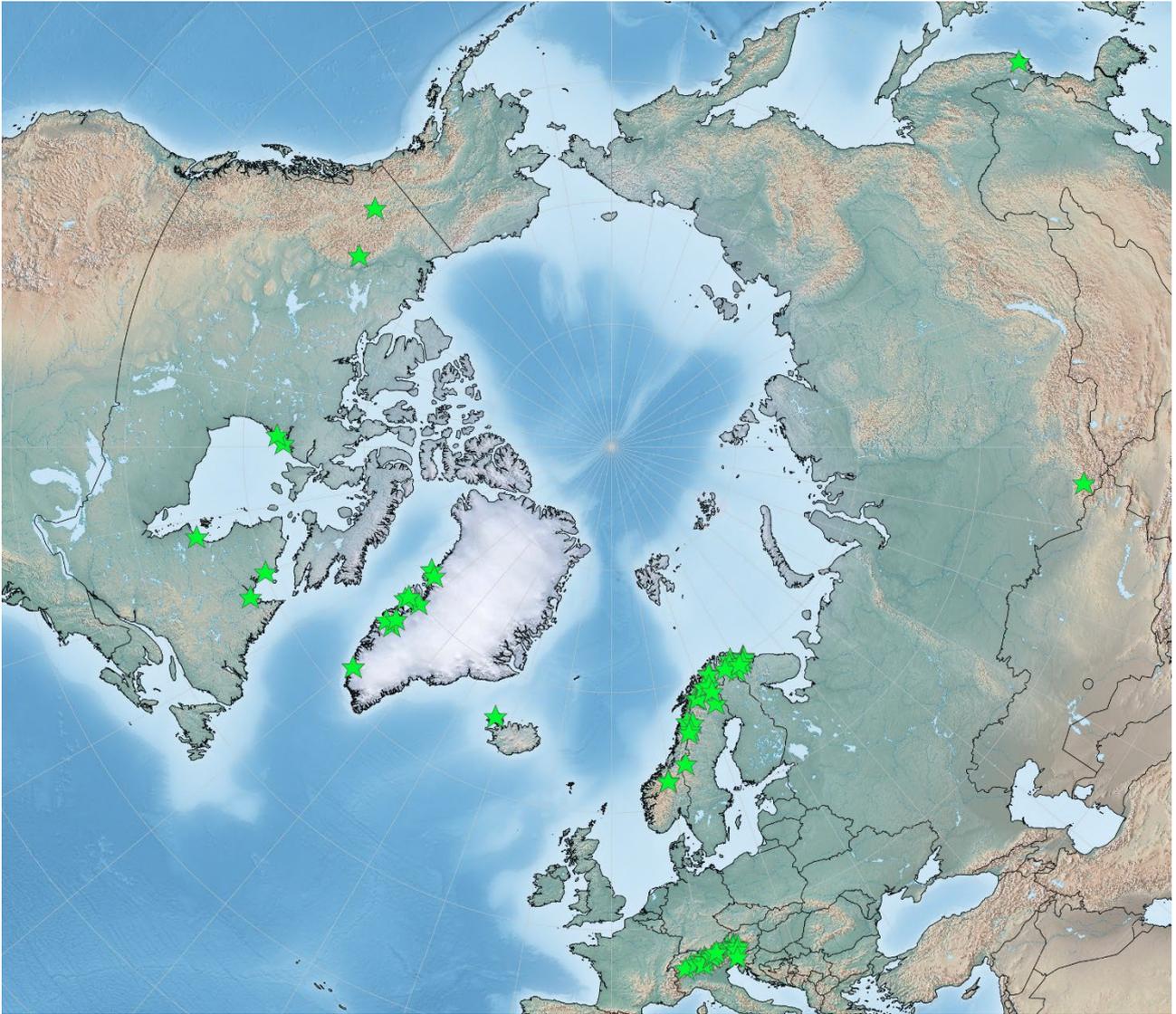
Habitats and host plants

Dry to moist tundra, shores; fens, meadows; wet places on mountain slopes.

Cyperaceae: *Carex* sect. *Chlorostachyae*: in the arctic-alpine region *Carex boecheriana*, *Carex capillaris*, and *Carex ledebouriana*.

Distribution

Arctic-alpine; type 1; found in arctic CAN (NU, QC), GR, IS, NO, and RU, and in the alpine Alaska-Yukon Ranges (CAN: YT, NT), the Rocky Mts. (CAN: BC), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Kola Peninsula (RU), the Alps (DE, CH, AT, SI), and the Sikhote-Alin and Altai Mts. (RU). Common in the Canadian Arctic and Greenland; rather common in the north of Fennoscandia and the arctic Kola Peninsula; in Germany reported only from the Berchtesgaden Alps, but common in the Swiss and Austrian Alps.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea caricis sensu lato

Triebel, *Microfungi Exs.* 295; SOMF; Austria

Anthracoidea caricis (Pers.) Bref.

Syn.: *Cintractia caricis* (Pers.) Magnus

Infection local. **Sori** in some female flowers, occurring around aborted nuts as globose, subglobose, or ovoid hard bodies, 0.5–1.5 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view irregular, angular, or suborbicular, occasionally with protuberances, 16–25(–27) × 14–20.5 μm, in side view 11–14 μm thick, medium or dark reddish brown; spore wall unevenly thickened, 1.5–4.0 μm thick, thickest at the angles and protuberances, sometimes with 1–2 indistinct internal swellings, light-refractive areas present, minutely to moderately verruculose, warts 0.2–0.4 μm high, sometimes partly fused and arranged into short rows. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium, 100–150 μm long, with apical cell 20–45 × 3.5–5.5 μm, producing 2–3 basidiospores on each cell; basidiospores ellipsoid or ovoid to obovoid, 6–14 × 3.5–5.5 μm.

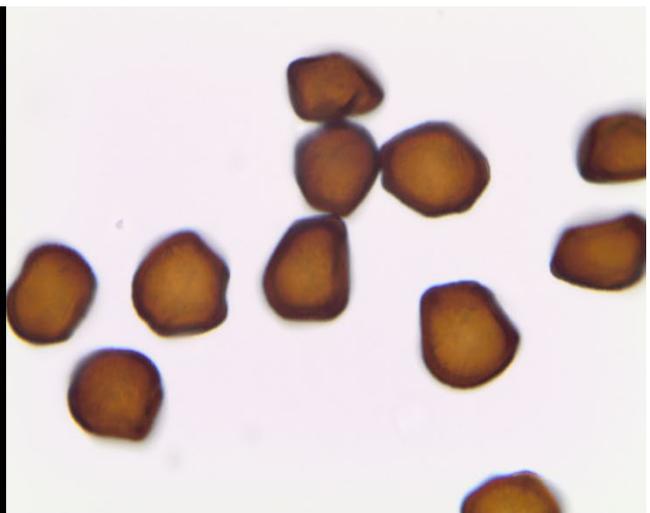
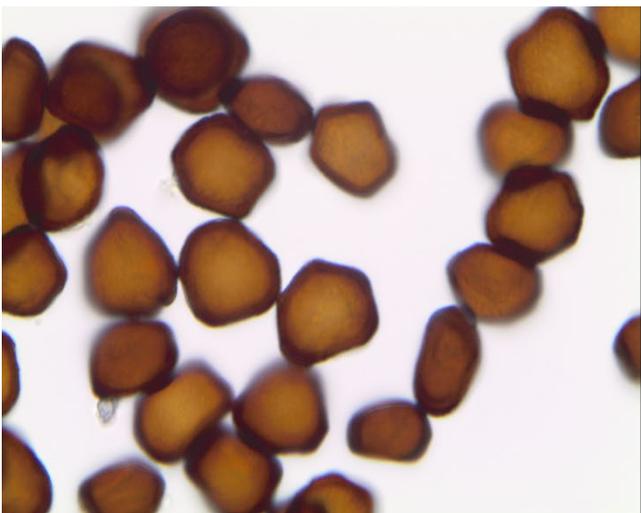
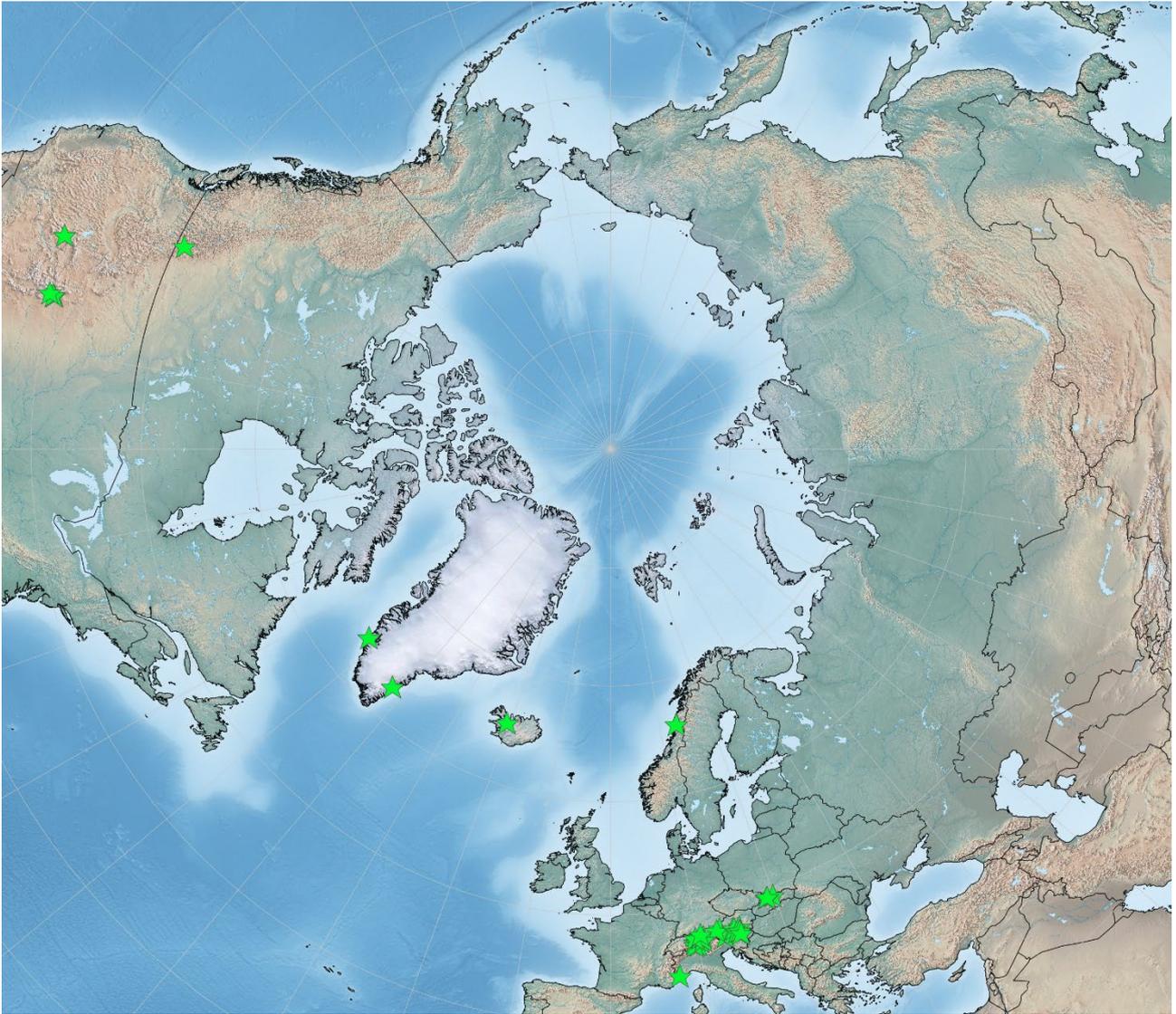
Habitats and host plants

Banks, snowbeds; moist or dry, sandy or rocky, open or shaded, mixed or coniferous woodlands; subalpine meadows.

Cyperaceae: *Carex* sect. *Acrocystis*: in the arctic-alpine region *Carex deflexa* var. *deflexa*, *Carex montana* (principal host), *Carex pilulifera* (principal host), and *Carex rossii*.

Distribution

Arctic-alpine; type 1; found in arctic Greenland and Iceland, and in the alpine Rocky Mts. (CAN: BC; and USA: UT, CO), the Alps (DE, FR, CH, AT), and the Tatras (PL, SK). In the arctic-alpine region very rare in Canada, the USA, Greenland, Iceland and Fennoscandia, and common in the Swiss and Austrian Alps, but it is not a typical arctic-alpine species.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea curvulae

Anthracoidea curvulae Vánky & Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose to broadly ellipsoid black hard bodies, 2.0–3.0(–4.0) mm long, when young covered by a thin peridium, later becoming exposed; spore mass of the mature sori semi-agglutinated on the surface.

Spores medium-sized, flattened, in plane view orbicular, suborbicular, broadly ellipsoid, or slightly irregular, 17–22.5 × 14.5–21 μm, in side view 10.5–14.5 μm wide, medium to dark reddish brown; spore wall evenly thickened, 1.2–1.6(–2.0) μm thick, lacking internal swellings or light-refractive areas, minutely verruculose, warts sparse to moderately dense, spore profile affected. Spore germination unknown.

C. Hinkova s.n.; SOMF 18461; Bulgaria

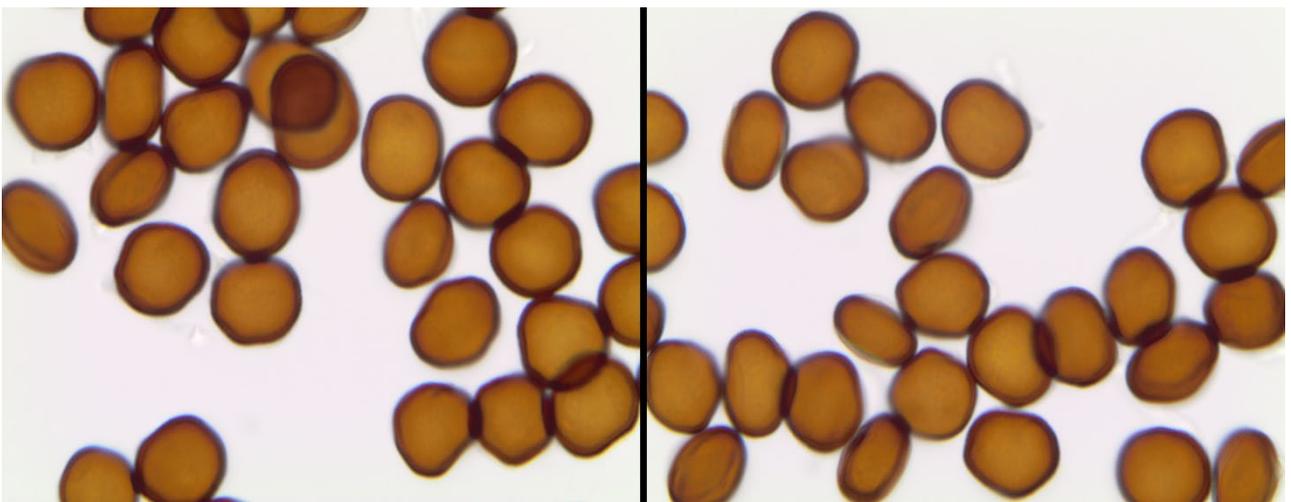
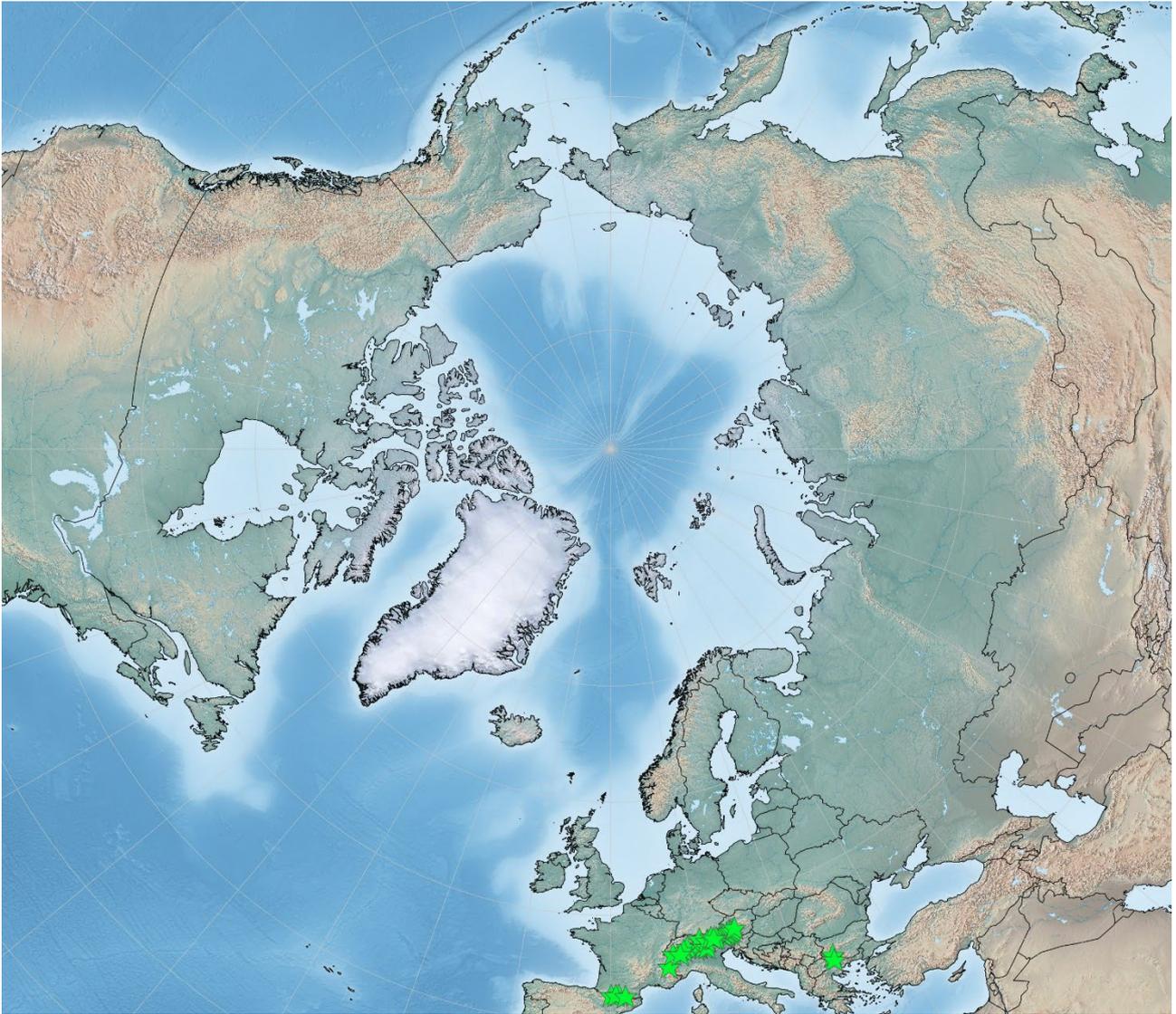
Habitats and host plants

Alpine and subalpine grassland (Alps, Pyrenees, and high mountains of the Balkan Peninsula).

Cyperaceae: Curvula Clade of *Carex*: *Carex curvula* subsp. *curvula*, and *C. curvula* subsp. *rosae*.

Distribution

Eurasian alpine; type 15; found in alpine regions of the Alps (CH, AT, IT, SI), the Pyrenees (FR, ES, AD), and the Rila and Pirin Mts. (BG). Common in the Swiss and Austrian Alps and the Pyrenees.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea elyanae McKenzie et al., Vánky Ustilaginales 803; SOMF 20915; Italy

Anthracoidea elyanae (Syd.) Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose, ovoid, or broadly ellipsoid hard bodies, 0.5–1.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small to medium-sized, flattened, in plane view suborbicular, broadly ellipsoid, ovoid, or slightly irregularly rounded, (16–)17–21(–22) × (14–)15–19(–20) μm, in side view 8.5–13.5 μm thick, often with a hyaline sheath on the flattened sides, medium or dark reddish brown; spore wall unevenly thickened, 1.0–2.0(–2.4) μm thick, often with 1–3 internal swellings, light-refractive areas and protuberances absent, smooth to minutely verruculose, spore profile not affected. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium, 70–100 μm long; initially producing only one basidiospore on each cell, later a second basidiospore forms from a secondary branch of the primary sterigma; basidiospores ellipsoid, ovoid, or obovoid, 6–18 × 4–9 μm.

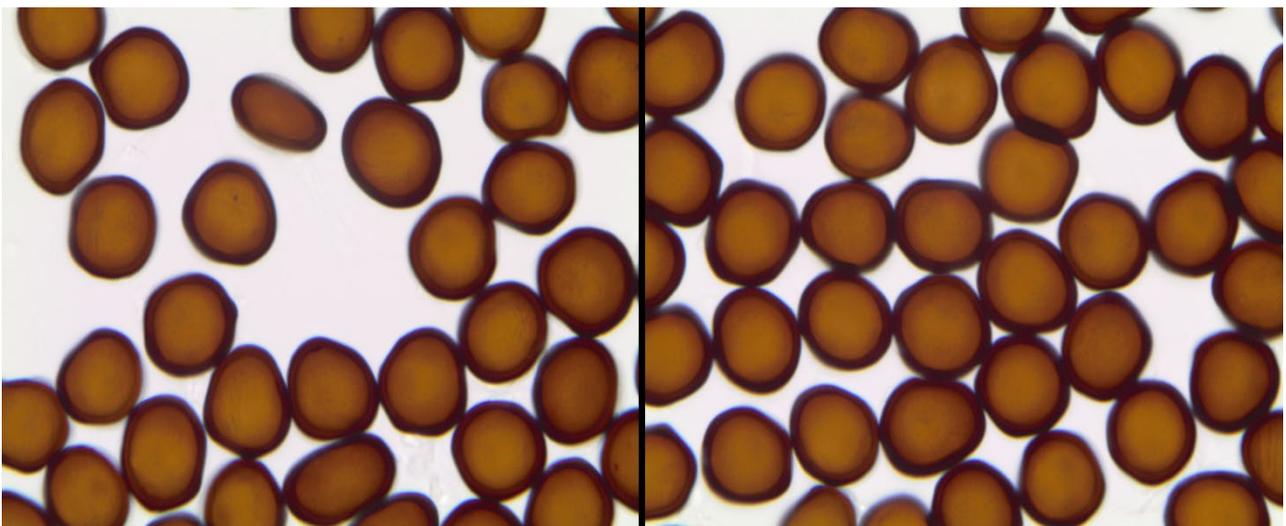
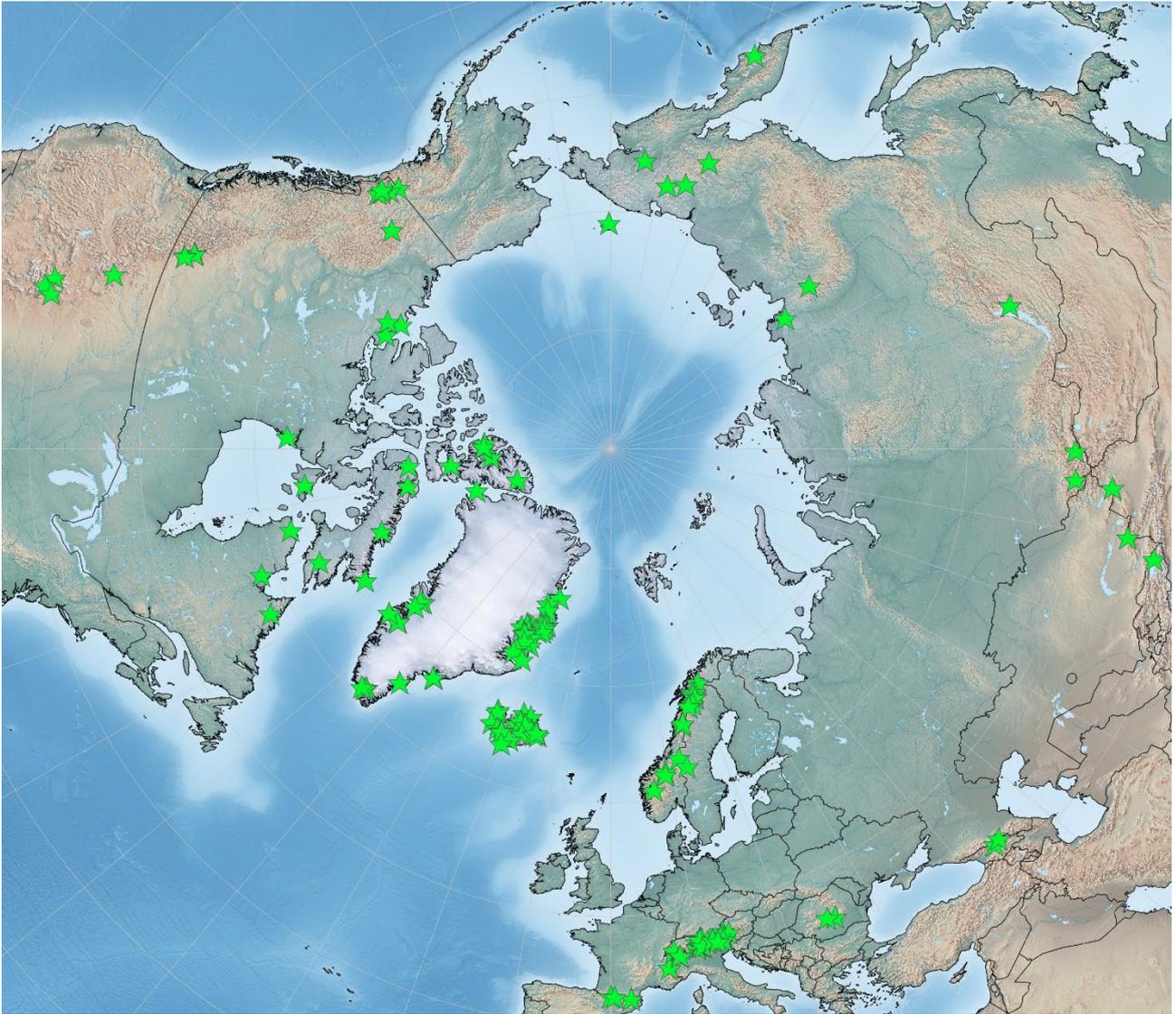
Habitats and host plants

Tundra, grassland, rocky slopes; moist meadows, boggy places among shrubs, sedge moors; slopes in *Juniperus* scrub; alpine meadows.

Cyperaceae: Kobresia Clade of *Carex*: in the arctic-alpine region *Carex borealipolaris* (*Kobresia sibirica*, *K. smirnovii*), *Carex capillifolia* (*K. capilliformis*, *K. macrolepis*), *Carex deasyi* (*K. schoenoides*), and *Carex myosuroides* (principal host).

Distribution

Arctic-alpine; type 1, found arctic CAN (NT, NU, QC, NL), GR, IS, and RU, and in the alpine Alaska-Yukon Ranges (AK; and CAN: YT), the Rocky Mts. (CAN: BC, AB; and USA: WY, CO), the Scandinavian Mts. (NO, SE), Dovre (NO), the Alps (DE, FR, CH, AT, IT), Carpathians (RO), and Pyrenees (FR, ES), the Verkhoyanskiy Range, Anyuy Range, Kolyma Highlands, Kamchatka, Altai Mts., and Buryatia (RU), and Tian Shan (KZ, KG). One of the most widespread *Anthracoidea* species in arctic Canada, Greenland, Iceland, and the Alps.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea ferrugineae

A. Feige & M. Kemler HMK 411; SOMF 31430; Austria

Anthracoidea ferrugineae Kemler, A. Feige, Begerow, T. Denchev & Denchev

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose, ovoid, or broadly ellipsoid hard bodies, 1.2–2.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view suborbicular, broadly ellipsoid, or irregularly rounded, sometimes irregularly polygonal or ellipsoid, (16–)17–23.5(–25.5) × (14–)15–19(–20.5) μm, in side view 10–14.5(–15.5) μm thick, dark reddish brown; spore wall unevenly to almost evenly thickened, (0.8–)1.0–2.8(–3.3) μm thick, without internal swellings, light-refractive areas, or protuberances; nearly smooth to

minutely verruculose, spore profile not affected, warts up to 0.15 μm high, usually isolated, sometimes 2–3 warts partly confluent, forming small groups. Spore germination unknown.

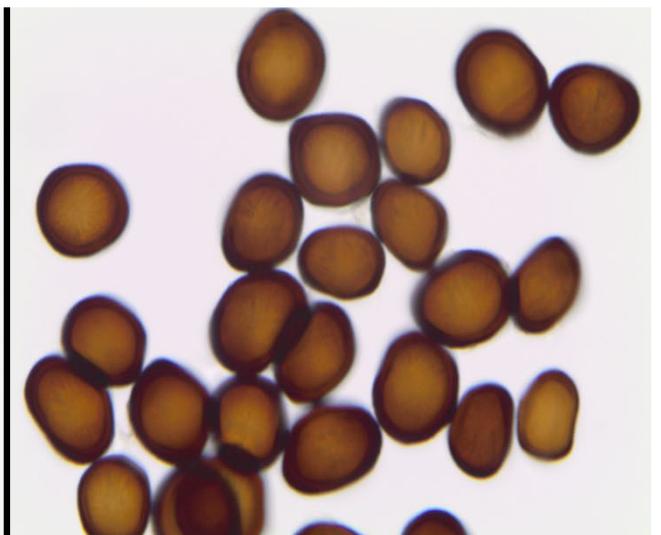
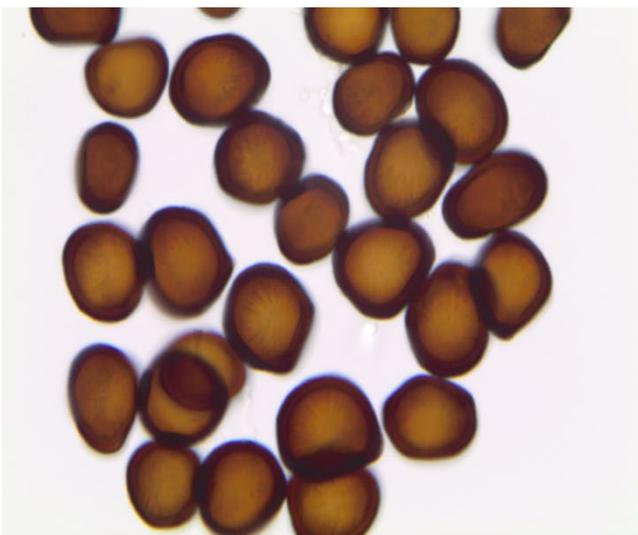
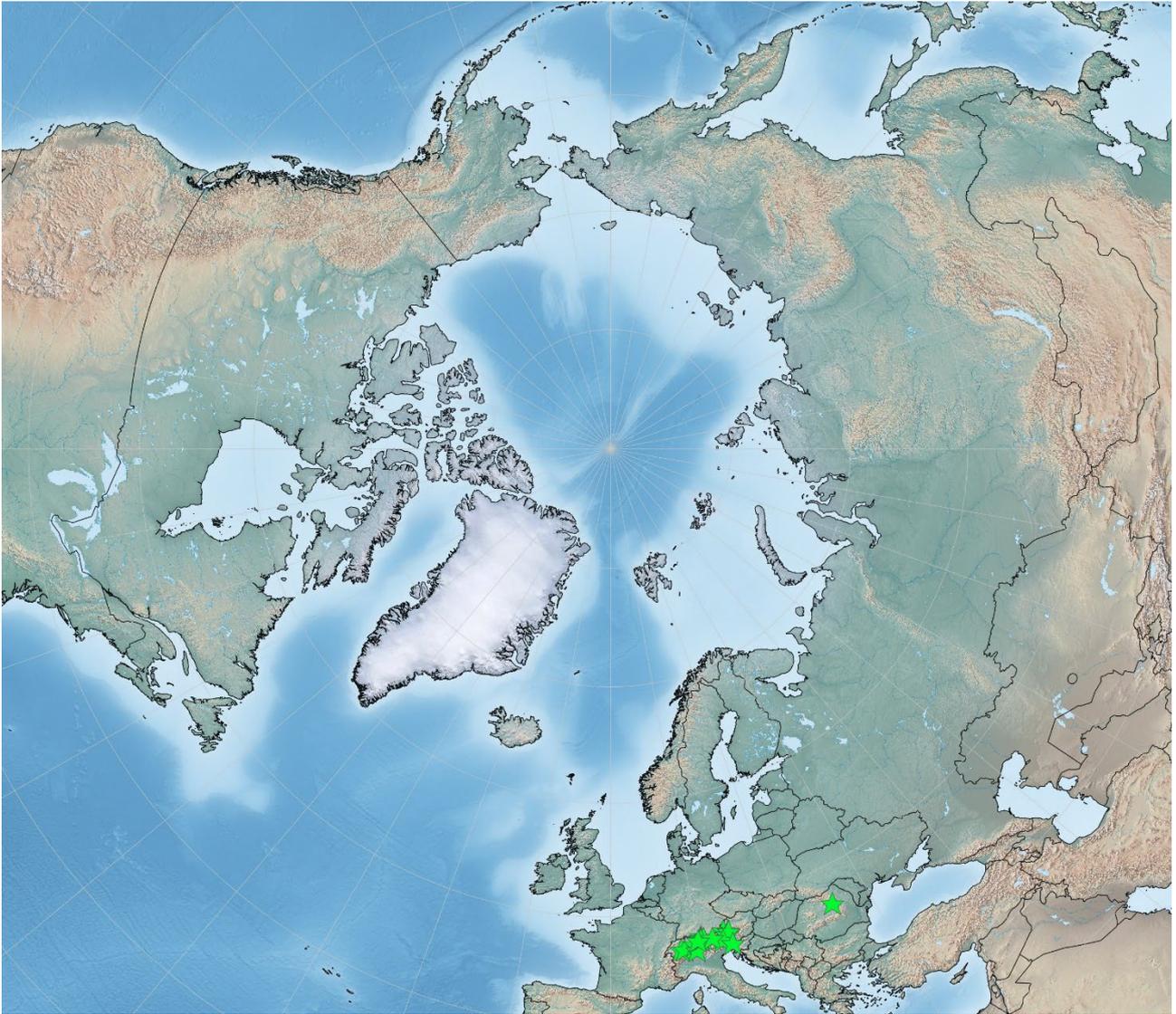
Habitats and host plants

High mountain vegetation, grassy and rocky places.

Cyperaceae: Flacca Clade of *Carex*: *Carex ferruginea*.

Distribution

Eurasian alpine; type 15; found in alpine regions of the Alps (DE, CH, AT, SI) and the Carpathians (RO). Common in the Alps.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea firmae

T. T. Denchev 16106; SOMF 30142; Austria

Anthracoidea firmae Kemler, A. Feige, Begerow, T. Denchev & Denchev

Infection local. **Sori** in some female flowers, occurring around aborted nuts as ovoid to ellipsoid hard bodies, 1.5–2.3 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view usually irregularly rounded to irregularly polygonal, sometimes broadly ellipsoid, suborbicular, or ovoid, sometimes with a protuberance, (15–)16–22.5(–24.5) × (13–)14–18.5(–19.5) μm, in side view 10–13.5(–14.5) μm thick, dark reddish brown; spore wall distinctly unevenly thickened, (0.8–)1.0–3.3(–4.0) μm thick, thickest at the angles and protuberances, often with 1–3(–4) internal swellings, light-refractive areas

present, minutely to moderately verruculose, spore profile not or very slightly affected, warts up to 0.2(–0.35) μm high, isolated or partly confluent, forming short rows or small groups. Spore germination of the *Anthracoidea*-type.

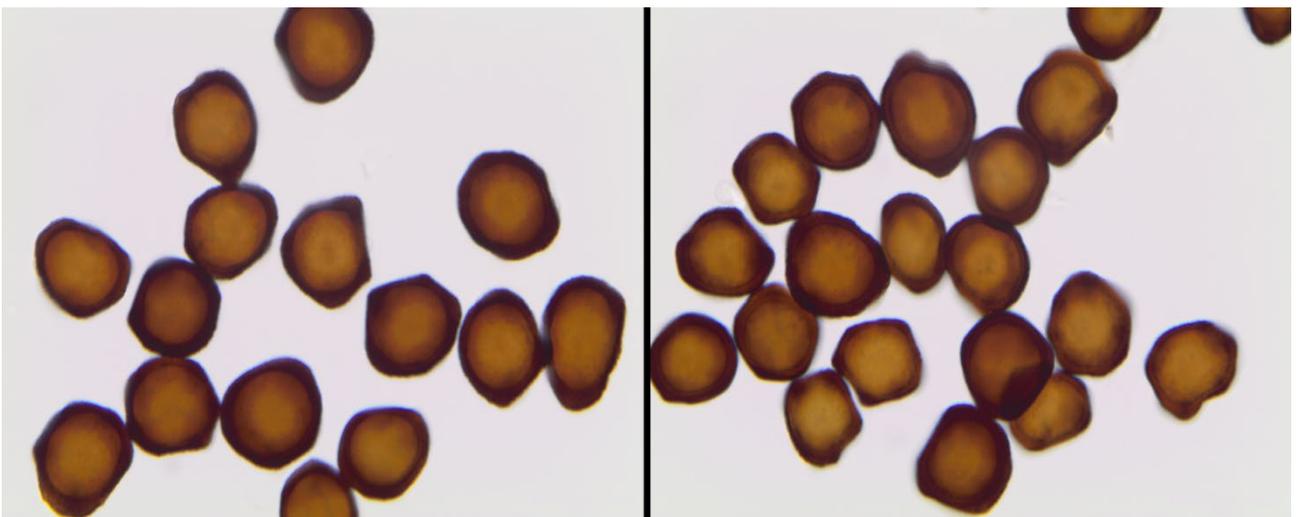
Habitats and host plants

Stony grassland and rocks.

Cyperaceae: Flacca Clade of *Carex*: *C. firma*.

Distribution

Eurasian alpine; type 15; commonly found in alpine regions of the Alps (DE, CH, AT, IT, SI).



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea fischeri

Anthracoidea fischeri (P. Karst.) Kukkonen

Syn.: *Cintractia fischeri* (P. Karst.) Liro

Infection local. **Sori** in some female flowers, occurring around aborted nuts as ovoid to ellipsoid hard bodies, 1.0–2.0 mm long, initially covered by a rather persistent silvery peridium hiding an agglutinated black spore mass; sori readily fall off the plant.

Spores small, 13–22 × 10–18 μm, subglobose to broadly ellipsoid, only slightly flattened, pale reddish brown; spore wall uniform, 1.5–2.5 μm thick, with 1–5 internal swellings, light-refractive areas absent, surface echinate, spore profile serrate, spines up to 1.0 μm high. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium, 50–117 μm long, producing 1–2 spores on each cell; basidiospores teardrop-shaped, 8–16 × 4–9 μm.

L. Ericson s.n.; UME 951567; Sweden

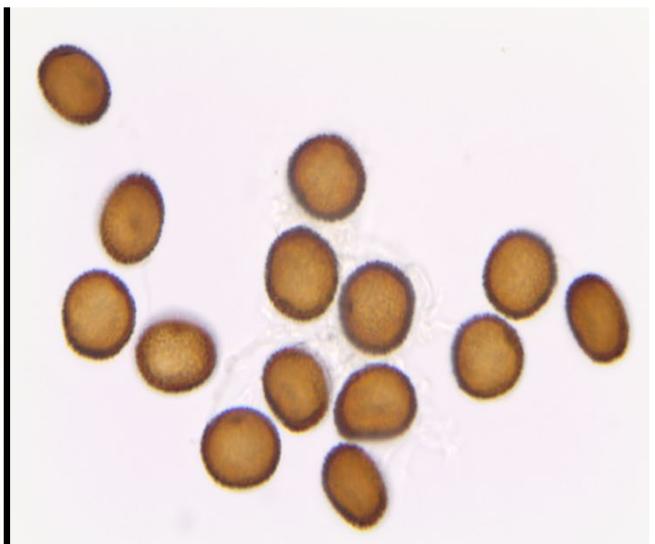
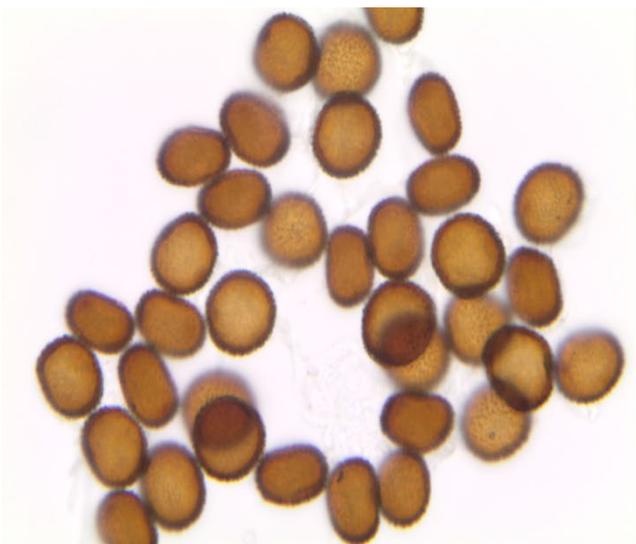
Habitats and host plants

Wet habitats, *Sphagnum* bogs, marshes and fens; coastal and estuarine marshes.

Cyperaceae: *Carex* spp.: in the arctic-alpine region, in *Carex* sect. *Glareosae*: *C. canescens* (principal host) and hybrids, and *C. lapponica*; in the Annectens Clade: *C. cusickii*; in the Disticha Clade: *C. disticha*; and in *Carex* sect. *Chordorrhizae*: *Carex chordorrhiza*.

Distribution

North American–Eurasian; type 5; found in arctic IS and RU, and in the alpine Alaska-Yukon Ranges (CAN: NT), the Rocky Mts. (CA: BC), the Scandinavian Mts. (NO, SE, FI), and Tian Shan (KZ). Very rarely recorded in the region. The general distribution and host spectrum of this fungus need further study.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea foetidae

E. Müller & J. Poelt P 248; GZU 000323454; Switzerland

Anthracoidea foetidae H. Zogg

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose hard bodies, 2.0–3.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small, flattened, in plane view orbicular or broadly ellipsoid, occasionally slightly irregular, (13–)14–21 × 12–18(–20) μm, in side view 10–13 μm wide, reddish brown; spore wall even, 0.5–1.0(–1.5) μm thick, without internal swellings or light-refractive areas, surface verrucose, warts large, 0.5–0.7 μm high, often partly confluent, spore profile affected. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium, up to 140 μm long; basidiospores ellipsoid, 7–12 × 3–4(–5) μm.

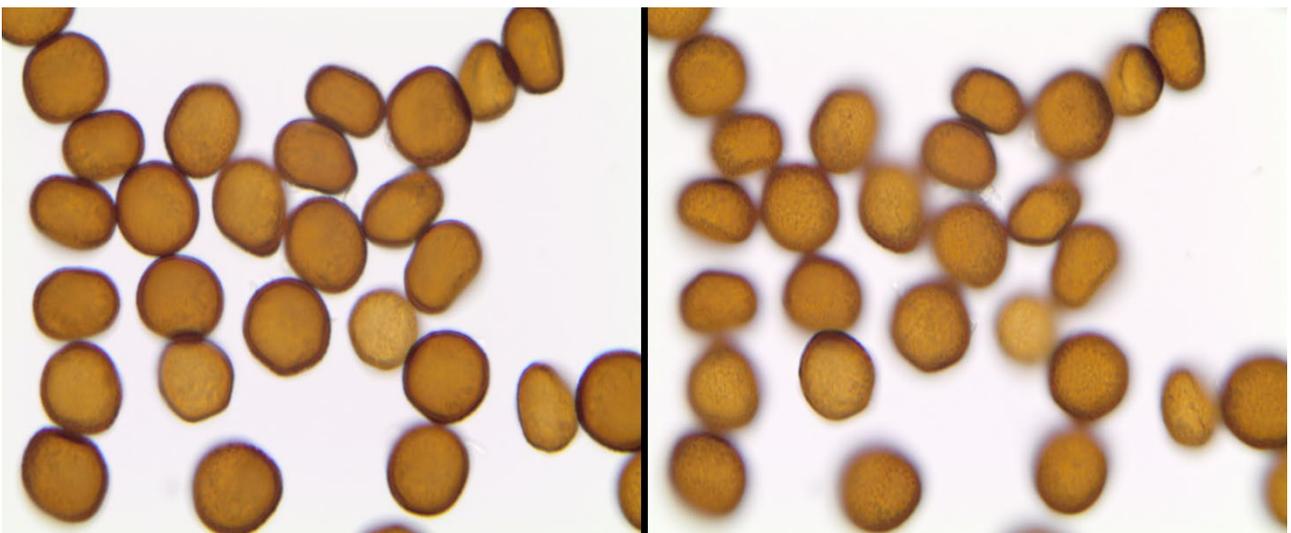
Habitats and host plants

Damp, grassy or stony places in the Alps.

Cyperaceae: Echinata Clade of *Carex*: *Carex foetida*.

Distribution

Eurasian; type 15, found in alpine regions of the Alps (CH). Very rare.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea heterospora

K. Vánky, Ustilaginales 208; SOMF 17848; Sweden

Anthracoidea heterospora (B. Lindeb.) Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose to ovoid hard bodies, 0.7–1.2 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small, flattened, in plane view suborbicular, broadly ellipsoid, irregularly rounded, subpolygonal, or ovoid, (12–)13–19.5(–21.5) × (11–)12–18(–20) μm, in side view 9–12.5 μm thick, medium reddish brown; spore wall slightly unevenly thickened, 1.0–1.8(–2.2) μm thick, with 1–4(–5) internal swellings, light-refractive areas and protuberances absent, minutely verruculose, warts up to 0.2(–0.3) μm high, spore profile not affected or very slightly affected, warts often partly confluent, forming short rows or small groups. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium producing ellipsoid basidiospores.

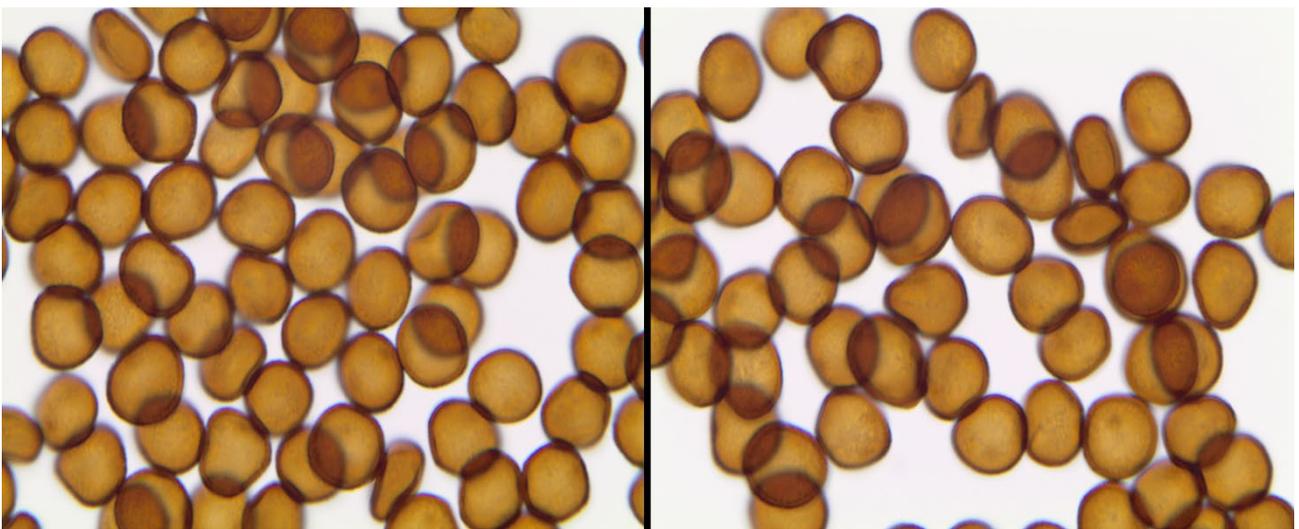
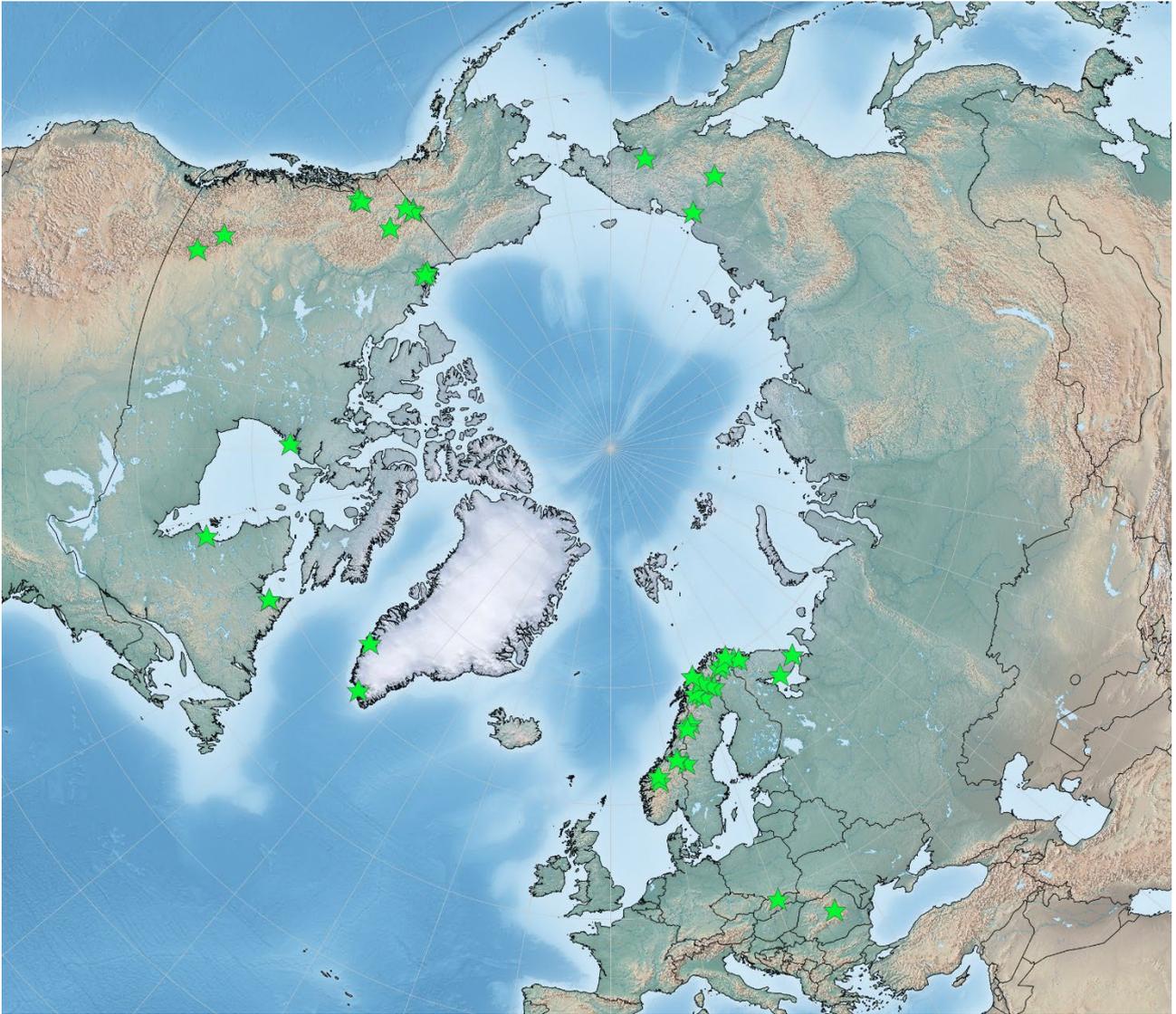
Habitats and host plants

Wet habitats; marshes, bogs, wet meadows, shallow water along shores.

Cyperaceae: *Carex* species: in the arctic-alpine region, *Carex* sect. *Phacocystis*: *Carex aquatilis* and its hybrids, *C. bigelowii* subsp. *lugens*, hybrids of *C. bigelowii*, *C. cespitosa*, *C. concolor*, *C. eleusinoides*, *C. ×flavicans*, *C. lenticularis*, *C. nigra* subsp. *nigra*, *C. nigra* subsp. *junceae* (*C. juncella*), *C. paleacea*, and *C. salina* var. *salina* (*C. aquatilis* var. *epigejos*).

Distribution

Cosmopolitan; type 1; found in arctic CAN (NT, NU, QC), GR, and RU, and in the alpine Alaska-Yukon Ranges (CAN: YT), the Rocky Mts. (CAN: BC, AB), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Kola Peninsula (RU), the Tatras (SK), Carpathians (RO), and the Kolyma Highlands (RU). In the arctic-alpine region, common in the Canadian Arctic, Yukon Ranges, Scandinavian Mts, and Russian Arctic, but rarely reported from the Canadian Rocky Mts., Greenland, the Tatras, the Carpathians, and the Russian Far East. The general distribution and host spectrum of this fungus need further study.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea inclusa

Anthracoidea inclusa Bref.

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose, broadly ellipsoid to ellipsoid, black hard bodies, 2.5–4.0 mm long, often remaining hidden within the bladder-like utricles or becoming only slightly visible; when young covered by a thin whitish peridium; spore mass of the mature sori agglutinated on the surface, usually broken into small pieces.

Spores small, slightly flattened, in plane view orbicular, suborbicular, oval, or broadly ellipsoid, occasionally angular, 13–20 × 10–16.5 μm, dark reddish brown; spore wall unevenly thickened, 1.0–2.0 μm thick, lacking internal swellings or light-refractive areas, coarsely verrucose, warts 0.5–1.0(–1.5) μm high, flattened at the apex, rather densely and irregularly arranged, often fused in small groups or short rows. Spore germination of the *Anthracoidea*-type, resulting in a 2-celled aerial basidium, 40–80 × 3–5 μm, producing a single basidiospore on each cell; basidiospores ovoid, 8–10 × 6–8 μm.

Vánky Ustilaginales 382; SOMF 17870; Sweden

Habitats and host plants

Shallow water, bogs and marshes, tundra, wet peaty ground.

Cyperaceae: Hirta Clade of *Carex*: *C. rostrata* (*C. stenolepis*), *C. rotundata*, and *C. ×saamica* (*C. rostrata* × *C. rotundata*).

Distribution

Eurasian alpine; type 15; found in the Scandinavian Mts. (SE, FI) and the Alps (DE). Very rarely reported in the alpine region; not a typical alpine species.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea irregularis

K. Vánky, Ustilaginales 210; SOMF 17850; Romania

Anthracoidea irregularis (Liro) Boidol & Poelt

Syn.: *Cintractia irregularis* Liro

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose to broadly ellipsoid hard bodies, 1.0–3.0 mm long, initially covered by a thin peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores large, flattened, in plane view distinctly irregular, often irregularly angular or elongate, usually with numerous conspicuous protuberances, 17–29 × 13–22 µm, occasionally (important to note as a difference from some closely related species where there are no such exceptions) some spores reach up to 32(–34) µm long, in side view 10.5–13.5 µm thick, medium to dark reddish brown; spore wall unevenly thickened, 1.5–3 µm thick, thickest at the angles and in the protuberances (up to 5 µm wide), 1–3 internal swellings present, often with large and well-developed light-refractive areas (numerous on some spores), surface minutely verruculose

(sometimes with higher warts slightly affecting the spore profile), warts partly confluent, forming short rows or small groups. Spore germination of the *Anthracoidea*-type.

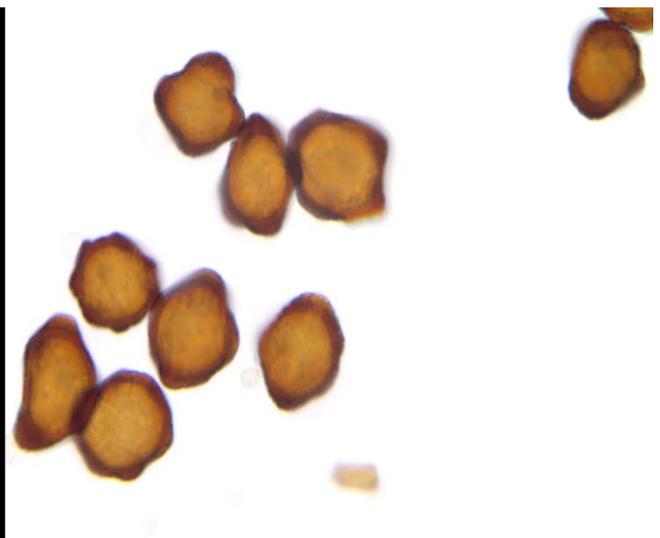
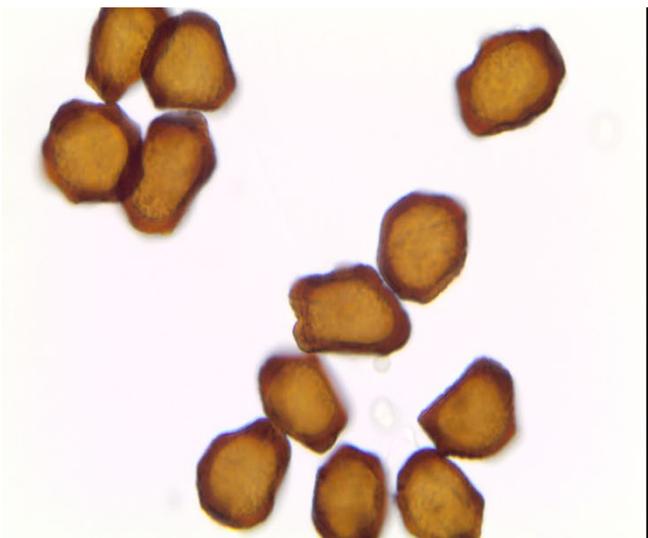
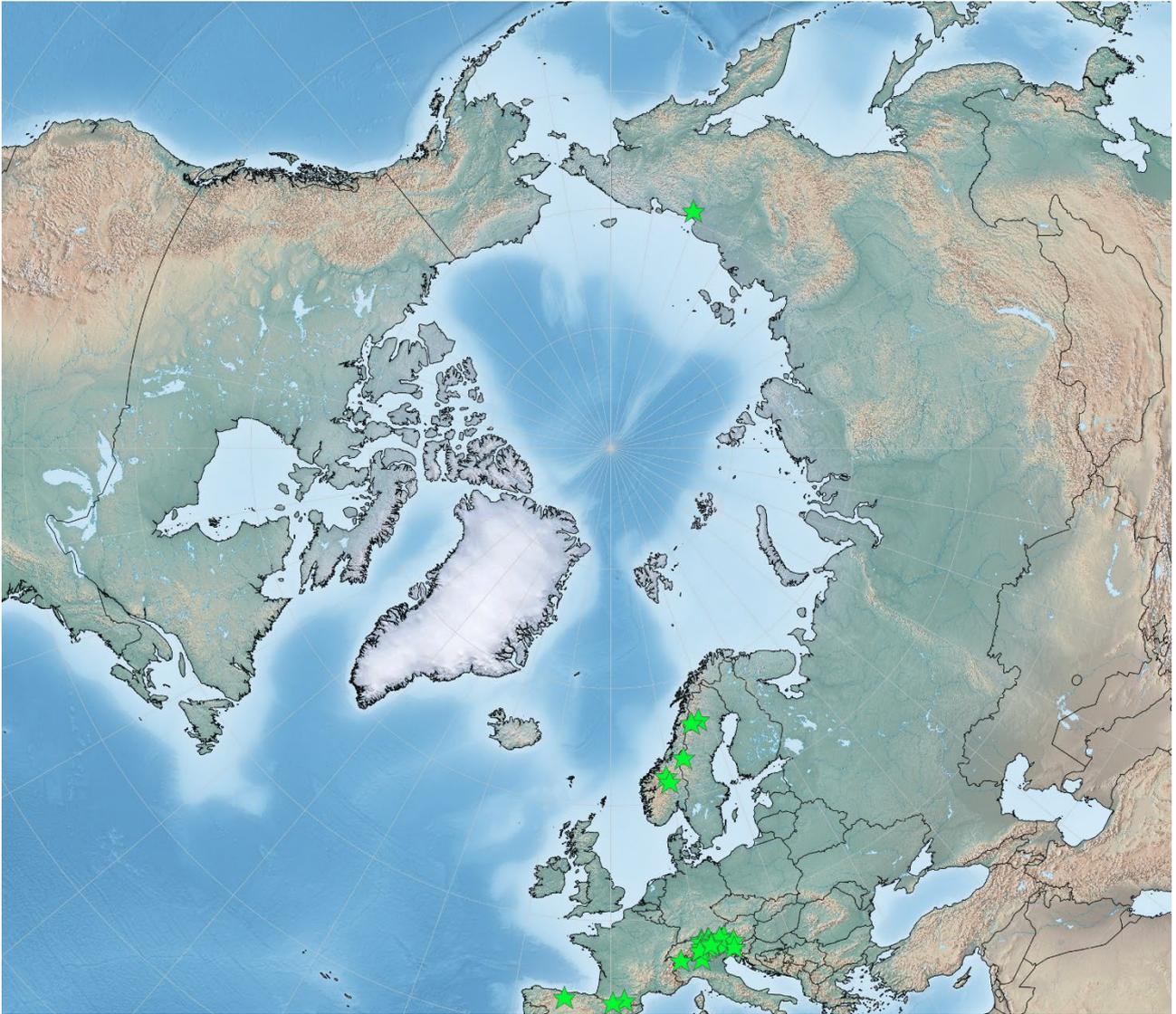
Habitats and host plants

Grasslands, mountain slopes, on rocks.

Cyperaceae: *Carex*: in the arctic-alpine region, in sect. *Digitatae*: *Carex ornithopoda*; and in sect. *Clandestinae*: *Carex pediformis*.

Distribution

Eurasian; type 9; found in arctic Russia, and in alpine regions of the Scandinavian Mts. (SE), Dovre (NO), the Alps (DE, CH, AT, IT, SI), the Pyrenees (FR, ES), and the Cantabrian Mts. (ES). Rarely reported from the arctic-alpine region. Most of the localities for this species are in forests or non-alpine grasslands.



Anthracoidea: Anthracoideaceae: Ustilaginales



***Anthracoidea karii* s.str.**

H. F. Göttsche HFG 87.076; C-F-107980

Anthracoidea karii (Liro) Nannf.

Syn.: *Cintractia karii* Liro

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose or ovoid hard bodies, 1.0–2.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small, flattened, in plane view suborbicular, broadly ellipsoid, orbicular, or ovoid, (14–)15–20(–21) × (13–)14–18(–19) μm, in side view 9.5–13 μm thick, medium reddish brown; spore wall evenly or slightly unevenly thickened, 0.8–1.4(–1.7) μm thick, with 1–4(–5) usually conspicuous internal swellings, light-refractive areas and protuberances absent, minutely verruculose, spore profile not affected; warts up to 0.15 μm high, solitary or partly confluent, forming short rows or small groups. Spore germination of the *Anthracoidea*-type.

