Funga Arctica & Alpina

volume 2

Rusts p.p.

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Termorshuizen and Swertz published Dutch Rust Fungi in 2011, comprising 345 species of rusts; the first overview of rusts occurring in the Netherlands since 1883.

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Contents

Introduction

Funga Arctica & Alpina is a forthcoming funga treating all basidiomycetes in arctic and alpine regions of the Northern Hemisphere. Volume 2 is issued simultaneously with volumes 1 and 3.

The funga is planned in seven volumes. For more information about the contents and publication of the individual volumes, please consult our homepage, https://funga-arctica-alpina.dk. For the history of the project, background, material and methods, geography, climate, host plants, results, and literature, consult volume 1.

This volume on rusts is based on ca. 9000 records of rust fungi from these regions, including 1500 collections in Fungarium C (Natural History Museum of Denmark, Copenhagen), 7000 records from the Global Biodiversity Information Facility (GBIF.org) and other public databases, and ca. 500 records from the literature.

The taxonomic species-concept is based on a number of rust fungas: Fischer (1904), Săvulescu (1953), Gäumann (1959), Wilson & Henderson (1966), Gjærum (1974), Poelt & Zwetko (1997), Henderson (2004), and Termorshuizen & Swertz (2011), as well as appropriate papers.

The distribution maps show localities obtained from GBIF (red circles), from the literature (yellow squares) and from Fungarium C (green stars).

In the Distribution section for each species, "type" is followed by a number designating one of 15 different distributional types, into which we sorted the included 142 species. See explanation in volume 1.

The photos of the spores are - when possible - taken at 400×, and show the teliospores. For *Chrysomyxa*, *Rossmanomyces*, *Melampsora*, *Hyalopsora*, *Melampsorella*, *Melampsora*, and *Pucciniastrum* the photos are of aeciospores or urediniospores.

For a few species these standards were not available, and we have used spores from other stages: *Phragmidium fusiforme* (aecia); *Puccinia brachypodii*, *Puccinia epilobii-fleischeri*, *Uromyces airae-flexuosae* (urediniospores), and *Uromyces lapponicus* (aecia).

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Biology, life cycles, abbreviations, maps

Rust fungi are a large group of basidiomycetes with one of the most complicated life-cycles. They are parasites of vascular plants and have evolved along with them. Members of the rust fungi are found throughout the angiosperms and gymnosperms, a few occur on ferns, but none on mosses and clubmosses. On gymnosperms only a few species are found, but they are widespread and potentially very harmful. On angiosperms they occur in many families, with the grasses (Poaceae) and the daisy family (Asteraceae) being important representatives. The economic damage caused by rust fungi, especially on cereal crops, is considerable.

The most extensive life cycle of a rust starts with a basidium producing haploid and monokaryotic basidiospores. Basidiospores germinate on the host plant and produce spermogonia which are often located on the upper side of the leaves. These spermogonia produce small, 1-celled spores, the spermatia, which are attractive to insects because of their sugar content. The insects transfer the spermatia to other spermogonia, leading to a haploid, dikaryotic mycelium which then gives rise to aecia. These are mm-large cups inserted on the surface of the leaves, pale, hyaline or yellowish with or without a dentate, crown-like margin (peridium). The aecia may be grouped or scattered. They develop aeciospores in chains, which are one-celled, often somewhat globose-polyhedric, pale to orange-yellowish, and usually echinulate. Aeciospores spread to a so-called alternate host, where they form uredinia. These are pulverulent, round to oblong, orange to brown sori on leaves and stems, forming urediniospores. These are pale brown, often finely echinulate or verruculose and produced on a pedicel of which usually only the remnants are visible. Later in the season on the same host telia are produced, which are pulverulent or pulvinate, brown to black, forming teliospores. These are brown, usually one- or two-celled, thick-walled and often provided with a more or less long pedicel except if they are formed within the host tissue. These spores have characteristic features and are therefore often used for identification at the species level. In each cell of the teliospores the two haploid nuclei merge to form one diploid nucleus. Usually after a resting period, in each teliospore cell meiosis and mitosis take place to produce four haploid, hyaline and thin-walled basidiospores. A minority of species have teliospores that do not have a resting period and hence germinate readily; these spores are sometimes called leptospores. These spores are light-coloured and thin-walled.

Many variations of this cycle occur. Host alternation may take place as described above (heteroecious rusts), with spermogonia and aecia produced on one host and uredinia and telia on another host. A frequently-occurring host alternation is between monocotyledons (mainly grasses and sedges) and dicotyledons. However, rusts may also complete their whole life cycle on the same plant (autoecious rusts). A number of other variations are known in the rusts (see definitions of terms below).

The descriptions are mainly based on Arthur (1907-1931), Săvulescu (1953), Gäumann (1959), Wilson & Henderson (1966), Parmelee (1989), Termorshuizen & Swertz (2011), Klenke & Scholler (2015), “Fungi Canadenses,” and the many articles on rust species by Savile and others. The descriptions of *Chrysomyxa* species are mainly based on Crane (2000, 2001).

Explanations and abbreviations

Rust fungi develop through a number of life stages

0	spermogonia
I	aecia
Iu	aecia uredinioid
II	uredinia
IIa	uredinia aecidioid
III	telia
IIIa	telia aecidioid
IIIg	teliospores germinating readily (leptospores)
III(g)	part of the teliospores germinating readily

Other codes used in their description

/	a slash between the stages indicates host alternation
(II)	round brackets indicate that the stage is rarely formed, or spores are formed in another sorus stage
[I]	square brackets indicate that the stage is lacking in arctic and alpine regions; in cases where a conifer (except *Juniperus*) is an obligate host the species is excluded, since we have by definition excluded conifers from arctic and alpine regions
s	an s means the infection is systemic, i.e. the infection moves throughout the host and often induces malformations.
(s)	an s in round brackets has the same meaning, but the systemic infection is partly local
*	an asterisk refers to the Notes at the end of the volume

Definition of life cycles

Macrocyclic hetereuform	0-I / II-III Spermogonia and aecia on one host, uredinia and telia on another.
Macrocyclic auteuform	0-I-II-III Spermogonia, aecia, uredinia and telia on the same host.
Demicyclic heteropsisform	I / II-III Aecia on one host, uredinia and telia on another; spermogonia missing.
Demicyclic autopsisform	I-II-III Aecia, uredinia and telia on one host; spermogonia missing.
Brachycyclic form	0-II-III Spermogonia develop directly into uredinia and telia; aecia missing.

Hemicyclic form	II-III Uredinia and telia present on one host; other stages missing.
Microcyclic form	III Only telia present (a characteristic cycle for cold environments).
Endocyclic form	IIIa Aeciospores germinate directly with a basidium, i.e. behave like a teliospore.

Maps

For general explanations about the maps, see volume 1. For symbols on the maps:

Red circles indicate localities taken from public databases, generally from GBIF, but also others (see list in volume 1).

Green stars indicate localities based on collections in Fungarium C (Natural History Museum of Denmark).

Yellow squares indicate localities taken from records reported in the literature.

Taxonomic arrangement and keys to all levels

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

Pucciniomycotina is a subdivision of the division Basidiomycota along with Ustilaginomycotina treated in volume 3, and Agaricomycotina treated in volumes 3-7.

Pucciniomycotina are not forming basidiomas and one or up to five life stages may be present. The basidia are transversely septate, and ultramicroscopically the hyphae are characterized by having simple septal pores and disc-like spindle pole bodies.

They are parasites on living plants, scale insects and mosses, or saprotrophic on wood and other debris.

Ten classes are recognized in this subdivision. Only one is included here:

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

Obligatory biotrophic parasites on angiosperms, gymnosperms and ferns. Fleshy basidiocarps absent. Life cycle including one or more different stages, autoecious (on the same plant) or heteroecious (on different plant species).

The germinating basidiospores give rise to (haploid, monokaryotic) spermogonia producing spermatia which fertilize other spermatia, resulting in haploid, dikaryotic aecia with or without a peridium; aecia solitary or in groups, often yellow to orange producing hyaline to yellowish, often echinulate aeciospores; aecia developing into pulverulent uredinia on the same plant (autoecious rusts) or after infection of another host plant (heteroecious rusts); uredinia forming brown, usually echinulate to verrucose, one-celled urediniospores on which remnants of the pedicel attachment are visible; next on the same host pulverulent or pulvinate, usually dark brown to black telia are formed; teliospores are one- to multi-celled, often 1-4-celled, thick-walled, with smooth, verrucose or otherwise ornamented wall with one or more germ-pores and often provided with a prominent pedicel. The teliospores are often species-characteristic and used for identification. After germination, they give rise to 4-celled, transversally septate basidia producing the haploid basidiospores.

Only one order is included here:

Pucciniales Caruel

Obligatory biotrophic parasites on angiosperms, gymnosperms and ferns. Fleshy basidiocarps absent. Life cycle including one or more different stages, autoecious (on the same plant) or heteroecious (on different plant species).

Haploid spermatia from spermogonia develop into mm-large aecia, which are often orange with a white, ± coronate margin. Aeciospores are hyaline, one-celled, ± globose-polyhedral, usually echinulate. Heteroecious species continue their development on another host and develop haploid uredinia, yellow or brown mm-large structures. They produce yellow or brown, thick-walled, one-celled, smooth or often finely verrucose or echinulate urediniospores. Later, most often on the same host, telia are formed, which are brown to black, pulverulent or pulvinate spots on the leaves, but in some cases they may be less organized and occur among the epidermis cells of the plant. Telia produce brown, thick-walled, smooth or ornamented teliospores provided with a pedicel. The teliospores are often species-characteristic and used for identification. After overwintering, the haploid, dikaryotic teliospores cells merge to give rise to one diploid cell, which then undergoes

meiosis and subsequent mitosis. After germination, this gives rise to 4-celled, transversally septate basidia producing the haploid basidiospores.

Rust species are found in all plant societies where their hosts occur. They do not occur in all plant families, but are common in some, e.g. Asteraceae and Poaceae, and are present in many others. Many are economically important plant pathogens and thus are controlled by heavy pesticide use or the use of resistant cultivars.

The order is common in arctic and alpine regions, including ca. 150 species associated with ca. 1000 plant species. In contrast, ca. 7000 species of rusts are known worldwide from ca. 300,000 plant species. The number of families in Pucciniales is variously interpreted as 10-15, of which six are treated here.

Key to families of Pucciniales

1a. Telia in cylindrical, mm-cm large, orange to brown, when fresh gelatinous masses on needles, branches and stems of *Juniperus*, or as aecia with a few mm long peridium on swollen parts of the leaves of *Sorbus*, *Hedlundia* and *Scandosorbus* ..... **Gymnosporangiaceae**, p. 11
1b. Telia in flat sori, non-gelatinous, pulverulent or pulvinate 2

2a. On ferns ..... **Pucciniastraceae** (***Hyalopsora***), p. 22
2b. On seed plants 3

3a. On Rosaceae 4
3b. On other families 5

4a. Teliospores 1-celled, not pedicellate ..... **Coleosporiaceae** (***Aculeastrum***), p. 8
4b. Teliospores 2- to multi-celled, pedicellate ..... **Phragmidiaceae**, p. 10

5a. Teliospores pedicellate, 1-2-celled ..... **Pucciniaceae**, p. 12
5b. Teliospores not pedicellate 6

6a. On birch (*Betula*) ..... **Pucciniastraceae** (***Melampsoridium***), p. 22
6b. On other plants 7

7a. On willow (*Salix*) ..... **Melampsoraceae**, p. 9
7b. On other plants 8

8a. On Ericaceae 9
8b. On other families ..... **Pucciniastraceae**, p. 21

9a. On *Vaccinium* ..... **Pucciniastraceae** (***Naohidemyces***), p. 22
9b. On other Ericaceae ..... **Coleosporiaceae**, p. 8

Coleosporiaceae Dietel

Most species macrocyclic, with spermogonia, aecia, uredinia and telia. Aecia with well developed peridium; aeciospores hyaline. Uredinia pulverulent, with or without peridium, pale orange; spores in chains. Telia orange to red, cushion-shaped, wax-like. Teliospores rectangular, in coherent rows, hyaline, smooth, gelatinous at apex.

Most species are heteroecious, some microcyclic. Spermogonia and aecia on conifers, uredinia and telia on Ericaceae. Most species make systemic infections and are thus independent of host alternation, but infection on conifers is non-systemic and must happen every year. Since conifers are absent by our definition of arctic and alpine areas, stages 0-I are not included in this work.

Three genera are treated here.

Key to genera

1a. On *Chamaedaphne, Empetrum* or *Rhododendron* (*Ledum*) ..... ***Chrysomyxa***
1b. On other plants..... 2

2a. On *Rubus arcticus* ..... ***Aculeastrum***
2b. On the wintergreen family (Pyrolaceae)..... ***Rossmanomyces***, p. 9

Aculeastrum M. Scholler & U. Braun

Only one species is treated, ***A. arcticum***, see p. 39.

Chrysomyxa Unger

Macrocyclic or microcyclic. Aecia with well-developed peridium. Aeciospores orange, globose to ellipsoid, strongly verrucose. Uredinia pulverulent, with or without a delicate peridium. Urediniospores subglobose, ovoid, ellipsoid or irregular, truncate at one or both ends, pale yellow. Telia often sparsely developed or lacking in the North, waxy, formed in spring on last year's leaves. Teliospores formed by catenulate growth, 1-celled, thin-walled, hyaline, germinating readily.

Most species heteroecious, some microcyclic. Hosts carrying spermogonia and aecia are non-systemic and need infections every year from hosts with uredinia or telia. Hosts carrying uredinia and telia have systemic infections and are thus independent of a host alternation. Spermogonia and aecia on needles of conifers, and thus by definition not included in this work. Uredinia and telia on members of the heather family (Ericaceae).

Seven species are treated here. *Chrysomyxa reticulata* from Canada is not included. It has spores where one side of the spore is covered with a broad longitudinal reticulum.

Key to species

1a. On *Rhododendron* (including *Ledum*)..... 2
1b. On other heather plants (Ericaceae)..... 7

2a. On *Rhododendron* with white flowers (formerly *Ledum*)..... 3
2b. On *Rhododendron* with coloured flowers 6

3a. Urediniospores indistinctly verrucose ..... ***C. nagodhii***, p. 49
3b. Urediniospores strongly verrucose 4

4a. Uredinia and telia epiphyllous ..... ***C. ledicola***, p. 47
4b. Uredinia and telia hypophyllous 5

5a. On *Rhododendron* (*Ledum*) *groenlandicum*; urediniospores with wall up to 1.6 µm thick and aeciospores with wall 1.5-2.7 µm thick ..... ***C. ledicola***, p. 47
5b. On *Rhododendron tomentosum* (*Ledum palustre*); urediniospores with wall up to 1 µm thick and aeciospores with wall 0.7 µm thick ..... ***C. ledi***, p. 45

6a. On *Rhododendron aureum*, *R. brachycarpum*, *R. chrysanthum*, *R. fauriae*, *R. japonoheptamerum* or *R. nudiflorum* ..... ***C. succinea***, p. 53
6b. On other species of *Rhododendron* ..... ***C. rhododendri***, p. 51

7a. On *Empetrum* ..... ***C. empetri***, p. 43
7b. On *Chamaedaphne calyculata* ..... ***C. cassandrae***, p. 41

Rossmanomyces Aime & McTaggart

Two species in arctic and alpine regions, both on Pyrolaceae. *Rossmanomyces ramischiae* seems to be dependent on a host change to *Picea* and is therefore not treated. For ***R. pyrolae***, see p. 55.

Melampsoraceae Dietel

Only one genus is included:

Melampsora Castange

Macrocyclic. Aecia without peridium, confluent, orange; aeciospores hyaline, catenulate, finely verrucose. Uredinia yellow to orange, surrounded or bordered with hyaline, thick-walled, clavate to capitate paraphyses; urediniospores oblong to ovoid, echinulate. Telia crust-like, developing subcuticular or subepidermal, red, brown to dark brown or black; teliospores in one layer, 1-4-celled, smooth, oblong, brownish, with one pore.

Autoecious or heteroecious. Most heteroecious species with spermogonia and aecia on conifers, but these stages are not treated in this work. Uredinia and telia on willows. Species on willows hybridize freely, and delimitation is difficult.

Five species are included. Furthermore, *M. dupiasii* Durr. is known from a record in the Pyrenees, on *Saxifraga geranioides.*

Key to species

1a. On *Saxifraga hirculus* in fens ..... ***M. hirculi***, p. 63
1b. On other species of saxifrage (*Saxifraga*), violet (*Viola*) or willow (*Salix*) 2

2a. On *Salix lapponum* and *Viola epipsila* ..... ***M. lapponum***, p. 65
2b. On other willows or with another aecia-host 3

3a. Uredinia and telia on *Salix*, e.g. *S. herbacea*, *S. polaris* and *S. reticulata*; aecia on saxifrage ..... ***M. arctica***, p. 57
3b. On other willows 4

4a. On *Salix glauca*, *S. lanata*, *S. myrsinites*, *S. myrsinifolia*, *S. polaris*, *S. lapponum* and others; circumpolar ..... ***M. epitea***, p. 61
4b. On North American species of willow; North American ..... ***M. bigelowii***, p. 59

Phragmidiaceae Corda

Macrocyclic, hemicyclic or demicyclic. Aecia without peridium, but surrounded with paraphyses. Aeciospores catenulate, each having many pores. Uredinia often pedicellate, surrounded by paraphyses. Urediniospores with many pores. Telia dark-coloured, with or without paraphyses, often on the underside. Teliospores 3- to multi-celled, thick-walled, often verrucose, each cell with 2 or more pores, pedicellate. Autoecious, on Rosaceae.

Three genera are treated.

Key to genera

1a. Teliospores multi-celled ..... ***Phragmidium***
1b. Teliospores 1-2-celled 2

2a. On lady's mantle (*Alchemilla*); teliospores 1-celled ..... ***Trachyspora***, p. 11
2b. On *Rubus*; teliospores 2-celled ..... ***Arthuriomyces***

Arthuriomyces Cummins & Y. Hirats.

Only one species is treated, ***A. peckianus***, see p. 81.

Phragmidium Link

Aecia without peridium, but surrounded by paraphyses. Aeciospores catenulate with many pores. Uredinia often surrounded by paraphyses. Uredospores pedicellate with many pores. Telia pulverulent, small, irregular, brown to black. Teliospores 3- to multi-celled, with 2 or more pores per cell, with thick, brown, usually coarsely verrucose wall, pedicellate, pedicel hyaline, robust, often swollen. Autoecious.

On Rosaceae. Eight species are included.

Key to species

1a. On *Rubus* ..... ***P. arcticum***, p. 83
1b. On other hosts 2

2a. On cinquefoil (*Potentilla*) 3
2b. On *Rosa* 6

3a. On *Potentilla crantzii*, *P. stipularis* or *P. diversifolia* 4
3b. On other species of *Potentilla* 5

4a. On *Potentilla crantzii* and *P. stipularis*; teliospores 2-celled..... ***P. biloculare***, p. 85
4b. On *Potentilla diversifolia* and *P. stipularis*; teliospores 4-celled..... ***P. boreale***, p. 87

5a. Spores 2-4 celled, mostly 3-celled..... ***P. ivesiae***, p. 91
5b. Spores 4-6 celled ..... ***P. potentillae***, p. 97

6a. Teliospores 2-3-celled ..... ***P. kamtschatkae***, p. 93
6b. Teliospores 6-12-celled 7

7a. North American; on *Rosa woodsia*, *R. nutkana*, *R. fendleri*, *R. spauldingii* and *R. suffulta*..... ***P. montivagum***, p. 95
7b. Eurasian; on *Rosa* sect. *Cinnamomeae*, e.g. *R. acicularis*, *R. pendulina* (*R. alpina*) ..... ***P. fusiforme***, p. 89

Trachyspora Fuckel

Spermogonia usually missing or not collected. Aecia uredinioid, systemic. Uredinia may rarely be formed, their spores in that case present in telia. Telia from systemic infections. Teliospores 1-celled, brown, verrucose, with septate pedicel. Autoecious. On *Alchemilla.* Two species are treated.

Key to species

1a. Uredinia (incl. uredinioid aecia) abundant, covering the whole lower leaf surface, orange-yellow ..... ***T. alchemillae***, p. 99
1b. Uredinia lacking, urediniospores sparsely formed in the telia ..... ***T. melospora***, p. 101

Gymnosporangiaceae Chevall.

Only one genus is included:

Gymnosporangium R. Hedw. ex DC.

Aecia with conspicuous split peridium on thickened leaf spots. Aeciospores ellipsoid, verrucose, brown, catenulate. Telia large, 10-15 mm, conspicuous, bright orange, cylindrical and gelatinous outgrowths. Teliospores 2-celled, long pedicellate, readily germinating. Mostly heteroecious. Spermogonia and aecia parasitic on Rosaceae (*Sorbus* and related), telia on *Juniperus*.

Some authors place the genus in Pucciniaceae.

Only one arctic-alpine species is included, ***G. cornutum****, p. 103.

Pucciniaceae Chevall.

Macrocyclic, microcyclic, hemicyclic, demicyclic and brachycyclic stages found. Aecia with peridium. Aeciospores globose, finely verrucose, catenulate. Uredinia orange to brownish, with or without paraphyses. Urediniospores ellipsoid to subglobose, verrucose, pedicellate. Telia brown to black, pulverulent or pulvinate. Teliospores 1-, 2-, rarely 3- or 4-celled, thick-walled, each cell with a germ-pore, pedicellate.

Autoecious or heteroecious on a wide variety of dicotyledon families and some monocot families. The family includes about 15 genera, of which three are treated here.

Key to genera

Endophyllum Lév.

Similar to microcyclic *Puccinia* species, but the aeciospores undergo karyogamy and germinate directly with a basidium, and thus behave functionally like teliospores. Without proper teliospores it is difficult to refer a certain species to a genus, and the few species behaving in this way end up as an unnatural group, *Endophyllum*. Apart from the species treated here, *E. alaskanum* (a synonym of *Puccinia veratri*) also behaves in this way.

Only one arctic-alpine species is treated, ***E. sempervivi***, see p. 105.

Puccinia Pers.

Macrocyclic, microcyclic, hemicyclic, demicyclic and brachycyclic. Aecia with peridium, usually in groups, yellow to orange. Aeciospores subglobose, usually finely echinulate, catenulate. Uredinia orange to brown, with or without paraphyses. Urediniospores ellipsoid to subglobose, usually finely echinulate or verrucose, pedicellate, but only inconspicuous remnants visible. Telia brown to black, pulverulent. Teliospores usually 2-celled, occasionally 1-, 3- or 4-celled. Each cell with one pore of which the placement usually is a species-specific character, smooth or ornamented, at the apex thickened or not, brown and thick-walled and then with a resting period, or pale brown and thin-walled and then germinating readily, pedicellate. Autoecious or heteroecious.

Puccinia is the largest genus of fungi and is possibly even larger than any plant genus, including an estimated 3300 species worldwide. Ninety-four species are included here. Another 11 species are described from similar areas.

Key to species of *Puccinia*

1a. On plants from the daisy family (Asteraceae) 2
1b. On plants from other families 32

2a. On whitish or greyish small flowers 3
2b. On yellow flowers, small or large 6

3a. On *Achillea*, *Artemisia* or *Erigeron* 4
3b. On other genera 5

4a. On *Achillea*; teliospores slender, constricted; upper cell darker brown than lower cell; pedicel persistent ..... ***P. cnici-oleracei***, p. 139
4b. On *Artemisia* or *Erigeron*; teliospores broad; uniformly brown, with or without a constriction, pedicel soon falling off 8

5a. On *Artemisia* ..... ***P. artemisiae-norvegicae***, p. 121
5b. On *Erigeron* ..... ***P. dovrensis***, p. 153

6a. On *Crepis* ..... ***P. crepidicola***, p. 145
6b. On other genera 7

7a. On *Hieracium* or *Taraxacum* 8
7b. On other genera 12

8a. On *Taraxacum* 9
8b. On *Hieracium*, *Agoseris*, *Krigia*, *Lygodesmia*, *Nabalus* or *Stephanomeria* 11

9a. Teliospores slender, upper cell darker brown than lower cell and with a constriction, pedicel persistent ..... ***P. dioicae***, p. 149
9b. Teliospores short and broad, uniformly brown, pedicel soon falling off, no constriction between upper and lower cell 10

10a. Spores with equatorial germ pore ..... ***P. hieracii***, p. 183
10b. Spores with germ pore close to septum ..... ***P. variabilis***, 281

11a. Teliospore with remarkably thick cap ..... ***P. columbiensis***, p. 141
11b. Teliospore cap not remarkably thick ..... ***P. hieracii***, p. 183

12a. On *Senecio nemorensis* ..... ***P. uralensis***, p. 275
12b. On other genera 13

13a. On *Arnica* or *Doronicum* 14
13b. On other genera 15

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16b. On other genera 17

17a. On *Lactuca* ..... ***P. minussensis***, p. 205
17b. On other genera 18

18a. Only aecia present 19
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19a. On *Aster*, *Centaurea*, *Cirsium* or *Chrysanthemum* ..... ***P. cnici-oleracei***, p. 139
19b. On other genera 20

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20b. On *Saussurea* ..... ***P. vaginatae***, p. 279

21a. On *Saussurea* ..... ***P. saussureae-alpinae***, p. 247
21b. On other genera 22

22a. On *Solidago* ..... ***P. virgae-aureae*** p. 285
22b. On other genera 23

23a. On *Endocellion*, *Homogyne* or *Petasites* ..... ***P. conglomerata***, p. 143
23b. On other genera 24

24a. On *Prenanthes* 25
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26a. Teliospores with distinct cap ..... ***P. uralensis***, p. 275
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27a. On *Cirsium* ..... ***P. laschii***, p. 201
27b. On other genera 28

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29a. On *Senecio* or *Tephroseris* ..... ***P. senecionis***, p. 253
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30a. In Eurasia; on *Leontodon, Prenanthes* and *Serratula* ..... ***P. variabilis***, p. 281
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31a. On *Aster* or *Centaurea* ..... ***P. cnici-oleracei***, p. 139
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32a. On plants from the cabbage family (Brassicaceae) 33
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33a. On *Noccaea* or *Parrya* ..... ***P. oudemansii***, p. 219
33b. On other genera 34

34a. Teliospores distinctly verrucose all over; on *Draba*, *Eutrema* or *Lesquerella* ..... ***P. drabae***, p. 155
34b. Teliospores smooth or apically finely verrucose 35

35a. On *Cochlearia* or *Eutrema* ..... ***P. eutremae***, p. 165
35b. On other genera 36

36a. On *Cardamine* or *Lesquerella* ..... ***P. cruciferarum***, p. 147
36b. On other genera 37

37a. On *Draba*, *Noccaea*, *Parrya*, *Teesdalia* or *Thlaspi* 38
37b. On other genera 39

38a. Spores finely verrucose ..... ***P. thlaspeos***, p. 267
38b. Spores smooth ..... ***P. oudemansii***, p. 219

39a. On *Boechera* 40
39b. On other genera 41

40a. Wall of teliospores 2-3.5 µm thick, pedicel short, deciduous ..... ***P. aberrans*** p. 107
40b. Wall of teliospores 1-2 µm thick, pedicel 1-2× spore length or longer, persistent ..... ***P. holboellii***, p. 185

41a. On *Erysimum, Polyctenium, Smelowskia* ..... ***P. aberrans***, p. 107
41b. On *Arabidopsis*, *Braya*, *Lepidium* or *Sisymbrium* ..... ***P. holboellii***, p. 185

42a. On plants from the carrot family (Apiaceae) 43
42b. On plants from other families 52

43a. On *Athamanta* ..... ***P. athamantina***, p. 123
43b. On other genera 44

44a. On *Chaerophyllum* ..... ***P. enormis***, p. 159
44b. On other genera 45

45a. On *Neogaya* ..... *P. frigida*, not included, see p. 325
45b. On other genera 46

46a. On *Anthriscus* 47
46b. On other genera 48

47a. Telia cinnamon brown, opening by a split; pores of teliospores covered with a 1.5-2 µm high cap ..... ***P. dolomitica***, p. 151
47b. Telia dark brown to black, opening by a pore; pores of teliospores covered with a 1-5 µm high cap ..... ***P. svendsenii***, p. 261

48a. Telia present; on *Ligusticum scoticum* ..... ***P. halosciadis***, p. 179
48b. Aecia present; on *Ligusticum* or other genera 49

49a. On *Peucedanum* 50
49b. On other genera 51

50a. With uredinia and telia; teliospores smooth ..... ***P. imperatoriae***, p. 191
50b. Only with telia; teliospores distantly verrucose ..... ***P. terrieri***, p. 265

51a. Aeciospores 22-30 × 18-26 µm, slightly oblong; on *Angelica*, *Astrantia*, *Carum*, *Conopodium*, *Ligusticum scoticum* or *Pimpinella* ..... ***P. bistortae***, p. 127
51b. Aeciospores 16-21 µm, subglobose; on *Angelica* or *Ligusticum mustelina* ..... ***P. mei-mamillata***, p. 203

52a. On plants from the buttercup family (Ranunculaceae) 53
52b. On plants from other families 60

53a. On *Clematis* 54
53b. On other genera 55

54a. With aecia, uredinia and telia ..... ***P. recondita***, p. 237
54b. Only with telia ..... ***P. atragenicola***, p. 125

55a. On *Ranunculus* 56
55b. On other genera 57

56a. On *Ranunculus*, but not *R. abortivus* ..... ***P. gibberulosa***, p. 173
56b. On *Ranunculus abortivus* ..... ***P. myosotidis***, p. 215

57a. Aecia in thickened bluish parts of the leaves ..... ***P. septentrionalis***, p. 255
57b. Aecia otherwise 58

58a. On *Trollius*; only with telia ..... ***P. trollii***, p. 271
58b. On other plants, or if on *Trollius* then without telia 59

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60a. On plants from the willowherb family (Onagraceae) 61
60b. On plants from other families 67

61a. On *Oenothera* 62
61b. On other genera 63

62a. With telia ..... ***P. columbiensis***, p. 141
62b. With aecia ..... ***P. dioicae***, p. 149

63a. On *Epilobium fleischeri* ..... ***P. epilobii-fleischeri***, p. 163
63b. On other species of *Epilobium* and *Gayophytum* 64

64a. On *Epilobium angustifolium* ..... ***P. gigantea***, p. 175
64b. On other species of *Epilobium* and *Gayophytum* 65

65a. On *Epilobium anagallidifolium* and *E. glandulosum* ..... ***P. veratri***, p. 283
65b. On other species of *Epilobium* and *Gayophytum* 66

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66b. Both cells in teliospores more or less round ..... ***P. epilobii***, p. 161

67a. On fringed grass-of-Parnassus (Celastraceae: *Parnassia fimbriata*) ..... ***P. parnassiae***, p. 225
67b. On plants from other families 68

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68b. On plants from other families 75

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69b. On other genera 70

70a. On *Koenigia* 71
70b. On *Bistorta*, *Polygonum* or *Pleurospermum* 72

71a. Pore of lower cell near septum ..... ***P. polygoni-alpini***, p. 235
71b. Pore of lower cell ¼ - ¾ depressed ..... ***P. bistortae***, p. 127

72a. On *Polygonum* ss. str. ..... ***P. polygoni-alpini***, p. 235
72b. On *Bistorta*, including *B. vivipara* and *B. officinalis*, or *Pleurospermum* 73

73a. Only with aecia ..... ***P. bistortae***, p. 127
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74a. Pore of lower cell near septum ..... ***P. septentrionalis***, p. 255
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77a. Teliospores verrucose ..... ***P. pazschkei***, p. 227
77b. Teliospores smooth or nearly so 78

78a. Lower cell of teliospores ± round ..... ***P. fischeri***, p. 169
78b. Lower cell of teliospores ± attenuated ..... ***P. pallidomaculata***, p. 223

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80b. On other genera 81

81a. On *Soldanella* ..... ***P. soldanellae***, p. 259
81b. On other genera of Primulaceae 82

82a. On *Lysimachia* ..... ***P. karelica***, p. 195
82b. On *Androsace* 83

83a. Teliospores 25-38 µm long ..... ***P. dubyi***, p. 157
83b. Teliospores 35-71 µm long ..... ***P. volkartiana***, p. 287

84a. On plants from the bedstraw family (Rubiaceae) 85
84b. On plants from other families 87

85a. On *Myosotis* ..... ***P. myosotidis***, p. 215
85b. On *Galium* 86

86a. Teliospores 30-53 um long; wall at apex 10-14 um thick ..... ***P. lagerheimii***, p. 197
86b. Teliospores 35-70 um long; wall at apex 5-10 um thick ..... ***P. rubefaciens***, p. 245

87a. On grasses (Poaceae) 88
87b. On plants from other families 90

88a. On *Brachypodium* ..... ***P. brachypodii***, p. 129
88b. On other grasses 89

89a. On *Poa* ..... ***P. poarum***, p. 231
89b. On other grasses ..... ***P. recondita***, p. 237

90a. On plants from the plantain family (Plantaginaceae) 91
90b. On plants from other families 93

91a. On *Lagotis* ..... ***P. gymnandrae***, p. 177
91b. On *Veronica* 92

92a. Telia on underside of leaves; usually on *Veronica alpina* ..... ***P. albulensis***, p. 109
92b. Telia on both sides of leaves; on other species of *Veronica* ..... ***P. rhaetica***, p. 239

93a. On sedges (Cyperaceae: *Carex*) 94
93b. On plants from other families 97

94a. On *Carex vaginata* ..... ***P. vaginatae***, p. 279
94b. On other species of *Carex* 95

95a. On *Carex magellanica* or *C. pluriflora* ..... ***P. karelica***, p. 195
95b. On other species of *Carex* 96

96a. Upper and lower cells in the teliospores almost equally long, pedicel brownish ..... ***P. dioicae***, p. 149
96b. Upper cell in the teliospores shorter and broader than lower cell, pedicel yellowish ..... ***P. caricina***, p. 133

97a. On plants from the pink family (Caryophyllaceae) 98
97b. On plants from other families 99

98a. Spores golden brown; on *Arenaria*, *Cerastium*, *Dianthus*, *Minuartia*, *Sagina*, *Silene*, *Stellaria* and *Wilhelmsia* ..... ***P. arenariae***, p. 115
98b. Spores grey-brown; on *Arenaria*, *Eremogone*, *Gypsophila*, *Minuartia*, *Stellaria* ..... ***P. hysteriiformis***, p. 189

99a. On plants from the bellflower family (Campanulaceae) 100
99b. On plants from other families 101

100a. Teliospores up to 45 µm long ..... ***P. campanulae***, p. 131
100b. Teliospores up to 33 µm long ..... ***P. novae-zembliae***, p. 217

101a. On plants from the borage family (Boraginaceae: *Hydrophyllum*; *Phacelia*) ..... ***P. recondita***, p. 237
101b. On plants from other families 102

102a. On thyme (Lamiaceae: *Thymus*) ..... ***P. thymi***, p.269
102b. On plants from other families 103

103a. On lousewort (Orobanchaceae: *Pedicularis*) 104
103b. On plants from other families 106

104a. On *Pedicularis capitata* ..... ***P. helicalis***, p. 181
104b. On other species of *Pedicularis* 105

105a. On *Pedicularis labradorica* or *P. lapponica* ..... ***P. lapponica***, p. 199
105b. On *Pedicularis flammea* or *P. oederi* ..... ***P. pedicularis***, p. 229

106a. On violets (Violaceae: *Viola*) 107
106b. On plants from other families 108

107a. Teliospores finely reticulate, not constricted ..... ***P. alpina***, p. 111
107b. Teliospores smooth, constricted ..... ***P. fergussonii***, p. 167

108a. On plants from the gooseberry family (Grossulariaceae: *Ribes*) 109
108b. On plants from other families 110

109a. With aecia; spores hyaline, 1-celled, finely verrucose ..... ***P. ribis***, p. 243
109b. With telia, spores brown, 2-celled, verrucose ..... ***P. caricina***, p. 133

110a. On crane's-bill (Geraniaceae: *Geranium*) 111
110b. On plants from other families 112

111a. Teliospores verrucose (upper cell), barely thickened at apex ..... ***P. morthieri***, p. 209
111b. Teliospores smooth, wall distinctly thickened at apex ..... ***P. geranii-silvatici***, p. 171

112a. On avens (Rosaceae: *Geum* or *Sieversia*) 113
112b. On plants from other families 114

113a. On *Geum turbinatum*; Rocky Mts., Alaska ..... ***P. sieversiae***, p. 257
113b. On *Geum calthifolium* or *Sieversia*; Rocky Mts., Chukotka ..... ***P. urbanii***, p. 277

114a. On plants from the stonecrop family (Crassulaceae: *Rhodiola*) ..... ***P. umbilici***, p. 273
114b. On plants from other families 115

115a. On Jacob's-ladder (Polemoniaceae: *Polemonium*) ..... ***P. polemonii***, p. 233
115b. On plants from other families 116

116a. On false-helleborine (Melanthiaceae: *Veratrum*) ..... ***P. veratri***, p. 283
116b. On plants from other families 117

117a. On bastard-toadflax (Santalaceae: *Thesium*) ..... ***P. mougeotii***, p. 211
117b. On plants from other families 118

118a. On plants from the gentian family (Gentianaceae: *Swertia*) ..... ***P. swertiae***, p. 263
118b. On purslane (Montiaceae: *Claytonia*) 116

119a. Not systemic; aecia and telia; telia dark brown,
wall of teliospores smooth ..... ***Puccinia claytoniae***, p. 135
119b. Systemic; only telia, these cinnamon brown,
wall of teliospores verrucose ..... ***Puccinia claytoniicola***, p. 137

Uredo Pers.

Only uredinia known, and thus no connection can be established with certainty to a "regular" genus. One species is included, ***U. alpestris***, p. 289.

Uromyces (Link) Unger

Similar to *Puccinia*, but the teliospores are 1-celled. Autoecious or heteroecious. Thirteen species are treated, two excluded:

Uromyces devoluensis Gäum. is only known from a few records in the French Alps, on leaves of *Senecio doronicum*.