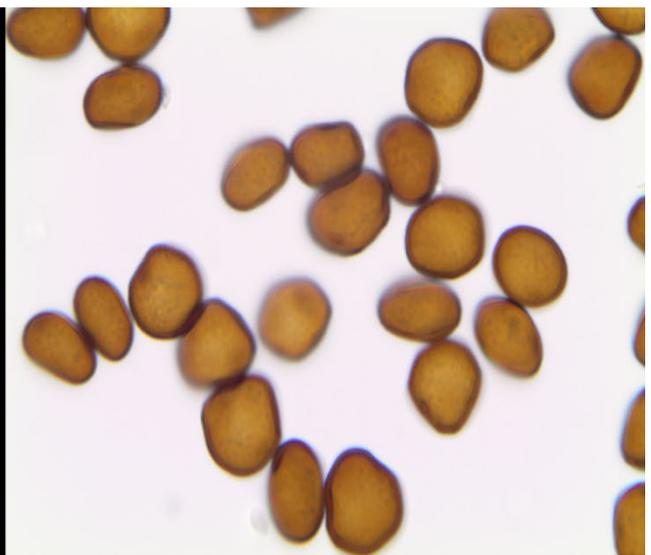
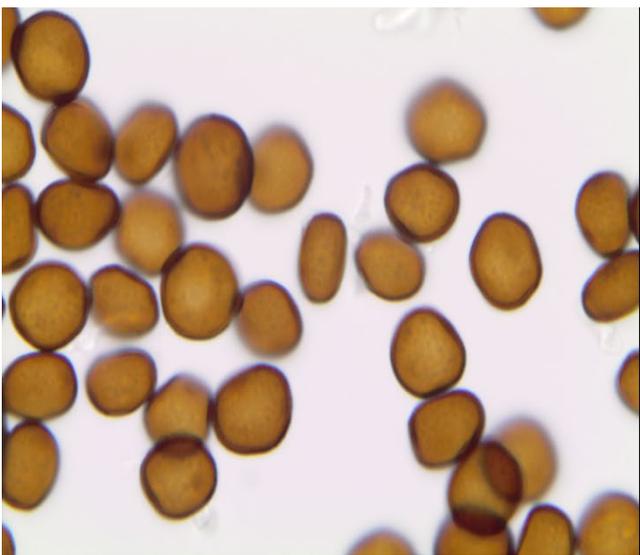
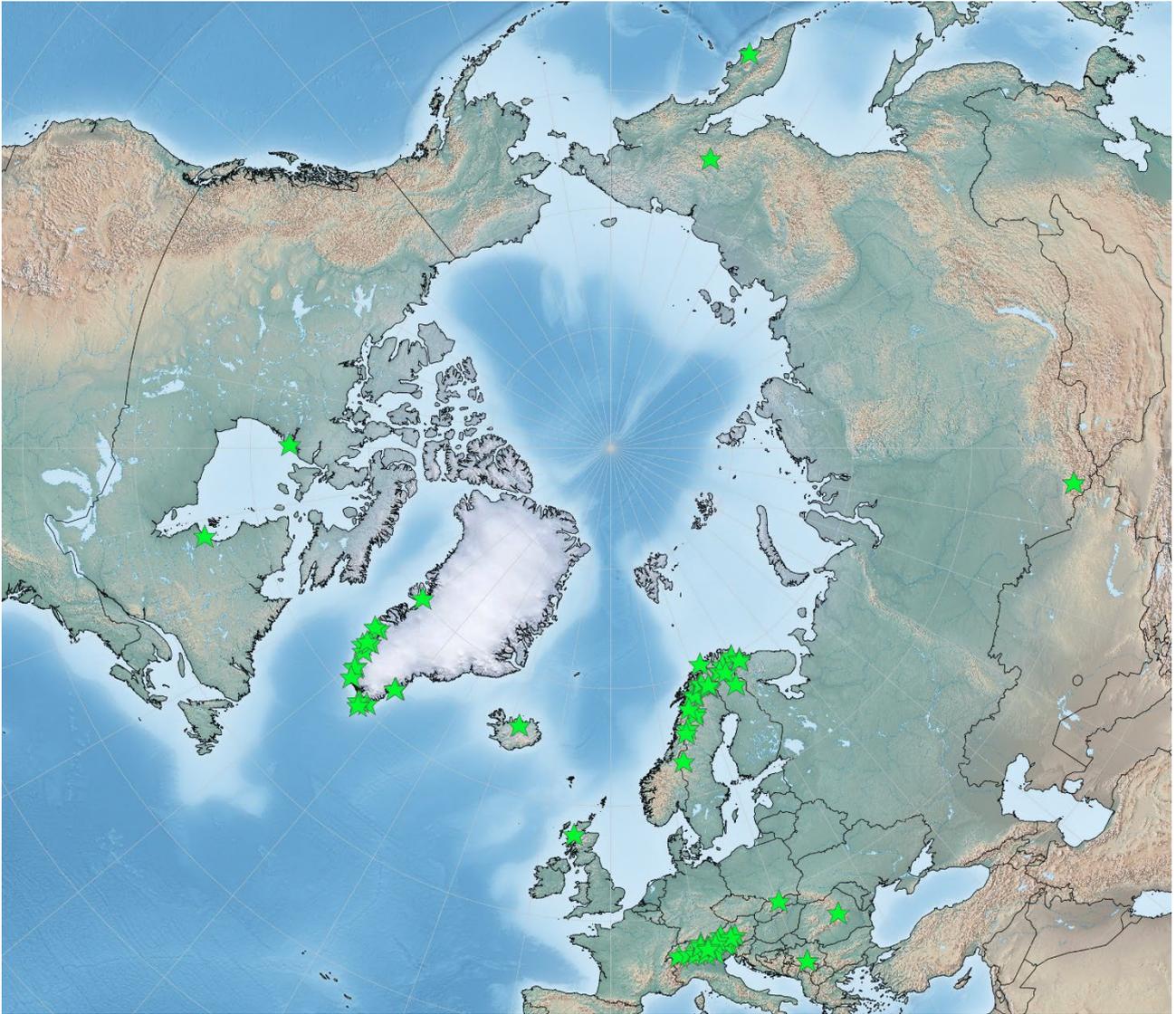
Habitats and host plants

Wet meadows, fens, bogs, swamps; peaty or sandy shores of streams or lakes; salt marshes and maritime rocks.

Cyperaceae: *Carex* species: in the arctic-alpine region, in the Echinata Clade: *Carex echinata* (*C. angustior*, *C. stellulata*); in *Carex* sect. *Glareosae*: *C. brunnescens*, *C. canescens*, *C. heleonastes*, *C. lapponica*, *C. loliacea*, *C. marina*, and hybrids.

Distribution

North American arctic–Eurasian; type 4; found in arctic CAN (NU, QC), GR, IS, NO, and RU, and in alpine regions of the Scandinavian Mts. (NO, SE, FI), the Alps (DE, CH, AT, IT), the Tatras (SK), the Carpathians (RO), Mt. Kopaonik (RS), and the Kolyma Highlands, Kamchatka, and the Altai Mts. (RU). Common.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea kitaibeliana

T. T. & C. M. Denchev 17113; SOMF 30152; Bulgaria

Anthracoidea kitaibeliana T. Denchev, Denchev, Begerow, A. Feige & Kemler

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose, ovoid, or broadly ellipsoid hard bodies, 2.5–6.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view irregularly rounded, broadly ellipsoid, irregularly polygonal, subglobose, or ovoid, occasionally with a protuberance, (15.5–)17–23(–25) × (14–)15–19.5(–21) μm, in side view 9.5–13(–14.5) μm thick, dark reddish brown; wall unevenly thickened, (1.0–)1.2–3.0(–3.7) μm thick, internal swellings absent, light-refractive areas occasionally present, minutely to moderately verruculose, warts up to 0.2(–0.35) μm high,

often confluent, forming an irregular pattern, spore profile not affected or very slightly affected. Spore germination unknown.

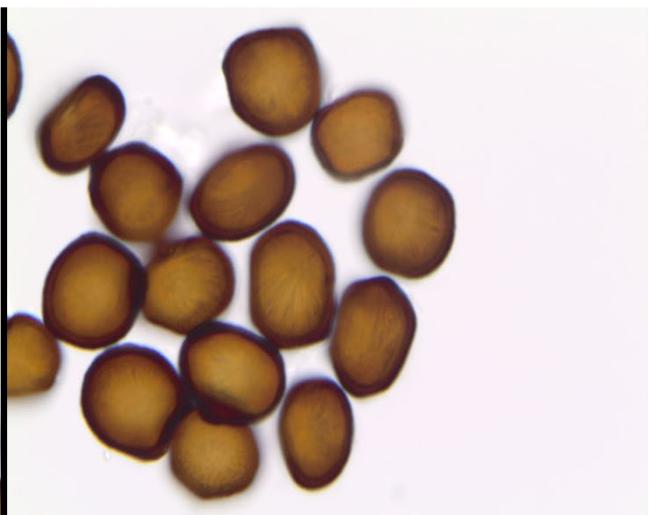
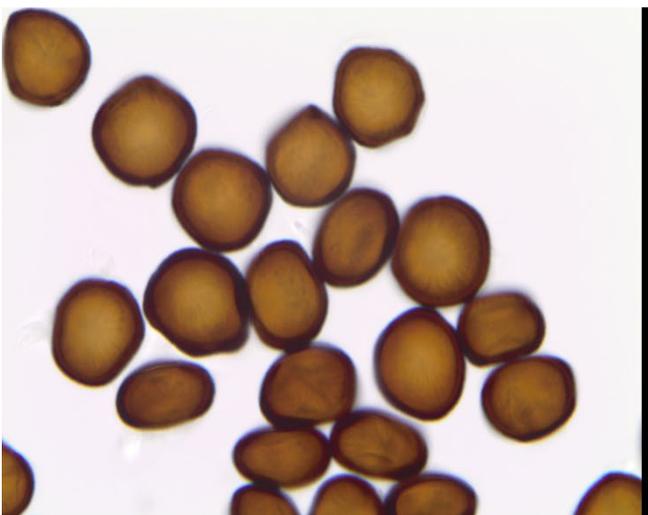
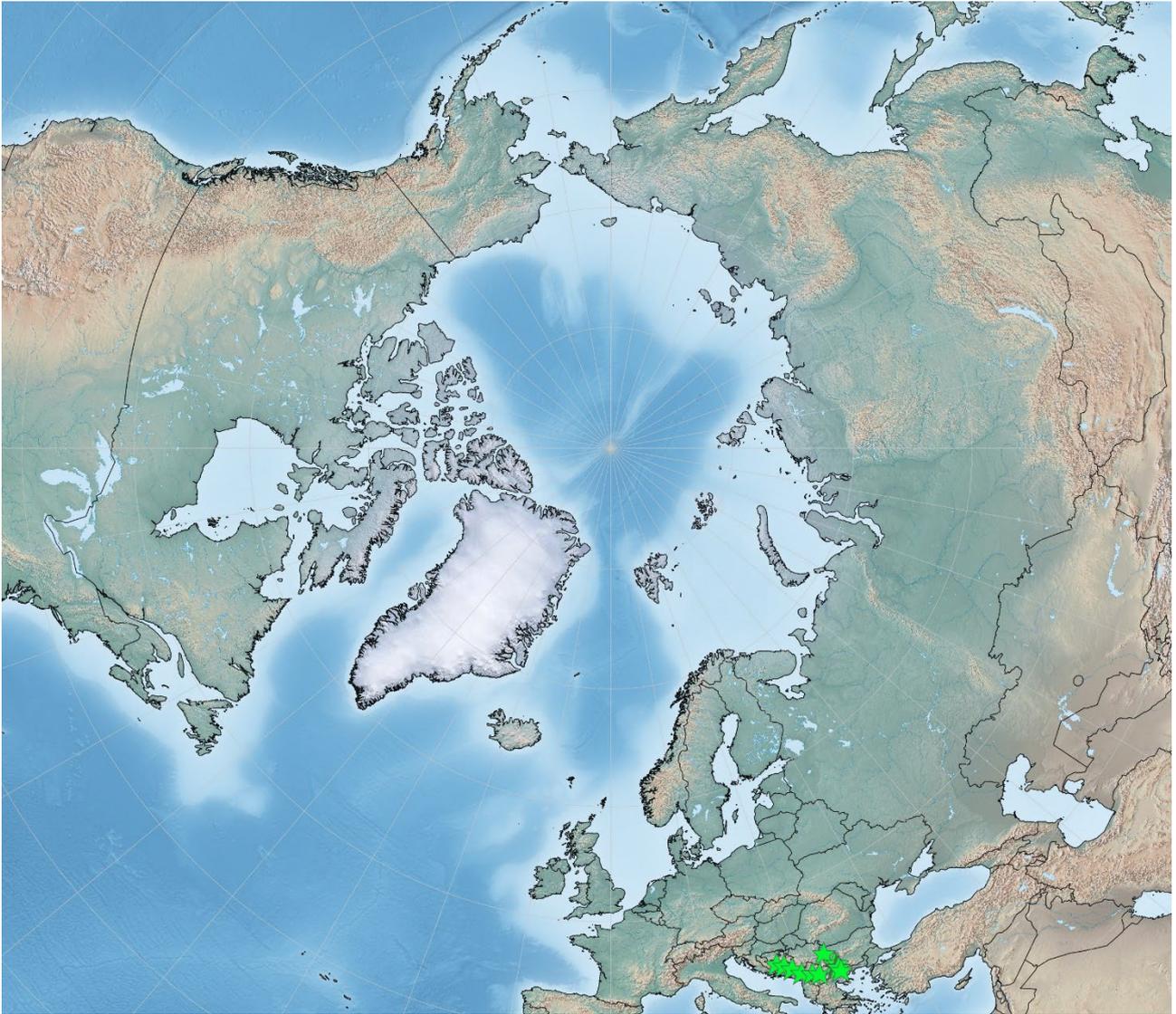
Habitats and host plants

Subalpine and alpine, dry, grassy or rocky slopes in the Balkan Peninsula.

Cyperaceae: incertae sedis in *Carex* subgen. *Carex*: *C. kitaibeliana*.

Distribution

Eurasian alpine; type 15; found in the Dinaric Alps (BA, ME), the Albanian Alps (AL), the Šar Mts. and the Jakupica Range (MK), and in the Balkan Range, Rila Mts., Pirin Mts., and Mt. Slavyanka (BG). Common in high mountains of the Balkan Peninsula.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea lasiocarpae

K. Vánky, Ustilaginales 214; SOMF 17854; Sweden

Anthracoidea lasiocarpae B. Lindeb.

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose hard bodies, 2.0–3.0 mm long, initially covered by a thin peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores large, flattened, in plane view broadly ellipsoid, ellipsoid, or slightly angular, 20–30 × 15–26 μm, in side view 13–16 μm thick, yellowish to medium reddish brown; spore wall 1.0–2.0(–2.5) μm thick, thickest at the angles, occasionally with weak internal swellings; surface minutely verruculose, spore profile smooth, warts solitary or partly confluent, forming short rows or small groups. Spore germination of the *Proceres*-type.

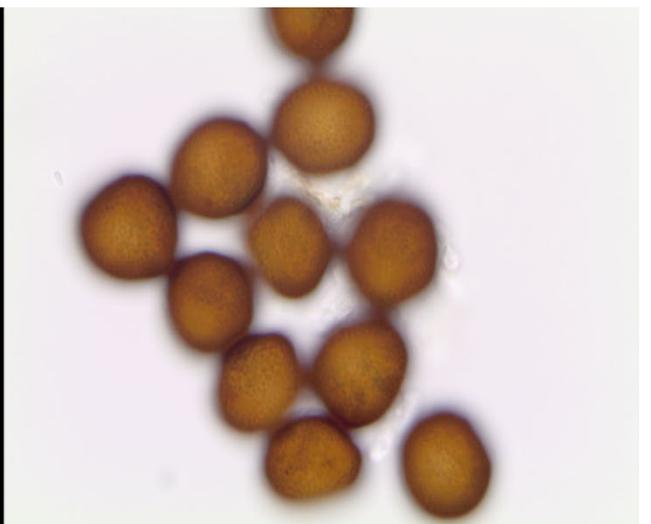
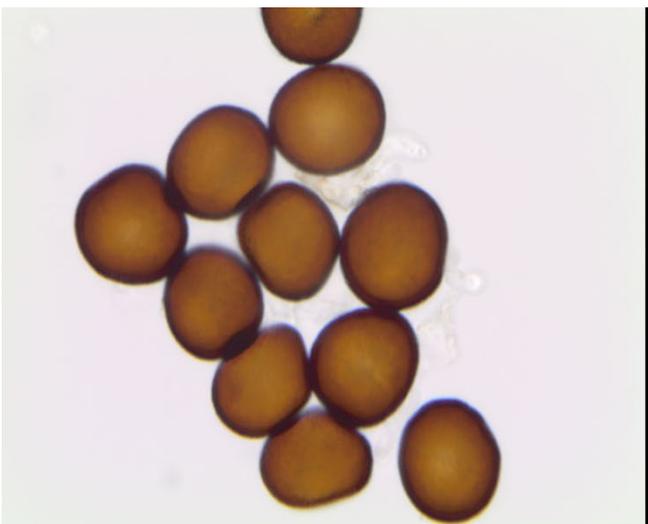
Habitats and host plants

Wet sites; sedge meadows, fens, bogs, lakeshores, streambanks.

Cyperaceae: Hirta Clade of *Carex*: *C. lasiocarpa* and *C. saxatilis*.

Distribution

Eurasian; type 9; found in arctic Norway and in the Scandinavian Mts. (NO, SE, FI), and the Khibiny Mts. (RU). Rather common in the north of Fennoscandia.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea laxae

Anthracoidea laxae Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as globose, subglobose, or ovoid hard bodies, 1.0–3.0 mm long, initially covered by a thin silvery peridium that later flakes away to expose a black semi-agglutinated spore mass.

Spores large, flattened, in plane view suborbicular to broadly ellipsoid, rounded, or slightly angular, 18–27(–30) × 13–23(–25) μm, in side view 10–13 μm thick, reddish brown; spore wall evenly thickened, 1.0–2.0 μm thick, usually with shallow internal swellings; surface minutely or moderately verruculose, warts 0.1–0.5 μm high, often partly confluent, forming short rows or small groups. Spore germination unknown.

G. Wistrand s.n.; UME 952111; Sweden

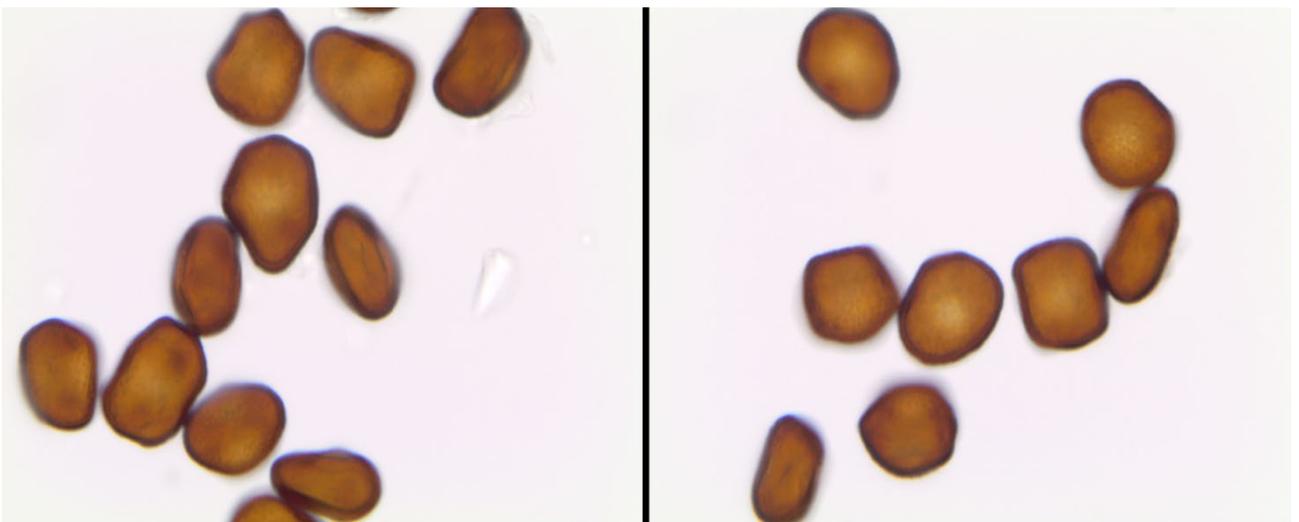
Habitats and host plants

Fens and peat bogs.

Cyperaceae: *Carex* sect. *Paniceae*: *C. laxa*.

Distribution

Eurasian alpine; type 9; found in the Scandinavian Mts. (NO, SE, FI). Common in the north of Sweden and Finland; with only one locality in Norway (Finnmark).



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea limosae T. Vánky & K. Vánky, Ustilaginales 384; SOMF 17872; Sweden

Anthracoidea limosae (Syd.) Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as ovoid or broadly ellipsoid hard bodies, 2.0–3.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores large, slightly flattened, in plane view suborbicular, broadly ellipsoid, slightly irregular, or ovoid, $18.5\text{--}31\text{--}(34) \times 16.5\text{--}25.5\text{--}(27) \mu\text{m}$, in side view $12\text{--}20 \mu\text{m}$ thick, medium or dark reddish brown; spore wall slightly unevenly thickened, $(1.0\text{--})1.2\text{--}2.0\text{--}(2.5) \mu\text{m}$ thick, without internal swellings, light-refractive areas, or protuberances, minutely to moderately verruculose, spore profile not affected or slightly affected, warts $0.1\text{--}0.5 \mu\text{m}$ high, partly confluent, forming short rows or small groups. Spore germination of the *Proceres*-type, resulting in a two-celled basidium, $250\text{--}350 \mu\text{m}$ long; producing cylindrical straight or slightly curved basidiospores, $32\text{--}104 \times 3\text{--}7 \mu\text{m}$.

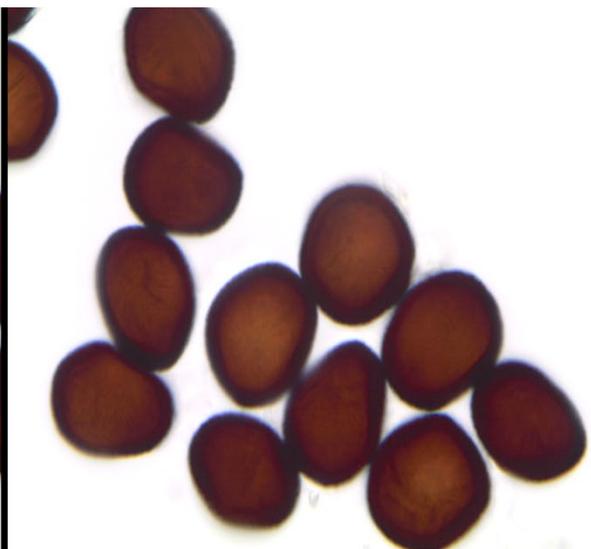
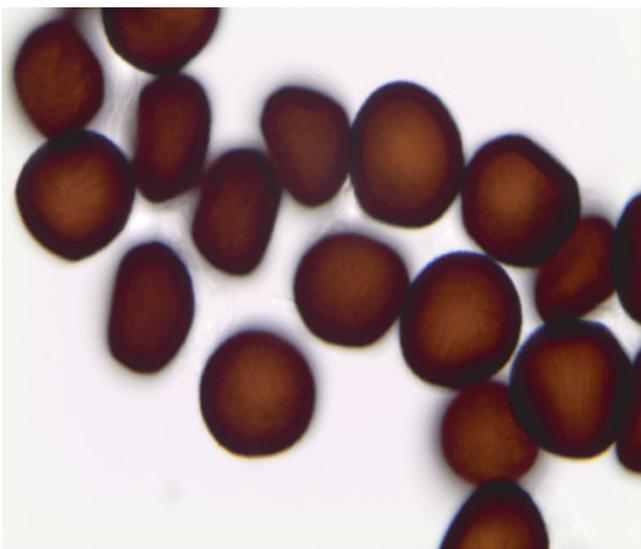
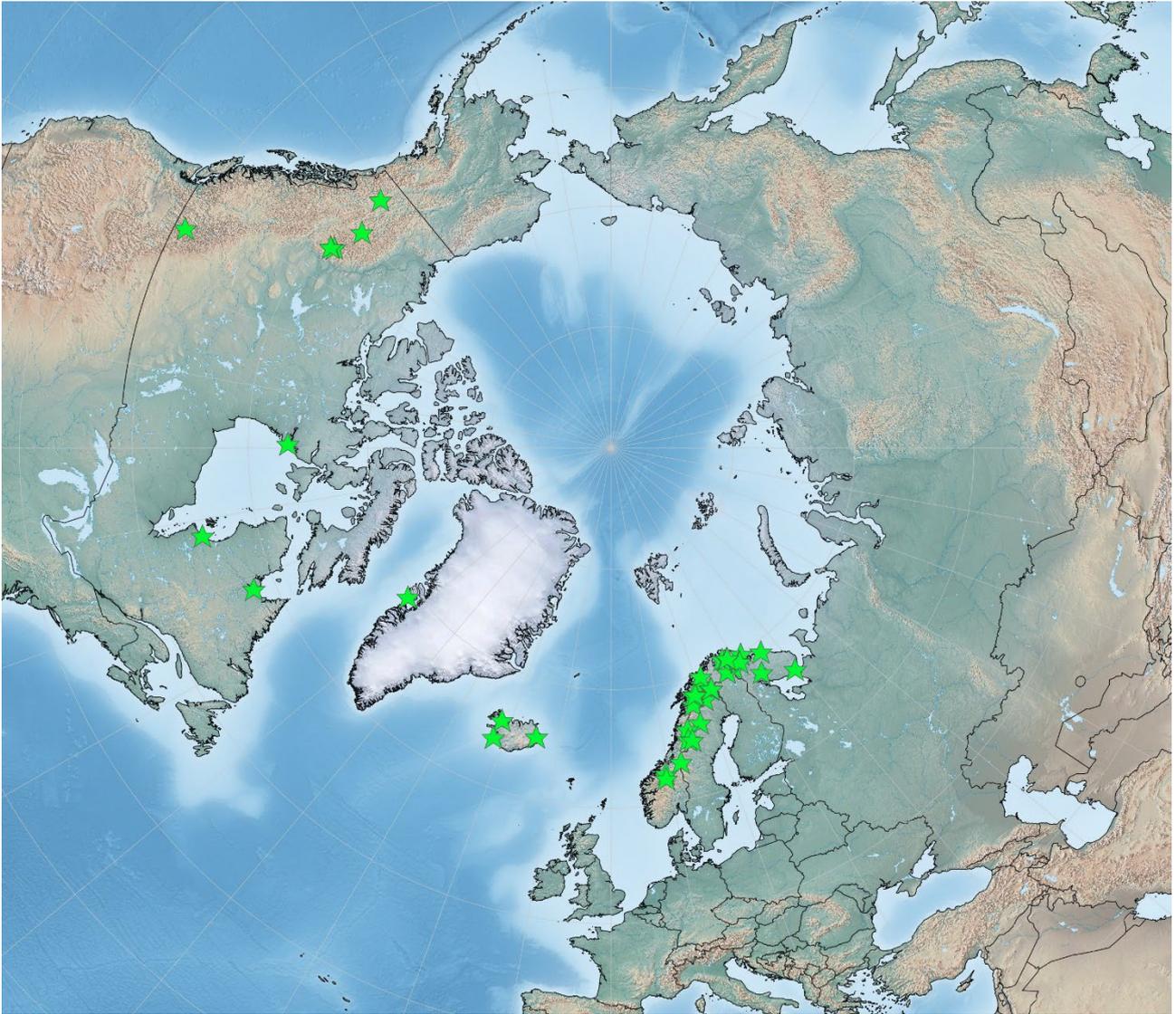
Habitats and host plants

Sphagnum bogs, marshes, wet meadows, streambanks; wet tundra; shores.

Cyperaceae: *Carex* sect. *Limosae*: *Carex limosa*, *Carex magellanica* subsp. *irrigua*, *Carex rariflora*, and hybrids between some of these species.

Distribution

Arctic-alpine; type 1; found in arctic Canada (NU, QC), Greenland, Iceland, and Russia, and in the Alaska-Yukon Ranges (CAN: YT, NT), the Rocky Mts. (CAN: BC), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), and Mt. Vuoggoaiv and the Khibiny Mts. (RU). Rather common in the north of Fennoscandia.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea lindebergiae

K. Vánky, Ustilaginales 216; SOMF 17856; Sweden

Anthracoidea lindebergiae (Kukkonen) Kukkonen

Syn: *Cintractia lindebergiae* Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose to ovoid hard bodies, 0.5–1.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small, flattened, in plane view suborbicular, orbicular, ovoid, or broadly ellipsoid, sometimes slightly irregularly rounded, (14.5–)15.5–20(–21) × (13.5–)14–17.5(–18.5) μm, in side view 9–12.5 μm thick, medium or dark reddish brown; spore wall evenly or slightly unevenly thickened, 1.0–1.8(–2.0) μm thick, without internal swellings, light-refractive areas, or protuberances, minutely verruculose, warts up to 0.2(–0.3) μm high, spore profile not affected or very slightly affected. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium, 100–150 μm long, producing 1–3 basidiospores on each cell; basidiospores cylindrical or narrowly ellipsoid, ovoid or obovoid, 8–16 × 3.5–6 μm.

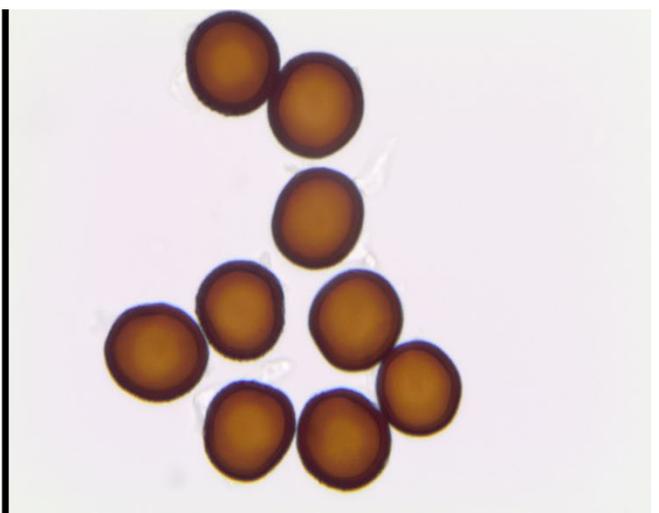
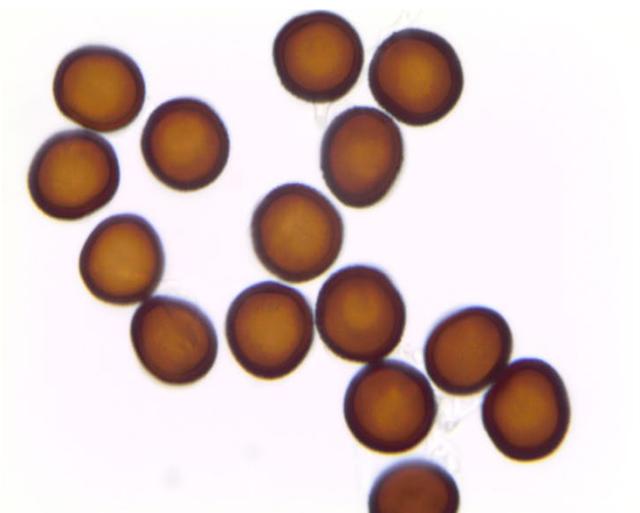
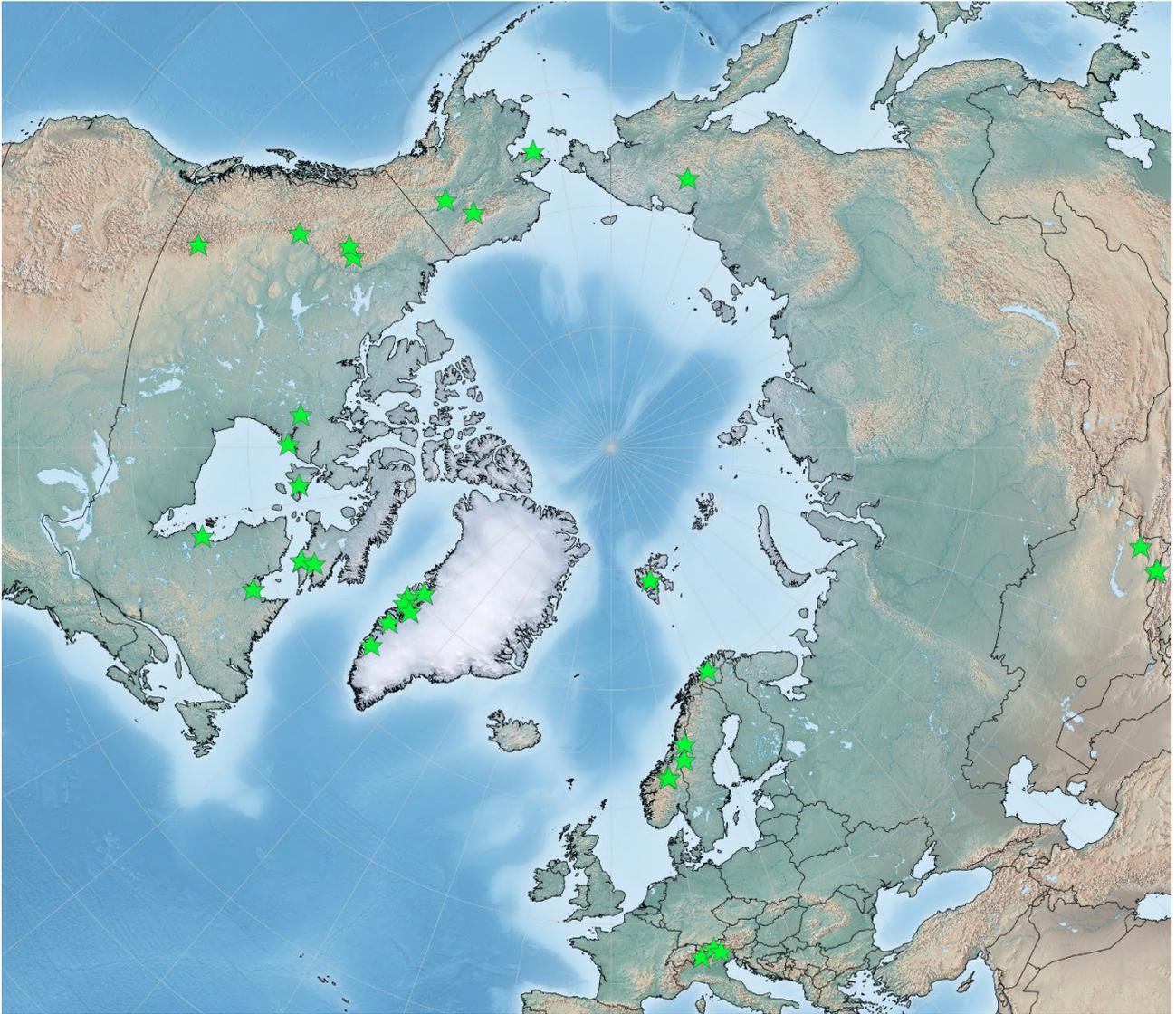
Habitats and host plants

Fens, marshes, margins of ponds, river terraces, mesic to wet tundra, rocky slopes; seashores; subalpine and alpine meadows.

Cyperaceae: Kobresia Clade of *Carex*: in the arctic-alpine region *Carex alatauensis* (*Kobresia humilis*), *C. kokanica* (*K. royleana*, *K. stenocarpa*), and *Carex simpliciuscula* (principal host).

Distribution

Arctic-alpine; type 1; found in arctic AK, CAN (NU, QC), GR, Svalbard, and RU, and in the alpine Alaska-Yukon Ranges (AK; and CAN: NT), the Rocky Mts. (CAN: BC, AB), the Scandinavian Mts. (NO, SE), Dovre (NO), the Alps (CH, AT, IT), the Anyuy Range (RU), and Tian Shan (KZ). Probably common in arctic Canada; rarely recorded from the Alaska-Yukon Ranges and Canadian Rocky Mts; common in West Greenland; in Norway restricted mainly to Dovre; in Sweden restricted to the central western mountains; very rare in the Alps.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea liroi

J. A. Nannfeldt 16632; UPS F-142865; Finland

Anthracoidea liroi (Lehtola) Nannf. & B. Lindeb.

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose to ovoid hard bodies, 1.0–1.5 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized to large, flattened, in plane view irregularly rounded, suborbicular, broadly ellipsoid, subpolygonal, or ovoid, (17–)19–25(–28) × (15–)17–23(–26) μm, in side view 12–15.5 μm thick, dark reddish brown; spore wall slightly unevenly thickened, 1.0–1.7(–2.0) μm thick, often with 1–2 internal swellings, without light-refractive areas or protuberances, minutely verruculose, spore profile not affected, sometimes very slightly affected, warts up to 0.2(–0.3) μm high, often partly confluent. Spore germination of the *Proceres*-type, resulting in a two-celled basidium, producing narrowly cylindrical basidiospores, straight or slightly curved and very long (mean 55 × 5.6 μm).

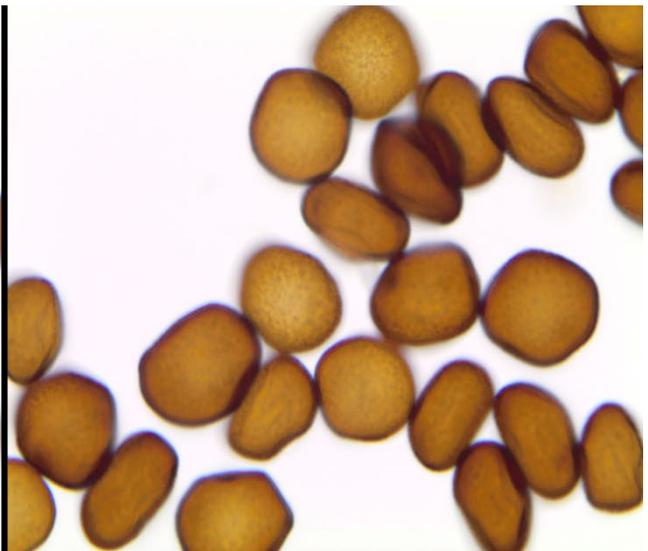
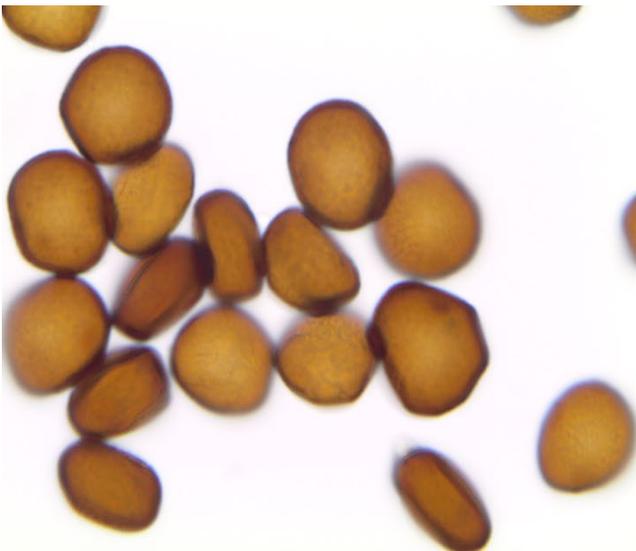
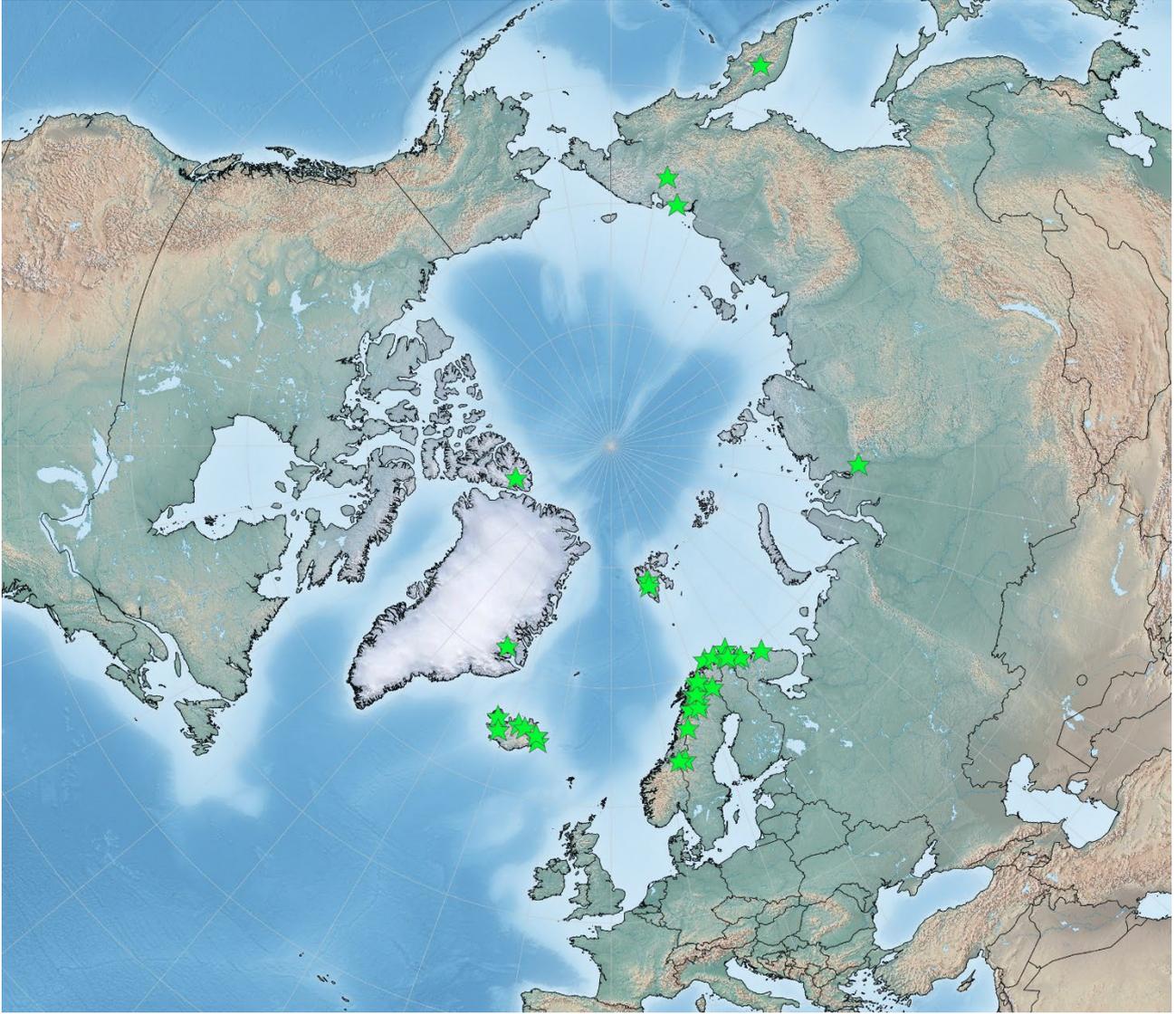
Habitats and host plants

Fens and shallow water, damp meadows, riversides; saline shores, salt marshes, gravelly seashores.

Cyperaceae: *Carex* sect. *Stylosae*: *Carex schmidtii*; *Carex* sect. *Phacocystis*: in the arctic-alpine region *Carex aquatilis*, *Carex bigelowii* subsp. *lugens*, *Carex cespitosa*, *Carex concolor*, *Carex lyngbyei*, *Carex nigra* including subsp. *juncea* (*Carex nigra* subsp. *juncella*), *Carex salina* (*Carex lanceata*), and *Carex subspathacea*.

Distribution

North American arctic–Eurasian; type 4; found in arctic CAN (NU), GR, IS, Svalbard, NO, and RU, and in the alpine Scandinavian Mts. (NO, SE, FI) and Kamchatka (RU). Common in Iceland and the north of Fennoscandia.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea misandrae

L. Ericson 287/04; UME 39640; Sweden

Anthracoidea misandrae Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose, ovoid or broadly ellipsoid hard bodies, 1.0–1.5 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view suborbicular, broadly ellipsoid, irregularly rounded, or ovoid, $17\text{--}26 \times 13\text{--}23 \mu\text{m}$, in side view $10\text{--}14.5 \mu\text{m}$ thick, medium or dark reddish brown; spore wall usually evenly thickened, $1.0\text{--}2.0\text{--}(2.5) \mu\text{m}$ thick, without internal swellings, light-refractive areas, or protuberances, minutely to moderately verruculose (occasionally verrucose), warts up to $0.5\text{--}(0.6) \mu\text{m}$ high, sometimes partly fused, forming short rows or small groups, spore profile affected; often with remnants of a hyaline sheath on the flattened sides. Spore germination unknown.

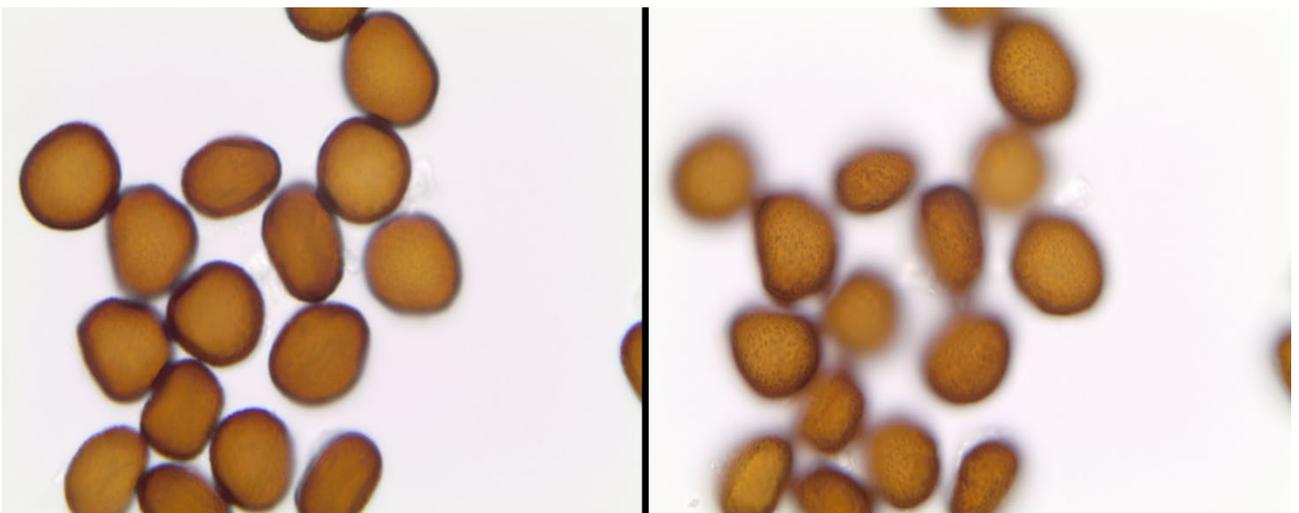
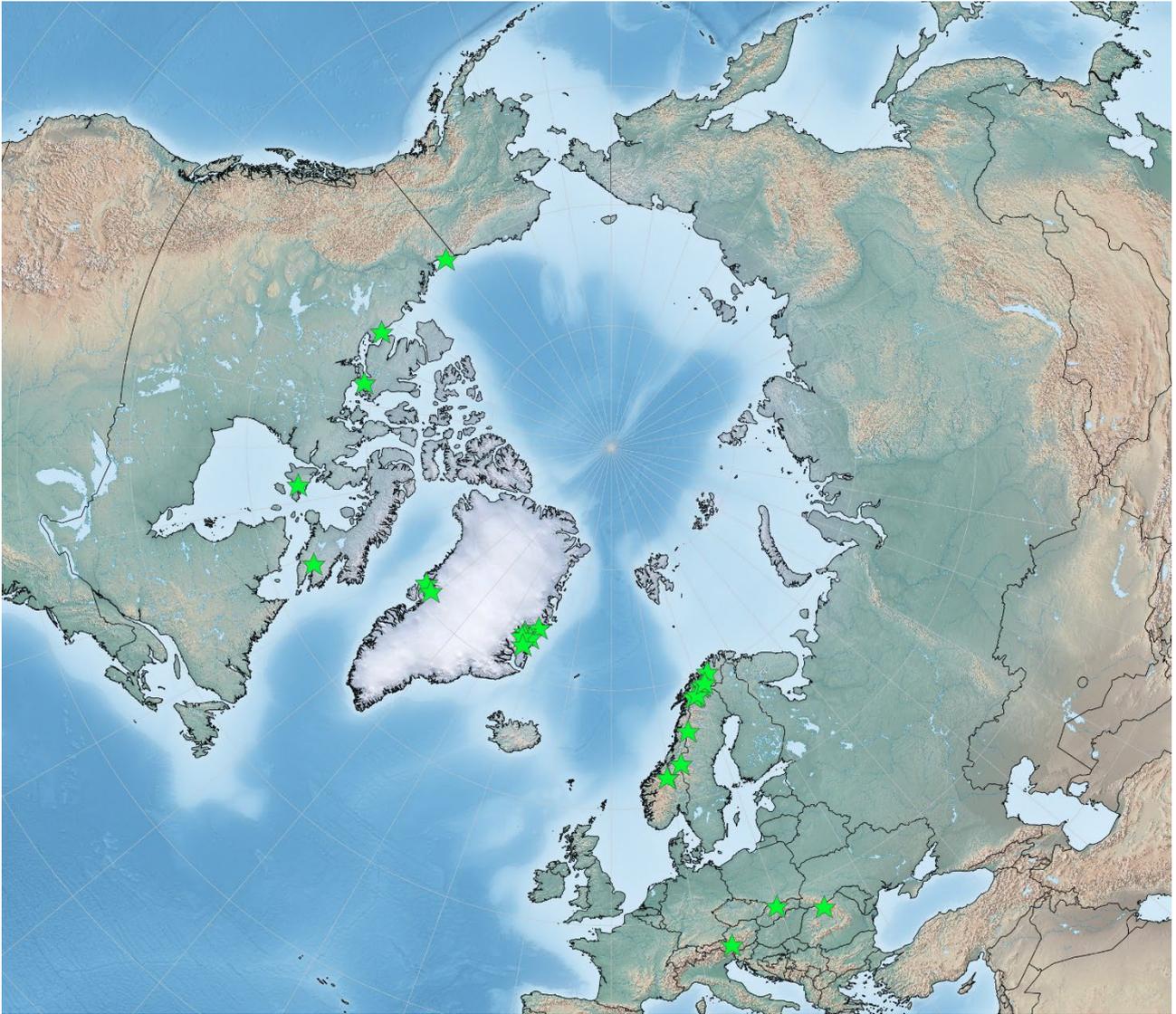
Habitats and host plants

Alpine-subalpine and arctic grasslands; sedge meadows, moist shores.

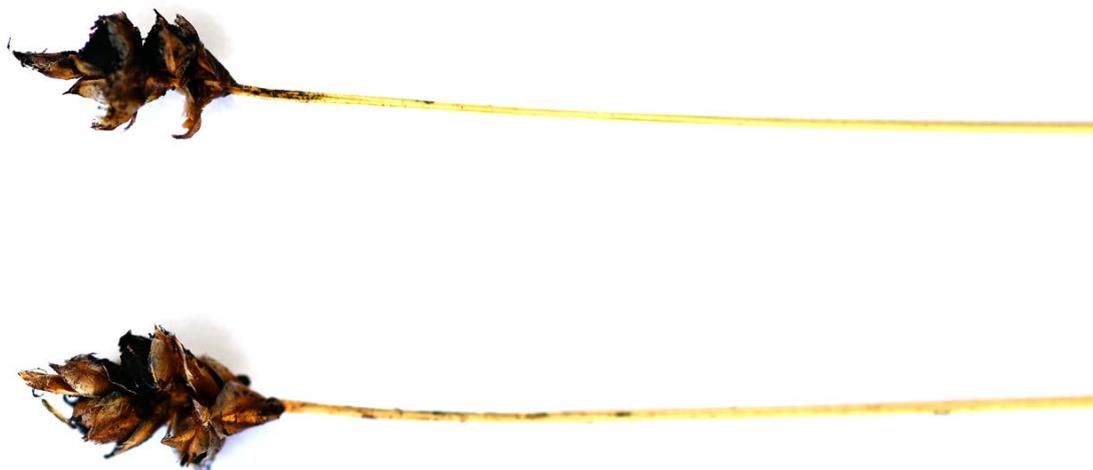
Cyperaceae: *Carex*: in the arctic-alpine region, in *Carex* sect. *Chartotecthium*: *Carex atrofusca* (principal host); in the Fuliginosa Clade: *Carex fuliginosa* subsp. *fuliginosa* and *C. fuliginosa* subsp. *misandra* (principal host).

Distribution

North American arctic–Eurasian alpine; type 10; found in arctic CAN (NU, YT, NT) and GR, and in the alpine Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Alps (AT), the Tatras (SK), and the Carpathians (RO). This fungus is common in the Canadian Arctic, Greenland, and the Scandinavian Mts, but very rarely reported from the Alps, the Tatras, and the Carpathians.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea nardinae

SAE-88.214-GR; C-F-107989

Anthracoidea nardinae (Kukkonen) Nannf.

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose or ovoid hard bodies, 1.0–2.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view suborbicular, slightly irregular, broadly ellipsoid, orbicular, or ovoid, (16–)17–22(–23) × (15–)16–19.5(–20.5) μm, in side view 10–14.5 μm thick, medium or dark reddish brown; spore wall slightly unevenly thickened, (1.0–)1.2–1.8(–2.2) μm thick, often with 1–3 internal swellings, light-refractive areas and protuberances absent, smooth. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium, 100–125 μm long, producing 1–3 basidiospores on each cell; basidiospores subglobose to ellipsoid or ovoid to obovoid, 7–15 × 4–8 μm.

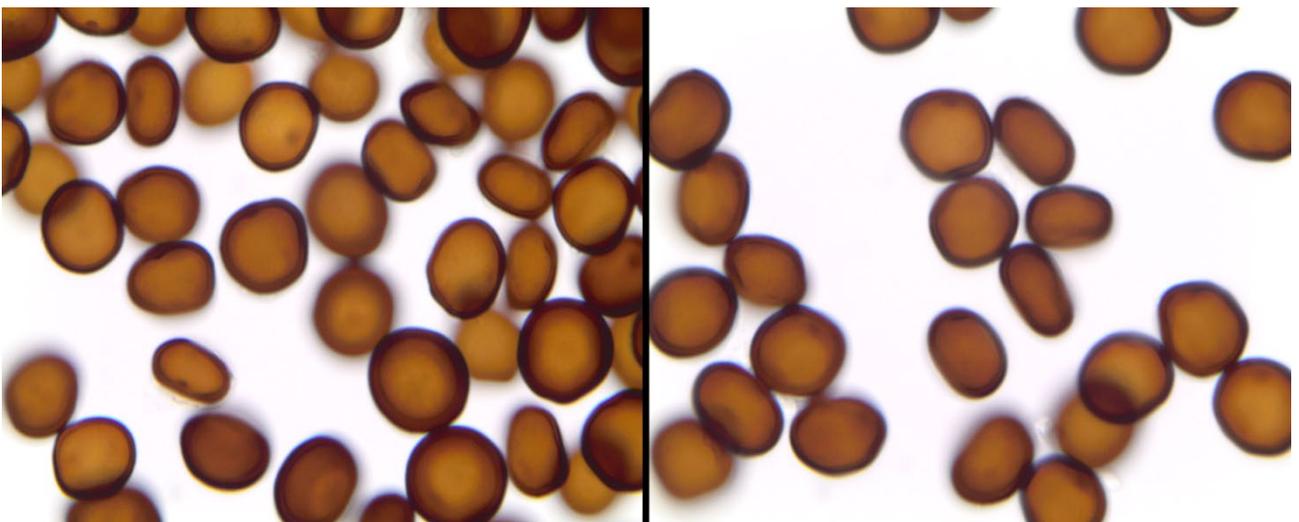
Habitats and host plants

Arctic and alpine tundra, cliffs; meadows; stony places in the mountains, ridges, and summits.

Cyperaceae: *Carex* sect. *Filifoliae*: *Carex elynoides*; and in the Capitata Clade: *Carex nardina* subsp. *nardina* and *Carex nardina* subsp. *hepburnii*.

Distribution

Arctic-alpine; type 1; found in arctic Canada (NU, QC), Greenland, and Svalbard, and in the alpine Rocky Mts. (USA: WY, CO), and the Scandinavian Mts. (NO). In Greenland common, from other parts of the study area very rarely reported.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea obtusatae

B. Martins & M. Schnittler 2468; SOMF 30400; Russia

Anthracoidea obtusatae T. Denchev, Denchev, Begerow & Kemler

Infection local. **Sori** in some female flowers, occurring around aborted nuts as ovoid or ellipsoid hard bodies, 1.3–2.5 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small, flattened, in plane view irregularly rounded, suborbicular, broadly ellipsoid, ellipsoid, or ovoid, (12.5–)13.5–19(–20) × (10.5–)11.5–15.5(–17) μm, in side view 12–14.5 μm thick, medium to dark reddish brown; spore wall unevenly thickened, 0.8–2.0(–2.3) μm thick, with 1–3(–4) visible internal swellings, light-refractive areas and protuberances absent, smooth. Spore germination unknown.

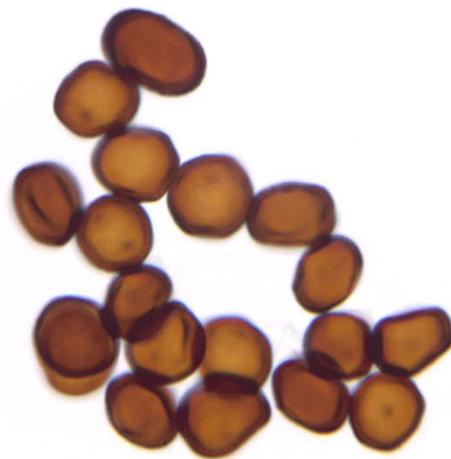
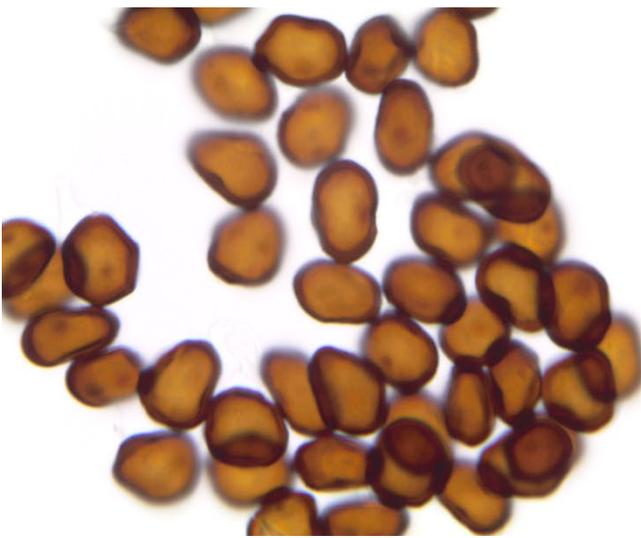
Habitats and host plants

Dry grasslands in high mountains.

Cyperaceae: Capitata Clade of *Carex*: *Carex obtusata*.

Distribution

Eurasian alpine; type 15; found in alpine regions of the Altai Mts. (RU, MN) and Tian Shan (KZ). Very rarely reported.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea paniceae K. Vánky et al., Ustilaginales 503; SOMF 18760; Switzerland

Anthracoidea paniceae Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as ovoid or ellipsoid hard bodies, 2.0–3.0 mm long, initially covered by a thin peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores large, slightly flattened, in plane view slightly irregular, broadly ellipsoid, or suborbicular, sometimes slightly angular, 18–27(–30) × 14–24 μm, in side view 11–14 μm thick, medium to dark reddish brown; spore wall uneven, 1.0–3.0 μm wide, internal swellings 1–3, sometimes hardly visible, light-refractive areas absent, minutely verruculose, warts up to 0.3 μm high, often confluent, forming small groups or short rows. Spore germination of the *Proceres*-type, resulting in a 2-celled basidium, 200–300 μm long; basidiospores cylindrical, rod-shaped, straight or slightly curved, rounded at the ends, 30–100 × 2–6 μm.