Uromyces sedi Gäum. was described from the French Alps on *Sedum anacampteros.*

Key to species

1a. On monocotyledons 2
1b. On dicotyledons 6

2a. On *Veratrum* ..... ***U. veratri***, p. 319
2b. On grasses, sedges or onion-like plants 3

3a. On chives (*Allium sibiricum*) ..... ***U. allii-sibirici***, p. 293
3b. On grasses or sedges 4

4a. On leaves of the sedge *Carex sempervirens* ..... ***U. caricis-sempervirentis***, p. 299
4b. On grasses 5

5a. On leaves of *Deschampsia flexuosa* ..... ***U. airae-flexuosae***, p. 291
5b. On other grasses ..... ***U. dactylidis***, p. 301

6a. On *Euphorbia* 7
6b. On other plants 8

7a. Teliospores smooth to finely verrucose ..... ***U. alpestris***, p. 295
7b. Teliospores with distinct longitudinal ribs ..... ***U. striolatus***, p. 317

8a. On *Phyteuma* 9
8b. On other plants 10

9a. With telia; spores brown, thick-walled, smooth ..... ***U. phyteumatum***, p. 311
9b. With aecia; spores hyaline, finely spinulose ..... ***U. caricis-sempervirentis***, p. 299

10a. On plants from the daisy family (Asteraceae) 11
10b. On other plants 12

11a. On goldenrod (*Solidago*) ..... ***U. sommerfeltii***, p. 315
11b. On *Adenostyles* ..... ***U. cacaliae***, p. 297

12a. On plants from the pea family (Fabaceae) 13
12b. On plants from other families 15

13a. On *Hedysarum* ..... ***U. hedysari-obscuri***, p. 305
13b. On other genera, like *Astragalus* and *Oxytropis* 14

14a. With telia; on *Astragalus* ..... ***U. phacae-frigidae***, p. 309
14b. With aecia; teliospores absent or immature (Arctic); on *Astragalus*, *Oxytropis* ..... ***U. lapponicus***, p. 307

15a. On primrose (*Primula*) ..... ***U. primulae-integrifoliae***, p. 313
15b. On plants from the buttercup family (Ranunculaceae) 16

16a. On *Ranunculus glacialis* ..... ***U. fischerianus***, p. 303
16b. On other species of *Ranunculus* ..... ***U. dactylidis***, p. 301

Pucciniastraceae Gäum. ex Leppik

Macrocyclic. Aecia with peridium. Aeciospores verrucose or partly smooth. Uredinia small, < 0.5 mm, often covering a large part of the leaf as an indistinct orange layer. Urediniospores echinulate, pedicellate. Telia inconspicuous, subepidermal. Teliospores 2-5-celled, thin-walled, pale brown, without pedicel. Autoecious or heteroecious. 0+I spermogonia and aecia on conifers, by definition not included in this work. II+III uredinia and telia on various plant species.

Key to genera of Pucciniastraceae

1a. On ferns; teliospores irregular, multi-celled, developing under the surface.....***Hyalopsora***
1b. On seed plants; teliospores developing on the surface 2

2a. On *Vaccinium* .....***Naohidemyces***
2b. On other plants.....3

3a. On birch (*Betula*); teliospores 1-celled.....***Melampsoridium***
3b. Teliospores 2-5-celled .....***Pucciniastrum***

Hyalopsora Magnus

Only one species is treated, ***H. aspidiotus***, p. 67.

Melampsoridium Kleb.

Only one species is treated, ***M. betulinum***, p. 71.

Naohidemyces S. Sato, Katsuya, & Y. Hirats.

Only one species is treated, ***N. vaccinii***, p. 73.

Pucciniastrum G.H. Otth

Macrocyclic or hemicyclic. Aecia on *Abies*, by definition not included in this work.

Spores 2- or multi-celled. Uredinia with ostiolate peridium. Urediniospores pedicellate, echinulate. Telia subepidermal, forming small crusts or scattered in the epidermis. Teliospores vertically septate into 2-4 cells. Heteroecious or autoecious. On *Arctostaphylos*, *Arctous*, *Epilobium*, *Potentilla* or *Pyrola*. Three species are treated here.

Key to species

1a. On *Epilobium*..... ***P. epilobii***, p. 75
1b. On other plants.....2

2a. On *Pyrola* ..... ***P. pyrolae***, p. 77
2b. On the heather plants *Arctostaphylos* and *Arctous* .....***P. sparsum***, p. 79

Unknown affinity

Schroeteriaster Magnus

Only one species is treated, ***S. alpinus***, p. 321.

Key to included rust species by host plant genus

Achillea

1a. Only spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Only telia ..... ***Puccinia cnici-oleracei***, p. 139

Achnatherum ..... ***Puccinia recondita***, p. 237

Aconitum ..... ***Puccinia recondita***, p. 237

Adenostyles

1a. Only spermogonia/aecia ..... ***Uromyces veratri***, p. 319
1b. Only telia ..... ***Uromyces cacaliae***, p. 297

Agoseris

1a. Only spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Uredinia and/or telia 2

2a. Macrocyclic; wall of teliospores not thickened at apex ..... ***Puccinia hieracii***, p. 183
2b. Microcyclic, only telia; wall of teliospores 7-15 µm thickened at apex ..... ***Puccinia columbiensis***, p. 141

Agrostis

1a. Uredinia orange-yellow, sparsely formed, soon surrounded by telia, pores of the urediniospores mostly inconspicuous ..... ***Puccinia poarum***, p. 231
1b. Uredinia cinnamon brown to dark brown, pores of the urediniospores usually with a clearly thickened ring; telia mostly formed later in the season ..... ***Puccinia recondita***, p. 237

Alchemilla

1a. Uredinia (including uredinioid aecia) abundant, covering the whole lower leaf surface, orange-yellow ..... ***Trachyspora alchemillae***, p. 99
1b. Uredinia lacking, urediniospores sparsely formed in the telia ..... ***Trachyspora melospora***, p. 101

Allium

Teliospores of both species 1-celled.

1a. Teliospores with longitudinal stripes; telia brown or cinnamon brown; only on *Allium sibiricum* ..... ***Uromyces allii-sibirici***, p. 293
1b. Teliospores distantly verrucose; telia dark brown; only on *A. ochotense* and *A. victoriale* ..... ***Puccinia japonensis***, p. 193

Alopecurus ..... ***Uromyces dactylidis***, p. 301

Androsace

1a. Telia amphigenous and on the flower stalks, pulverulent; teliospores 25-38 × 16-21 µm, not coronate, pedicel deciduous ..... ***Puccinia dubyi***, p. 157
1b. Telia hypophyllous on the rosette leaves, pulvinate; teliospores 35-71 × 12-20 µm, coronate, pedicel persistent ..... ***Puccinia volkartiana***, p. 287

Angelica

1a. Aecia cupulate, not embedded in host tissue, peridium firm.... ***Puccinia mei-mamillata***, p. 203
1b. Aecia embedded in host tissue, peridium fragile..... ***Puccinia bistortae***, p. 127

Anthoxanthum (including *Hierochloë*)

1a. Uredinia with hyaline to light yellow-brown, capitate, thick-walled paraphyses, wall 2-2.5 µm thick; telia without paraphyses ..... ***Puccinia brachypodii***, p. 129
1b. Uredinia without paraphyses; telia with dark brown, thin-walled paraphyses dividing the sori in locules..... ***Puccinia recondita***, p. 237

Anthriscus

1a. Telia cinnamon brown, opening by a split; pores of teliospores covered with a 1.5-2 µm high cap ..... ***Puccinia dolomitica***, p. 151
1b. Telia dark brown to black, opening by a pore; pores of teliospores covered with a 1-5 µm high cap ..... ***Puccinia svendsenii***, p. 261

Aquilegia..... ***Puccinia recondita***, p. 237

Arabidopsis

1a. Teliospores 14-28 µm wide ..... ***Puccinia holboellii***, p. 185
1b. Teliospores 12-21 µm wide ..... ***Puccinia thlaspeos***, p. 267

Arabis

1a. Teliospores 14-28 µm wide ..... ***Puccinia holboellii***, p. 185
1b. Teliospores 12-21 µm wide ..... ***Puccinia thlaspeos***, p. 267

Arctagrostis..... ***Puccinia brachypodii***, p. 129

Arctostaphylos ..... ***Pucciniastrum sparsum***, p. 79

Arctous..... ***Pucciniastrum sparsum***, p. 79

Arenaria..... ***Puccinia arenariae***, p. 115

Arnica

1a. Uredinia lacking; telia blackish ..... ***Puccinia arnicae-scorpioidis***, p. 117
1b. Uredinia present; telia chestnut brown ..... ***Puccinia arnicalis***, p. 119

Arrhenatherum..... ***Puccinia brachypodii***, p. 129

Artemisia

1a. Only spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Telia present; uredinia present or lacking..... 2

2a. Telia pulvinate; teliospores germinating readily, smooth; uredinia lacking ..... ***Puccinia cnici-oleracei***, p. 139
2b. Telia pulverulent; teliospores not germinating readily, verrucose; uredinia present..... ***Puccinia artemisiae-norvegicae***, p. 121

Aster

1a. Only spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Only telia ..... ***Puccinia cnici-oleracei***, p. 139

Astragalus

1a. Spermogonia/aecia systemic; telia rare in the Arctic ..... ***Uromyces lapponicus***, p. 307
1b. Only telia, abundant..... ***Uromyces phacae-frigidae***, p. 309

Astrantia ..... ***Puccinia bistortae***, p. 127

Athamanta ..... ***Puccinia athamantina***, p. 123

Betula..... ***Melampsoridium betulinum***, p. 71

Bistorta

1a. Pore of lower cell of teliospores against septum, both pores covered with a 4-5 µm high caps..... ***Puccinia septentrionalis***, p. 255
1b. Pore of lower cell of teliospores 1/4 or more depressed from septum..... 2

2a. Pore of lower cell of teliospores 1/4 to 3/4 depressed from septum, caps covering the pores indistinct..... ***Puccinia bistortae***, p. 127
2b. Pore of lower cell of teliospores usually against or close to pedicel, caps covering the pores conspicuous ..... ***Puccinia mei-mamillata***, p. 203

Boechera

All species with apex of teliospores thickened.

1a. Wall of teliospores 2-3.5 µm thick, pedicel short, deciduous ..... ***Puccinia aberrans***, p. 107
1b. Wall of teliospores 1-2 µm thick, pedicel 1× spore length or longer, persistent..... 2

2a. Teliospores 14-28 µm wide..... ***Puccinia holboellii***, p. 185
2b. Teliospores 12-21 µm wide..... ***Puccinia thlaspeos***, p. 267

Brachypodium ..... ***Puccinia brachypodii***, p. 129

Braya..... ***Puccinia holboellii***, p. 185

Bromus..... ***Puccinia recondita***, p. 237

Cacalia ..... ***Puccinia uralensis***, p. 275

Calamagrostis ..... ***Puccinia recondita***, p. 237

Campanula

1a. Teliospores up to 45 µm long, especially upper cell finely verrucose ..... ***Puccinia campanulae***, p. 131
1b. Teliospores up to 33 µm long, smooth ..... ***Puccinia novae-zembliae***, p. 217

Cardamine ..... ***Puccinia cruciferarum***, p. 147

Carex

1a. Teliospores 1-celled ..... ***Uromyces caricis-sempervirentis***, p. 299
1b. Most or all teliospores 2-celled 2

2a. Teliospores always 2-celled; urediniospores with (2-)3-5 pores, equatorial except 1 apical, sometimes 1 basal; on *C. magellanica* and *C. pluriflora* ..... ***Puccinia karelica***, p. 195
2b. Teliospores (1-)2-celled; placement of pores of urediniospores different 3

3a. Uredinia of two types, containing (i) thick-walled (3-4.5 µm) spores and (ii) thin-walled (1.5-2 µm) spores; teliospores up to 48 µm long and 14-16 µm wide; on *Carex vaginata* ..... ***Puccinia vaginatae***, p.279
3b. Uredinia of a single type containing spores with wall up to 2(-3) µm thick; teliospores up to 60 or 71 µm long and 12-23(-25) µm wide 4

4a. Pores of urediniospores surrounded by a smooth zone ..... ***Puccinia dioicae***, p. 149
4b. Pores of urediniospores not surrounded by a smooth zone ..... ***Puccinia caricina***, p. 133

Carum ..... ***Puccinia bistortae***, p. 127

Centaurea

1a. Only spermogonia/aecia, aecia aecioid ..... ***Puccinia dioicae***, p. 149
1b. Also uredinia and telia or only telia, aecia uredinioid ..... ***Puccinia hieracii***, p. 183

Cerastium

1a. Uredinia and telia; telia inconspicuous, formed within the epidermis cells; uredinia systemic, orange-yellow ..... ***Melampsorella elatina***, p. 69
1b. Only telia, conspicuous 2

2a. Telia pulvinate, pale brown to brown, teliospores germinating readily, easily falling apart and then seemingly 1-celled ..... ***Puccinia arenariae***, p. 115
2b. Telia pulverulent, black; teliospores not germinating readily, not falling apart ..... ***Puccinia hysteriiformis***, p. 189

Chaerophyllum ..... ***Puccinia enormis***, p. 159

Chamaedaphne ..... ***Chrysomyxa cassandrae***, p. 41

Chamaenerion ..... ***Pucciniastrum epilobii***, p. 75

Chrysanthemum ..... ***Puccinia cnici-oleracei***, p. 139

Chrysosplenium ..... ***Puccinia pallidomaculata***, p. 223

Cicerbita ..... ***Puccinia mulgedii***, p. 213

Cichorium ..... ***Puccinia hieracii***, p. 183

Cirsium

1a. Only spermogonia/aecia; aecia aecioid ..... ***Puccinia dioicae***, p. 149
1b. Only telia or macrocyclic and then aecia uredinioid 2

2a. Telia pulvinate; teliospores germinating readily ..... ***Puccinia cnici-oleracei***, p. 139
2b. Spermogonia, uredinioid aecia, uredinia and pulverulent telia; teliospores not germinating readily ..... ***Puccinia laschii***, p. 201

Clarkia ..... ***Puccinia dioicae***, p. 149

Claytonia

1a. Not systemic; aecia and telia; telia dark brown, wall of teliospores smooth ..... ***Puccinia claytoniae***, p. 135
1b. Systemic; only telia, these cinnamon brown, wall of teliospores verrucose ..... ***Puccinia claytoniicola***, p. 137

Clematis

1a. Only spermogonia/aecia ..... ***Puccinia recondita***, p. 237
1b. Only telia ..... ***Puccinia atragenicola***, p. 125

Cnicus undulatus (= *Cirsium undulatus*) ..... ***Puccinia hieracii***, p. 183

Cochlearia

1a. Infection systemic, plants malformed; telia initially brown, then cinereous by presence of basidiospores, pulvinate, teliospores germinating readily ..... ***Puccinia thlaspeos***, p. 267
1b. Infection not systemic, plants not malformed, telia dark brown to almost black, teliospores not germinating readily ..... ***Puccinia eutremae***, p. 165

Conopodium ..... ***Puccinia bistortae***, p. 127

Crepis

1a. Spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Uredinia/telia ..... ***Puccinia crepidicola***, p. 145

Dactylis ..... ***Uromyces dactylidis***, p. 301

Deschampsia

1a. Telia rarely present; uredinia without paraphyses ..... ***Uromyces airae-flexuosae***, p. 291
1b. Telia usually present; uredinia with scattered, thick walled paraphyses ..... ***Puccinia brachypodii***, p. 129

Dianthus ..... ***Puccinia arenariae***, p. 115

Dirca ..... ***Puccinia dioicae***, p. 149

Doronicum ..... ***Puccinia arnicae-scorpioidis***, p. 117

Draba

1a. Teliospores not germinating readily, wall at apex not thickened, telia pulverulent ..... ***Puccinia drabae***, p. 155
1b. Teliospores germinating readily, wall at apex thickened to 3-11 µm, telia pulvinate ..... ***Puccinia thlaspeos***, p. 267

Elymus ..... ***Puccinia recondita***, p. 237

Empetrum ..... ***Chrysomyxa empetri***, p. 43

Endocellion ..... ***Puccinia conglomerata***, p. 143

Epilobium

1a. Aecia present 2
1b. Aecia lacking 4

2a. Telia common between the aecia ..... ***Puccinia epilobii-fleischeri***, p. 163
2b. Telia lacking 3

3a. Spermogonia amphigenous, peridium of aecia cupulate ..... ***Puccinia dioicae***, p. 149
3b. Spermogonia hypophyllous, peridium of aecia recurved ..... ***Puccinia veratri***, p. 283

4a. Uredinia and telia very small, diameter < 0.25 mm, teliospores 2-4-celled, not pedicellate ..... ***Pucciniastrum epilobii***, p. 75
4b. Only telia, diameter > 0.5 mm, teliospores 2-celled, pedicellate 5

5a. Teliospores 31-56 µm long, at apex thickened to 6-12 µm ..... ***Puccinia gigantea***, p. 175
5b. Teliospores < 45 µm long, at apex not thickened or thickened up to 5 µm 6

6a. Teliospores 13-25 µm wide, wall at apex usually not thickened ..... ***Puccinia epilobii***, p. 161
6b. Teliospores 11-16 µm wide, wall at apex thickened up to 5 µm ..... ***Puccinia scandica***, p. 251

Eremogone ..... ***Puccinia hysteriiformis***, p. 189

Erigeron

1a. Only spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Only telia ..... ***Puccinia dovrensis***, p. 153

Erysimum

All species with apex of teliospores thickened.

1a. Wall of teliospores 2-3.5 µm thick, pedicel short, deciduous ..... ***Puccinia aberrans***, p. 107
1b. Wall of teliospores 1-2 µm thick, pedicel 1× spore length or longer, persistent 2

2a. Teliospores 14-28 µm wide ..... ***Puccinia holboellii***, p. 185
2b. Teliospores 12-21 µm wide ..... ***Puccinia thlaspeos***, p. 267

Euphorbia

1a. Sprouts not or only the lower part malformed; wall of teliospores densely and very finely verrucose ..... ***Uromyces alpestris***, p. 295
1b. Sprouts completely malformed; wall of teliospores provided with longitudinal ridges ..... ***Uromyces striolatus***, p. 317

Eurybia ..... ***Puccinia dioicae***, p. 149

Euthamia ..... ***Puccinia dioicae***, p. 149

Eutrema

1a. Telia systemic, brown, teliospores strongly verrucose ..... ***Puccinia drabae***, p. 155
1b. Telia not systemic, dark brown to almost black, teliospores smooth or finely striate ..... ***Puccinia eutremae***, p. 165

Festuca

1a. Teliospores 2-celled; uredinia sparsely present, soon surrounded by telia, pores of the urediniospores mostly inconspicuous ..... ***Puccinia poarum***, p. 231
1b. Teliospores 1-celled; uredinia often present, pores of the urediniospores mostly conspicuous ..... ***Uromyces dactylidis***, p. 301

Galium

1a. Teliospores 35-70 µm long, wall at apex 5-10 µm thick, pedicel often longer than spore length ..... ***Puccinia lagerheimii***, p. 197
1b. Teliospores 30-53 µm long, wall at apex 10-14 µm thick, pedicel up to 30 µm long ..... ***Puccinia rubefaciens***, p. 245

Gayophytum ..... ***Puccinia epilobii***, p. 161

Geranium

1a. Telia soon naked, wall of teliospores at apex not thickened, upper cell strongly verrucose, lower cell finely verrucose, pore of lower cell equatorial or inferior ..... ***Puccinia geranii-silvatici***, p. 171
1b. Telia long covered by the epidermis, wall of teliospores at apex thickened to 6-12 µm, smooth or with only few faint warts, pore of lower cell against septum, often inconspicuous ..... ***Puccinia morthieri***, p. 209

Geum

1a. On *Geum calthifolium*; British Columbia and Russian Far East ..... ***Puccinia urbanii***, p. 277
1b. On *Geum turbinatum*; USA (Alaska, Utah, Wyoming) ..... ***Puccinia sieversiae***, p. 257

Gymnocarpium ..... ***Hyalopsora aspidiotus***, p. 67

Gypsophila ..... ***Puccinia hysteriiformis***, p. 189

Hackelia ..... ***Puccinia hydrophylli***, p. 187

Hedlundia ..... ***Gymnosporangium cornutum***, p. 103

Hedysarum ..... ***Uromyces hedysari-obscuri***, p. 305

Helenium ..... ***Puccinia poarum***, p. 231

Hieracium

1a. Macrocyclic, aecia uredinioid..... ***Puccinia hieracii***, p. 183
1b. Microcyclic, only telia..... 2

2a. Telia soon naked, teliospores 2-celled, 32-55 × 15-24 µm ..... ***Puccinia columbiensis***, p. 141
2b. Telia long covered by the epidermis, teliospores 1-2-celled, the 2-celled 36-70 × 16-30 µm..... ***Puccinia uralensis***, p. 275

Hierochloë, see ***Anthoxanthum***

Homogyne

1a. Only spermogonia/aecia ..... ***Uromyces veratri***, p. 319
1b. Only telia ..... ***Puccinia conglomerata***, p. 143

Hydrophyllum

1a. Only spermogonia/aecia ..... ***Puccinia recondita***, p. 237
1b. Only telia ..... ***Puccinia hydrophylli***, p. 187

Hymenoxys ..... ***Puccinia poarum***, p. 231

Hypochaeris ("*Hypochoeris*")

1a. Primary uredinia in circular groups, secondary uredinia scattered, urediniospores 28-35 × 20-26 µm..... ***Puccinia montivaga***, p. 207
1b. Uredinia scattered, urediniospores 21-32 × 15-28 µm..... ***Puccinia hieracii***, p. 183

Jacobaea ..... ***Puccinia dioicae***, p. 149

Jasione ..... ***Puccinia campanulae***, p. 131

Juniperus ..... ***Gymnosporangium cornutum***, p. 103

Koeleria ..... ***Puccinia brachypodii***, p. 129

Koenigia

1a. Teliospores with germ-pores covered with hyaline cap ..... ***Puccinia polygoni-alpini***, p. 235
1b. Teliospores with germ-pores with indistinct hyaline cap..... ***Puccinia bistortae***, p. 127

Krigia ..... ***Puccinia columbiensis***, p. 141

Lactuca

1a. Macrocyclic; infection by spermogonia and aecia systemic; aecia sunken in host tissue..... ***Puccinia minussensis***, p. 205
1b. Only spermogonia/aecia; infection not systemic; aecia not sunken in host tissue..... ***Puccinia dioicae***, p. 149

Lagotis ..... ***Puccinia gymnandrae***, p. 177

Ledum, see ***Rhododendron***

Leontodon, see ***Scorzoneroides***

Lepidium (escaped from gardens) ..... ***Puccinia holboellii***, p. 185

Lesquerella

1a. Telia soon naked, not confluent; teliospores germinating readily, smooth or nearly so, but top part of upper cell finely verrucose ..... ***Puccinia cruciferarum***, p. 147
1b. Telia long covered by the epidermis, often confluent; teliospores not germinating readily, strongly verrucose..... ***Puccinia drabae***, p. 155

Leymus..... ***Puccinia recondita***, p. 237

Ligusticum

1a. Only telia ..... ***Puccinia halosciadis***, p. 179
1b. Only spermogonia/aecia 2

2a. Aecia not cupulate, embedded in host tissue, peridium fragile..... ***Puccinia bistortae***, p. 127
2b. Aecia cupulate, not embedded in host tissue, peridium firm.... ***Puccinia mei-mamillata***, p. 203

Lycoseris ..... ***Puccinia dioicae***, p. 149

Lygodesmia..... ***Puccinia hieracii***, p. 183

Lysimachia..... ***Puccinia karelica***, p. 195

Mertensia ..... ***Puccinia hydrophylli***, p. 187

Milium ..... ***Puccinia brachypodii***, p. 129

Minuartia

1a. Telia pulvinate, pale brown to brown, later cinereous by the formation of basidiospores; 2-celled teliospores easily falling apart and then seemingly 1-celled ..... ***Puccinia arenariae***, p. 115
1b. Telia pulverulent, black; teliospores not germinating readily and not falling apart ..... ***Puccinia hysteriiformis***, p. 189

Moneses

1a. Wall of urediniospores < 1 µm thick; infection systemic, causing discoloration or stunting..... ***Rossmanomyces pyrolae***, p. 55
1b. Wall of urediniospores 1-2.5 µm thick; infection not systemic, not causing malformations ..... ***Pucciniastrum pyrolae***, p. 77

Mulgedium..... ***Puccinia dioicae***, p. 149

Myosotis..... ***Puccinia myosotidis***, p. 215

Nabalus

1a. Microcyclic, only telia; wall of teliospores 7-15 µm thickened at apex ..... ***Puccinia columbiensis***, p. 141
1b. Macrocyclic; wall of teliospores thickened or not at apex 2

2a. Aecia uredinioid, usually on the veins, where they induce small thickenings and malformations; lower cell of teliospores with equatorial pore, urediniospores with 2 supraequatorial pores ..... ***Puccinia hieracii***, p. 183
2b. Aecia aecioid, scattered over the whole leaf, in large or small clusters, not inducing thickenings or malformations, lower cell of teliospores with (sub)apical pore, urediniospores with 2-3 eqatorial pores ..... ***Puccinia variabilis***, p. 281

Noccaea

1a. Infection systemic, plants malformed, telia long covered by the epidermis, teliospores not germinating readily, verrucose, pedicel deciduous ..... ***Puccinia oudemansii***, p. 219
1b. Infection local, plants not malformed, telia soon naked, teliospores germinating readily, smooth, pedicel persistent ..... ***Puccinia thlaspeos***, p. 267

Oenothera

1a. Only spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Only telia ..... ***Puccinia columbiensis***, p. 141

Origanum ..... ***Puccinia thymi***, p. 269

Orthilia ..... ***Rossmanomyces pyrolae***, p. 55

Oxyria ..... ***Puccinia oxyriae***, p. 221

Oxytropis ..... ***Uromyces lapponicus***, p. 307

Parnassia ..... ***Puccinia parnassiae***, p. 225

Parrya ..... ***Puccinia oudemansii***, p. 219

Pedicularis

1a. Teliospores smooth ..... ***Puccinia lapponica***, p. 199
1b. Teliospores not smooth 2

2a. Teliospores with spirally arranged, 0.2-0.6 µm high at 1.4-2 µm spacing ridges; telia dark yellow-brown, more hypophyllous than epiphyllous ..... ***Puccinia helicalis***, p. 181
2b. Teliospores verrucose with irregular warts and labyrinthiform ridges, not spirally arranged; telia dark cinnamon brown or chestnut brown, more epiphyllous than hypophyllous ..... ***Puccinia pedicularis***, p. 229

Petasites

1a. Only spermogonia/aecia ..... ***Puccinia poarum***, p. 231
1b. Only telia ..... ***Puccinia conglomerata***, p. 143

Peucedanum

1a. Only telia; teliospores smooth ..... ***Puccinia imperatoriae***, p. 191
1b. Uredinia and telia; teliospores distantly verrucose ..... ***Puccinia terrieri***, p. 265

Phacelia ..... ***Puccinia recondita***, p. 237

Phryma ..... ***Puccinia dioicae***, p. 149

Phyteuma

1a. Only spermogonia/aecia ..... ***Uromyces caricis-sempervirentis***, p. 299
1b. Only telia, these systemic, teliospores germinating readily ..... ***Uromyces phyteumatum***, p. 311

Picris ..... ***Puccinia hieracii***, p. 183

Pimpinella ..... ***Puccinia bistortae***, p. 127

Pleurospermum ..... ***Puccinia bistortae***, p. 127

Poa

1a. Uredinia with scattered, thick-walled paraphyses ..... ***Puccinia brachypodii***, p. 129
1b. Uredinia without paraphyses or sometimes with only a few at the margin 2

2a. Teliospores 2-celled; uredinia sparsely formed, soon surrounded by telia, pores of the urediniospores mostly inconspicuous ..... ***Puccinia poarum***, p. 231
2b. Teliospores 1-celled; uredinia often present, pores of the urediniospores mostly conspicuous ..... ***Uromyces dactylidis***, p. 301

Polemonium ..... ***Puccinia polemonii***, p. 233

Polyctenium ..... ***Puccinia aberrans***, p. 107

Polygonum, see ***Bistorta***

Potentilla

1a. Teliospores with 4.5-7(-8) µm long apiculus, smooth ..... ***Phragmidium potentillae***, p. 97
1b. Teliospores without apiculus 2

2a. Teliospores smooth or finely verrucose above, (2-)3(-4)-celled ..... ***Phragmidium ivesiae***, p. 91
2b. Teliospores completely or only lower part verrucose 3

3a. Teliospores (1-)2(-3)-celled, pedicel persistent ..... ***Phragmidium biloculare***, p. 85
3b. Teliospores (2-)4(-5)-celled, pedicel easily breaking ..... ***Phragmidium boreale***, p. 87

Prenanthes

1a. Only telia; teliospores 20-42 × 12-21 µm, pores covered with 2-4 µm high caps ..... ***Puccinia conglomerata***, p. 143
1b. Macrocyclic; teliospores 28-40 × 18-24 µm, caps over pores inconspicuous ..... ***Puccinia variabilis***, p. 281

Primula

1a. Teliospores 1-celled ..... ***Uromyces primulae-integrifoliae***, p. 313
1b. Teliospores 2-celled ..... ***Puccinia arctica***, p. 113

Pyrola

1a. Wall of urediniospores < 1 µm thick; infection systemic, causing discoloration or stunting ..... ***Rossmanomyces pyrolae***, p. 55
1b. Wall of urediniospores 1-2.5 µm thick; infection not systemic, not causing malformation ..... ***Pucciniastrum pyrolae***, p. 77

Ranunculus

1a. Only spermogonia/aecia 2
1b. Only telia or also uredinia present 3

2a. Infection systemic, inducing malformations on the leaves, aeciospores 16-20 × 13-17 µm ..... ***Schroeteriaster alpinus***, p. 321
2b. Infection not systemic, not inducing malformations, aeciospores 17-25 µm in diameter ..... ***Uromyces dactylidis***, p. 301

3a. Uredinia and telia; teliospores 1-celled, infection systemic, plants yellowish green ..... ***Uromyces fischerianus***, p. 303
3b. Only telia; teliospores 2-celled, infection not systemic, plants not discoloured 4

4a. Teliospores provided with coarse ridges ..... ***Puccinia gibberulosa***, p. 173
4b. Teliospores smooth ..... ***Puccinia myosotidis***, p. 215

Rhodiola ..... ***Puccinia umbilici***, p. 273

Rhododendron (including *Ledum*)

1a. Flowers white 2
1b. Flowers coloured 5

2a. Urediniospores indistinctly verrucose, nearly smooth ..... ***Chrysomyxa nagodhii***, p. 49
2b. Urediniospores strongly verrucose 3

3a. Uredinia and telia epiphyllous ..... ***Chrysomyxa ledicola***, p. 47
3b. Uredinia and telia hypophyllous 4

4a. Urediniospores without a longitudinal reticulate area ..... ***Chrysomyxa ledi***, p. 45
4b. Urediniospores with a longitudinal reticulate area ..... *Chrysomyxa reticulata*, not included

5a. Peridium of uredinia conspicuous, persistent ..... ***Chrysomyxa succinea***, p. 53
5b. Peridium of uredinia inconspicuous, collapsing ..... ***Chrysomyxa rhododendri***, p. 51

Ribes

1a. Only spermogonia/aecia ..... ***Puccinia caricina***, p. 133
1b. Only telia ..... ***Puccinia ribis***, p. 243

Rosa

1a. Aecia and uredinia lacking; teliospores 2-3-celled..... ***Phragmidium kamtschatkae***, p. 93
1b. Spermogonia, aecia, uredinia and telia present; teliospores > 6-celled.....2

2a. Telia surrounded by paraphyses ..... ***Phragmidium fusiforme***, p. 89
2b. Telia not surrounded by paraphyses (note that teliospores are initially formed in uredinia, which are surrounded by paraphyses) ..... ***Phragmidium montivagum***, p. 95

Rubus

1a. Teliospores formed between the epidermis cells, 1-celled, not pedicellate..... ***Aculeastrum arcticum***, p. 39
1b. Teliospores formed in sori, 2- or more-celled, pedicellate.....2

2a. Teliospores 2-celled..... ***Arthuriomyces peckianus***, p. 81
2b. Teliospores 3-10-celled ..... ***Phragmidium arcticum***, p. 83

Rumex..... ***Schroeteriaster alpinus***, p. 321

Sagina..... ***Puccinia arenariae***, p. 115

Salix

1a. Uredinia intermixed, but not surrounded with paraphyses..... ***Melampsora epitea***, p. 61
1b. Uredinia surrounded with paraphyses 2

2a. Uredinia surrounded but not intermixed with paraphyses..... ***Melampsora lapponum***, p. 65
2b. Uredinia surrounded and intermixed with paraphyses 3

3a. Urediniospores finely echinulate, wall 2.5-7 µm thick; wall of teliospores at apex up to 4 µm thick..... ***Melampsora arctica***, p. 57
3b. Urediniospores sparsely verrucose, wall 2.5-3.5 µm thick; wall of teliospores at apex not thickened..... ***Melampsora bigelowii***, p. 59

Saussurea

1a. Only uredinia and telia ..... ***Puccinia saussureae-alpinae***, p. 247
1b. Only spermogonia/aecia 2

2a. Spermogonia amphigenous, peridial cells of aecia up to 25 µm wide..... ***Puccinia dioicae***, p. 149
2b. Spermogonia epiphyllous, peridial cells of aecia 27-34 µm wide..... ***Puccinia vaginatae***, p. 279

Saxifraga

1a. Only spermogonia and aecia; teliospores lacking 2
1b. Teliospores present.....3

2a. Spermogonia and aecia usually epiphyllous..... ***Melampsora arctica***, p. 57
2b. Spermogonia and aecia amphigenous or only hypophyllous ..... ***Melampsora epitea***, p. 61

3a. Teliospores not organized in sori, subepidermal..... ***Melampsora hirculi***, p. 63
3b. Teliospores *Puccinia*-like, conspicuous sori formed on the leaves.....4

4a. Teliospores verrucose, at least the upper cell ..... ***Puccinia pazschkei***, p. 227
4b. Teliospores smooth, very finely punctate or provided with lines, but not rough 5

5a. Infection systemic; pore of lower cell of teliospores equatorial or lower ..... ***Puccinia fischeri***, p. 169
5b. Infection not systemic; pore of lower cell of teliospores higher than equatorial 6

6a. Teliospores 26-38 × 13-16 µm, pore of lower cell against septum ..... ***Puccinia pallidomaculata***, p. 223
6b. Teliospores 20-45 × 14-22 µm, pore of lower cell near septum to 1/4(-1/2) depressed..... ***Puccinia saxifragae***, p. 249

Scandosorbus..... ***Gymnosporangium cornutum***, p. 103

Scorzoneroides..... ***Puccinia hieracii***, p. 183

Sempervivum ..... ***Endophyllum sempervivi***, p. 105

Senecio

1a. Aecia present 2
1b. Aecia lacking 3

2a. Teliospores present ..... ***Puccinia senecionis***, p. 253
2b. Teliospores lacking..... ***Puccinia dioicae***, p. 149

3a. Telia long covered by epidermis; teliospores 1-2-celled, the 2-celled large, 36-70 × 16-30 µm ..... ***Puccinia uralensis***, p. 275
3b. Telia soon naked; teliospores 2-celled, 20-42 × 12-21 µm ..... ***Puccinia conglomerata***, p. 143

Serratula

1a. Only spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Macrocyclic; aecia uredinioid ..... ***Puccinia hieracii***, p. 183

Sieversia..... ***Puccinia urbanii***, p. 277

Silene ..... ***Puccinia arenariae***, p. 115

Sisymbrium..... ***Puccinia holboellii***, p. 185

Smelowskia

Both species with apex of teliospores thickened.

1a. Wall of teliospores 2-3.5 µm thick, pedicel short, deciduous ..... ***Puccinia aberrans***, p. 107
1b. Wall of teliospores 1-2 µm thick, pedicel 1× spore length or longer, persistent ..... ***Puccinia holboellii***, p. 185

Soldanella..... ***Puccinia soldanellae***, p. 259

Solidago

1a. Only spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Only telia 2

2a. Teliospores 1-3-celled, pedicel up to 0.5× spore length..... ***Puccinia virgae-aureae***, p. 285
2b. Teliospores 1-celled, pedicel 2× spore length or more..... ***Uromyces sommerfeltii***, p. 315

Sorbus ..... ***Gymnosporangium cornutum***, p. 103

Stellaria

1a. Uredinia and telia; telia not organized in sori, formed within the epidermis cells; uredinia orange-yellow..... ***Melampsorella elatina***, p. 69
1a. Only telia 2

2a. Telia pale brown to brown, teliospores germinating readily, easily falling apart and then seemingly 1-celled ..... ***Puccinia arenariae***, p. 115
2b. Telia black, teliospores not germinating readily, not falling apart..... ***Puccinia hysteriiformis***, p. 189

Stephanomeria..... ***Puccinia hieracii***, p. 183

Symphyotrichum ..... ***Puccinia dioicae***, p. 149

Swertia ..... ***Puccinia swertiae***, p. 263

Taraxacum

1a. Only spermogonia/aecia ..... ***Puccinia dioicae***, p. 149
1b. Uredinia and/or telia present..... 2

2a. Aecia uredinioid, usually on the veins, where they induce small thickenings and malformations; lower cell of teliospores with equatorial pore, urediniospores with 2 supraequatorial pores ..... ***Puccinia hieracii***, p. 183
2b. Aecia aecioid, scattered over the whole leaf, in large or small clusters, not inducing thickenings or malformations, lower cell of teliospores with (sub)apical pore, urediniospores with 2-3 equatorial pores ..... ***Puccinia variabilis***, p. 281

Teesdalia ..... ***Puccinia oudemansii***, p. 219

Tephroseris

1a. Only spermogonia and aecia..... ***Puccinia dioicae***, p. 149
1b. Teliospores present..... ***Puccinia senecionis***, p. 253

Teucrium ..... ***Puccinia thymi***, p. 269

Thalictrum

1a. Only telia ..... ***Puccinia rhytismoides***, p. 241
1b. Only spermogonia and aecia..... 2

2a. Aeciospores 19-29 × 13-26 µm; spermogonia epiphyllous.....***Puccinia recondita***, p. 237
2b. Aeciospores 18-22 µm in diameter; spermogonia usually lacking.....***Puccinia septentrionalis***, p. 255

Thesium .....***Puccinia mougeotii***, p. 211

Thymus .....***Puccinia thymi***, p. 269

Tripolium .....***Puccinia dioicae***, p. 149

Trollius
1a. Only spermogonia/aecia .....***Puccinia recondita***, p. 237
1b. Only telia .....***Puccinia trollii***, p. 271

Tussilago.....***Puccinia poarum***, p. 231

Vaccinium.....***Naohidemyces vaccinii***, p. 73

Veratrum
1a. Teliospores 1-2-celled, distantly echinulate/verrucose; urediniospores usually with 1 pore.....***Puccinia veratri***, p. 283
1b. Teliospores 1-celled, smooth; urediniospores usually with 2-3 pores .....***Uromyces veratri***, p. 319

Veronica
1a. Telia hypophyllous, often on the midrib, also on the lower stem internodes, partly producing readily germinating spores.....***Puccinia albulensis***, p. 109
1b. Telia amphigenous, not preferring the midrib, rarely on the stems, producing only resting spores.....***Puccinia rhaetica***, p. 239

Viola
1a. Only aecia .....***Melampsora lapponum***, p. 65
1b. Aecia lacking 2

2a. Only uredinia .....***Uredo alpestris***, p. 289
2b. Only teliospores.....3

3a. Telia soon naked; teliospores finely reticulate, not or barely constricted at septum .....***Puccinia alpina***, p. 111
3b. Telia long covered by the epidermis; teliospores smooth, moderately constricted at septum .....***Puccinia fergussonii***, p. 167

Wilhelmsia .....***Puccinia arenariae***, p. 115

Aculeastrum: Coleosporiaceae: Pucciniales

Aculeastrum arcticum **L. Holm 64, Fungi Ex. Suec. 1528; C-F-156063; Sweden**

Aculeastrum arcticum (Tranzschel) M. Scholler & U. Braun

Syn.: *Pucciniastrum arcticum* Tranzschel

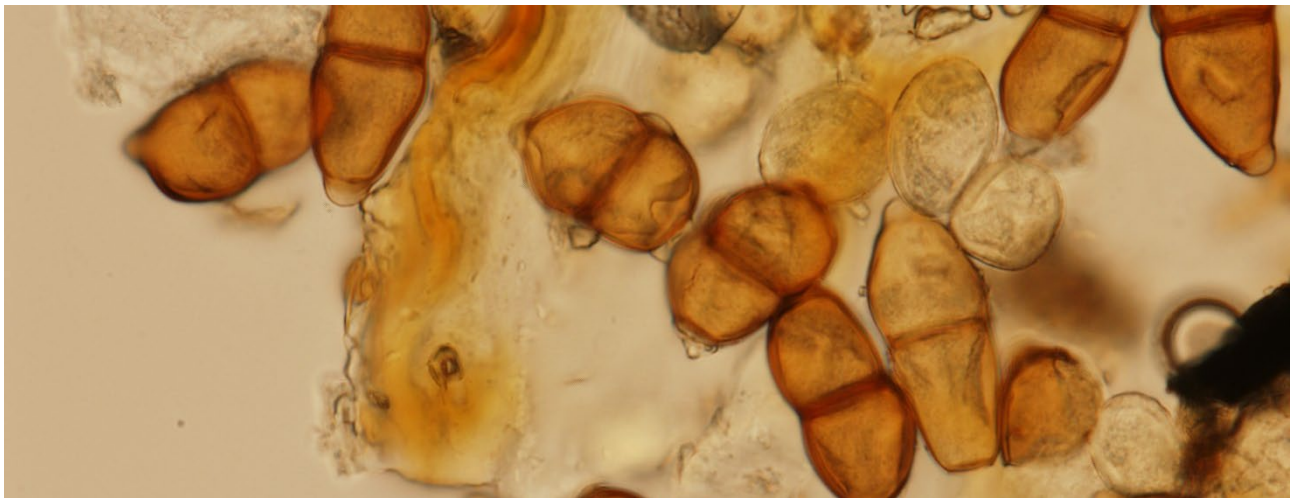
Macrocyclic hetereuform – [0-I]-II-(III). Spermogonia hypophyllous, inconspicuous. **Aecia** hypophyllous, nearly cylindrical, fragile. Spores subglobose to broadly ellipsoid, 17-25 × 14-18 µm, wall hyaline, incl. tubercles 2-3 µm thick, covered with fine, somewhat deciduous tubercles. **Uredinia** hypophyllous, densely scattered, covering large parts of the leaves, diameter 0.1-0.2 mm, round, bullate, surrounded by a firm peridium, dehiscent by a central pore, slightly pulverulent, ruptured epidermis inconspicuous, orange-yellow, later pale yellow. Spores oblong or obovoid, 21-26 × 13-16 µm, wall hyaline, 1-2 µm thick, finely echinulate. **Telia** may be lacking, hypophyllous, subepidermal, small, flat, brownish. Spores intercellular between the epidermis cells, 1-celled, subglobose to cuboid, diameter 19-25 µm, wall brownish, smooth.

Host plants

[0-I, **Pinaceae:** *Picea* species; by definition not included; change of host not obligatory**]**
II-III, **Rosaceae:** *Rubus arcticus.* **III** is not found in Norway.

Distribution

Arctic-alpine-boreal; circumpolar; type 5; recorded from arctic North America (AK, CAN), arctic Eurasia (NO, SE, FI), the Urals and Kamchatka (RU), and alpine Eurasia (Altai).



Chrysomyxa: Coleosporiaceae: Pucciniales

Chrysomyxa cassandrae **Warming & Rostrup, 1887; C-F-127122; Denmark (Bot. Gard.)**

Chrysomyxa cassandrae (Gobi) Tranzschel

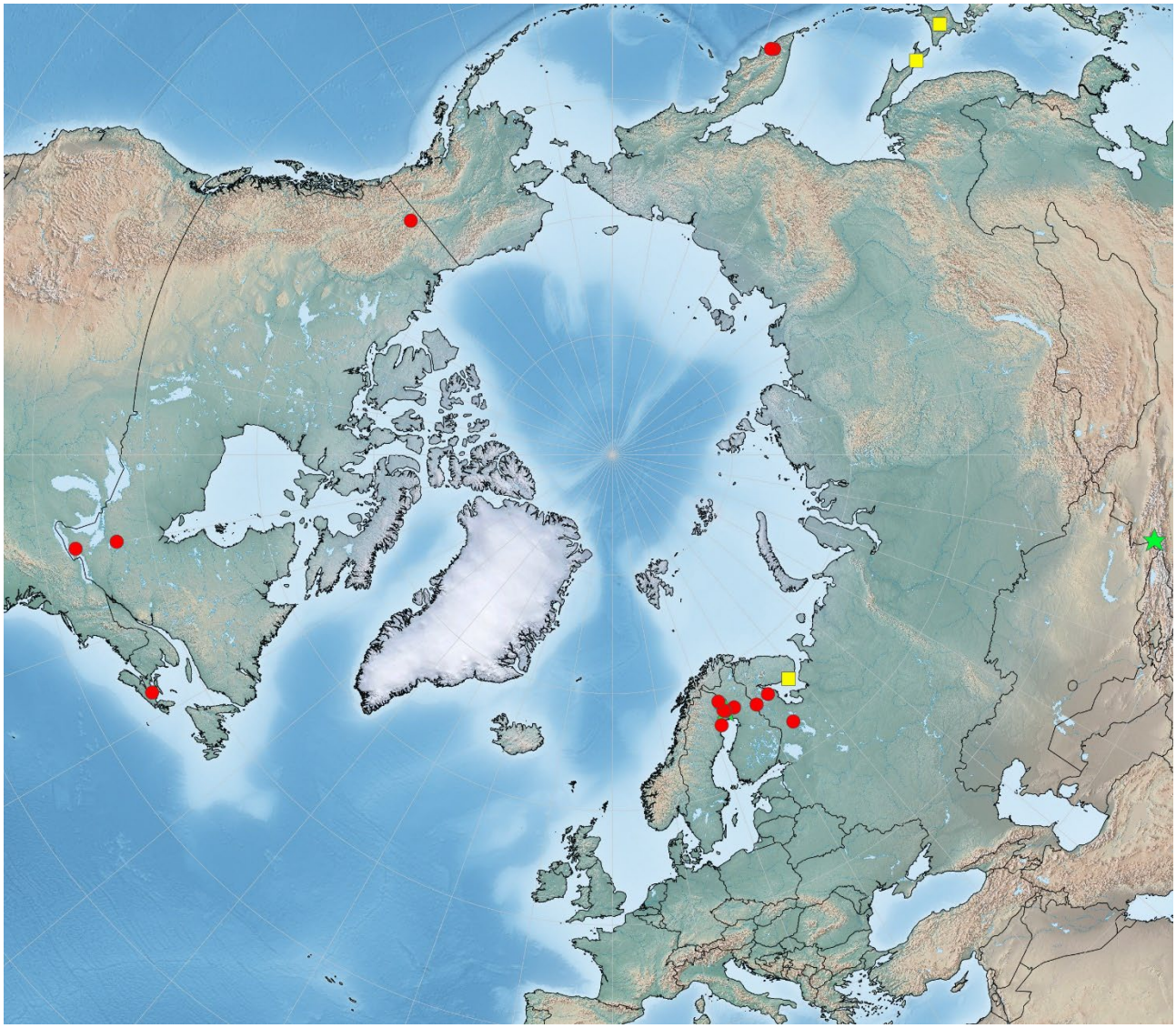
Macrocyclic hetereuform – [0-I] / II-III. Causing premature needle loss. **Spermogonia** amphigenous on current-year needles, prominent, subepidermal, rusty orange or brown when dry. **Aecia** mostly epiphyllous on current-year needles, tubular or tongue-like, 3 × 0.3-0.5 mm, not confluent. Spores globose to ellipsoid, with a broad shallow cap at one or both ends, part of a broad longitudinal smoother area with a broken, skirt-like edge, orange, 17-31(-36) × 14-22 µm, warts cylindrical with thin basal connections, annulate, with flat or uneven tops, except in longitudinal smoother area, where they are broad, shallow bumps, wall hyaline, 0.8 µm thick, wall plus warts 0.8-3.3 µm thick, peridium persistent. **Uredinia** hypophyllous, on leaves of previous year, in groups, not confluent, occasionally on the petioles or main leaf veins, causing brown leaf spots, round, diameter 0.25-0.75 mm, with inconspicuous peridium consisting of collapsed, thin-walled cells. Spores subglobose to ellipsoid, with a broad cap at one or both ends, part of a broad flat longitudinal smoother area with a broken skirt-like edge, deep orange, 16-33 × 14-24 µm, wall incl. warts hyaline, 1.2-2.5 µm thick, warts crowded, cylindrical, annulate, with flat tops, except in longitudinal smoother area where they are broad, shallow bumps. **Telia** in clusters of irregular size and shape, erumpent through the epidermis, pulvinate, orange. Spores 1-celled, cuboid to oblong, 12.5-26 × 12.5-18 µm, wall < 1 µm thick.

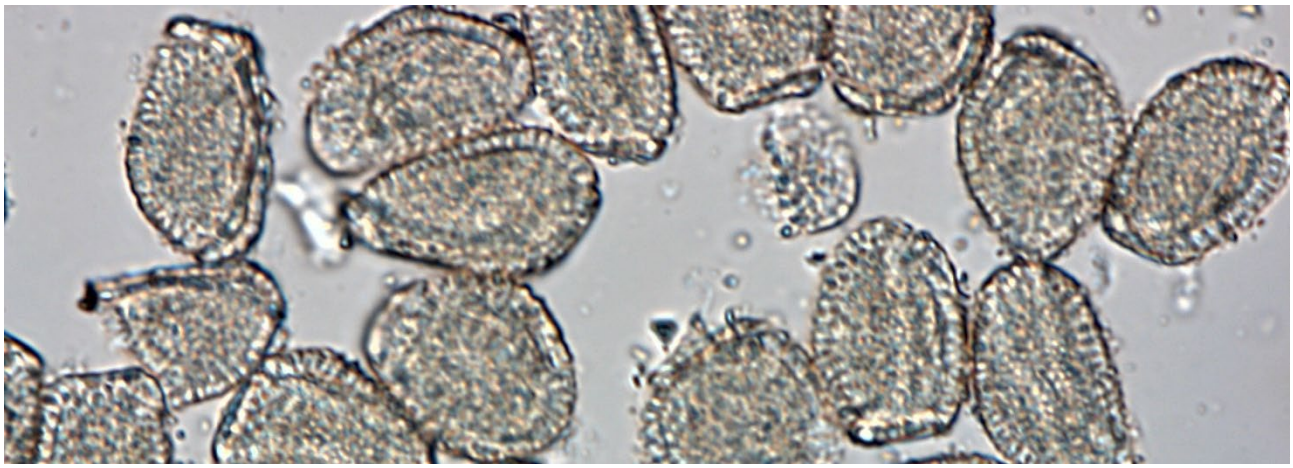
Host plants

[0-I, **Pinaceae:** *Picea* species; by definition not included; change of host not obligatory**]**
II-III, **Ericaceae:** *Chamaedaphne calyculata.*

Distribution

Arctic-alpine-boreal; eastern Eurasian; type 1; recorded from arctic SE, FI, and RU, and from alpine CAN, RU, C-Asia, and JP. Rare or rarely collected.





Chrysomyxa: Coleosporiaceae: Pucciniales

Chrysomyxa empetri **J. A. Nannfeldt 5292, Fungi Ex. Suec. 1201; C-F-153890; Sweden**

Chrysomyxa empetri (Pers.) J. Schröt.

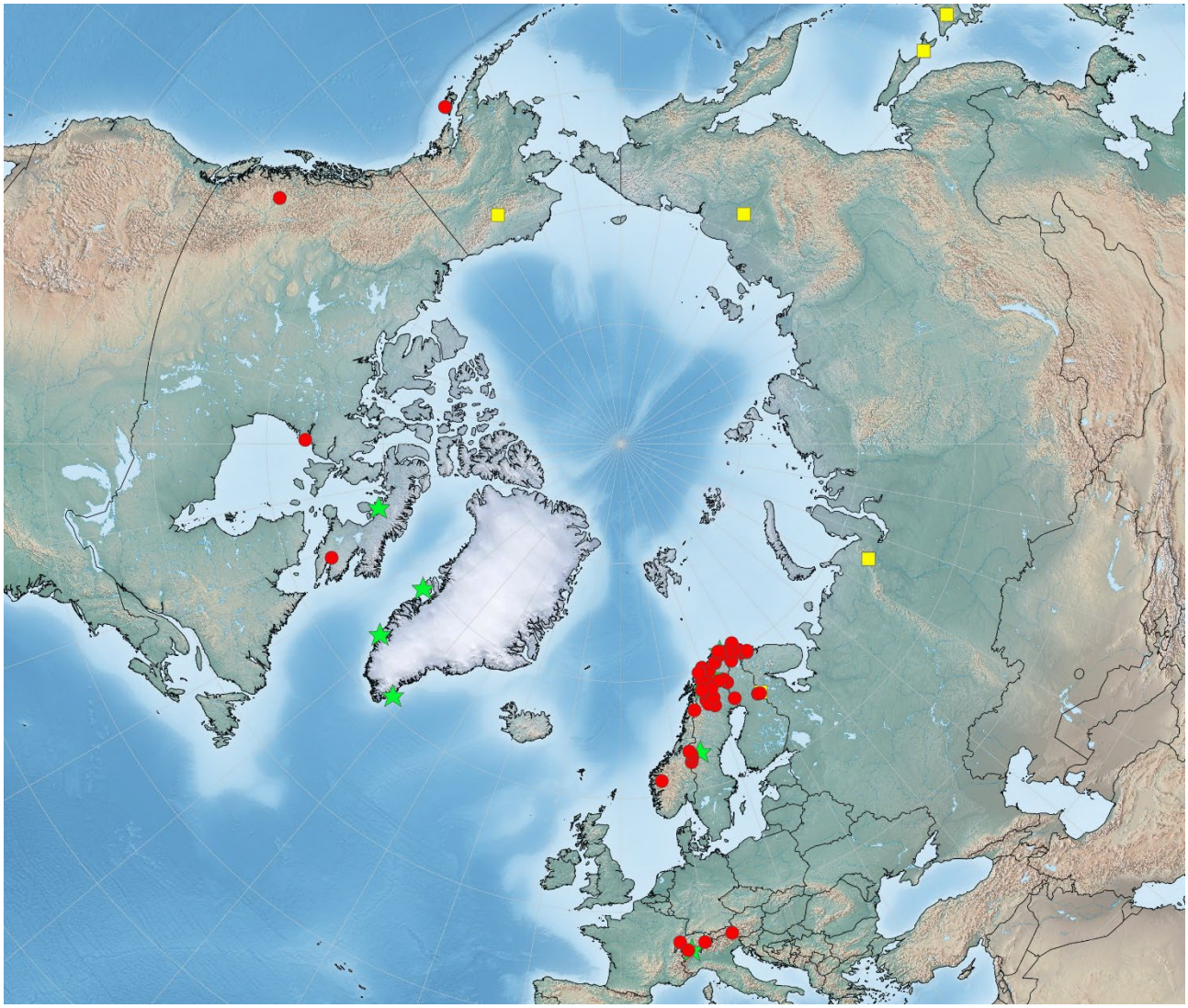
Macrocyclic hetereuform – [0-I] / II-(IIIg). Spermogonia amphigenous on current-year needles, conspicuous, abundant, uniseriate, yellowish, later red-brown to black. **Aecia** amphigenous on current-year needles, on pale spots, discrete, tongue-shaped, 0.3-1.4 mm wide, 0.5(-2) mm high, peridium hyaline. Spores yellow, ovoid, ellipsoid or lenticular, one or both ends flat, 27-50(-60) × 16-37 µm, wall hyaline, incl. warts 1.2-3.3(-4.1) µm thick, densely and strongly verrucose, warts tiny, ends covered with delicate cap. **Uredinia** epiphyllous, sparse, pustulate, ellipsoid to elongate, 0.2-2 mm long, pulverulent, bright orange, peridium of 1 cell layer, adhering to the ruptured epidermis. Spores globose to broadly ellipsoid, orange, 23-49 × 19-36 µm, arranged in chains, wall hyaline, incl. warts 1.6-3.3(-4.1) µm thick, densely and strongly verrucose at ca. 1.5 µm spacing, pore(s) inconspicuous. **Telia** epiphyllous on overwintering leaves, sparse or lacking, up to the whole leaf length, round to elongate, pulvinate, waxy when young, velvety when mature, yellow. Spores 1-celled, germinating readily, oblong, yellow, 18-45 × 15-24 µm, in 3-6-celled chains, wall hyaline, 1 µm thick, smooth, pore inconspicuous.

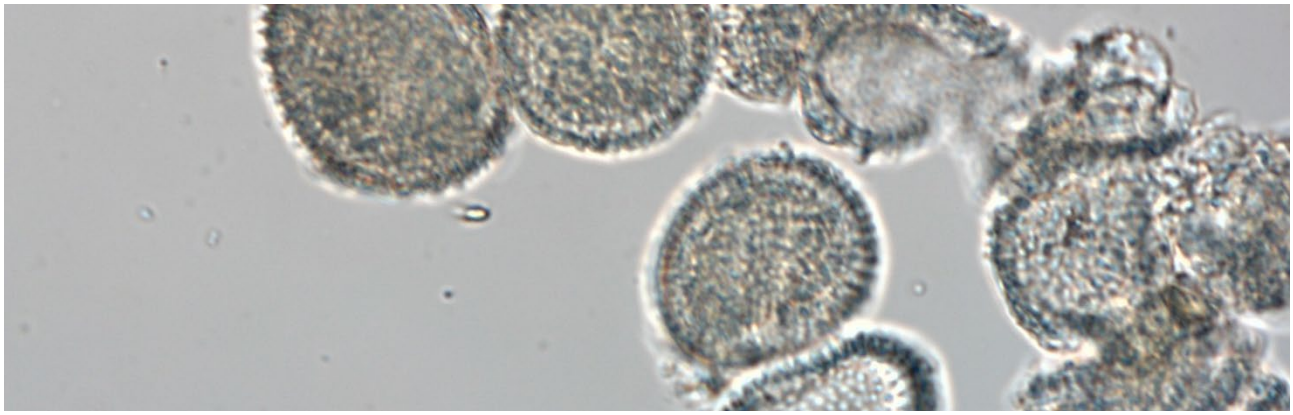
Host plants

[0-I, **Pinaceae:** *Picea* species, by definition not included; change of host not obligatory**]**
II-III, **Ericaceae:** *Empetrum hermaphroditum* and *E. nigrum.*

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic AK, CAN, GR, NO, SE, FI, and RU, and from the alpine Rocky Mts. (CAN), Dovre (NO), the Alps (FR, CH, AU), Sakhalin (RU), and Hokkaido (JP).





Chrysomyxa: Coleosporiaceae: Pucciniales

Chrysomyxa ledi **HK 16.027; C-F-104057**

Chrysomyxa ledi (Alb. & Schwein.) de Bary

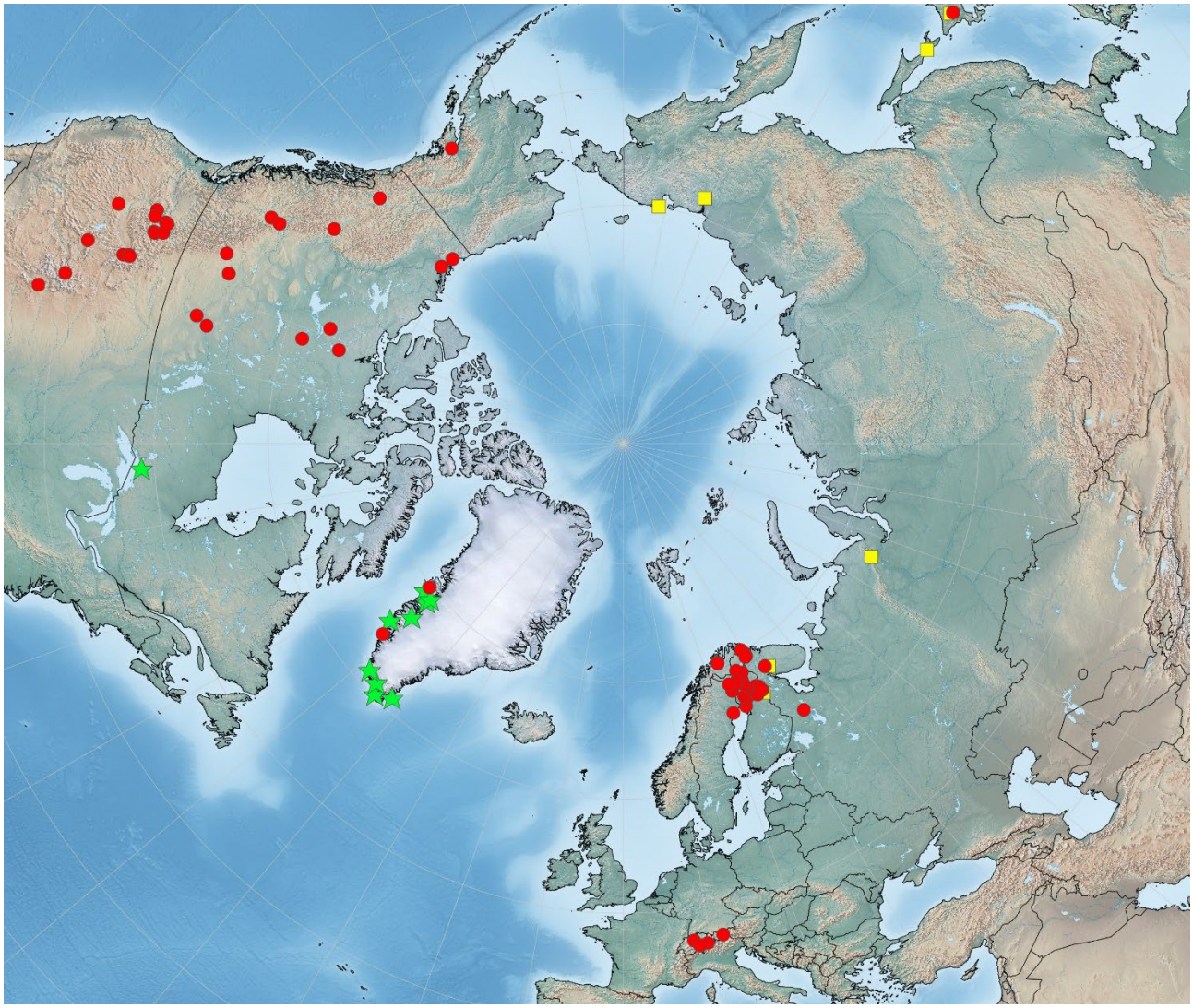
Macrocyclic hetereuform – [0-I] / II-(IIIg). Spermogonia amphigenous on current-year needles, subepidermal, common, inconspicuous, honey-coloured, later red-brown. **Aecia** amphigenous on current-year needles on yellow spots, tubular, diameter 0.3-1.3 mm, up to 1.5(-3) mm high, peridium membranaceous, white, irregularly torn. Spores subglobose to ellipsoid, yellow, 20-38 × 15-28 µm, with a clear, narrow, longitudinal groove, wall hyaline, 0.8 µm thick, densely verrucose, warts 0.8-4.1 µm high, annulate, tapering. **Uredinia** mostly hypophyllous on leaves of previous year, occasionally caulicolous, scattered or in small groups, round, diameter 0.2-0.3 mm, sometimes confluent, with a peridium of 2-3 layers of thin-walled pseudoparenchymatous cells. Spores globose to ovoid, sometimes ellipsoid, 18-30 × 16-26 µm, sometimes with a longitudinal groove, wall hyaline, up to 1 µm thick, finely verrucose, warts 1.3-2 µm high at ca. 1.5 µm spacing, pores inconspicuous. **Telia** hypophyllous, uncommon, sparsely aggregated, flat, diameter 0.5-2 mm, orange-red to blood red. Spores germinating readily, 1-celled, cuboid or oblong, hyaline, 13-30 × 10-20 µm, in 6-10-celled chains, wall hyaline, thin, smooth.

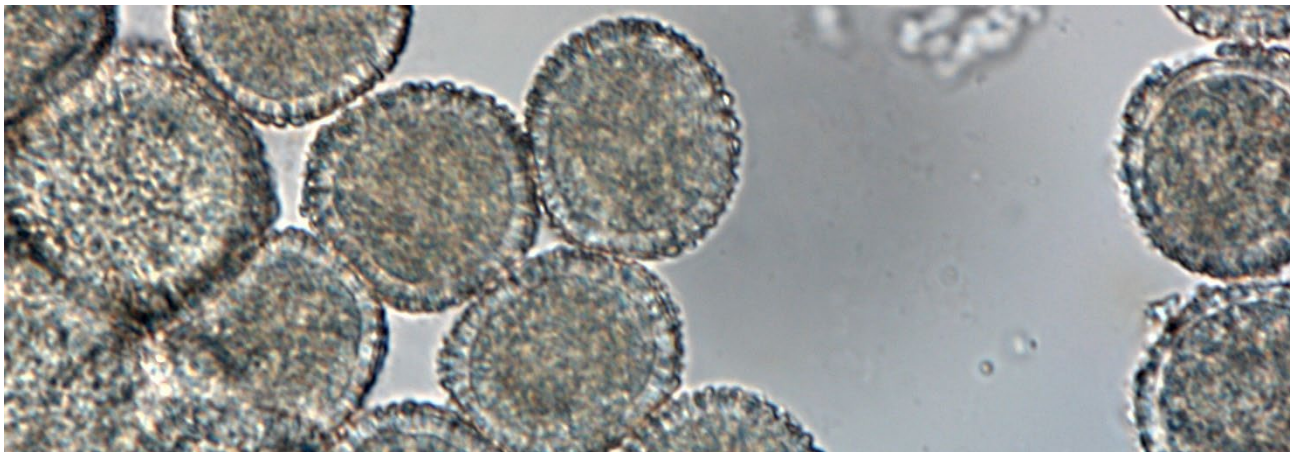
Host plants

[0-I, **Pinaceae:** *Picea* species, by definition not included; change of host not obligatory**]**
II-III, **Ericaceae:** *Rhododendron* (*Ledum*) species, e.g. *R. tomentosum* (*L. palustre*), *R. columbianum* (*L. glandulosum*), and *R. groenlandicum.*

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic AK, CAN, GR, NO, SE, FI, and RU, and from alpine regions of the Alps (CH, AT), the Urals and Sakhalin (RU), and Hokkaido (JP).





Chrysomyxa: Coleosporiaceae: Pucciniales

Chrysomyxa ledicola **H. H. Bruun; C-NHMD001862327**

Chrysomyxa ledicola (Peck) Lagerh.

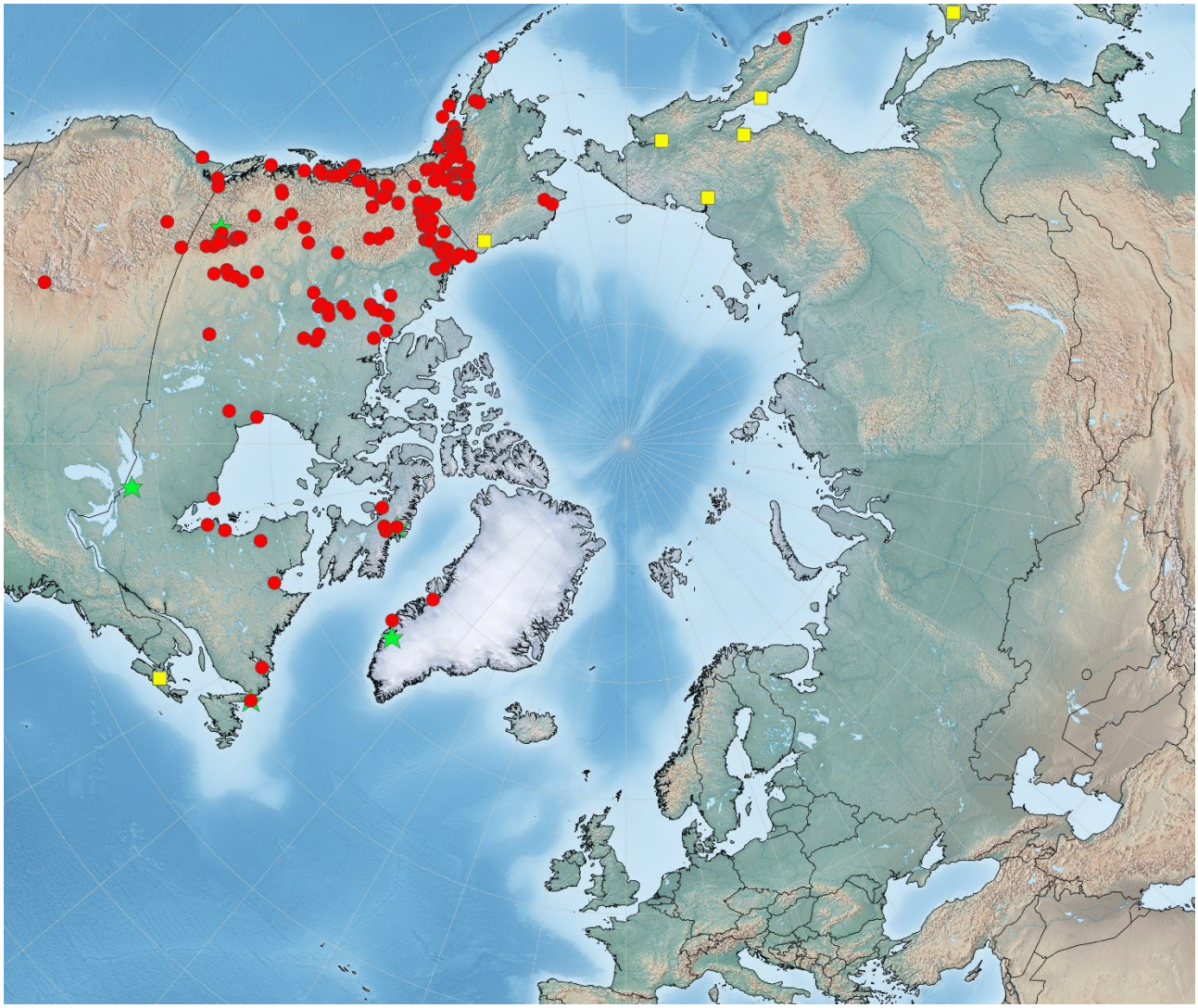
Macrocyclic hetereuform – [0-I] / II-III. Spermogonia amphigenous on current-year needles, abundant. **Aecia** amphigenous, scattered, peridium hyaline, not persistent. Spores subglobose to ellipsoid, deep orange or reddish orange, very variable in size, 23-60 × 18-54 µm, wall 1.5-2.7 µm thick, strongly verrucose, sometimes with inconspicuous shallow, longitudinal, wart-contained indentations, warts 0.8-3 µm high. **Uredinia** epiphyllous on irregular reddish spots on previous-year leaves, rarely hypophyllous on the leaf midvein, flower pedicels and seed capsules, subepidermal, scattered, single or in circular groups, initially covered with 1-2 layers of cuboid or oblong cells, erupting through the epidermis as bright, orange, pulverulent pustules. Spores subglobose to ellipsoid, reddish orange, 21-45 × 14-37 µm, wall hyaline, 0.7-1.6 µm thick, strongly verrucose, sometimes with an inconspicuous shallow, longitudinal, wart-containing indentation, warts 0.8-3.3 µm high. **Telia** epiphyllous, forming irregular crusts, gelatinous when young, erumpent through epidermis, pale brown, orange or reddish brown. Spores 1-celled, cuboid to oblong, 18-24 × 12-16 µm, with 3-6 together in cylindrical chains, wall hyaline, smooth.

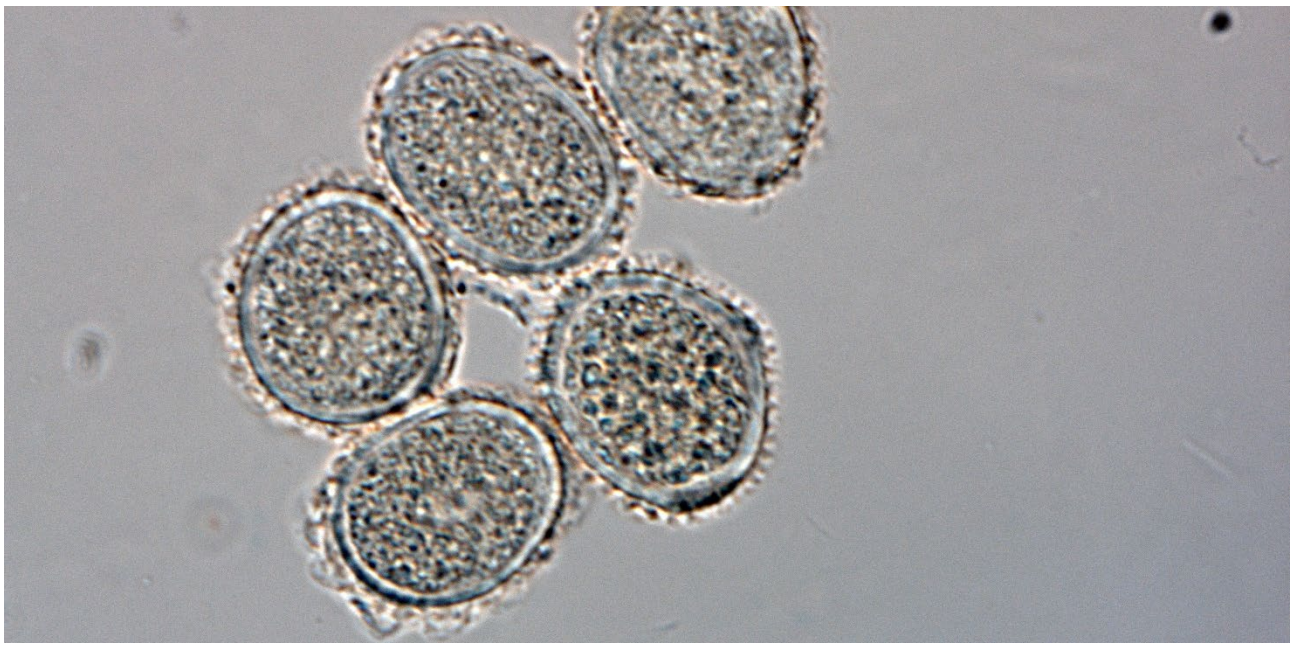
Host plants

[0-I, **Pinaceae:** *Picea* species, by definition not included; change of host not obligatory**]**
II-III, **Ericaceae:** *Rhododendron tomentosum* (*Ledum decumbens*) and *R. groenlandicum*.

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic AK, CAN, GR, and RU, and from the alpine Rocky Mts. (CAN, USA), Kamchatka (RU), and Hokkaido (JP).





Chrysomyxa: Coleosporiaceae: Pucciniales

Chrysomyxa nagodhii HK 18.234C; C-F-111275

Chrysomyxa nagodhii P.E. Crane

Syn.: *Chrysomyxa ledicola* p.p.

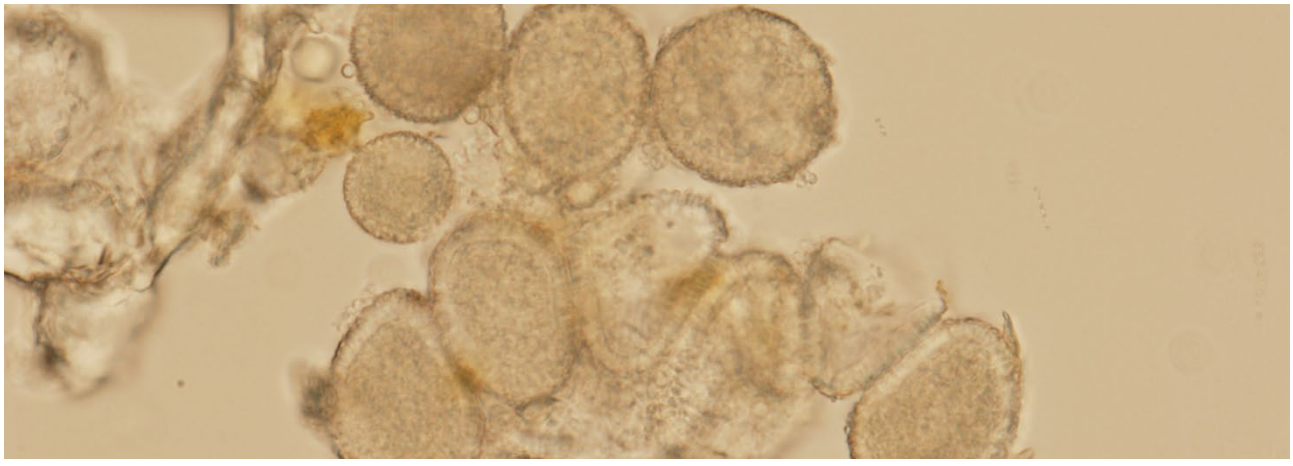
Macrocyclic hetereuform – [0-I] / II-III. Spermogonia amphigenous on current-year needles, abundant. **Aecia** amphigenous, scattered, diameter 0.25-2 mm, peridium tubular, not persistent. Spores globose, subglobose, ellipsoid or ovoid, deep orange, 15-31(-34) × 14-24 µm, wall < 0.8 µm thick, densely verrucose, caps at both ends or at one side of the spore, shallow, nearly smooth, warts incl. wall 1.6-4.1 µm thick, variable in width, annulate. **Uredinia** hypophyllous on previous-year, yellow- or orange-mottled leaves, diameter 0.25 mm, cupulate, peridium rudimentary. Spores subglobose, ovoid, ellipsoid or irregular, truncate at one or both ends, melon yellow, 15-36 × 12-22 µm, wall incl. warts 0.8-2.5 µm thick, densely but indistinctly verrucose, smooth at both ends, warts of variable size and shape, flat-topped. **Telia** deep orange, gelatinous, flat, diameter 0.1-0.2 mm. Spores 1-celled, cuboid, becoming ellipsoid when mature, wider towards the top of the sorus, 12-23 × 15-28 µm.

Host species and habitats

[0-I, **Pinaceae:** *Picea* species, by definition not included; change of host not obligatory**]**
II-III, **Ericaceae:** *Rhododendron* (*Ledum*) *groenlandicum.*

Distribution

Arctic-alpine; North-American; type 14; recorded from arctic Canada and the alpine Rocky Mts. (CAN). Described recently and may have a wider distribution.