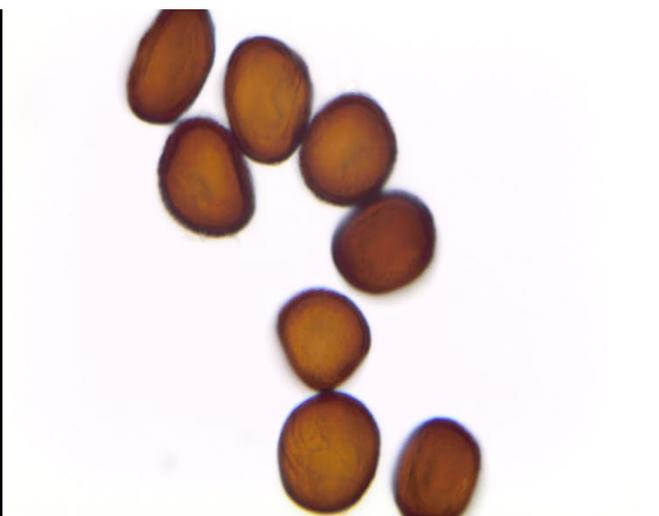
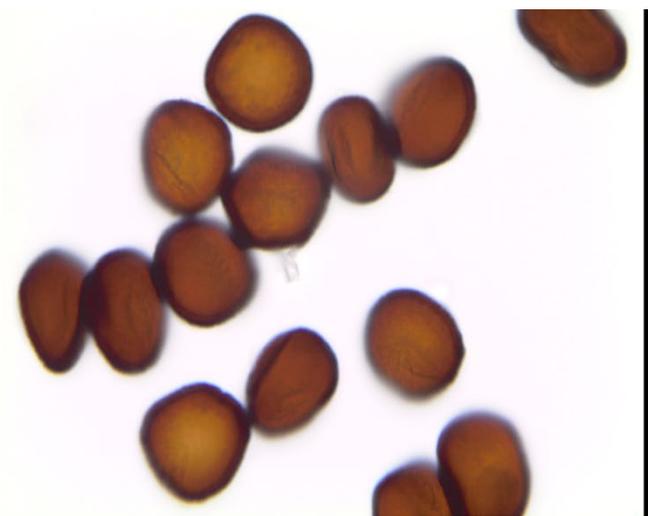
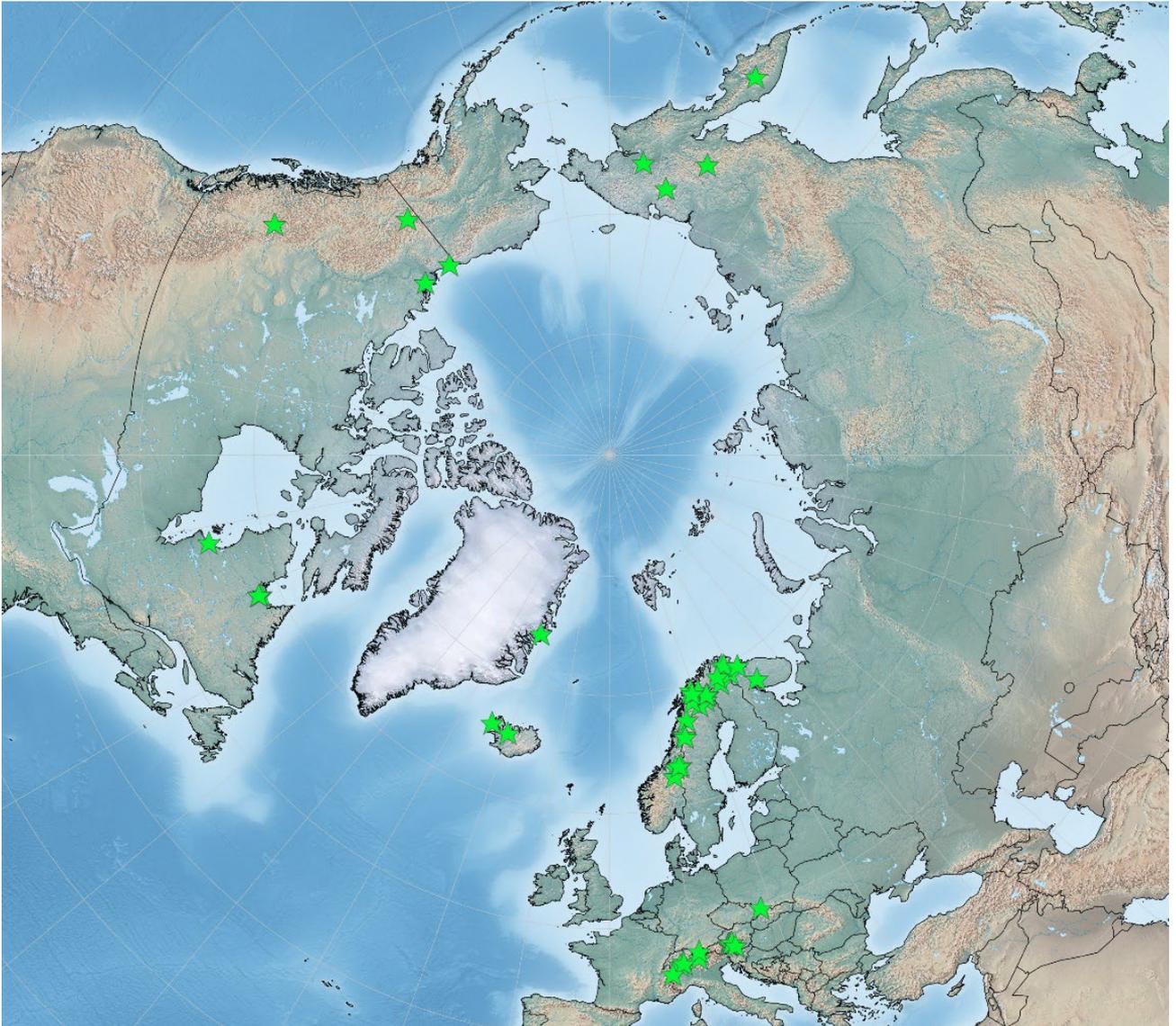
Habitats and host plants

Fens, marshes, damp grassland.

Cyperaceae: Capitata Clade of *Carex*: in the arctic-alpine region *Carex bicolor*, *C. livida*, *C. panicea* (principal host), *C. vaginata* var. *vaginata* (*C. quasivaginata*, principal host), and *C. vaginata* var. *petersii* (*C. falcata*).

Distribution

Arctic-alpine; type 1; found in arctic CAN (NT, QC), GR, IS, and RU, and in the alpine Alaska-Yukon Ranges (CAN: YT), the Intermountain West (CAN: BC), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Khibiny Mts. (RU), the Alps (CH, AU, IT), and Tatras (CZ), and the Kolyma Highlands and Kamchatka (RU). Rather common in the north of Fennoscandia and in Scotland. In Central Europe (the Alps, Tatras, and Carpathians) it is a montane to subalpine fungus.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea pratensis

Anthracoidea pratensis (Syd.) Boidol & Poelt

Cintractia pratensis Syd.

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose, ovoid, or broadly ellipsoid hard bodies, 2.0–3.0 mm long, initially covered by a thin peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores large, flattened, in plane view suborbicular, broadly ellipsoid, angular, or slightly irregular, often with protuberances, $18\text{--}31 \times 17\text{--}25\text{--}(27)$ μm , in side view $13\text{--}15$ μm thick, dark reddish brown; spore wall unevenly thickened, $1\text{--}4\text{--}(5)$ μm wide, thickest at the angles and protuberances, internal swellings low, 1 or 2, only rarely seen, light-refractive areas often present, minutely verruculose, warts up to 0.3 μm high, often partly confluent, forming short rows. Spore germination of the *Proceres*-type.

C. M. Denchev III-41; SOMF 18501; Bulgaria

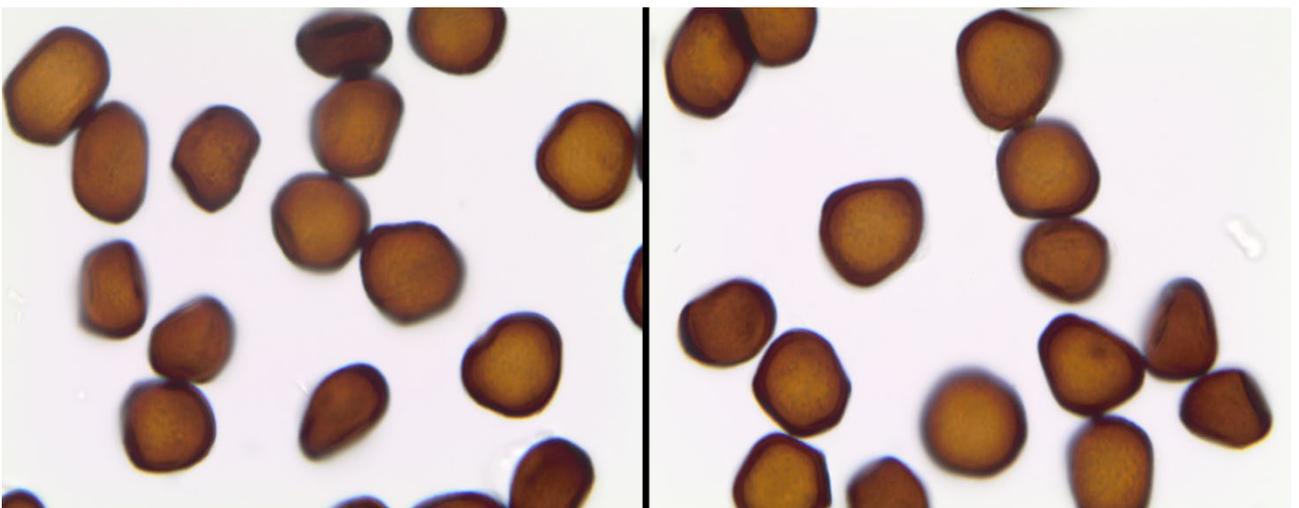
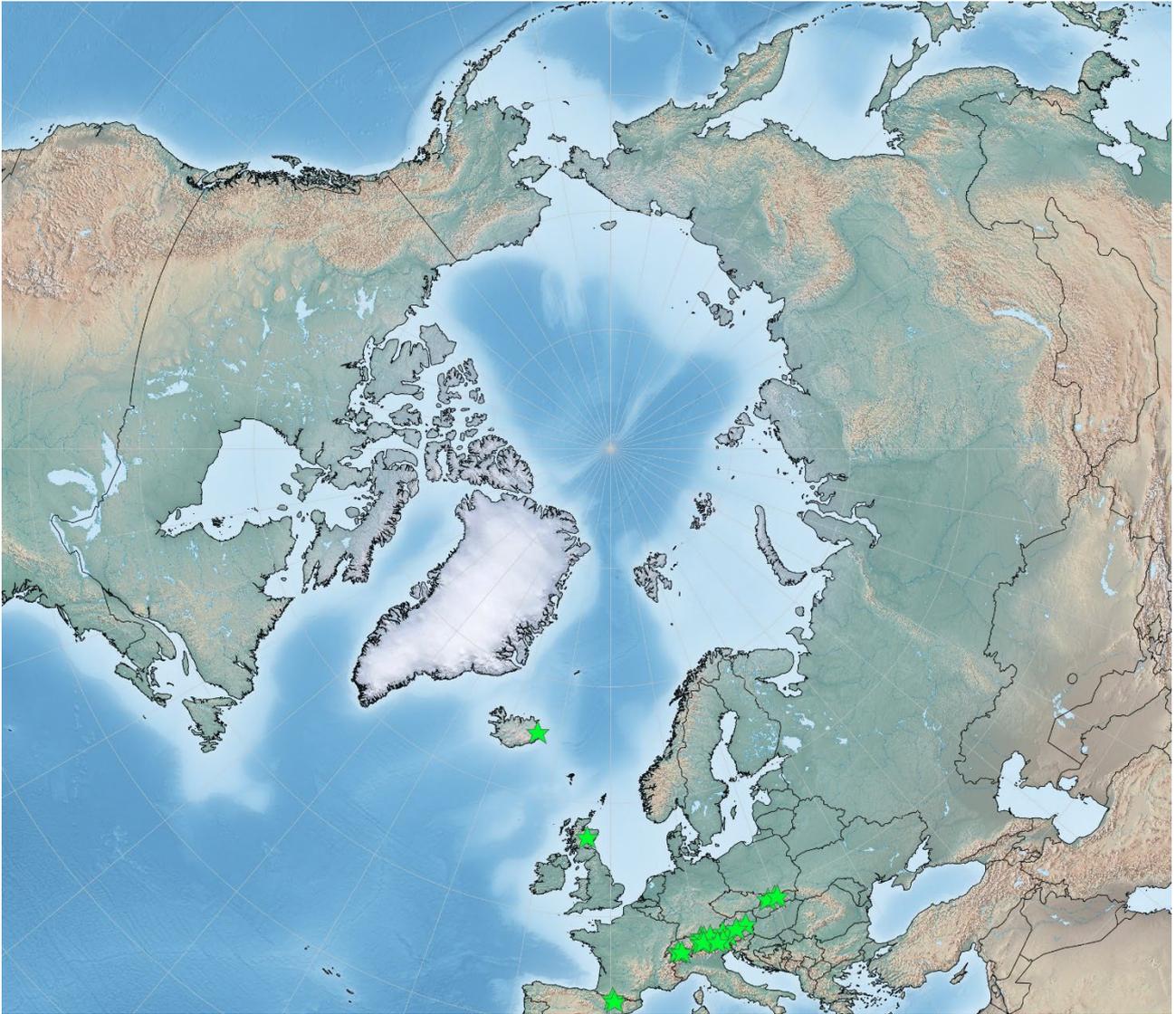
Habitats and host plants

Grasslands, meadows, wetland margins, disturbed habitats.

Cyperaceae: Flacca Clade of *Carex*: *C. flacca*.

Distribution

Eurasian; type 9; found in arctic Iceland, and in alpine regions of the Alps (DE, CH, AU, IT), the Tatras (PL, SK), and the Pyrenees (ES). Since it occurs in Iceland and the Alps, this species is included in the scope of this book, even though it is better classified as subalpine, boreal and temperate. In southeastern Europe, it is a common lowland species.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea pseudofetidae

L. Martins 2476; B 10 0240205; Russia

Anthracoidea pseudofetidae L. Guo

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose, ovoid or broadly ellipsoid hard bodies, 0.7–1.7 mm long, initially covered by a thick dark brown peridium that later flakes away to expose a blackish brown spore mass, powdery on the surface.

Spores very small, irregularly rounded, subglobose, broadly ellipsoid, ovoid or ellipsoid, (8.5–)9.5–11.5(–12.5) × (8–)8.5–10.5(–11.5) μm, medium reddish brown; spore wall unevenly thickened, 0.9–1.5 μm thick, with a few paler, rounded areas with thinner wall (0.5–0.9 μm thick), without internal swellings, light-refractive areas, or protuberances, minutely verruculose-echinulate, ornaments up to 0.15 μm high, usually solitary and sparsely spaced, occasionally partly confluent, forming short rows or small groups, spore profile not affected. Spore germination unknown.

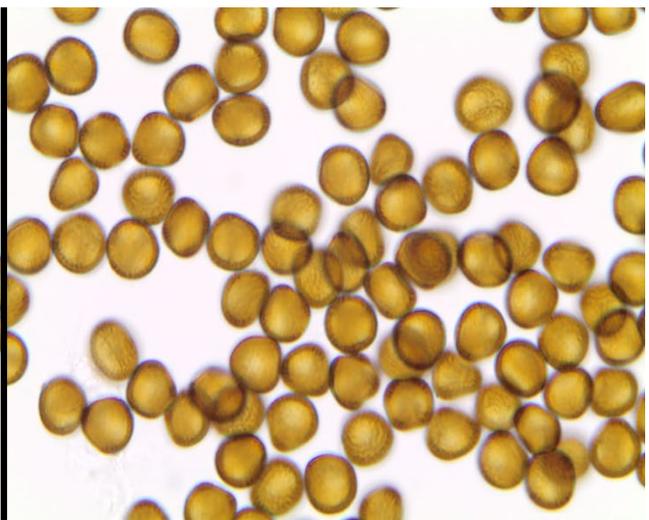
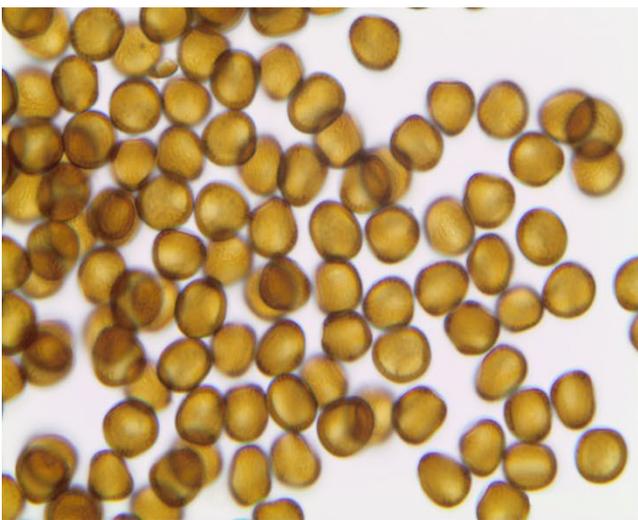
Habitats and host plants

Near coastal beaches and ocean shores (*Carex maritima*) or sedge meadows (*C. enervis*).

Cyperaceae: Disticha Clade of *Carex*: in the arctic-alpine region, *Carex enervis* and *Carex maritima*.

Distribution

North American arctic–Eurasian alpine; type 10; found in arctic Greenland, and in alpine regions of the Altai Mts. (Russia). A very rare species.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea pulicaris

L. Ericson 190/05; UME 39443; Sweden

Anthracoidea pulicaris Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as ovoid or broadly ellipsoid black hard bodies, 2.0–2.5 mm long, powdery on the surface, partly enclosed by the longitudinally splitting utricles.

Spores medium-sized, flattened, in plane view irregular, occasionally suborbicular to ellipsoid, 17–24(–26) × 12–21 μm, dark reddish brown; spore wall 1.0–3.5 μm thick, thickest at the angles, often with light-refractive areas, internal swellings small, 1–3 or absent, minutely to moderately verruculose, warts 0.1–0.4 μm high, sometimes confluent, forming small groups or short rows, spore profile affected. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium, 100–150 μm long, producing several basidiospores on each cell; basidiospores ellipsoid, ovoid or obovoid, 4.5–11 × 2.5–4.5 μm.

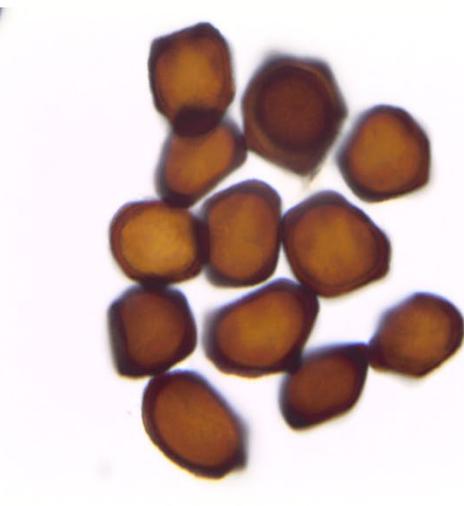
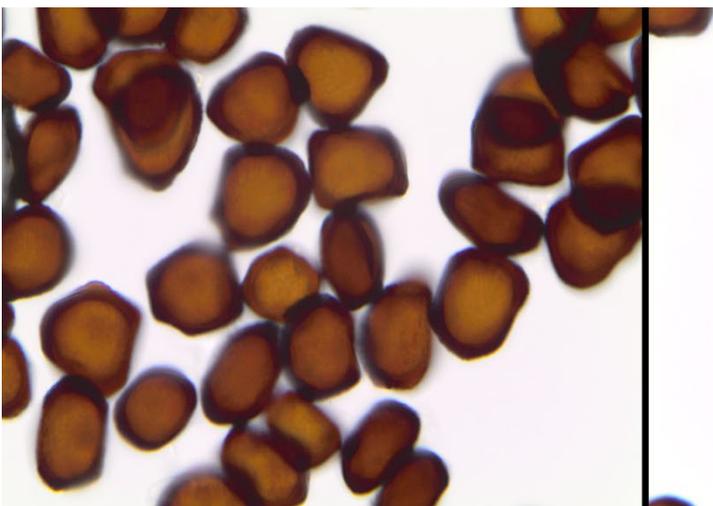
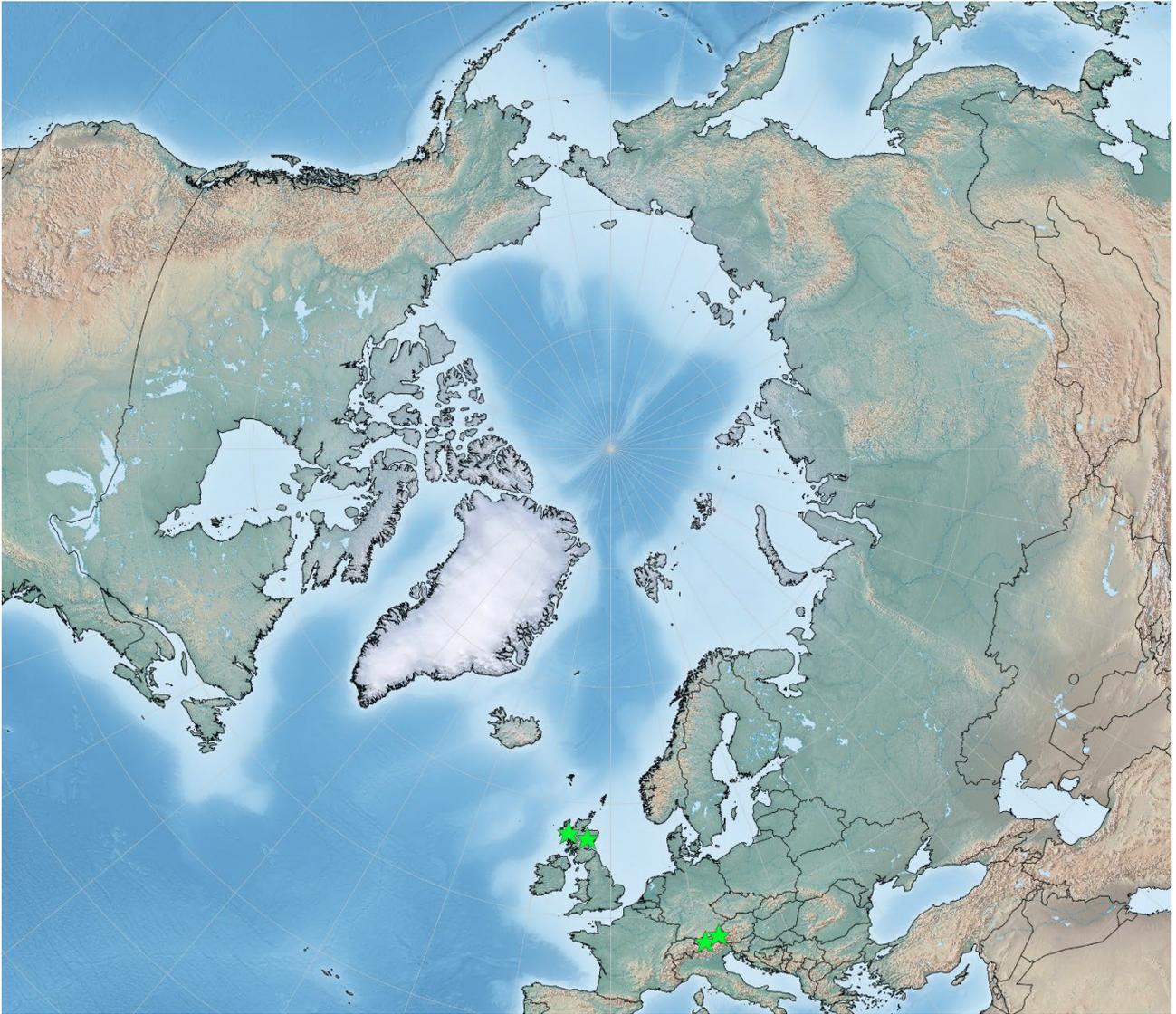
Habitats and host plants

Wet habitats (wet meadows, bogs, fens).

Cyperaceae: *Carex* sect. *Psyllophorae*: *Carex pulicaris*.

Distribution

Eurasian alpine; type 15; found in alpine regions of the Alps (AT). A rare species.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea rupestris

P. Alanko, Vánky Ustilaginales 807; SOMF 20852; Norway

Anthracoidea rupestris Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose or ovoid hard bodies, 1.2–2.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view usually irregularly rounded to angular, sometimes broadly ellipsoid or suborbicular, sometimes with a protuberance, (15.5–)17–23(–26) × (14–)15–20.5(–22) μm, in side view 10.5–14.5 μm thick, dark reddish brown; spore wall unevenly thickened, 1.0–3.0(–3.8) μm thick, thickest at the angles and protuberances, usually with 1–4 clearly visible internal swellings, light-refractive areas often present, minutely verruculose, warts up to 0.2(–0.3) μm high, spore profile not affected or very slightly affected, warts sometimes partly confluent, forming short rows or small groups. Spore germination of the

Anthracoidea-type, resulting in a two-celled basidium, 100–150 μm long, producing several basidiospores on each cell; basidiospores ellipsoid, ovoid, or obovoid, 5–12 × 3–6 μm.

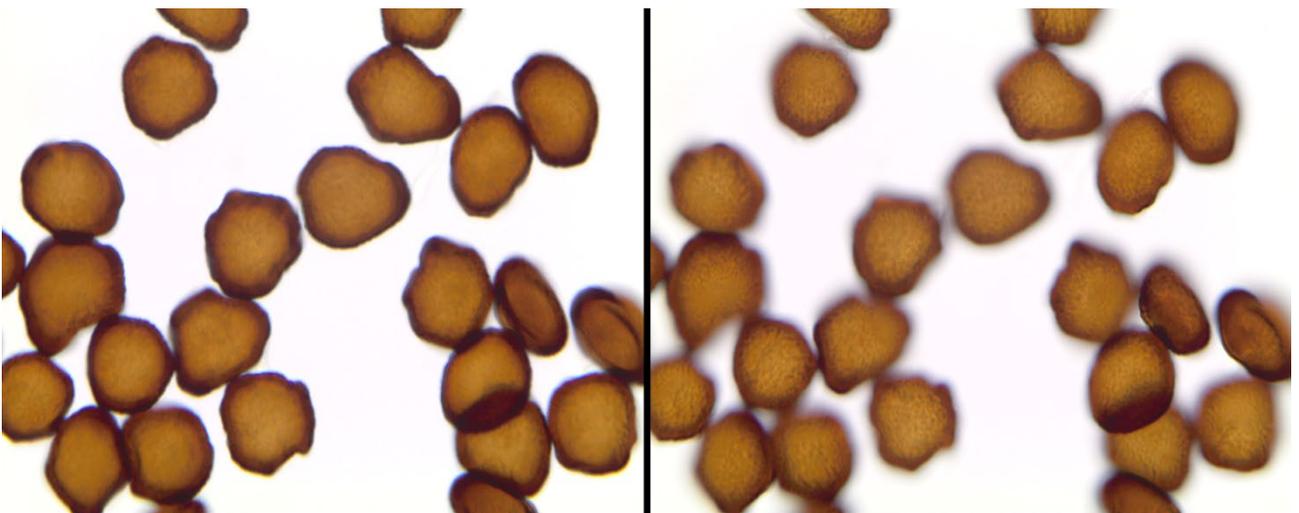
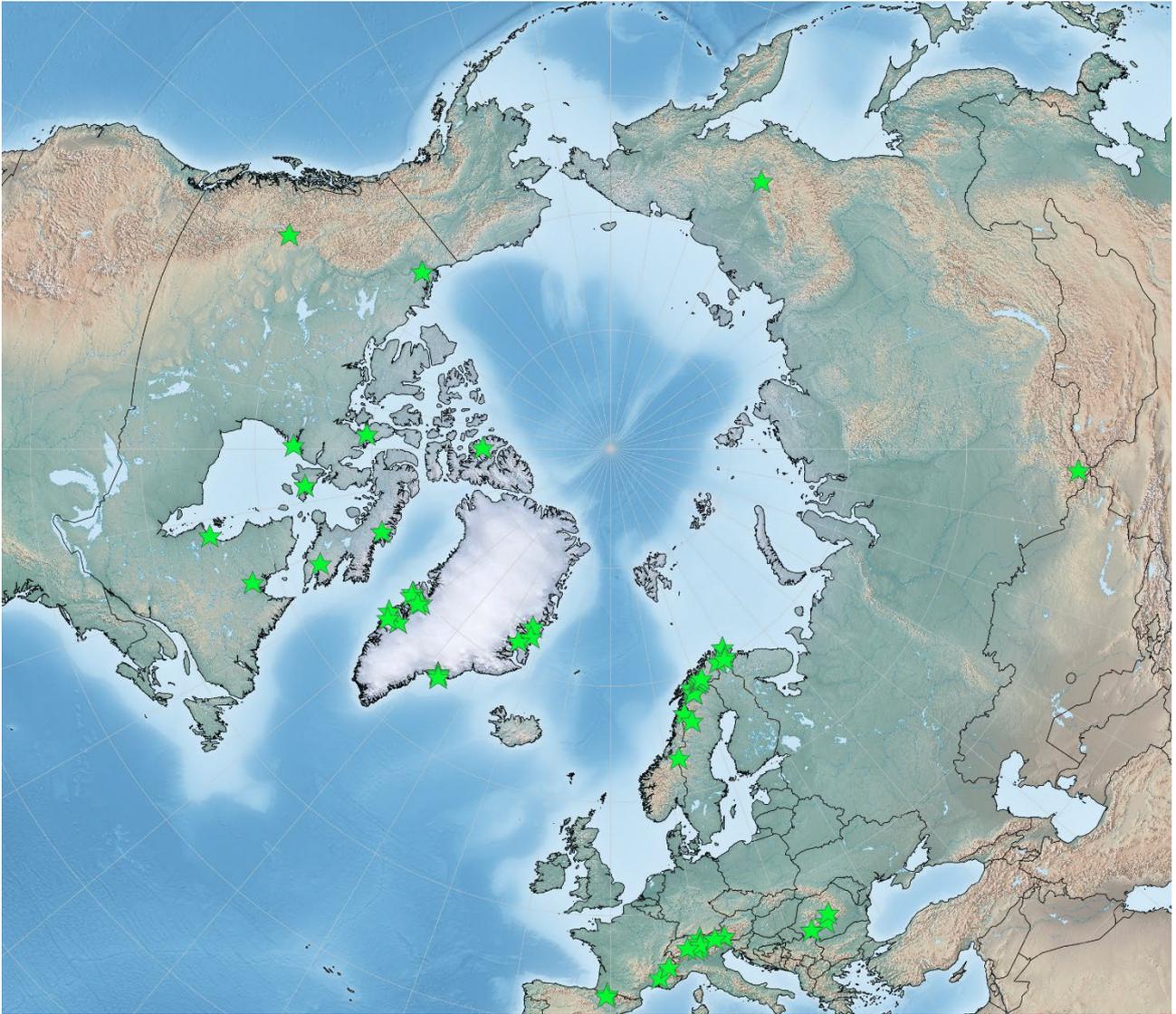
Habitats and host plants

Dry rocky and stony places; alpine grasslands.

Cyperaceae: Capitata Clade of *Carex*: *Carex rupestris*.

Distribution

Arctic-alpine; type 1; found in arctic CAN (NT, NU, QC), GR, and NO, and in the alpine Rocky Mts. (CAN: BC), the Scandinavian Mts. (NO, SE, FI), the Alps (DE, FR, CH, AT, IT), Carpathians (RO), Pyrenees (FR, ES), Altai Mts. (MN), and the Chersky Range (RU). Rather common in Arctic Canada and Greenland, and in the north of Norway, Sweden, and Finland.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea savilei

D. B. O. Savile 525; DAOM 28182; Canada (Quebec)

Anthracoidea savilei Denchev & T. Denchev

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose or broadly ellipsoid hard bodies, 1.2–1.7 mm long, initially covered by a thick dark brown peridium that later flakes away to expose a blackish brown spore mass, powdery on the surface.

Spores small, flattened, in plane view slightly irregular, subpolygonal, broadly ellipsoid, or suborbicular, (15–)16–21.5 × 12.5–19 μm, in side view 11–13 μm thick, medium reddish brown; spore wall unevenly thickened, 1.2–2.5 μm thick, thickest at the angles, with 1–3 sometimes conspicuous internal swellings, occasionally with light-refractive areas, minutely verruculose, warts up to 0.3 μm high, spore profile not or slightly affected, often covered by a gelatinous sheath. Spore germination unknown.

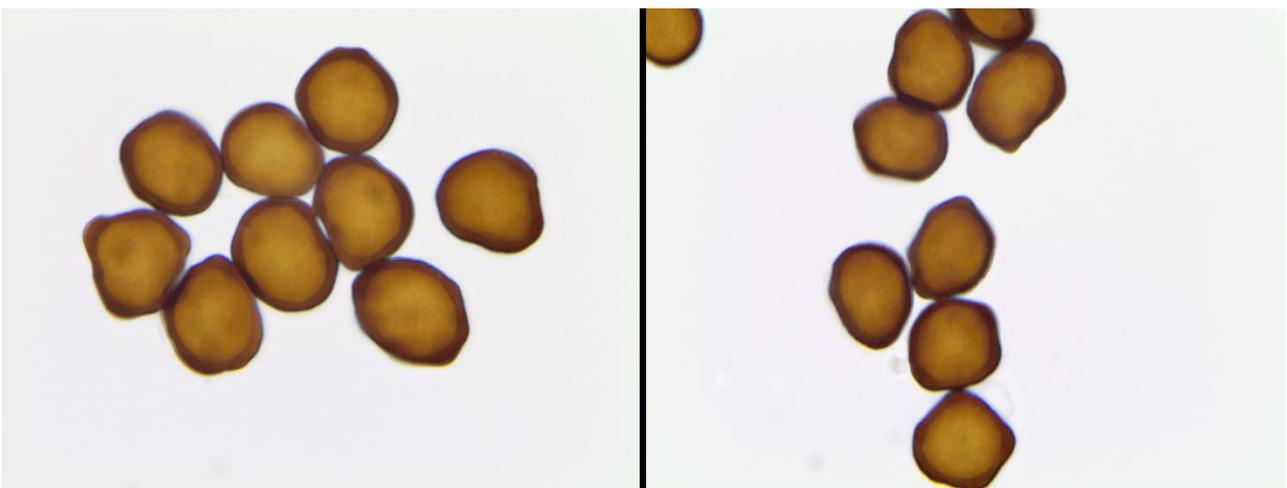
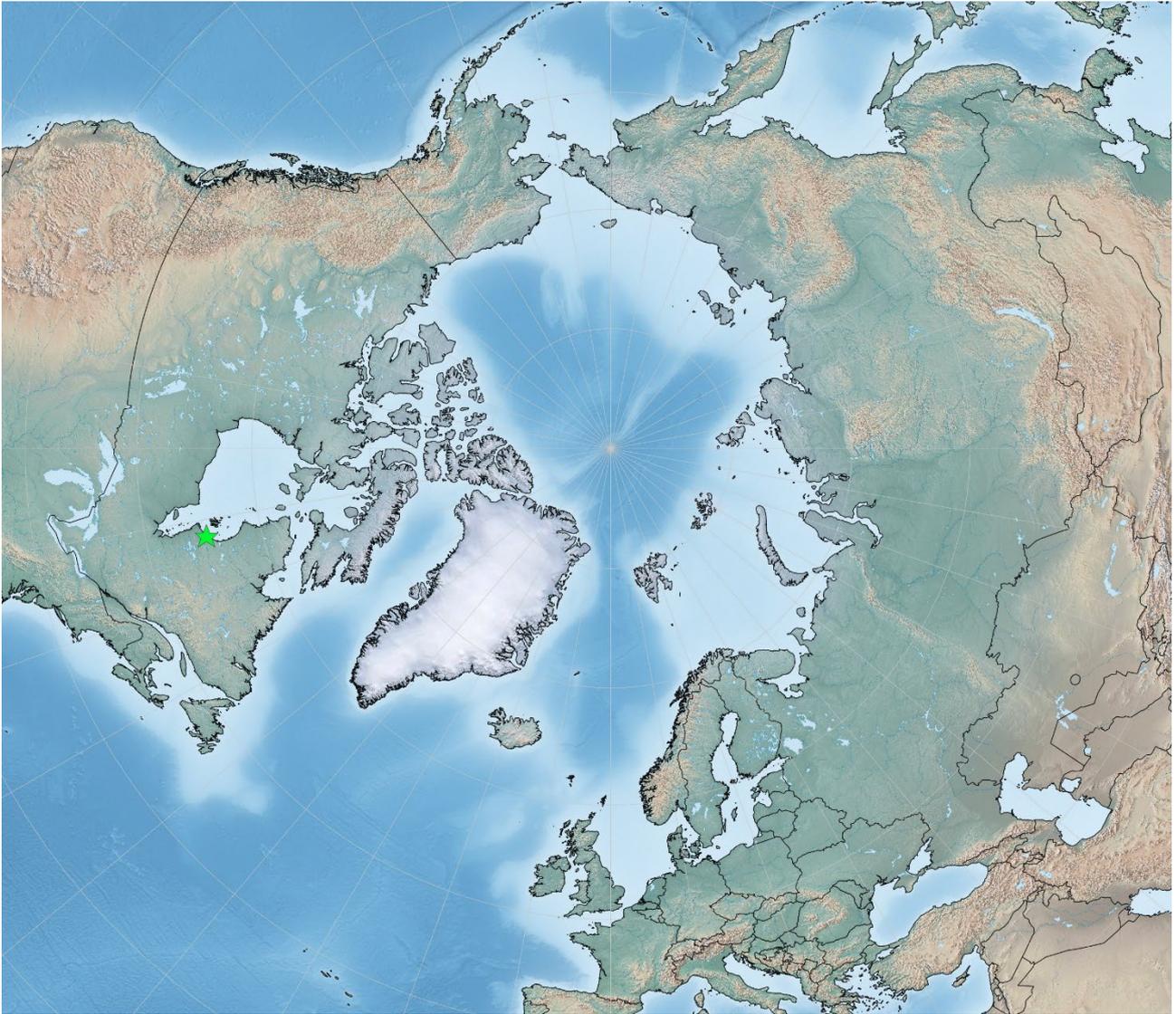
Habitats and host plants

Tundra; wet meadows, along streams, slopes.

Cyperaceae: *Carex* sect. *Racemosae*:
Carex norvegica.

Distribution

North American arctic; type 12; found in arctic Canada (Quebec). Only known from the type collection.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea scirpi

HK 18.312; C-F-111313

Anthracoidea scirpi (J.G. Kühn) Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as globose or subglobose hard bodies, 0.8–1.5 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view suborbicular, slightly irregular, broadly ellipsoid, orbicular, or ovoid, (17–)18–22(–23) × (15.5–)16.5–20(–21) μm, in side view 11–14 μm thick, medium or dark reddish brown; spore wall slightly unevenly thickened, (1.0–)1.2–2.0(–2.2) μm thick, without internal swellings, light-refractive areas, or protuberances, smooth. Spore germination of the *Anthracoidea*-type, resulting in a two-celled basidium, 60–120 μm long; basidiospores lacrymiform, ovoid or obovoid, 14–27(–29) × 3.5–7(–9) μm.

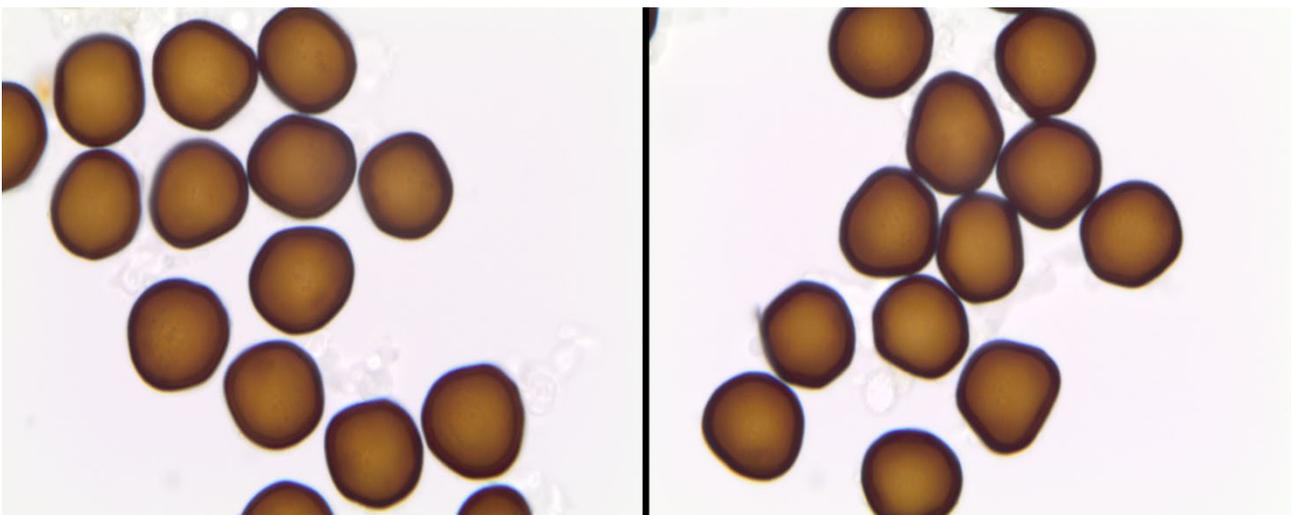
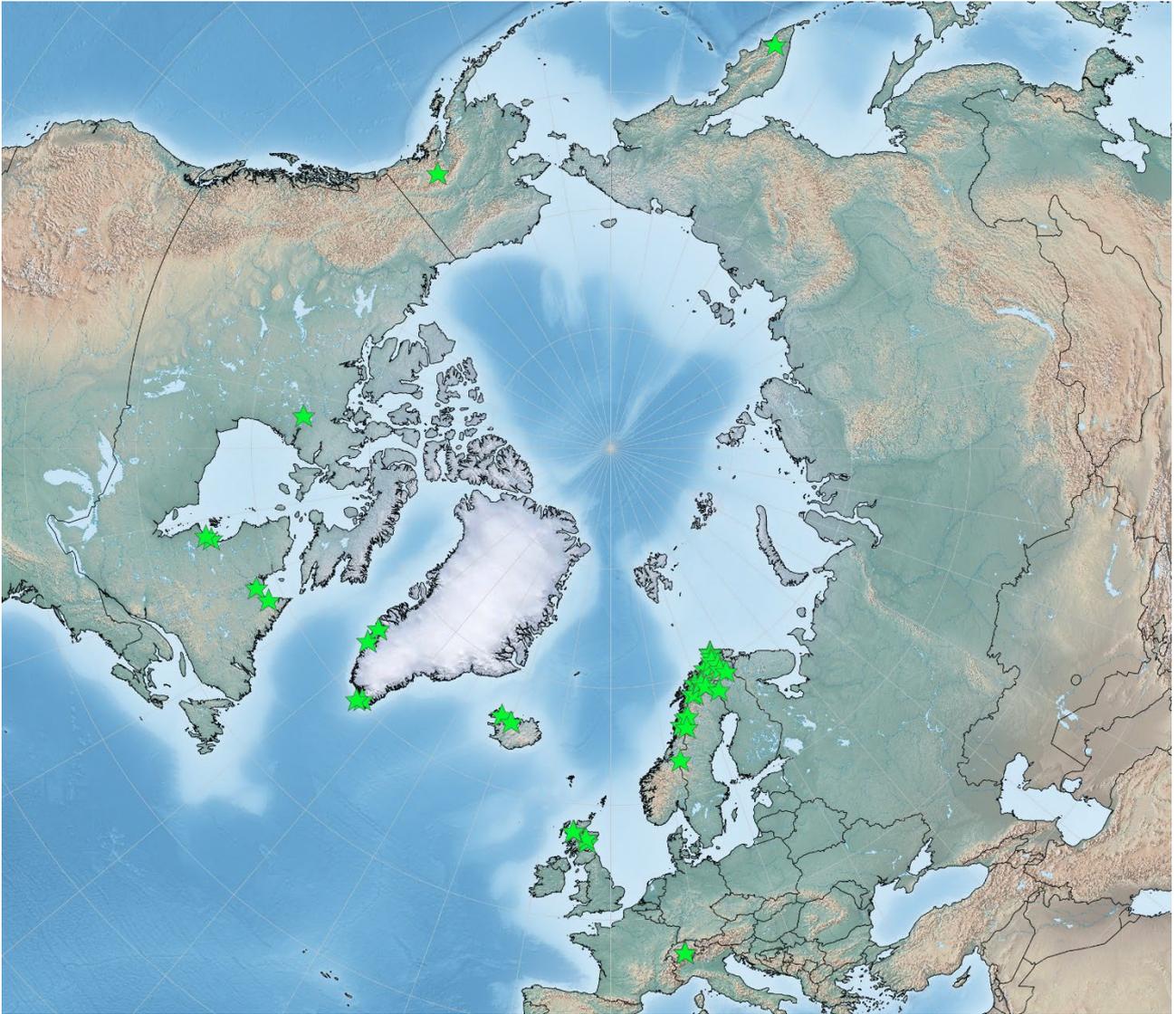
Habitats and host plants

Tundra; open, wet, rocky or peaty meadows, fens, bogs, riverbanks; shores; damp peaty places in high mountains.

Cyperaceae: *Trichophorum cespitosum*.

Distribution

Arctic-alpine; type 1; found in arctic CAN (NU, QC), GR, IS, and NO, and in the alpine Alaska-Yukon Ranges (AK), the Scandinavian Mts. (NO, SE, FI), the Khibiny Mts. (RU), the Alps (CH), and Kamchatka (RU). Common in the north of Norway, Sweden, and Finland. Very rarely reported from the Alps, Russia, and North America.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea scirpoidea

E. Léveillé-Bourret 919; SOMF; Canada (Quebec)

Anthracoidea scirpoidea Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose hard bodies, ca. 1.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized to large, flattened, in plane view suborbicular, broadly ellipsoid, slightly irregularly rounded, or ovoid, (18–)19–26(–27) × (16.5–)17.5–22(–23.5) μm, in side view 13–15.5 μm thick, often with a hyaline sheath on the flattened sides, medium or dark reddish brown; spore wall evenly or slightly unevenly thickened, 1.3–2.4(–2.8) μm thick, often with 1–3(–4) internal swellings, light-refractive areas and protuberances absent, minutely verruculose, warts up to 0.2(–0.3) μm high, spore profile not affected or sometimes very slightly affected, warts usually isolated, sometimes partly confluent, forming short rows or small groups. Spore germination of the *Proceres*-type, resulting in a two-celled

basidium, 225–300 μm long, producing cylindrical straight or slightly curved basidiospores, 28–64(–72) × 3.4–6.4 μm.

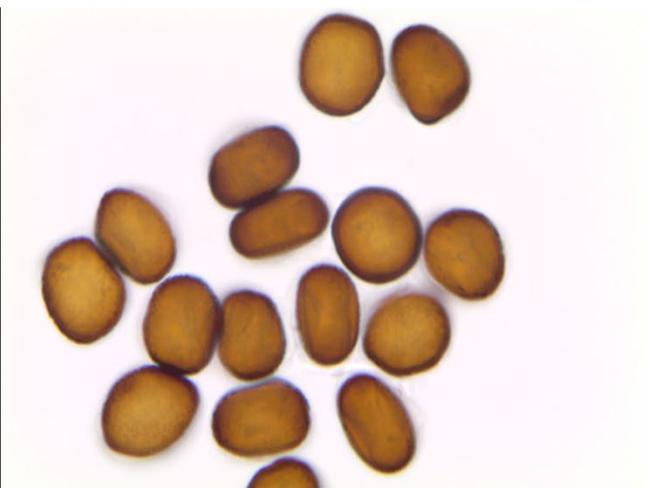
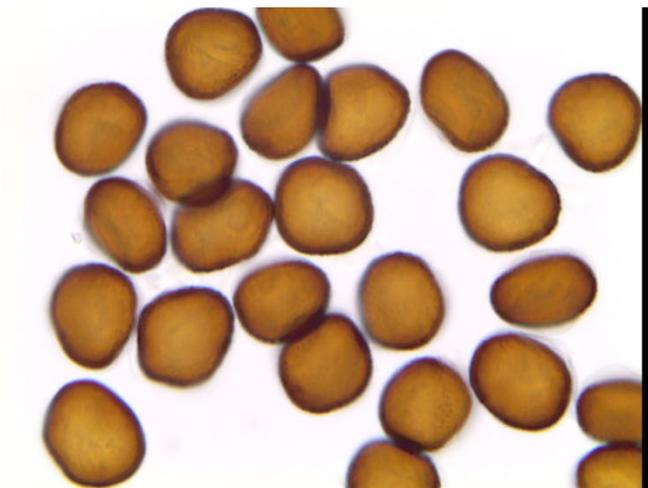
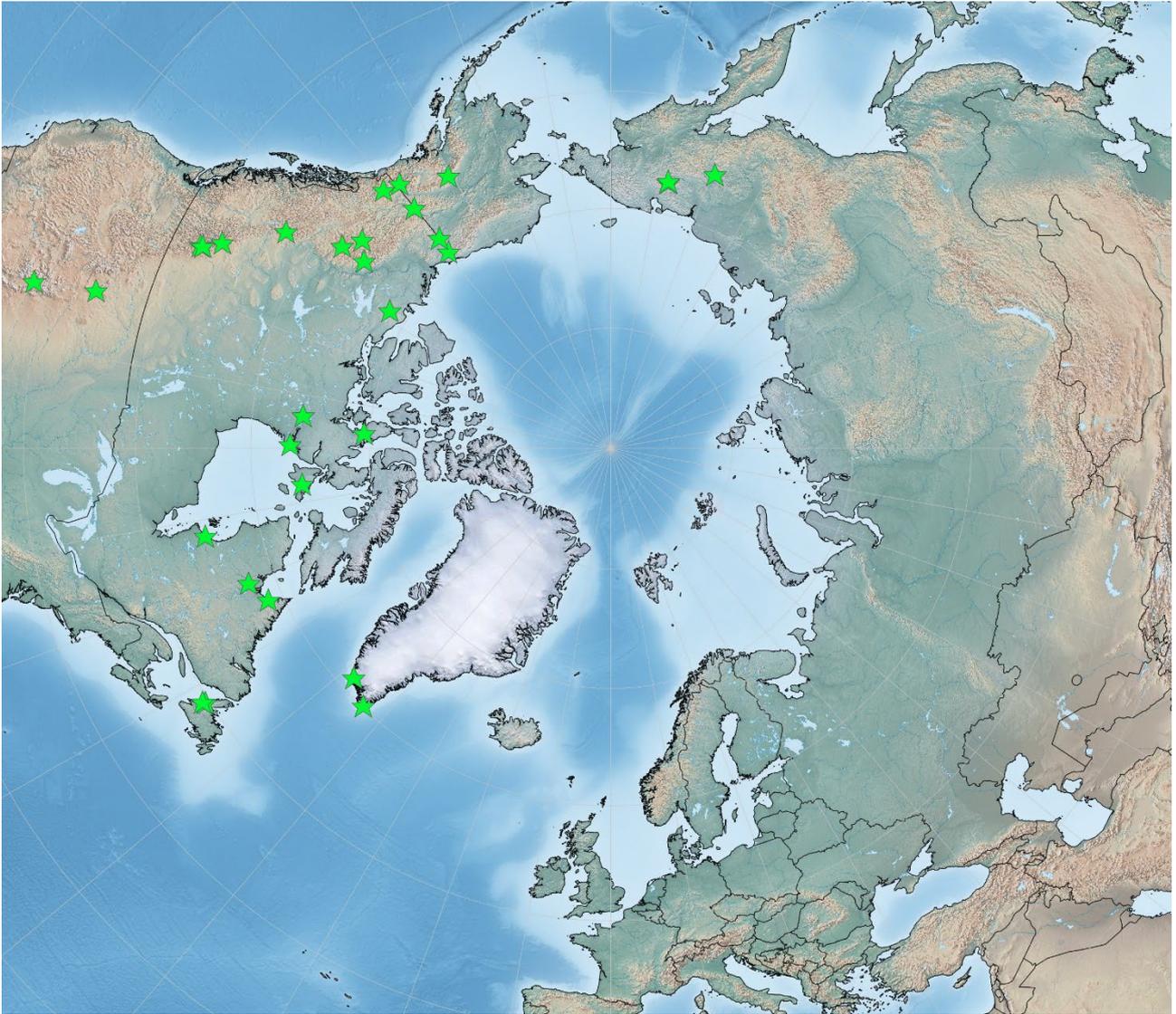
Habitats and host plants

Commonly found in dry tundra; alpine meadows, occasionally in wet meadows along streams, river terraces, lakeshores, seashores.

Cyperaceae: *Carex* sect. *Scirpinae*: *Carex scirpoidea*.

Distribution

Arctic-alpine; type 3; found in arctic CAN (NU, QC), GR, and RU, and in the alpine Alaska-Yukon Ranges (AK; and CAN: YT), the Melville Hills (CAN: NT), the Rocky Mts. (CAN: BC, AB; and US: WY, CO), Newfoundland (CAN), and the Kolyma Highlands (RU). Common in Canada; very rarely reported from the USA, Greenland, and Russia.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea sempervirentis

Anthracoidea sempervirentis Vánky

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose, ovoid, broadly ellipsoid, or ellipsoid hard bodies, 1.8–3.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized, flattened, in plane view irregularly rounded, irregularly polygonal, broadly ellipsoid, suborbicular, or ovoid, sometimes with a protuberance, (16–)18–25(–27.5) × (14–)15.5–20(–22.5) μm, in side view 10–14.5(–15.5) μm thick, dark reddish brown; spore wall distinctly unevenly thickened, (1.2–)1.4–3.8(–4.6) μm thick, thickest at the angles and protuberances, sometimes with 1(–2) internal swellings, light-refractive areas present, minutely to moderately verruculose, warts up to 0.3(–0.5) μm high, spore profile slightly affected, warts often partly confluent, forming short rows or small groups. Spore germination unknown.

T. T. Denchev 16103: SOMF 31427; Austria

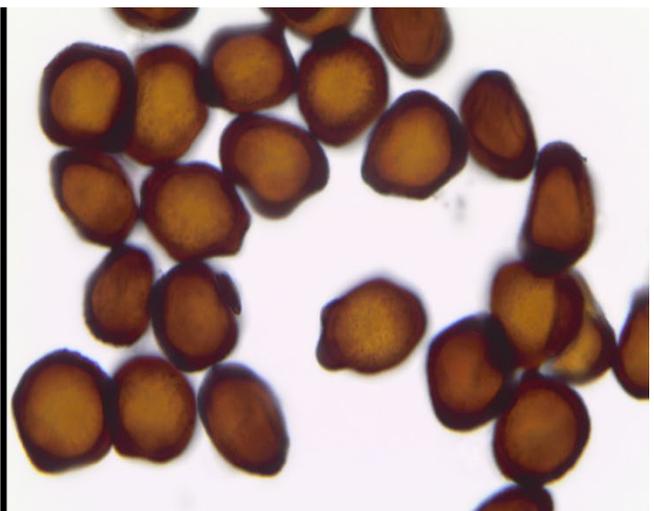
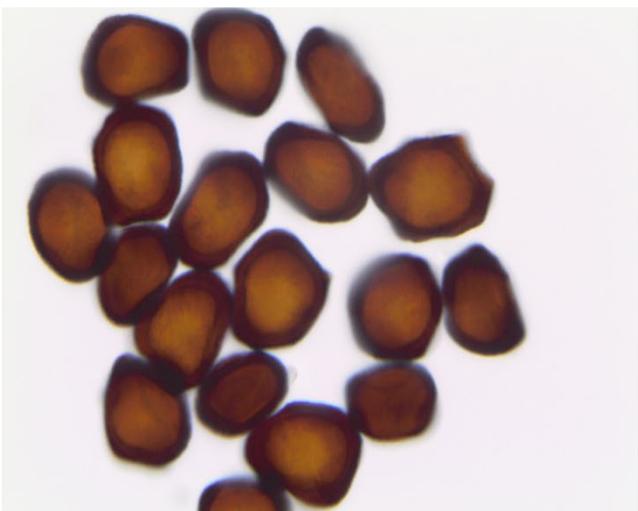
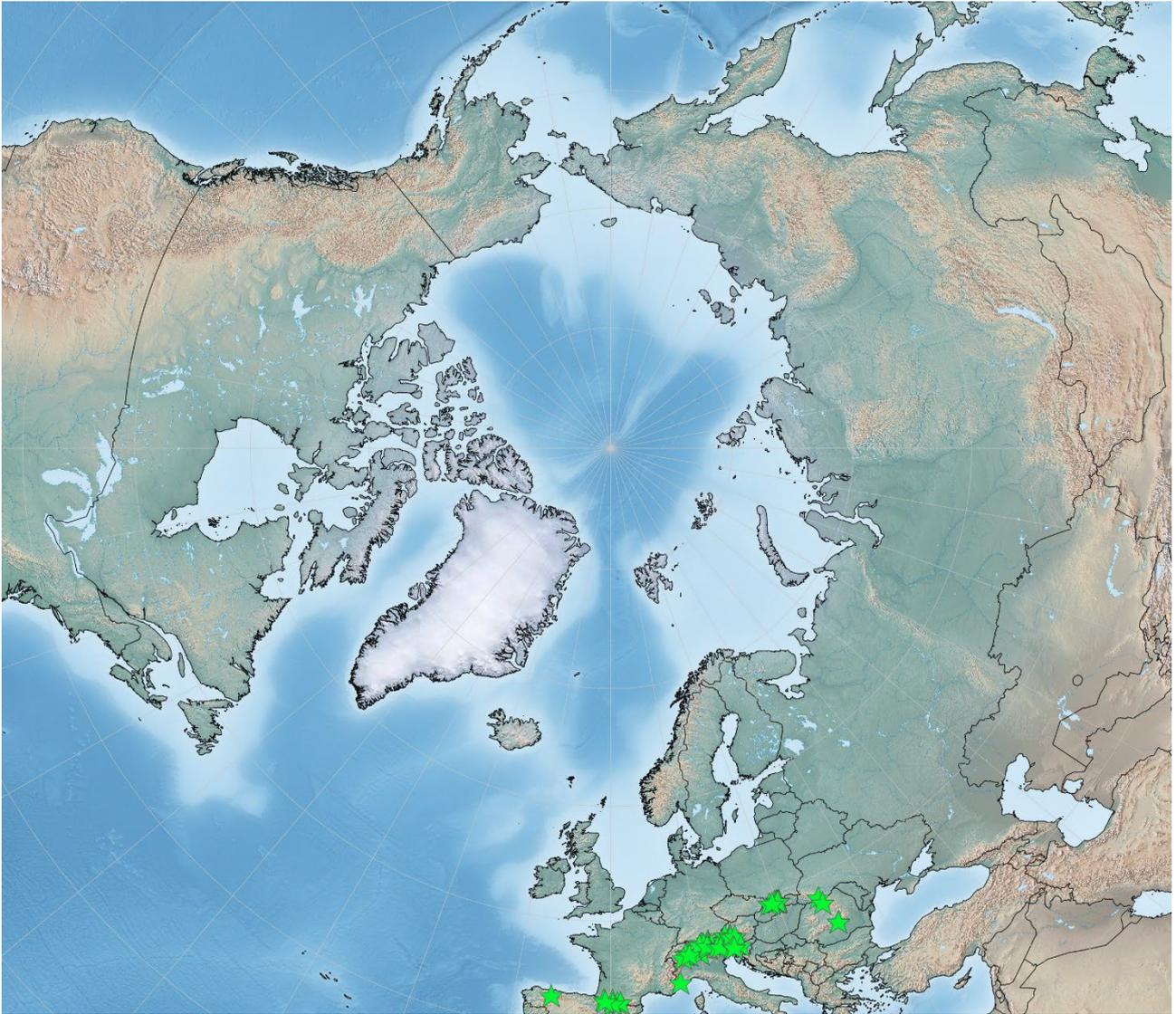
Habitats and host plants

Dry grassland and rocky slopes in subalpine and alpine belts.

Cyperaceae: Flacca Clade of *Carex*: *Carex sempervirens*.

Distribution

Eurasian alpine; type 15; found in alpine regions of the Alps (DE, FR, CH, AU, IT, SI), the Tatras (PL, SK), the Carpathians (RO, UA), the Pyrenees (FR, ES), and the Cantabrian Mts. (ES). Very common.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea turfosa

K. Vánky, Ustilaginales 221; SOMF 17861; Sweden

Anthracoidea turfosa (Syd.) Kukkonen

Infection local. **Sori** in some female flowers, occurring around aborted nuts as ovoid or broadly ellipsoid hard bodies, 1.2–2.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores medium-sized to large, flattened, in plane view irregularly rounded, broadly ellipsoid, subpolygonal, or suborbicular, sometimes slightly irregularly rounded, (17.5–)19–26.5(–28) × (16–)17–22.5(–23.5) μm, in side view 11.5–14.5 μm thick, dark reddish brown; spore wall slightly unevenly thickened, 1.2–2.3(–2.6) μm thick, sometimes with 1(–3) internal swellings (hard to observe because of the dark-colored spores), light-refractive areas and protuberances absent, minutely verruculose, spore profile not affected. Spore germination of the *Proceres*-type, resulting in a two-celled basidium,

200–250 μm long, producing cylindrical, slightly curved basidiospores.

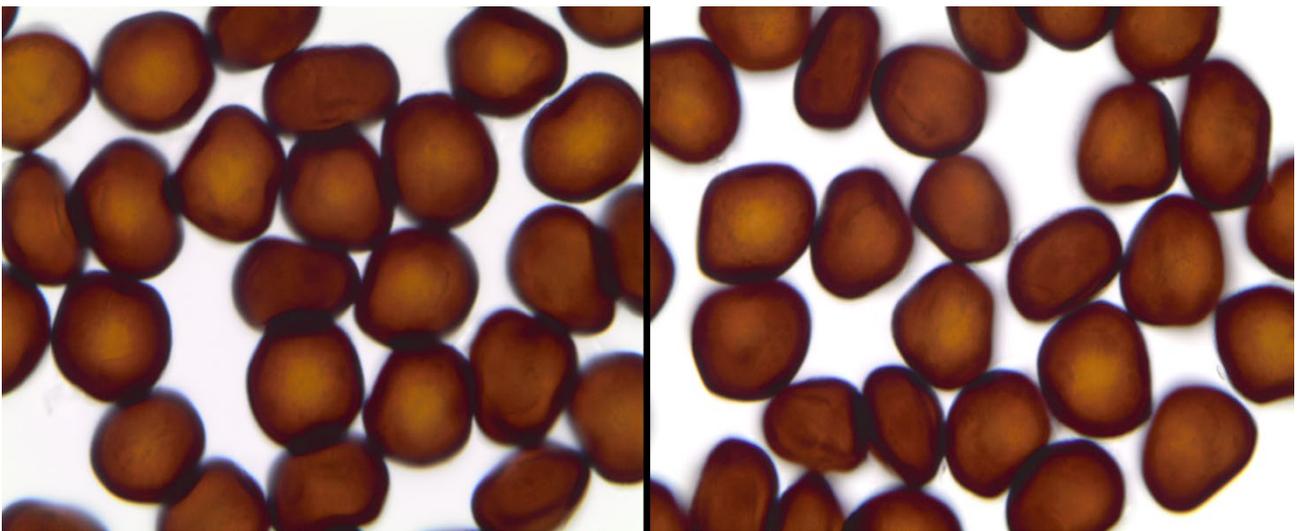
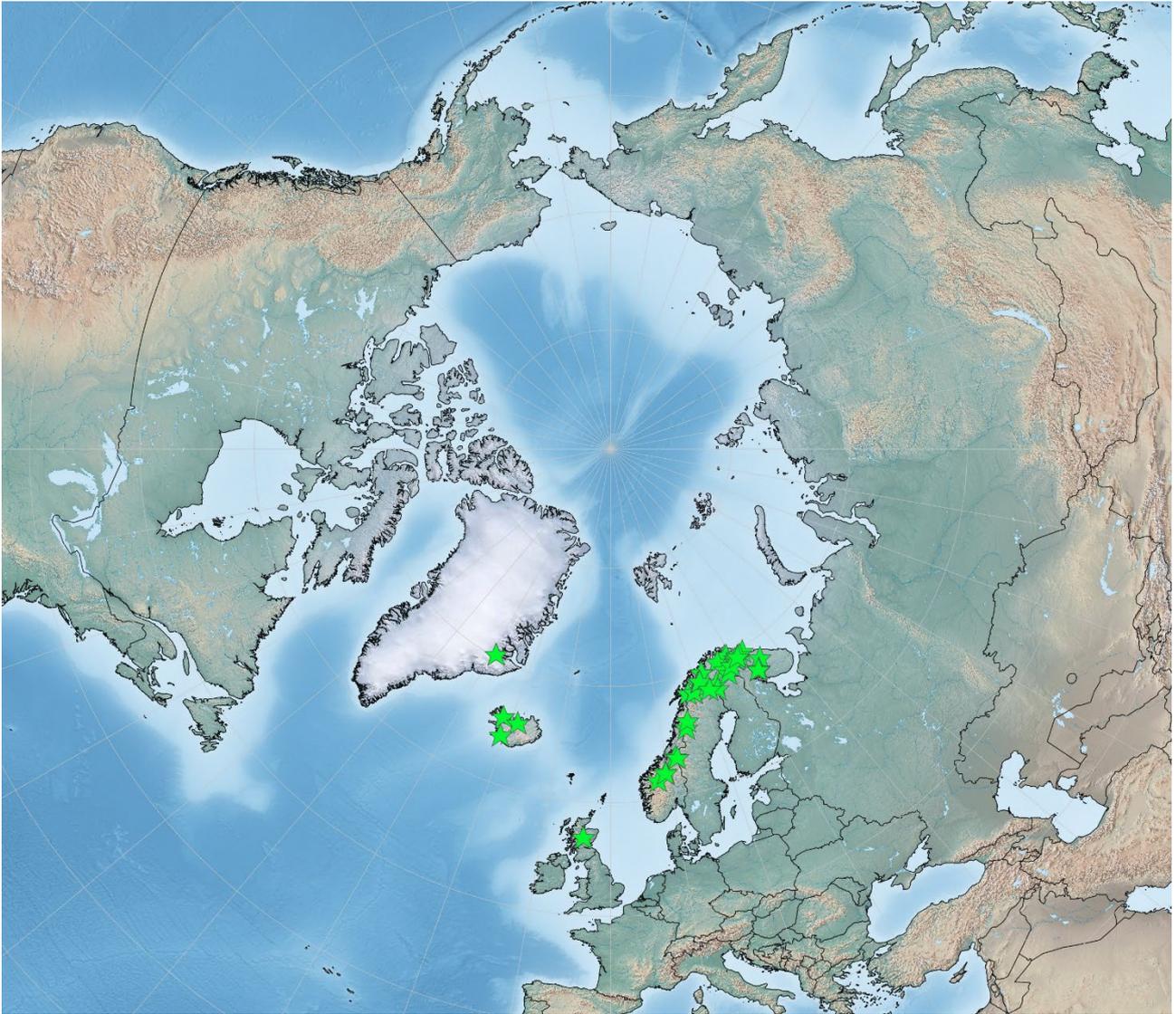
Habitats and host plants

Tundra, damp places, swamps, fens, wet meadows, riverbeds and lakeshore mires; subalpine meadows.

Cyperaceae: *Carex* sect. *Physoglochin*; in the arctic-alpine region *Carex dioica*, *C. parallela*, and hybrids.

Distribution

North American arctic–Eurasian; type 4; found in arctic GR, IS, and RU, and in the alpine Scandinavian Mts. (NO, SE, FI), Dovre (NO), and the Khibiny Mts. (RU). Rather common in the north of Fennoscandia, where it is coextensive with *Carex dioica* and *Carex parallela*; rare in Greenland and Iceland.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea umbrosae T. T. Denchev & C. M. Denchev 1643; SOMF 30500; Bulgaria

Anthracoidea umbrosae T. Denchev, Denchev, Begerow & Kemler

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose to ovoid hard bodies, 1.5–2.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small, flattened, in plane view irregularly rounded, suborbicular, broadly ellipsoid, ellipsoid, or ovoid, (14.5–)15.5–20.5(–22) × (13–)14–17.5(–18.5) μm, in side view 10–13 μm thick, medium to dark reddish brown; spore wall unevenly thickened, 1.0–2.0(–2.3) μm thick, sometimes with 1–2 usually inconspicuous internal swellings, light-refractive areas rarely present, protuberances absent, minutely verruculose to almost smooth, spore profile not affected, warts up to 0.2 μm high, sometimes partly confluent, forming short rows or small groups. Spore germination unknown.

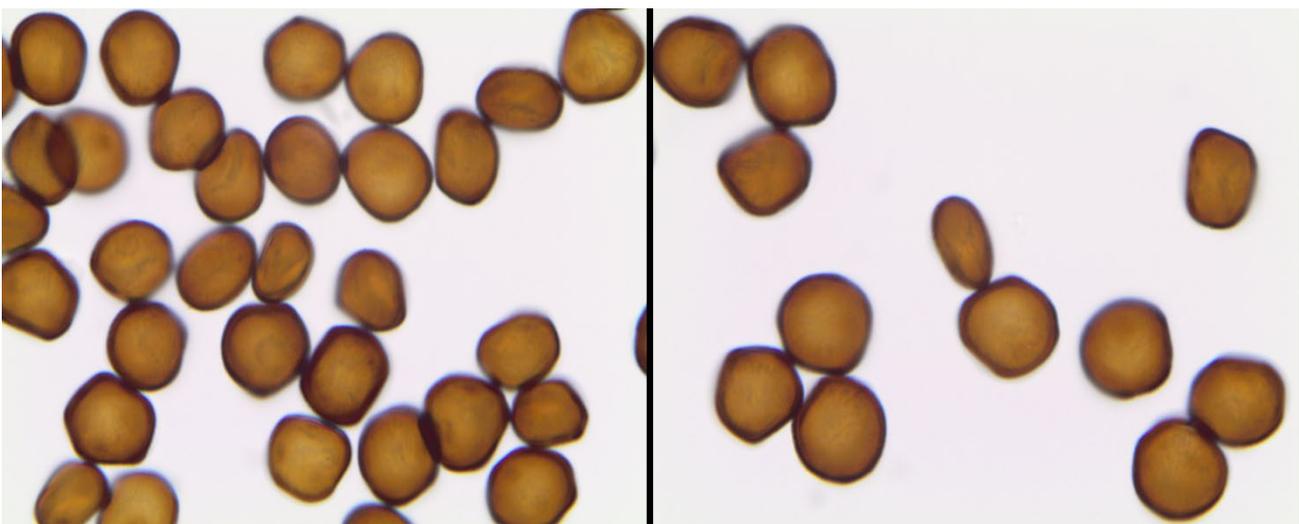
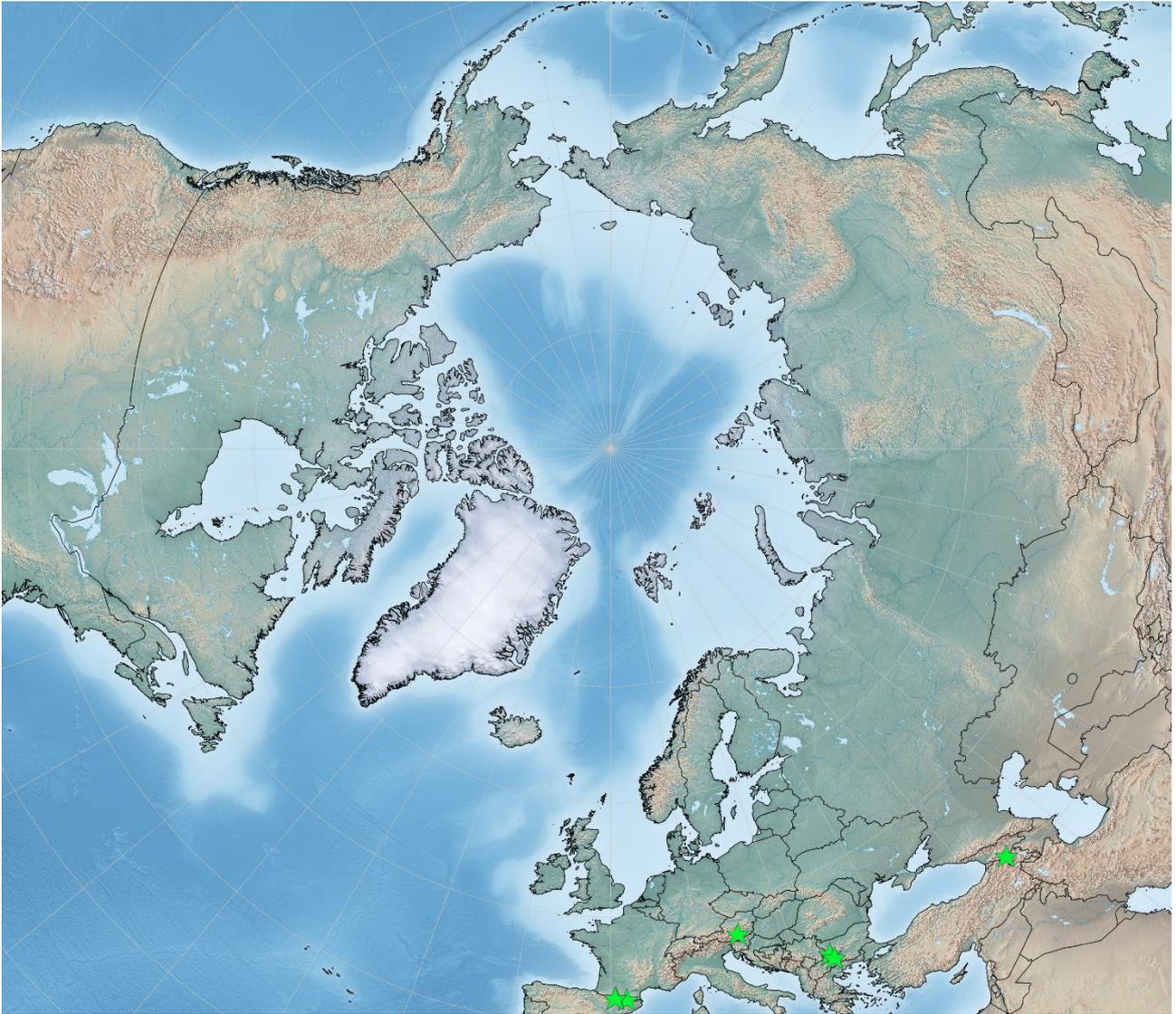
Habitats and host plants

Damp, stony or grassy slopes in high mountains.

Cyperaceae: Rhomboidales-Mitrata Clade of *Carex*: *C. umbrosa* subsp. *umbrosa*, *C. umbrosa* subsp. *huetiana*, and hybrids.

Distribution

Eurasian alpine; type 15; found in alpine regions of the Alps (AT), the Pyrenees (ES, AD), Mt. Vitosha, and the Rila Mts. (BG). Rarely reported.



Anthracoidea: Anthracoideaceae: Ustilaginales



Anthracoidea verrucosa

Anthracoidea verrucosa (Savile) Nannf.

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose to ovoid hard bodies, 0.5–3.0 mm long, initially covered by a thin greyish peridium that later flakes away to expose a black spore mass, powdery on the surface.

Spores small to medium-sized, flattened, in plane view suborbicular, orbicular, broadly ellipsoid, or ovoid, (14.5–)15.5–21(–23) × (13.5–)14.5–17(–18) μm, in side view 9–12.5 μm thick, medium reddish brown; spore wall evenly or slightly unevenly thickened, 0.7–1.4 μm thick, often with 1–3(–4) weak internal swellings, light-refractive areas and protuberances absent, minutely verruculose, warts up to 0.3 μm high, spore profile slightly affected, warts sometimes partly confluent, forming short rows or small groups. Spore germination unknown.

W. G. Solheim 2009; NY; USA (Wyoming)

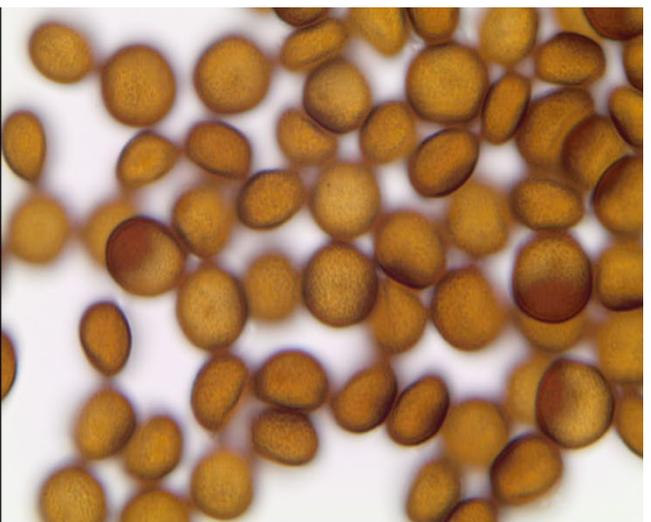
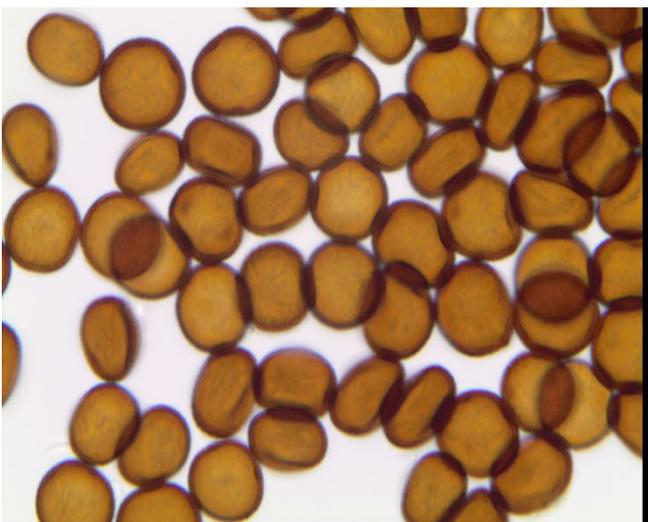
Habitats and host plants

Mountain lake and river shores, moist meadows and slopes, bogs; seashores in the Arctic.

Cyperaceae: *Carex* sect. *Cyperoideae*: in the arctic-alpine region, *Carex ebenea*, *Carex macloviana*, *C. phaeocephala*, and *C. preslii*; in the Disticha Clade: *C. hoodii*.

Distribution

North American; type 8, found in arctic Greenland, and in the alpine Intermountain West (CAN: BC) and Rocky Mts. (CAN: BC; and USA: WY). Rarely reported.



Moreaua: Anthracoideaceae: Ustilaginales



Moreaua apicis

J. A. Calder et al. 15112; DAOM 70098; Canada (BC)

Moreaua apicis (Savile) Vánky

Syn.: *Thecaphora apicis* Savile

Infection systemic. **Sori** destroying the nutlets, globose, ca. 1 mm in diameter, blackish brown, initially covered by a thin layer of host epidermis that dehisces early to expose the powdery mass of spore balls.

Spore balls globose, ellipsoid, or irregular, 12–30 × 9–25 µm, yellowish brown, composed of (1–)2–20 spores. **Spores** subglobose, broadly ellipsoid, or irregular, with slightly flattened sides, sometimes subcuneiform, 6.5–14.5 × 5.5–9.5 µm, yellowish brown; spore wall even, 0.5–0.8 µm thick, free surface rough.

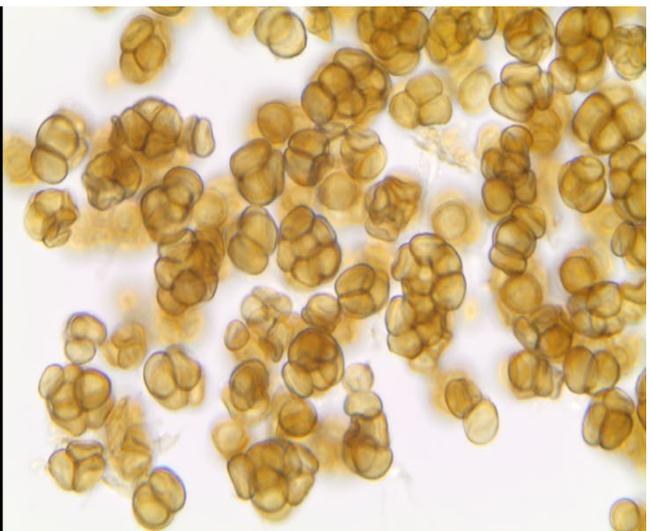
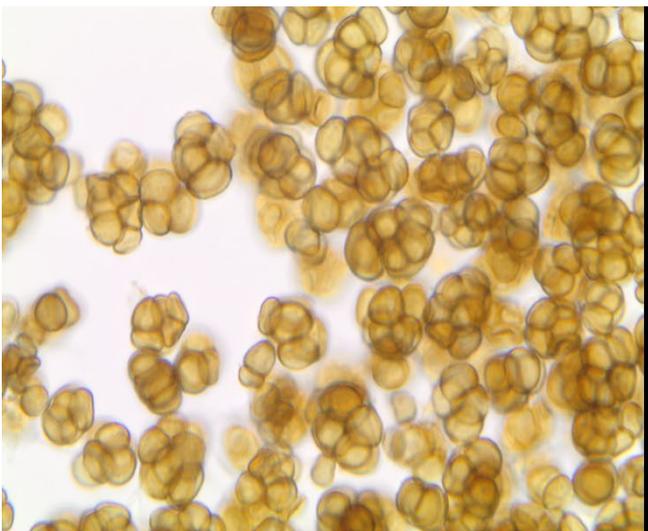
Habitats and host plants

Moist meadows, streambanks, snowbeds; high mountain grassland and damp rocky places.

Cyperaceae: *Carex micropoda* and *Carex pyrenaica* subsp. *pyrenaica*.

Distribution

Alpine; type 1; found in the alpine Intermountain West (CAN: BC), the Rocky Mts. (CAN: BC; and USA: MT), and the Pyrenees (FR). Very rare.



Orphanomyces: Anthracoideaceae: Ustilaginales



Orphanomyces arcticus

K. Vánky, Ustilaginales 574; SOMF 20426; Sweden

Orphanomyces arcticus (Rostr.) Savile

Syn.: *Tilletia arctica* Rostr.; *Ustilago arctica* (Rostr.) B. Lindeb.

Infection systemic. **Sori** forming external irregular crusts on the leaf epidermis of an infected plant; spore mass semi-agglutinated, blackish brown. Infected plants do not flower.

Spores single, subglobose, irregular, broadly ellipsoid or ovoid, sometimes irregularly elongate, (12–)13–18(–20) × (10.5–)11.5–14(–16) μm, medium reddish brown; spore wall reticulate or foveolate-reticulate, 0.9–1.4 μm thick, meshes polyhedral or irregular, 0.4–2.0(–2.5) μm wide, muri up to 0.4(–0.5) μm high.

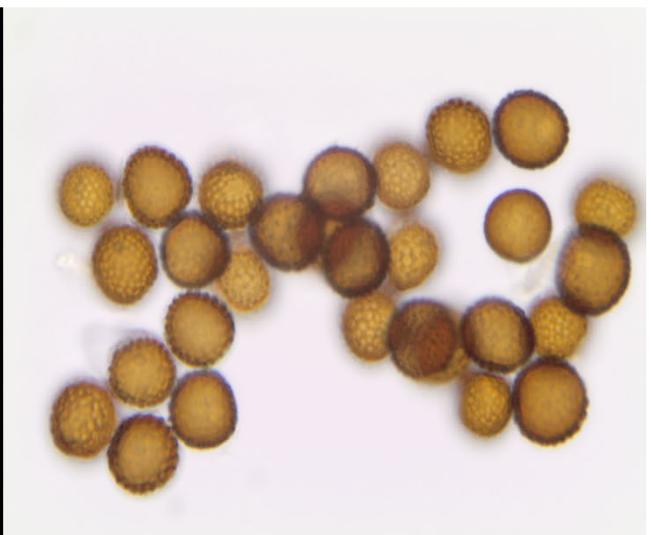
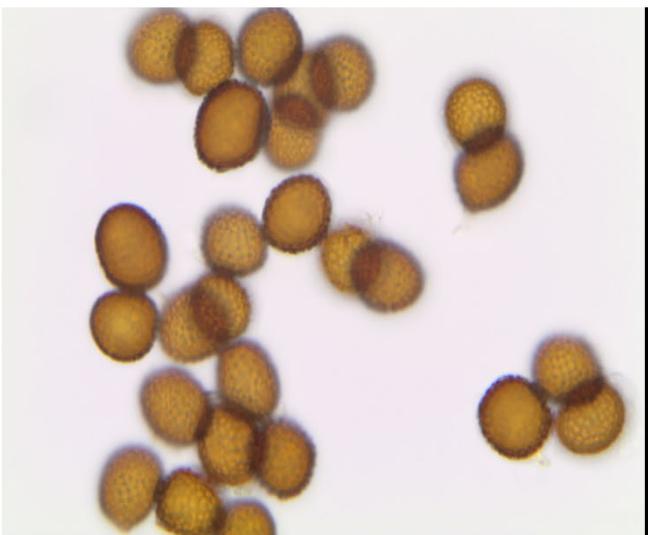
Habitats and host plants

Arctic peatlands; beaches, dunes, river and ocean shores, rocks near the coast, salt marshes; mesic to moist tundra; wet habitats (*Sphagnum* bogs, moist meadows); mountain lake and river shores; alpine meadows.

Cyperaceae: *Carex* species; in the arctic-alpine region *Carex brunnescens* (*C. vitilis*), *Carex canescens* (*C. cinerea*), *Carex capillaris*, *Carex davalliana*, *Carex ebenea*, *Carex eburnea*, *Carex glareosa*, *Carex lachenalii* (*C. lagopina*, *C. tripartita*), *Carex macloviana* (*C. festiva*), *Carex maritima*, and *Carex stenophylla*.

Distribution

Arctic-alpine; type 1; found in arctic CAN (NU), GR, IS, and NO, and in the alpine Rocky Mts. (USA: UT, CO), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Alps (AT), and Kamchatka (RU). Common in the Scandinavian Peninsula, rarely reported from the rest of the study area.



Planetella: Anthracoideaceae: Ustilaginales



Planetella lironis

T. Sørensen 9196; C-NHMD001862571

Planetella lironis Savile

Infection local. **Sori** in some female flowers, occurring around aborted nuts as subglobose hard bodies, ca 2 mm long, covered by a thick yellow-brown peridium that later flakes away to expose a black agglutinated (semi-agglutinated on the surface) spore mass.

Spores slightly flattened, with a thick-walled, medium reddish brown equatorial band and two thin-walled light yellow-brown polar areas; in plane view suborbicular, orbicular, broadly ellipsoid, or slightly irregularly rounded, (10.5–)11–13.5(–14.5) × (9.5–)10–12.5(–13) μm; equatorial band 6.0–8.2 μm wide; in plane view polar areas suborbicular, orbicular, ellipsoid, broadly ellipsoid, or slightly irregularly rounded, 5.5–7.5(–8.5) μm long; spore wall unevenly thickened, (1.5–)1.7–2.5(–2.7) μm thick at the equatorial band, 0.5–1.0(–1.2) μm thick at the polar areas, minutely verruculose, warts densely spaced, up to 0.2 μm high, spore profile not affected.

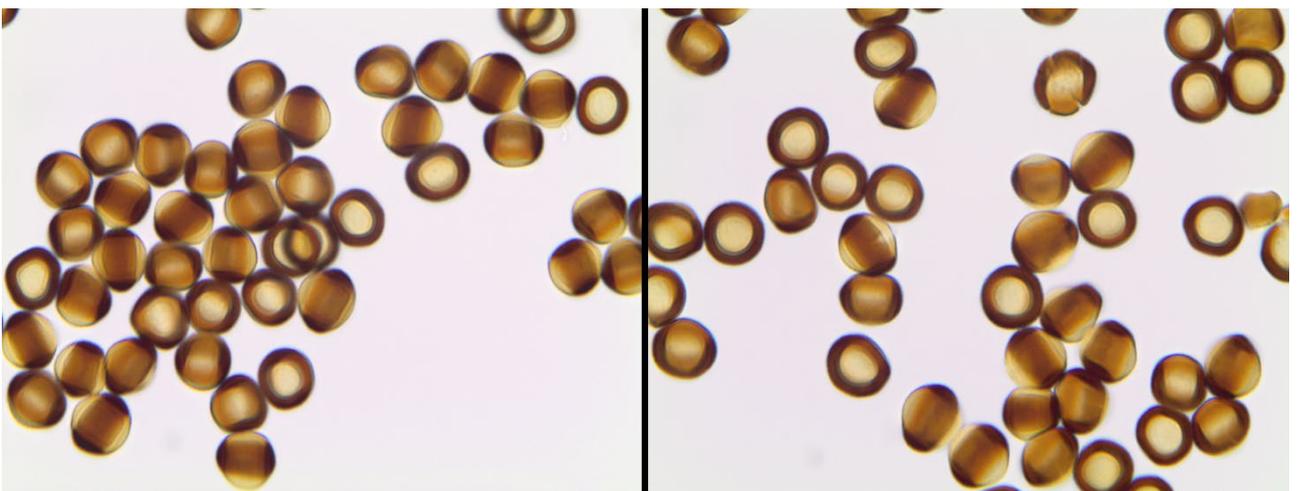
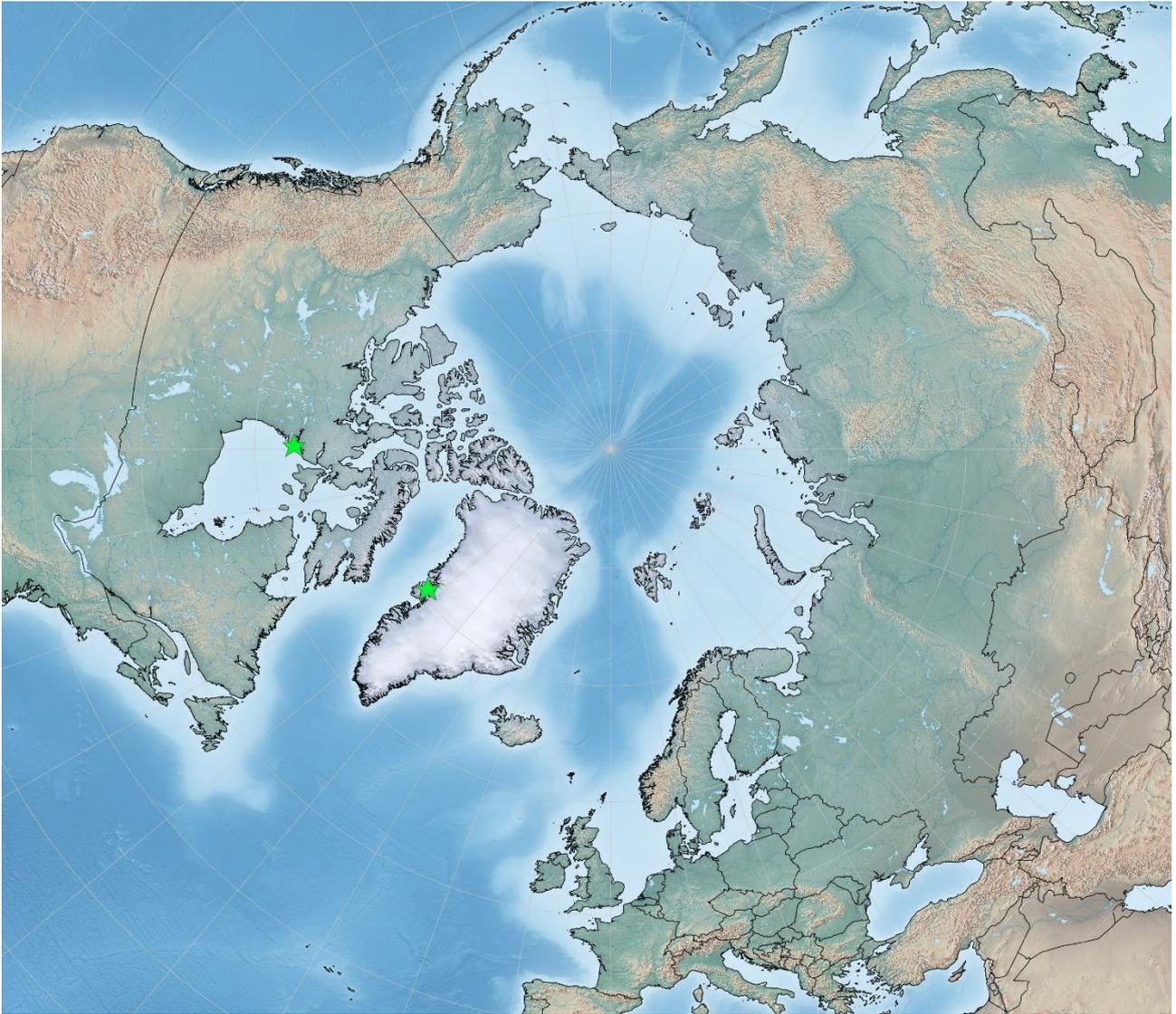
Habitats and host plants

Marshy tundra, seashores (estuaries and lagoons, beaches), river terraces, rock barrens; mostly near the coast.

Cyperaceae: *Carex* species; in the arctic region *Carex maritima*.

Distribution

North American arctic; type 12; found in arctic Canada (NU) and Greenland. Very rarely reported.



Schizonella: Anthracoideaceae: Ustilaginales



Schizonella elyanae

M. Luceño & P. Vargas 419; MA 342212; Spain

Schizonella elyanae (A. Blytt) Liro

Syn.: *Schizonella melanogramma* var. *elyanae* A. Blytt

Infection systemic. **Sori** occurring in leaves as striae or irregular spots, initially covered by the silvery epidermis, which later ruptures to disclose a semi-agglutinated, blackish brown mass of spores.

Spores joined in pairs, sometimes in groups of three, often separating into single spores, depressed on the contact side, in plane view suborbicular, irregular, broadly ellipsoid, or ovoid, 6–9(–10.5) × (5.5–)6–8.5(–9.5) μm, in side view usually irregularly hemispherical, light to medium yellow-brown; spore wall unevenly thickened, (0.8–)1.0–1.6(–1.9) μm thick, thinner and lighter on the contact side, smooth.

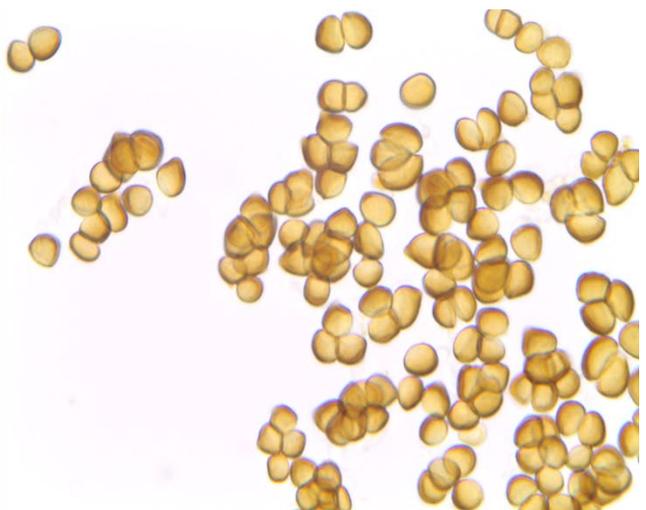
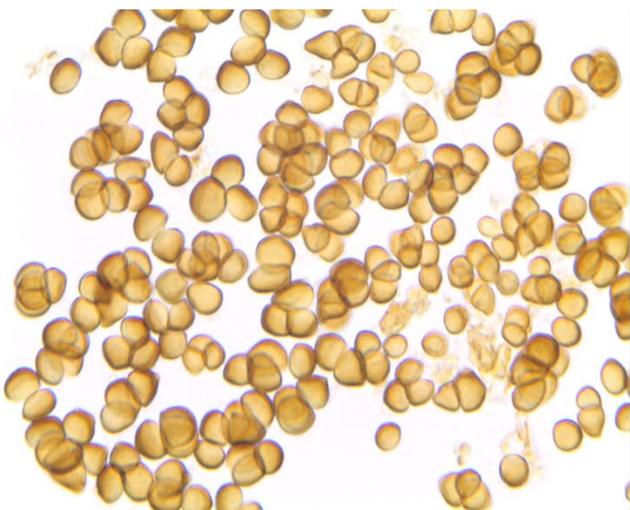
Habitats and host plants

Tundra, grassland, heaths, bare rocky dry to wet ground; alpine meadows, on rocks, dry ridges, grassy slopes, among shrubs.

Cyperaceae: *Carex myosuroides* (*Kobresia myosuroides*).

Distribution

North American arctic–Eurasian; type 4; found in arctic Canada (NU), Greenland, and Iceland, and in the alpine Scandinavian Mts. (NO, SE), Dovre (NO), the Alps (DE, CH, AT, IT), and the Anyuy Range (RU). Uncommon throughout the host range.



Schizonella: Anthracoideaceae: Ustilaginales



Schizonella melanogramma sensu lato

S. Tóth s.n.; SOMF 8773; Hungary

Schizonella melanogramma (DC.) J. Schröt.

Infection systemic. **Sori** occurring in leaves as striae or irregular spots, initially covered by the epidermis, which later ruptures to disclose a semi-agglutinated blackish brown mass of spores.

Spores joined in pairs, often separating into single spores, depressed on the contact side, in plane view suborbicular, broadly ellipsoid, irregular, or ovoid, 8–13(–15) × 5–11 μm, in side view usually irregularly hemispherical, dark reddish brown; spore wall unevenly thickened, thinner and lighter on the contact side, in LM smooth.

Habitats and host plants

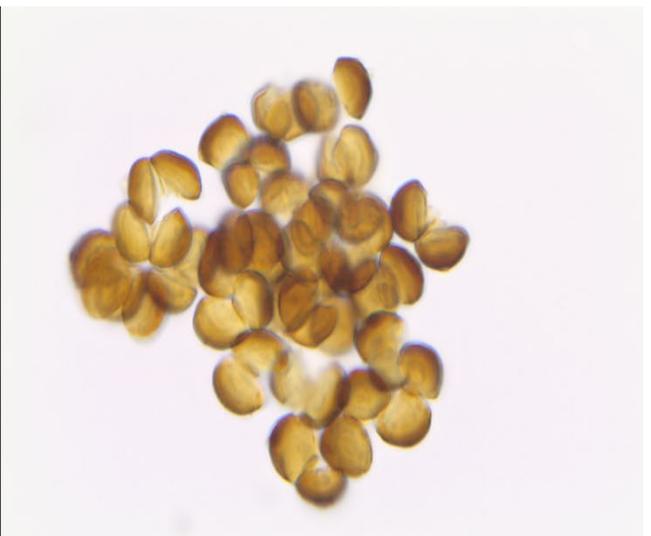
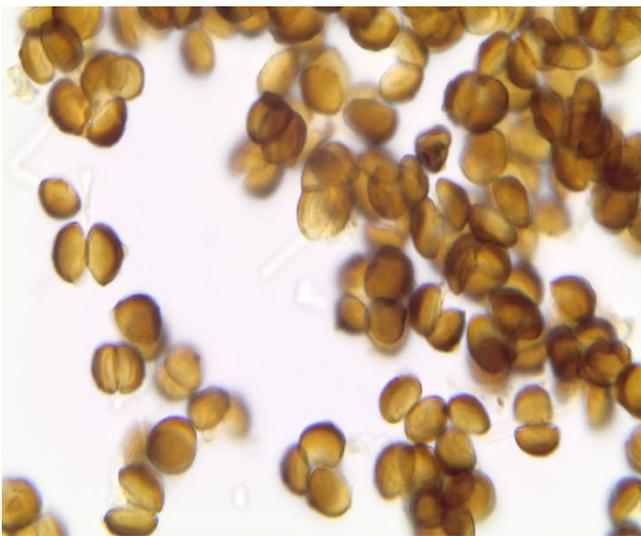
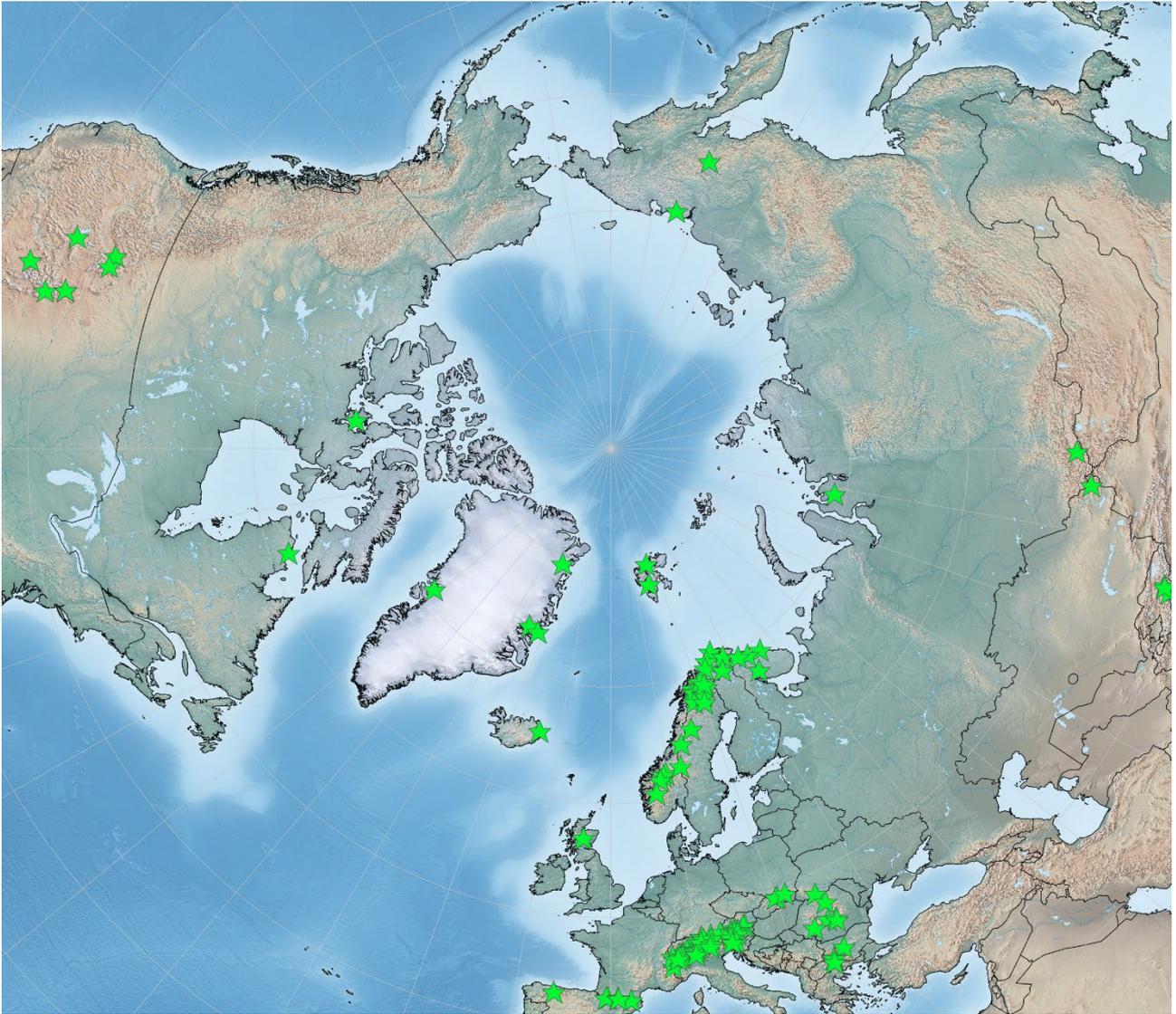
Arctic tundra, fens, bogs, shores of lakes, cliffs; alpine meadows, dry to wet grassy slopes, stream sides, rock ledges, dry or wet stony places, wet gravel of snowbeds.

Cyperaceae: *Carex* species; in the arctic-alpine region *Carex aquatilis*, *Carex atrata*, *Carex bigelowii*, *Carex concolor*, *Carex curvula*, *Carex dacica*, *Carex ericetorum*, *Carex ferruginea*, *Carex firma*, *Carex fuliginosa*, *Carex fuliginosa* subsp. *misandra*,

Carex globularis, *Carex lazareii*, *Carex liparocarpos*, *Carex nardina*, *Carex nigricans*, *Carex ornithopoda*, *Carex ornithopodioides*, *Carex pediformis*, *Carex podocarpa*, *Carex raynoldsii*, *Carex rotundata*, *Carex rupestris*, *Carex sabynensis*, *Carex saxatilis*, *Carex scirpoidea* var. *pseudoscirpoidea*, *Carex sempervirens*, *Carex stenocarpa*, *Carex umbrosa*, and *Carex vaginata*.

Distribution

Arctic-alpine; type 1, found in arctic CAN (NU, QC), GR, IS, Svalbard, NO, and RU, and in the alpine Rocky Mts. (USA: ID, WY, UT, CO), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Khibiny Mts. (RU), the Alps (DE, FR, CH, AT, IT, SI), Tatras (SK), Carpathians (RO, UA), Pyrenees (FR, ES), Cantabrian Mts. (ES), the Balkan Range, Rila Mts., and Pirin Mts. (BG), the Kolyma Highlands, and Kamchatka (RU), the Altai Mts. (RU, KZ), and Tian Shan (KG). In the arctic-alpine zone, it is a rather common species in Europe, but is very rarely reported from Asia and North America.



Stegocintractia: Anthracoideaceae: Ustilaginales



Stegocintractia hyperborea

A. Hagen s.n.; O

Stegocintractia hyperborea (A. Blytt) M. Piepenbr.

Syn.: *Ustilago hyperborea* A. Blytt; *Cintractia hyperborea* (A. Blytt) Liro

Infection systemic. **Sori** in all spikelets of an infected plant, filling the basal part of the perianth and surrounding the spikelet axis, more or less enclosed by the perianth segments, initially covered by a thin peridium that soon flakes away to expose an initially agglutinated, later powdery spore mass.

Spores slightly flattened, in plane view suborbicular, slightly irregular, broadly ellipsoid, or orbicular, (16.5–)17.5–22(–24) × (15.5–)16.5–20(–21) μm, medium to dark reddish brown; spore wall two-layered, unevenly thickened, (3.0–)3.2–4.3(–4.7) μm thick (including the 0.7–1.3 μm thick inner layer), usually with two thinner and lighter stripe-like areas on the opposite flattened sides of the spores, moderately verruculose-echinulate, ornaments up to 0.5(–0.6) μm in height, spore profile affected.

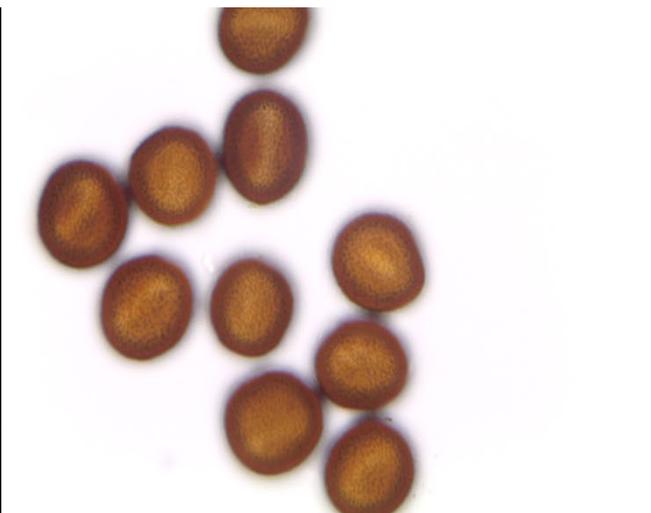
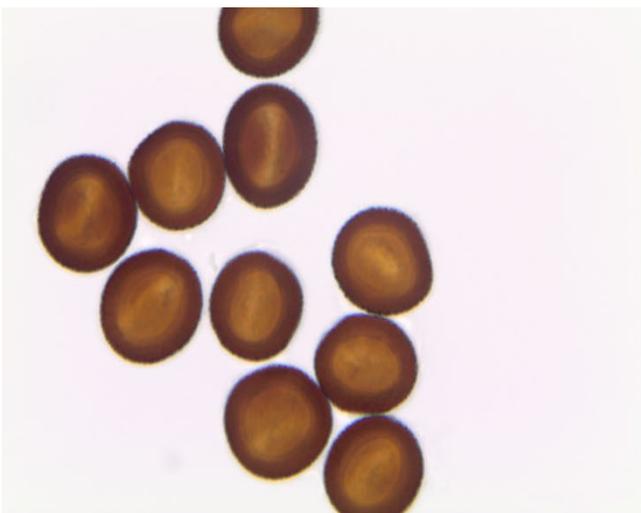
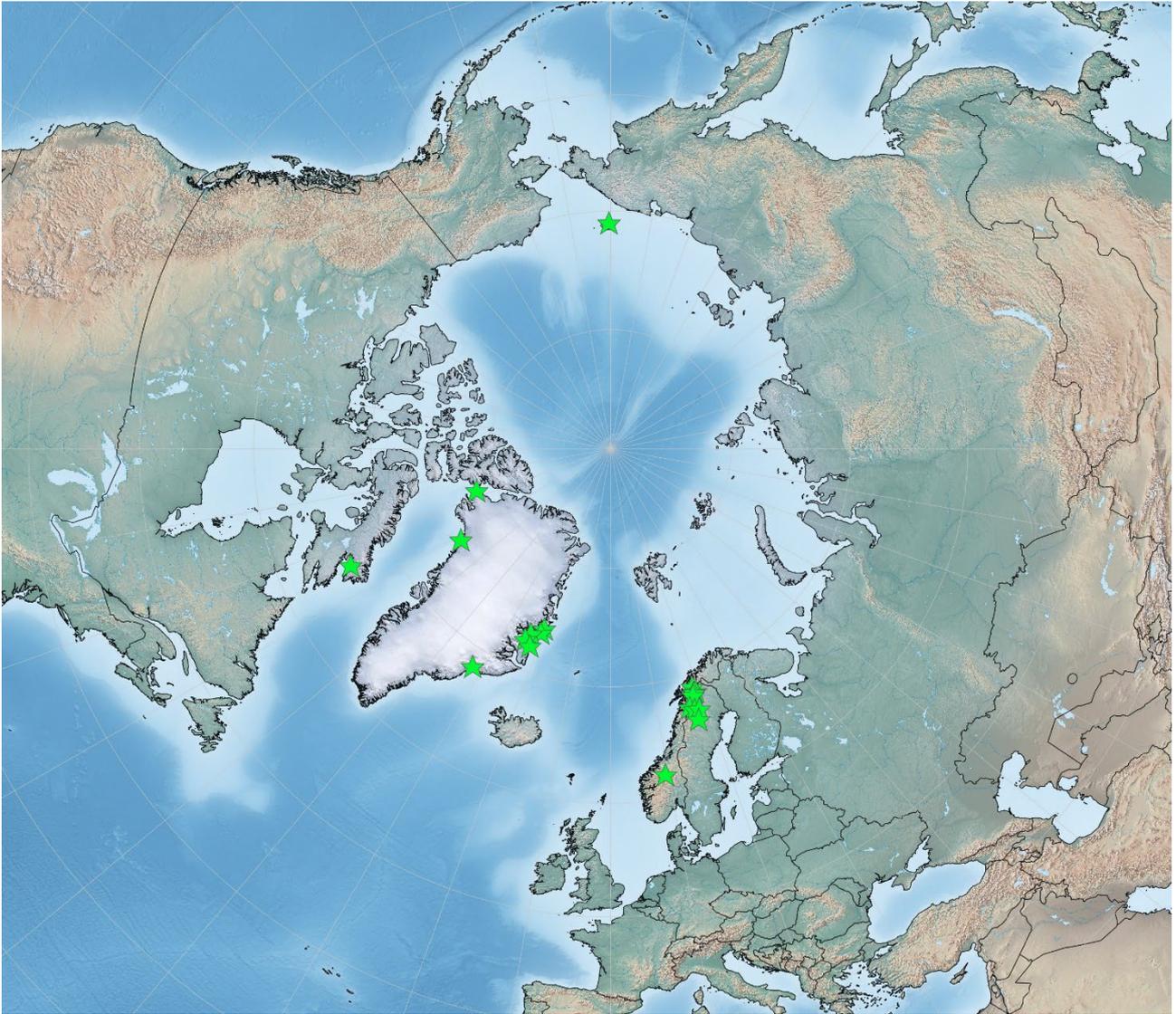
Habitats and host plants

Arctic tundra, wet meadows, around streams, margins of ponds, exposed rocky and sandy hillsides, mountain summits, seashores.

Juncaceae: *Luzula confusa* and *Luzula nivalis*.

Distribution

North American arctic–Eurasian; type 4; found in arctic Canada (NU), Greenland, Svalbard, and Russia, and in the alpine Scandinavian Mts. (NO, SE) and Dovre (NO). Rarely reported; the known localities are mainly from Greenland and Swedish Lapland.



Stegocintractia: Anthraciodesaceae: Ustilaginales



Stegocintractia lidii J. I. Liro & H. Roivainen, Mycoth. Fenn. 424; CP1031046; Finland

Stegocintractia lidii (Liro) M. Piepenbr.

Syn.: *Cintractia lidii* Liro; *Ustilago lidii* (Liro) Nannf.

Infection systemic, infected plants dwarfed.

Sori in all spikelets of an inflorescence, surrounding the basal part of the glumes and the axis of the sterile spikelets, as an initially agglutinated, later powdery, black spore mass, enveloped by perianth segments and the bract.

Spores globose, usually ellipsoid, sometimes irregular, $15\text{--}21 \times 11\text{--}18 \mu\text{m}$, medium to dark reddish brown; spore wall ca. $1 \mu\text{m}$ thick, reticulate-foveolate, 7–12 meshes per spore diameter.

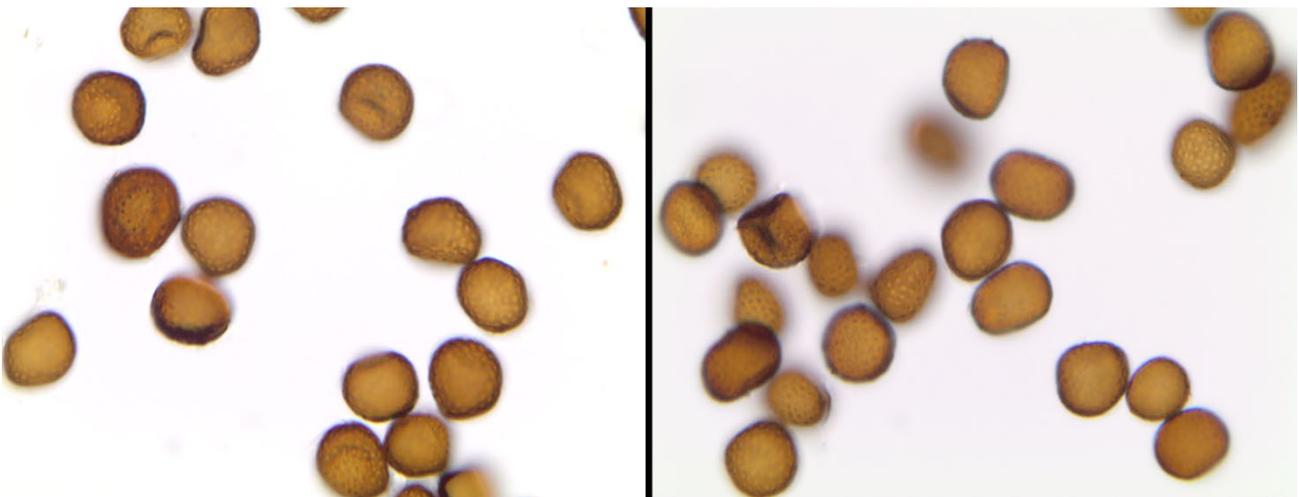
Habitats and host plants

Wet tundra and mossy margins of ponds and streams; wet gravel and open rocky slopes in alpine zones.

Juncaceae: *Juncus biglumis*.

Distribution

Eurasian; type 9; found in arctic Svalbard and in the alpine Scandinavian Mts. (FI). Very rarely reported, known only from Svalbard and Finnish Lapland.



Stegocintractia: Anthraciodesaceae: Ustilaginales



Stegocintractia luzulae

HK 18.179; C-F-111319

Stegocintractia luzulae (Sacc.) M. Piepenbr., Begerow & Oberw.

Syn.: *Ustilago luzulae* Sacc.; *Cintractia luzulae* (Sacc.) G.P. Clinton

Infection systemic. **Sori** in all spikelets of an infected plant, filling the basal part of the perianth and surrounding the spikelet axis, more or less enclosed by the perianth segments, initially covered by a thin peridium that soon flakes away to expose an initially agglutinated, later powdery spore mass.

Spores slightly flattened, in plane view suborbicular, orbicular, or broadly ellipsoid, sometimes slightly irregular or ovoid, (19.5–)20.5–28.5(–30) × (18.5–)19.5–25(–26) μm, medium to dark reddish brown; spore wall unevenly thickened, (1.6–)1.8–3.2(–3.5) μm thick (an inner layer, 0.7–1.3 μm thick, may be observed in some spores), often with a thinner, slightly paler rounded area of 8–13 μm diameter, foveolate.

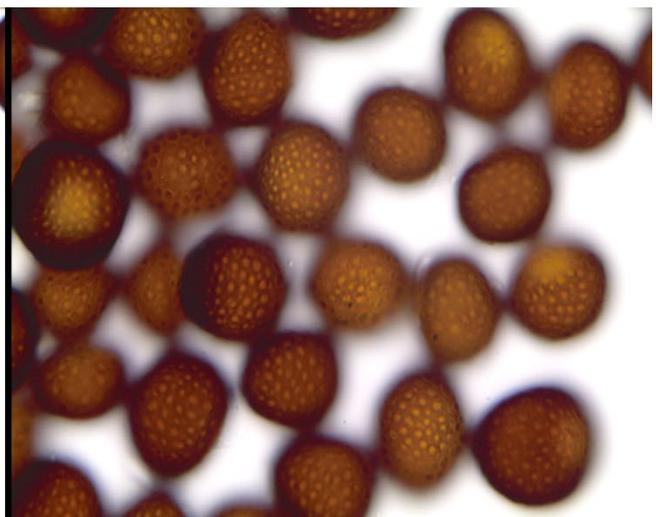
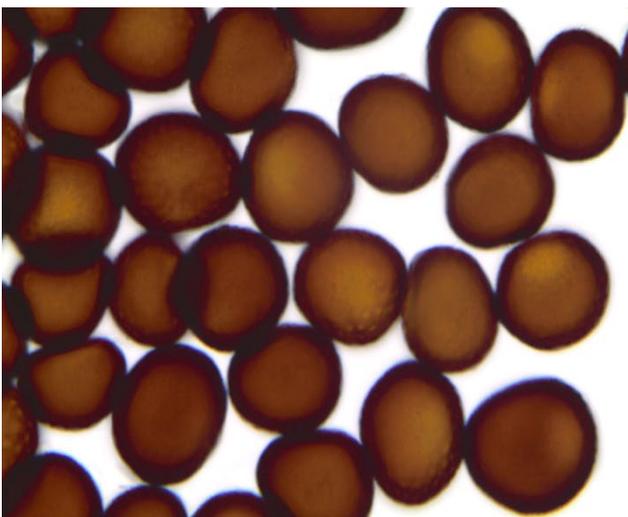
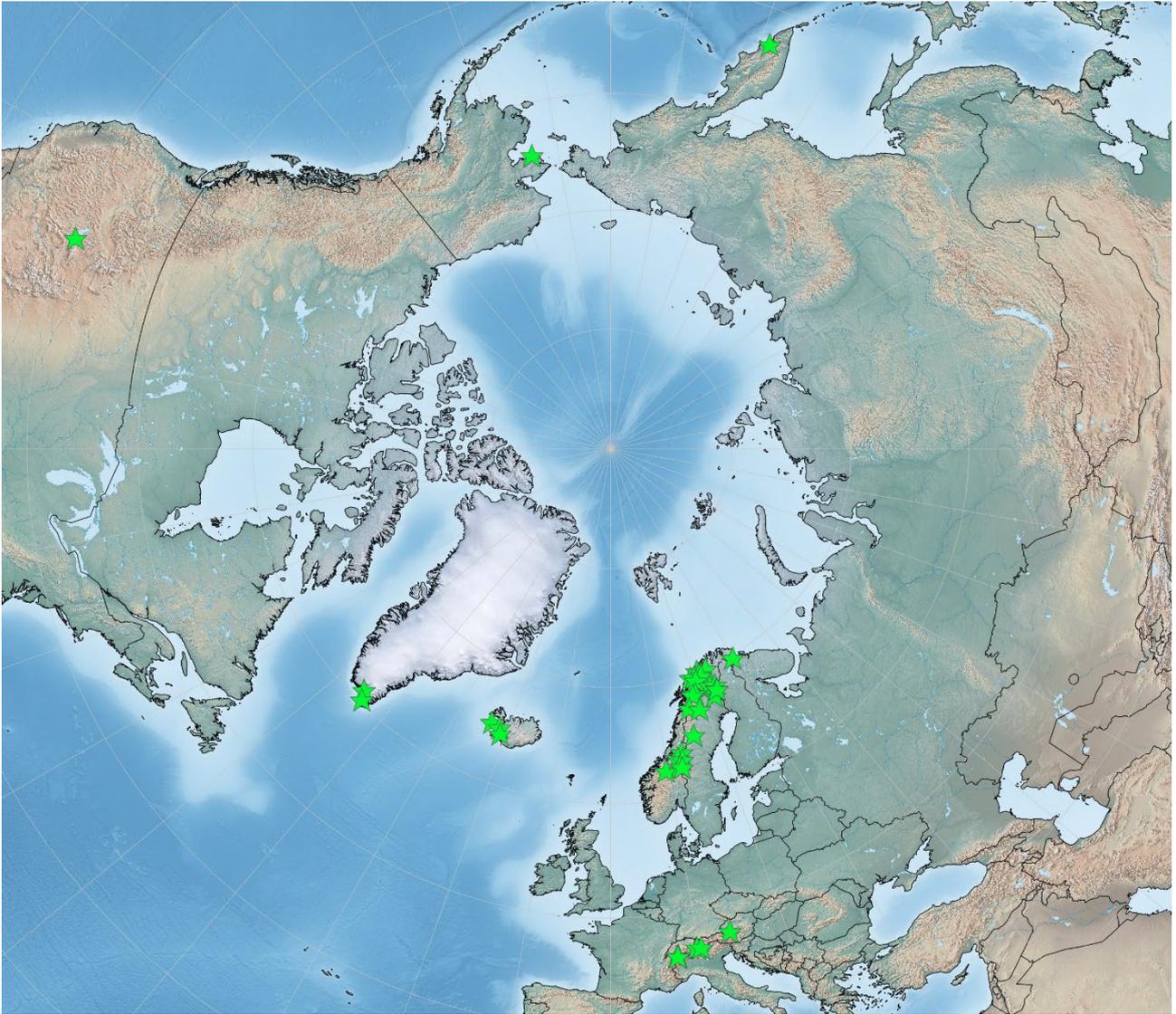
Habitats and host plants

Arctic and alpine tundra; montane and subalpine moist meadows, wet grasslands, peat bog margins, woodlands.

Juncaceae: *Luzula* species; in the arctic-alpine region *Luzula campestris*, *Luzula multiflora* sensu lato, *Luzula multiflora* subsp. *frigida* (*Luzula frigida*), *Luzula nivea*, *Luzula spicata*, *Luzula sudetica*, and *Luzula wahlenbergii*.

Distribution

Arctic-alpine; type 1; found in arctic AK, GR, IS, and NO, and in the alpine Rocky Mts. (USA: UT), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Alps (CH, AT), and Kamchatka (RU). In the arctic-alpine region, it is a common species in Iceland and the Scandinavian Peninsula, while in Central and South Europe almost all of its hosts (*Luzula pilosa*, *L. forsteri*, *L. luzulina*, *L. luzuloides*, and *L. sylvatica* subsp. *sylvatica* and subsp. *sieberi*) are confined to deciduous, coniferous or mixed forests (in lowlands and mountains), scrubs, maquis, or non-alpine meadows and grasslands.



Stegocintractia: Anthracioidaceae: Ustilaginales



Stegocintractia spadicea

K. Vánky, Ustilaginales 273; SOMF 18036; Slovakia

Stegocintractia spadicea (Liro) M. Piepenbr. & Begerow

Syn.: *Cintractia spadicea* Liro; *Ustilago spadicea* (Liro) Vánky

Infection systemic, infected plants often stunted. **Sori** in swollen and congested flowers, occupying the capsules and the basal part of the inner perianth segments, forming a black, naked, initially agglutinated, later more or less powdery spore mass.

Spores subglobose, ovoid, elongate, or irregular, 13–21 × 10–16 μm, yellowish brown to pale reddish brown; spore wall 1–1.5 μm thick, foveolate-reticulate with bright interspaces.