Chrysomyxa: Coleosporiaceae: Pucciniales

Chrysomyxa rhododendri **HK 21.015b; C-F-159637; Germany**

Chrysomyxa rhododendri (DC.) de Bary

Syn.: *Chrysomyxa ledi* var. *rhododendri* (DC.) Savile

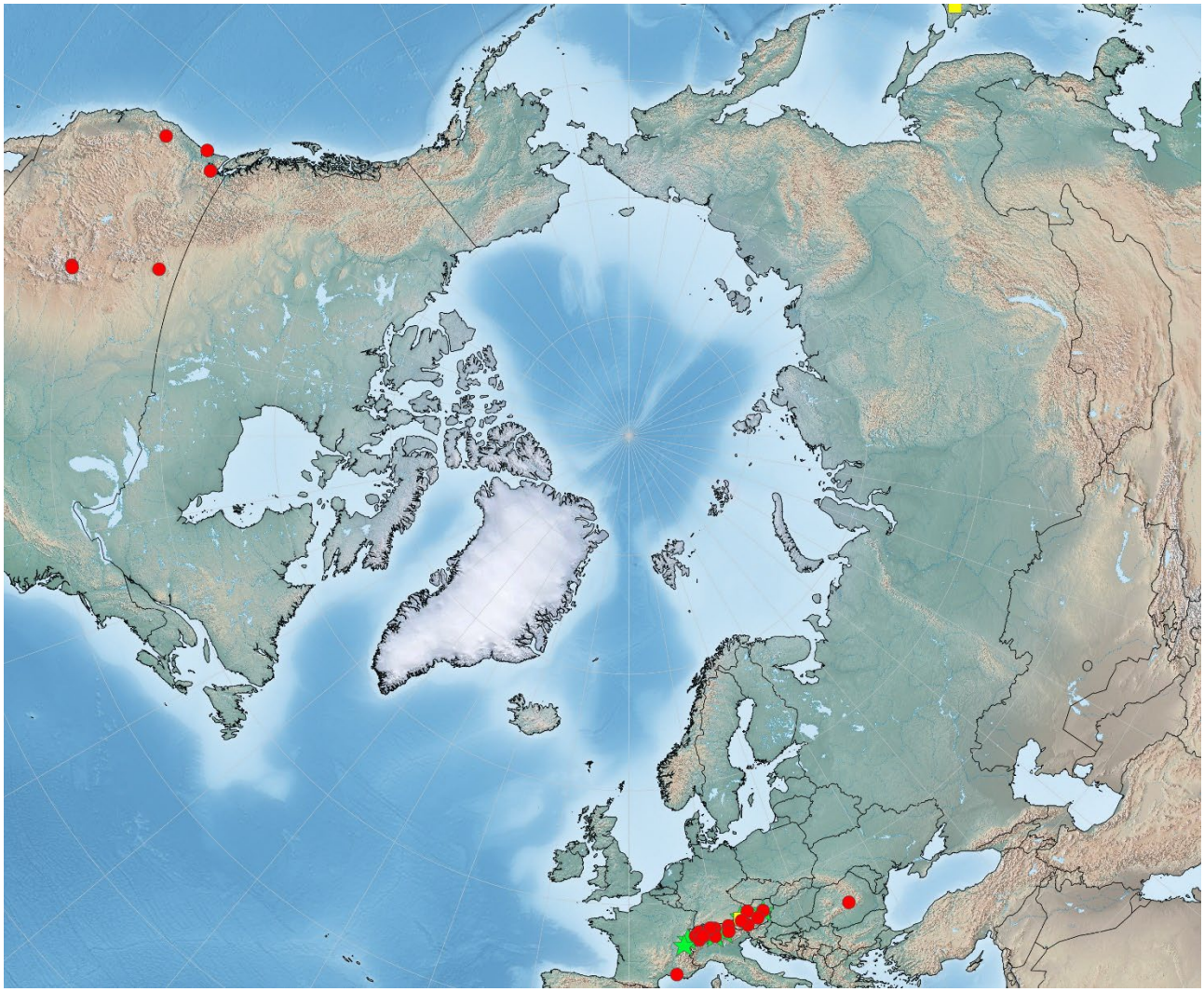
Macrocyclic hetereuform – [0-I] / II-III. Spermogonia and aecia on yellowed zones of current-year needles, causing premature defoliation. **Spermogonia** prominent, round or elongate on needle surface, amphigenous, diameter 140-220 µm, 110-150 µm high. **Aecia** amphigenous, diameter 0.3–1.3 mm, single or confluent. Spores subglobose to ellipsoid, with one or both ends flat or with a small delicate cap, part of an indistinct longitudinal stripe containing irregular shallow bumps, 18-30 × 16-22 µm, wall hyaline, incl. warts 2.0-3.3 µm thick, peridium delicate, shredding at maturity but persistent. **Uredinia** hypophyllous on leaves of previous years, also on the petioles, fruit pedicels and twigs, scattered, erumpent through epidermis, round, pulvinate, diameter 0.2-0.7 mm, larger on twigs, flat-bottomed in cross section, with an inconspicuous peridium of collapsed, thin-walled cells. Spores mostly ellipsoid or ovoid, occasionally subglobose, one or both ends slightly flattened or with a small cap, part of a shallow longitudinal stripe containing shallow, irregular bumps, 18-32(-36) × 14-22 µm, wall hyaline, < 1 µm thick, wall incl. warts 1.2-2.9 µm thick. **Telia** hypophyllous on leaves of previous year, in groups, confluent, erumpent through the epidermis, larger and more irregular in shape than uredinia, up to 1 mm long. Spores 1-celled, cuboid to ellipsoid or irregular, 20-28(-34) × 12-21 µm, wall colourless, thin, smooth.

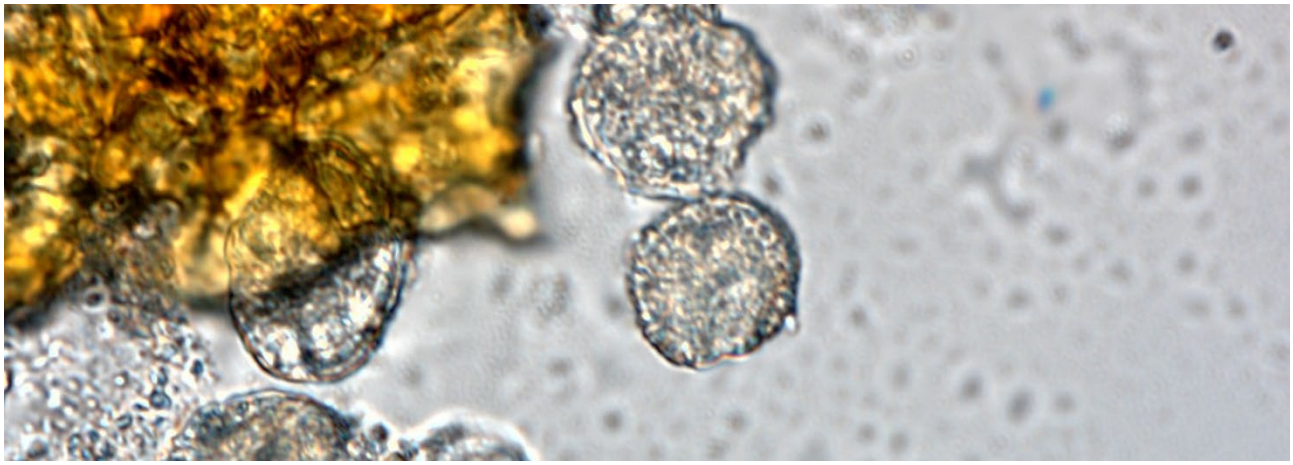
Host plants

[0-I, **Pinaceae:** *Picea* species, by definition not included; change of host not obligatory**]**
II-III, **Ericaceae:** *Rhododendron* species, e.g. *R. canadense*, *R. carolineanum*, *R. ferrugineum*, *R. hirsutum*, *R. intermedium*, *R. lapponicum*, and *R. maximum.*

Distribution

Alpine; circumpolar; type 5; recorded from alpine regions of the Rocky Mts. (USA), the Alps (DE, FR, CH, AT), the Carpathians (RO), and Hokkaido (JP).





Chrysomyxa: Coleosporiaceae: Pucciniales

Chrysomyxa succinea **E. Hultén; S-F134915; Russia (Kamchatka)**

Chrysomyxa succinea (Sacc.) Tranzschel

Syn.: *Chrysomyxa alpina* Hirats. f.; *C. expansa* Dietel

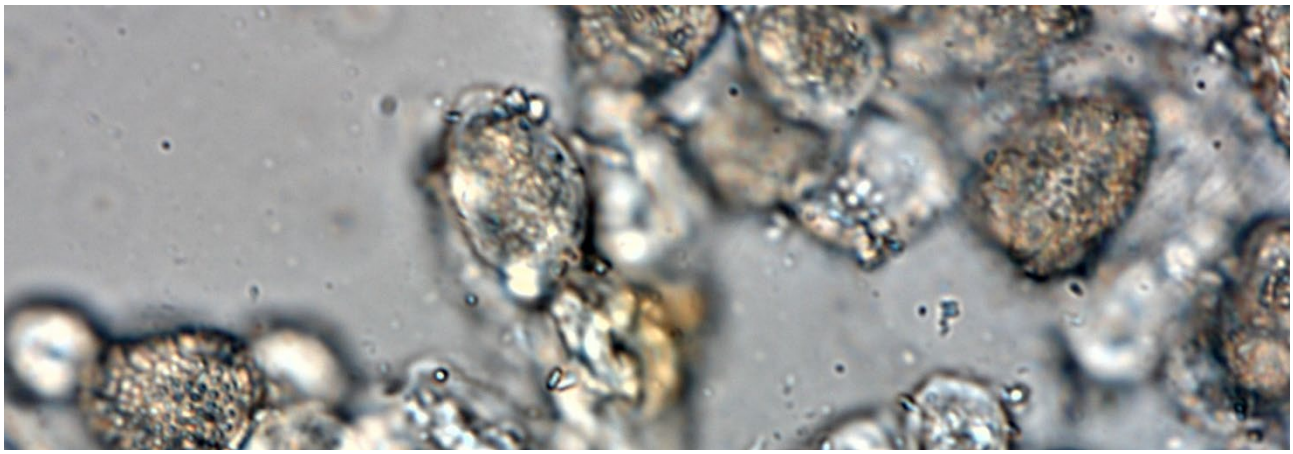
Macrocyclic hetereuform – [I] / II-III. Spermogonia not known. **Aecia** hypophyllous, in 2 rows on yellow lesions, elongate, laterally compressed. Spores subglobose to ellipsoid or slightly ovoid, 18-34 × 13-23 µm, with a broad shallow cap at one or both ends, the broad longitudinal area with a broken, skirt-like edge, wall incl. warts 1.0-2.8 µm thick, warts cylindrical, annulate, peridium persistent. **Uredinia** hypophyllous, round, cushion-like, scattered or in groups, gelatinous when young, later covered by a firm, diameter 0.2-0.7 mm, persistent peridium. Spores subglobose to ellipsoid or polygonal to fusoid, often with flattened ends, 20-28 (-36) × 14-22 µm, catenulate, wall <1 µm thick, one side covered with a shallowly warted longitudinal cap, elsewhere densely verrucose, warts annulate, cylindrical to irregular in shape, 1-2 µm high. **Telia** hypophyllous, in small circular groups, erumpent, raised, gelatinous, subglobose when young, later more irregular, diameter 0.2-0.7 mm, separate or confluent, with a short stem (120-260 µm long) composed of narrow, densely packed filamentous cells. Spores 1-celled, surrounded by a clear matrix, subglobose to ellipsoid, 16-26 × 8-20 µm, catenulate.

Host plants

[I, **Pinaceae:** *Picea* species, by definition not included; change of host not obligatory**]**
II-III, **Ericaceae:** *Rhododendron aureum*, *R. brachycarpum*, *R. chrysanthum*, *R. fauriae*, *R. japonoheptamerum*, and *R. nudiflorum.*

Distribution

Alpine; Eurasian; type 15; recorded from alpine eastern Asia, in the Altai Mts. and Kamchatka (RU), and Hokkaido (JP).



Rossmanomyces: Coleosporiaceae: Pucciniales

Rossmanomyces pyrolae **HK 16.061; C-F-104091**

Rossmanomyces pyrolae (Rostr.) Aime & McTaggart

Syn.: *Chrysomyxa pyrolae* Rostr.; C. *pirolata* (Körn.) G. Winter

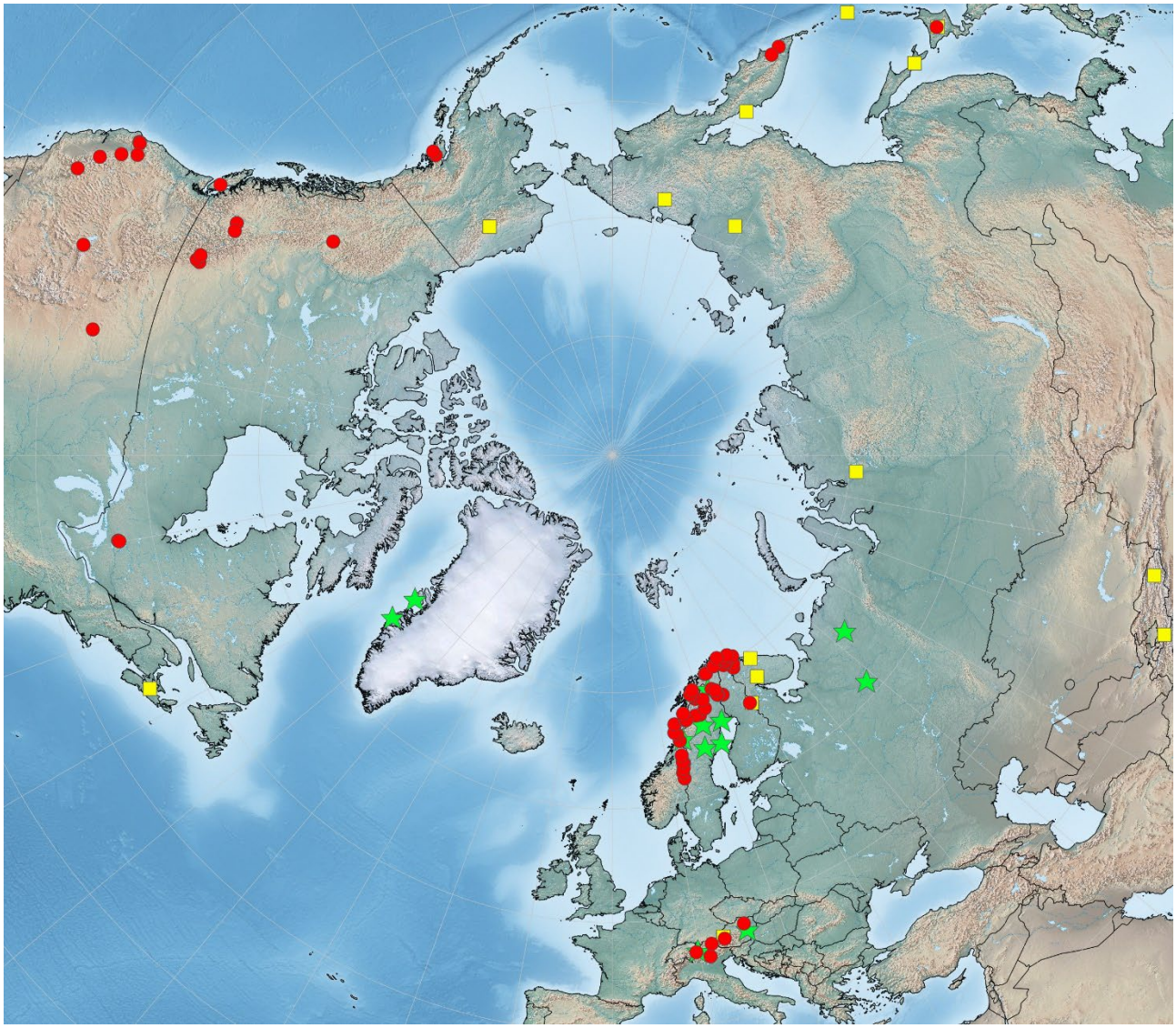
Macrocyclic hetereuform – [0-I] / II-(IIIg). Spermogonia and aecia systemic in cones, rarely in young shoots. **Spermogonia** epiphyllous on the cone scales, abundant, subepidermal, inconspicuous, flat, diameter 0.5-1 mm. **Aecia** amphigenous on the cone scales, bullate, erumpent through the epidermis, often confluent in 5-10 mm long groups, peridium white, evanescent. Spores subglobose to ellipsoid, orange, 21-42(-56) × 17-35 µm, wall hyaline, 0.5-1 µm thick, densely and strongly verrucose, warts pyramidal, diameter 3-4 µm and 1.6-4.1 µm high. **Uredinia** systemic, most hypophyllous, also epiphyllous, on overwintered leaves, often covering the whole surface, and on petioles, bracts and floral parts, round, diameter 0.25-1.5 mm, initially covered by the epidermis, then naked and surrounded by the ruptured epidermis, yellow, orange or yellow-red, peridium evanescent. Spores formed in chains with intercalary cells, subglobose or ellipsoid, angular, orange-yellow or orange, 15-33(-38) × 13-28 µm, wall hyaline, 0.4-1 µm thick, densely verrucose, warts diameter 0.5-2 µm and 3(-4) µm high at 2-3 µm spacing. **Telia** systemic, less common than uredinia, hypophyllous on overwintered leaves, conspicuous, flat, covering the whole surface uniformly, waxy, yellow-red, finally blood red, but brownish when dry. Spores germinating readily, 1-celled, cuboid or ellipsoid, 12-26 × 7-13 µm, wall hyaline, 1 µm thick, smooth, in 100-130 µm long chains.

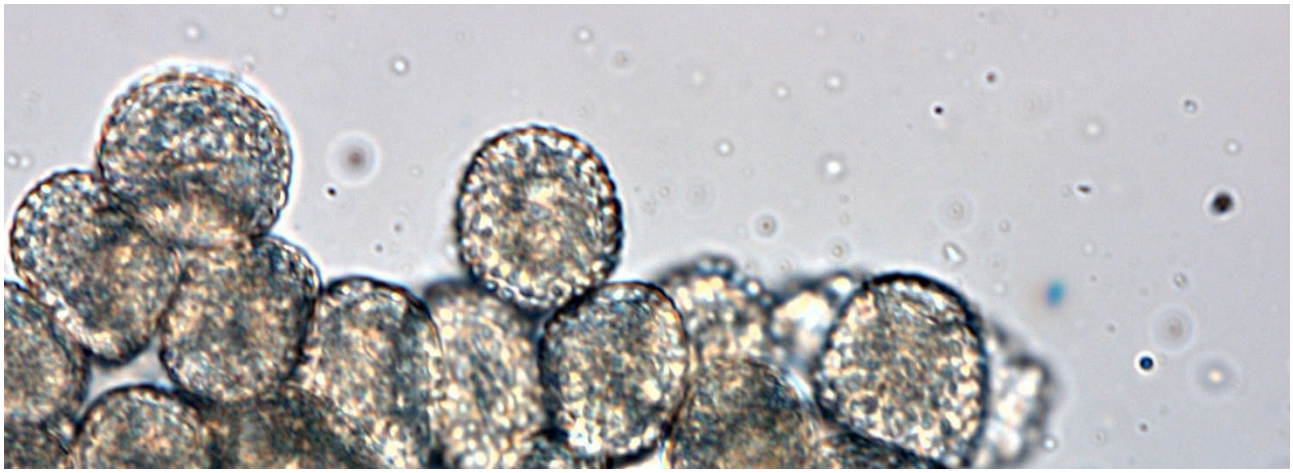
Host plants

[0-I, **Pinaceae:** *Picea* species; by definition not included; change of host not obligatory**]**
II-III, **Pyrolaceae:** *Moneses uniflora*, *Orthilia secunda* (*O. obtusata*), and *Pyrola.**

Distribution

Arctic-alpine-boreal-northern-temperate; North American-Eurasian; type 1; recorded from arctic AK, CAN, GR, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (USA), the Alps (DE, FR, CH, AT, SI, IT), the Pyrenees (ES), the Carpathians (RO), Dovre (NO), the Scandinavian Mts. (SE), the Urals and the Altai Mts. (RU), and Hokkaido (JP).





Melampsora: Melampsoraceae: Pucciniales

Melampsora arctica **HK 17.009B; C-F-104898**

Melampsora arctica Rostr.

Syn.: *Melampsora alpina* Juel; *M. epitea* p.p.

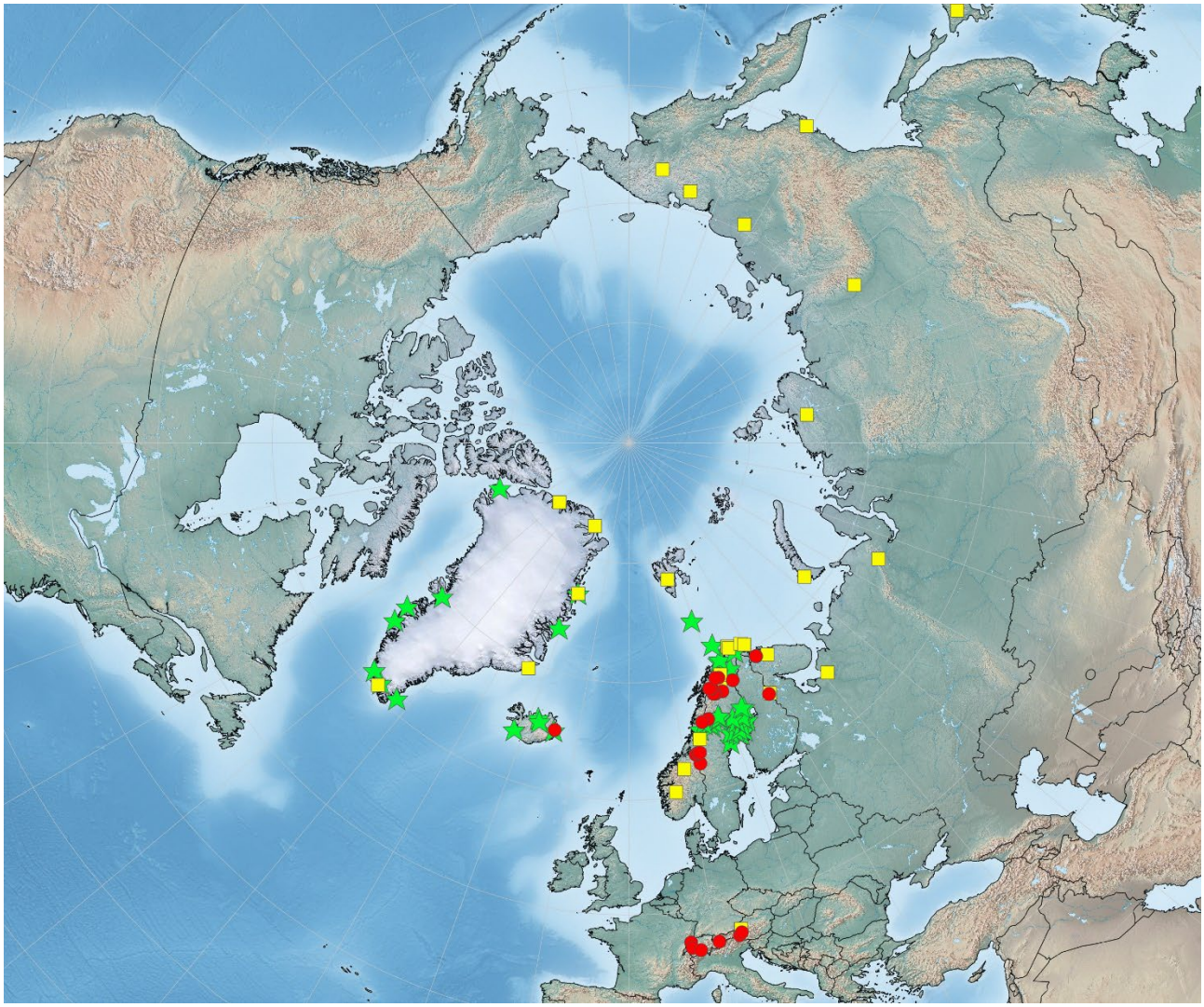
Macrocyclic hetereuform – 0-I / II-III. **Spermogonia** epiphyllous, subepidermal, orange. **Aecia** usually epiphyllous, somewhat concentrated towards the leaf tip, diameter 0.3-1 mm, scattered, initially covered by the epidermis, then naked, orange. Spores 16-27 × 13-24 µm, wall hyaline, 1.5-3.5 µm thick, finely verrucose. **Uredinia** mainly epiphyllous, also hypophyllous, round, diameter 0.25-0.5 mm, scattered, initially covered by the epidermis, then naked, orange-yellow to orange, later brownish, surrounded and intermixed with hyaline, capitate, 40-65 µm long paraphyses, capita 17-24 µm wide, wall 3-7 µm thick. Spores subglobose, 14-25 × 11-24 µm, wall hyaline, 2.5-7 µm thick, finely echinulate, spines 0.9 µm high. **Telia** subepidermal, amphigenous, single or confluent in small crusts, usually opposite to the uredinia, remaining covered by the epidermis, reddish brown, brown, later blackish. Spores 1-celled, oblong or prismatic, 23-50 × 6-17 µm, wall pale yellowish, light golden brown or brownish, up to 1 µm, at apex 4 µm thick, smooth, pore apical, inconspicuous.

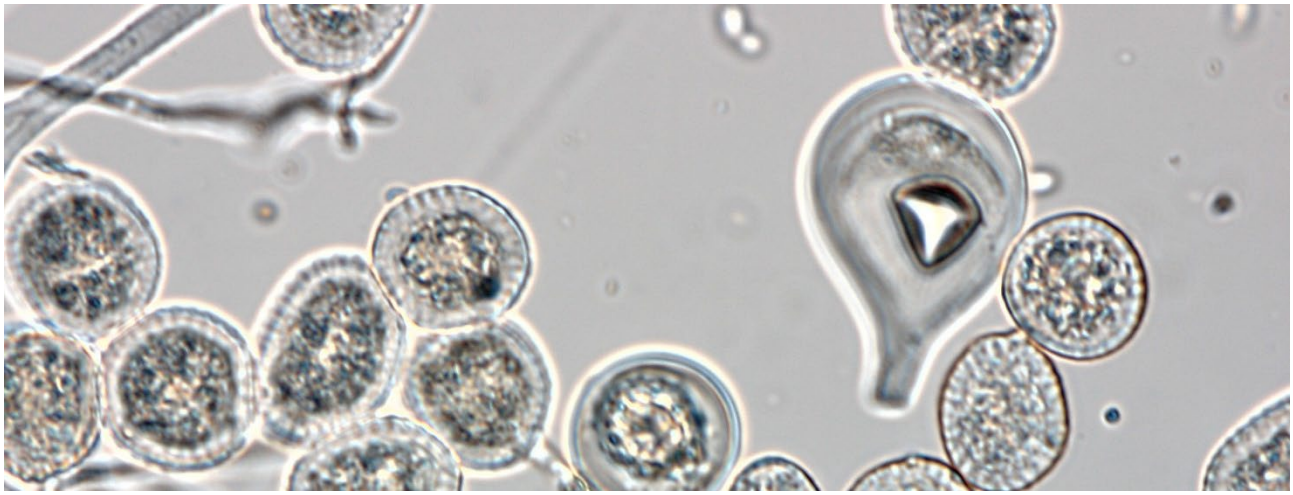
Host plants

0-I, **Saxifragaceae:** *Saxifraga*.*
II-III, **Salicaceae:** *Salix*.*

Distribution

Arctic-alpine-boreal; circumpolar, but missing in Alaska and Canada; type 4; in North America only in Greenland; in Eurasia from arctic IS, Svalbard, NO, SE, FI, and RU, and from alpine regions of the Alps (CH, AT), Dovre (NO), the Urals and Magadan (RU), and Hokkaido (JP).





Melampsora: Melampsoraceae: Pucciniales

Melampsora bigelowii **E. T. & E. Bartholomew; C-F-169357; USA (Montana)**

Melampsora bigelowii Thüm.

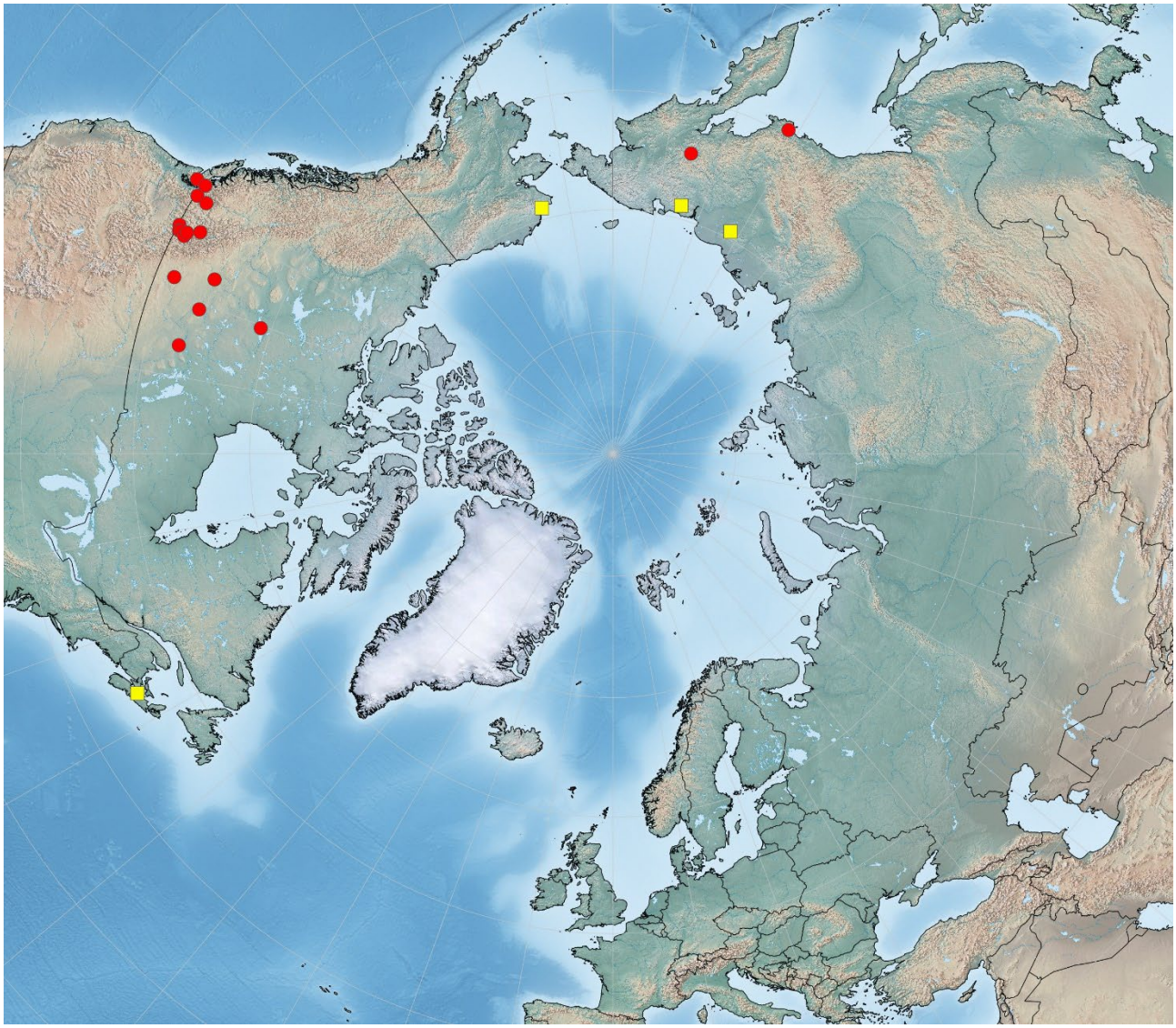
Macrocyclic hetereuform – [0-I] / II-III. Spermogonia amphigenous, subcuticular, scattered or somewhat gregarious, minute, punctiform, pale yellow. **Aecia** mainly hypophyllous, subepidermal, scattered or somewhat gregarious, oblong, small, diameter 0.1-0.2 mm, soon naked and surrounded by some remains of the epidermis, pulverulent, pale yellow, later white. Spores globose, 18-27 × 15-22 µm, wall hyaline, 2-3 µm thick, finely verrucose, pores scattered. **Uredinia** chiefly hypophyllous, also epiphyllous, usually on yellow spots, scattered or gregarious, round, diameter 0.3-0.5 mm, soon naked, orange-yellow, later pale yellow, somewhat pulverulent, mixed and surrounded with 50-70 µm long, capitate paraphyses, capita 22-25 µm wide, wall 3-5 µm thick, the surrounding paraphyses more clavate and thinner-walled. Spores globose, 17-24 × 15-19 µm, wall hyaline, 2.5-3.5 µm thick, sparsely verrucose, pores scattered. **Telia** subepidermal, amphigenous, sometimes only epiphyllous or hypophyllous, round or irregular, diameter 0.5 mm, often confluent, orange-yellow, later yellowish brown or purplish brown. Spores 1-celled, oblong or prismatic, ends rounded, 29-42 × 11-14 µm, wall cinnamon brown, 1 µm thick, smooth.

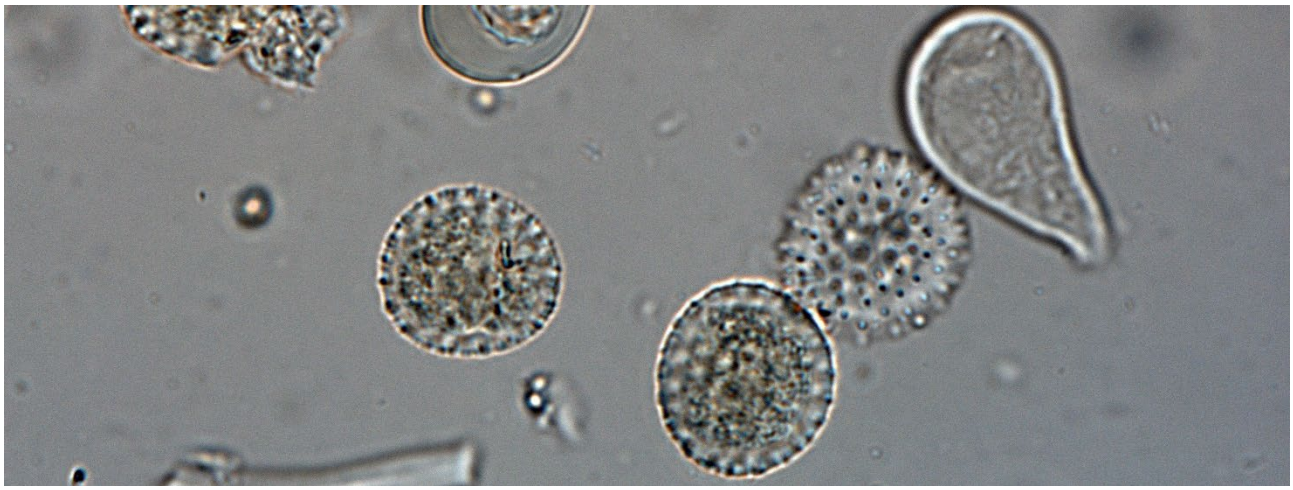
Host plants

[0-I, **Pinaceae:** *Larix* species, by definition not included; change of host not obligatory**]**
II-III, **Salicaceae:** Numerous species of *Salix*.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic AK, CAN, and RU, and from the alpine Rocky Mts. (CAN) and Chukotka (RU).





Melampsora: Melampsoraceae: Pucciniales

Melampsora epitea **HK 16.042b; C-F-108380**

Melampsora epitea Thüm., including *M. laricis-epitea* Kleb. and *M. reticulatae* A. Blytt

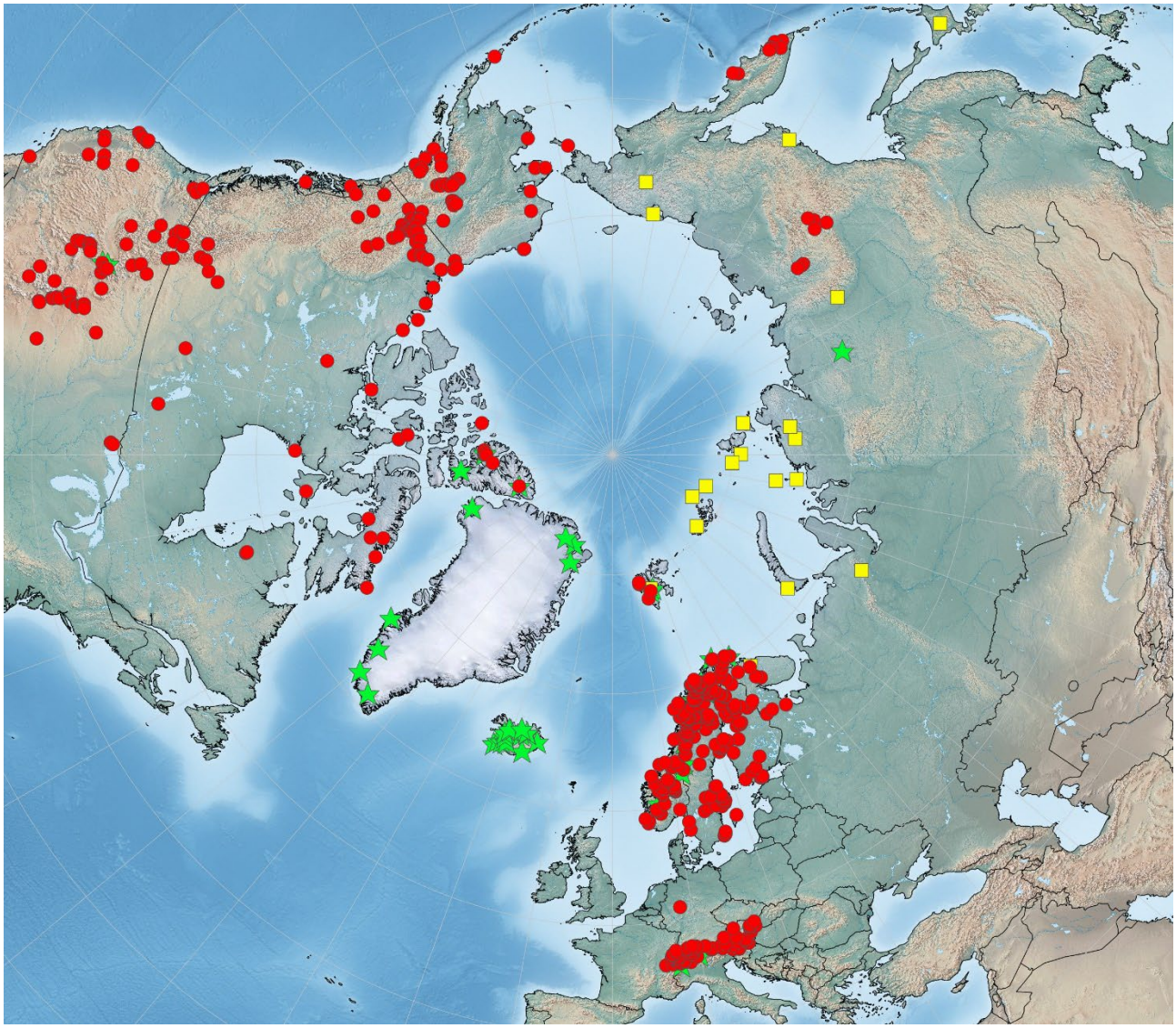
Macrocyclic hetereuform – 0-I / II-III. Spermogonia amphigenous. **Aecia** amphigenous or only hypophyllous, on yellow spots that are also conspicuous on the corresponding opposite leaf side, scattered or in groups, orange, peridium inconspicuous, evanescent. Spores subglobose to ellipsoid, 15-25 × 10-21 µm (on *Saxifraga aizoides* 24-32 × 16-22.5 µm), wall hyaline, 1.5-2.5(-5) µm thick, finely verrucose. **Uredinia** hypophyllous, diameter 0.5-1.5 mm, initially covered by the epidermis, then naked, initially pulvinate, then pulverulent, bright yellow to orange-yellow, intermixed with many, usually thick-walled, capitate, 30-60 µm long paraphyses, capita up to 26 µm wide, wall up to 8 µm thick. Spores subglobose to broadly ellipsoid, 12-25 × 10-18 µm, wall hyaline, 1.5-3.5 µm thick, finely verrucose/echinulate, pores 3-6, scattered, inconspicuous. **Telia** subepidermal, hypophyllous, less often epiphyllous, scattered or in clusters, often confluent, diameter 0.25-1 mm, flat, surrounded by the ruptured epidermis, yellow-brown or orange, later red-brown or dark brown. Spores 1-celled, oblong to short-cylindrical, 20-50 × 7-14 µm, wall pale yellow, 1-2 µm thick, smooth.

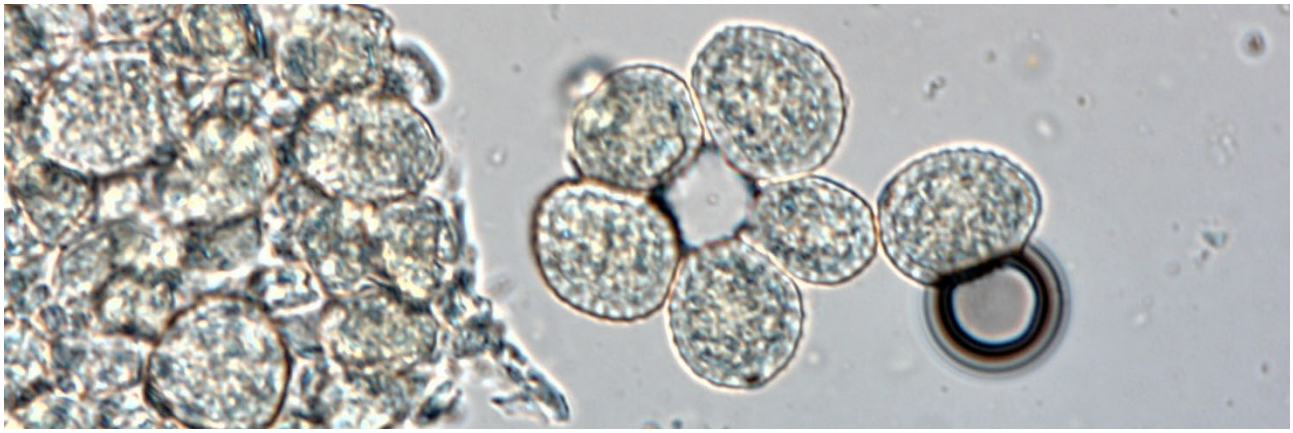
Host plants

0-I, **Saxifragaceae:** *Saxifraga*.*
II-III, **Salicaceae:** *Salix*.*

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic AK, CAN, GR, IS, Svalbard, NO, SE, FI, and RU, and from alpine regions of the Alps (DE, FR, CH, AT, SI, IT), Dovre (NO), the Scandinavian Mts. (SE), the Urals, Verkhoyanskij Mts., and Kamchatka (RU), and Hokkaido (JP).





Melampsora: Melampsoraceae: Pucciniales

Melampsora hirculi **R. Soini; C-F-156057; Finland**

Melampsora hirculi Lindr.

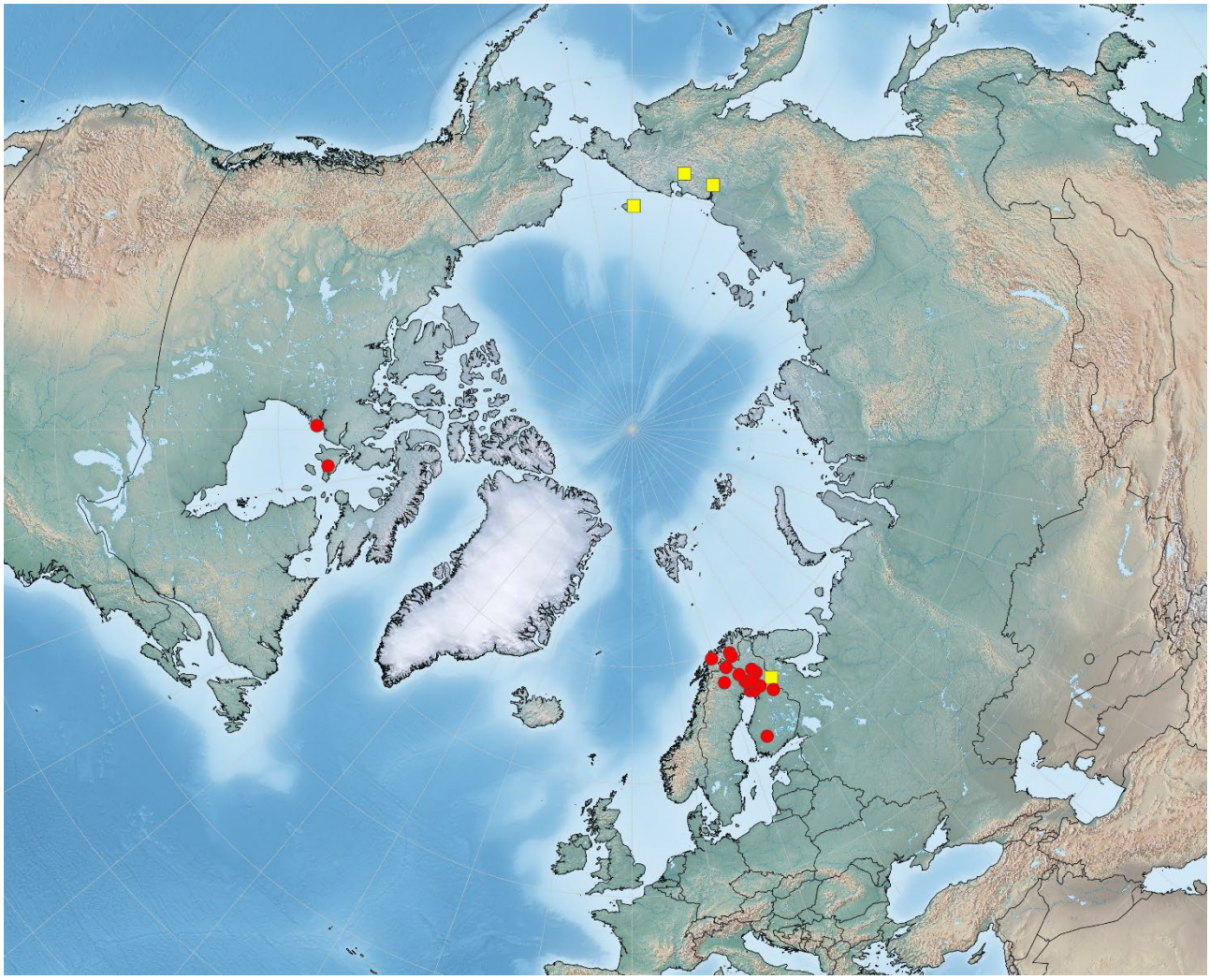
Demicyclic form – I-II-III. Aecia often lacking, hypophyllous or amphigenous, also on the sepals and stems, light yellow, occasionally mixed with some clavate to capitate paraphyses, 49-70 × 13-17 µm, wall hyaline, 1.5-2.5(-3.5) µm thick at apex. Spores subglobose to obovoid, (16-)19-28(-33) × (13-)15-22(-25) µm, wall 1-1.5(-1.8) µm thick, densely verrucose with round warts, warts 0.3-0.5 µm high. **Uredinia** often lacking, hypophyllous, small, roundish, yellowish, mixed with clavate to capitate paraphyses, sometimes abundant, 45-80 × 14-21 µm, wall 2.5-6.5 µm thick at apex. Spores subglobose to ellipsoid, 18-27 × 14-21 µm, wall hyaline, 1-1.3 µm thick, echinulate, pores inconspicuous. **Telia** subepidermal, hypophyllous, also epiphyllous, sometimes also on the sepals and stems, small, more or less confluent forming flesh-coloured, later dark brown to blackish crusts. Spores 1-celled, ellipsoid to cylindrical, 30-52(-57) × 7-18 µm, wall subhyaline, later yellow-brown, 0.7-1.7(-2) µm thick, smooth, not thickened at apex, pore inconspicuous.

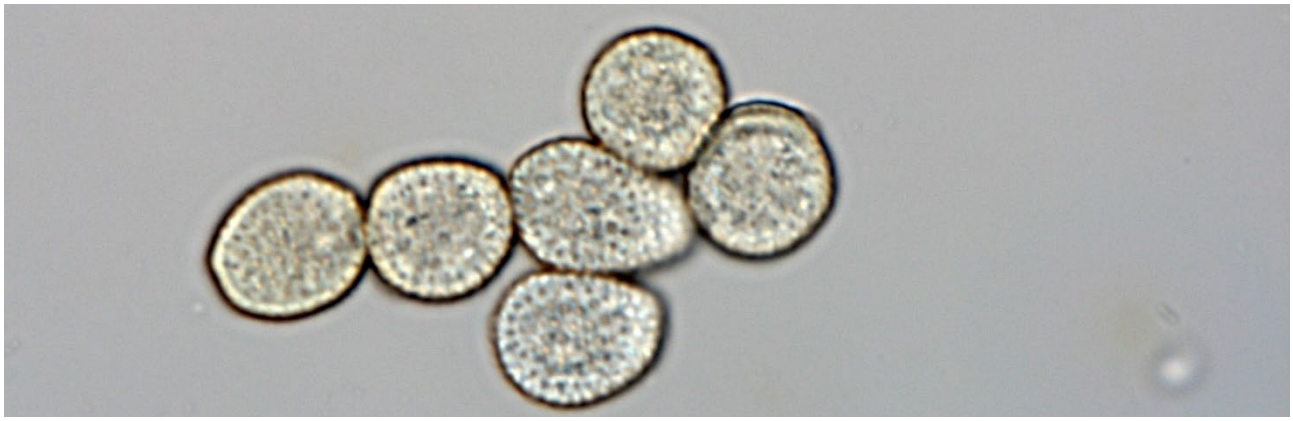
Host plant

I-II-III, **Saxifragaceae:** *Saxifraga hirculus.*

Distribution

Arctic-boreal; circumpolar; type 6; recorded from arctic CAN, NO, SE, FI, and RU.





Melampsora: Melampsoraceae: Pucciniales

Melampsora lapponum **J. Lind; C-F-153980; Sweden**

Melampsora lapponum Lindf.

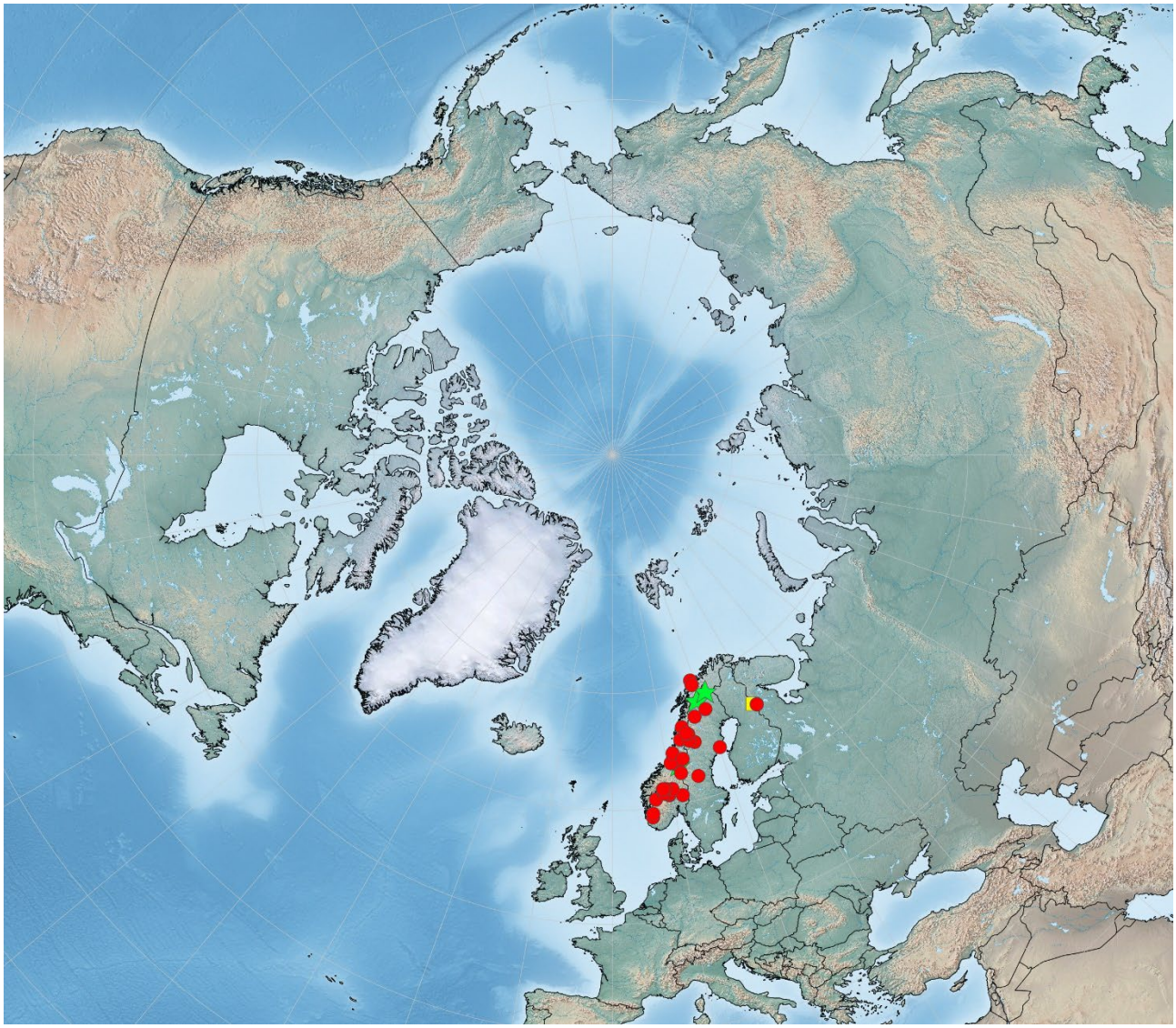
Macrocyclic hetereuform – I / II-III. Spermogonia not described. **Aecia** usually hypophyllous, occasionally epiphyllous. Spores ellipsoid, 19-27 × 18-20 µm, wall hyaline, up to 3 µm thick, very densely and very finely verrucose. **Uredinia** hypophyllous, diameter 0.25 mm, pulverulent, yellow, hyaline, surrounded with capitate paraphyses, 1-4 µm thick, capita 15-30 µm wide, except the outermost paraphyses, which are thin-walled, small and clavate. Spores globose to ellipsoid, yellow, 20-21 × 15-16 µm. **Telia** subepidermal, usually epiphyllous, diameter 0.25-0.5 mm, dark brown. Spores 1-celled, prismatic, ends rounded, 30-50 × 6-12 µm, wall brown, thin, smooth, pore indistinct.

Host plants

I, **Violaceae:** *Viola epipsila*, *Viola palustris*, and *Viola suecica.*
II-III, **Salicaceae:** *Salix lapponum.*

Distribution

Alpine and possibly slightly arctic-boreal; Eurasian; type 15; generally following *Salix lapponum*; recorded from the alpine Scandinavian Mts. (NO, SE, FI, RU), but not from the Alps.



Hyalopsora: Pucciniastraceae: Pucciniales

Hyalopsora aspidiotus **HK 18.227 (micro Fungi Ex. Suec. 1209a; C-F-156059); mat. lost**

Hyalopsora aspidiotus (Peck) Magnus

Syn.: *Hyalopsora polypodii-dryopteris* (Moug. & Nestl.) Magnus; *Uredo polypodii* J. Schröt.

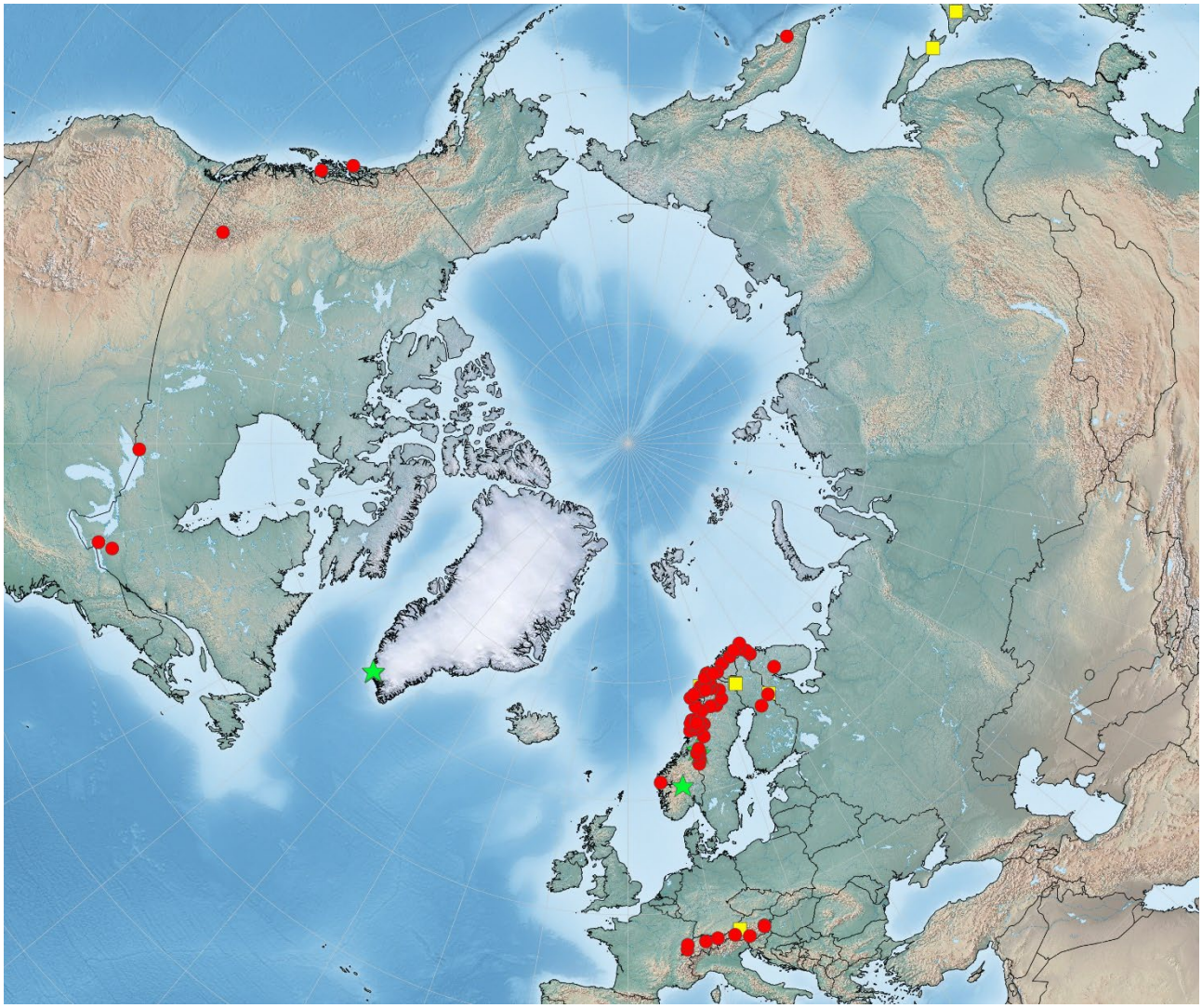
Macrocyclic hetereuform – [0-I] / II-(III). Spermogonia hypophyllous or amphigenous on first-year needles, subepidermal, on round, light yellow or yellow spots, in 2 rows on both sides of the midrib. **Aecia** hypogenous or amphigenous on yellowish first-year needles, 0.2-1 mm high, diameter 0.2-0.7 mm, ± cylindrical, hyaline, peridium delicate but not evanescent. Spores subglobose to broadly ellipsoid, 21-24 × 16-19 µm, wall hyaline, thin, very finely and densely verrucose. **Uredinia** subepidermal, most hypophyllous, also epiphyllous, mostly on yellow spots, scattered or in loose clusters, often covering the whole surface, round, diameter 0.2-0.5 mm, initially covered by a poorly developed peridium and epidermis, later naked and surrounded by the epidermis, somewhat pulverulent, golden yellow. Spores of 2 types (but transitions occur): (i) ellipsoid, ovoid, oblong or pyriform, 25-40 × 16-26 µm, wall hyaline, 1-2 µm thick, smooth or inconspicuously verrucose, pores 4, equatorial, inconspicuous, (ii) obovoid, 36-72 × 30-40 µm, wall hyaline, 2.5-3.5(-7) µm thick, thicker at the edges, smooth or very finely verrucose, pores 6-8, scattered (in literature often referred to as amphispores). **Telia** probably often lacking, hypophyllous, on yellow spots, often covering the whole surface. Spores germinating readily, intracellular in the epidermis cells, in dense clusters, angular, (2-)3-5(-7)-celled, 20-35 × 20-28 µm, wall hyaline, 1 µm thick, smooth.

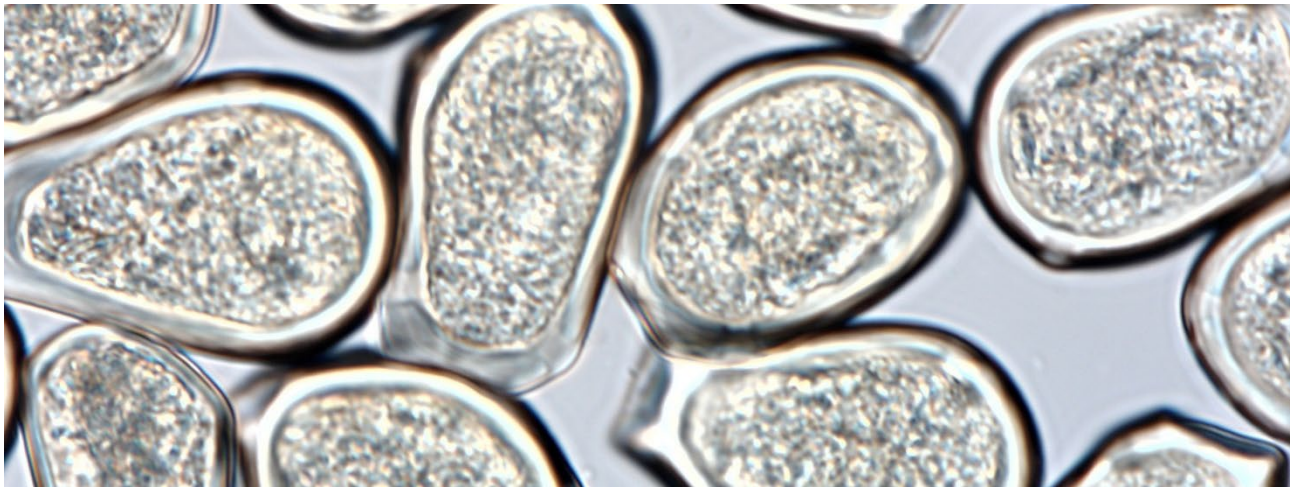
Host plants

[0-I, **Pinaceae:** *Abies* species, not included by definition; change of host not obligatory**]**
II-III, **Woodsiaceae:** *Gymnocarpium dryopteris*.

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic GR, NO, and FI, and from alpine regions of the Alps (FR, CH, AT), Dovre (NO), the Scandinavian Mts. (NO, SE), Sakhalin and Kamchatka (RU), and Hokkaido (JP).





Melampsorella: Pucciniastraceae: Pucciniales

Melampsorella elatina HK 18.090; C-F-111268

Melampsorella elatina (Alb. & Schwein.) Arthur

Syn.: *Melampsorella caryophyllacearum* (DC.) J. Schröt.

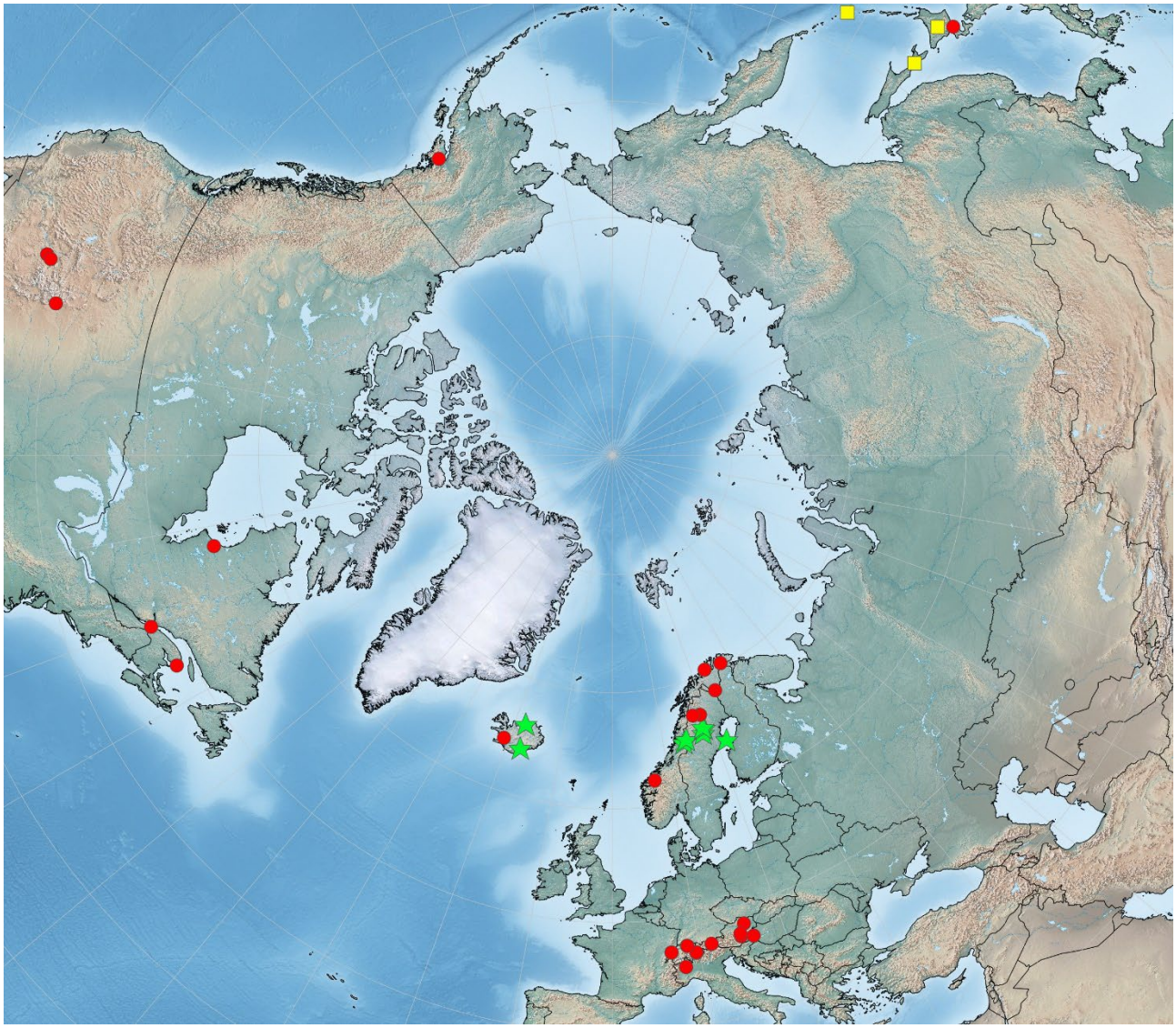
Macrocyclic hetereuform – [0s-Is] / IIs-(IIIg). Systemic with witches' brooms and trunk swellings. **Spermogonia** systemic, mostly epiphyllous, also amphigenous, subcuticular, honey yellow. **Aecia** systemic, hypophyllous, in 2 rows at both sides of the middle vein, initially covered by the epidermis and 2 layers of parenchymatous host cells, then erupting, hemispherical to short cylindrical, 0.4-1 × 0.2-0.8 mm, pale orange or red-yellow, peridium hyaline, torn, soon irregularly dehiscent. Spores subglobose or broadly ellipsoid, somewhat angular, orange-yellow, 16-30 × 14-20 µm, wall hyaline, 1-2 µm thick, densely and finely verrucose. **Uredinia** systemic, hypophyllous, rarely epiphyllous or on the petioles, scattered or somewhat clustered, occasionally covering the whole surface, round, diameter 0.1-0.4 mm, often appearing through the stomata, bullate, yellow or orange-yellow, peridium firm, hemispherical, opening with a pore. Spores ellipsoid, obovoid or pyriform, 16-30 × 12-21 µm, wall hyaline or pale yellow, 1-1.5 µm thick, distantly echinulate, pores 2-3, short pedunculate. **Telia** rare or lacking, hypophyllous, rarely epiphyllous, often covering the whole surface, which is discoloured white to pale red. Spores germinating readily, 1(-2)-celled, intracellular within the epidermis cells, subglobose, ellipsoid or short cylindrical, sometimes angular, diameter 12-25 µm, wall hyaline or pale yellowish, thin, smooth.

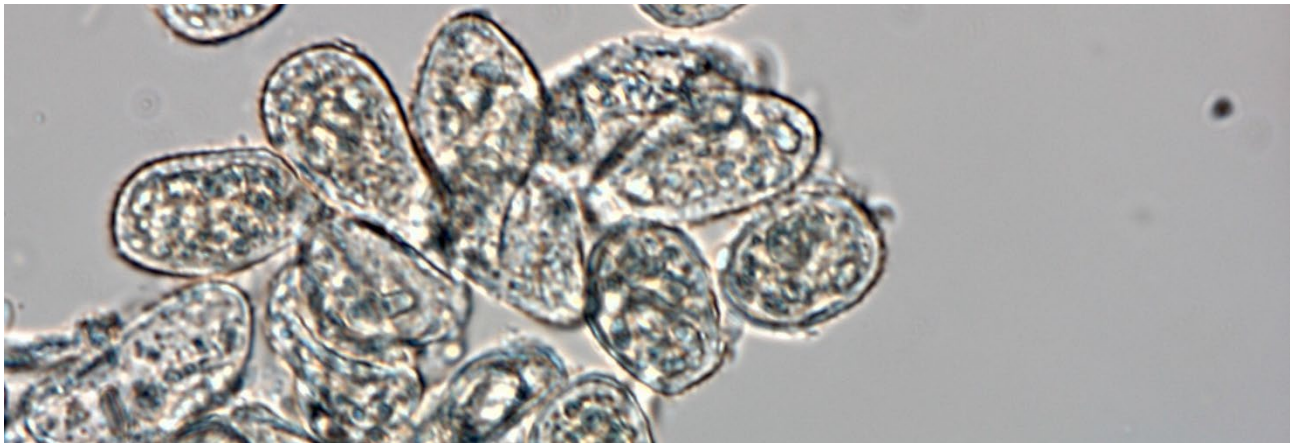
Host plants

[0-I, **Pinaceae:** *Abies* species, by definition not included; change of host not obligatory**]**
II-III, **Caryophyllaceae:** *Cerastium** and *Stellaria*.* **III** is not found in Norway.

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic IS, NO, and FI, and from the alpine Rocky Mts. (AK, USA), Newfoundland (CAN), the Alps (FR, CH, AT, IT), Dovre (NO), the Scandinavian Mts. (SE), Sakhalin (RU), and Hokkaido (JP).





Melampsoridium: Pucciniastraceae: Pucciniales

Melampsoridium betulinum **HK 17.295 (photo SAE); C-F-151746; Iceland**

Melampsoridium betulinum (Pers.) Kleb.

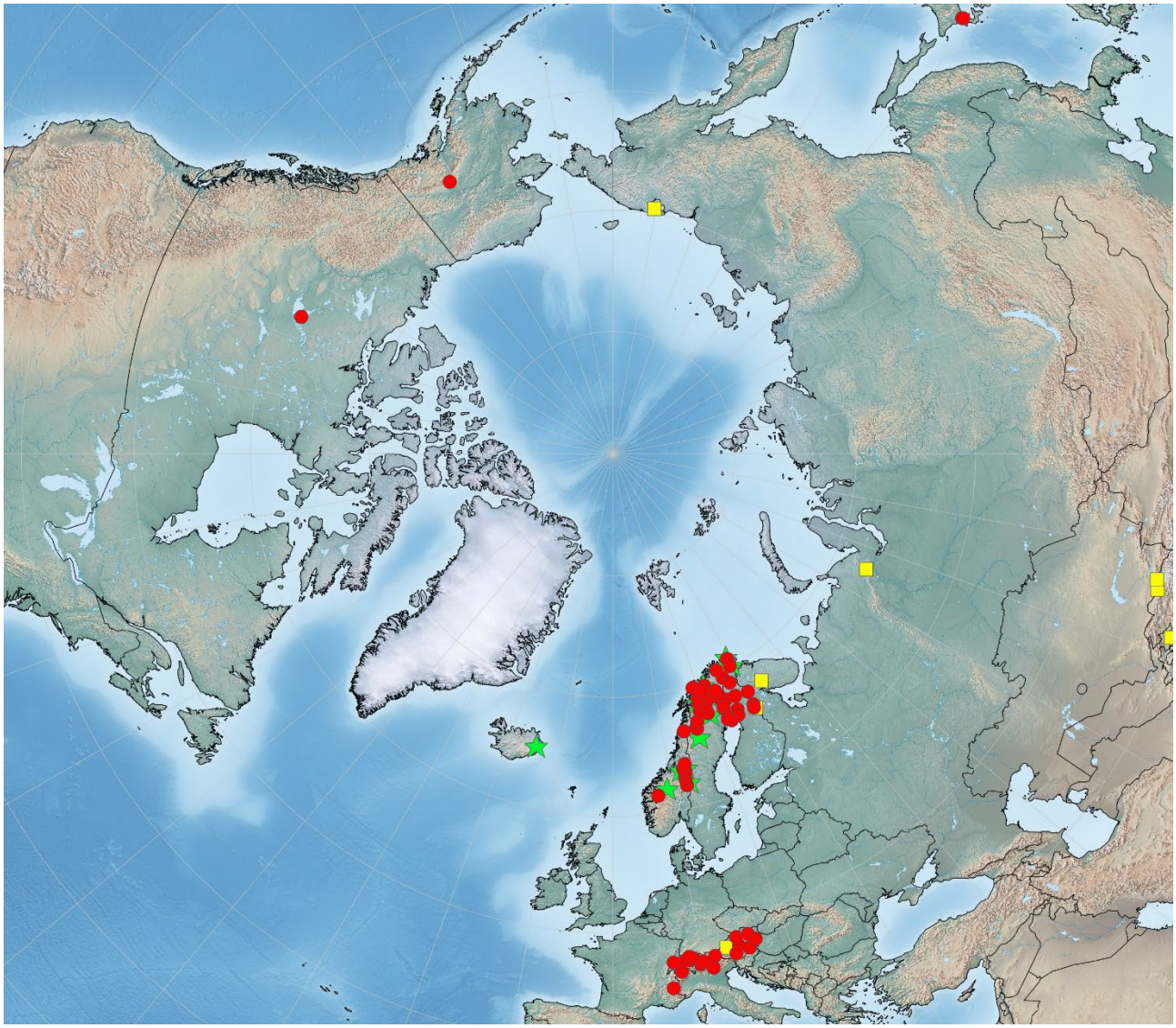
Macrocyclic hetereuform – [0-I] / II-III. Spermogonia amphigenous, abundant, pale yellow. **Aecia** hypophyllous, scattered or in 2 rows on each side of the midrib, peridium light red-orange, later white, 0.1-1.5 × 0.3-1 mm, 0.3-0.6 mm high. Spores 14-24 × 11-18 µm, wall 1-2 µm thick, densely and finely verrucose. **Uredinia** hypophyllous, opposite to yellow spots, scattered, diameter 0.1-0.5 mm, peridium firm, yellow, opening with a pore, ostiolar cells 23-30 µm long. Spores subcylindrical, one end rounded and the other tapering, 25-36 × 10-17 µm, wall hyaline, 1-1.5 µm thick, distantly echinulate/verrucose but smooth at the broader end (1000×), pores 4-6, at each end 2-3. **Telia** hypophyllous, scattered, often covering the whole surface, orange, later yellow-brown. Spores 1-celled, prismatic, 30-52 × 7-16 µm, wall hyaline, 1 µm, at apex 2 µm thick, smooth.

Host plants

[0-I, **Pinaceae:** *Larix* species, by definition not included; change of host not obligatory**]**
II-III, **Betulaceae:** *Betula*.*

Distribution

Arctic-alpine-boreal-temperate; cosmopolitan;
type 5; recorded from arctic AK, CAN, IS, NO, SE, FI, RU, and from alpine regions of the Alps (DE, FR, CH, AT, IT), Dovre (NO), the Scandinavian Mts. (SE), the Urals (RU), C-Asia, and Hokkaido (JP).



Naohidemyces: Pucciniastraceae: Pucciniales

Naohidemyces vaccinii **L. & H. Roivanen; C-F-155933; Finland**

Naohidemyces vaccinii (Jørst.) S. Sato, Katsuya & Y. Hirats. ex Cummins & Y. Hirats.

Syn.: *Pucciniastrum vaccinii* (Wint.) Jørst.; *Thekopsora vaccinii* (Wint.) Hirats.;
P. myrtilli (Schum.) Arth.; *T. myrtillina* P. Karst.; *Melampsora vacciniorum* (Link) Schröt.