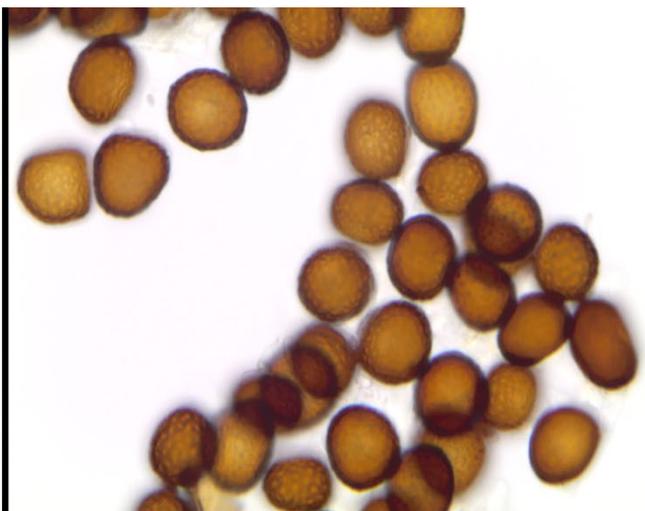
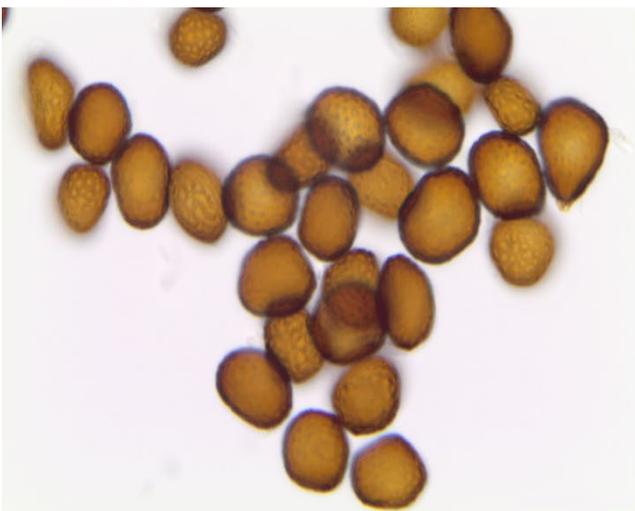
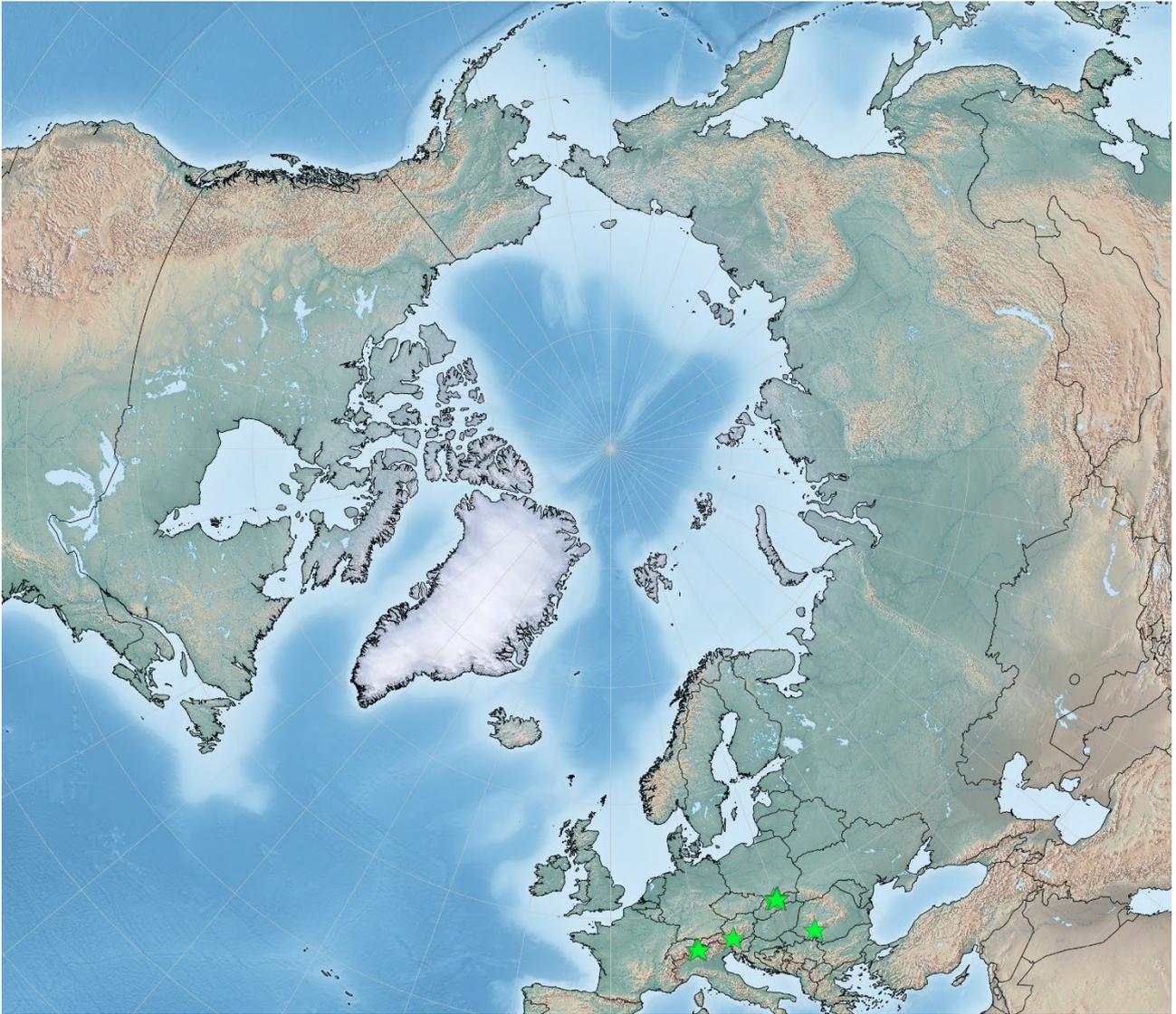
Habitats and host plants

Rocky and stony subalpine and alpine slopes.

Juncaceae: *Luzula alpinopilosa* subsp. *alpinopilosa* (*Luzula spadicea*) and *Luzula alpinopilosa* subsp. *obscura*.

Distribution

Eurasian alpine; type 15; found in alpine regions of the Alps (CH, AT), Tatras (PL, SK), and Carpathians (RO).



Ustilago: Ustilaginaceae: Ustilaginales



Ustilago calamagrostidis sensu lato

Ustilago calamagrostidis (Fuckel) G.P. Clinton

Infection systemic. **Sori** in leaves, leaf sheaths and in the inflorescence axis, occasionally in the spikelets, appearing as long streaks between the veins, initially covered by the epidermis that soon ruptures to expose the blackish brown dusty spore mass; the leaf blades rupture longitudinally, becoming threaded and twisted; the sori often appear as a blackish brown layer covering the axis of the inflorescence.

Spores globose, subglobose, or broadly ellipsoid, $14\text{--}19 \times 11\text{--}15 \mu\text{m}$, medium olive brown; spore wall echinate, spines up to $1 \mu\text{m}$ high.

C. M. Denchev s.n.; SOMF 18425; Bulgaria

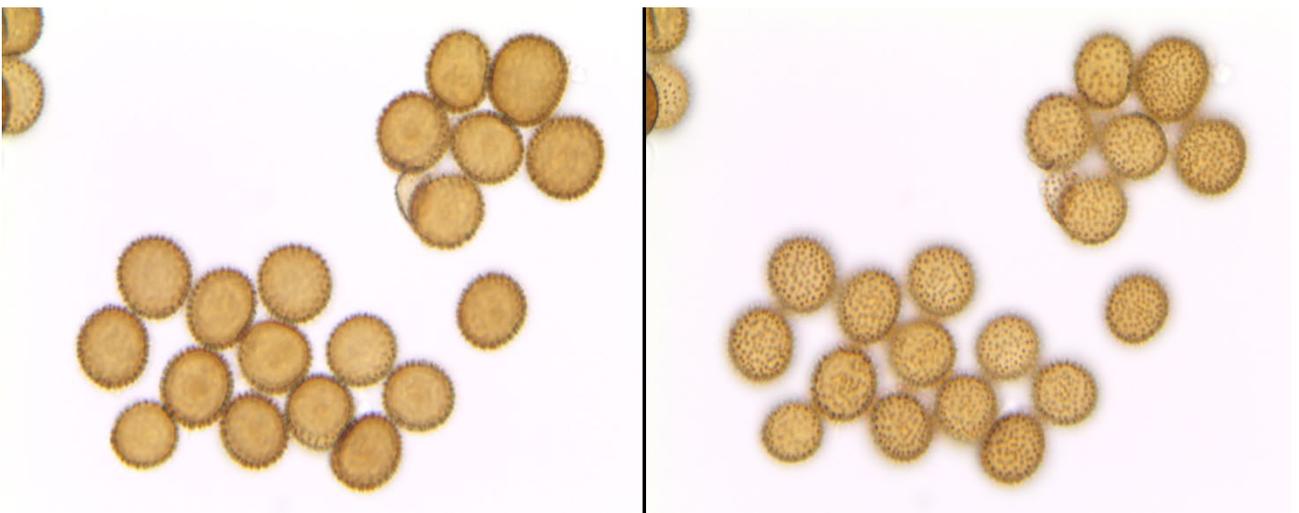
Habitats and host plants

In arctic and subalpine habitats; wet meadows, mire margins, lakeshores, riverbanks.

Poaceae: *Calamagrostis* species; in the arctic-alpine region *Calamagrostis purpurea*.

Distribution

North American arctic–Eurasian; type 4; found in arctic Greenland and Russia, and in the alpine Sikhote-Alin Range (Russia). Very rarely reported from the arctic-alpine region.



Ustilago: Ustilaginaceae: Ustilaginales



Ustilago scrobiculata M. Nilsson et al., Vánky Ustilaginales 645; SOMF 19573; Sweden

Ustilago scrobiculata Liro

Infection systemic. **Sori** appearing in leaves as long striae between the veins, initially lead-coloured and covered by the epidermis, which soon ruptures to expose the blackish brown powdery spore mass.

Spores globose, subglobose, or ovoid, 12–18 × 10–14 µm; spore wall scrobiculate, with ornaments ca. 1 µm high, the bases of which are confluent in meandriform, often interrupted ridges.

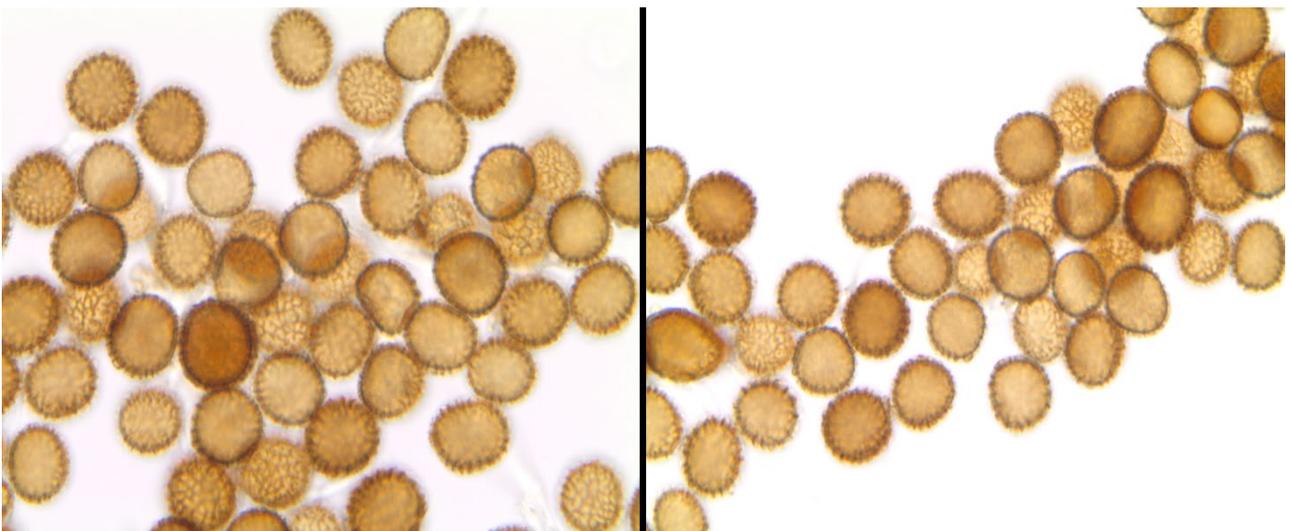
Habitats and host plants

Moist meadows, marshes, and fens.

Poaceae: *Calamagrostis* species; in the arctic-alpine region *Calamagrostis purpurea* and *Calamagrostis stricta*.

Distribution

Eurasian; type 15; found in arctic Russia, and in the alpine Scandinavian Mts. (NO, SE, FI). Very rarely reported from the arctic-alpine region.



Ustilago: Ustilaginaceae: Ustilaginales



Ustilago striiformis sensu lato

C. Dobolyi s.n.; SOMF 6056; Hungary

Ustilago striiformis (Westend.) Niessl

Infection systemic. **Sori** appearing in leaves, leaf sheaths, and culms as streaks parallel with the veins, occasionally by fusion covering most of the leaf surface, occasionally also in the inflorescence, initially covered by the epidermis that soon ruptures to expose a dark brown powdery spore mass.

Spores globose, subglobose, broadly ellipsoid, or ovoid, occasionally irregular, $8.5\text{--}15(-16) \times 8\text{--}12(-13) \mu\text{m}$, light olive brown; spore wall minutely echinulate, spore profile affected.

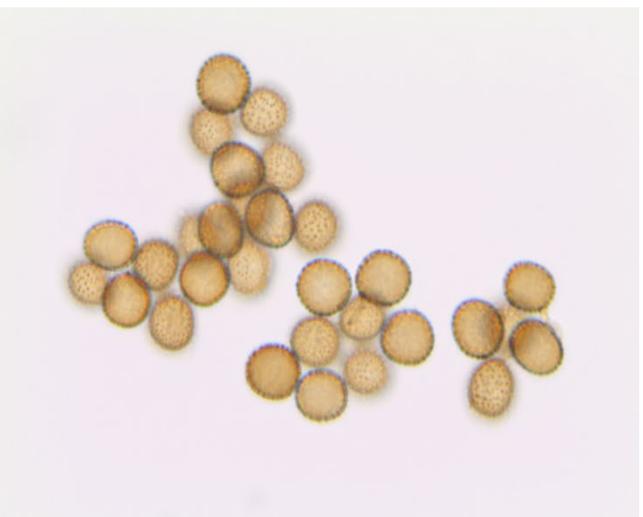
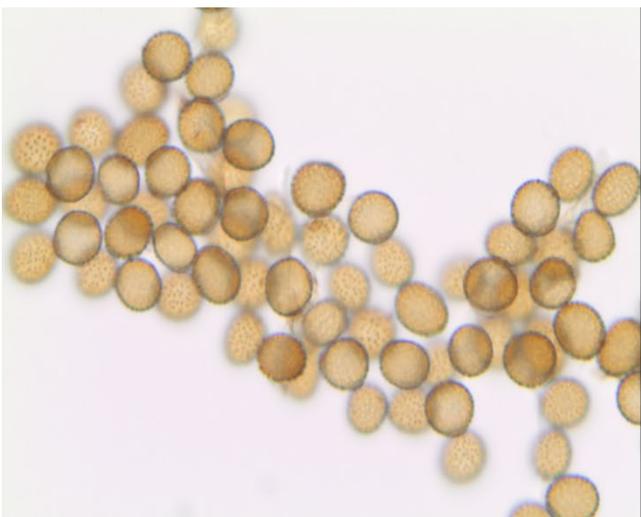
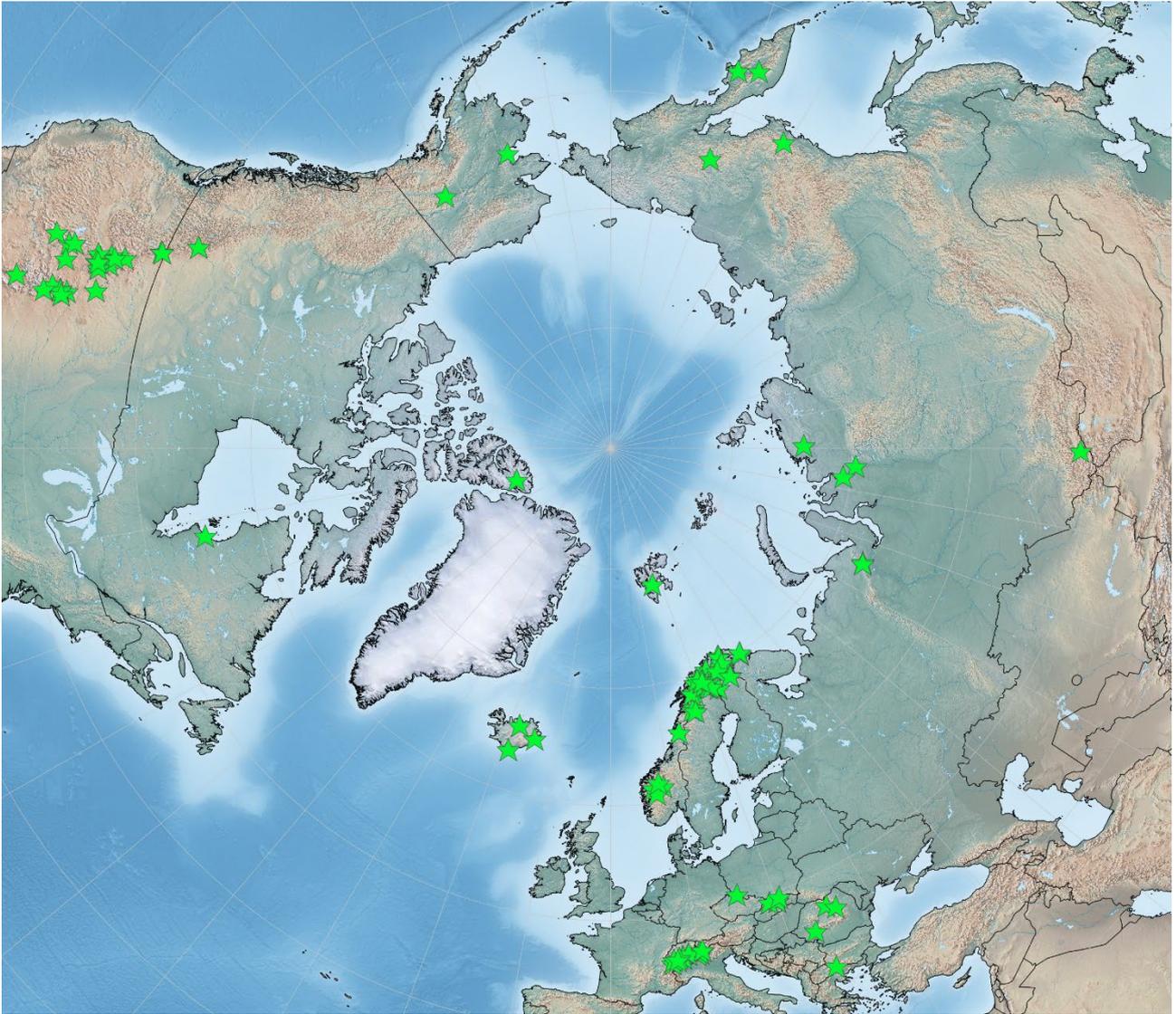
Habitats and host plants

The host plants grow in a wide range of habitats: tundra, meadows, stony slopes and mountain rocks; grasslands, shrublands, swamps, bogs, marshes, stream and lake margins; alpine and subalpine meadows, ridges, scree, snowbeds.

Poaceae: On a wide range of grasses including *Agrostis*, *Alopecurus*, *Anthoxanthum*, *Arctagrostis*, *Avenella*, *Beckmannia*, *Bromus*, *Calamagrostis*, *Danthonia*, *Deschampsia*, *Elymus*, *Festuca*, *Helictochloa*, *Koeleria*, *Melica*, *Phleum*, *Poa*, *Podagrostis*, *Puccinellia*, *Sesleria*, *Sibirotrisetum*, and *Vahlodea*.

Distribution

Cosmopolitan; type 1; found in arctic AK, CAN (NU, QC), IS, Svalbard, NO, and RU, and in the alpine Alaska-Yukon Ranges (AK), the Rocky Mts. (CAN: AB; and US: ID, MT, WY, UT, CO), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Alps (FR, CH), Tatras (PL, SK), Carpathians (RO), and Pirin Mts. (BG), and the Altai Mts., Chersky Range, Kolyma Highlands, and Kamchatka (RU). Widespread.



Doassansia: Doassansiaceae: Doassansiales



Doassansia epilobii Oberwinkler et al., Vánky *Ustilaginales* 666; SOMF 19774; Germany

Doassansia epilobii Farl. ex De Toni

Sori in leaves, forming pale yellow, later brown, round, ovoid, or irregular spots, 1–6 mm in diameter, with numerous spore balls embedded in the host tissue appearing as minute dark brown raised dots.

Spore balls globose or subglobose, occasionally irregularly lobed following coalescence, 100–250 × 70–120 μm, composed of a central spore mass surrounded by a multi-layered cortex of small sterile cells; small groups of sterile cells may be scattered between the spores. **Cortical cells** rounded or irregularly angular, mostly radially flattened, tangentially 2–10 μm long; wall 1–2 μm thick; the lumen of the outermost cells usually disappearing; yellowish brown to brown, firmly bound together without free spaces between them, forming a 2–12 μm thick cortex composed of 1–4 or more layers. **Spores** rounded or irregularly angular, 8–15 × 6.5–10.5 μm, firmly bound together but often with small, free spaces at the corners between them; spore wall smooth, yellow, ca. 0.6 μm thick.

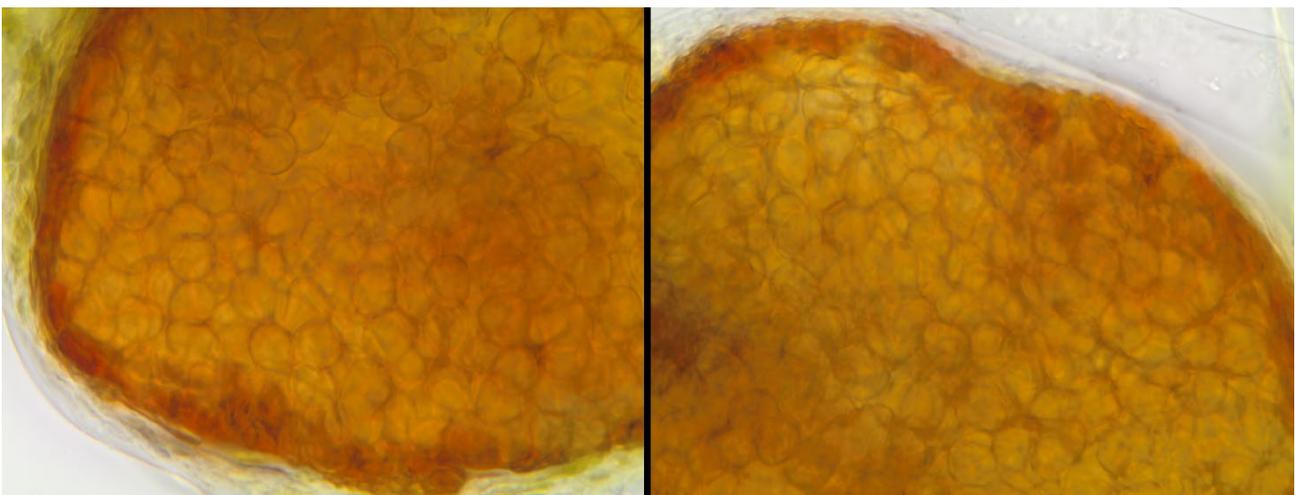
Habitats and host plants

High montane and alpine meadows; freshwater habitats, marsh meadows, moraines, alluvia.

Onagraceae: *Epilobium* species; in the arctic-alpine region *Epilobium alpestre* (*Epilobium trigonum*), *Epilobium alsinifolium* (*Epilobium organifolium*), *Epilobium anagallidifolium*, *Epilobium clavatum*, *Epilobium hornemannii*, and *Epilobium palustre*.

Distribution

North American–Eurasian alpine; type 3; found in arctic CAN (QC), and in the alpine Intermountain West (CAN: BC), the Rocky Mts. (USA: MT, CO), the Alps (DE), the Tatras (SK), the Pyrenees (FR), and Kamchatka (RU). Very rarely collected in the study area, probably overlooked. The only Norwegian locality (Torsken) is outside the arctic-alpine region.



Entyloma: Entylomataceae: Entylomatales



Entyloma arnicale E. Müller & K. Vánky, Ustilaginales 392; SOMF 17910; Switzerland

Entyloma arnicale Ellis & Everh.

Infection systemic. **Sori** occurring in leaves as amphigenous, circular or angular spots, 1–8 mm in diameter, at first greenish yellow, later brown, eventually necrotic except at margin and very opaque.

Spores solitary or adhering in small groups, subglobose, ovoid, or somewhat irregular, (10–)12–17.5(–20) × (8.5–)10–15(–16) μm, subhyaline when young but becoming yellow or light yellow brown at maturity; spore wall (0.7–)1.0–3.5 μm thick, with 1(–2) uniform inner layers, (0.5–)0.7–1.3(–1.8) μm thick, and uneven outer layer, 0.5–3.0 μm thick, often raised into rounded warts and ridges.

Anamorph on certain hosts regularly present, on others apparently absent. Conidiophores fasciculate in stomata, hypophyllous, rarely amphigenous; conidia hyaline, falcate, slightly curved, 10–26 × 2.2–4.0 μm, occasionally acicular, straight, 28–47 × 1.7–2.3 μm.

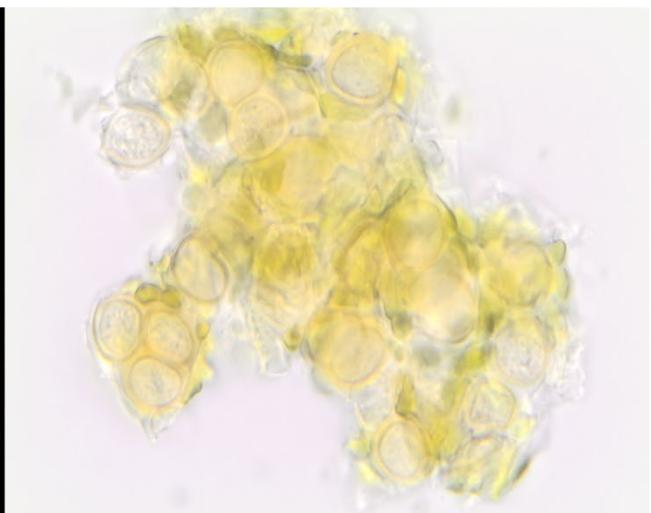
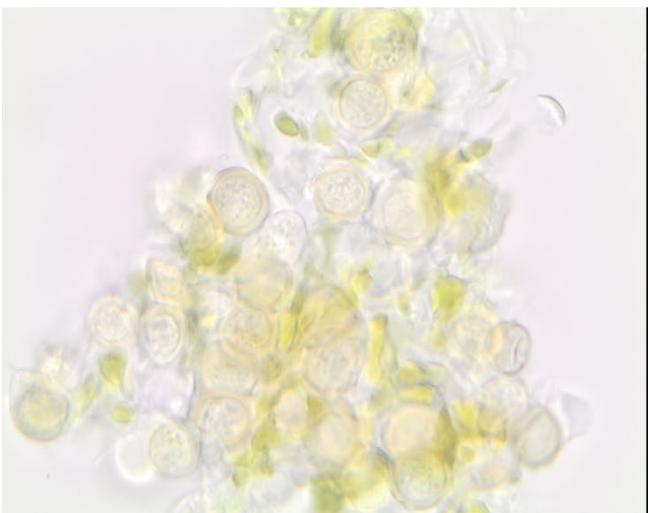
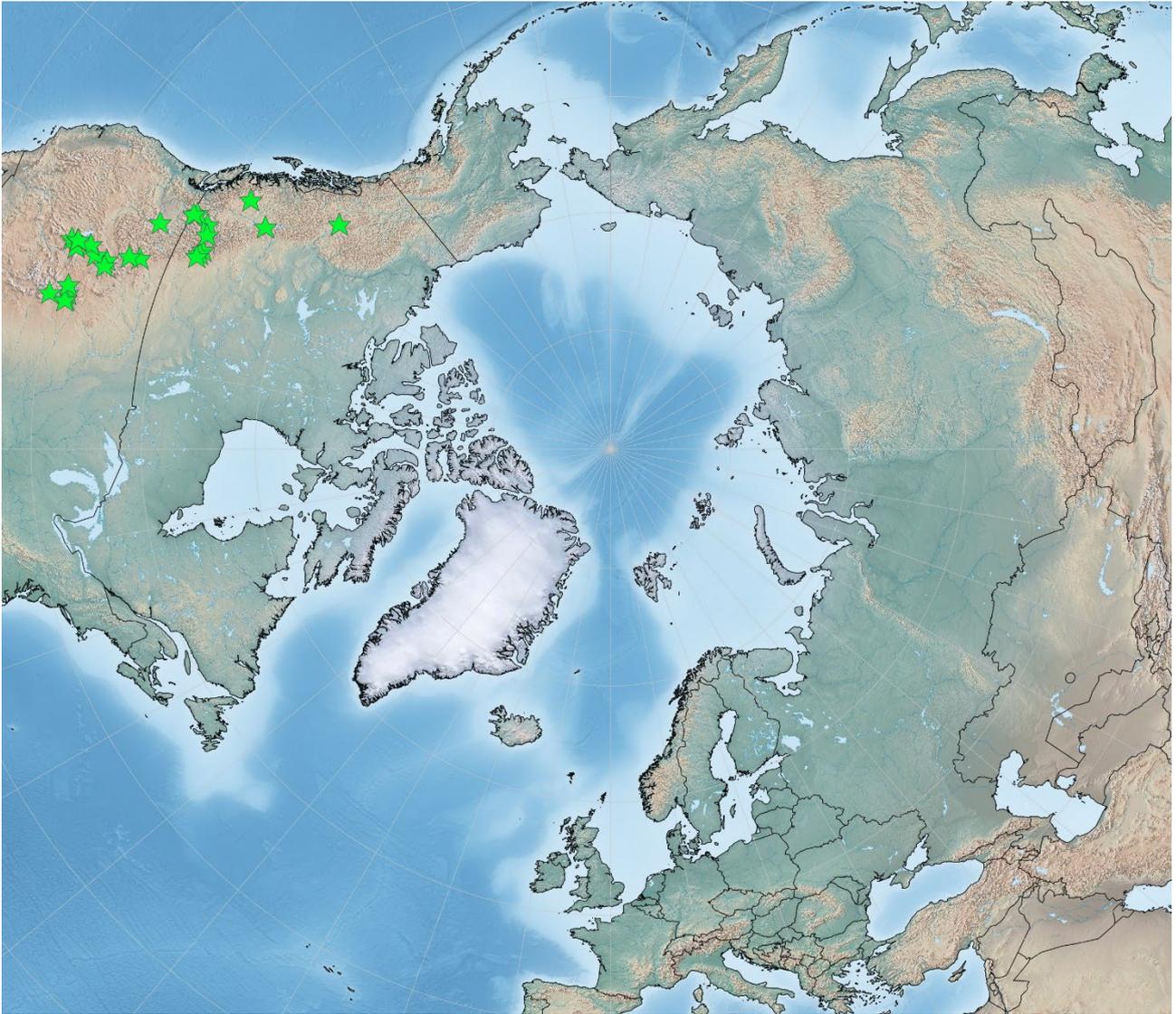
Habitats and host plants

Moist areas, along stream banks, snowmelt areas, montane to alpine meadows.

Asteraceae: *Arnica* species; in the alpine region *Arnica chamissonis*, *Arnica cordifolia*, *Arnica gracilis*, *Arnica latifolia*, *Arnica longifolia*, *Arnica mollis* (*A. subplumosa*), and *Arnica rydbergii*.

Distribution

North American alpine; type 14; found in the alpine Alaska-Yukon Ranges (CAN: YT), the Intermountain West (CAN: BC; and USA: ID), the Rocky Mts. (CAN: BC, AB; and USA: MT, WY, UT, CO). Rarely collected in the study area. In Europe, this smut fungus is known on *Arnica montana* from localities in non-alpine grasslands in the Alps (DE, CH, AT, IT), the Carpathians (RO, UA), and the Cantabrian Mts.



Entyloma: Entylomataceae: Entylomatales



Entyloma erigerontis J. I. Liro & H. Roivainen, *Mycoth. Fenn.* 361; CP1030982; Finland

Entyloma erigerontis Syd. & P. Syd. ex Cif.

Infection systemic. **Sori** in leaves, forming round or ovoid, at first yellow, later brown spots, 1–5 mm in diameter.

Spores densely crowded, subglobose, ovoid, or slightly irregular, 10–15 × 7–12 μm, pale yellow; spore wall 1.0–2.0 μm thick, smooth.

Anamorph present.

Habitats and host plants

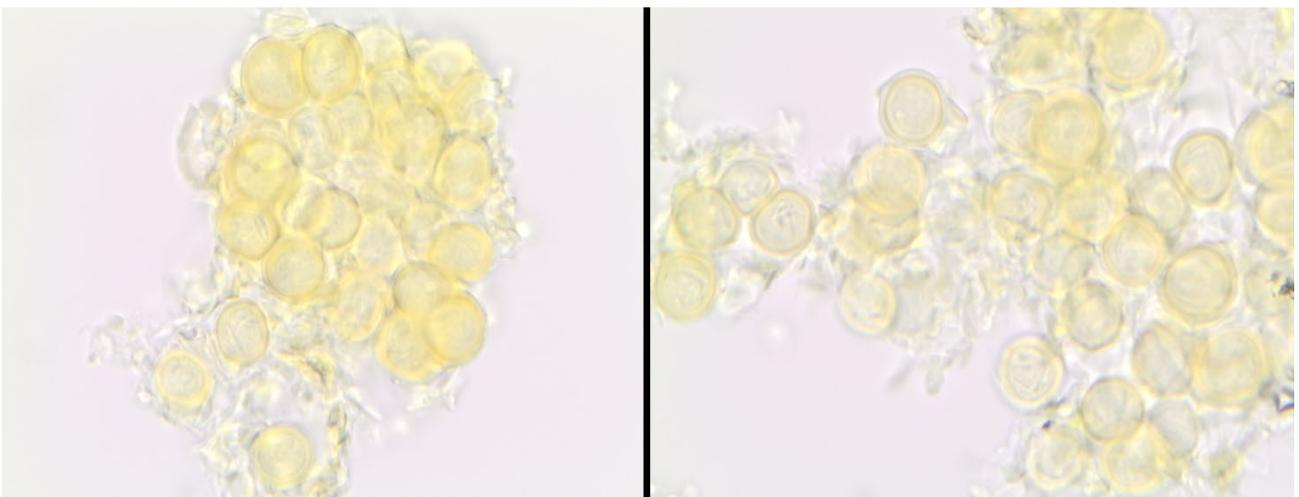
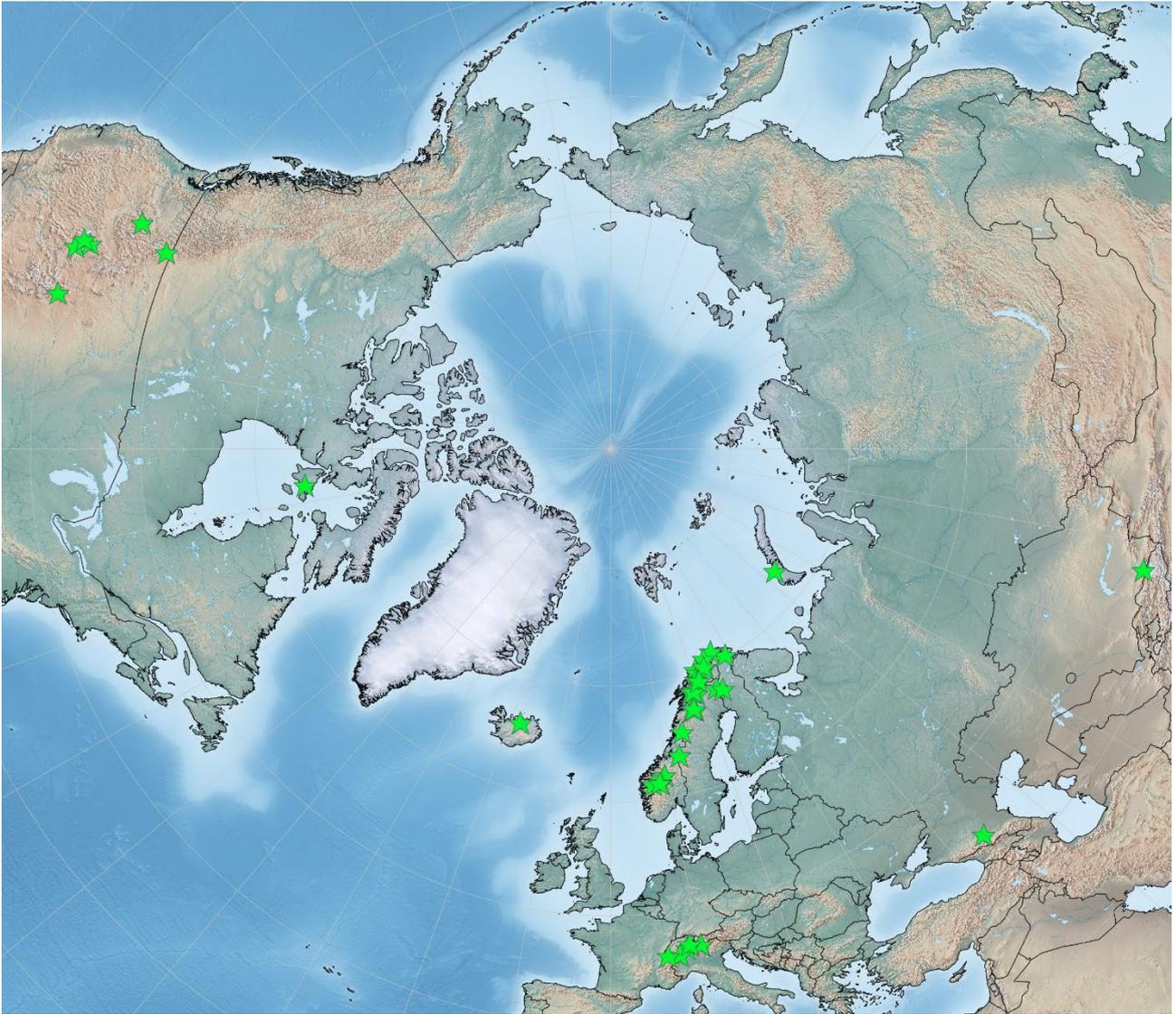
Arctic and alpine tundra, *Dryas*-tundra, snowbed slopes, pond and stream margins, river terraces, streambeds, shaley or gravelly slopes, peat deposits, high mountain vegetation, grasslands, rocky places (including limestone), ridges, around snowbanks.

Asteraceae: *Erigeron* species; in the arctic-alpine region *Erigeron acris*, *Erigeron alpinus*,

Erigeron aurantiacus, *Erigeron borealis*, *Erigeron eriocephalus*, *Erigeron glabratus*, *Erigeron glacialis*, *Erigeron humilis* (*Erigeron unalaschkensis*), *Erigeron politus* (*Erigeron acris* subsp. *politus*, *Erigeron elongatus*), *Erigeron schleicheri* (*Erigeron gaudinii*), *Erigeron speciosus*, *Erigeron uniflorus*, and *Erigeron ursinus*.

Distribution

Arctic-alpine; type 1, found in arctic CAN (NU), IS, NO, and RU, and in the alpine Rocky Mts. (USA: ID, MT, WY, UT, CO), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Alps (FR, CH), and Tian Shan (KZ). In the arctic-alpine region, this smut fungus is common in Norway and Sweden, but rarely collected in the other countries.



Entyloma: Entylomataceae: Entylomatales



Entyloma lapponicum

Liro & Roivainen, Mycoth. Fenn. 364; CP1030985; Finland

Entyloma lapponicum Liro

Infection systemic. **Sori** in leaflets, midribs, petioles, and stems, forming round to elongate white spots or swellings.

Spores variable in shape, globose, subglobose or irregularly angular, 12–23 × 10–18 μm, dense, subhyaline to pale yellow; spore wall two-layered, often uneven, 1.5–4.0 μm thick.

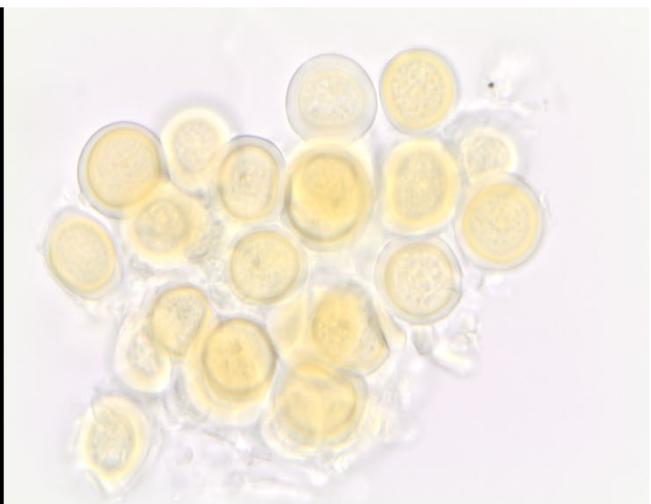
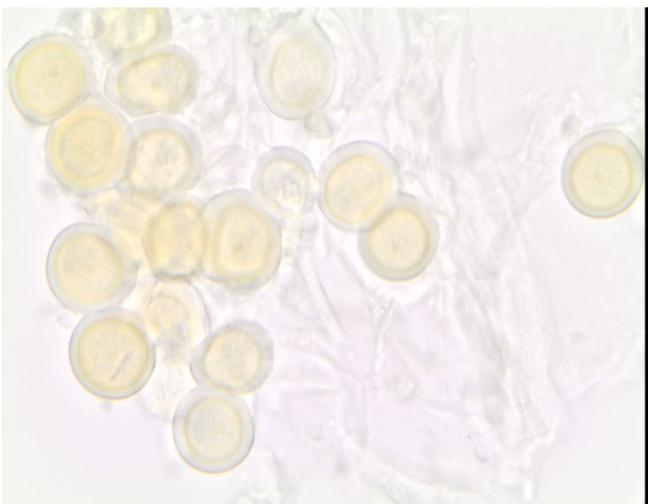
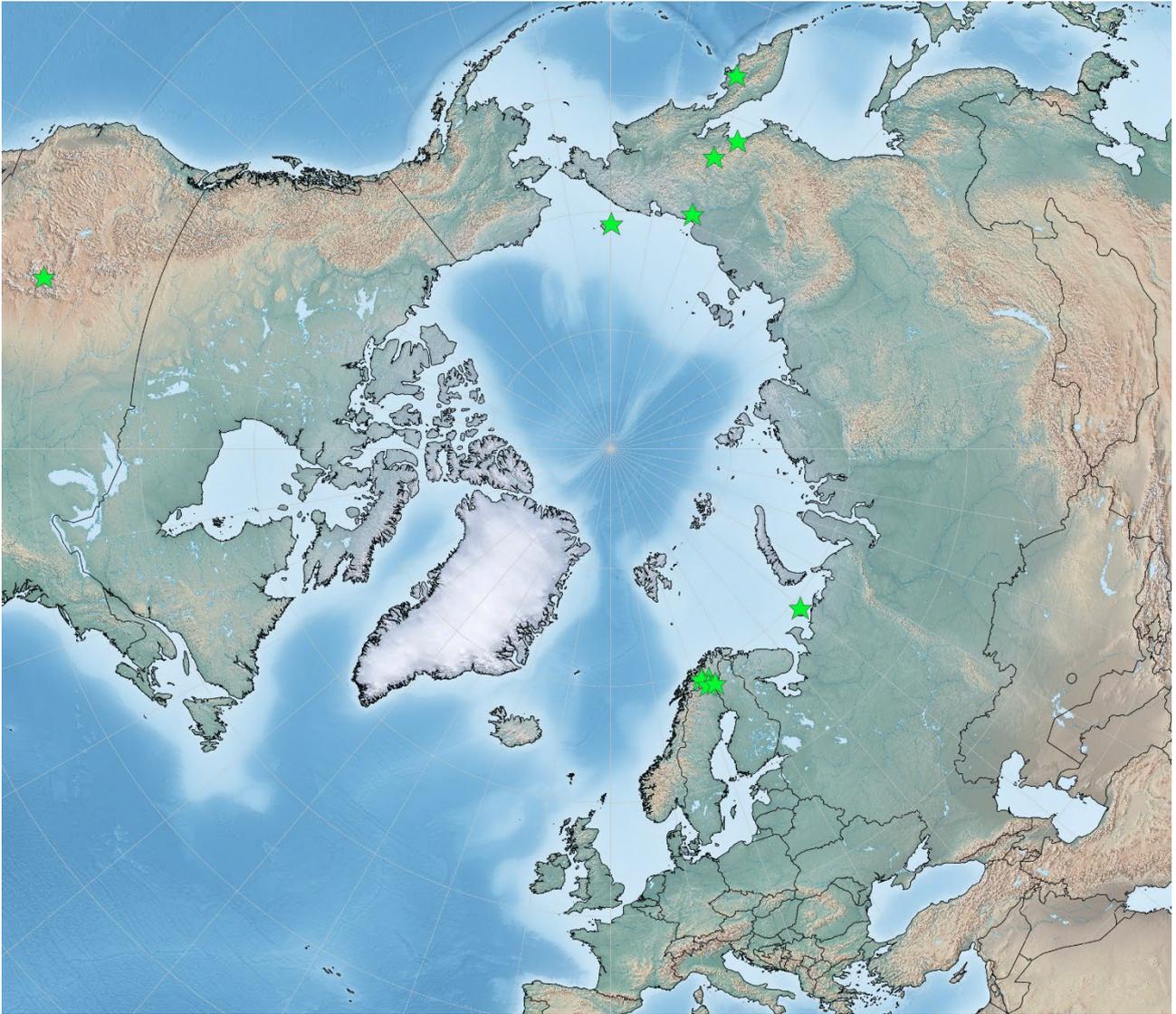
Habitats and host plants

Alpine-subalpine and arctic grassland; wet to moist swamps, meadows, river terraces, streambanks.

Polemoniaceae: *Polemonium* species; in the arctic-alpine region *Polemonium boreale* and *Polemonium villosum* (*P. acutiflorum*, *P. campanulatum*).

Distribution

North American alpine–Eurasian; type 5; found in arctic Russia, and in the alpine Rocky Mts. (USA: CO), the Scandinavian Mts. (NO, FI), the Kolyma Highlands, and Kamchatka (RU). A very rare species.



Entyloma: Entylomataceae: Entylomatales



Entyloma leontodontis

Entyloma leontodontis Syd. & P. Syd. ex Cif.

Infection systemic. **Sori** in leaves, forming round or ellipsoid, slightly swollen spots, initially yellowish, later pale brown or reddish brown, 1–6 mm in diameter, often with a light yellowish green halo.

Spores single or adhering in small groups, globose, ovoid, or irregularly angular, 10–15 × 8–13.5 μm, subhyaline to pale yellowish brown; spore wall regular to slightly uneven, 1.0–2.5 μm thick, smooth. **Anamorph** absent.

E. Baudys s.n.; BPI 175555; Czech Republic

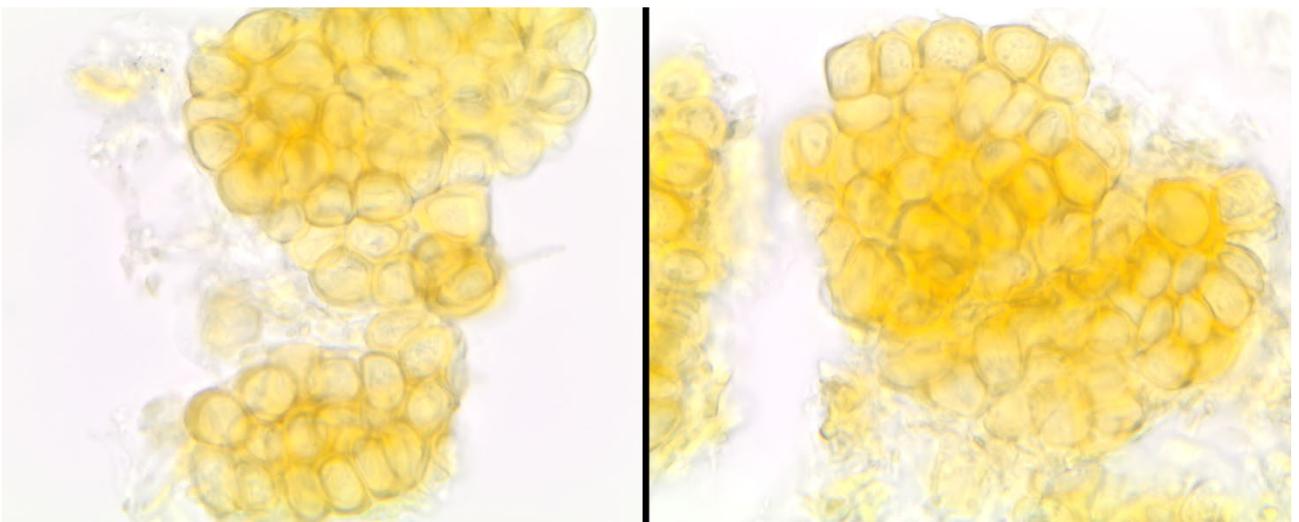
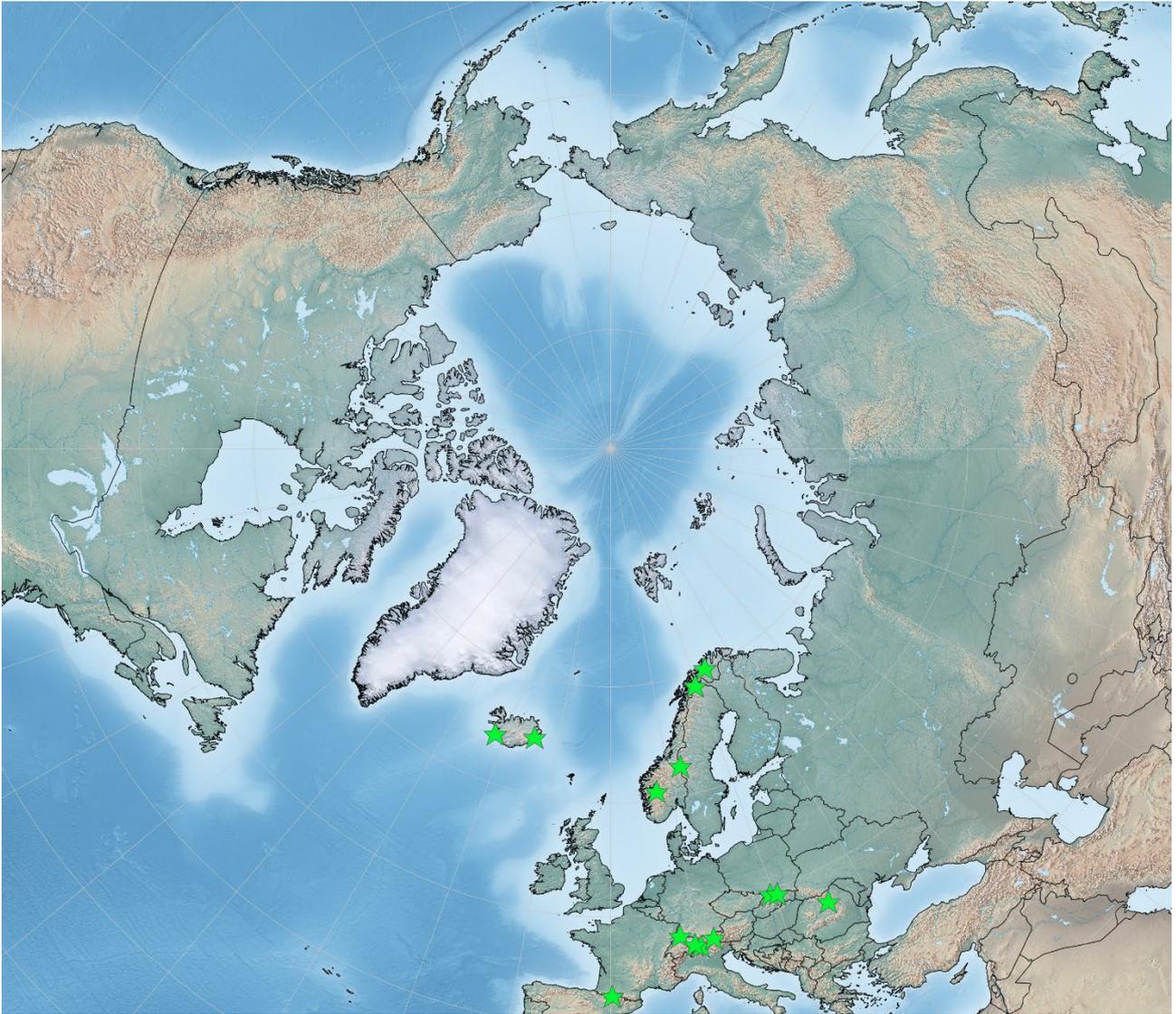
Habitats and host plants

Meadows, pastures, stony slopes.

Asteraceae: *Leontodon* and *Scorzoneroides*; in the arctic-alpine region *Leontodon hispidus* subsp. *hispidus*, *Scorzoneroides autumnalis* (*L. autumnalis*), *S. helvetica* (*L. helveticus*), *S. pyrenaica* (*L. pyrenaica*).

Distribution

Eurasian; type 9; found in arctic Iceland, and in the alpine Scandinavian Mts. (NO, SE), Dovre (NO), Schwarzwald (DE), and the Alps (CH, AT), Tatras (PL), Carpathians (RO), and Pyrenees (FR). Rarely reported, probably overlooked. Most Central European localities of this fungus on *Leontodon hispidus* and *Scorzoneroides autumnalis* are outside the arctic-alpine region.



Entyloma: Entylomataceae: Entylomatales



Entyloma microsporum Dingley, Vánky Ustilaginales 462; SOMF 18776; New Zealand

Entyloma microsporum (Unger) J. Schröt.

Syn.: *Entyloma microsporum* var. *pygmaeum* Allesch.

Infection systemic. **Sori** occurring in leaves and petioles as hard pustules or swellings, at first yellowish white and disc-like, later brown, swollen, subglobose, or fusiform, wart-like, with cracked surface.

Spores embedded in the host tissue, crowded, globose, ovoid, or irregular, 11–23 × 10–16 µm, light yellow; spore wall two-layered, inner layer yellow, uniformly ca. 0.5–1.0 µm thick, outer layer hyaline, uneven, 1.0–9.0 µm thick, smooth.

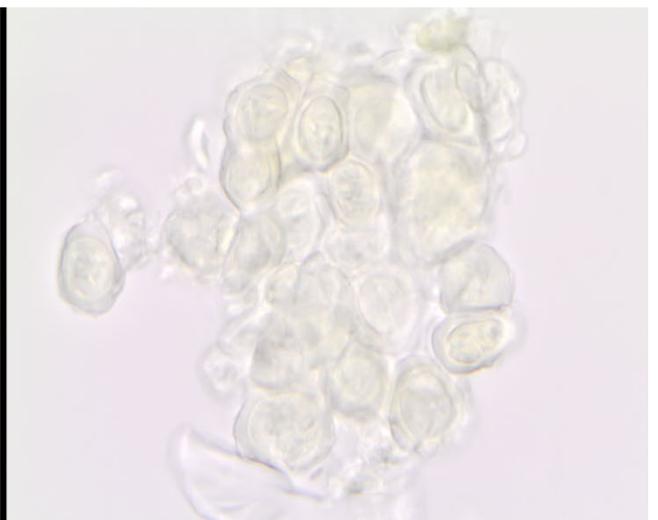
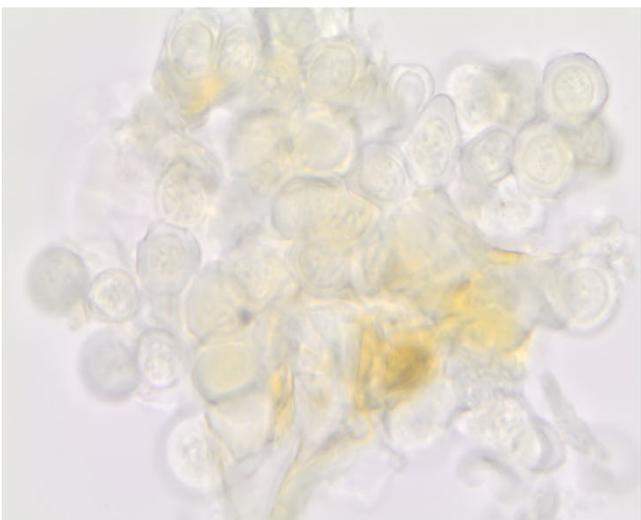
Habitats and host plants

Moist to wet meadows and pastures, stream banks, damp rocks, around persistent snow patches.

Ranunculaceae: *Ranunculus* species; in the arctic-alpine region *R. montanus*, *R. pygmaeus*, and *R. tuberosus* (*R. nemorosus*).

Distribution

Cosmopolitan; type 10; found in arctic Greenland, and in alpine regions of the Alps (CH, AT, SI). A very rare species in the study area. Most localities for this fungus are outside the arctic-alpine region.



Jamesdicksonia: Geogefischeriaceae: Geogefischeriales



Jamesdicksonia dactylidis sensu lato

C. Hinkova s.n.; SOMF 401; Bulgaria

Jamesdicksonia dactylidis (Pass.) R. Bauer, Begerow, A. Nagler & Oberw.

Syn.: *Entyloma dactylidis* (Pass.) Cif.; *E. catabrosae* Johanson; *E. crastophilum* Sacc.;
E. deschampsiae Liro; *E. nubilum* Liro; *E. semenoviana* (Lavrov) Gutner

Infection systemic. **Sori** in leaves and sheaths, forming linear to ovoid, greenish grey to blackish spots, 0.1–2(–3) mm long, scattered, sometimes confluent, often moderately swollen.

Spores densely packed, tending to cohere in irregular groups, variable in shape and size, from globose to irregularly polyhedral or elongate, 6–15(–20) × 5–11 μm, yellowish to blackish brown; spore wall smooth, ca. 1–2 μm thick.

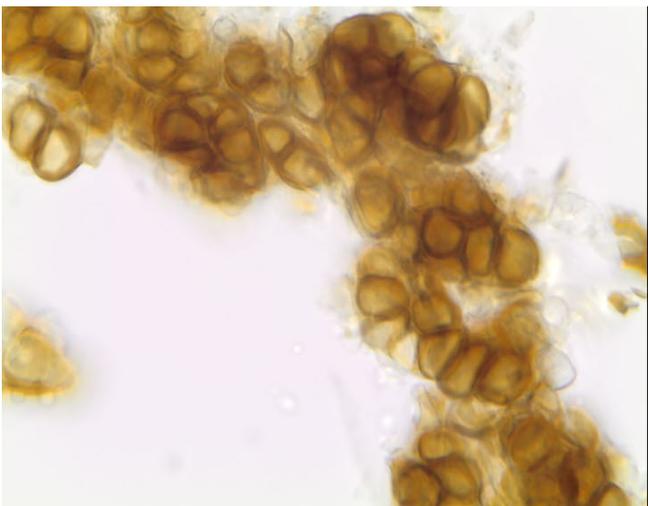
Habitats and host plants

The host plants in the study area grow in alpine-subalpine and arctic grassland; wet tundra; marshy meadows, the margins of rivers, streams, ponds, and lakes; and moist or dry grassland on mountain slopes.

Poaceae: on many genera of grasses; in the arctic-alpine region on *Alopecurus arundinaceus* (*Alopecurus ventricosus*), *Alopecurus pratensis*, *Avenella flexuosa* (*Deschampsia flexuosa*), *Catabrosa aquatica*, *Deschampsia cespitosa* (*Aira cespitosa*), *Dupontia fisheri*, *Poa annua*, *Poa secunda* subsp. *juncifolia* (*Poa nevadensis*), *Poa alpina* × *arctica*, *Polypogon maritimus*, and *Polypogon monspeliensis*.

Distribution

Cosmopolitan; type 5; found in arctic Iceland, Svalbard, Norway, and Russia, and in the alpine Alaska-Yukon Ranges (AK), the Rocky Mts. (USA: WY, UT), and Tian Shan (KZ). Rarely recorded from the study area.



Tilletia: Tilletiaceae: Tilletiales



Tilletia cerebrina

J. N. Nygaard s.n.; C-F-102484

Tilletia cerebrina Ellis & Everh.

Infection systemic. **Sori** in all ovaries of an infected plant, broadly ellipsoid or ovoid, $1.0\text{--}1.5 \times 0.7\text{--}1.0$ mm, with a short acute tip, bearing a rudimentary style and stigmas, partially visible between spreading floral bracts, covered by a thin purplish brown or yellow-brown pericarp that later ruptures to expose a powdery, dark reddish brown mass of spores and sterile cells.

Sterile cells irregular, sometimes subglobose, broadly ellipsoid, ellipsoid, or reniform, $(12\text{--})13\text{--}19(\text{--}20.5) \times (7.5\text{--})8.5\text{--}14(\text{--}15.5)$ μm , hyaline; cell wall $(1.0\text{--})1.2\text{--}1.7(\text{--}2.0)$ μm thick, smooth. **Spores** globose, subglobose, or broadly ellipsoid, sometimes ovoid or slightly irregularly rounded, $(22\text{--})23\text{--}28(\text{--}29.5) \times (20.5\text{--})21.5\text{--}26(\text{--}27.5)$ μm , medium reddish brown, cerebriform to incompletely reticulate; spore wall $2.5\text{--}3.2(\text{--}3.5)$ μm thick (including reticulum), muri $(21\text{--})23\text{--}27(\text{--}29)$ on equatorial circumference, in optical median view subacute, acute, or blunt, $(0.7\text{--})0.9\text{--}1.7(\text{--}2.0)$ μm high.

Habitats and host plants

Moist to wet habitats, from near sea level to alpine elevations; wet meadows and pastures, wet places near rivers and stream banks, river sand and gravel, damp alpine meadows.

Poaceae: *Aira* species, *Deschampsia* species; in the arctic-alpine region *Deschampsia brevifolia* (*D. cespitosa* subsp. *brevifolia*, *D. arctica*), *D. cespitosa* (*D. glauca*), *D. elongata*, and *D. koelerioides*.

Distribution

Arctic-alpine; type 1; found in arctic CAN (NU), GR, NO, and RU, and in the alpine Rocky Mts. (USA: ID, WY), the Scandinavian Mts. (NO, SE, FI), Dovre (NO), the Alps (DE, AT), Carpathians (RO), and Altai Mts. (RU), the Pamir-Alay Range (UZ), and Tian Shan (UZ). Rarely reported, probably overlooked.

Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium aequale

K. Høiland, CC (micro C-F-8103); Norway

Exobasidium aequale Sacc.

Basidioma parasitic, annual, surculicolous; infected shoots not elongate, with leaves yellowish to bright red on the upper surface, chalky white on the underside, not enlarged.

Spores oblong ellipsoid, (14-)15-22 × (6-)7-9 μm or almost cylindrical, 28 × 6 μm, or slightly sigmoid, not septate. **Conidia** not known.

Basidia 6-8 μm broad, 2-sterigmate.