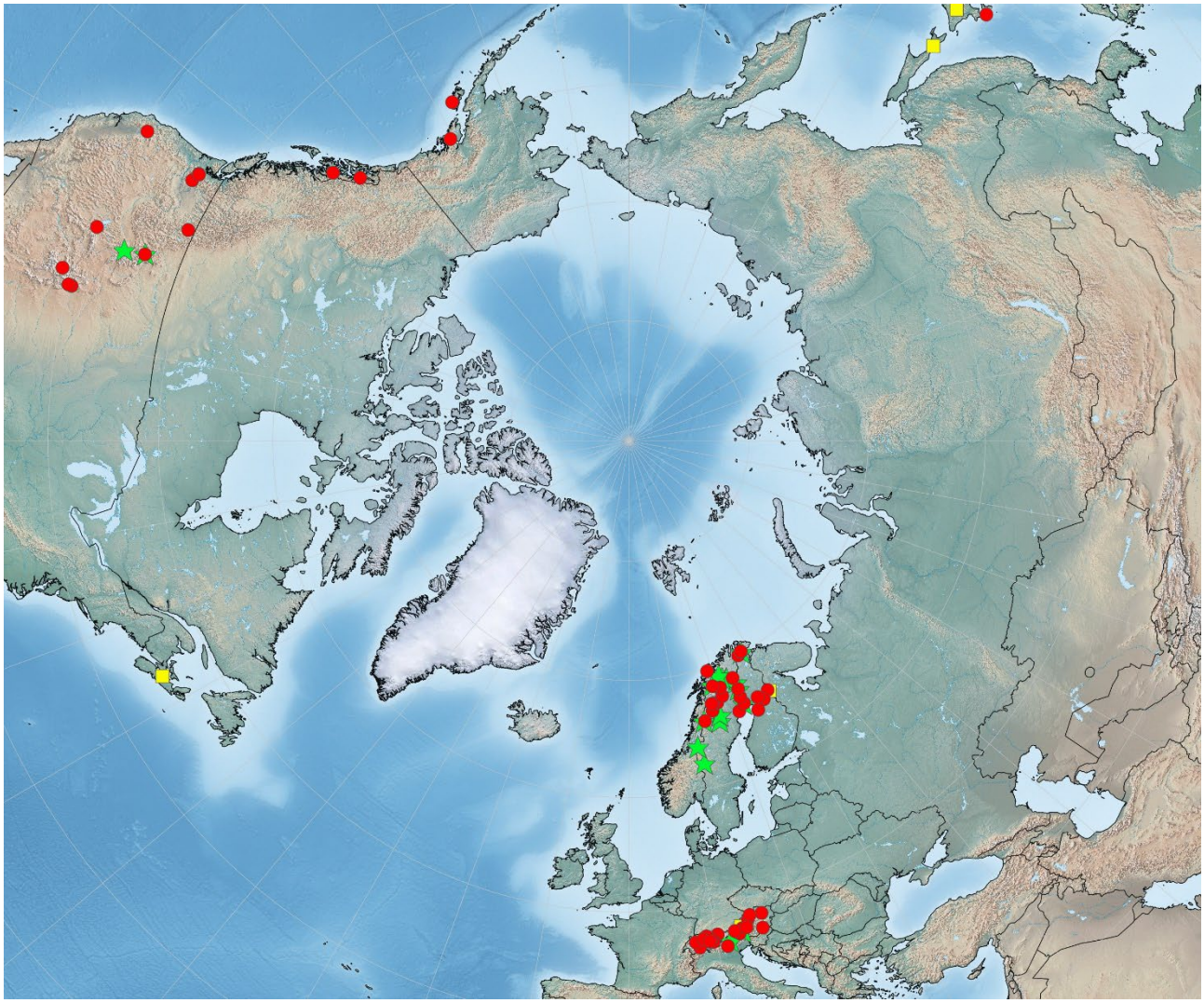
Macrocyclic hetereuform – [0-I] / II-(III). **Spermogonia** hypophyllous, occasionally epiphyllous, abundant, conspicuous. **Aecia** hypophyllous, in 2 rows on yellow spots, and on the cones, diameter 0.2-0.3 mm, 0.5-1 mm high. Spores subglobose or broadly ellipsoid, 18-27 × 15-21 µm, wall hyaline, 1-1.5 µm thick, finely verrucose. **Uredinia** hypophyllous, scattered or in loose groups, diameter 0.1-0.2 mm, pustulate, round, peridium hemispherical, blister-like, long covered by the epidermis, opening with a central pore, yellow-red, later pale yellow, mixed with rudimentary paraphyses. Spores obovoid or ellipsoid, somewhat angular, 16-27(-38) × (10-)12-22(-27) µm, wall hyaline, 1-2 µm thick, finely echinulate. **Telia** rare, hypophyllous on old fallen leaves, small, forming brown crusts. Spores intracellular within the epidermis cells, 1-4-celled, oblong or columnar, 14-17 × 7-12 µm, wall hyaline or subhyaline, 1 µm thick, smooth, pedicel lacking.

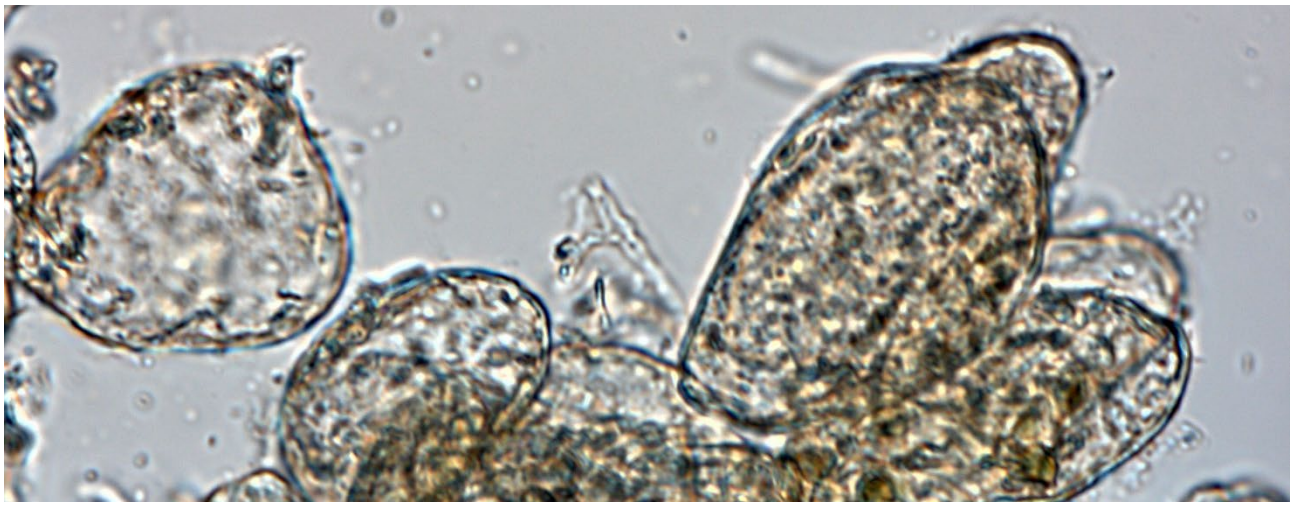
Host plants

[0-I, **Pinaceae:** *Tsuga* in North America, by definition not included; change of host not obligatory**]**
II-III, **Ericaceae:** *Vaccinium* species, e.g. *V. membranaceum*, *V. myrtillus*, *V. oxycoccos*, *V. uliginosum*, and *V. vitis-idaea.*

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic AK, CAN, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (USA), the Alps (CH, AT, IT), the Scandinavian Mts. (FI, SE), Sakhalin (RU), and Hokkaido (JP).





Pucciniastrum: Pucciniastraceae: Pucciniales

Pucciniastrum epilobii **O. Davidsson 136; C-F-8983; Iceland**

Pucciniastrum epilobii G.H. Otth

Syn.: *Melampsora epilobii* Fuckel

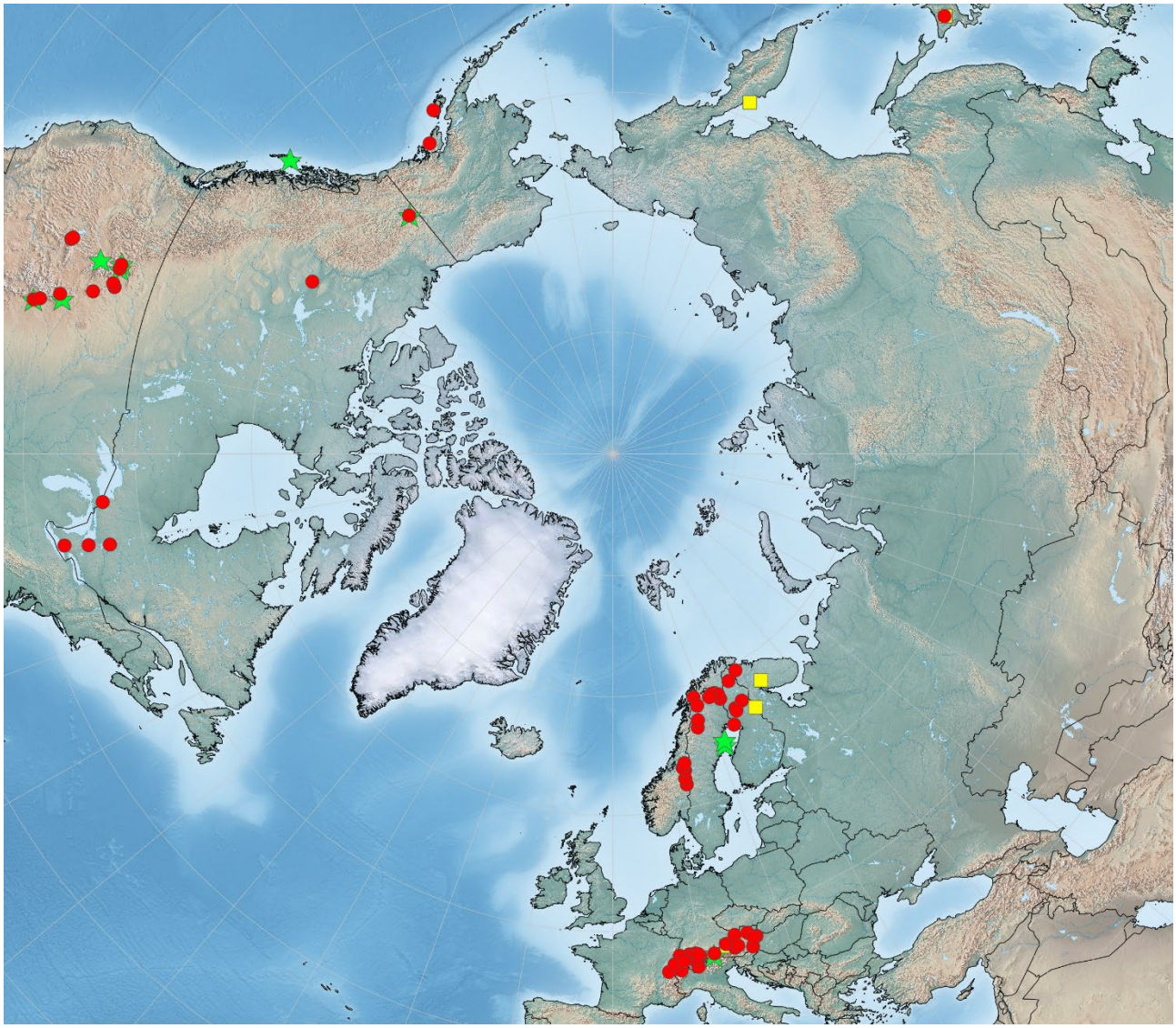
Macrocyclic hetereuform – [0-I] / II-III. Spermogonia hypophyllous, abundant, inconspicuous. **Aecia** hypophyllous, usually in 2 rows, 1 mm high, diameter 0.25-0.3 mm, cylindrical, hyaline or whitish. Spores irregular-obovoid, 13-21 × 10-14 µm, wall hyaline, 1-1.5 µm thick, finely verrucose except for a small, smooth zone. **Uredinia** mainly hypophyllous, rarely epiphyllous and on the stems, scattered or in groups, on red or yellow spots, round, diameter 0.1-0.25 mm, bullate, long covered by a thin, subglobose peridium, opening with a central pore, then pulverulent, orange-yellow, later pale yellow. Spores ovoid or ellipsoid, 14-24 × 10-17 µm, wall hyaline, 1-2 µm thick, distantly, finely and shortly echinulate, pores indistinct. **Telia** subepidermal, hypophyllous, rarely epiphyllous or on the stems, scattered or in small groups, confluent into extended crusts, flat, diameter 0.1-0.3 mm, reddish brown, later blackish brown. Spores between the epidermis cells, 2-4-celled, the 2-celled 17-35 × 7-15 µm, wall brown or chestnut brown, 1-1.5 µm, at apex 3 µm thick, smooth, pore 1, supraequatorial, pedicel lacking.

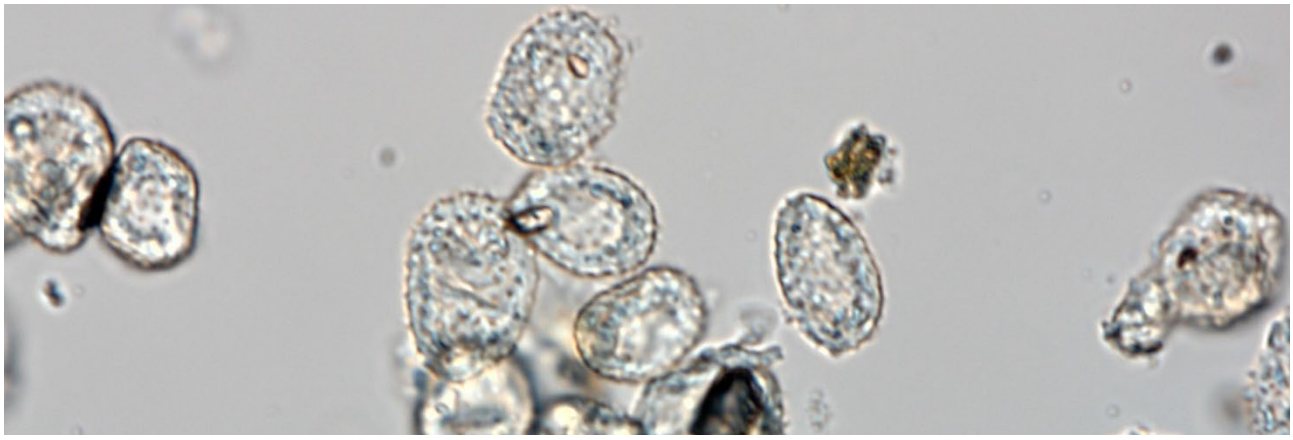
Host plants

[0-I, **Pinaceae:** *Abies* species, by definition not included; change of host not obligatory**]**
II-III, **Onagraceae:** *Chamaenerion angustifolium*, *C. latifolium*, *Epilobium adenocaulon*, *E. halleanum*, *E. alsinifolium*, *E. anagallidifolium*, *E. ciliatum, E. collinum*, *E. arcticum*, *E. hornemannii*, *E. lactiflorum*, *E. montanum*, *E. palustre*, *E. parviflorum*, *E. roseum*, and *E. tetragonum*.
In Norway, telia are only known from *C. angustifolium* and *E. palustre*.

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic AK, CAN, NO, SE, FI, and RU, and from alpine regions of the Alps (FR, CH, AT), the Scandinavian Mts. (SE), Kamchatka (RU), and Hokkaido (JP).





Pucciniastrum: Pucciniastraceae: Pucciniales

Pucciniastrum pyrolae **H. H. Bruun; C-NHMD001862566**

*Pucciniastrum pyrolae** (J.F. Gmel.) J. Schröt.

Syn.: *Melampsora pyrolae* (J.F. Gmel.) J. Schröt.; *Thekopsora pyrolae* (J.F. Gmel.) J. Schröt.

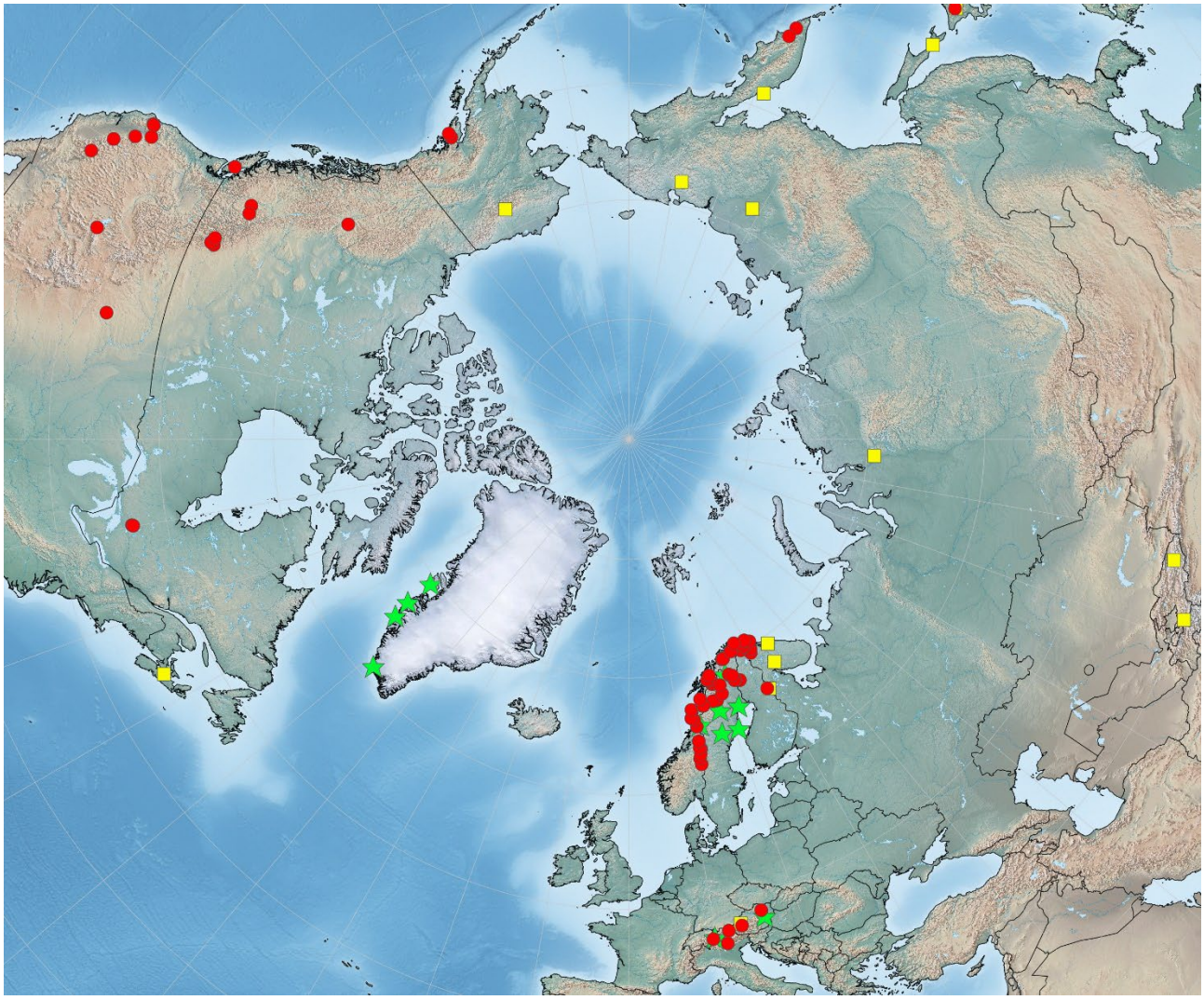
Hemicyclic form – II-(III). Uredinia hypophyllous, also epiphyllous, occasionally on the petioles, opposite leaf side forming yellow, red or red-brown spots, scattered or in small groups, diameter 0.1-0.4 mm, pustulate, long covered by the epidermis, brown-yellow, peridium hemispherical, firm, opening with a pore. Spores ellipsoid, obovoid or clavarioid, 23-40 × 11-19 µm, wall hyaline or subhyaline, 1-2.5 µm thick, finely verrucose/echinulate, sometimes slightly more pronounced at apex, pores inconspicuous. **Telia** rarely formed, subepidermal, hypophyllous, inconspicuous. Spores 1-celled, elongate or prismatic, hyaline, 24-28 × 10-12 µm, wall hyaline, 1 µm thick, smooth, pore inconspicuous.

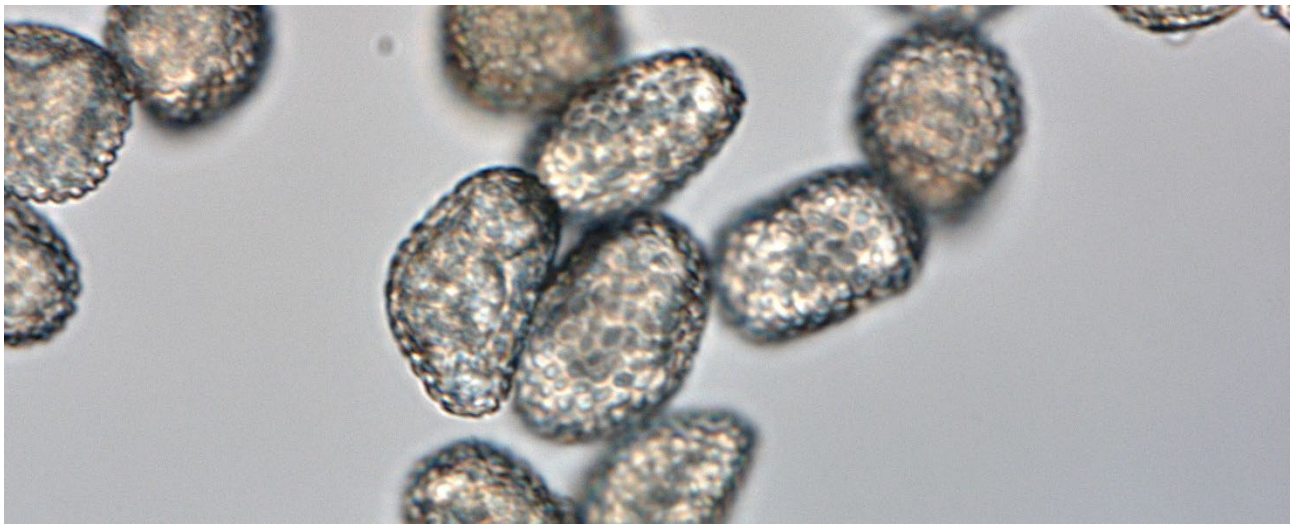
Host plants

II-III, **Pyrolaceae:** *Moneses uniflora*, *Pyrola* species, e.g. *Pyrola chlorantha*, *P. elliptica*, *P. media*, *P. minor*, *P. picta*, and *P. rotundifolia*.

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic AK, CAN, GR, NO, SE, FI, and RU, and from alpine regions of the Alps (CH, AT, IT), the Scandinavian Mts. (SE), the Urals, Kamchatka, and Sakhalin (RU), C-Asia, and Hokkaido (JP).





Pucciniastrum: Pucciniastraceae: Pucciniales

Pucciniastrum sparsum **L. Holm 407, Fungi Ex. Suec. 1530; C-F-155511; Sweden**

Pucciniastrum sparsum (G. Winter) E. Fisch.

Syn.: *Thekopsora sparsa* (G. Winter) Magnus

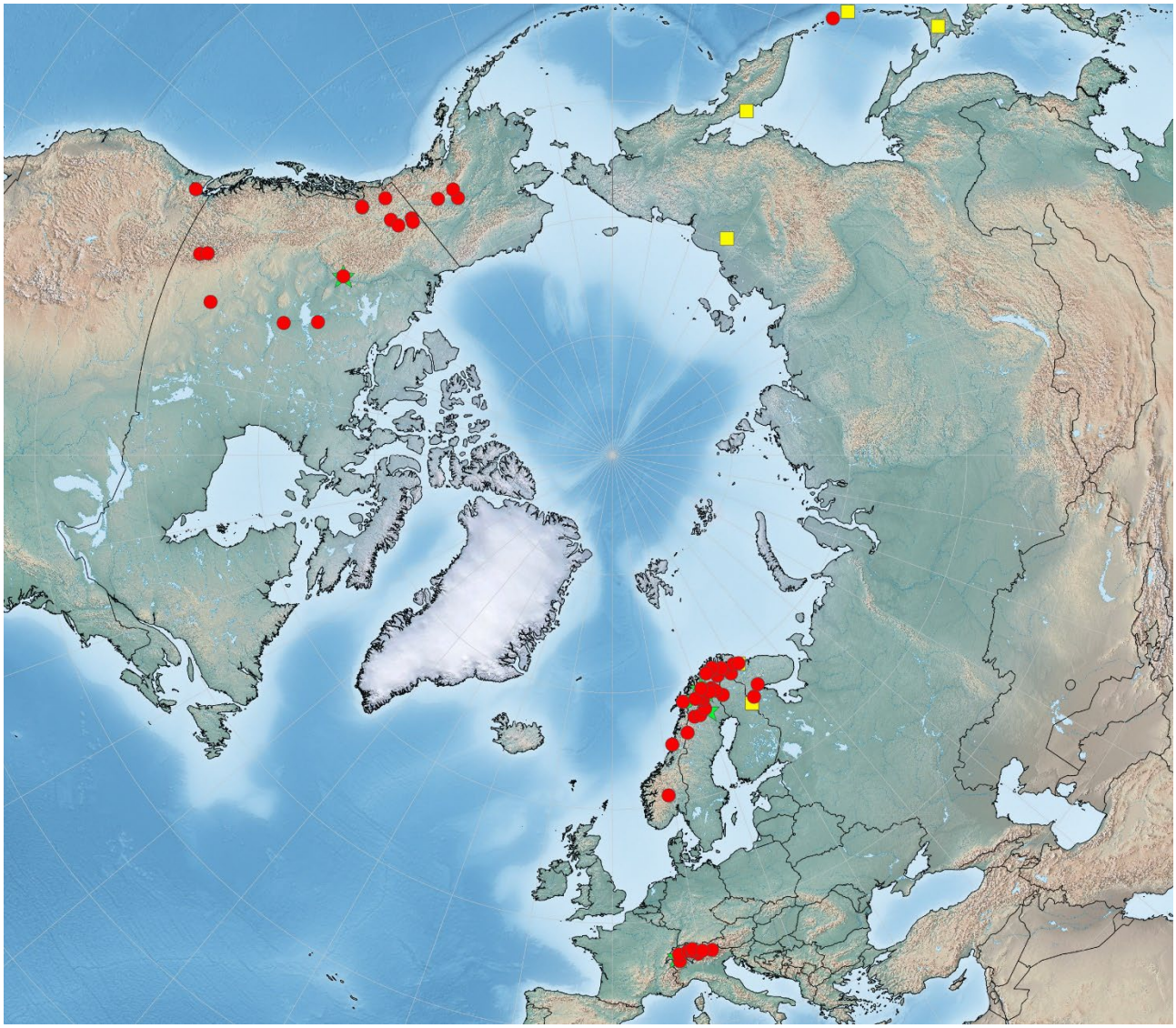
Macrocyclic hetereuform – [0-I] / II-III. Spermogonia amphigenous, inconspicuous. **Aecia** on first-year needles on slightly discoloured spots, 0.5 mm high, columnar, flesh-red. Spores subglobose to ellipsoid, orange-yellow, 21-32 × 18-25 µm, wall hyaline, 1 µm thick, densely verrucose except for a small, linear, smooth zone. **Uredinia** hypophyllous, also amphigenous, opposite to carmine red spots, gregarious on discoloured spots or scattered, diameter 0.3-0.5 mm, pustulate, round or irregular, surrounded by a peridium which opens with a pore, yellow or orange. Spores oblong-clavarioid or ellipsoid, 28-45(-50) × 12-20 µm, wall hyaline, 0.5-2 µm thick, sparsely and finely to clearly verrucose/echinulate. **Telia** subepidermal, epiphyllous or amphigenous, inconspicuous. Spores intracellular in the epidermis cells, 4-8-celled with crosswise septa, crowded, 24-35 × 18-35 µm, wall brown or cinnamon brown, 2 µm, at apex 6 µm thick, smooth, 1 apical pore in each cell, cap inconspicuous.

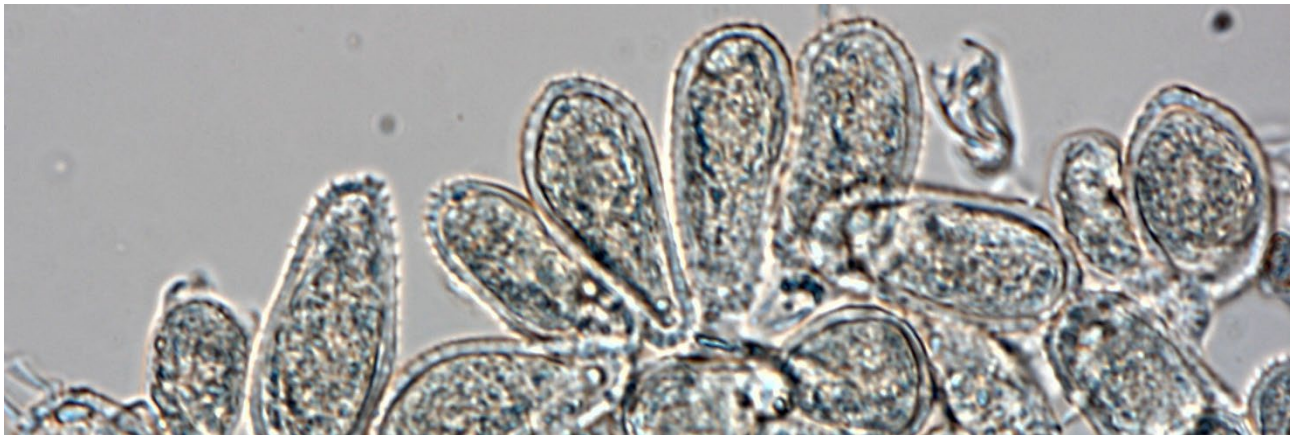
Host plants

[0-I, **Pinaceae:** *Picea abies*, by definition not included; change of host not obligatory**]**
II-III, **Ericaceae:** *Arctostaphylos uva-ursi*, *Arctous alpina*, and *A. rubra.*

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 5; recorded from arctic AK, CAN, NO, SE, FI, and RU, and from alpine regions of the Alps (CH, AT), Dovre (NO), the Scandinavian Mts. (SE), Kamchatka (RU), and Hokkaido (JP).





Arthuriomyces: Phragmidiaceae: Pucciniales

Arthuriomyces peckianus **T. Ulvinen; C-F-153931; Finland**

Arthuriomyces peckianus (Howe) Cummins & Y. Hirats.

Syn.: *Gymnoconia peckiana* (Howe) Trotter; *G. interstitialis* (Schltdl.) Lagerh.

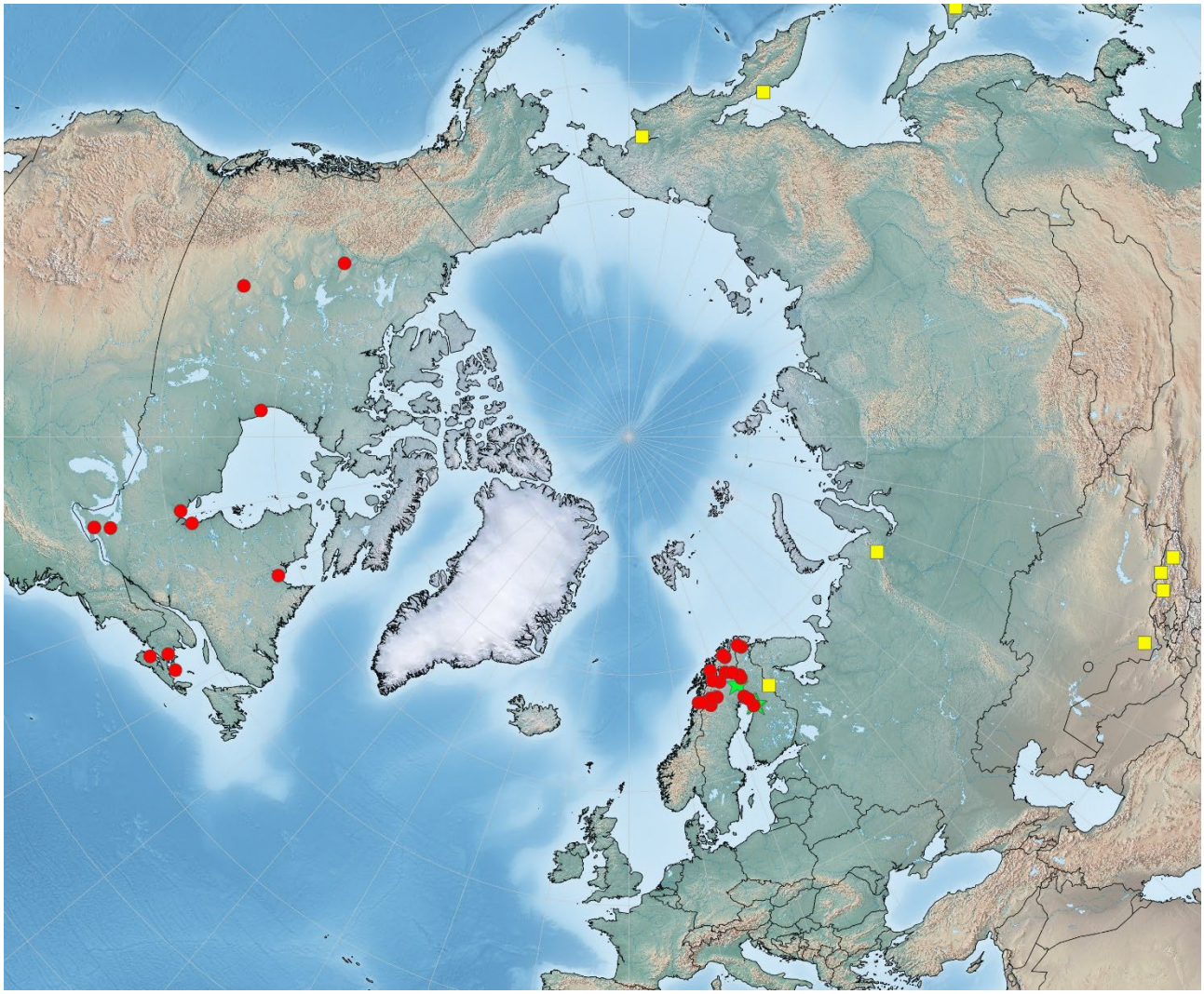
Demicyclic heteropsisform – 0-I-IIIs (also microcyclic form exists). Systemic incl. the roots, leaves smaller and paler. **Spermogonia** chiefly epiphyllous, abundant, scattered, prominent. **Aecia** chiefly hypophyllous, on dwarfed leaves and shoots, covering the whole or part of the surface, diameter 0.5-1.5 mm, initially covered by the epidermis, then surrounded by the ruptured epidermis and naked, somewhat pulverulent, golden yellow or red-yellow. Spores subglobose to ellipsoid, 19-38 × 16-34 µm, wall hyaline, 1.5-2 µm thick, finely verrucose, pores 6-10, scattered, inconspicuous. **Telia** hypophyllous on yellowish spots, scattered, not confluent, partially covered by the epidermis, then naked, pulverulent, dark brown or blackish brown. Spores 2-celled, ellipsoid or spindle-shaped, lower cell at lower pore somewhat protuberant, slightly or not constricted at septum, 30-45 × 18-28 µm, wall chestnut brown, 1.5-2 µm thick, smooth but around the pore a few hyaline warts, pore of upper cell apical, pore of lower cell supraequatorial to close to pedicel, both covered with a hyaline cap, with 1-6 warts around the pores, pedicel hyaline, short, fragile.

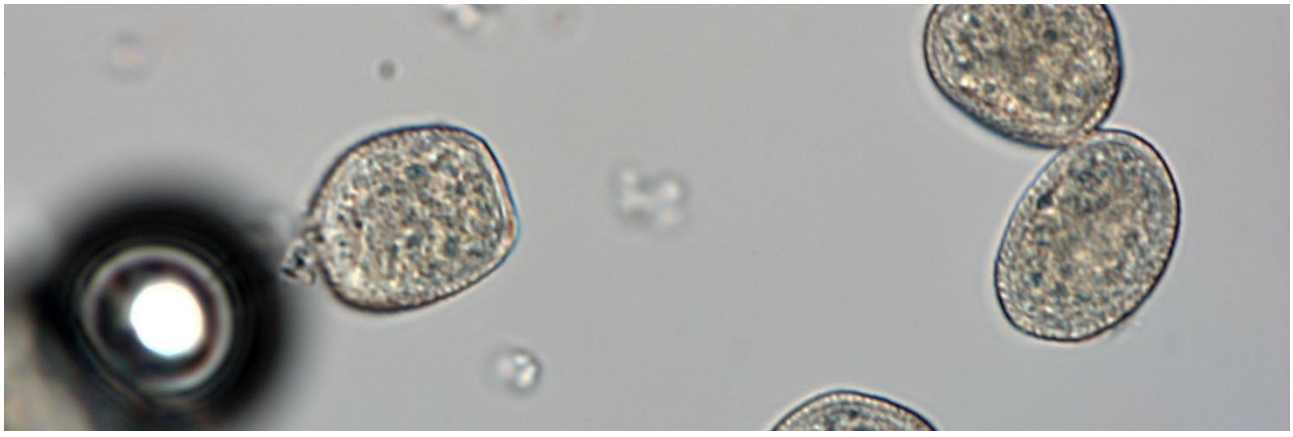
Host plants

0-I-III, **Rosaceae:** *Rubus allegheniensis*, *R. arcticus*, *R. idaeus*, *R. loganobaccus*, *R. nigrobaccus*, *R. occidentalis*, *R. pubescens*, *R. saxatilis*, *R. strigosus*, and *R. villosus.*

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic CAN, NO, SE, FI, and RU, and from alpine C-Asia, Kamchatka (RU), and Hokkaido (JP).





Phragmidium: Phragmidiaceae: Pucciniales

Phragmidium arcticum **J. Lind; C-F-155498; Sweden**

Phragmidium arcticum Lagerh.