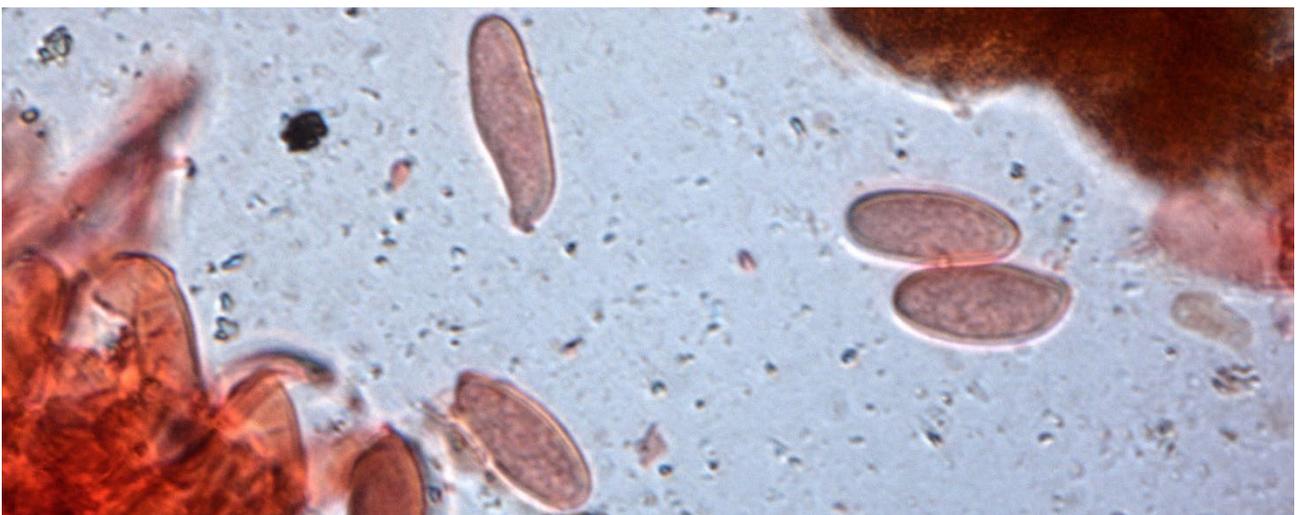
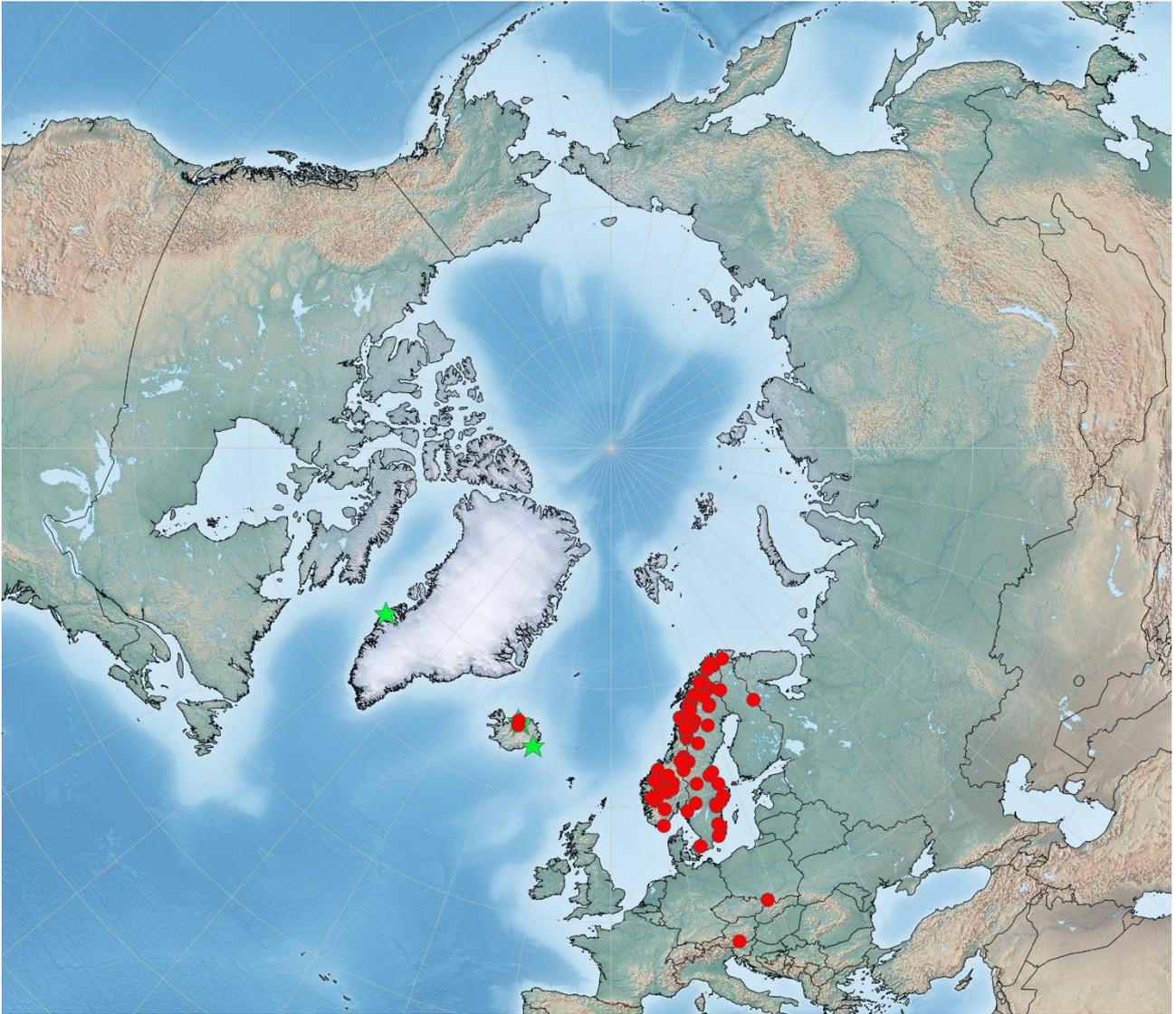
Habitat and hosts

On *Vaccinium myrtillus* in open forests of *Betula* and subalpine scrub, also in arctic-alpine vegetation.

Distribution

Arctic-alpine; North American-Eurasian; type 4. In arctic Greenland, Iceland, Norway, Sweden, Finland, and Russia; in the Alps very rare, known from only a few records in Austria and Germany.

Seemingly restricted to northern Europe with many Scandinavian records, but also recorded rarely from Greenland, Iceland and northern Russia. The host plant is common everywhere, so the species is most likely very rare.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium angustisporum

O. C. Hagestad, CC (micro C-F-155705); Norway

Exobasidium angustisporum Linder

Basidioma parasitic, annual, surculicolous; infected shoots solitary or clustered, with slightly enlarged leaves, pale yellowish to dark purple on the upper surface, on the underside concolorous or with white hymenial areas.

Spores (7-)11-16(-19) μm , cylindrical to allantoid, non-septate or rarely 1-septate.

Conidia cylindrical, 5-10 \times 1-2 μm . **Basidia** (2-)3-5(-6)-sterigmate.

Habitat and host

On *Arctostaphylos alpina* in arctic-alpine vegetation and in *Betula* scrub.

Distribution

Arctic-alpine; circumpolar; type 9. A rare species with an arctic-alpine distribution, absent outside this area. Known from arctic Alaska, Canada, Norway, Sweden, Finland, and Russia, and from the European Alps (Switzerland, Austria).



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium burtii

W. G. Ziller, DAOM 72648; C-F-169358; Canada (BC)

Exobasidium burtii Zeller

Basidioma parasitic, forming pale, not hypertrophied leaf spots ca. 0.5-1.5 cm in diameter.

Spores (14-)16-24 × 3-5.5 μm, cylindrical or slightly allantoid, sterigma prominent, eventually 0-1-3 septate. **Conidia** 4.5-14 × 1-1.5 μm, cylindrical or slightly ellipsoid.

Basidia 4(-5)-sterigmate, projecting 35-50 × 8-10 μm beyond the cuticle, sterigmata 5-6.5 × 1.5 μm.

Habitat and host

On *Rhododendron albiflorum*, restricted to the southwestern part of Canada and the northwestern part of the USA.

Distribution

Alpine; North American, type 14; characteristically restricted to the central and northern Rocky Mts. in Canada (BC) and the USA (WA, with a few records from OR).



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium cassiopes

SAE 89.123 (micro TB 99.062); C-F-108106

Exobasidium cassiopes Peck

Basidioma parasitic, surculicolous; infected shoots scattered, slightly elongate, with pale whitish-greenish stems and often inflated elongate leaves, often with a pink flush, eventually with hymenium, but apical leaves often without hymenium.

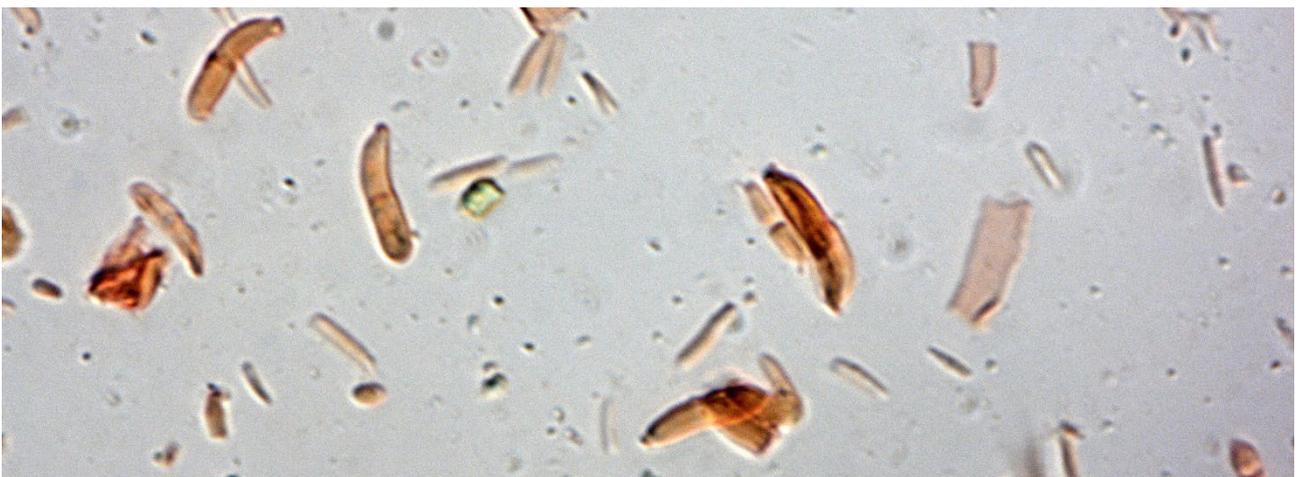
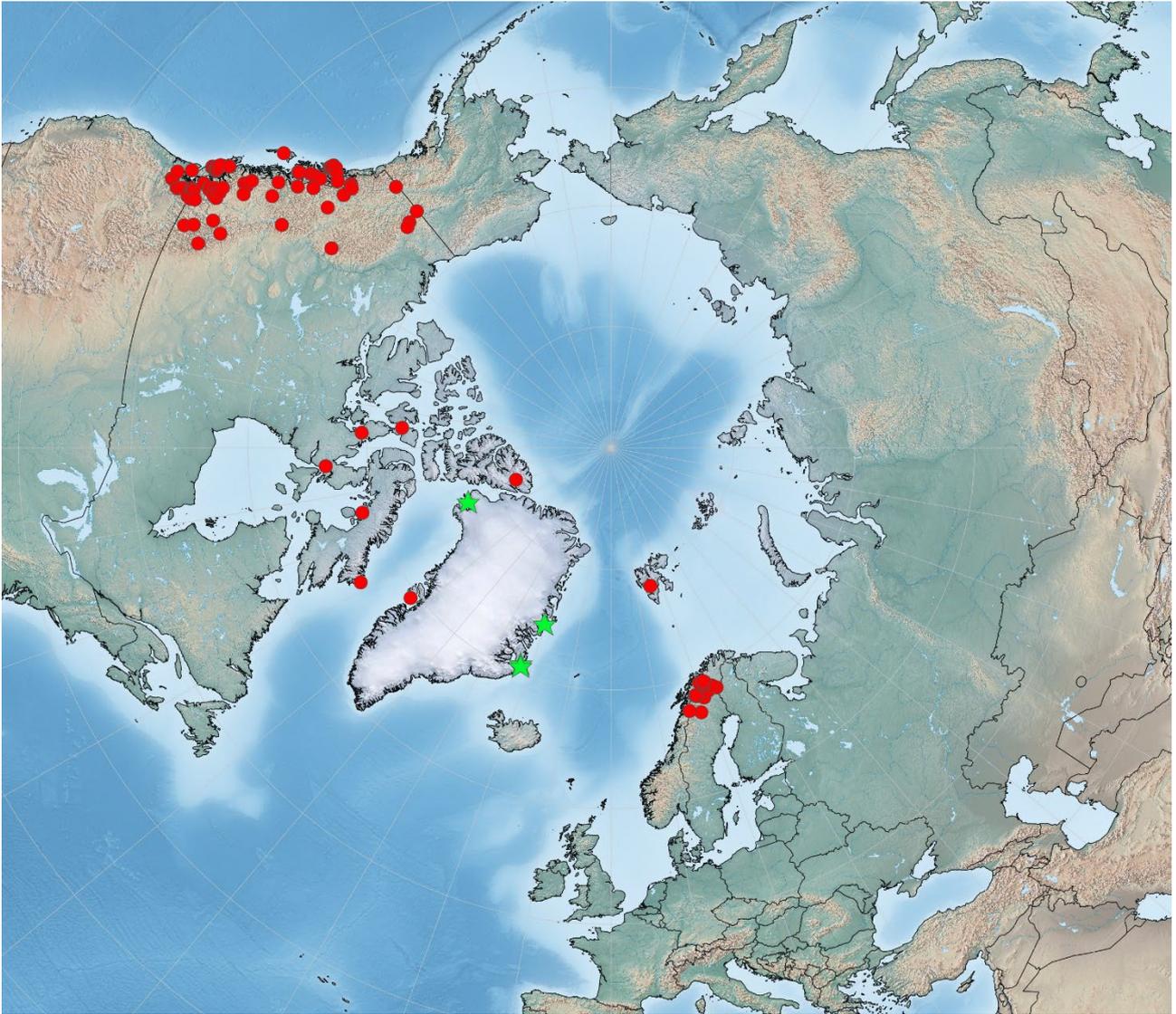
Spores (9-)10-16(-19) × 2.5-3.5(-4) μm, often septate. **Conidia** cylindrical, (5-)6-12(-13) × 0.8-1.5 μm. **Basidia** 30 × 5 μm broad, 2-4-sterigmate.

Habitat and hosts

On *Cassiope tetragona* and *C. hypnoides*.
On dry to moist, often calcareous ground, often forming large heath-like stands, but also mixed with other vegetation.

Distribution

Arctic-alpine; circumpolar; type 10. Known from arctic Canada, Greenland, Svalbard and northernmost Norway, Sweden, Finland, and a few records from the extreme west of Russia. Alpine records are restricted to the northwestern USA, Canada, and Alaska.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium empetri

H. Szczygiel (inaturalist.org); Alaska

Exobasidium empetri S. Ito & Otani

Basidioma parasitic; infection systemic, infected shoots yellow or red, hardly infected, hypophyllous.

Spores 14-18 × 6-8 μm, generally 1-septate, more rarely non-septate or 3-septate, broadly clavate or ellipsoid, with conspicuous, laterally projecting hilum. **Conidia** absent. **Basidia** projecting 28-40 × 6-8 μm, 2-sterigmate, sterigmata 8.5-11 × 3-3.5(-4.5) μm.

No material was available for microscopic details; these are from notes by Savile in 1959 (in GBIF.org).

Habitat and host

On *Empetrum nigrum* in open heaths, often near the coast.

Distribution

Alpine; circumpolar; type 8; with a very limited distribution in arctic-alpine Japan (Hokkaido), Russia (Sakhalin), Alaska, and Canada (BC). Apparently very rare.



No collection with spores was available to us.

Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium expansum

S. Nesterova, CC (micro C-F-156728); Russia

Exobasidium expansum Nannf.

Basidioma parasitic; infection systemic, with infected shoots only slightly modified but many shoots may occur together as “witches’ brooms,” with leaves pale green to reddish, often mottled on the upper surface, and on the underside developing a chalk white hymenium between the larger veins.

Spores 9-15 × 2.5-4 μm, cylindrical to allantoid, eventually 1-septate. **Conidia** 5-9 × 1-2 μm, bacilliform to slenderly ellipsoid.

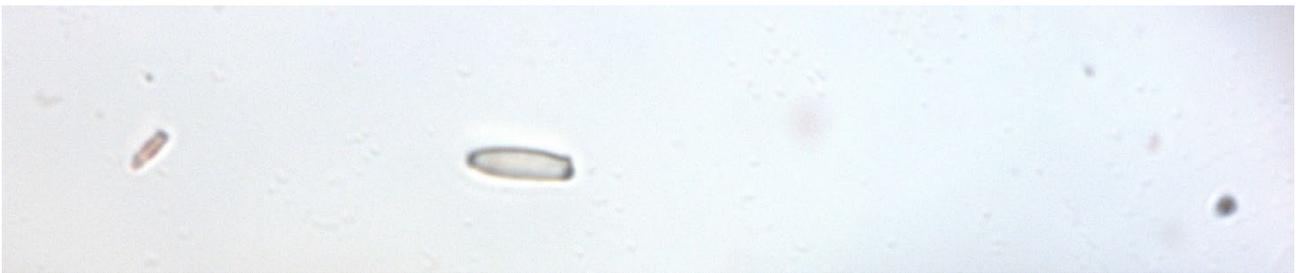
Basidia > 26 × 10-13 μm, 2-4-sterigmate.

Habitat and host

On *Vaccinium uliginosum*. Following the host plant, but still poorly known.

Distribution

Arctic-alpine; Eurasian; type 9. Recently described (Nannfeldt 1981) and only known from a few countries; in arctic Norway, Sweden, Finland, and Russia; and from alpine sites in Germany. Also occurring in boreal and temperate regions.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium hypogenum

HK 16.167; C-F-108404

Exobasidium hypogenum Nannf.

Basidioma parasitic, surculicolous; infected shoots scattered, hardly elongate, with pale whitish-greenish stems and often distinctly inflated-elongate red or white leaves, eventually with hymenium on the underside, but apical leaves often without hymenium.

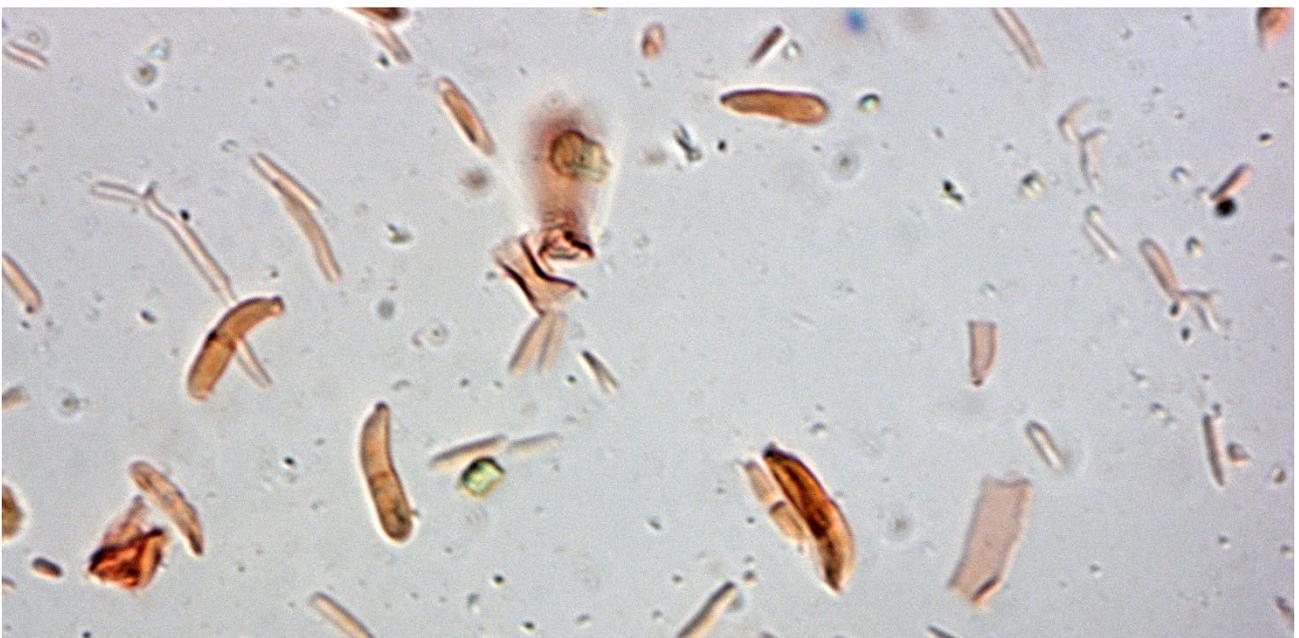
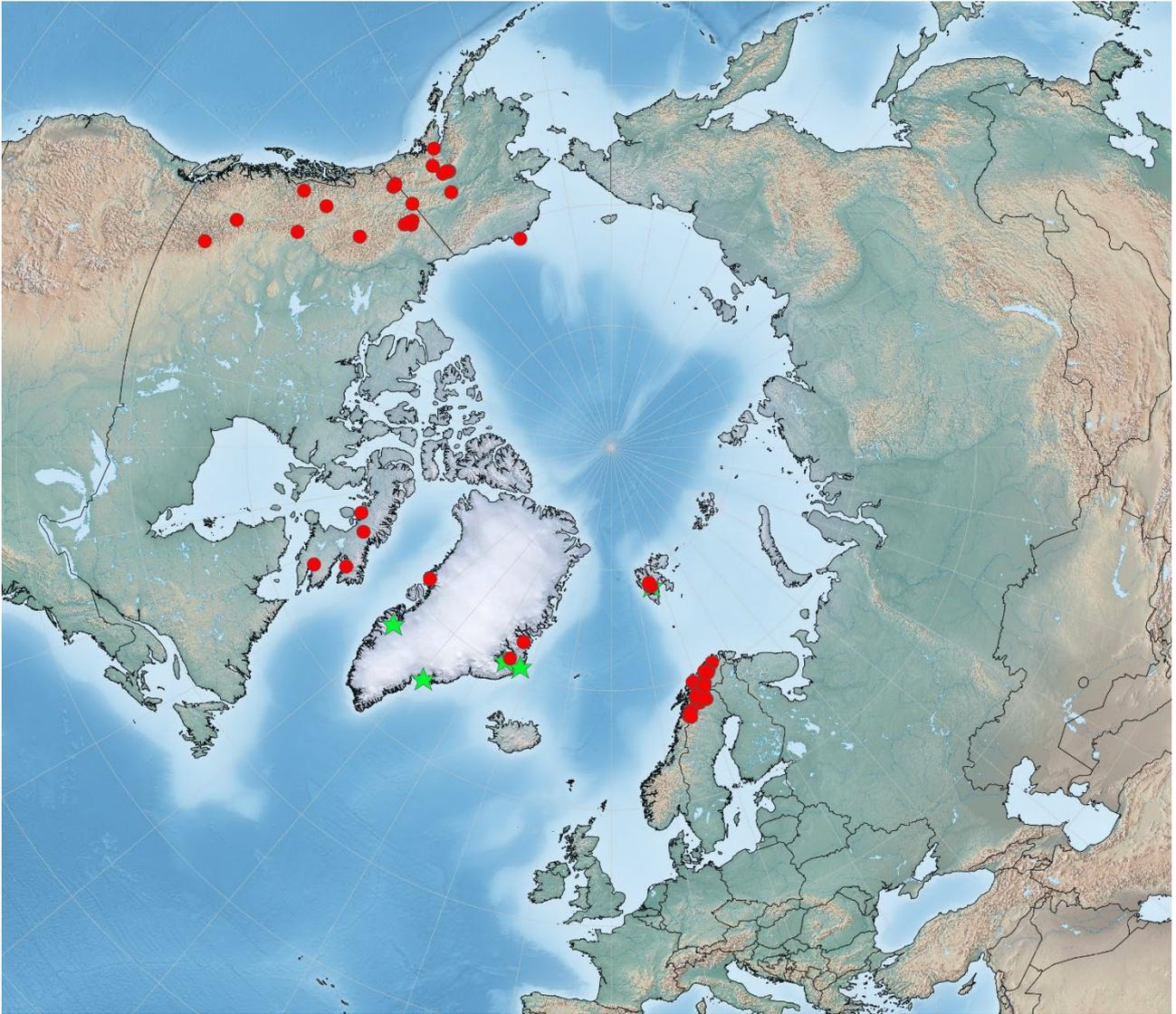
Spores (12-)13-15(-17) × 2.5-4 μm, subcylindrical, rarely septate. **Conidia** cylindrical, 4-11 × 0.8-2.0 μm. **Basidia** 17 × 3-5 μm broad, (2-)4-sterigmate.

Habitat and host

On *Cassiope* in dry to moist, often calcareous ground; host forming large heath-like stands, but also mixed with other vegetation. Often in the same localities as *Exobasidium cassiopes*.

Distribution

Arctic-alpine; circumpolar; type 3. Occurring in arctic Alaska, Canada, Greenland, Svalbard and northernmost Norway, Sweden, and Russia (the Kola Peninsula), and in the alpine Rocky Mts. in Canada and Alaska.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium juelianum

V. Dudka, CC (micro C-F-35520); Russia

Exobasidium juelianum Nannf.

Basidioma parasitic; infection systemic, causing the plant to become smaller, dwarfish, and richly branched; leaves with a red upper surface and eventually a partially whitish or more or less whitish underside.

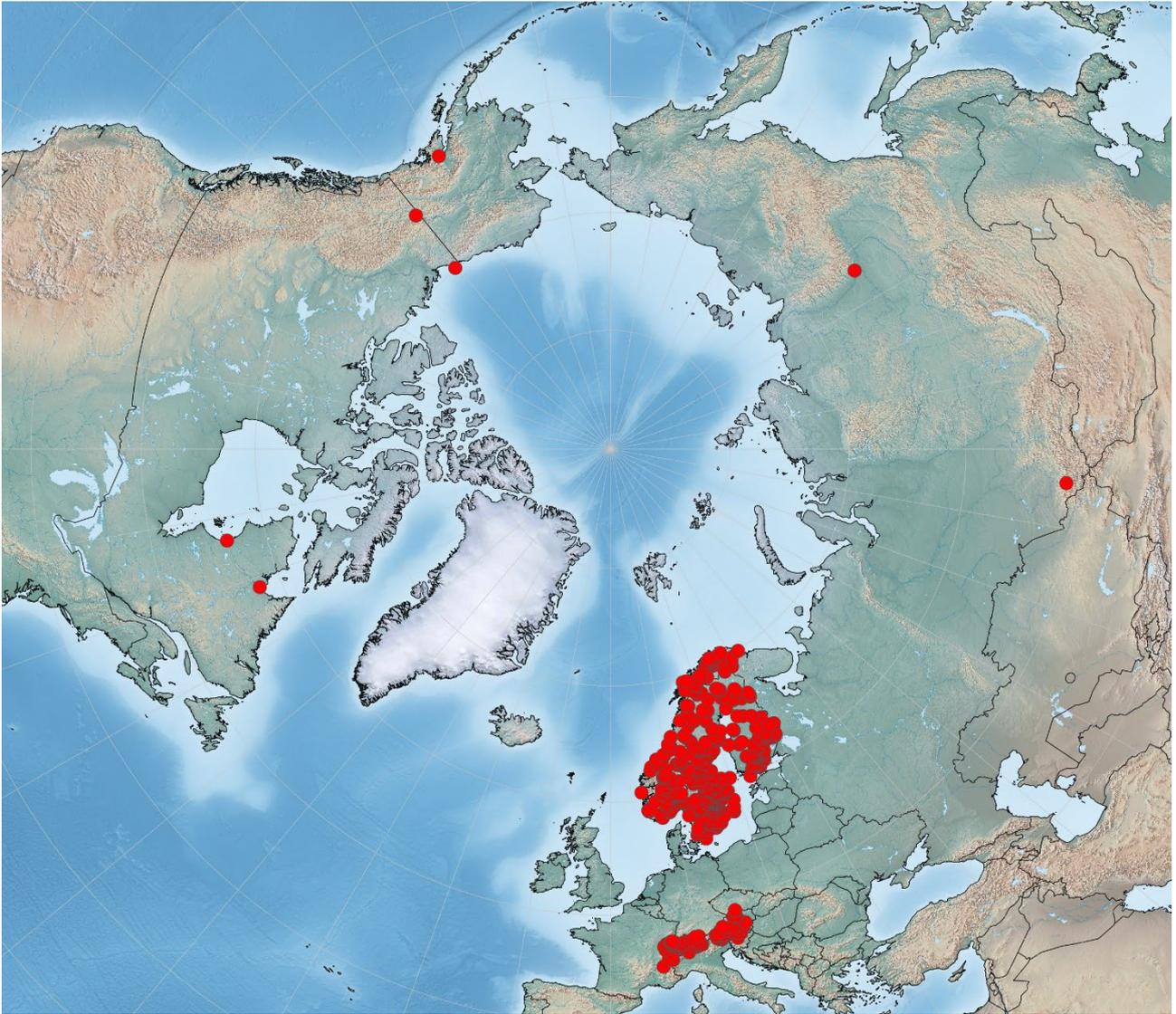
Spores 9-14 × 2-4 μm, cylindrical to slightly allantoid, 1-4-septate. **Conidia** 5-10 × 0.8-1.5 μm, bacilliform. **Basidia** 25-45 × 6-4 μm, 4(-5)-sterigmate.

Habitat and host

On *Vaccinium vitis-idaea* in tundra, heaths and other open arctic areas.

Distribution

Arctic-alpine; circumpolar; type 1. In the Arctic known from Alaska, Canada (YT, NL), Norway, Sweden, Finland, and Russia. In alpine areas known from Switzerland and Austria. A conspicuous species.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium karstenii

V. Dudka, CC (micro J. Lind, C-F-155698); Russia

Exobasidium karstenii Sacc. & Trotter

Basidioma parasitic; infection probably systemic; infected shoots occurring as scattered or gregarious annual growth coming from older or underground parts of the plant; leaves broadened as an effect of the infection, becoming soft and dark purple on the upper surface and pale whitish on the underside when mature.

Spores 12-18(-20) × 2.0-4.5 μm, cylindrical or slightly allantoid, at maturity 1-4-septate.

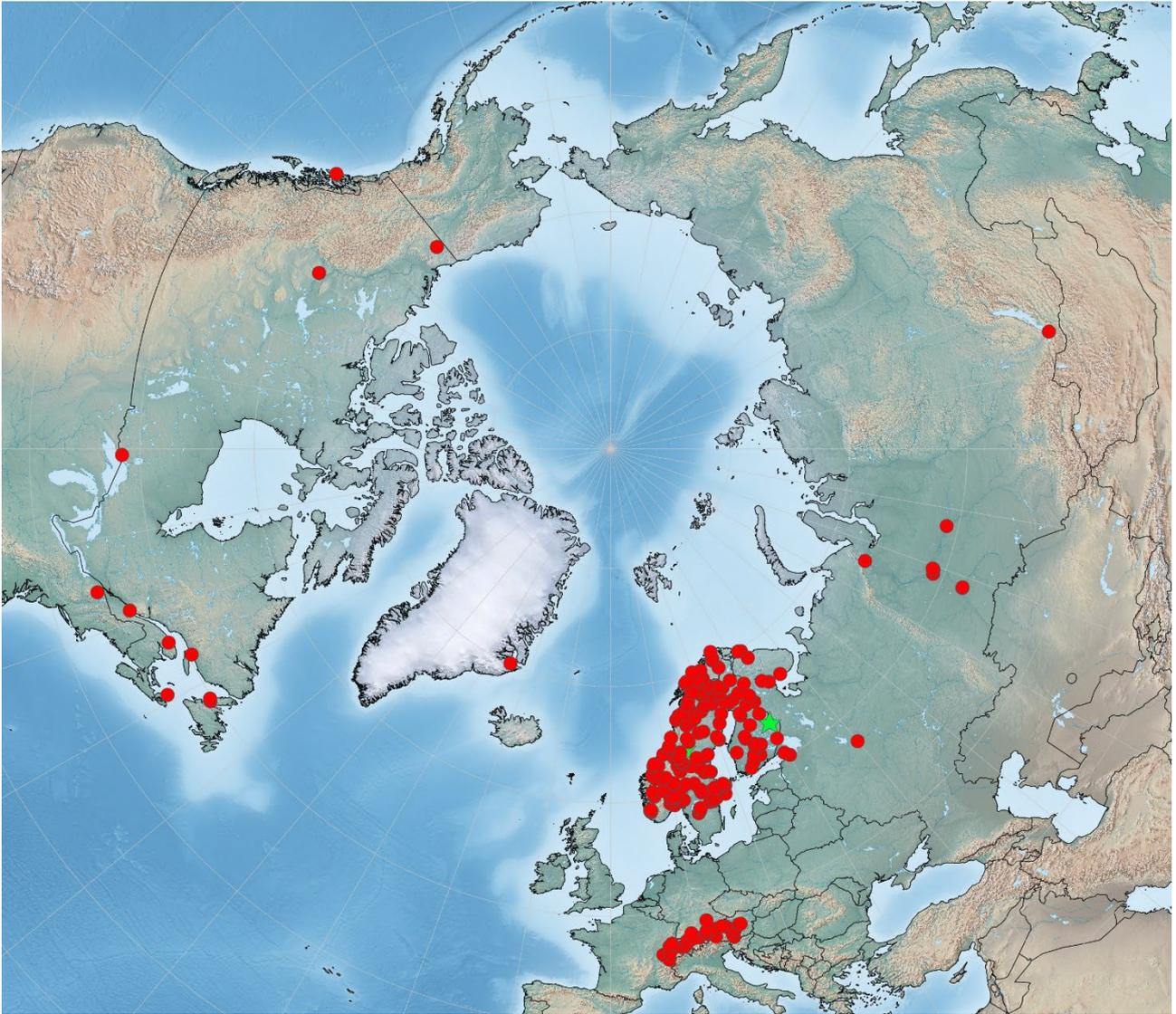
Conidia 9-13 × 0.8-1.5 μm, bacilliform to subfusiform. **Basidia** 35-50 × 3.5-5 μm, 2-4-sterigmate. **Hyphae** 1-2.5 μm broad, without clamp connections.

Habitat and host

On *Andromeda polifolia* and *A. glaucophylla*. Following the host plants throughout their distribution, in heaths, bogs and forests.

Distribution

Arctic-alpine; circumpolar; type 1. In the arctic zone known from northern Canada (YT, NL), Norway, Sweden, Finland, and Russia (the Kola Peninsula and Kamchatka); also in the Alps (Switzerland, Austria and Germany).



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium ledi

J. Lind; C-F-156683; Sweden

Exobasidium ledi P. Karst.

Basidioma parasitic, inconspicuous, forming small pale yellowish spots on the leaves, smooth on the upper leaf surface, waxy on the fertile underside, one to several on each leaf.

Spores 12-15 × 2.5-4.5 μm, elongate to slightly allantoid, with prominent apiculus, septum not seen. **Conidia** acicular, 4-6 × 1 μm.

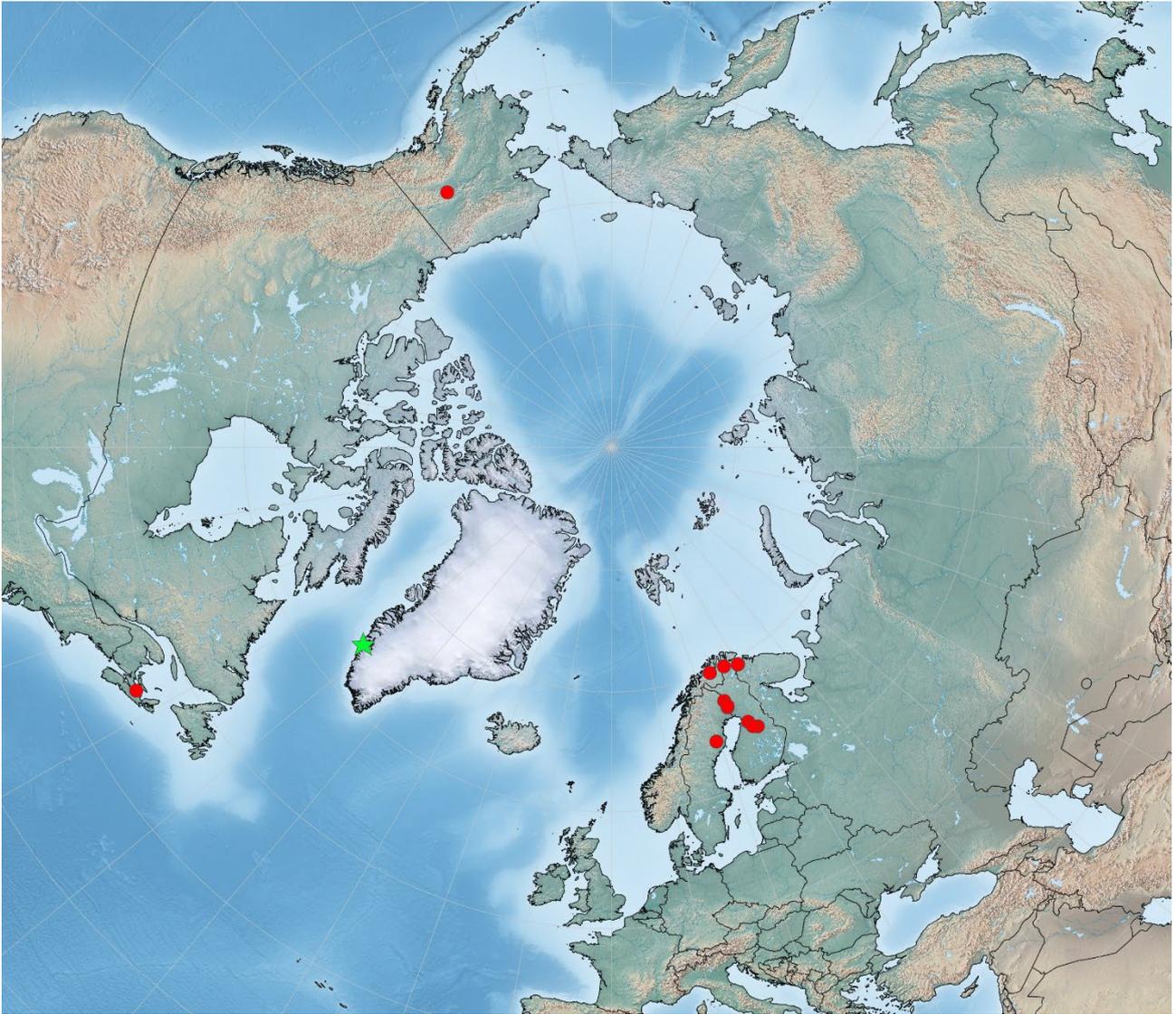
Basidia up to 100 μm long, cylindrical, 4-sterigmate.

Habitat and host

On *Rhododendron tomentosum* (*Ledum palustre*) and *Rhododendron groenlandicum* (*Ledum groenlandicum*). Apparently rare, with very few records.

Distribution

Arctic; circumpolar; type 1. Known from a few localities in arctic Alaska and Canada (Nova Scotia), and from alpine regions of the USA (Idaho, Oregon, Washington), Greenland, Norway, Sweden, Finland, and Russia.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium myrtilli

S. Moen (CC); Norway

Exobasidium myrtilli Siegm.

Syn.: *Exobasidium vaccinii-myrtilli* (Fuckel) Juel; *E. decolorans* Harkness

Basidioma parasitic; infection systemic; infected shoots at first with pale green leaves, slightly enlarged, upper surface becoming yellowish and finally red, underside slightly whitish from developing hymenium.

Spores (9-)10-16 × 1.5-4.0 μm, cylindrical or slightly sigmoid, often becoming 1(-3)-septate, apiculate. **Conidia** cylindrical, 7-11 × 1-2 μm, bacilliform to subfusiform. **Basidia** 25-32 × 7-7.5 μm, 4-6-sterigmate.

Habitat and hosts

On *Vaccinium myrtilloides*, mainly in coniferous forests on open and acid ground. In the northwestern USA, populations occurring as a parasite on *Rhododendron occidentale* were

previously known as *Exobasidium decolorans*. *Cassiope tetragona* was mistakenly reported as a host in Kobayasi et al. (1967).

Distribution

Arctic-alpine; circumpolar; type 9. In arctic Norway (including a few collections from Dovre), Sweden, and Finland. In subalpine sites known from a few places in the northwestern USA (OR and WA, not included), the Alps (France, Switzerland, Austria), the Pyrenees (France), Dovre (Norway), and Altai (Russia). Also in boreal and temperate lowlands, particularly in coastal regions.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium pachysporum

G. W. Montelin; C-F-155694; Sweden

Exobasidium pachysporum Nannf.

Basidioma parasitic, circumscribed; infected leaves normal, on the upper surface with 0.5 cm broad spots, pink at centre, with broad yellowish margin, underside at maturity whitish.

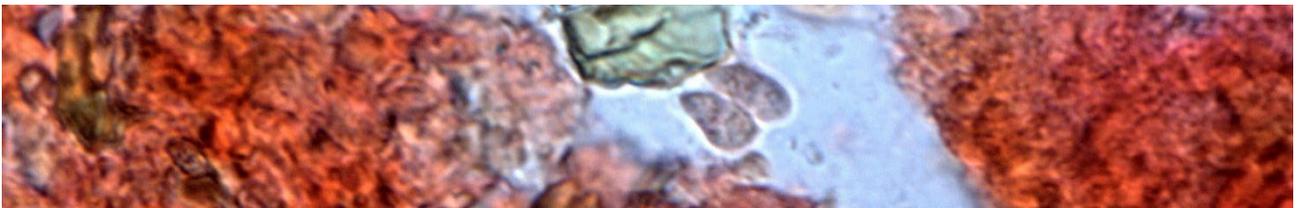
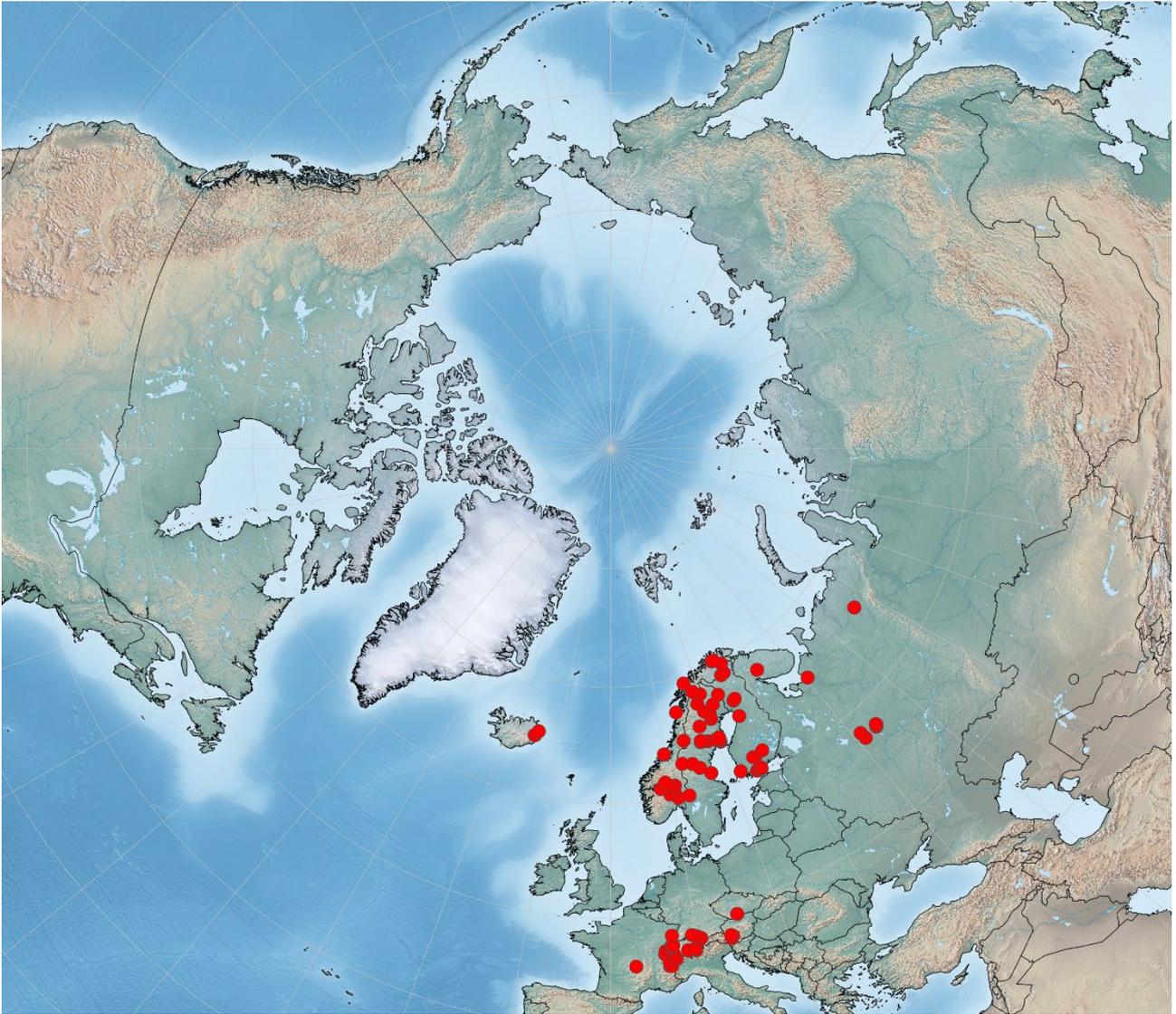
Spores 10-16 × 2-6 μm, ellipsoid, at maturity 1-3-septate. **Conidia** 6-10 × 1-1.5 μm, bacilliform. **Basidia** 50-55 × 4.5-5.5 μm, (3-)4-sterigmate. **Hyphae** 1-2 μm, without clamp connections.

Habitat and host

On *Vaccinium uliginosum*. Following the host throughout its distribution.

Distribution

Arctic-alpine; circumpolar; type 9, but in North America only represented by a single collection from Mt. Lafayette in New Hampshire (leg. D. H. Linder, 1935, C). Known from Iceland, large parts of Norway, Sweden, Finland, and Russia, and from the Alps, in Switzerland, Austria, France, and Germany, and from Siberia. Also known from many boreal and temperate regions.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium phyllodoces

C. & T. van Loon, CC (micro I. Kukkonen 557, DAOM 215147, UPS F-682235); Canada (BC)

Exobasidium phyllodoces (Savile) Savile

Syn.: *Exobasidium vaccinii-uliginosi* var. *phyllodoces* Savile

Basidioma parasitic, surculicolous.

Spores 13-16.5(-17) × 4.5-6 μm, cylindrical to weakly ellipsoid, with pronounced sterigmata, hyaline. **Basidia** 17-18 × 5-6 μm, 2-spored.

Habitat and hosts

A poorly known species, occurring on *Phyllodoce aleutica*, *P. empetrifomis*, and *P. glanduliflora*, but so far not found on the most widespread species of *Phyllodoce*, *P. caerulea*.

Distribution

Arctic-alpine; North American; type 14. Recorded from Canada (AB, BC, YT) and the USA (WA). Seemingly restricted to the northwestern corner of the USA (in Washington state) and western Canada.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium rhododendri SAE, 2021 (lost, micro HK 21.015a, C-F-152069); Germany

Exobasidium rhododendri (Fuckel) C.E. Cramer

Basidioma parasitic, circumscribed; infected leaves with conspicuous fleshy irregular “gall-apples,” which are more or less globose, at first green, then red, contracted at base, with hymenium all over.

Spores 12-15 × 2.5-4 μm, cylindrical to slightly allantoid, at maturity 1-septate.

Conidia 5-10 × 0.8-2 μm, bacilliform to subfusiform. **Basidia** 40-50 × 8-12 μm broad, 4-6-sterigmate.

Habitat and hosts

On *Rhododendron*, following the host species throughout their range. Commonly occurring in alpine regions on *R. ferrugineum* and *R. luteum*, but also in other areas where species of *Rhododendron* are introduced. Some records from arctic regions come from introduced hosts.

Distribution

Alpine; Eurasian; possibly circumpolar; type 15. Some or even many arctic populations have most likely been introduced together with the bushes.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium savilei

J. Dearness, det. Nannfeldt, DAOM 133040;
C-NHMD001788866; Canada (ON)

Exobasidium savilei Nannf.

Syn.: *Exobasidium vaccinii* sensu auct. p.p.

Basidioma parasitic, making the leaves reddish or brownish red and more slender, and underside with a whitish hymenium.

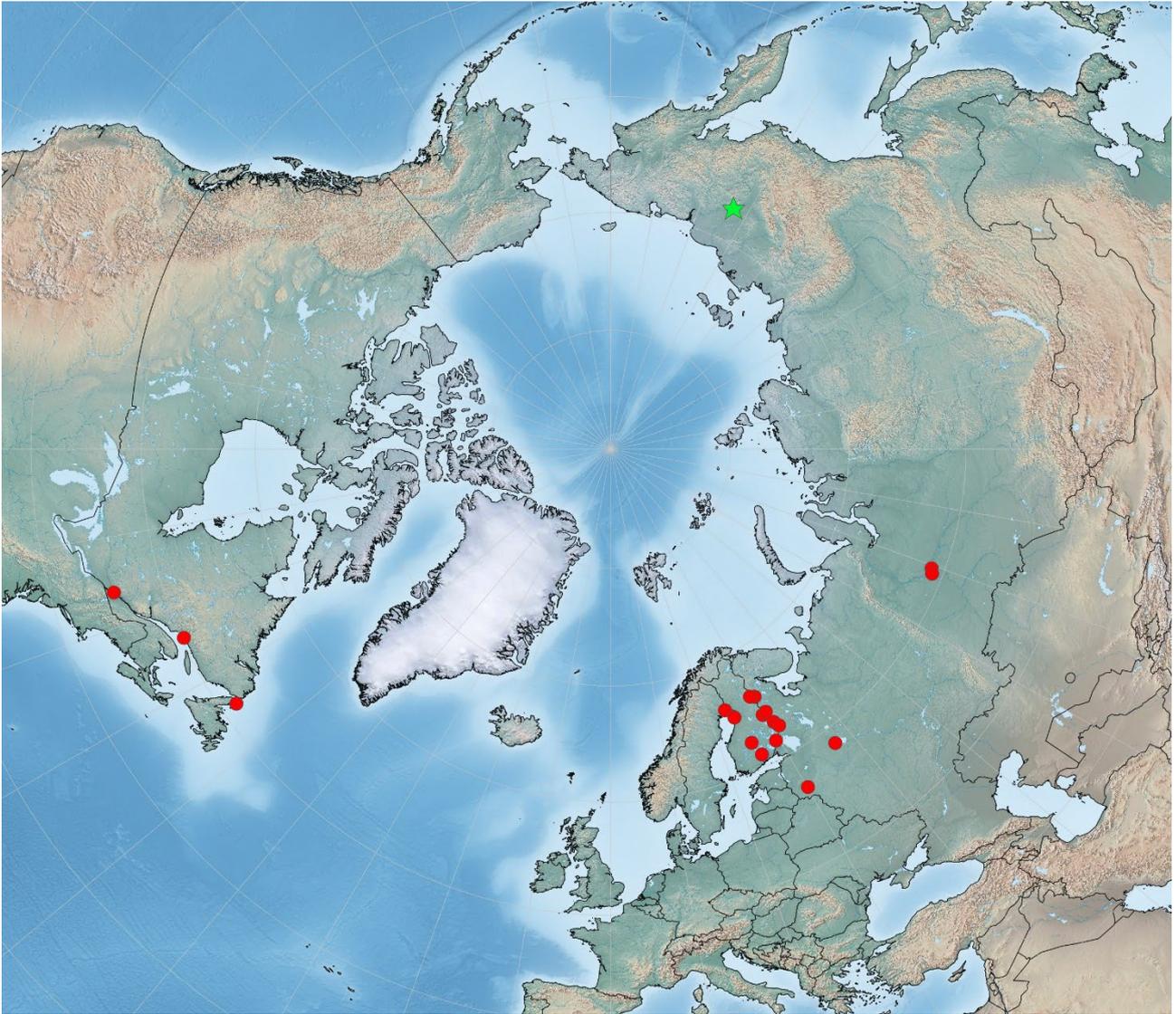
Spores 10-13 × 2.5-4.0 μm, finally septate, subcylindrical to subclavate. **Conidia** 6-10 × 0.8-1.0 μm, bacilliform. **Basidia** not seen fully, ca. 5 μm broad, with 4 sterigmata.

Habitat and host

On the leaves of *Chamaedaphne calyculata*. The host is distributed in subarctic and arctic regions of the northern Hemisphere, except for the Atlantic area (missing from Fennoscandia, Iceland and Greenland).

Distribution

Alpine; circumpolar, type 1. Probably following its host in North America and Eurasia, absent in alpine Atlantic areas (see above). The fungus is however much more rare or rarely collected than the host.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium splendidum

SAE-2018.376-GR; C-F-112923

Exobasidium splendidum Nannf.

Basidioma parasitic, annual, surculicolous; infected shoots clustered or solitary, slightly elongate; leaves enlarged, fleshy, with slightly revolute margin, shining and bright red on the upper surface, on the underside with a distinct white hymenium.

Spores (15-)20-27 × 6.0-11.5 μm, on average 21-24 × 9.5-11 μm, broadly oblong ellipsoid to subpyriform, not septate. **Conidia** not known.

Basidia 25 × 5-8 μm, 2-sterigmate.

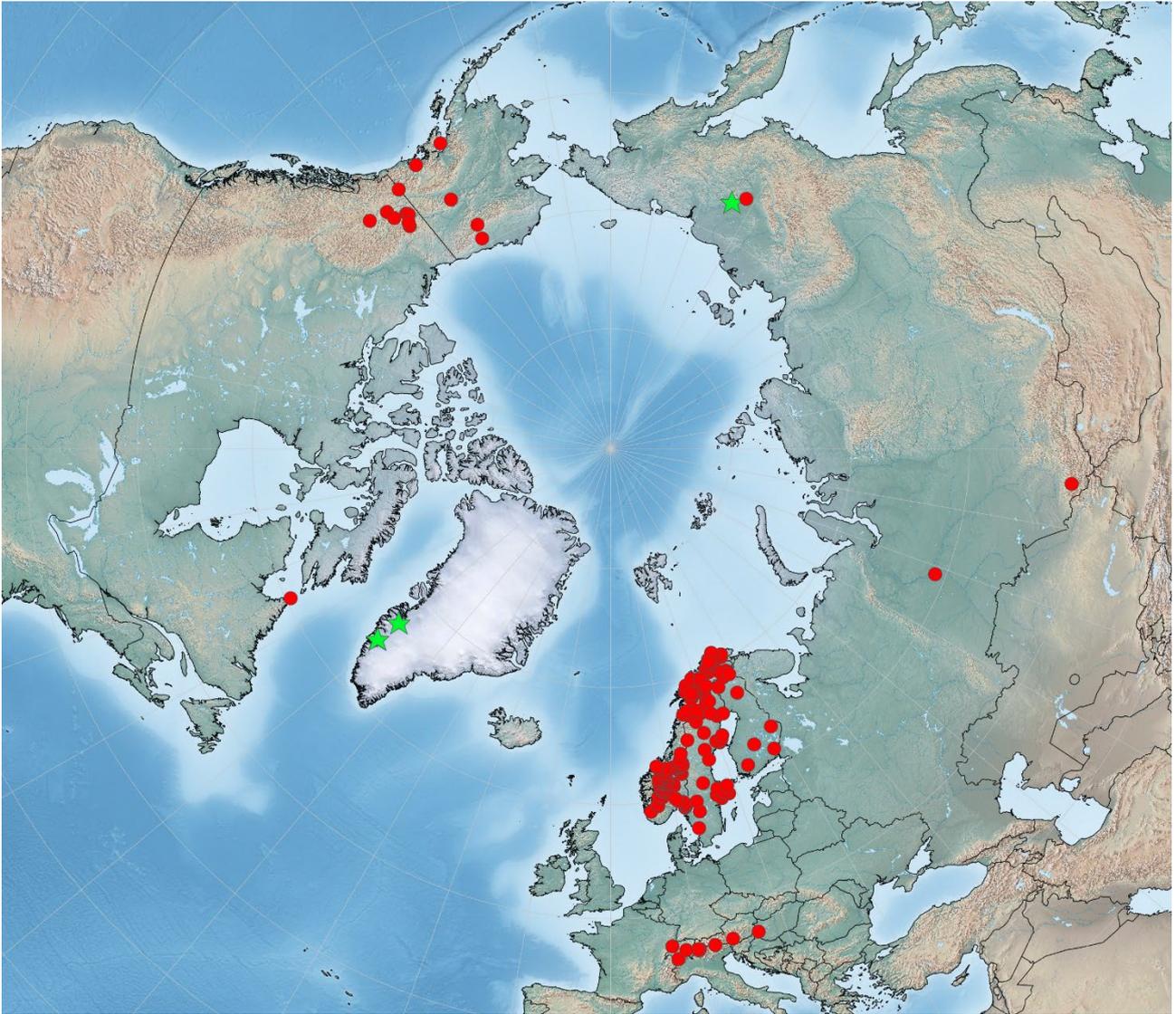
Habitat and host

On *Vaccinium vitis-idaea*. Obligatory following the host, in heaths, bogs, and open forests, on nutrient-poor, sandy or turfy soil.

Distribution

Arctic-alpine; circumpolar; type 1. Known from Alaska, Canada (YT, NL), Greenland, Norway, Sweden, Finland, and Russia; and in the Alps (Germany, Switzerland, and Austria), the Tatra Mts. (Poland), and Russia.

Exobasidium. splendidum follows the host into northern boreal areas, but is absent from more southerly temperate areas where the host is still frequent.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium uvae-ursi

H. Szczygiel, CC (micro C-F-156760); Alaska

Exobasidium uvae-ursi (R. Maire) Juel

Basidioma parasitic; infected shoots with dark purplish leaves on the upper surface and whitish hymenial underside; hymenium not continuous, patchy.

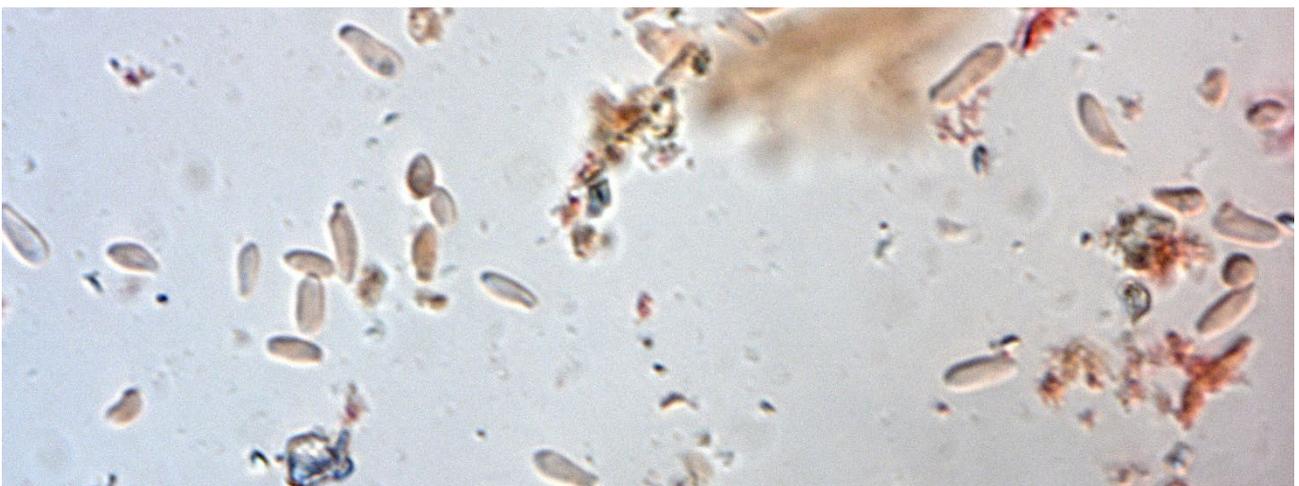
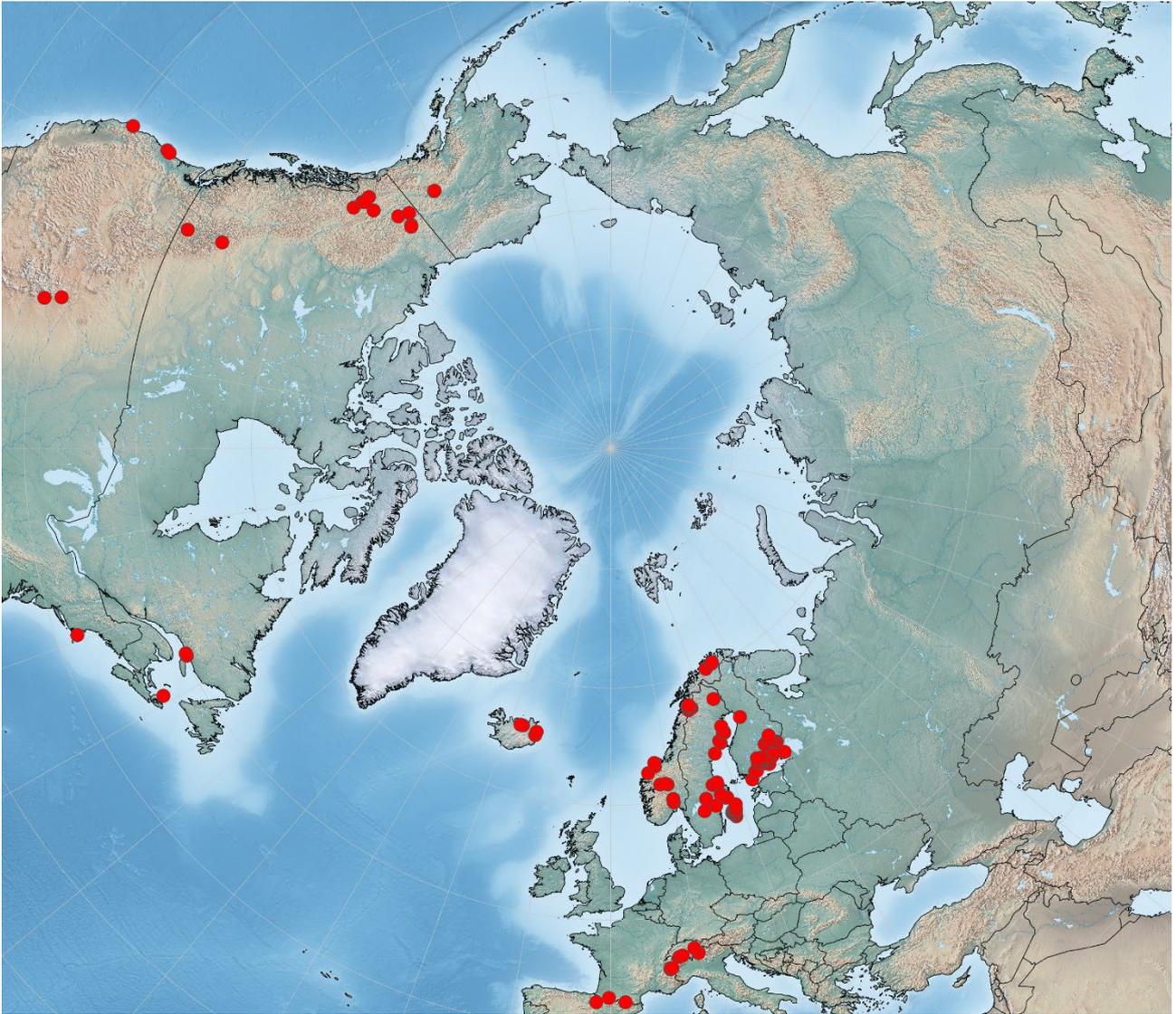
Spores 15-22 × 5-6 μm, cylindrical or slightly allantoid, at maturity 1-3-septate. **Conidia** 6-8 × 2-3 μm, clavate. **Basidia** 2-3(-4)-sterigmate.

Habitat and host

On *Arctostaphylos uva-ursi*.

Distribution

Arctic-alpine; circumpolar, but not known from Russia; type 1. Known from Canada, USA, Iceland, Norway, Sweden, and Finland, and from alpine Switzerland and from the Pyrenees, but not Austria. Also in boreal and temperate regions.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium vaccinii

HK, 2018 (specimen lost); Sweden

Exobasidium vaccinii (Fuckel) Woronin

Basidioma parasitic on living leaves of ericaceous plants, i.e. circumscribed; infected leaves distinctly swollen and gall-like, a few scattered on each plant or solitary; leaves red to pink on the upper surface, white and chalky on the underside, sometimes with hypertrophied shoots and deformed flowers.

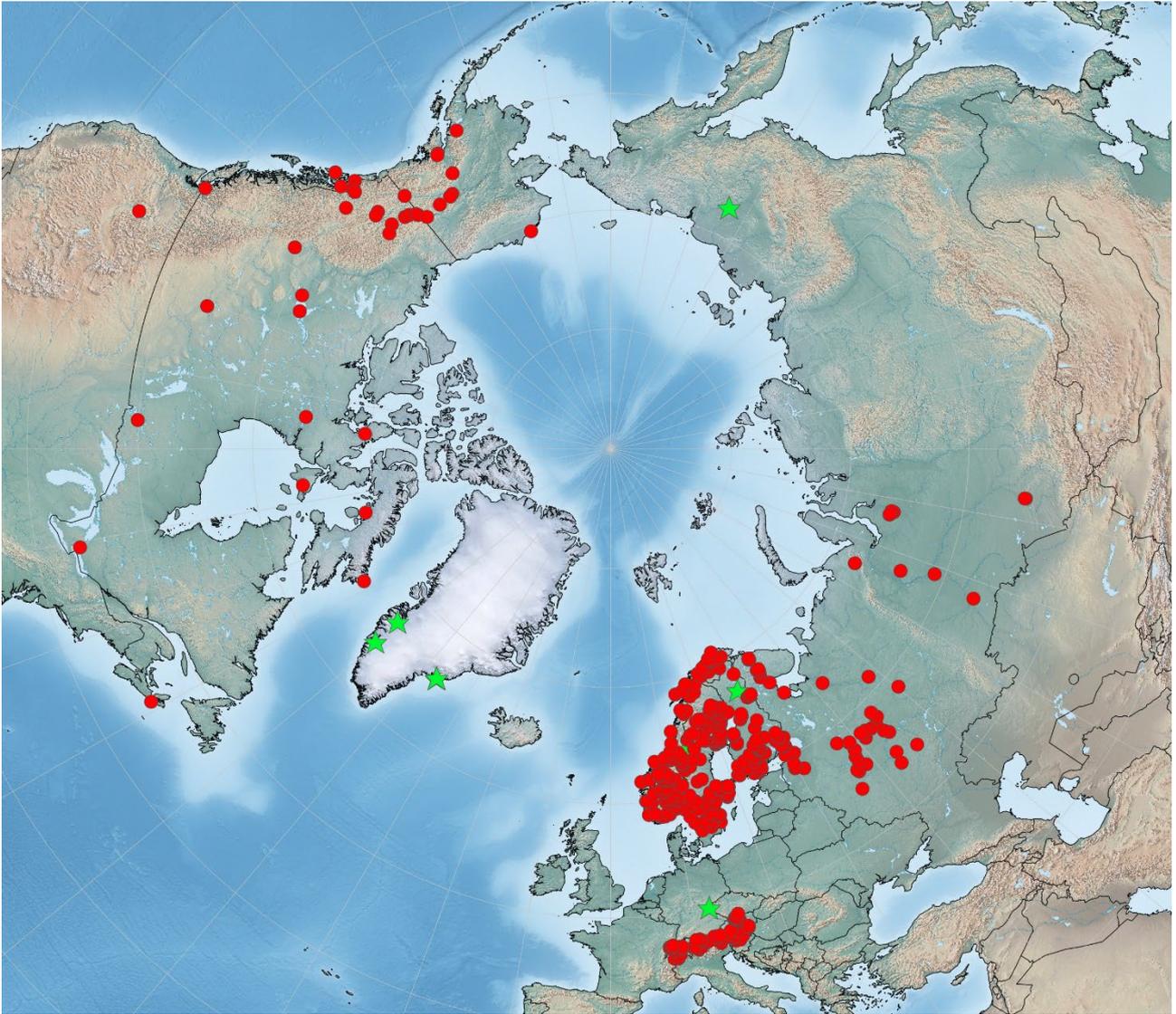
Spores 11-19 × 2.5-4.5 μm, on average 14-16.5 × 3-4 μm, slightly allantoid, eventually 1-3-7-septate. **Conidia** present, 8-11 × 1 μm. **Basidia** 4(-2)-sterigmate, 45-60 × 4-6 μm. **Hyphae** 1-2 μm, without clamp connections.

Habitat and hosts

It is the least specialised species of the genus, recorded from ca. 90 host species (e.g. *Vaccinium vitis-idaea*), and following the hosts in heaths, bogs, and open forests, on nutrient-poor, sandy or turfy soil.

Distribution

Arctic-alpine; circumpolar; type 1. Known from Alaska, Canada, and Greenland; widespread in Norway, Sweden and Finland; also in Russia, and in the Alps (Germany, Switzerland, Austria) and the Tatras (Poland). It is rare in Greenland and absent in Iceland. *Exobasidium vaccinii* follows the hosts into northern boreal areas and is also widespread in the temperate zone.



Exobasidium: Exobasidiaceae: Exobasidiales



Exobasidium vaccinii-uliginosi

HK 17.010B; C-F-104900

Exobasidium vaccinii-uliginosi Boud.

Basidioma parasitic, surculicolous; infected shoots scattered, with leaves slightly enlarged, soft, and red, underside white at maturity.

Spores 16-23(-28) × 6.5-9(-12) μm, broadly clavate to oblong ellipsoid, not septate.

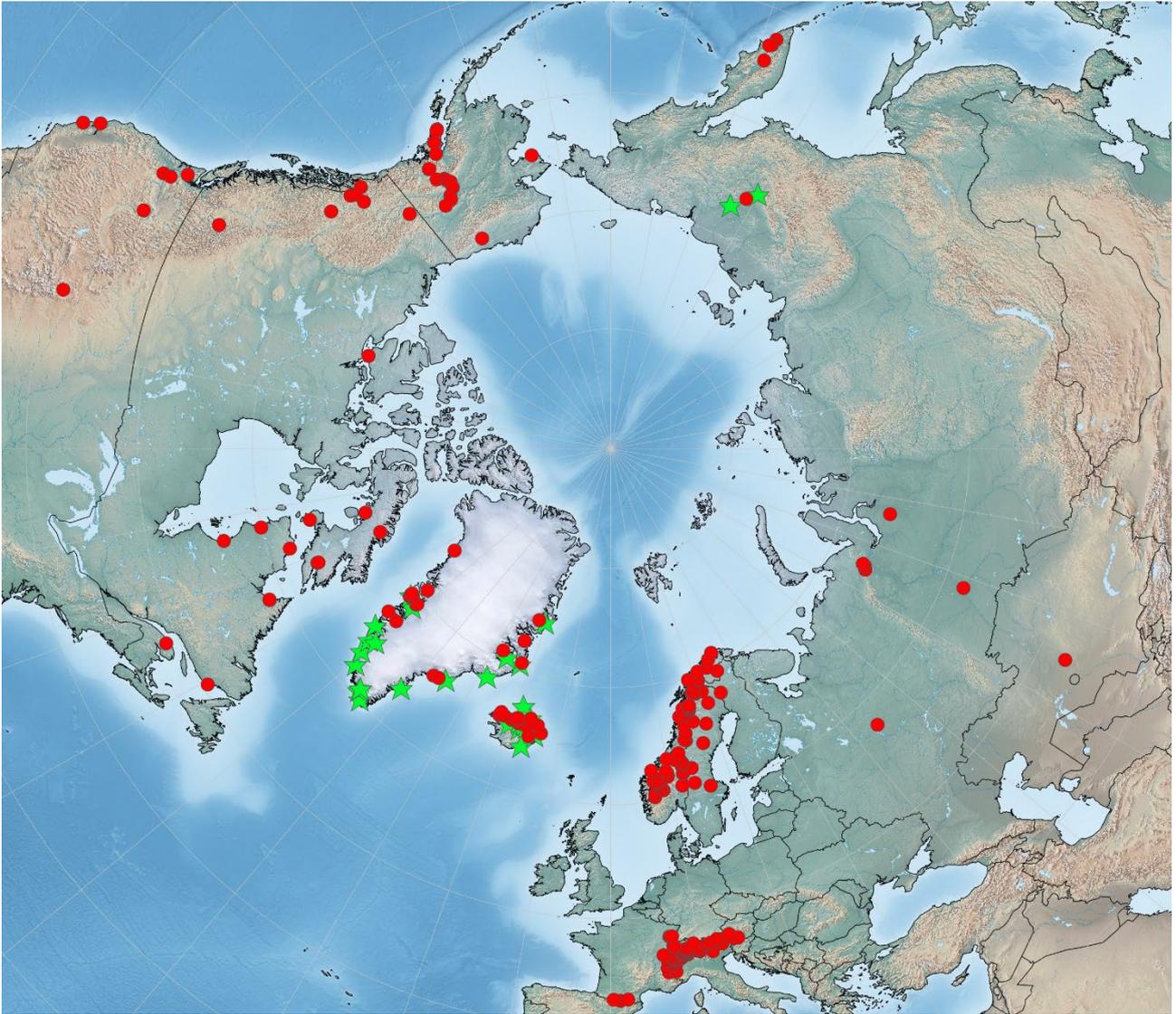
Conidia not known. **Basidia** 70-80 × 8-10 μm broad, 2-sterigmate. **Hyphae** 1.5-3 μm broad, without clamp connections.

Habitat and hosts

On *Vaccinium uliginosum*, which has a worldwide distribution in arctic regions, and on *V. scoparium*, *Arctostaphylos nevadensis*, *A. patula*, and *Phyllodoce empetriformis*, which are restricted to northern and central Canada and to the northwestern USA.

Distribution

Arctic-alpine; circumpolar; type 1. Reported from Alaska, Canada, Greenland, Iceland, northern Norway, Sweden, Finland and Russia. In alpine regions known from the Rocky Mts., Switzerland, Austria, France, Germany, the Pyrenees and Russia (Kamchatka).



Arcticomyces: Exobasidiaceae: Exobasidiales



Exobasidium warmingii

H. H. Bruun; C-NHMD001790383

Exobasidium warmingii Rostr.

Syn.: *Arcticomyces warmingii* (Rostr.) Savile; *Entyloma schinzianum* (Magnus) Bubák

Basidioma parasitic; infection systemic; shoots not flowering, the leaves becoming pink, inflated and tortuose, with hymenium on both sides, seen as fascicles of basidia.

Spores 10-15 × 1.5-3 μm, fusoid, 1-septate at maturity (from type by Savile: 11-15.5 × 2-3 μm). **Conidia** 6-12 × 1 μm, bacilliform.

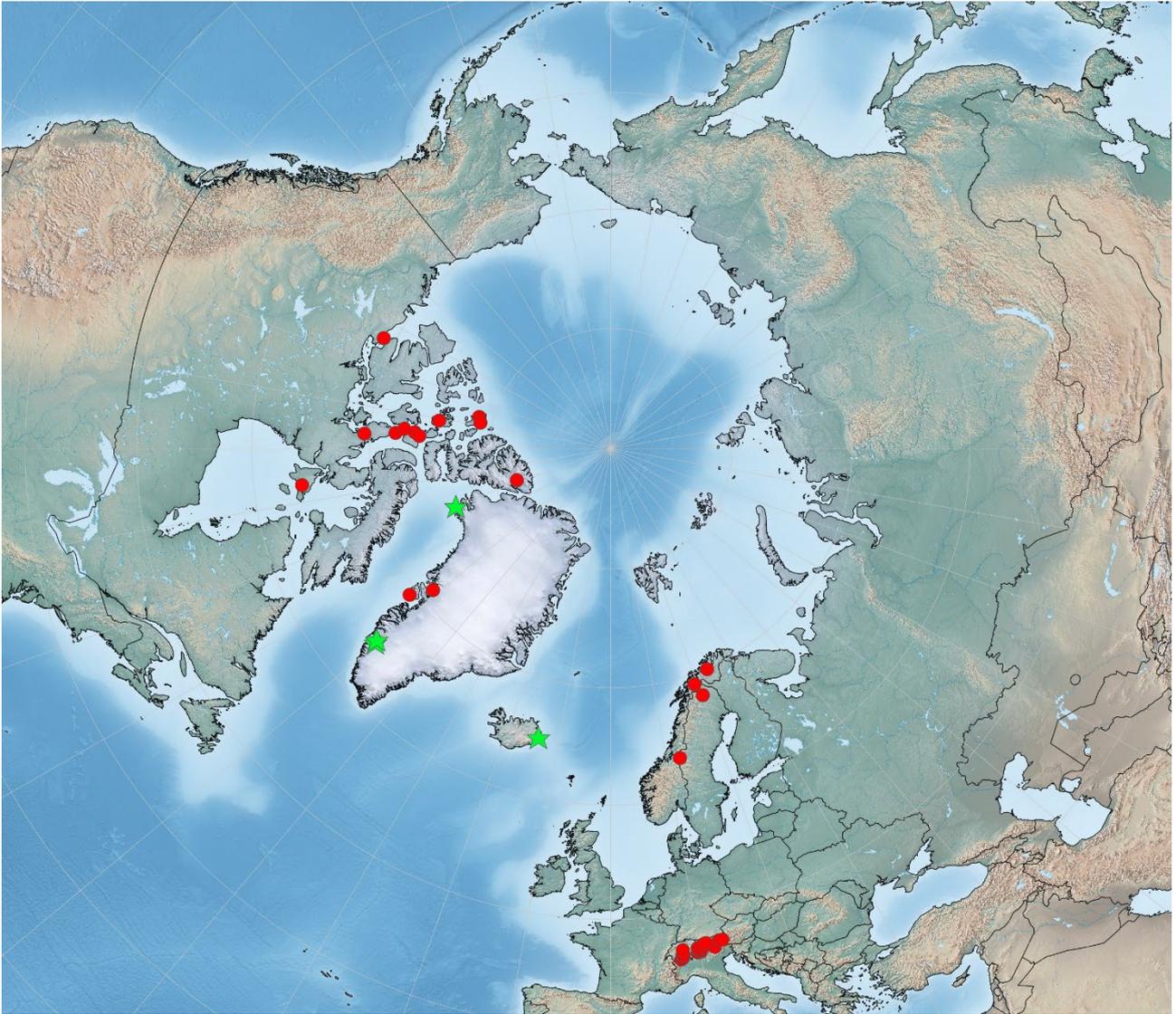
Basidia 30-60 × 3-6 μm, 2-4-sterigmate, (Savile, noted on type: 22-28 × 6-6.5 μm).

Habitat and hosts

On species of *Saxifraga*. *Saxifraga oppositifolia* is the main host in Canada, but other species may also act as hosts, e.g. *S. aizoides*, *S. aspera*, *S. aizoon*, *S. bryoides*, *S. paniculata* (photo) and *S. rotundifolia*.

Distribution

Arctic-alpine; circumpolar; type 4. A rarely collected, predominantly high-Arctic species, known from northern Canada, Greenland, northern Norway, and Sweden. Alpine records are from Switzerland and Austria.



Phaeotremella: Tremellaceae: Tremellales



Phaeotremella foliacea

E. Rald 93.656 (specimen lost; micro C-F-169636)

Phaeotremella foliacea (Pers.) Wedin, J.C. Zamora & Millanes

Syn.: *Tremella foliacea* (Pers.) Pers.

Basidioma breaking through the bark from a central point, pale to dark brown, of large folded lobes, gelatinous, becoming watery-slimy, 2-12 cm, horny when dry.

Spores 8-10(-13) × (5.5-)7-9 μm, subglobose, white, repetitive. **Conidia** hyaline, 3-4.5 × 2-3 μm. **Probasidia** globose to subglobose, 12.5-24 × 10-18 μm, cruciate-septate; **epibasidia** up to 50 × 2-6 μm, 2-4-celled. **Hyphae** hyaline, thin-walled, 1-6 μm broad; clamp connections present.

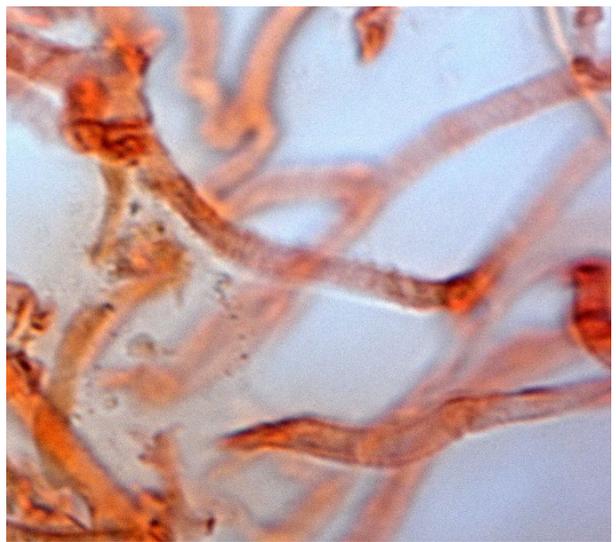
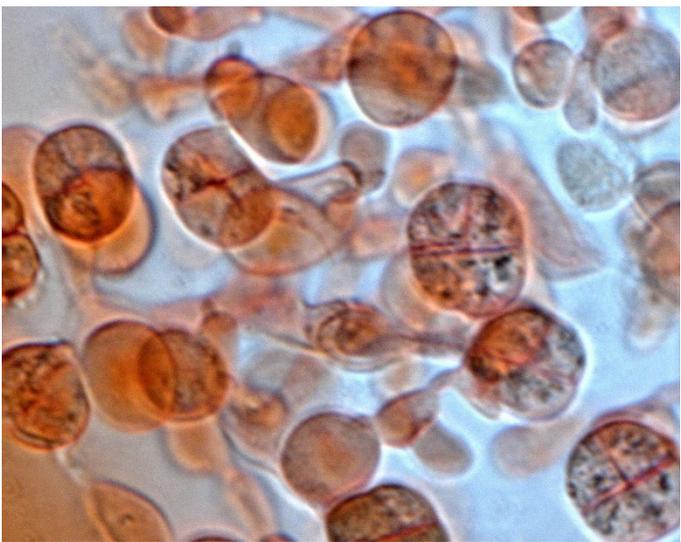
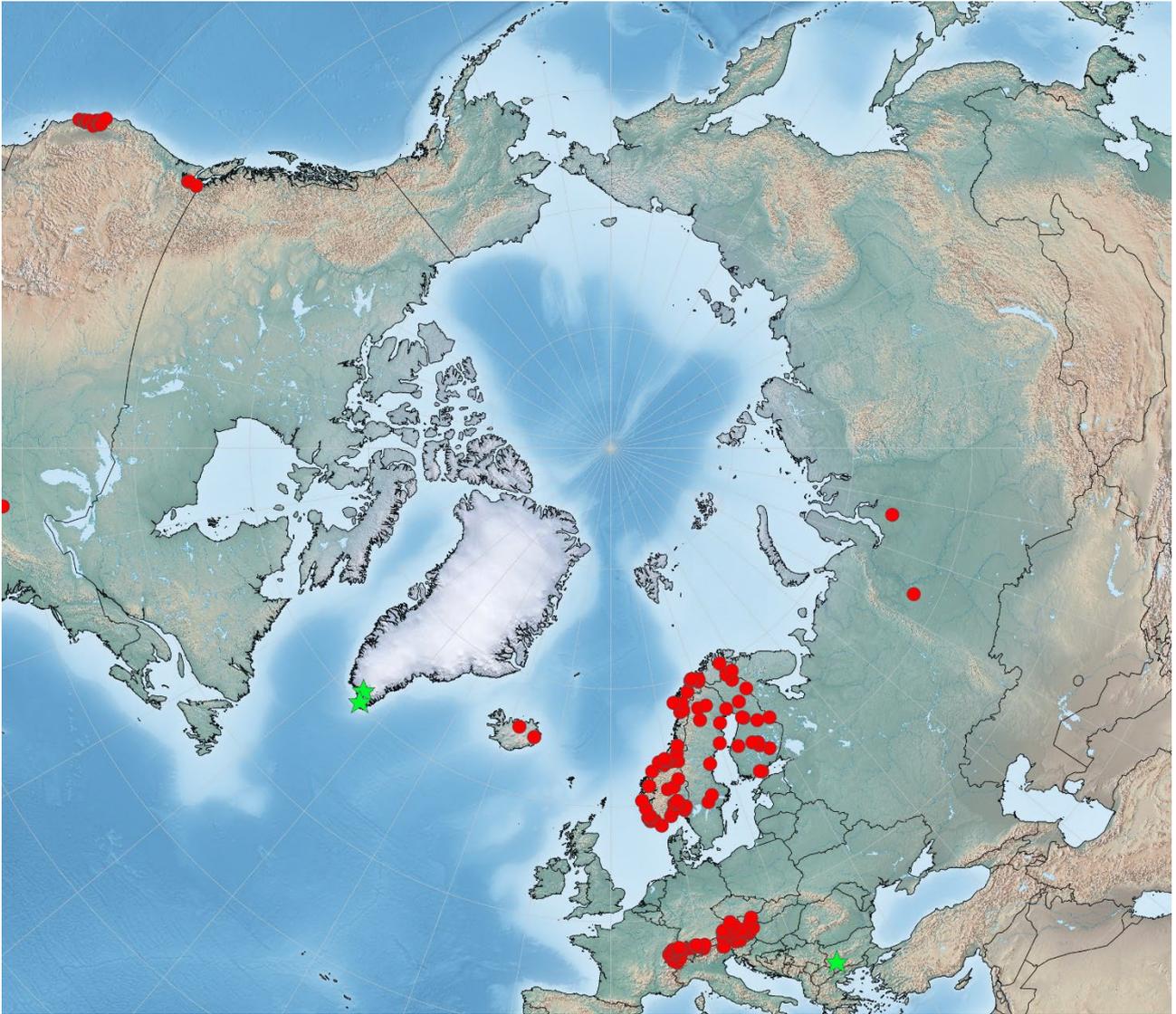
Habitat and host fungus

On various deciduous trees and shrubs, in cold regions mostly on *Betula*.

Distribution

Arctic-alpine; circumpolar; type 1. Rare in arctic areas; found in Alaska, Greenland, Iceland, Norway, Sweden, and Finland, but rarely. Recorded in alpine areas from the Rocky Mts., Canada (Labrador), Switzerland, Austria, and the Pyrenees. Widely distributed in subarctic, boreal and temperate areas, see e.g. map of records from Norway in Torkelsen (1971).

Recently separated from *Tremella* based on DNA sequences (Liu et. al 2015).



Tremella: Tremellaceae: Tremellales



Tremella indecorata

TB 85.017; C-F-140643

Tremella indecorata Sommerf.

Basidioma parasitic, breaking through the bark or on pyrenomycetes on the wood, at first hyaline, then whitish, eventually becoming pale grey or grey-brown, broadly attached to the substrate, from a few mm up to ca. 1 cm in size, irregularly cushion-shaped, winding-lobed to slightly cerebriform, when dry more or less shrinking to a thin crust, matt or shiny.

Spores $8-15 \times 8-12.5 \mu\text{m}$, hyaline, subglobose, with distinct apiculus, repetitive. **Conidia** allantoid, $2.5-3.5 \times 1.5 \mu\text{m}$. **Probasidia** globose to subglobose, $10-20 \times 8-18 \mu\text{m}$, cruciate-septate, 2-4 celled; **epibasidia** remarkably long, $75-100 \times 2-3 \mu\text{m}$. **Hyphae** hyaline, thin-walled, 1-4 μm , when old slightly encrusted, with clamp connections; haustoria present.

Habitat and host fungus

Parasitizing larger pyrenomycetes (like *Diatrype*) on branches and twigs of deciduous trees and shrubs, or apparently directly on the wood. On species of *Salix*.

Distribution

Hardly arctic-alpine, but included here due to the subarctic record from Greenland (see volume 1 Introduction). Widely distributed in coastal areas of boreal and temperate regions.



Tremella: Tremellaceae: Tremellales



Tremella karstenii

HK 18.299; C-F-111411

Tremella karstenii Hauerslev

Syn.: *Tremella juniperina* P. Karst., non L.

Basidioma parasitic, irregularly pustulate, 0.1-0.2(-0.3) cm, smooth, hyaline whitish, soft gelatinous.

Spores 4.0-5.5(-6.0) μm , hyaline, globose to subglobose, rather thick-walled, repetitive.

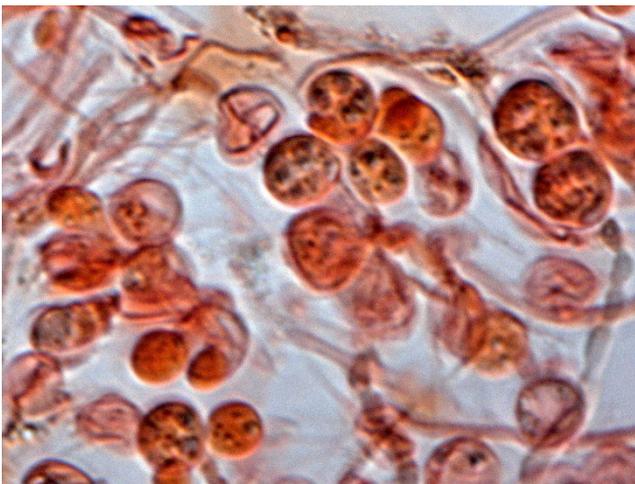
Probasidia 9.5-12 μm , oblong to subglobose, cruciate-septate, 4-celled; **epibasidia** 30-50 \times 2 μm . **Hyphae** 1.5-3 μm broad, hyaline, thin-walled to slightly thick-walled; clamp connections present, often with terminally pointed haustoria.

Habitat and host fungus

On the pyrenomycete *Colpoma juniperi* on twigs of *Juniperus*.

Distribution

Arctic-alpine; North American–Eurasian; type 4. Most likely overlooked due to the size and substrate. Known from arctic Greenland, Norway and Finland, and from alpine Norway, Sweden, the Alps (very few records), and the Pyrenees.



Tremella: Tremellaceae: Tremellales



Tremella mesenterica (anamorph)

HK 18.301; C-F-111285

Tremella mesenterica Retz.

Syn.: *Tremella lutescens* Fr.

Basidioma pale to deep yellow or orange-yellow, gelatinous, becoming softer and in wet weather slimy, discoloured to whitish, lobed-folded, several cm long and 0.5-2 cm high.

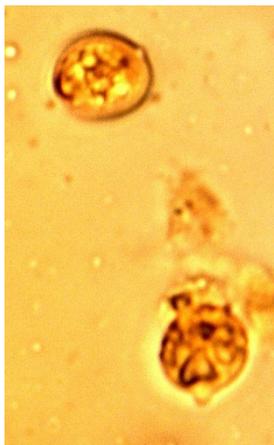
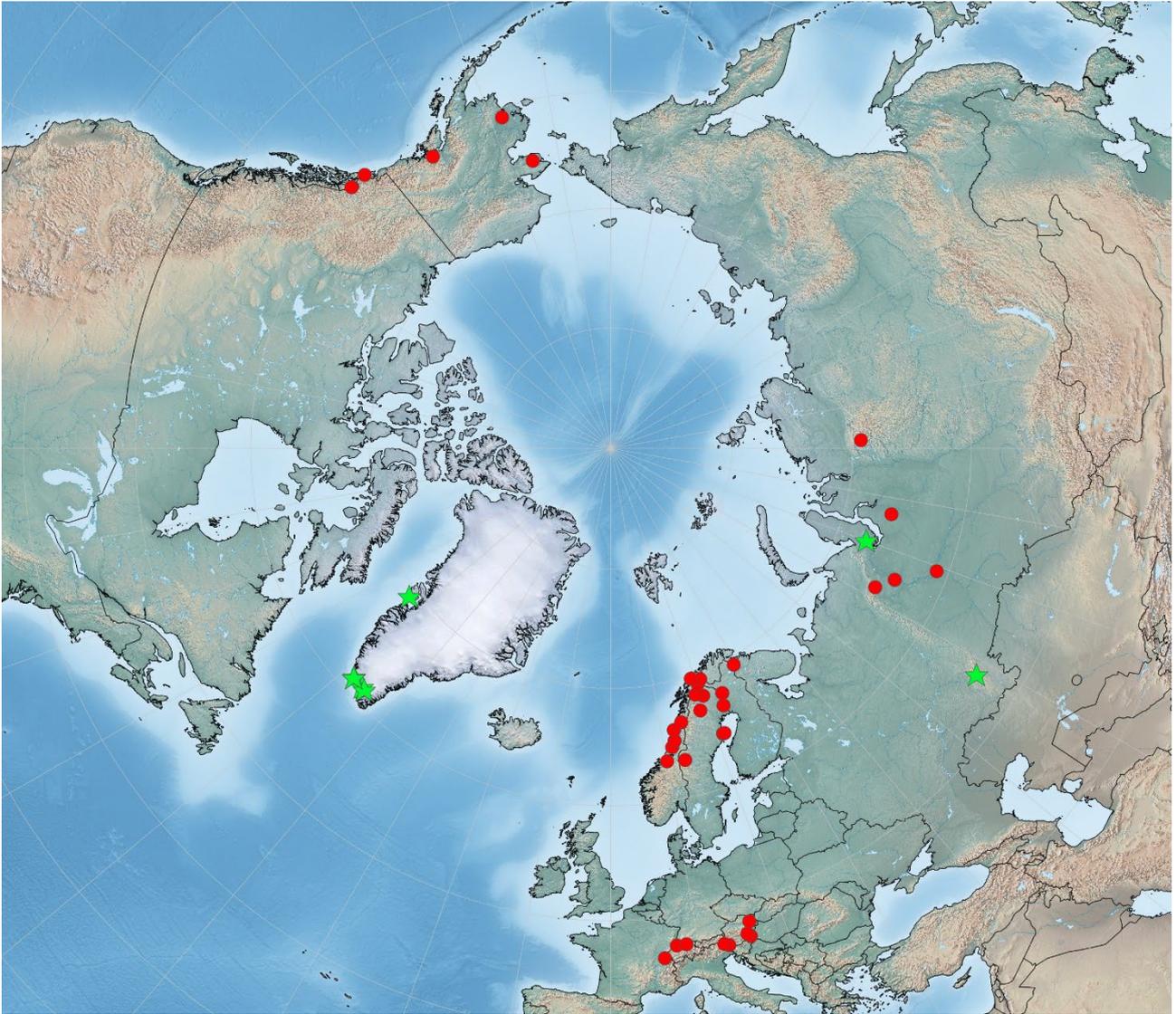
Spores 13-15 × 10-12 μm, hyaline, subglobose, repetitive. **Conidia** yellow, subglobose, ca. 3-4 μm in diameter, arising from bundles of hyphae early in the season. Most of our collections are found with conidia, without spores. **Probasidia** subglobose to ellipsoid, 10-26 × 10-20 μm; **epibasidia** up to 160 × 2-3.5 μm. **Hyphae** 1-3 μm, with clamps and haustoria.

Habitat and hosts

On *Betula pubescens*, *Alnus alnobetula*, and possibly *Salix glauca*.

Distribution

Arctic-alpine; circumpolar; type 1; widespread and common, known from most arctic-alpine regions. See map of occurrences in Norway in Torkelsen (1971).



Tremella: Tremellaceae: Tremellales



Tremella penetrans

M. D. Paulsen, det. K. Hauerslev; C-F-49019; Denmark
(inside watery *Dacrymyces stillatus*)

Tremella penetrans (Hauerslev) Jülich

Syn.: *Sebacina penetrans* Hauerslev

Basidioma parasitic, absent; living parasitically inside the basidiomata of *Dacrymyces* in scattered parts of the host and deforming it, eventually giving it a watery appearance.

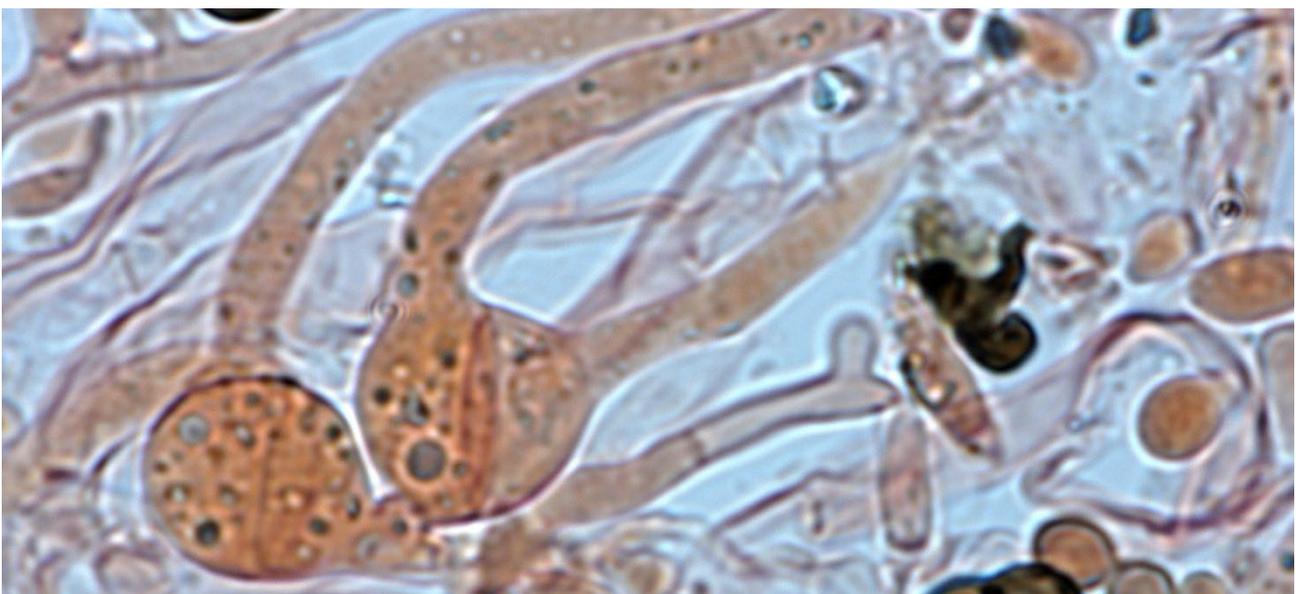
Spores subglobose to broadly ellipsoid, $10-15 \times 6-12 \mu\text{m}$ in diameter, hyaline, thin-walled, with prominent sterigmata, repetitive, at maturity budding with conidia. **Conidia** $4-6 \times 3-4 \mu\text{m}$, ellipsoid. **Probasidia** subglobose or broadly ellipsoid, $8-16 \mu\text{m}$ in diameter, at maturity split by a longitudinal wall, normally only one of them developing an **epibasidium**, becoming remarkably long, up to $308 \mu\text{m}$, and $2.5-4 \mu\text{m}$ broad. **Hyphae** hyaline, $1.5-2.5 \mu\text{m}$, regular to irregular; clamp connections present; haustoria present.

Habitat and host fungus

Inside the basidiomata of *Dacrymyces* on twigs and branches of *Alnus*, *Salix* and *Betula*. Most commonly occurring in *Dacrymyces stillatus* on *Alnus*. Outside the arctic-alpine area, also found on *D. punctiformis* on coniferous wood.

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic North America (GR) and alpine North America (Canada: BC), and from arctic Eurasia (IS), and the European Alps (IT). Rather recently described from Denmark (Hauerslev 1987), where numerous records are known. Found three times in Greenland in this investigation. It is possible that the species may be confused with *Tremella obscura*, also on *Dacrymyces*. The smaller spores, $5-10 \times 4-7 \mu\text{m}$, should distinguish the latter species.



Tremella: Tremellaceae: Tremellales



Tremella sibirica

P. Corfixen, PC 02.075; C-F-61489; Russia (Siberia; type)

Tremella sibirica Knudsen, spec. nov.

This new species is formally described on p. 340.

Basidioma parasitic, 2.5-4 mm when dry (not seen fresh), cerebriform-folded, greasy-shiny, dark brown.

Spores 9-11 × 5-8 μm, Q = 1.4, ovoid or oblique-ovoid, applanate, apiculus often thickened, thin-walled, hyaline, repetitive, reddish brown in congo red. **Probasidia** at first almost globose and 10-13 μm in diameter, then splitting cruciately into four cells, yellowish, more rarely 2-celled, densely crowded; **epibasidia** long, tubular, up to 40 × 2 μm, irregular, apparently soon detaching from probasidia. **Hyphae** 1.5-3-5 μm broad, hyaline, smooth or scattered, encrusted when old, with distinct walls, without or with granulate interior, irregular; clamp connections numerous, of normal and open

type; distinct haustoria present. **Mature basidia** reddish brown in congo red.

Habitat and host fungus

So far only known from the type collection in Russia, on *Megalocystidium leucoxanthum* (Bres.) Jülich (Stereaceae). On rotten wood of *Salix*.

Distribution

Eurasian alpine; type 15; only known from the type in Russia (Siberia), in subalpine mountains in the Chelyabinsk region. The somewhat similar *Tremella versicolor* grows on the closely related *Gloeocystidiellum lividoceruleum*, but has spores 6 × 4 μm.



Dacrymyces: Dacrymycetaceae: Dacrymycetales



Dacrymyces capitatus

HK 97.287b; C-F-65566; Russia (Kamchatka)

Dacrymyces capitatus Schw.

Syn.: *Dacrymyces deliquescens* f. *stipitatus* Bourdot & Galzin; *D. ellisii* Coker;

D. deliquescens var. *ellisii* (Coker) L.L. Kenn.; *D. radicans* f. *stipitatus* (Bourdot & Galzin) Donk

Basidioma parasitic, cup-shaped, stipitate, 1-3 mm, scattered, gregarious, pale to dark brown.

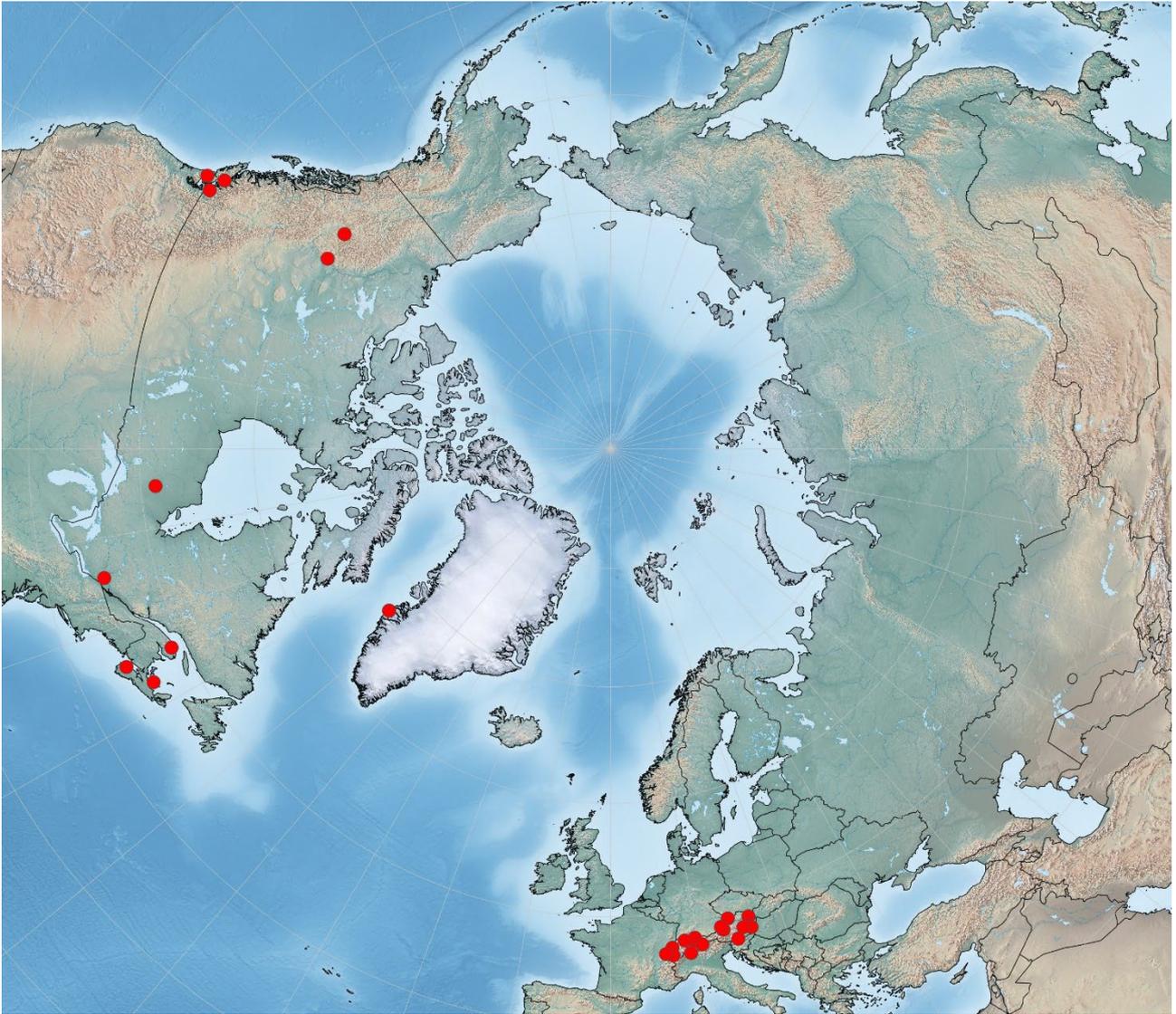
Spores 10-13 × 4-5.5 μm, somewhat irregularly allantoid, hyaline, with three thin septa. **Basidia** with a lower cylindrical part, 30-35 μm, and an upper forked part, 2.5-4.5 μm, apically attenuated. **Hyphae** distinct, ca. 2 μm broad; clamp connections absent.

Habitat and hosts

On deciduous wood, in cold regions especially on *Alnus*.

Distribution

Arctic-alpine; circumpolar. Known from a few arctic records in Greenland, northern Canada, northern Norway and Russia (Siberia). In alpine regions recorded from the Rocky Mts. (USA), the Pyrenees (France, Spain) and the Alps (Switzerland, Austria, Germany).



Dacrymyces: Dacrymycetaceae: Dacrymycetales

*Dacrymyces lacrymalis* (freeze-dried)

TB 83.018; C-F-7749

Dacrymyces lacrymalis (Pers.) Nees

Basidioma 4-5 mm broad, gelatinous, concave, margin reflexed, sometimes irregularly folded when large, stipitate below, yellow.

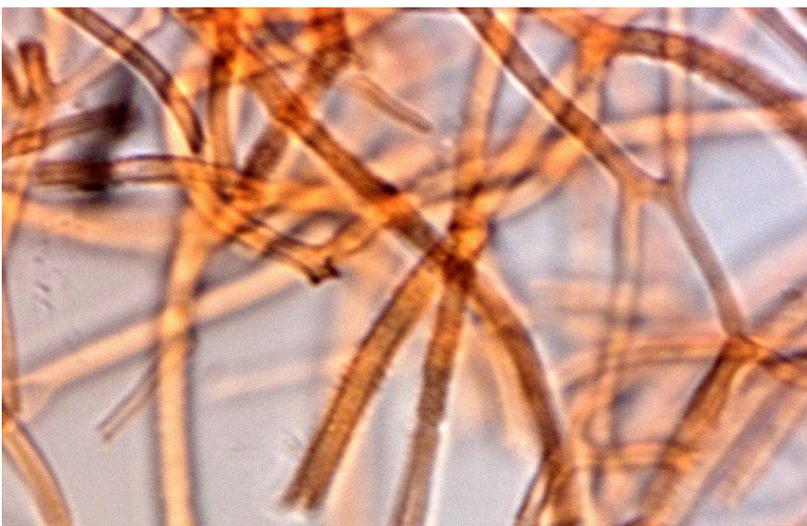
Spores 12-14 × 3.5-5.5 μm, without walls or with 1-3 thin or thick walls. **Basidia** 35-40 × 2.5-4.5 μm. **Hyphae** 2-2.5 μm wide, smooth or finely asperulate; clamp connections and conidia absent.

Habitat and hosts

On twigs and branches of dead *Salix* and *Betula* in scrubs.

Distribution

Arctic-alpine, boreal and temperate; circumpolar. Common in many alpine areas, but also occurring in arctic areas, though much more rarely. Known from arctic Canada, Greenland, Norway and Russia. In alpine regions recorded from the Rocky Mts. (USA), the Pyrenees (France, Spain), and the Alps (Switzerland, Austria, Germany). For Norway, see map in Torkelsen (1971).



Dacrymyces: Dacrymycetaceae: Dacrymycetales



Dacrymyces stillatus

SAE-2018.290-GR; C-F-112836

Dacrymyces stillatus Nees

Basidioma 2-6 mm, cushion-shaped, slightly contracted at base, irregular, gelatinous-waxy, shining, pale yellow, gregarious.

Spores 12-14 × 3.5-4 μm, thick-walled and always 1-3 septate, with thin and thick walls.

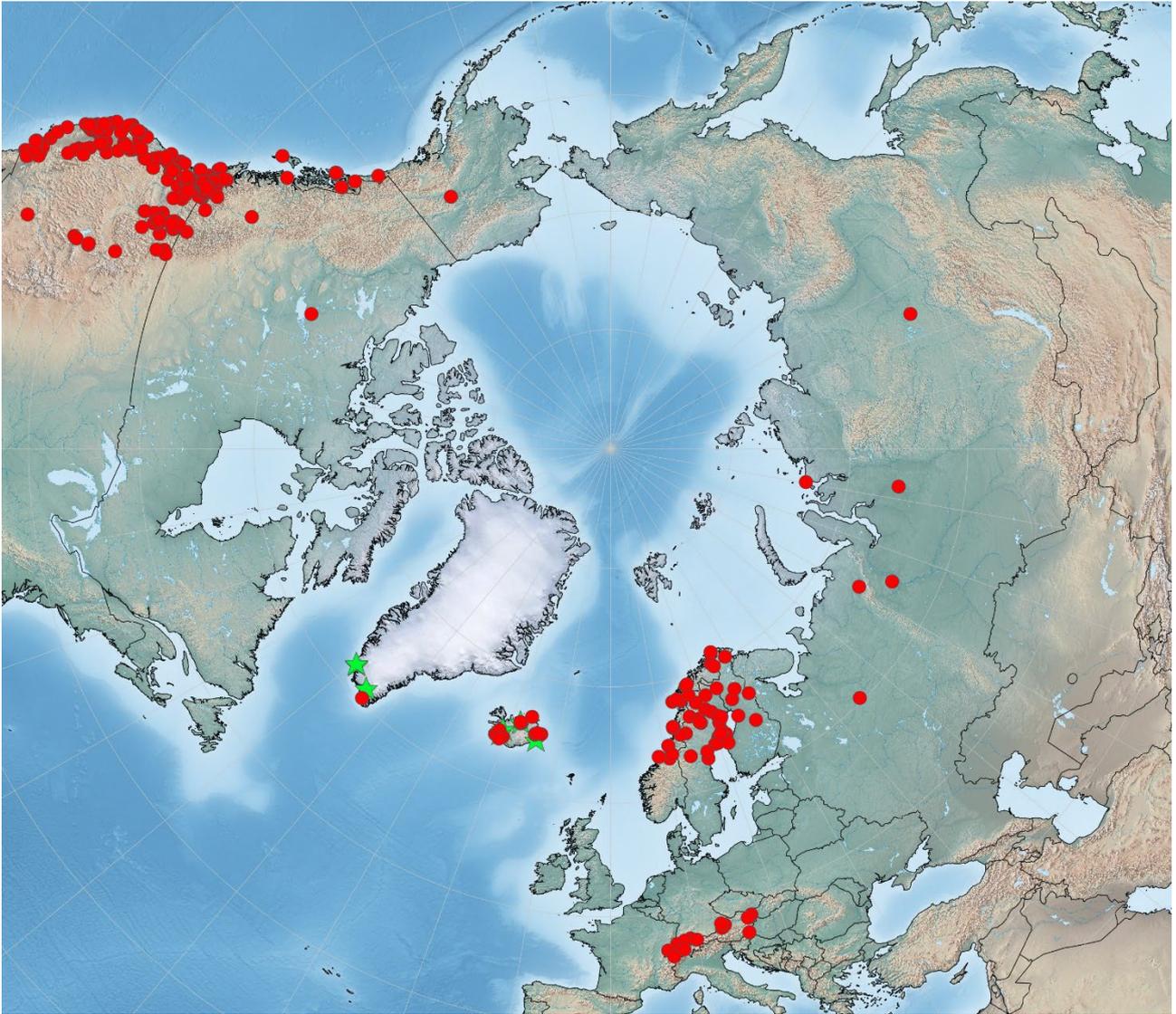
Basidia 25-50 × 3-6 μm, cylindrical, 2-sterigmate. **Hyphae** 2-3 μm broad, thin to slightly thick-walled, smooth; clamp connections absent. **Conidial state** common, hyphae breaking into arthrospores, 9-10 × 3-4 μm.

Habitat and hosts

Common on conifers, but in arctic-alpine areas also on deciduous shrubs like *Salix* and *Betula*.

Distribution

Arctic-alpine, boreal and temperate; circumpolar; type 1. Widespread in cold areas as well as in boreal and temperate regions. For Norway, see map in Torkelsen (1971).



Guepiniopsis: Dacrymycetaceae: Dacrymycetales



Guepiniopsis suecica

Savchenko, CC (micro Alstrup 767320, C-F-7803); Estonia

Guepiniopsis suecica (McNabb) Jülich

Basidioma 1-5 mm broad, ca. 2 mm high, flattened, with a more or less circular outline, at first pale yellow, becoming deeper yellow, most of the surface adhering to substrate.

Spores 15-20 × 5-6.5 μm, elongate cylindrical, with a marked sterigma, in one specimen (figured below) many or most with 7 septa, outline of spores regular or with slightly constricted part, strongly granulose, large granules staining grey in congo red. **Basidia** 57-63 × 6-7 μm, cylindrical, 2-sterigmate.

Hyphae 2.5 μm broad, smooth or finely asperulate; clamp connections numerous, distinct, both normal and medallion clamps.

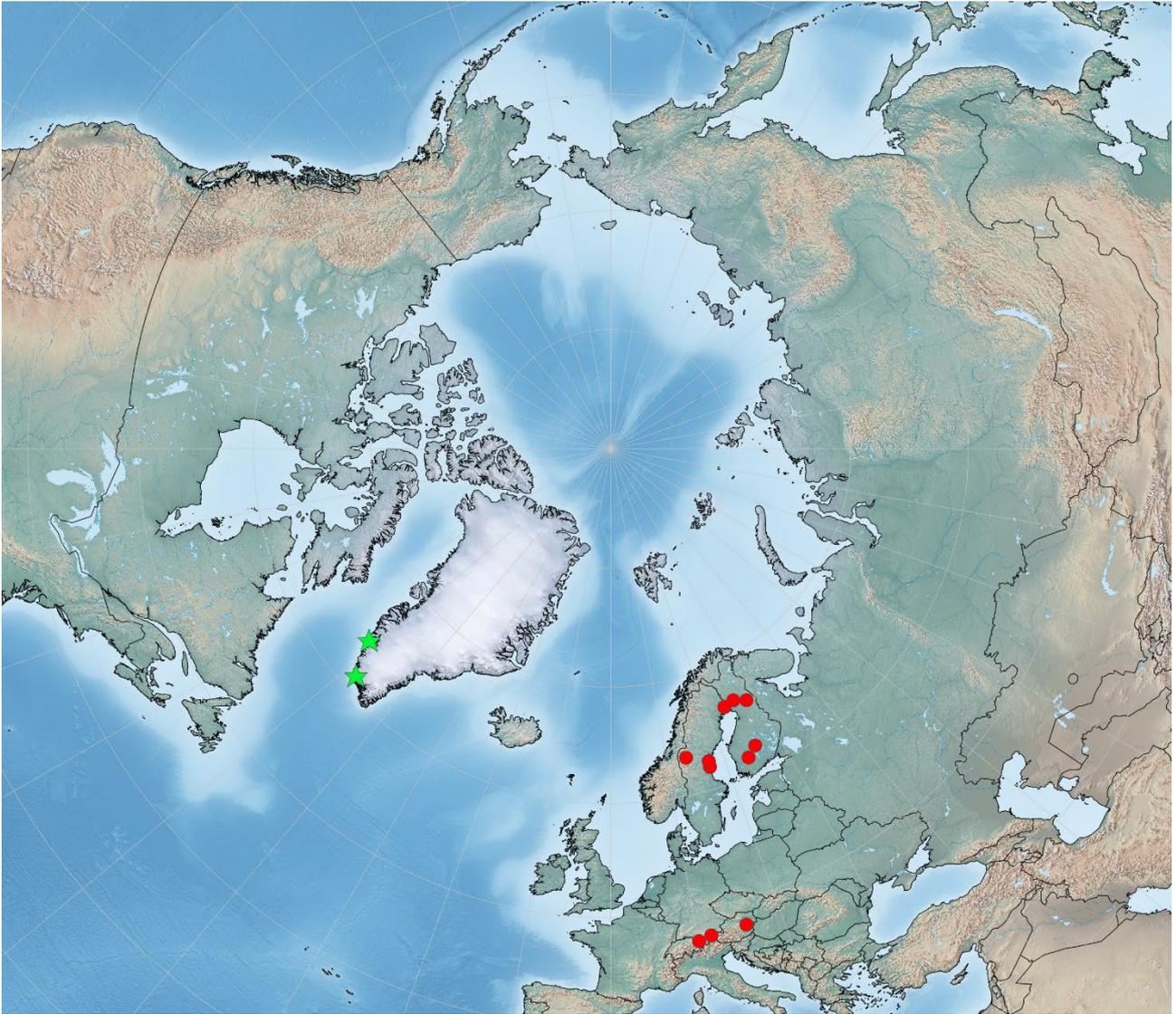
Hyphidia scattered, with corkscrew-like apex; apex 1-2 μm broad.

Habitat and hosts

In groups on decorticated, very decayed wood in scrub of *Alnus alnobetula* and *Salix glauca*. In warmer areas generally only on dry twigs of *Pinus sylvestris*.

Distribution

A rare species, known from a few subalpine to subarctic localities, but much more common on conifers in boreal and temperate regions. Included here on the basis of two records from southern Greenland.



Alloexidiopsis: Auriculariaceae: Auriculariales



Alloexidiopsis calcea

L. Ryvarden (K. Hauerslev 5318); C-F-65211; Norway

Alloexidiopsis calcea (Pers.) L.W. Zhou & S.L. Liu

Syn.: *Exidiopsis calcea* (Pers.) K. Wells

Basidioma resupinate, thin, whitish, greyish or dirty brownish, forming a thin, well-delimited crust, 5-10 × 2-5 cm, not hyaline, when dry and old sometimes cracking.

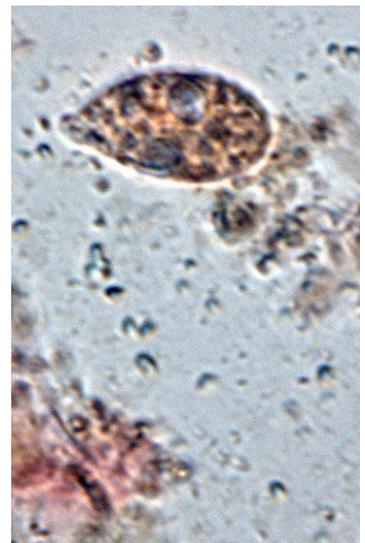
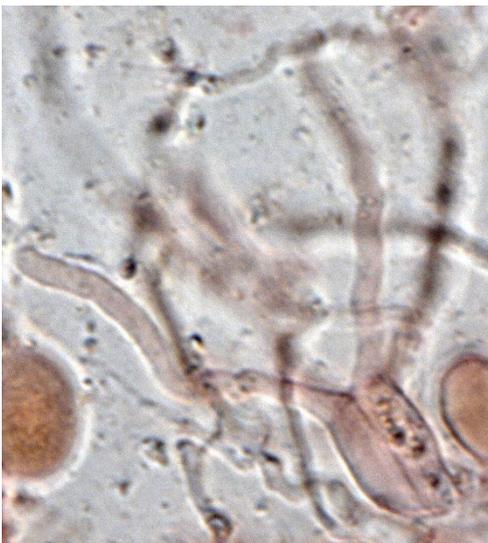
Spores 12.5-16.5 × 5-6.5 μm, allantoid, hyaline, thin-walled, repetitive. **Probasidia** 2-4-celled, cruciate-septate, subglobose to broadly ovoid, with a basal clamp, sterigmata 2-3 μm. **Hyphae** 1-3 μm broad. **Hyphidia** clavate or with a few branches, smooth or encrusted, 1.5-3 μm broad.

Habitat and hosts

Very common on bark or wood of *Picea* in the boreal zone. The only two Greenlandic records are both from *Salix glauca*.

Distribution

Arctic-alpine; circumpolar. In coniferous boreal forests north to Nordland (Norway) and Kuusamo (Finland). Not arctic, but subarctic, boreal and temperate; included here due to the two Greenland records.



Exidia: Auriculariaceae: Auriculariales



Exidia cartilaginea

TB 19G.054; C-F-151945

Exidia cartilaginea Lundell & Neuhoff

Syn.: *Exidia candida* var. *cartilaginea* (Lundell & Neuhoff) Spirin & Malysheva

Basidioma hyaline to whitish, becoming yellow to pale brown and finally deeper brown, often zonate with a paler margin and a darker centre, firm gelatinous to cartilaginous, adhering to the substrate, 1-1.5 cm broad, several cm long, cushion-shaped, underside white-hairy at margin.

Spores 10-14 × 3.0-4.5 μm, hyaline, thin-walled, (sub)allantoid, repetitive. **Conidia** slightly allantoid, 5-6 × 1.5-2 μm. **Probasidia** 12-16 × 10-13 μm, subglobose to ellipsoid, crosswise septate; epibasidia 25-60 × 1.5-3 μm. **Hyphidia** hyaline, irregular, branched, 1-3 μm broad. **Hyphae** hyaline, 1-2.5 μm; clamp connections present.

Habitat and host

On trunks and branches of *Betula*.

Distribution

Arctic-alpine; circumpolar, but strongly biased towards Eurasia; type 1. Known from arctic Alaska, Greenland, Norway, Sweden, Finland and Russia, and from alpine regions of the Pyrenees and the Alps (Switzerland, Austria, and Germany).



Exidia: Auriculariaceae: Auriculariales



Exidia glandulosa

E. Rald, 1988 (specimen lost, micro C-F-69996); Denmark

Exidia glandulosa (Bull.) Fr.

Basidioma black or greyish along the margin, shiny, \pm appressed to the substrate, from one to several cm long, 1-2 cm thick, irregular, gelatinous, underside greyish, matt, drying to a hard plicate network, sometimes with a greyish surface due to deposited spores.

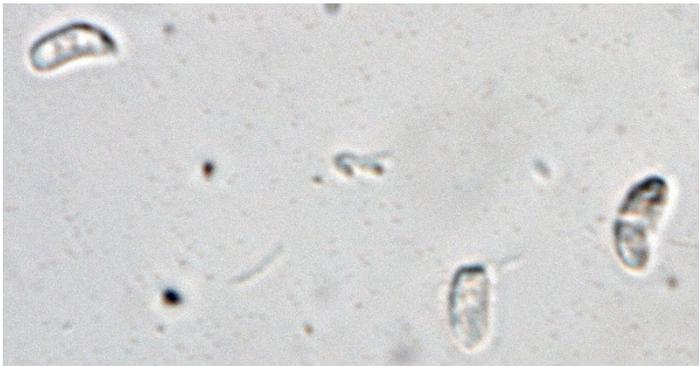
Spores 10-15(-17) \times 4-5(-6) μm , hyaline, allantoid, repetitive. **Probasidia** 10-16 \times 7-13 μm ; **epibasidia** 30-50 \times 2-3 μm , 0.5-4 μm . **Hyphae** hyaline, thin-walled, with clamp connections.

Habitat and hosts

On branches and trunks of many deciduous hosts, but in arctic areas mostly on *Salix*.

Distribution

Arctic-alpine; circumpolar; type 1. Common in arctic regions where there are still shrubs large enough to host it. Missing in Greenland and Iceland. In the far north of Norway, see special map by Torkelsen (1971).



Exidia: Auriculariaceae: Auriculariales



Exidia recisa

SAE-2018.285-GR; C-F-112831

Exidia recisa (Ditmar) Fr.

Basidioma gregarious, pale to dark brown, softly gelatinous, pezizoid or resembling a kettledrum, slightly stipitate, 1-2 cm, upper side smooth, stem-part granulose, margin furrowed, often hanging from branches, when dry membranous, dark reddish brown.

Spores 11-15 × 2.5-4.0 μm, hyaline, allantoid, repetitive. **Conidia** allantoid, 5-6 × 1.5-2 μm.

Probasidia 9-16 × 4-11 μm, subglobose-ellipsoid; crosswise septate, 2-4-celled; **epibasidia** cylindrical, 18-30 × 2-2.5 μm.