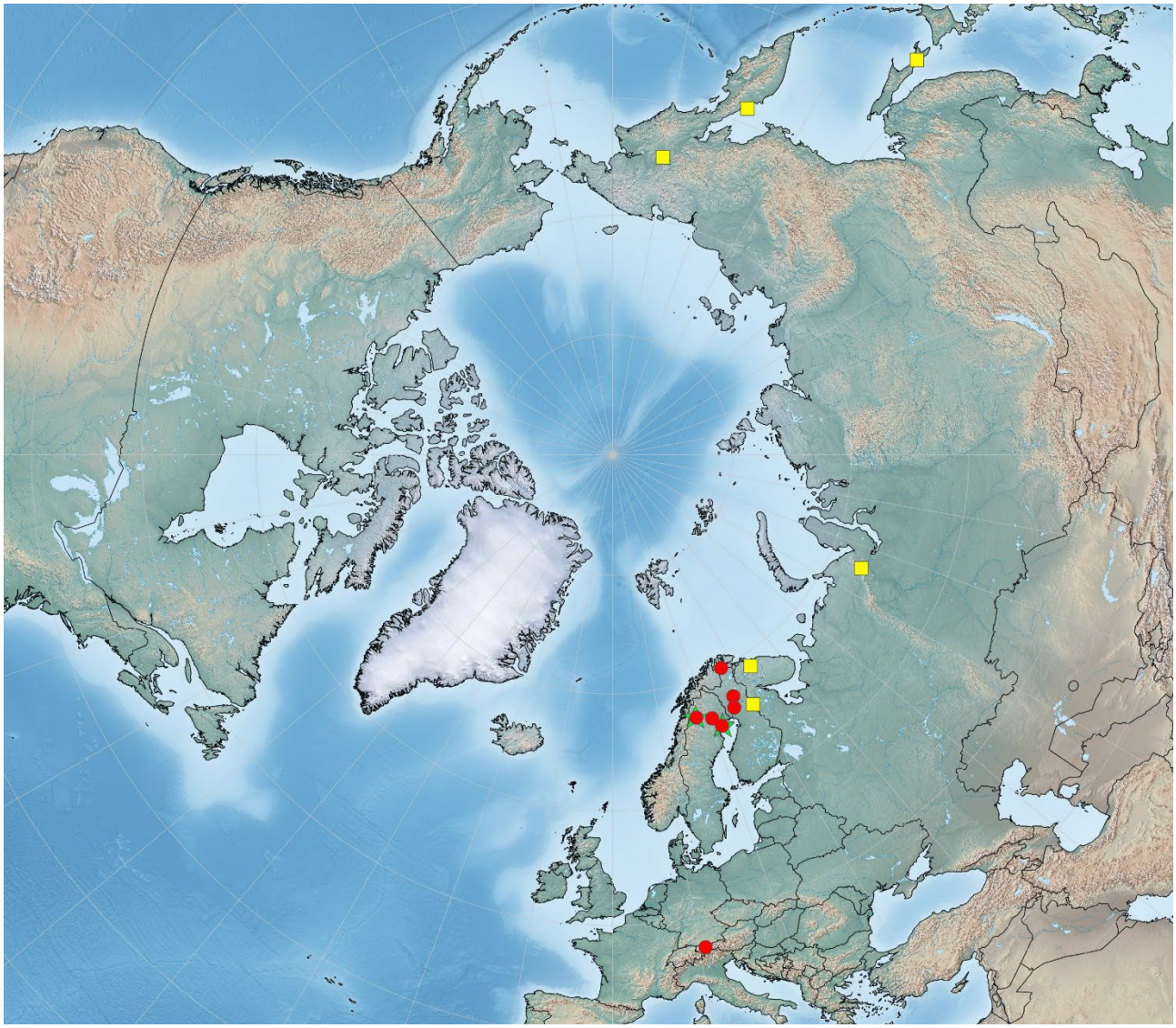
Demicyclic autopsis form – I-II-III. Aecia caeomoid, hypophyllous, at the veins somewhat elongate, clustered, with curved, gradually widened, up to 60 × 8-15 µm, hyaline paraphyses, with wall up to 7 µm thick at apex. Spores (16-)18-24(-27) × 14-20(-22) µm, wall hyaline, 0.5-0.8 µm thick, densely verrucose, warts irregular, labyrinthiform-tesselate, tops flat, 0.5-0.8(-1) µm high, 0.6-2.5(-3) × 0.8-7 µm, pores ca. 5-6, scattered, inconspicuous but occasionally 3.5-4.5 µm wide caps over pores inside the spores evident. **Uredinia** sparse, hypophyllous, scattered, round, small, punctate. Spores 16-24 × 12-17 µm, wall hyaline, 0.6-1 µm thick, densely and finely echinulate, spines ca. 0.6-0.8 µm high, 0.5-0.7 µm at 1-2.2 µm spacing, pores ca. 5-6, scattered, inconspicuous but occasionally caps over pores indicate their presence. **Telia** hypophyllous, scattered, diameter 0.1-0.3 mm, black. Spores 5-9(-10)-celled, nearly cylindrical, not or barely constricted at septa, 65-140(-155) × (22-)23-28(-30) µm, apiculus 2-12(-14) µm long, wall yellow, 2.2-3.5(-4) µm thick, wall densely verrucose, warts very irregular, 0.5-2.5 µm high, 0.8-3.8(-4.5) × up to 6(-9) µm, pores (2-)3(-4) per cell, more or less equatorial, pedicel 50-155 µm long, swelling moderately in basal half with dextrorsely helical striae crossing axis at 40-60 µm.

Host plants

I-II-III, **Rosaceae:** *Rubus arcticus*, *Rubus chamaemorus*, *Rubus pubescens*, and *Rubus saxatilis.*

Distribution

(Arctic-)alpine-boreal; Eurasian; type 9; recorded from arctic NO, FI, and RU, and from alpine regions of the Alps (AT), the Urals and Kamchatka (RU).



Phragmidium: Phragmidiaceae: Pucciniales

Phragmidium biloculare **J. A. Parmelee 4420, DAOM 130372; C-F-155095; Canada**

Phragmidium biloculare Dietel & Holw.

Hemicyclic form – II-III. Aecia caeomoid, hypophyllous and on the petioles and stems, on poorly defined coloured spots, scattered or in groups, diameter 0.5-1 mm, roundish, soon naked and surrounded by the ruptured epidermis, somewhat pulverulent, orange-yellow, later pale yellow. Spores subglobose to broadly ellipsoid, 20-30 × 15-23 µm. **Telia** hypophyllous and on the stems, initially between the aecia, later scattered irregularly, initially covered by the epidermis, soon naked and surrounded by the ruptured epidermis, diameter 0.5 mm, round or oblong, somewhat pulverulent, dull chestnut brown. Spores (1-)2(-3)-celled, ellipsoid, ends rounded, not constricted at septa, 30-40 × 19-26 µm, wall cinnamon brown, 3-4 µm thick, densely verrucose with hyaline, large tubercles, pores 3 in each cell, inconspicuous, coarsely verrucose, sometimes smooth, pedicel hyaline or subhyaline, about 0.5× spore length, tapering downward, firm, persistent.

Host plants

II-III, **Rosaceae:** *Potentilla crantzii* (*P. gelida*), *P. flabellifolia*, and *P. stipularis.*

Distribution

Alpine; North-American; type 14; recorded from the alpine Rocky Mts. (CAN, USA). Very rare or poorly recorded.

Phragmidium: Phragmidiaceae: Pucciniales

Phragmidium boreale **G. B. Cummins 84-39; S-F433040; USA (Wyoming)**

Phragmidium boreale Tranzschel

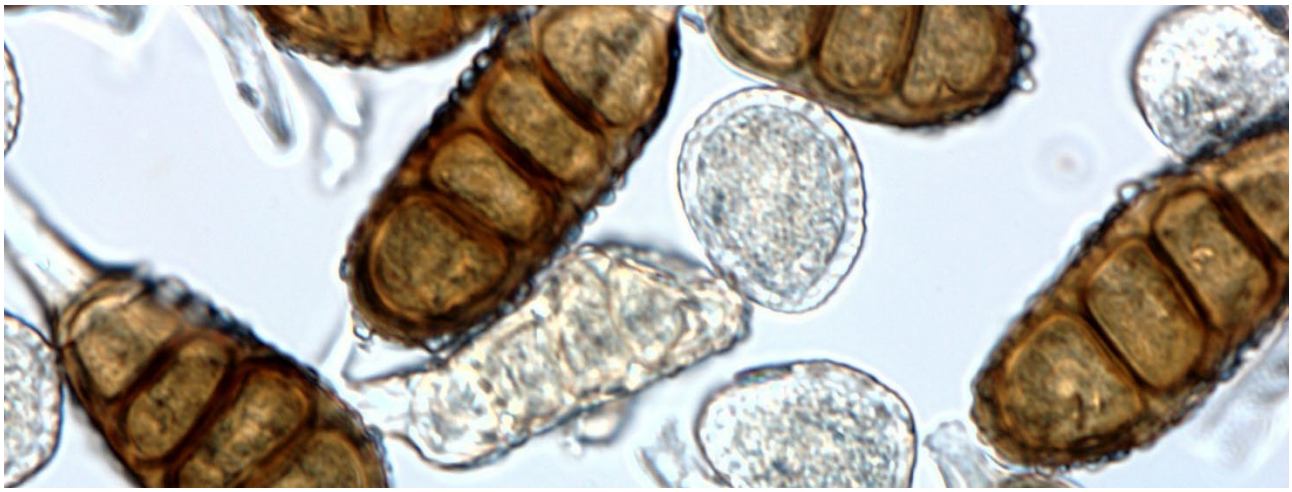
Macrocyclic auteuform – (0)-I-(II)-III. Spermogonia rarely formed. **Aecia** caeomoid, hypophyllous and diameter ca. 1 mm, or on the petioles and stems and 3-4 mm long, orange, paraphyses scarce or lacking. Spores ovoid, 20-30 × 15-22 µm, wall hyaline, 1.3-2.2 µm thick, echinulate, with spines 0.5-0.8 µm high and diameter 0.3-0.8 µm at (1-)1.3-3 µm spacing, pores indistinct, 6-8, scattered. **Uredinia** difficult to discern from aecia except when spores are pedicellate, scarce. **Telia** mainly hypophyllous, pulverulent, dark brown. Spores short-cylindrical, cylindrical or narrowly ellipsoid, (2-)4(-5)-celled, usually not or sometimes slightly constricted at septa, 34-65 × 18-28 µm, ends rounded, apiculus lacking, wall chocolate brown, 1.5-3.2(-3.7) µm thick, upper half smooth or finely and densely verrucose with warts 0.2-1.6 µm high and diameter 1.2-3.5 µm, lower half sparsely to densely verrucose with warts generally hemispheric, 0.5-2.2(-2.7) µm high and diameter 0.8-3.5(-4.5) µm, pores rather indistinct, 2-3 per cell, pedicel hyaline, 66-102 µm long but easily breaking and then seemingly short, 5-9 µm wide, tapering to 4.5-5.5 µm below.

Host plants

0-I-II-III, **Rosaceae:** *Potentilla diversifolia* and *P. stipularis.*

Distribution

Arctic-alpine; circumpolar; type 5; recorded from arctic Russia, and from the alpine Rocky Mts. (CAN, USA) and C-Asia.



Phragmidium: Phragmidiaceae: Pucciniales

Phragmidium fusiforme HK 21.023; C-F-159647; Germany

Phragmidium fusiforme J. Schröt.

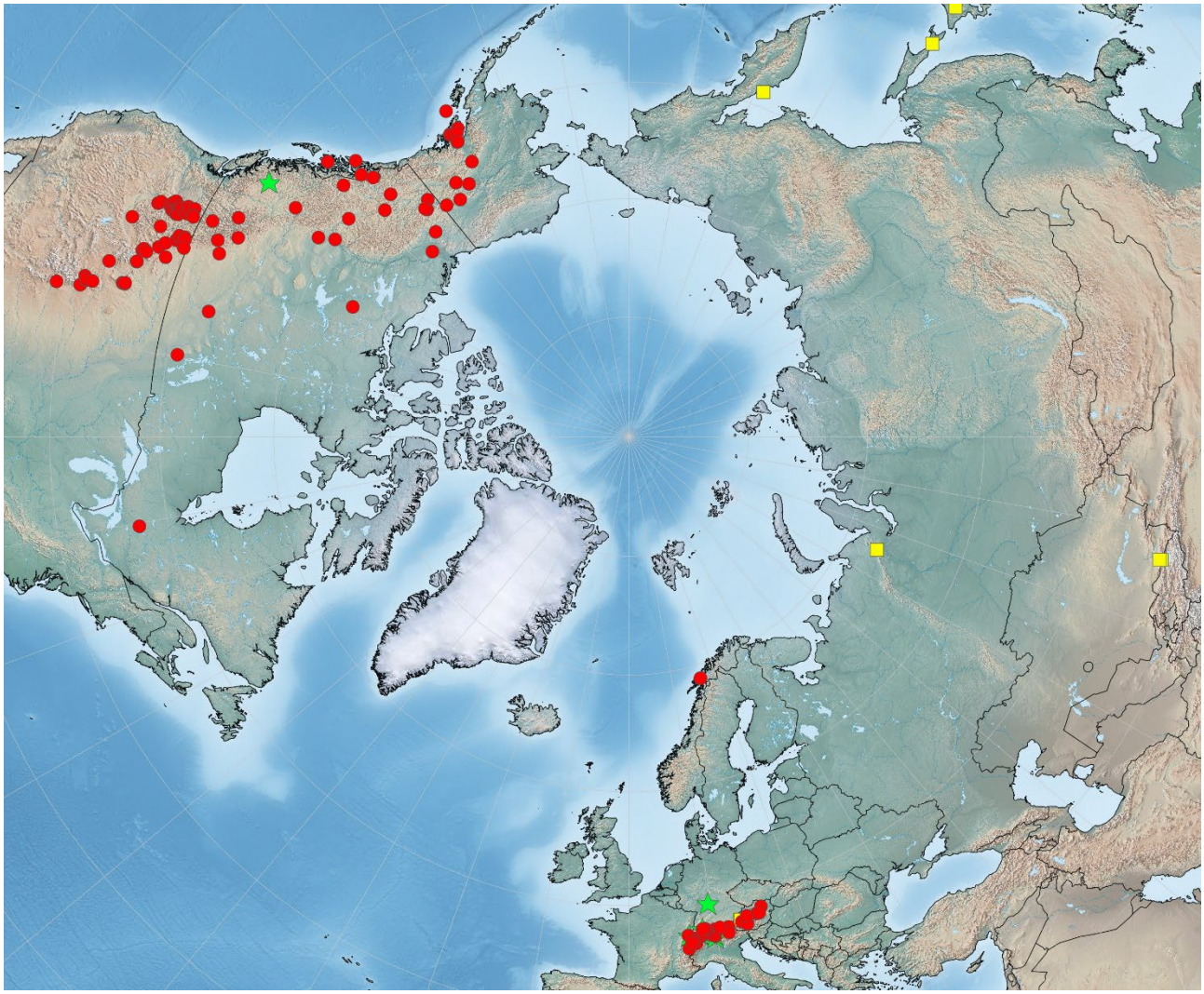
Macrocyclic auteuform – 0-I-II-III. Spermogonia subcuticular, epiphyllous, rarely hypophyllous, yellow-brown, inconspicuous. **Aecia** caeomoid, hypophyllous, also epiphyllous, on the petioles and fruits, on the veins and petioles remarkably lengthened, and on the petioles and fruits forming diameter >1 cm cushions, bright yellow fading to orange, paraphyses few to many, similar to those in uredinia. Spores catenulate, with conspicuous, ca. 5 µm long intercalary cells, subglobose to somewhat oblong, somewhat angular, 17-30 × 14-23 µm, wall hyaline, 1.5-3 µm thick, finely and distantly echinulate, spines 0.5-0.8 µm high and broad, pores (4-)6-9(-10), scattered, inconspicuous, but hemispherical, 1-1.8 µm high, diameter (1-)1.2-2.5(-2.8) µm, caps over pores inside the spores evident. **Uredinia** hypophyllous, punctate, small, light yellow, surrounded by many, incurved, hyaline, clavate, allantoid or capitate, 40-85 µm long paraphyses, near apex up to 20 µm wide, gradually changing to form teliospores. Spores nearly subglobose, obovoid or ellipsoid, hyaline or yellowish, 17-27(-28) × 14-23 µm, wall hyaline, 0.7-2 µm thick, densely and finely echinulate, spines (0.5-)0.6-0.8 µm high and diameter 0.5-0.7 µm, pores 6-9(-10), scattered, inconspicuous, but hemispherical, 0.5-1 µm high and diameter 2-3 µm, caps over pores inside the spores evident. **Telia** developing from the uredinia, black, paraphyses as in uredinia. Spores (4-)6-11(-13)-celled, ± fusoid, ellipsoid or cylindrical, not constricted at septa, 42-115(-125) × 20-34 µm, wall brown, 3-5(-6) µm thick, verrucose, with warts at base, brownish, 0.5-1(-1.5) µm high and 0.8-2.5(-3) µm broad, sometimes elongate and then up to 4.5 µm long, grading to usually smooth at apex, apex usually gradually tapering to an occasionally septate, (0-)2-11(-13) µm long apiculus, pores 2-4 in each cell, ± equatorial, pedicel hyaline except brown adjacent to spore attachment, (50-)60-160(-180) µm long, the lower half thickened to 15-26 µm, near the base again somewhat narrower, persistent, with steep dextrorse-helical striae crossing axis of pedicel at 10-30 µm.

Host plants

0-I-II-III, **Rosaceae:** *Rosa* sect. *Cinnamomeae*, e.g. *Rosa acicularis*, *R. amblyotis*, *R. majalis*, *R. nutkana*, and *R. pendulina* (*R. alpina*).

Distribution

Arctic-alpine-mountainous; circumpolar; type 1; recorded from arctic AK, CAN, and RU, and from alpine regions of the Rocky Mts. (CAN, USA), the Alps (DE, FR, CH, AT), the Urals, Verkhoyanskyi Mts., Kamchatka and Sakhalin (RU), C-Asia, and Hokkaido (JP). Also in Central Europe in the mountains.



Phragmidium: Phragmidiaceae: Pucciniales

Phragmidium ivesiae **W. G. & R. Solheim 2682; CP1004833; USA (Wyoming)**

Phragmidium ivesiae Syd. & P. Syd.

Macrocyclic auteuform – (0)-(I)-II-III. Spermogonia epiphyllous, less hypophyllous, diameter 0.4-1 mm, rare or lacking, together with aecia. **Aecia** caeomoid, apparently rare, hypophyllous, becoming slightly pulverulent, bright orange-yellow fading to pale yellow, surrounded by few clavate paraphyses or paraphyses lacking. Spores ovoid, 19-28 × (14.5-)16-22 µm, wall hyaline to pale yellow, (1-)1.5-2 µm thick, echinulate, with spines 0.7-1(-1.2) high and diameter 0.6-1(-1.2) µm at 1.5-3.5(-4) µm spacing, pores indistinct, generally 4-6. **Uredinia** hypophyllous, rarely epiphyllous, scattered, round, diameter 0.7-1 mm, ruptured epidermis inconspicuous, bright yellow fading to nearly white, surrounded by few hyaline, thin-walled paraphyses or paraphyses lacking. Spores subglobose or broadly ellipsoid, yellow, 18-30 × 15-22 µm, wall hyaline or pale yellow, 1.5-2 µm thick, finely echinulate with spines similar as in aeciospores or slightly smaller, pores 4-8, scattered and inconspicuous. **Telia** initially developing from the uredinia, hypophyllous, abundant, scattered, roundish or irregular, diameter 0.4-1.5 mm, soon naked, ruptured epidermis inconspicuous, pulverulent, dark brown to blackish brown, paraphyses lacking or few. Spores short-cylindrical, cylindrical or narrowly ellipsoid, (2-)3(-4)-celled, not or slightly constricted at septa, the 2-celled 26-37 × 18-30 µm, the 3-celled 36-57 × 18-30 µm, the 4-celled 50-66 × 18-30 µm, ends rounded, apiculus lacking, wall chocolate brown, (1.8-)2-3.8(-4.2) µm thick, smooth or upper part finely verrucose, with warts 0.2-1.6 µm high and diameter 1.2-3.5 µm, pores distinct, (2-)3(-4) per cell, equatorial but in top cell 1-2 supraequatorial, pedicel hyaline but close to spore pale yellow, 70-90(-105) µm long but easily breaking and then seemingly short, 5-9 µm wide, apical part thick-walled, not or barely swollen.

Host plants

0-I-II-III, **Rosaceae:** *Potentilla.**

Distribution

Alpine; North-American; type 14; only recorded from the alpine Rocky Mts. (CAN, USA) and the Great Lakes area.

Phragmidium: Phragmidiaceae: Pucciniales

Phragmidium kamtschatkae **E. Hultén; S-F-433464; Russia (Kamchatka)**

Phragmidium kamtschatkae (H.W. Anderson) Arthur & Cummins

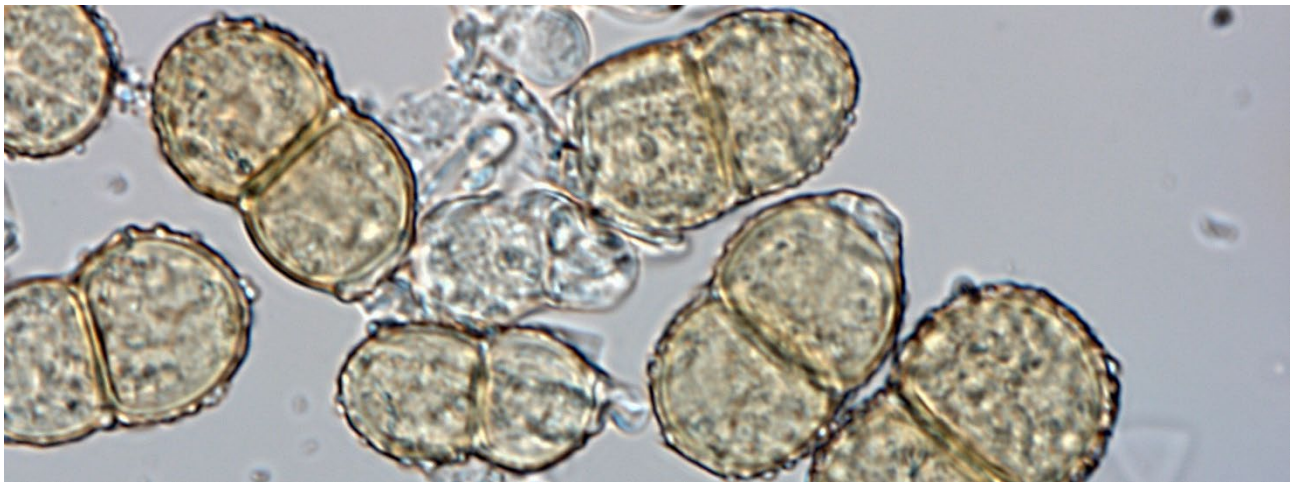
Probably macrocyclic hetereuform – 0-IIIsg. Systemic, leaves thickened. **Spermogonia** epiphyllous, foetid. **Telia** most hypophyllous, also epiphyllous, also on the branches, covering the whole surface, scattered, confluent, surrounded by the ruptured epidermis, pulverulent, greyish black or brownish. Spores germinating readily, 2-3-celled, slightly constricted at septa, short cylindrical, 20-54 × 13-37 µm, wall 0.5-3 µm thick, smooth to slightly verrucose with warts arranged in lines, pedicel pale yellowish, 1-2× spore length, firm, deciduous.

Host plants

0-III, **Rosaceae:** *Rosa* sect. *Cinnamomeae*, e.g. *Rosa acicularis*, *R. amblyotis*, *R. davurica*, *R. majalis*, *R. rugosa*, and *R. platyacantha.*

Distribution

Alpine; circumpolar; type 7; recorded from alpine regions of the Rocky Mts. (USA), the Urals and Kamchatka (RU), C-Asia, and Hokkaido (JP).



Phragmidium: Phragmidiaceae: Pucciniales

Phragmidium montivagum **Cummins, Myc. Saximont. 519; CP1004835; USA (Colorado)**

Phragmidium montivagum Arthur

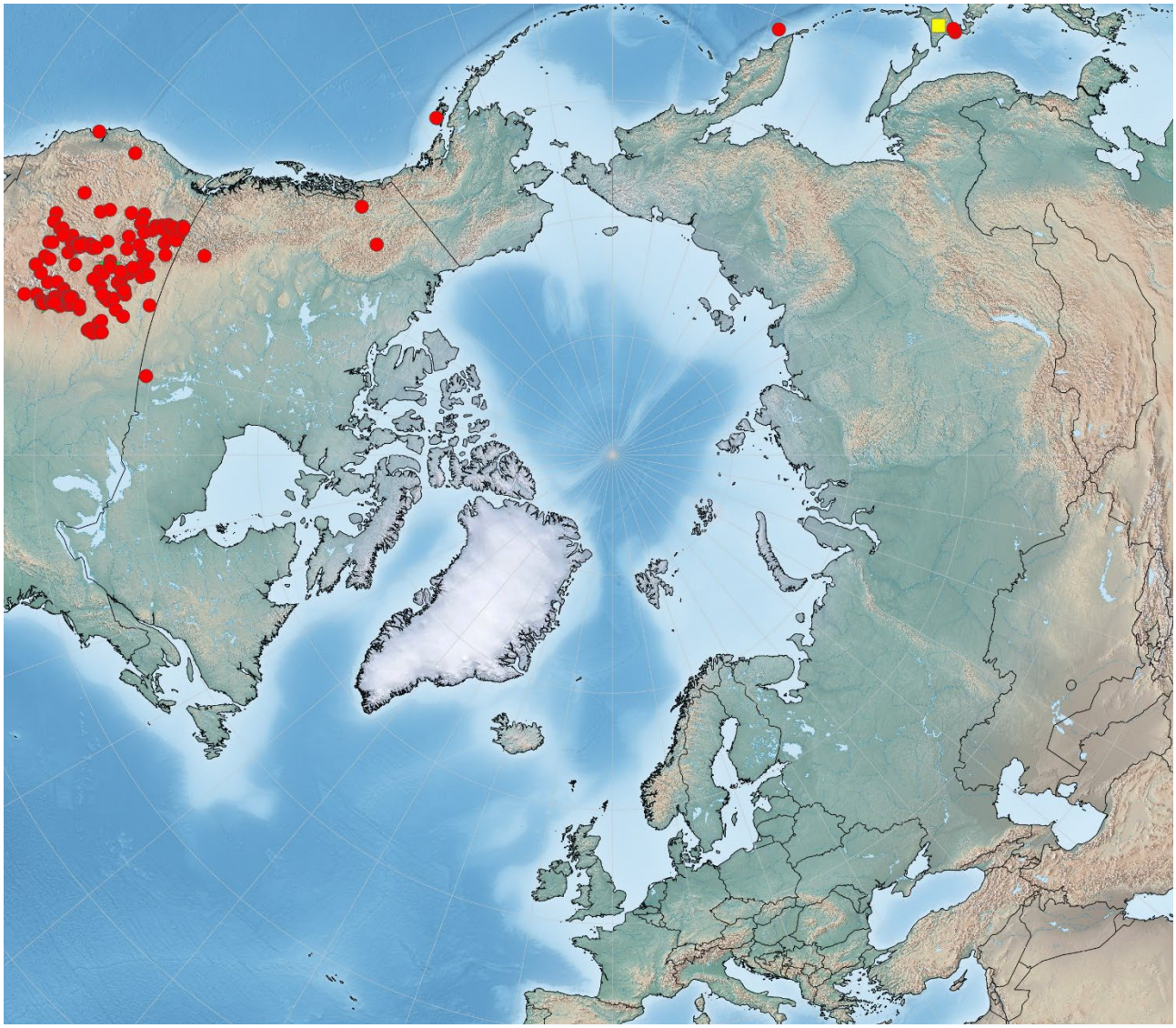
Macrocyclic auteuform – 0-I-II-III. Spermogonia amphigenous, inconspicuous, gregarious, often confluent, in small groups surrounded by the aecia or on spots opposite the aecia. **Aecia** caeomoid, hypophyllous and on the petioles, diameter 0.4-1.5 mm, solitary or in irregular groups, often confluent to form groups of 5-10 mm, causing hypertrophy and distortion on petioles and young shoots, applanate, bright orange-yellow fading to pale yellow, ruptured epidermis usually inconspicuous, surrounded by conspicuous, abundant, thin-walled, slightly curved, capitate or clavate, 50-70 × 12-25 µm paraphyses with smooth, 1-1.5 µm thick wall. Spores globose to broadly ellipsoid, 21-26 × 16-19 µm, wall subhyaline, 1.5-2 µm thick, sparsely but distinctly verrucose, pores indistinct, scattered, ca. 8. **Uredinia** abundant, hypophyllous, scattered, round, diameter ca. 0.1 mm, soon naked, ruptured epidermis inconspicuous, surrounded by many, cylindrical to subclavate, curved, 45-64 × 9-11 µm paraphyses with hyaline or subhyaline, 1 µm thick, smooth wall. Spores subglobose to obovoid, 18-24 × 16-20 µm, wall pale yellow, 1.5-2 µm thick, densely verrucose echinulate with warts at 2 µm spacing, pores indistinct, scattered, 6 or more. **Telia** initially developing from the uredinia, abundant, hypophyllous, scattered, diameter 0.1-0.5 mm, blackish or blackish brown, paraphyses lacking in the newly developed sori. Spores cylindrical, (6-)8(-9)-celled, not constricted at septa, 64-96 × 24-29 µm, rounded below and narrowed above, the apex with a conical, subhyaline apiculus of 7-10 µm long, wall blackish brown, 5-7 µm thick, densely and moderately verrucose, pores indistinct, pedicel rugose when dry, about 1× spore length, 7-9 µm wide, firm, persistent, swelling in water to 15-30 µm.

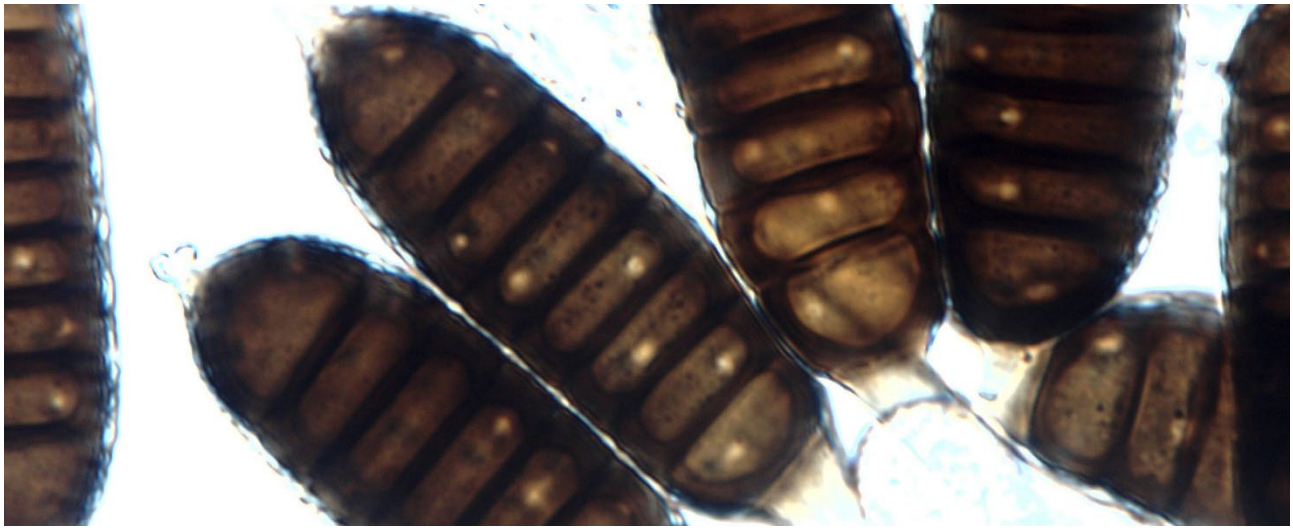
Host plants

0-I-II-III, **Rosaceae:** *Rosa.**

Distribution

Alpine; circumpolar; type 7; recorded from the alpine Rocky Mts. (CAN, USA), Kamchatka (RU), and Hokkaido (JP).





Phragmidium: Phragmidiaceae: Pucciniales

Phragmidium potentillae **HK 19.028 (micro from Sweden); C-F-152321; Russia (Altai)**

Phragmidium potentillae (Pers.) P. Karst.

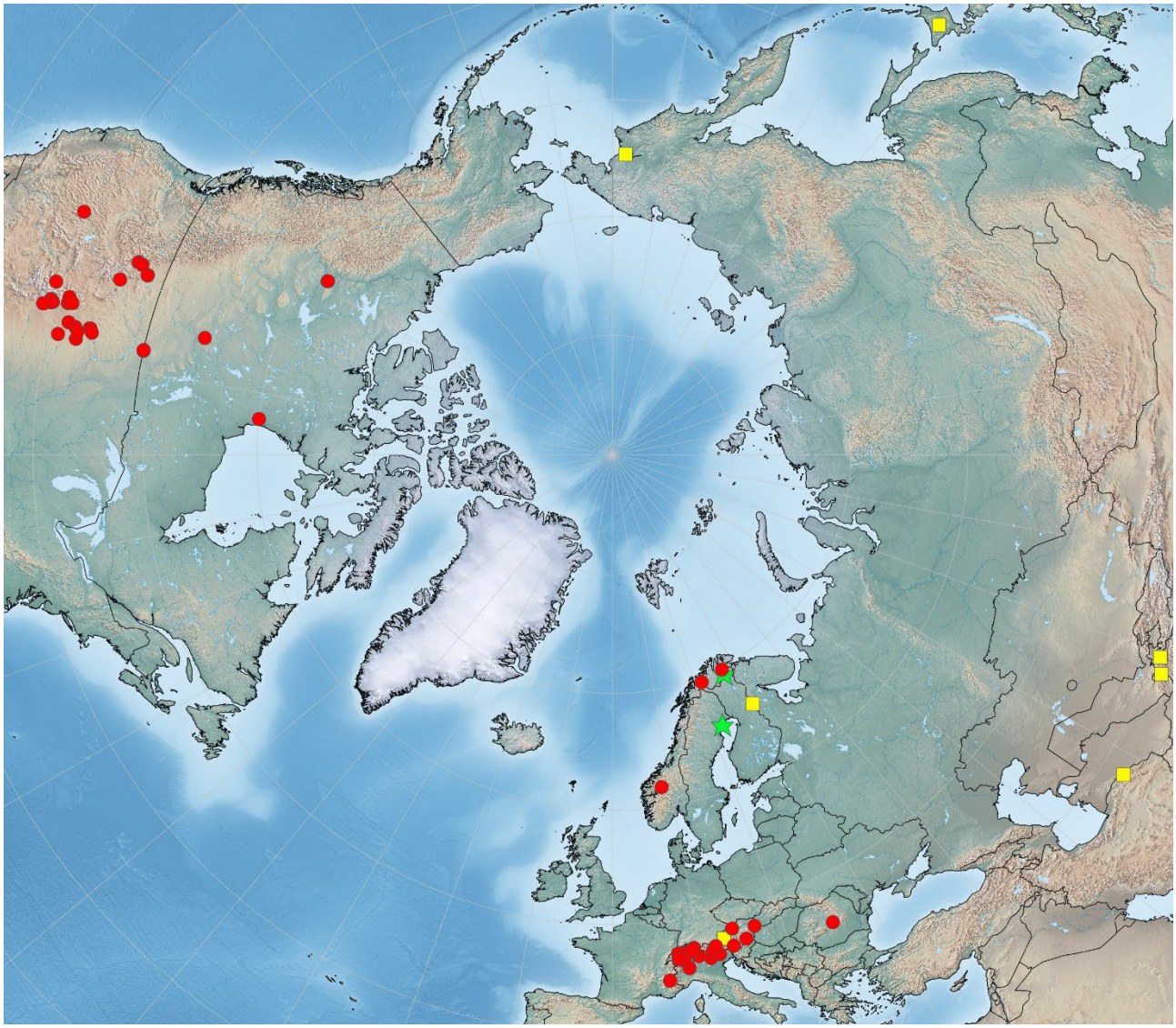
Macrocyclic auteuform – 0-I-II-III. Spermogonia amphigenous and on the petioles, not common, surrounded by the aecia. **Aecia** caeomoid, epiphyllous, hypophyllous or amphigenous, scattered or in groups, on the leaves round, diameter 0.5-1.5 mm, on the petioles in large crusts, orange or orange-red, surrounded by few to many hyaline, cylindrical or subclavate, up to 80 µm × 6-10 µm paraphyses with wall 0.5-1.5 µm, at apex 1.3-3(-5) µm thick. Spores subglobose or ovoid, yellow or orange, 17-30 × 14-27 µm, wall hyaline or pale yellowish, 1.5-2 µm thick, echinulate, with spines diameter 0.5-0.8(-1) µm at (1-)1.2-3.2(-4.5) µm spacing. **Uredinia** hypophyllous, scattered, often confluent, round, diameter 0.5-1 mm, first covered by the swollen epidermis, then naked and surrounded by the ruptured epidermis, pulverulent, yellow or orange-yellow, surrounded by few to many, clavate, curved, up to 80 × 9-21 µm paraphyses. Spores subglobose, obovoid or ellipsoid, yellow, 17-28(-33) × 13-25 µm, wall hyaline, 1.5-2 µm thick, finely echinulate with spines similar as in aeciospores, pores inconspicuous, scattered. **Telia** partially developing from the uredinia, hypophyllous, scattered or in groups, round, soon naked, pulvinate, black, paraphyses lacking in the newly developed sori. Spores (1-)5-6-celled, not or barely constricted at septa, 32-108 × 18-30 µm, wall brown or chocolate brown, 3-4 µm thick, smooth, the apex with a not sharply defined, blunt apiculus of 4.5-7(-8) µm long, pores 2-3 in end cells, (2-)3-4 elsewhere, supraequatorial, pedicel hyaline, up to 60-240 µm long, 7-12 µm wide, firm, persistent, not or barely swollen.

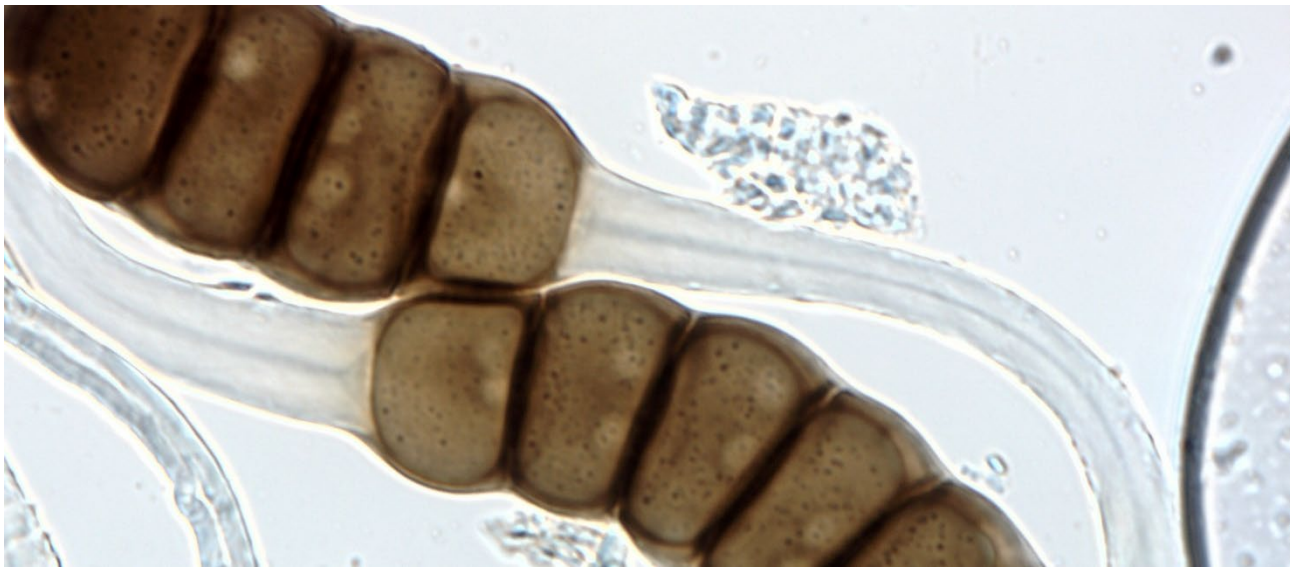
Host plants

0-I-II-III, **Rosaceae:** *Potentilla.**

Distribution

(Arctic-)alpine-boreal-temperate; circumpolar; type 5; recorded from arctic CAN, NO, FI, and RU, and from alpine regions of the Alps (DE, FR, CH, AT, IT), the Carpathians (RO), Dovre (NO), the Scandinavian Mts. (SE), C-Asia, and Hokkaido (JP).