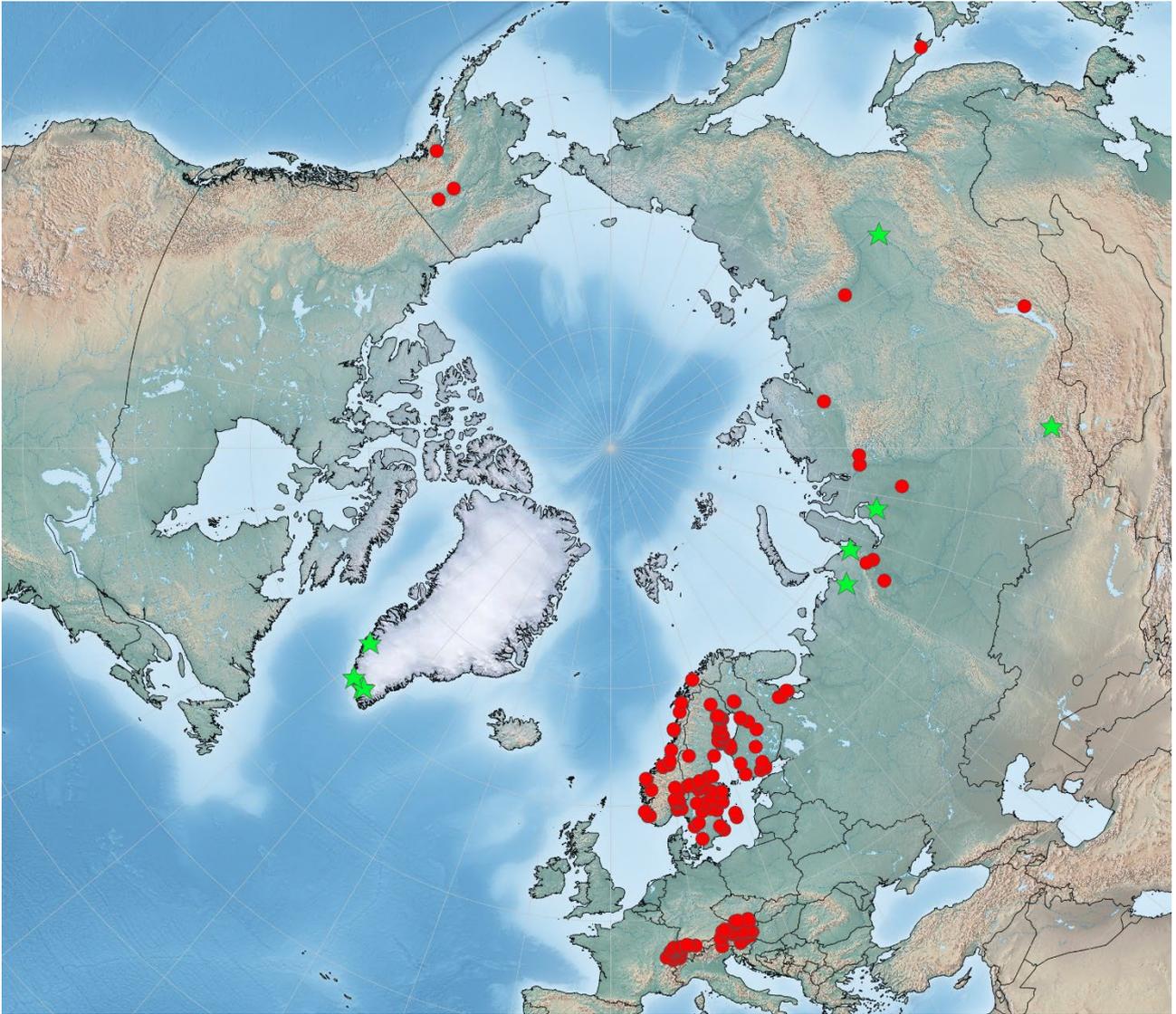
Hyphae 1-4 μm broad; clamp connections present.

Habitat and hosts

Most records on *Alnus*, a few records on *Salix*, but in warmer climates more commonly on *Salix*.

Distribution

Arctic-alpine; circumpolar; type 1. In arctic regions of Greenland, Norway, Sweden, Finland and Russia. See special map in Torkelsen (1971). In alpine regions in Switzerland and Austria.



Exidia: Auriculariaceae: Auriculariales



Exidia repanda

HK 18.109 (micro M. Lange, C-F-4177); C-F-111084

Exidia repanda Fr.

Basidioma cushion-shaped, semiglobose to irregular, up to 1 cm in diameter, attached to the substrate at one point, cartilaginous, not coherent, pale dirty hyaline, becoming more brown to medium brown, smooth or irregularly folded, margin smooth.

Spores 12-15 × 2.5-4 μm, hyaline, allantoid, repetitive. **Conidia** 4-6 × 1.5 μm, cylindrical.

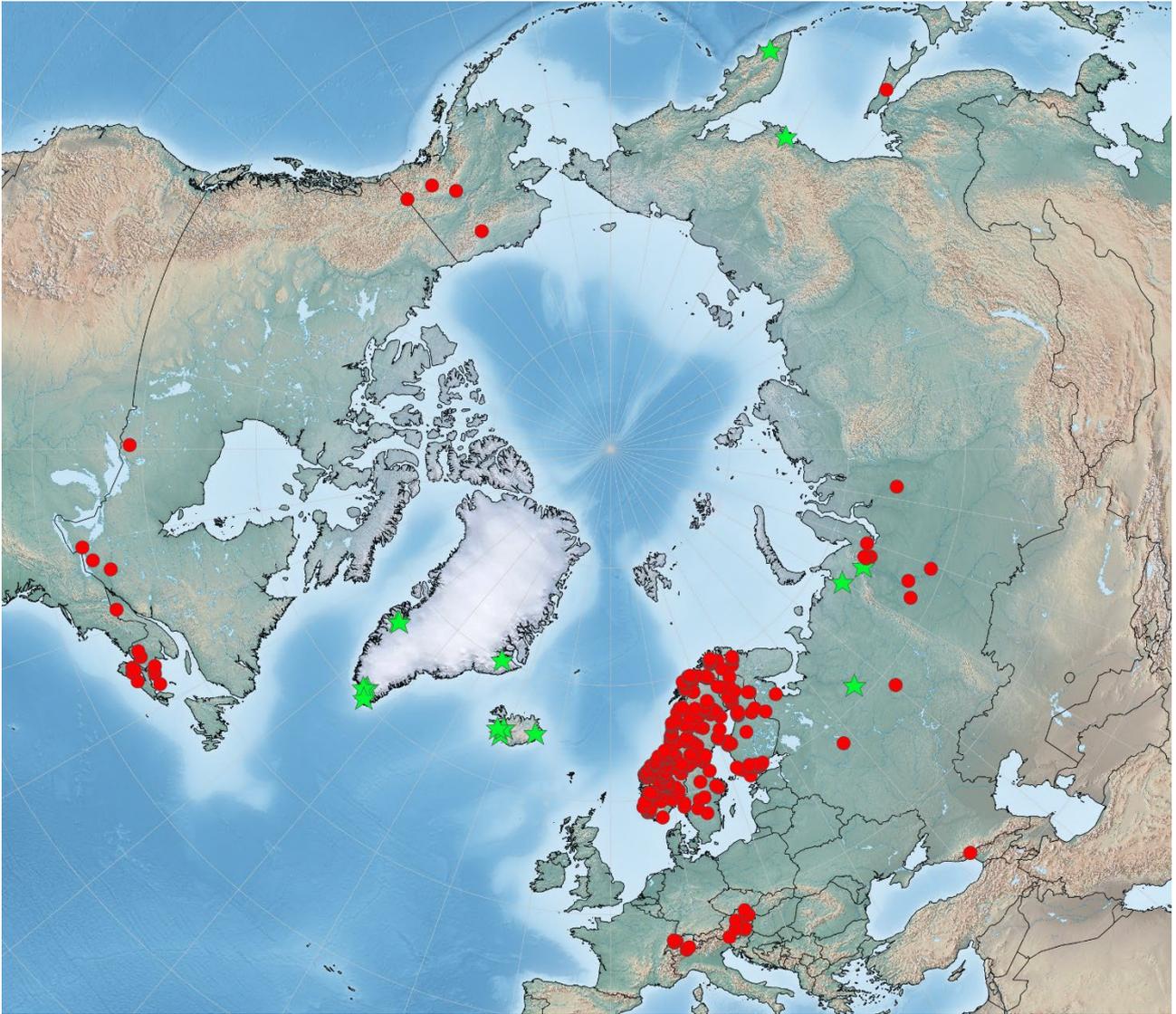
Probasidia ellipsoid, 9-14 × 11-12 μm, cruciate-septate, 2-4-celled; **epibasidia** 30-50 × 2-3.5 μm, cylindrical. **Hyphae** 2-3 μm broad; clamp connections present.

Habitat and hosts

Common on *Betula*, in arctic areas also on *Sorbus* and *Salix*.

Distribution

Arctic-alpine; circumpolar; type 1. Especially common along the western coast of Scandinavia, in Iceland, and southern Alaska, rare in the Alps. Throughout Russia to Kamchatka. For Norway, see special map in Torkelsen (1971).



Exidia: Auriculariaceae: Auriculariales



Exidia thuretiana

HK (micro HK 91.156, C-F-7689); Denmark

Exidia thuretiana (Lév.) Fr.

Basidioma irregularly cushion-shaped, 3 mm to 3 cm, coherent, shiny, hyaline, waxy, cartilaginous, appressed, smooth.

Spores 15-20(-24) × 5.5-6.5(-7) μm, hyaline, allantoid, smooth, repetitive. **Conidia** absent.

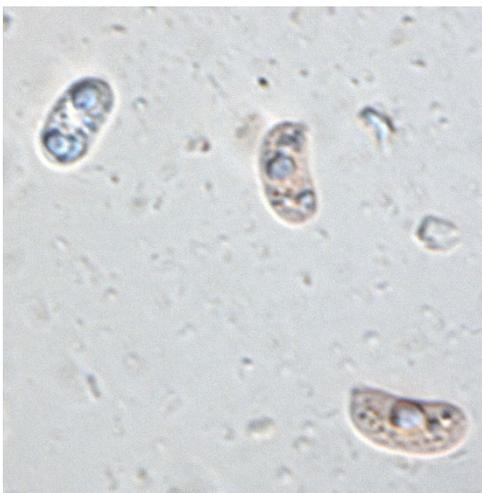
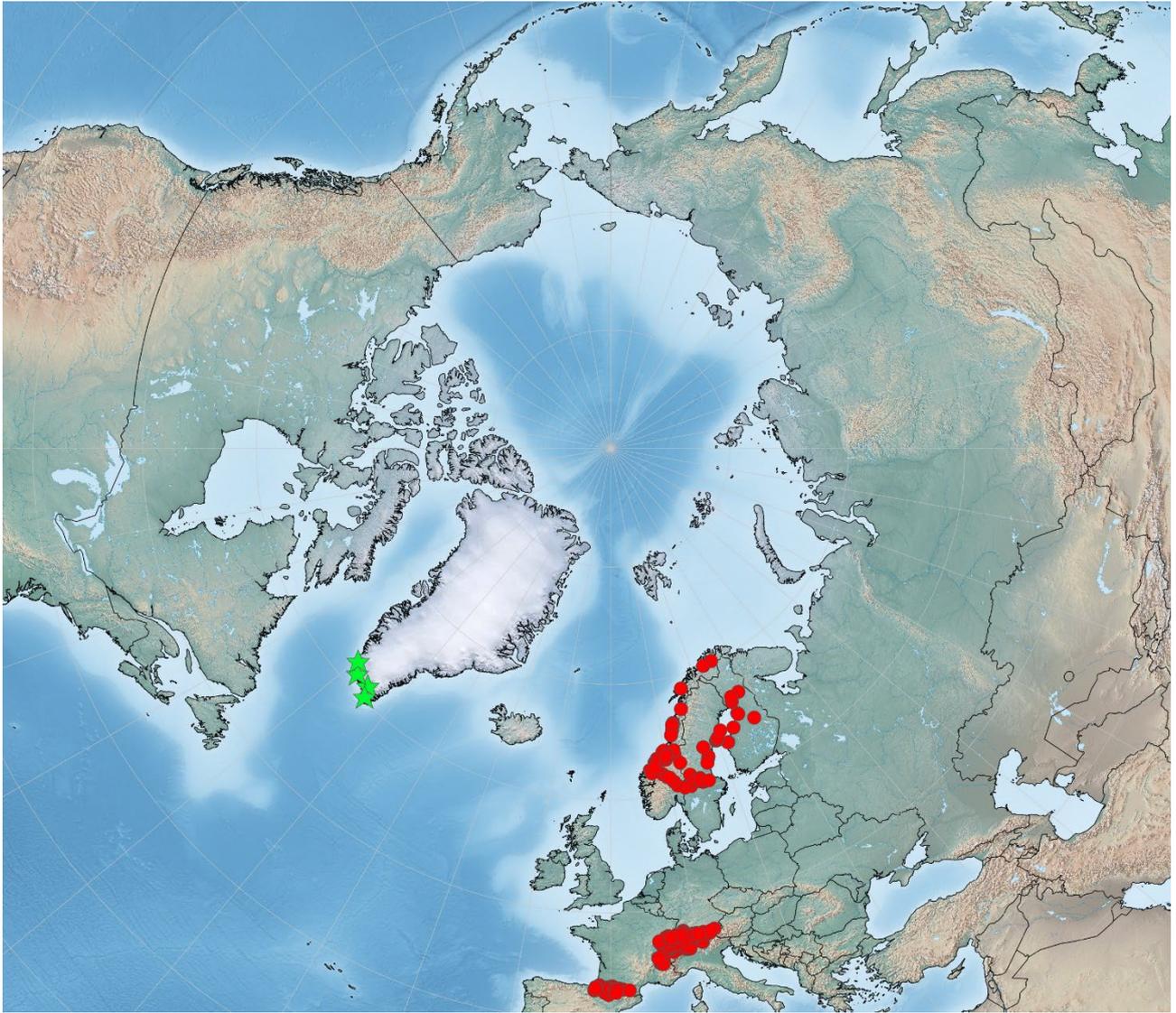
Probasidia ellipsoid, 15-24 × 11-15 μm, cruciate-septate, 2-4-celled; **epibasidia** 30-115 × 2-3 μm. **Hyphae** 2-3.5 μm broad; clamp connections present.

Habitat and hosts

On various species of deciduous wood, most often on *Fagus* in temperate regions; in the Alps up to 600 m; in subarctic and subalpine regions on *Salix* and *Betula*.

Distribution

This species is hardly arctic, but rather subarctic-subalpine-boreal or temperate. Here it is included due to its presence in Greenland.



Exidiopsis: Auriculariaceae: Auriculariales



Exidiopsis arctica

TB 86.005; NHMD001788806

Exidiopsis arctica (Kobayasi) Knudsen, comb. nov., see p. 340

Basionym: *Sebacina arctica* Kobayasi 1967

Syn.: *Exidiopsis groenlandica* Hauerslev, nom. prov. (in fungarium C, unpublished)

Basidioma broadly effused, with distinct margin, waxy-gelatinous, hyaline, 0.5-1 mm thick, surface unevenly folded-wrinkled, somewhat pruinose.

Spores slightly allantoid or with one side appanate, $13.0-14.5 \times 5-7 \mu\text{m}$, hyaline, repetitive. **Probasidia** ovoid, cruciate-septate, $13.5-18 \times 9-11 \mu\text{m}$, 2-celled, with a basal clamp; **epibasidia** $35-45 \times 2 \mu\text{m}$.

Dendrophyses numerous, simple or irregularly branched at apex, 1-1.3 μm broad.

Hyphae irregularly interwoven, 1.5-2.5 μm broad, thin-walled, with clamp connections. Loose bundles of tight, straight or curved hyphae occur, 5-10 in each fascicle. Clamp connections at the bases of the basidia.

Habitat and hosts

On *Salix alaxensis* (Alaska) and *Salix glauca* (Greenland).

Distribution*

Arctic; North American; type 12. Only known from the type locality in Alaska (Cape Thompson) and a collection from Narsarsuaq in southern Greenland.



Exidiopsis: Auriculariaceae: Auriculariales



***Exidiopsis effusa* (invisible!)**

HK 83.400; C-F-7709

Exidiopsis effusa (Sacc.) Möller

Syn.: *Sebacina effusa* (Sacc.) Maire

Basidioma resupinate, pale lilaceous to pink, ca. 1/3 mm thick, margin effused, extended over several cm, waxy.

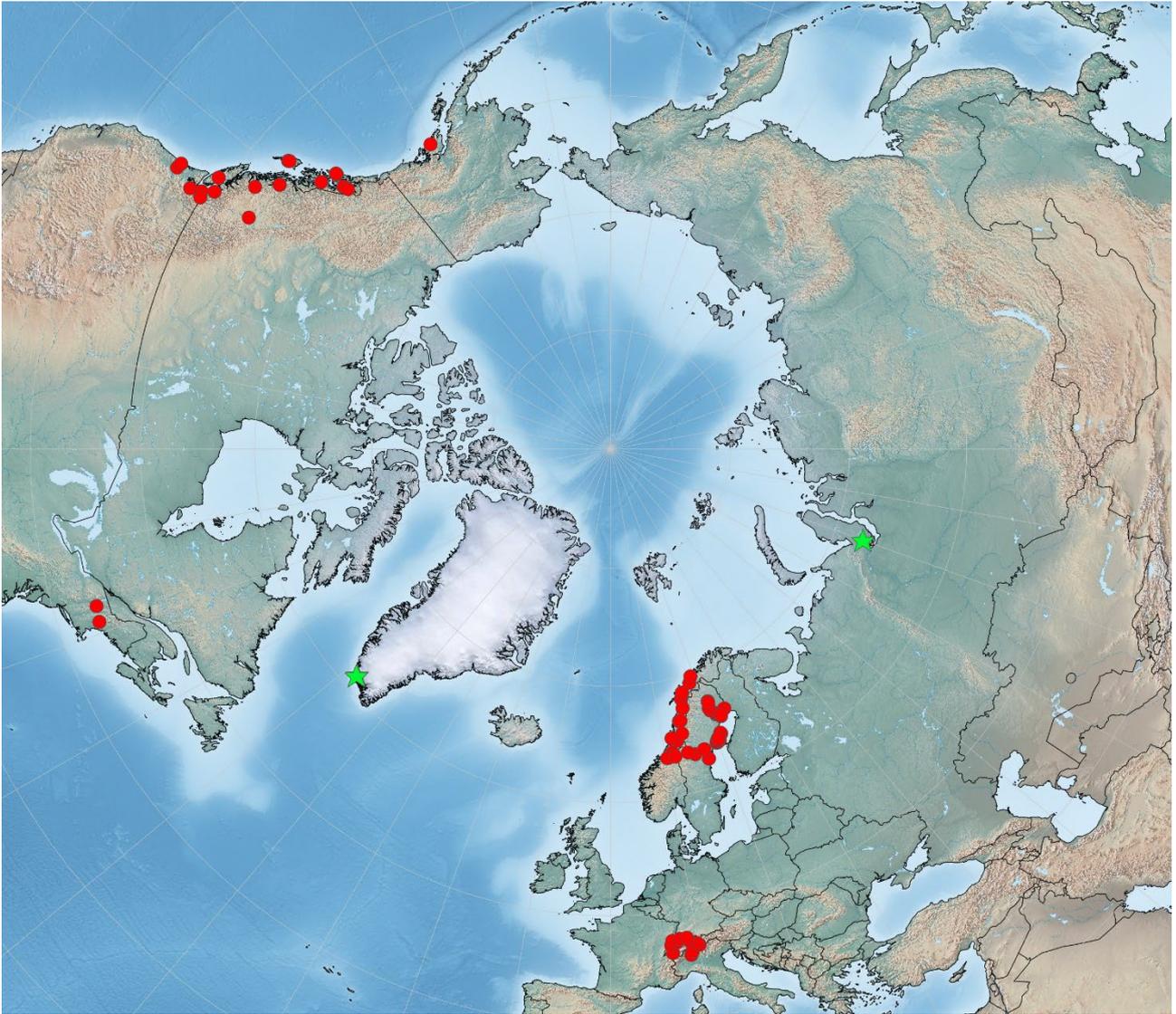
Spores 10.5-17 × 4-5 μm, allantoid, hyaline, thin-walled, smooth, sometimes with granular contents, repetitive. **Probasidia** oblong ovoid, cruciate-septate, 2-4-spored, 11-16 × 9-10 μm, with a basal clamp; **epibasidia** 20-40 × 1-2 μm, cylindrical. **Hyphidia** strongly branched, almost with torulose constrictions. **Hyphae** indistinct, 2-2.5 μm broad, irregular. Clamp connections at the base of the basidia.

Habitat and host

On rotten wood of *Alnus*.

Distribution

Probably not arctic, but included due to a few records from Greenland. Common in boreal and temperate regions, also on other deciduous trees and shrubs.



Exidiopsis Auriculariaceae Auriculariales

***Exidiopsis pallida* (invisible!)**

V. Mukhin, N IEE-4306; C-F-6525

Exidiopsis pallida K. Wells & Raitv.

Basidioma watery-hyaline, gelatinous, firmly attached and difficult to distinguish from the substrate, thin, when dry almost invisible, slightly greasy-shining.

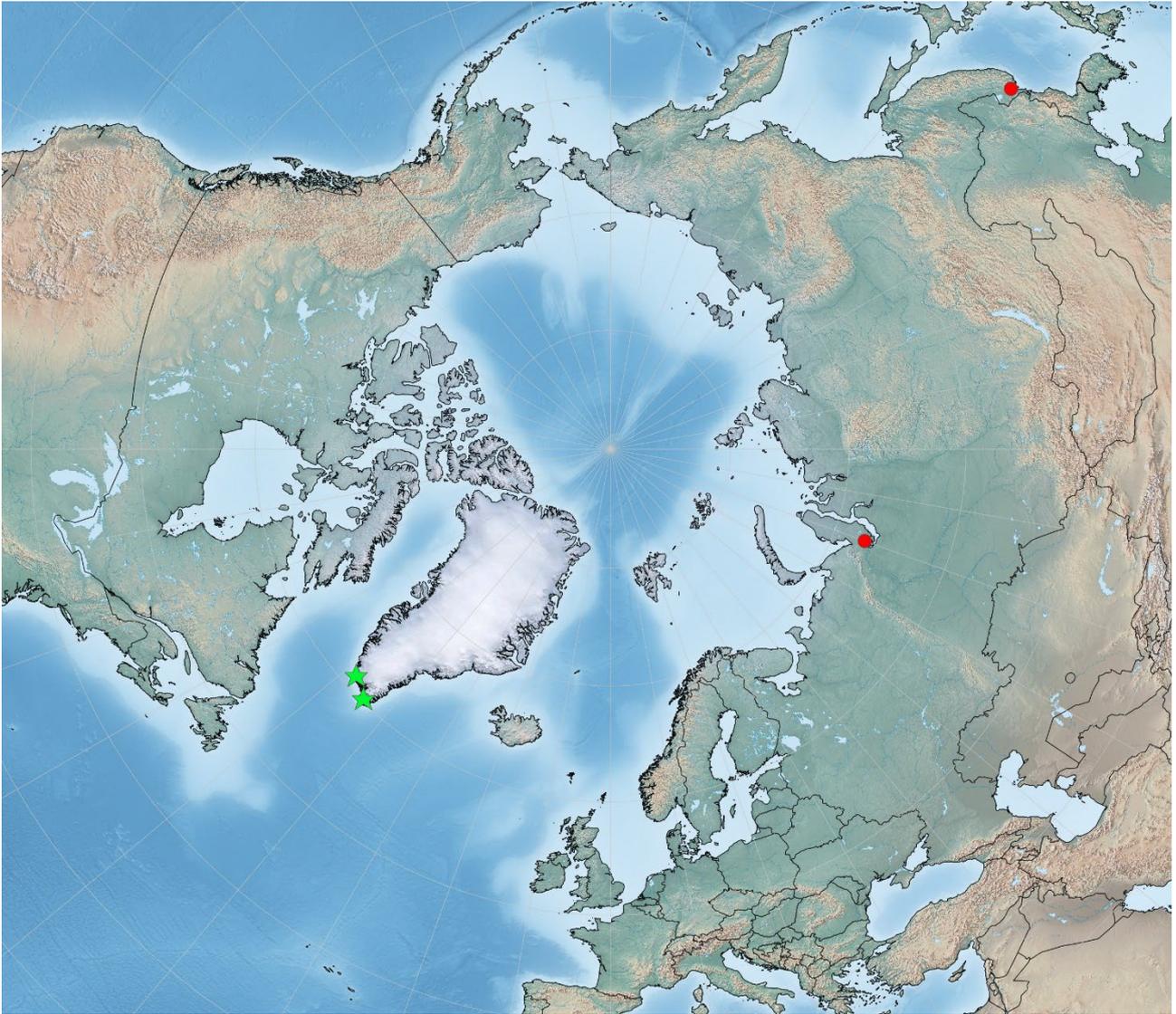
Spores 15-11 × (4-)5-7 μm, allantoid to almost oblong, smooth, inside strongly granulose, greyish in cotton blue. **Probasidia** globose-subglobose, becoming elongate, 10-15 μm, 2-4 sterigmate; **epibasidia** prominent, 20-30 × 2-4 μm. **Hyphae** irregular, 2-4 μm broad; clamp connections not seen.

Habitat and hosts

Forming thin waxy crusts on the bark or directly on the wood of old *Salix glauca* and *Alnus fruticosa*.

Distribution

Still poorly known and very likely overlooked. Collected a few times by V. Mukhin in southern Greenland, and from Russia on the Yamal Peninsula; Parmasto collected the type in the Russian Far East.



Heteroradulum: Auriculariaceae: Auriculariales



Heteroradulum deglubens

SAE-2021.037-DE; C-F-152202; Germany

Heteroradulum deglubens (Berk. & Broome) Spirin & Malysheva

Syn.: *Eichleriella deglubens* (Berk. & Broome) Lloyd; *E. spinulosa* (Berk. & Curt.) Burt

Basidioma resupinate, crust-shaped, stereoid, irregular, sometimes following cracks in the bark, firmly attached, from one to several cm long and 1-7 mm high, hazelnut brown, towards margin paler, becoming brownish or reddish when bruised, surface at centre and when old grey-brown, irregularly knobby with tooth- or spine-like excrescences, margin distinct, around 1 mm thick, growing margin whitish, hairy, well-defined; dried specimens shrinking and forming lacunae.

Spores hyaline, oblong, cylindrical or slightly allantoid, $15-20 \times 6-7 \mu\text{m}$, with large granular contents and distinct apiculus, non-amyloid.

Basidia $25-50 \times 8-14 \mu\text{m}$, cruciate-septate, clavate; 2-4-celled. **Cystidia** absent, but

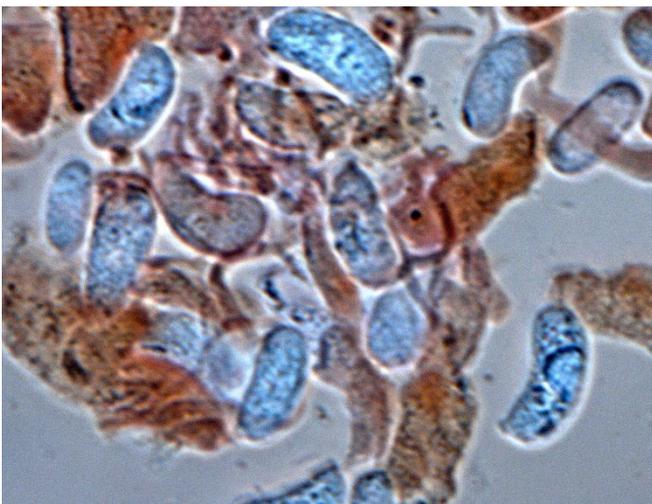
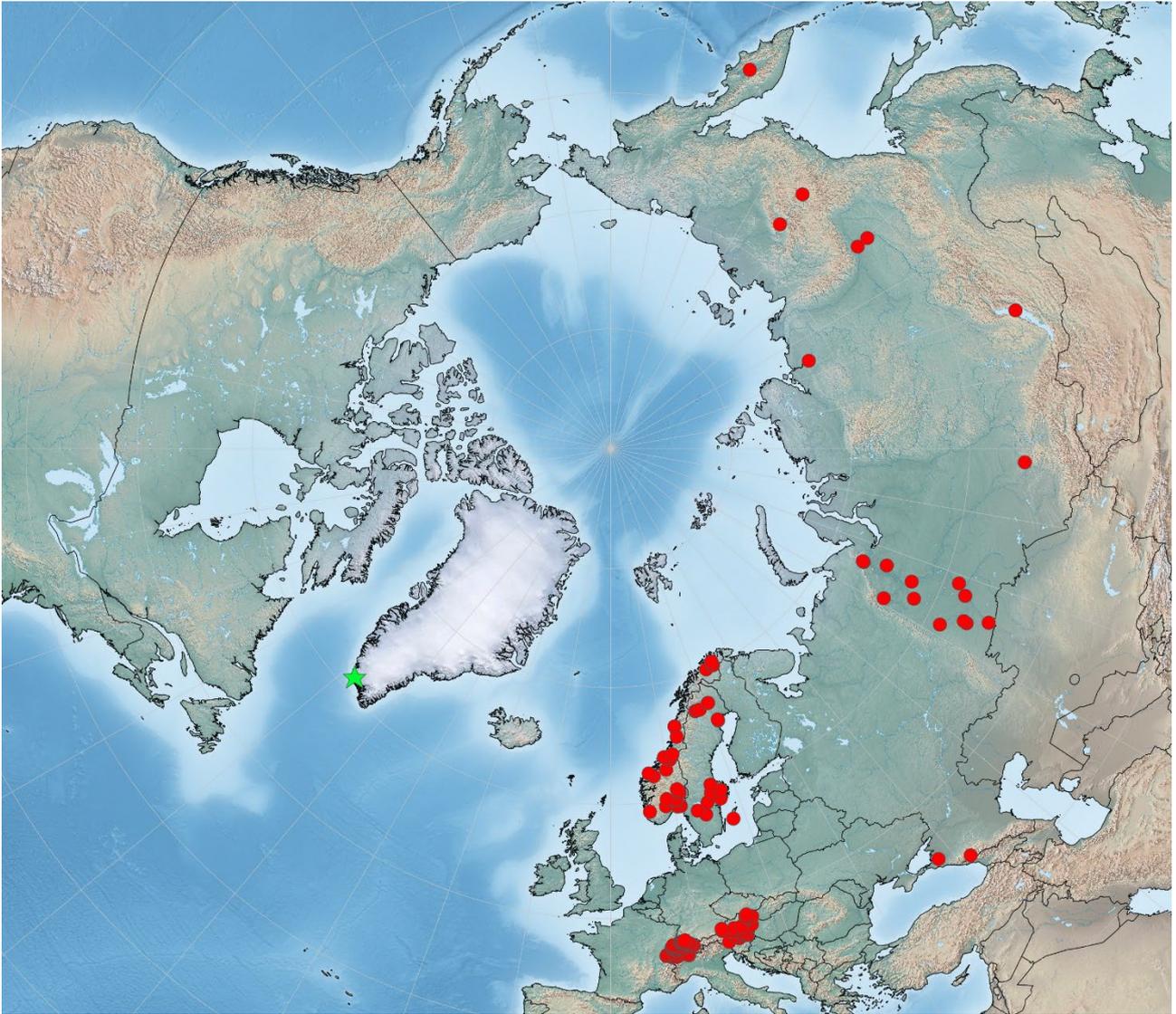
irregular hyphal encrusted ends (hyphidia) occur. **Hyphae** irregular, 1.5-3.5 μm broad, with parallel walls, rather thick-walled, smooth or encrusted with yellowish granula; clamp connections present, but very scattered.

Habitat and hosts

Saprotrophic on wood, especially trunks of *Alnus* and *Salix*, more rarely *Betula* and *Populus*.

Distribution

Arctic-alpine; circumpolar; type 4. A record from Finnmark (Norway) was published as *E. leucophaea*, a Mediterranean species.



Sclerotrema: Auriculariaceae: Auriculariales



Sclerotrema griseobrunnea

HK 87.133; C-F-6865

Sclerotrema griseobrunnea (K. Wells & Raitv.) Spirin & Malysheva

Syn.: *Exidiopsis griseobrunnea* K. Wells & Raitv.

Basidioma crust-shaped, stereoid, light olive grey to reddish brown or grey-brown to hazel brown, at first arid waxy, as small patches, then becoming confluent and forming long patches along the branch, very finely granulose, ca. 0.5 mm thick, eventually cracking; margin reflexed or when actively growing effused and fimbriate, pale.

Spores 10.5-15(-17) × 3-5(-5.5) μm, allantoid, hyaline, granulose inside, thin-walled.

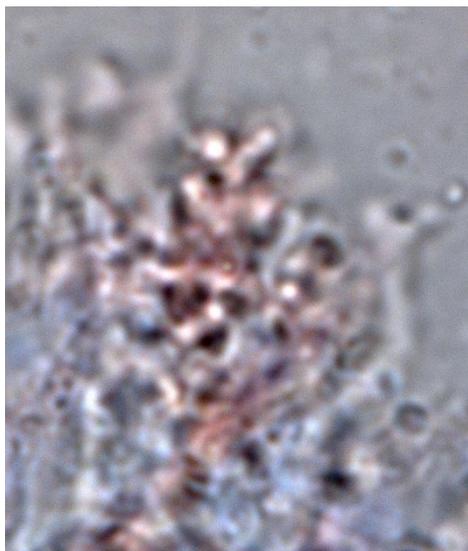
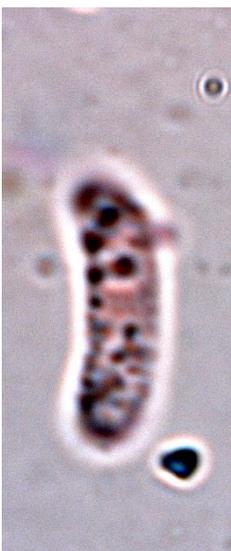
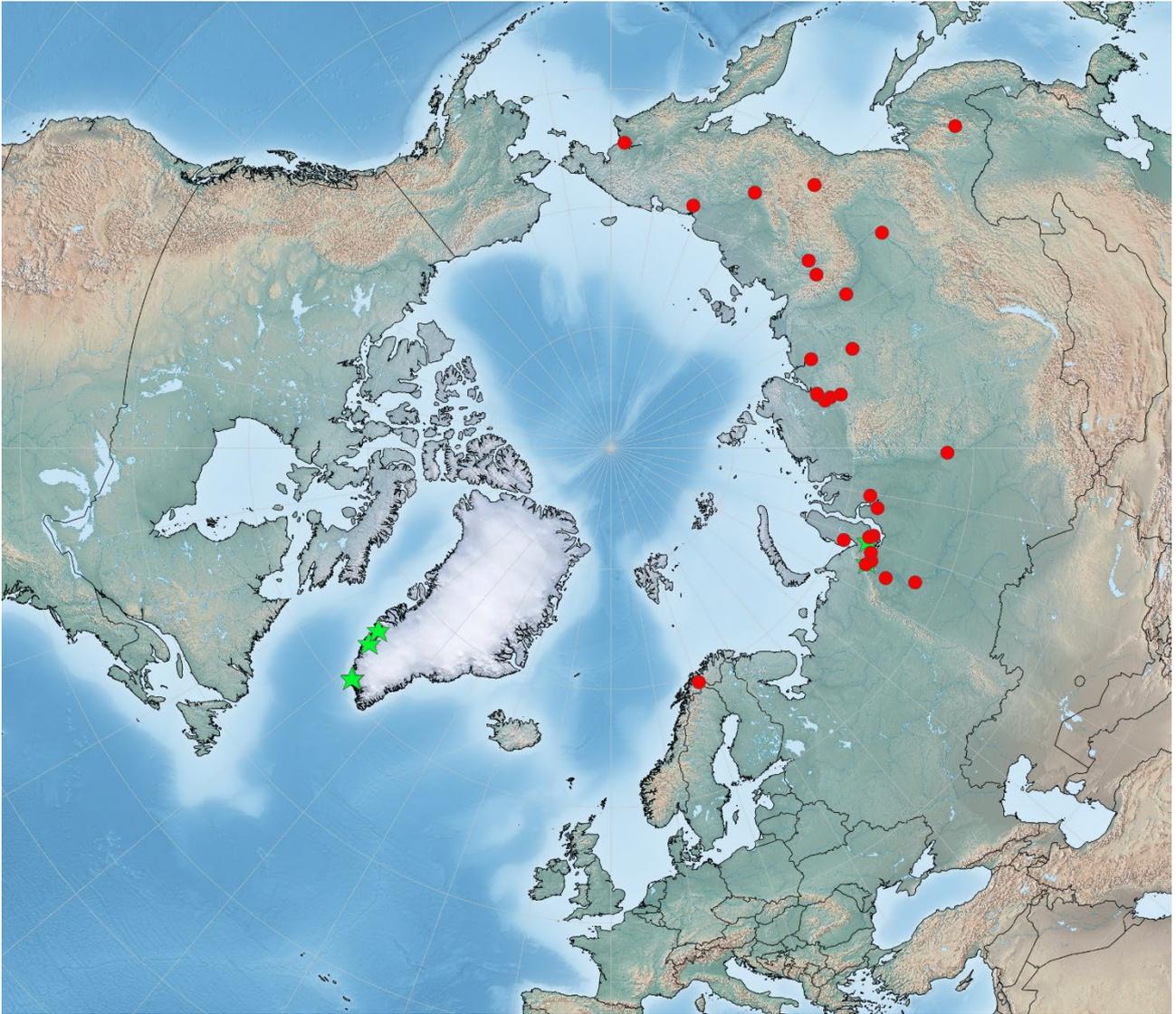
Probasidia 10-14 μm, subglobose; **epibasidia** crosswise septate, 2-4 celled, 11.5-18 × 8-10.5 μm. **Hyphae** thick-walled, 1.5-5.5 μm broad; **dendrohyphidia** branched, becoming encrusted with yellowish granulae.

Habitat and hosts

Saprotrophic on trunks and large branches of *Alnus fruticosa*, possibly also *Salix*.

Distribution

Arctic; Greenlandic-Eurasian; type 4. Found throughout Siberia, with a few records from Greenland.



Basidioidendron: Unknown family: Auriculariales



Basidioidendron caesiocinereum

K. Hauerslev 2270; C-F-72749

Basidioidendron caesiocinereum (Höhn. & Litsch.) Luck-Allen

Syn.: *Corticium caesiocinereum* Höhn. & Litsch.

Basidioma resupinate, effused, ca. 0.1 mm thick, greyish-bluish with a lilaceous tinge, waxy, warty, hardly visible when dry, reticulate.

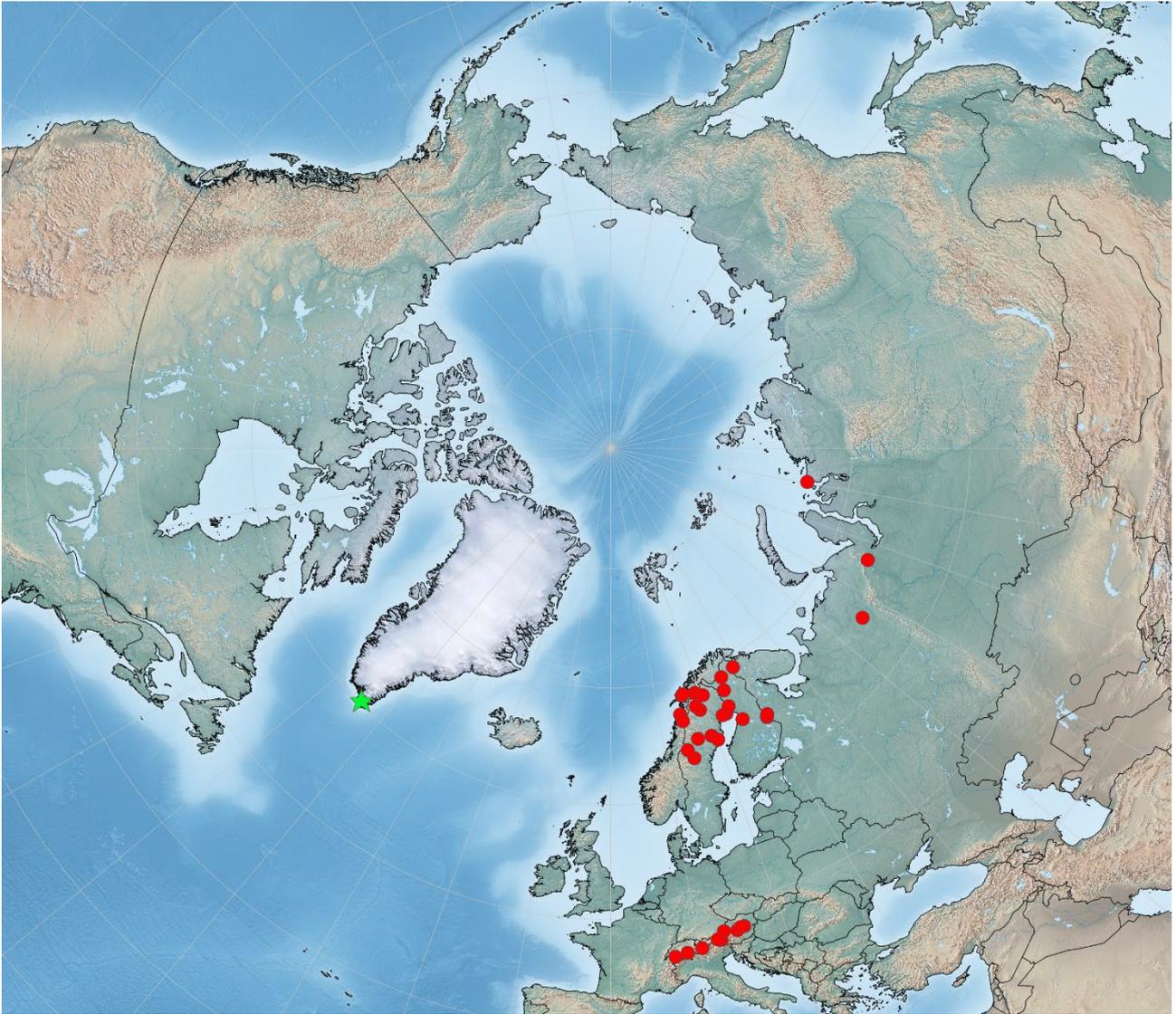
Spores 6.5-9 μm , subglobose, with distinct apiculus, finely punctate, remarkably grey in water or in congo red; secondary spores not seen. **Probasidia** 10-14 \times 7-9 μm , oblong ovoid, cruciate-septate, eventually (2-)4-celled; **epibasidia** 7-12 μm , with pointed apices. **Gloeocystidia** 40-50 \times 4-8 μm , irregularly sac-shaped, with hyaline contents becoming yellow to brownish. **Hyphae** indistinct, 1-3 μm broad, gelatinized, without clamps.

Habitat and host

On rotten wood of *Betula*, *Salix* and *Rhododendron*. In subalpine regions common on conifers.

Distribution

Arctic-alpine; (North American)-Eurasian; known from a wide range of temperate, boreal, subarctic and arctic regions.



Basidiiodendron: Unknown family: Auriculariales



Basidiiodendron cinereum

T. Læssøe 84.331; C-F-7721

Basidiiodendron cinereum (Bres.) Luck-Allen

Syn.: *Sebacina cinerea* Bres.

Basidioma resupinate, 0.1-0.2 mm thick, waxy gelatinous, pale grey, smooth or pruinose.

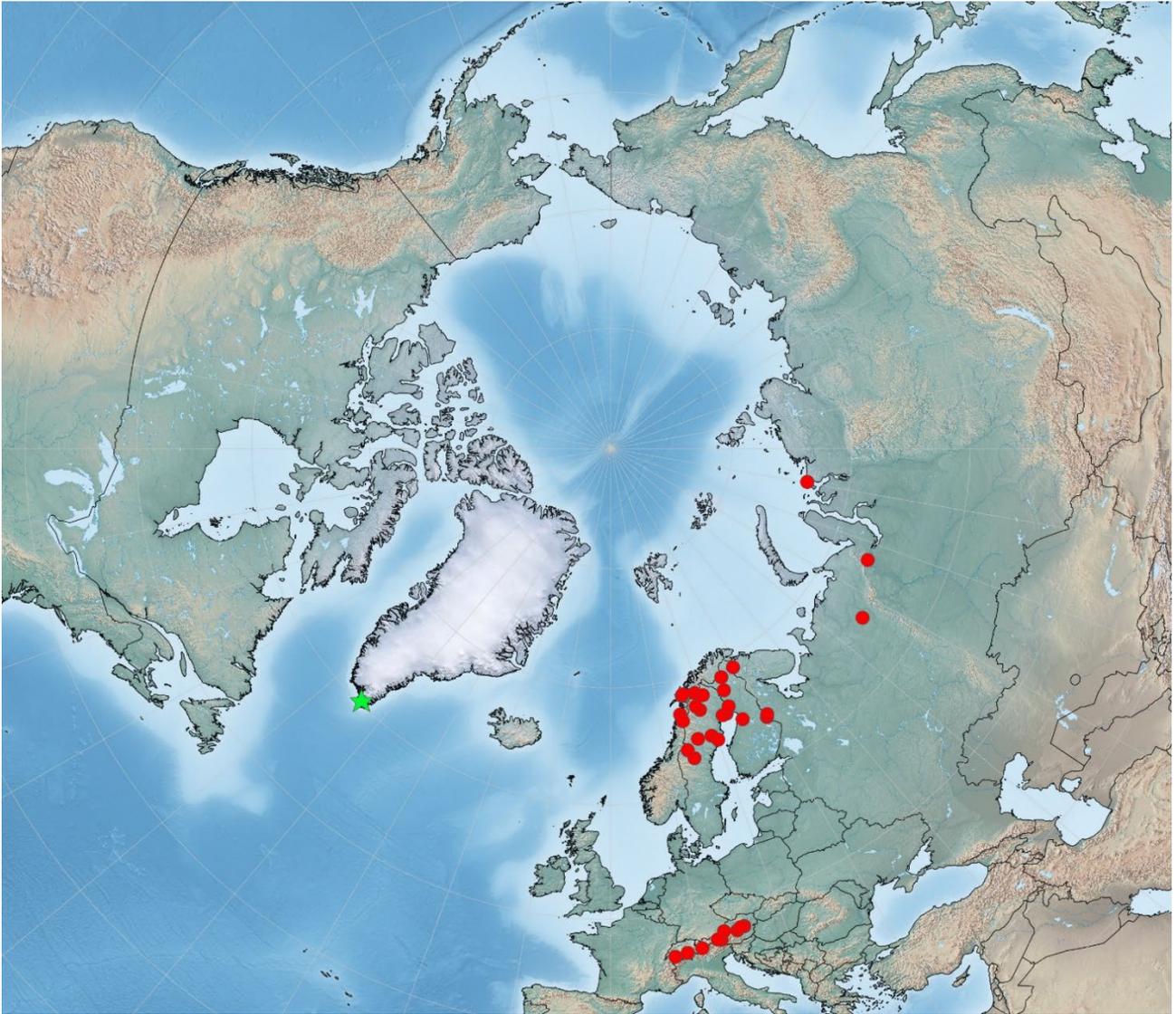
Spores 8-11(-13) × 6-8 μm, ovoid to subglobose, smooth, appearing grey in water and in congo red, thin-walled, with distinct apiculus, repetitive. **Probasidia** oblong ovoid, 14-17 × 10-13 μm, cruciately 4-celled; **epibasidia** short, robust and pointed; **basidia** produced in clusters at the end of lateral outgrowths originating from clamps and eventually collapsing from below, forming clusters of involucre. **Hyphidia** short and thin, strongly branched. **Gloeocystidia** clavate to cylindrical, 16-35(-60) × 4-7.5 μm, at first hyaline, becoming resinous yellowish. **Hyphae** thin, hyaline, 2 μm broad, thin-walled, with clamp connections.

Habitat and hosts

On very rotten wood of *Salix* and *Populus*.

Distribution

Arctic-alpine-boreal-temperate; broadly distributed on rotten wood, apparently not preferring cold areas.



Basidiiodendron: Unknown family: Auriculariales



Basidiiodendron eyrei

J. H. Petersen 83.264; C-F-7707

Basidiiodendron eyrei (Wakef.) Luck-Allen

Syn.: *Sebacina eyrei* Wakef.; *Bourdotia eyrei* (Wakef.) Bourdot & Galzin

Basidioma resupinate, 0.1-0.2 mm thick, waxy gelatinous, pale grey, smooth or pruinose.

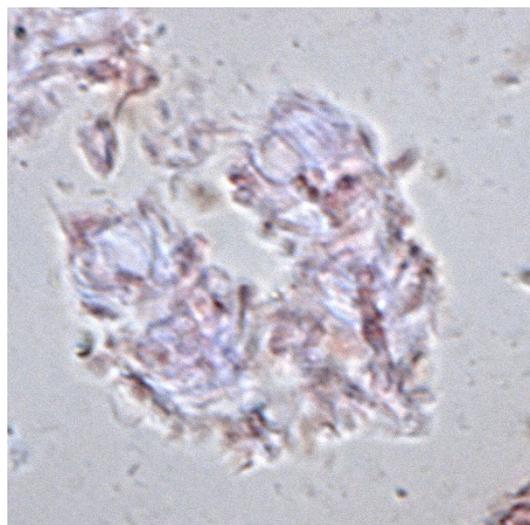
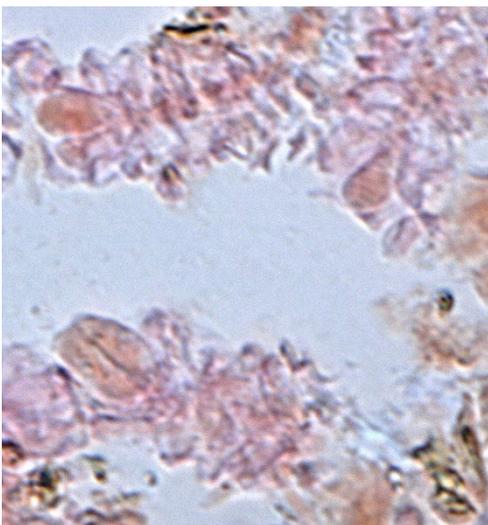
Spores 4-5 × 5-7 μm, ovoid to subglobose, smooth, hyaline, thin-walled, with indistinct apiculus, repetitive. **Probasidia** oblong ovoid, clavate to cylindrical, 15-35(-60) × 4-8 μm, initially smooth, hyaline, thin-walled, with indistinct apiculus, repetitive. **Basidia** with 4-8 μm long sterigma. **Gloeocystidia** hyaline, becoming yellowish resinous. **Hyphae** 1.5-2 μm, thin, hyaline, thin-walled, with clamps.

Habitat and host

Rotten wood of *Salix*.

Distribution

A temperate-boreal-subarctic species included here due to a few records from Greenland.



Notes

Alternative key to species of *Anthracoidea*

The key is made for those who prefer not to use the key on p. 14, which is based on the subgeneric classification of *Carex*.

- 1a. On *Trichophorum (Scirpus) cespitosum* *A. scirpi*, p. 197
 1b. On *Carex*..... 2
- 2a. On species of the *Kobresia* clade 3
 2b. On other species of *Carex* 4
- 3a. Spores smooth in side view; spore wall with 1-3 internal swellings;
 on *Carex myosuroides*, *C. borealipolaris*, *C. capillifolia*, or *C. deasyi* *A. elynae*, p. 149
 3b. Spores minutely verruculose, warts up to 0.2(-0.3) μm high; internal
 swellings absent; on *C. alatauensis*, *C. kokanica*, or *C. simpliciuscula*... *A. lindebergiae*, p. 175
- 4a. On species of *Carex* with one spike (sect. *Monostachyae*) 5
 4b. On species of *Carex* with more than one spike 12
- 5a. Spore wall minutely verruculose 6
 5b. Spore wall in LM smooth 7
- 6a. Verrucae on spores up to 0.2(-0.3) μm high; spores medium-sized,
 (15.5-)17-23(-26) μm long; on *Carex rupestris* *A. rupestris*, p. 193
 6b. Verrucae on spores up to 0.5-0.7 μm high, somewhat confluent;
 spores small, (13-)14-21(-23) μm long; on *C. foetida*..... *A. foetidae*, p. 157
- 7a. Spike with 6-7 female flowers (*Carex pulicaris*) *A. pulicaris*, p. 191
 7b. Spike with more than 7 female flowers 8
- 8a. Fruit strigose; plant ca. 10 cm tall (*Carex scirpoidea*) *A. scirpoideae*, p. 199
 8b. Fruit smooth; plant ca. 5 cm tall 9
- 9a. Plant in dense tufts; spikes with an ovoid shape (*Carex nardina*) *A. nardinae*, p. 181
 9a. Plant with creeping rhizomes 10
- 10a. Spikes attenuate (*Carex obtusata*)..... *A. obtusatae*, p. 183
 10b. Spikes cylindric 11
- 11a. Male and female flowers in the same spike (*Carex curvula*) *A. curvulae*, p. 147
 11b. Male and female flowers in different spikes (*C. parallela* and *C. dioica*) *A. turfosa*, p. 203
- 12a. All spikes similar, with both male and female flowers;
 female flowers with two stigmas (sect. *Homostachyae*) 13
 12b. Only the terminal spike with both male and female flowers;
 other spikes either male or female; female flowers with two or three stigmas 20

- 13a. On *Carex maritima* or *C. enervis*; spores (8.5-)9.5-11.5(-12.5) μm long; spore wall depressed in 3-6 places where the wall is paler and thinner *A. pseudoforetidae*, p. 189
- 13b. On other species of *Carex*; with larger spores..... 14
- 14a. Spikes clustered above..... 15
- 14b. Spikes scattered 19
- 15a. Host on gravel along lakesides (*Carex glareosa*); spore wall verruculose echinulate, profile affected, ornaments of very different sizes, 0.1-1.0 μm high..... *A. aspera*, p. 133
- 15b. Host in grassland or bogs..... 16
- 16a. Spikes 3-8 (*Carex macloviana*) *A. verrucosa*, p. 207
- 16b. Spikes 2-4 17
- 17a. Culms branching (*Carex chordorrhiza*) *A. fischeri*, p. 155
- 17b. Culms not branching..... 18
- 18a. Cluster of spikes up to 1.5 cm long (*Carex norvegica*)..... *A. savilei*, p. 195
- 18b. Cluster of spikes up to > 3 cm long (*C. disticha* or *C. cusickii*)..... *A. fischeri*, p. 155
- 19a. Spores subglobose to globose, wall echinate, spines up to 1 μm high; on *Carex brunnescens*, *C. canescens*, *C. lapponica*, *C. mackenziei* or *C. sempervirens* *A. fischeri*, p. 155
- 19b. Spores broadly ellipsoid, wall minutely verruculose, spore profile not affected, warts up to 0.2 μm high; on *C. brunnescens*, *C. canescens*, *C. heleonastes*, *C. lapponica*, *C. loliacea*, or *C. marina* *A. kariii*, p. 165
- 20a. More than one female spike; terminal spike with male and 3-stigmate female flowers (*Pseudohomostachyae*) 21
- 20b. More than one female spike and one or more male spikes..... 25
- 21a. No bracts exceeding the spikes; spores with a regular outline, 14-21 \times 18-25 μm , broadly ellipsoid to subglobose, brown to dark brown (*Carex fuliginosa* or *C. atrofusca*) *A. misandrae*, p. 179
- 21b. Basal supporting bract exceeding the spikes; spores with an irregular outline 22
- 22a. Spores 15-21 μm 23
- 22b. Spores 17-28 μm 24
- 23a. Spores 15-18 \times 16-21 μm , pale brown to brown (*Carex fuliginosa*) *A. altera*, p. 129
- 23b. Spores 15.5-20.5 \times 14-17.5 μm , medium to dark reddish brown (*Carex umbrosa*)..... *A. umbrosae*, p. 205
- 24a. Spikes clustered, bending; spores 17-25 μm (*Carex atrata*) *A. atratae*, p. 135
- 24b. Spikes scattered, upright; spores 19-28 μm (*C. buxbaumii*)..... *A. buxbaumii*, p. 141

- 25a. Flowers with two stigmas (*Distigmaticae*).....26
- 25b. Flowers with three stigmas (*Tristigmaticae*).....28
- 26a. Longest bract longer than the spikes; spikes upright;
spores 10-18 × 13-21 μm (*Carex aquatilis*)**A. heterospora**, p. 159
- 26b. Longest bract shorter than the spikes27
- 27a. Spikes hanging or upright; spores 17-23 × 19-24 μm (*Carex lyngbyei*) **A. liroi**, p. 177
- 27b. Spikes sessile, short; bract short (*C. bigelowii* or *C. scopulorum*)..... **A. bigelowii**, p. 139
- 28a. Perigynia white or transparent; spikes in a dense terminal group;
bracts often horizontal; in the Alps (*Carex baldensis*).....**A. baldensis**, p. 137
- 28b. Perigynia coloured; bract(s) at an angle; in the Alps or elsewhere29
- 29a. Male spike absent; spores large, 18-27(-30) μm; on *Carex bicolor*,
C. livida, *C. panicea*, or *C. vaginata***A. paniceae**, p. 185
- 29b. Male spike present30
- 30a. Male spike sessile31
- 30b. Male spike stipitate33
- 31a. Bract distinct, equalling the length of the culms (*Carex pilulifera*)..... **A. caricis**, p. 145
- 31b. Bract very short32
- 32a. Male spike below female spike (*Carex digitata*).....**A. irregularis**, p. 163
- 32b. Male spike(s) above female spikes (*C. montana*)..... **A. caricis**, p. 145
- 33a. Female spikes upright; fruits with very short or normal beak.....34
- 33b. Female spikes nodding/hanging; fruits with longer beak.....41
- 34a. Fruits with very short beak35
- 34b. Fruits with normal beak36
- 35a. Small plant, ca. 5 cm high (*Carex glacialis*).....**A. rupestris**, p. 193
- 35b. Larger plant, ca. 20 cm high (*C. panicea*, *C. vaginata*, or *C. livida*).....**A. paniceae**, p. 185
- 36a. Bracts, glumes or fruits brown37
- 36b. Bracts green38
- 37a. Bracts brown (*Carex firma*)..... **A. firmae**, p. 153
- 37b. Glumes and fruits dark brown (*C. atrofusca*).....**A. misandrae**, p. 179
- 38a. Female spikes stipitate and slightly nodding (*Carex sempervirens*)... **A. sempervirentis**, p. 201
- 38b. Female spikes distinctly hanging from very thin stems39
- 39a. Female spike solitary, rarely 2-3; spores appearing slightly verrucose
(*Carex limosa*, *C. magellanica*, or *C. rariflora*).....**A. limosae**, p. 173
- 39b. Female spikes 2-340

- 40a. Female spikes green (*Carex capillaris*).....*A. capillaris*, p. 143
 40b. Female spikes with brown scales (*C. laxa*) *A. laxae*, p. 171
- 41a. Spores distinctly verrucose or echinulate 42
 41b. Spores almost smooth or verrucose 43
- 42a. Spores echinulate, 11-18 × 13-20 μm (*Carex rostrata*) *A. inclusa*, p. 161
 42b. Spores verrucose, 12-20 × 10-18 μm (*C. atherodes*, *C. rostrata*,
 or *C. utriculata*) *A. americana*, p. 131
- 43a. Spores smooth or finely verrucose 44
 43b. Spores with warts 0.2-0.4 μm; on *Carex kitaibeliana*)..... *A. kitaibeliana*, p. 167
- 44a. On *Carex lasiocarpa*, *C. rostrata*, or *C. saxatilis*..... *A. lasiocarpae*, p. 169
 44b. On *Carex flacca* 45
- 45a. Spores 17-23 × 15-19 μm *A. ferrugineae*, p. 151
 45b. Spores 18-31 × 17-25 μm *A. pratensis*, p. 187

Exidiopsis arctica (Kobayasi) Hauerslev ex Knudsen, comb. nov.

Basionym: *Sebacina arctica* Kobayasi, in Kobayasi et al., Rep. (Annual) Inst. Ferment. Res. Osaka 3: 62 (1967).

Mycobank # 861537.

Hitherto only known from the type-collection in Alaska, but here we add a collection from southern Greenland, which we believe to be conspecific with Kobayasi's collection. The Greenland specimen was studied by Knud Hauerslev, a specialist of this group of fungi, but unfortunately he died before he could publish it. The Greenlandic specimen differs from Kobayasi's in having loose hyphal cords, which he may have overlooked when he described *Sebacina arctica*. Since these are not clearly a part of the basidioma, for now we refer both collections to the same species (see description on p. 321).

The generic name *Sebacina* was previously used as in a broad sense to include many resupinate heterobasidiomycetes, but it is now considered to be a genus characterized by the absence of clamp connections.

Exidiopsis grisea (Bres.) Bourdot & Maire (*Sebacina grisea* Bres.) is closely related.

Tremella sibirica Knudsen & Corfixen, spec. nov.

Holotype: Russia, Siberia, Chelyabinskaya oblast, Yuryuzan river, Iremel Mts., 45 km south of Yuryuzan, alt. 930 m, 54°57' N, 58°83' E; 27.08.2002, leg. Peer Corfixen (PC 02.075); deposited in the Natural History Museum of Denmark (C; barcode no. C-F-61489).

Mycobank # 861531.

Basidioma parasitic, 2.5-4 mm when dry (not seen fresh), cerebriform folded, greasy shining, dark brown.

Spores 9-11 × 5-8 μm, Q= 1.4, ovoid or oblique ovoid, applanate, apiculus often thickened, thin-walled, hyaline, repetitive, reddish brown in congo red. **Probasidia** at first almost globose and 10-13 μm in diameter, then splitting cruciately into four cells, yellowish, more rarely 2-celled, densely crowded; **epibasidia** long, tubular, seen up to 40 × 2 μm, irregular, apparently soon loosening from probasidium. **Hyphae** 1.5-3-5 μm broad, hyaline, smooth or encrusted here and there when old, with distinct walls, with or without granulose interior, irregular; clamp connections numerous, of normal and open type; distinct haustoria present. **Mature basidia** reddish brown in congo red.

So far only known from the type collection in Russia, on *Megalocystidium leucoxanthum* (Bres.) Jülich (Stereaceae), on rotten wood of *Salix* in subalpine mountains in the Chelyabinsk-region. The somewhat similar *Tremella versicolor* grows on the closely related *Gloeocystidiellum lividocaeruleum*, but has spores 6 × 4 μm. See photo on p. 299.

In recent years our knowledge of the genus *Tremella* and its biology has made significant progress especially thanks to the work of Paul Diederich (1996). *Tremella* was shown to be a parasite of different fungal groups and to be much more diverse than hitherto believed. The presence of a *Stereum* inside *Tremella encephala* on pine trees has long been known, as well as two minute species of *Tremella* on *Aleurodiscus*, but numerous species have since been described.

This new species connects to the group of *Tremellae* on basidiomycetes, of which another is represented in this volume, *Tremella penetrans*, which parasitizes the basidiomata of *Dacrymyces* species. The largest group so far known occurs on lichenized fungi, which are excluded from this work (see Diederich et al. 2022). A third, smaller group parasitizes larger pyrenomycetes, e.g. *Tremella karstenii*, which is also included here.

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