Trachyspora: Phragmidiaceae: Pucciniales

Trachyspora alchemillae **HK 16.180C; C-F-108422**

Trachyspora alchemillae (Pers.) Fuckel

Syn.: *Trachyspora intrusa* (Grev.) Arthur

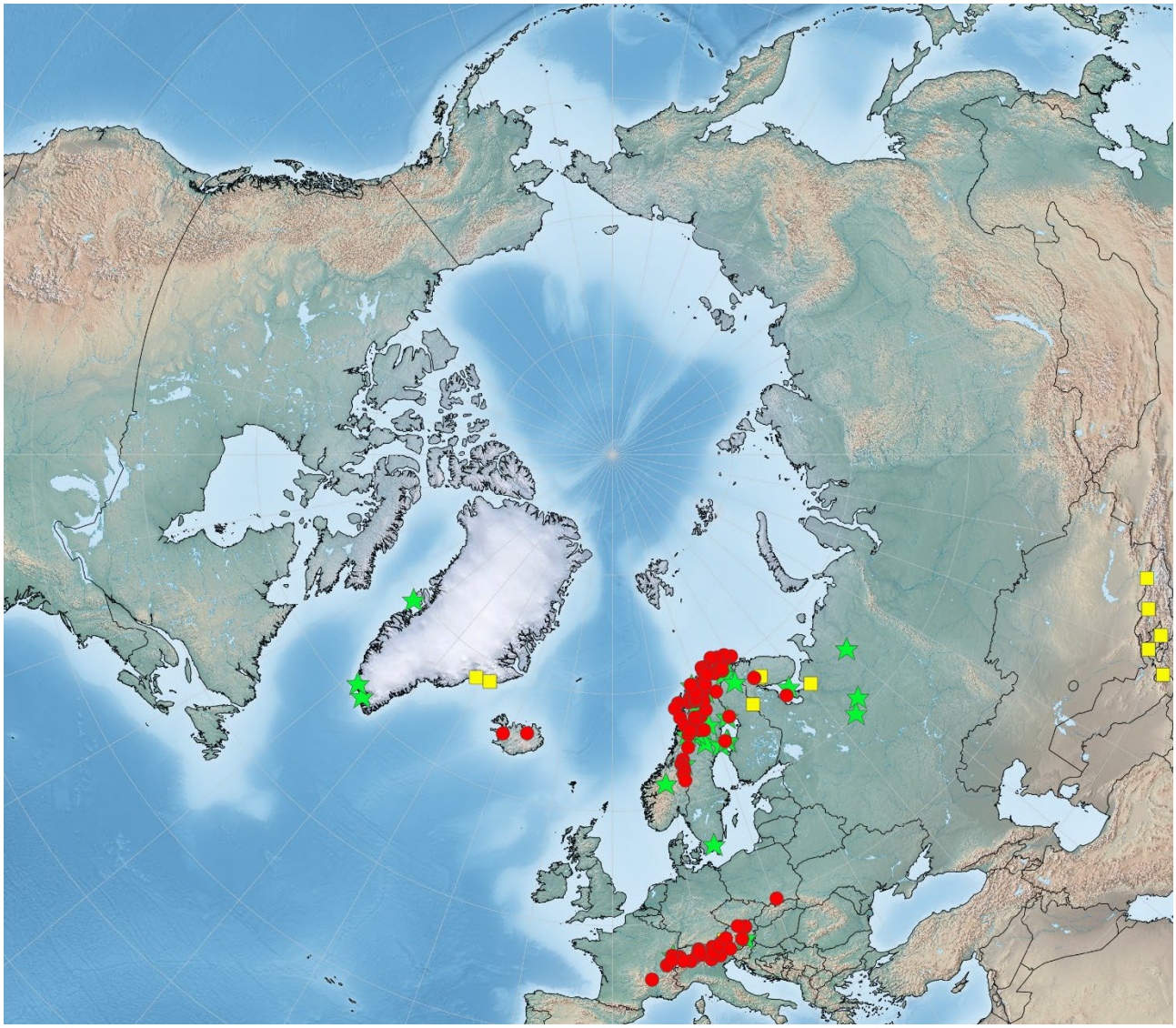
Macrocyclic auteuform – Ius-(II)-III. Systemic, plants pale, leaves more erect and petioles lengthened. **Aecia** systemic, uredinioid, hypophyllous, usually covering the whole surface, confluent, pulverulent, orange to yellow, later whitish. Spores globose to ellipsoid, 16-25 × 14-21 µm, wall hyaline, 1 µm thick, densely and very finely echinulate, pores inconspicuous. **Uredinia** abundant, hypophyllous, covering the whole surface, orange-yellow. Spores globose or ellipsoid, orange-yellow, 16-35 × 14-21 µm, wall hyaline, echinulate. **Telia** hypophyllous, scattered, pulverulent, light to dark red-brown. Spores 1-celled, subglobose, ellipsoid or obovoid, 20-43 × 20-32 µm, wall yellow-brown, cinnamon brown or brown, 3-4 µm thick, irregularly and especially in upper part strongly verrucose with warts up to 4.3 µm high and diameter 5.7 µm, towards the base sometimes with smooth zones, pores inconspicuous, pedicel subhyaline to pale yellow, with a septum, 1× spore length or shorter, deciduous.

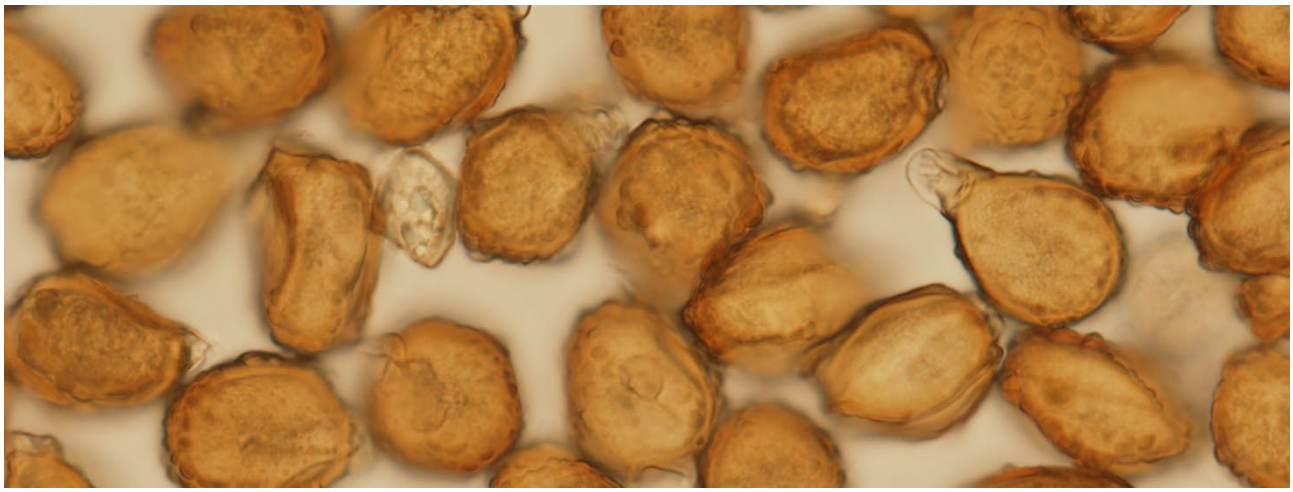
Host plants

I-II-III, **Rosaceae:** *Alchemilla.**

Distribution

Arctic-alpine-boreal-temperate; circumpolar, Eurasia and Greenland; type 4; recorded from arctic GR, IS, Svalbard, NO, SE, FI, and RU, and from alpine regions of the Alps (FR, CH, AT), the Tatras (PL), Dovre (NO), the Scandinavian Mts. (SE), C-Asia, and Hokkaido (JP).





Trachyspora: Phragmidiaceae: Pucciniales

Trachyspora melospora **J. Poelt; S-F-22482; Austria**

Trachyspora melospora (Therry) Dietel

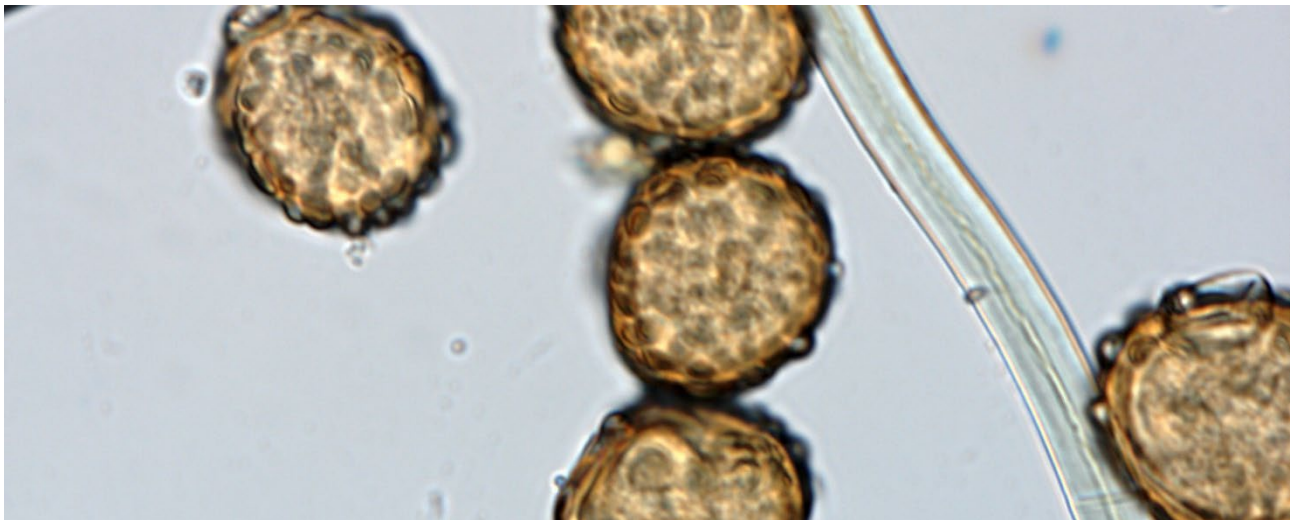
Hemicyclic form – (II)-III. Urediniospores sparsely formed within the telia. Spores subglobose to ellipsoid, 20-28 × 18-28 µm, wall hyaline or pale yellow. **Telia** mostly hypophyllous, covering the surface to a great extent, long covered by the epidermis, then naked and pulverulent, rusty brown. Spores 1-celled, subglobose to ellipsoid, (23-)27-32(-45) × (19-)26-30(-37) µm, wall brown, thick, irregularly and strongly verrucose, rarely smooth, pores inconspicuous, pedicel septate, deciduous.

Host plants

II-III, **Rosaceae:** *Alchemilla* subsect. *Chirophyllum*, e.g. *Alchemilla plicatula* and *Alchemilla alpina* s.l.

Distribution

Alpine; Eurasian; type 15; only recorded from the Alps (DE, FR, CH, AT).



Gymnosporangium: Gymnosporangiaceae: Pucciniales

Gymnosporangium cornutum SAE-2018.295-GR; C-F-112841

*Gymnosporangium cornutum** Arthur ex F. Kern.

Syn.: *Aecidium cornutum* Pers.

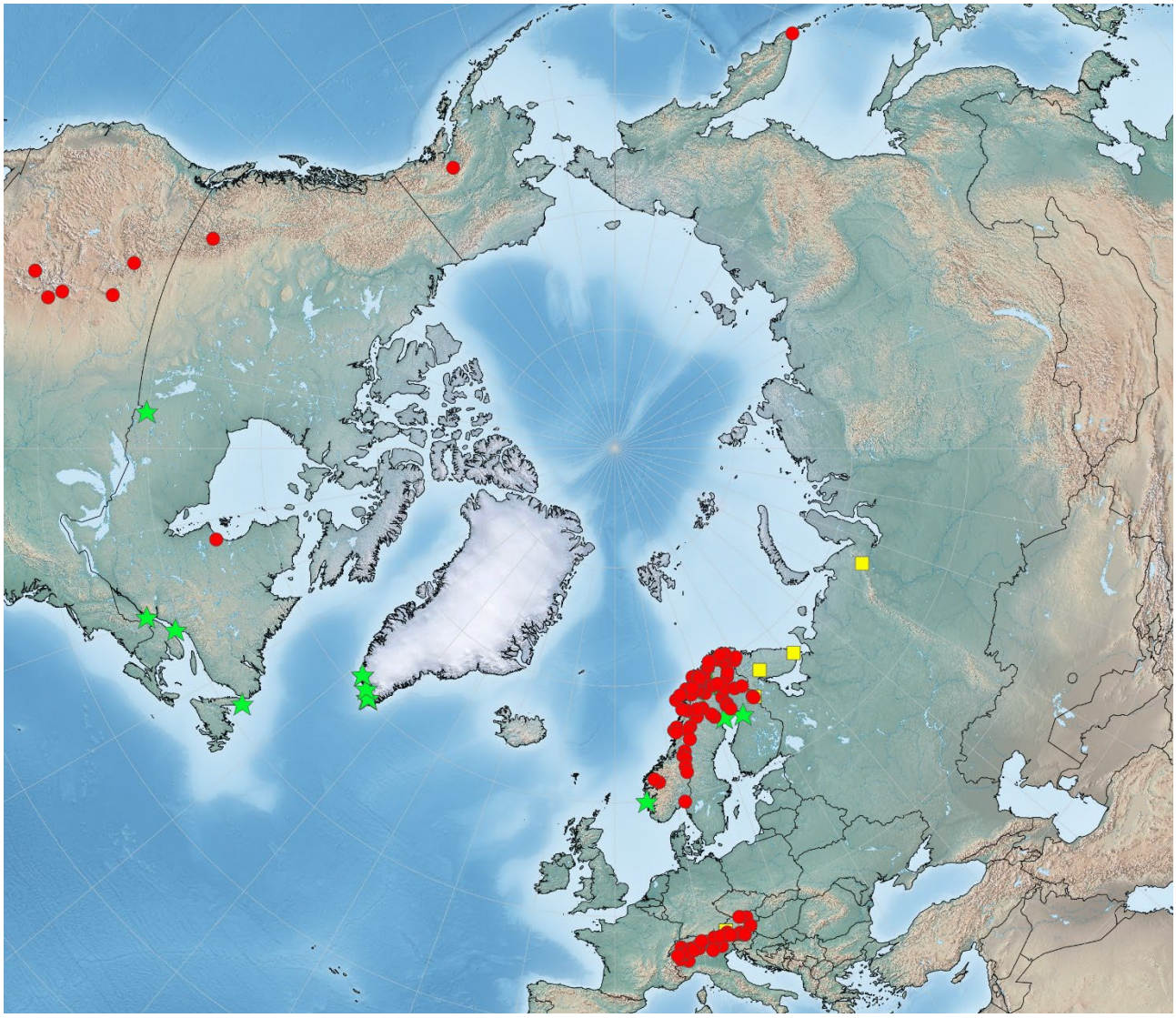
Demicyclic heteropsisform – 0-I / IIIg. Spermogonia epiphyllous, on large, orange or red spots, in crowded, small groups, yellowish, later black. **Aecia** hypophyllous, with approx. 10-30 together on large, yellow or orange, thickened, diameter 3-10 mm spots, also on the petioles, broadly cylindrical or cornute, attenuated at apex, curved, 3-5 mm high, 0.4-0.6 mm wide, opening at apex, finally lacerate with circular to irregular openings at the sides, peridial cells 55-110 × 18-40 × 30-40 µm, outer wall 1-2 µm thick and smooth or verrucose, inner wall 8-12 µm thick and rugose, provided with transverse, interrupted ridges arranged in parallel. Spores subglobose, chestnut brown, 20-29 × 18-25 µm, wall yellow-brown, 1-2 µm thick, finely and densely verrucose, warts at 1 µm spacing, pores scattered, 6-12, covered with a conspicuous, hyaline cap. **Telia** on fusoid, thickened parts of the young branches, also on the needles, occasionally also on older branches, scattered or in confluent groups, applanate to hemispherical, 1-6 mm long, smaller on the needles, initially chocolate brown, pulvinate, then gelatinous, orange. Spores germinating readily, 2-celled, ellipsoid, ends tapering, not or barely constricted at septum, 30-56(-70) × 15-30 µm, wall dark cinnamon brown, ca. 1 µm thick, pores 1-2 in each cell, in the upper cell equatorial or (sub)apical, in the lower cell close to septum, all covered with a conspicuous, prominent, hyaline cap, pedicel hyaline, long, about 4× spore length, cylindrical, 4-7 µm wide, gelatinizing with moisture.

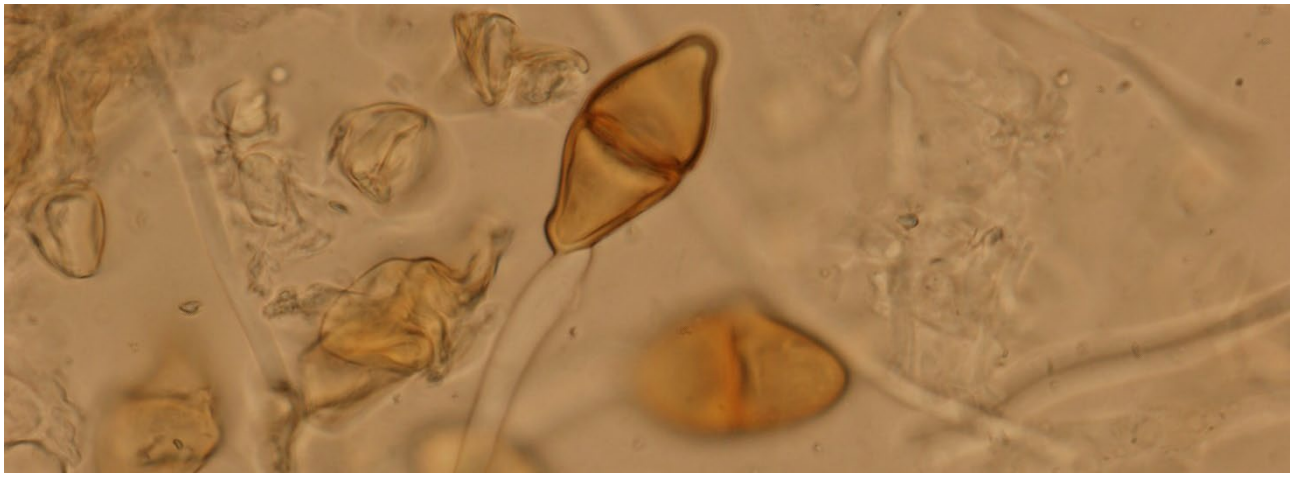
Host plants

0-I, **Rosaceae:** *Sorbus** and the related genera *Hedlundia** and *Scandosorbus*.*
III, **Pinaceae:** *Juniperus*.*

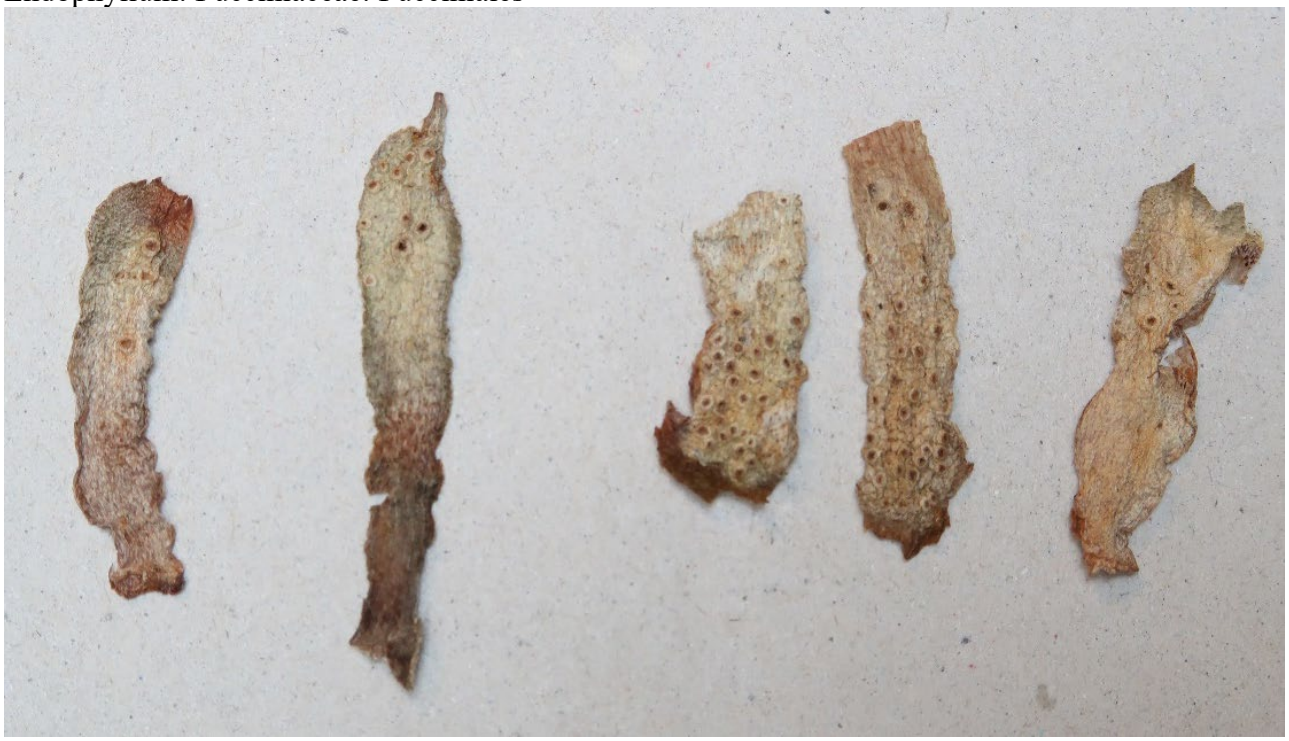
Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic AK, CAN, GR, NO, SE, FI, and RU, and from alpine regions of the Alps (CH, AT), Dovre (NO), the Scandinavian Mts. (SE), the Urals, the Altai Mts., and Kamchatka (RU), C-Asia, and Hokkaido (JP).





Endophyllum: Pucciniaceae: Pucciniales



Endophyllum sempervivi **P. Vogel, Flora Marchica; C-F-163353; Poland**

*Endophyllum sempervivi** (Alb. & Schwein.) de Bary

Endocyclic form – 0-IIIas. Systemic, leaves are more erect, narrower, thicker, yellowish and ca. 2× longer. **Spermogonia** epiphyllous, also amphigenous, subepidermal, scattered between the telia, brownish. **Telia** aecioid, amphigenous, embedded in host tissue, irregularly scattered, surrounded by a peridium, opening with a pore, finally cupulate, diameter 0.5-1 mm. Spores aecioid, pale yellow-brown, 18-35 × 18-28 µm, wall light yellow-brown or yellow-brown, 2.5-3 µm thick, densely and finely verrucose, warts at 1-1.5 µm spacing, pores ca. 10.

Host plants

0-III, **Crassulaceae:** *Sempervivum* species, e.g. *S. arachnoideum*, *S. globuliferum*, *S. montanum*, *S. tectorum*, and *S. wulfenii.*

Distribution

Alpine; Eurasian; type 9; recorded from the Alps (FR, CH, AT, IT) and Hokkaido (JP). Also anthropogenic, e.g. in northern Norway.

Puccinia: Pucciniaceae: Pucciniales

Puccinia aberrans **O. Paulsen 795; C-F-155314; Tajikistan**

Puccinia aberrans Peck

Microcyclic form – 0-IIIs. Spermogonia amphigenous, scattered over large areas, honey yellow. **Telia** systemic, mainly hypophyllous, also amphigenous, densely gregarious, covering large areas, round, diameter 0.3-0.5 mm, soon naked and surrounded by the ruptured epidermis, initially pulvinate, then pulverulent, chestnut brown. Spores (1-)2(-3)-celled, the 2-celled ellipsoid, oblong or oblong-ovoid, apex rounded or obtuse, base rounded or tapering, not or slightly constricted at septum, 35-45 × 22-28 µm, wall chestnut brown, 2-3.5 µm thick, slightly thinner towards the base, and conspicuously thicker near septum, apex 7-10 µm thick, faintly verrucose-rugose but appearing smooth when wet, pedicel hyaline, short, deciduous.

Host plants

0-III, **Brassicaceae:** *Boechera lyallii*, *Erysimum cheiranthoides*, *Polyctenium fremontii*, *Smelowskia americana*, and *S. calycina.*

Distribution

Arctic-alpine; circumpolar; type 3; recorded from the Canadian arctic, and from the alpine Rocky Mts. in Canada and the USA; in Eurasia only known from C-Asia.

Puccinia: Pucciniaceae: Pucciniales

Puccinia albulensis **HK 17.073B; C-F-104963**

Puccinia albulensis Magnus

Syn.: *P. porteri* Peck

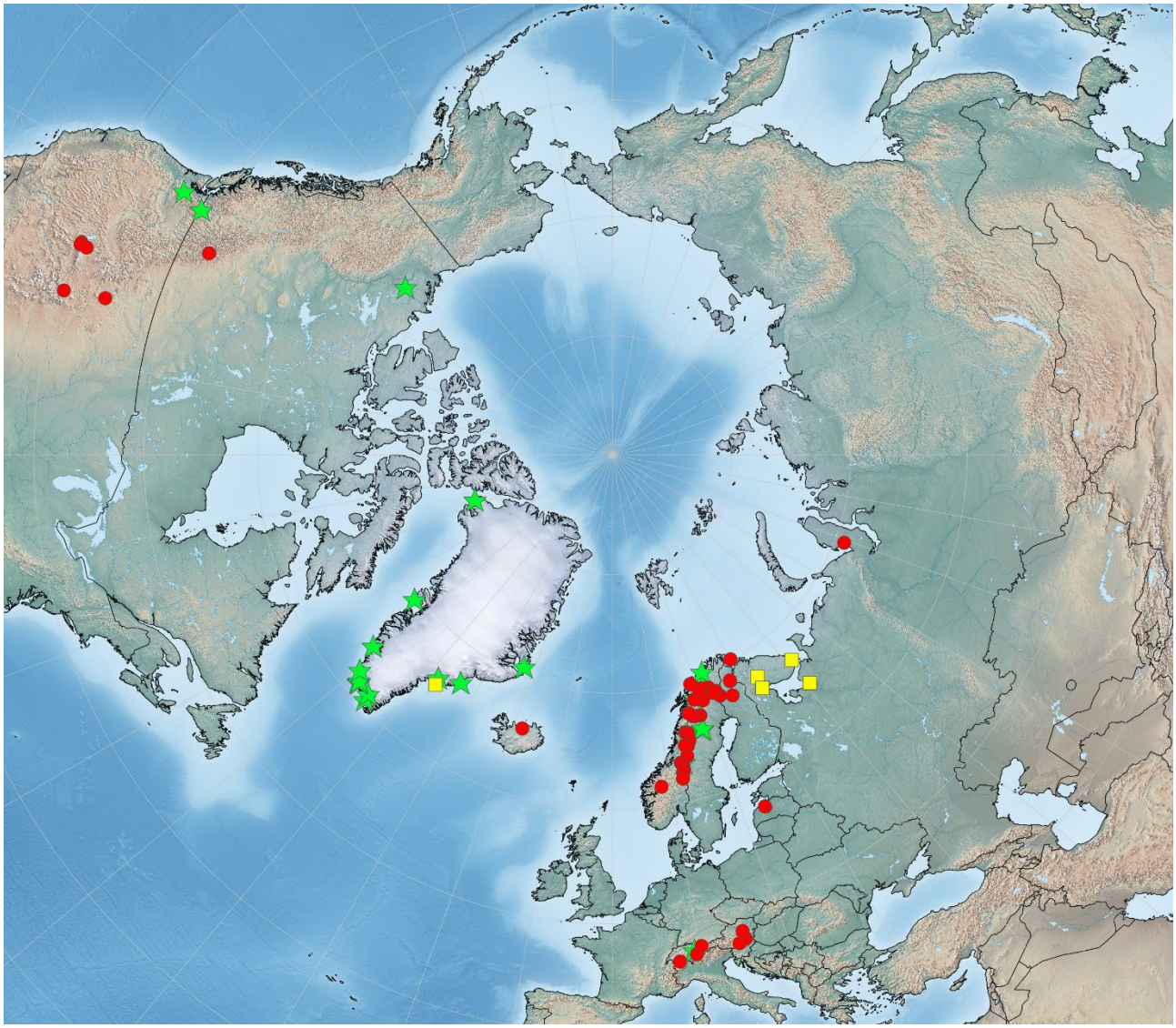
Microcyclic form – III(s)g. Infection systemic or local. **Telia** hypophyllous, often on the midrib, also on the lower stem internodes, irregularly roundish or oblong, usually in groups, especially those on the leaf veins but also covering the whole lower leaf, occasionally scattered, initially covered by the epidermis, then naked, 2 types: (i) producing readily germinating spores, pulvinate, becoming cinereous by presence of basidiospores and (ii) producing resting spores, pulverulent, cinnamon brown to chestnut brown. Spores 2-celled, ellipsoid, slightly to moderately constricted at septum, (21-)23-41(-44) × 13-22 µm, wall (i) hyaline and thin, smooth or nearly smooth, and (ii) cinnamon brown to brown, 1-1.8 µm thick, nearly smooth or finely punctate, finely verrucose or finely rugose, pore in upper cell apical, in lower cell against septum, both pores covered with a 1.5-4.5(-5.5) high and (5-)7-11(-13) µm wide cap, pedicel (i) hyaline, short, deciduous, or (ii) persistent.

Host plants

III, **Plantaginaceae:** *Veronica alpina*, *V. aphylla*, *V. cusickii*, *V. longifolia*, and *V. wormskjoldii.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic CAN, GR, IS, NO, SE, FI, and RU, and from alpine parts of the Rocky Mts. (CAN, USA), the Alps (CH, AT), Dovre (NO), the Scandinavian Mts. (NO, SE), and the Urals (RU).



Puccinia: Pucciniaceae: Pucciniales

Puccinia alpina **H. Roivainen & J. I. Liro, Mycoth. Fenn. 84; C-F-155328; Finland**

Puccinia alpina Fuckel

Syn.: *Puccinia ruebelii* Volkart (cf. Poelt & Zwetko 1997).

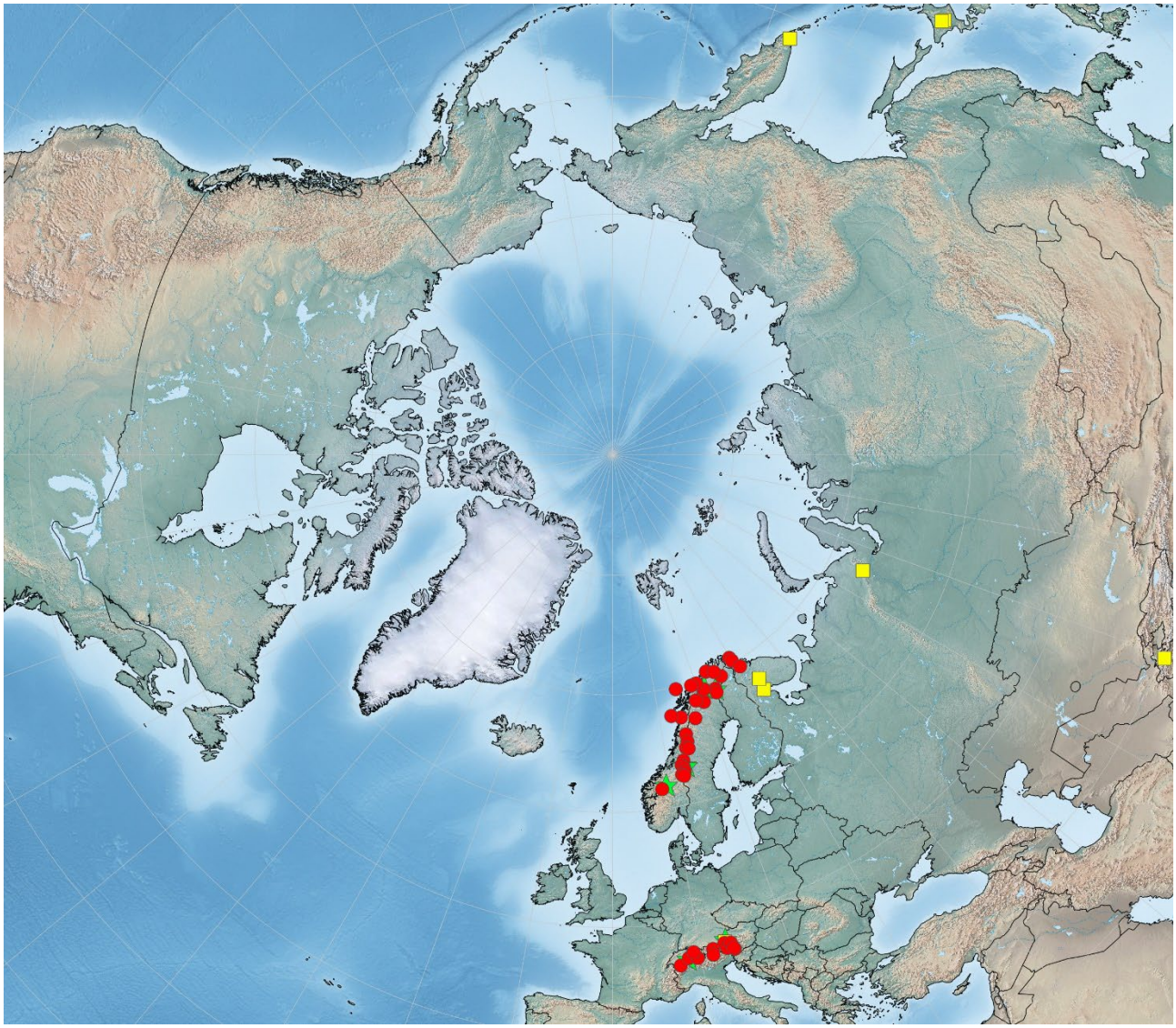
Microcyclic form – III. Telia hypophyllous and on the petioles, covering large parts of the leaves, causing slight malformations, scattered, often confluent, roundish to irregularly oblong, up to 2 mm long, initially covered by the epidermis, soon naked, pulverulent, brown or dark brown. Spores 2-celled, ellipsoid or fusoid, not or barely constricted at septum, 35-52 × 14-24 µm, wall light brown or brown, 1.5-2.5 µm thick, finely reticulate, pore of upper cell apical and covered with a hyaline, ca. 5 µm high cap, pore of lower cell against or close to septum and covered with a similar cap or cap inconspicuous, pedicel hyaline, short, deciduous.

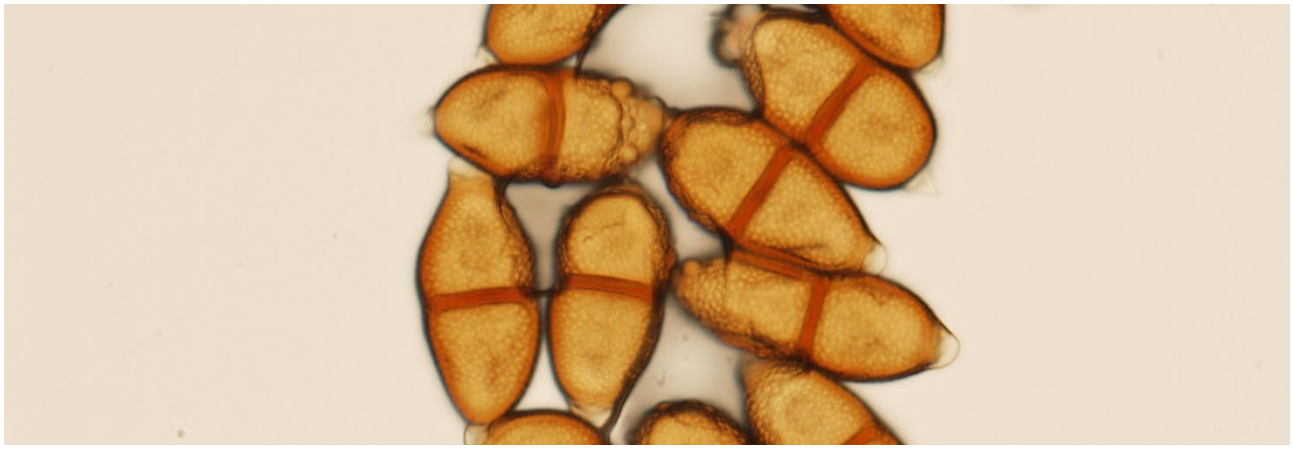
Host plants

III, Violaceae: *Viola* species, e.g. *Viola biflora*, *V. odorata*, *V. pinnata*, *V. turkestanica*, and *V. vaginata.*

Distribution

Arctic-alpine; Eurasian; type 9; recorded from arctic NO, SE, FI, and RU, and from alpine regions of the Alps (CH, AT), Dovre (NO), the Scandinavian Mts. (NO, SE), the Urals and Kamchatka (RU), C-Asia, and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia arctica **K. Reinilä et al., Mycoth. Fenn. 159; C-F-156023; Finland**

Puccinia arctica Lagerh.

Syn.: *Puccinia ciliata* Mains; non *P. ciliata* (Kom.) Tranzschel, nom. illeg.

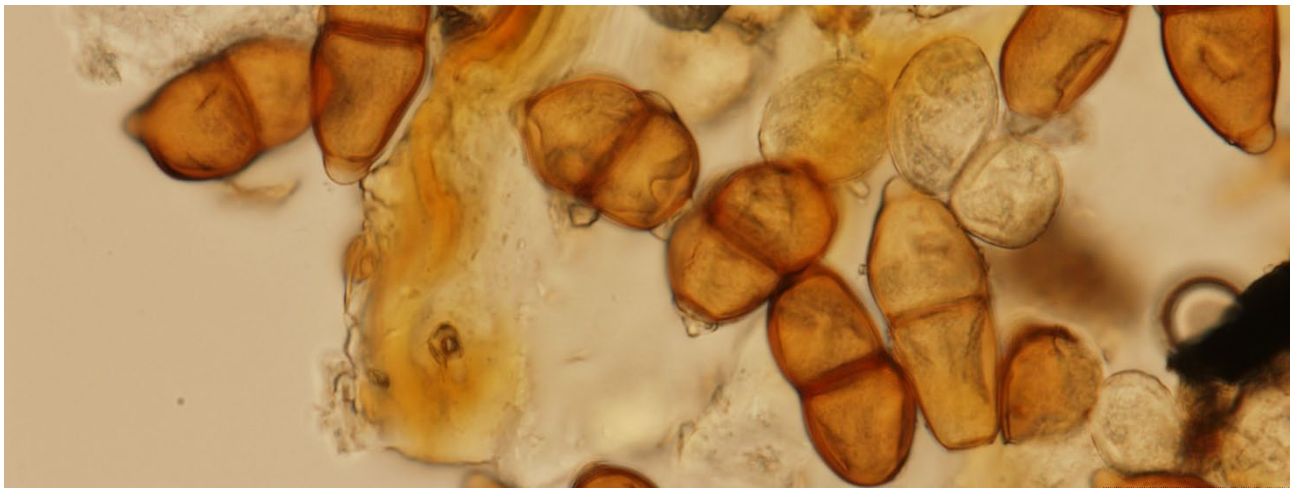
Demicyclic autopsisform – I-(II)-III. Aecia hypophyllous, single or in circular groups of 2-4 mm, cupulate, peridium minute, margin revolute, lacerated, pale yellowish. Spores subglobose to ellipsoid, angular, diameter 14-21 µm, wall hyaline to pale yellow, 1 µm thick, densely and finely verrucose. **Urediniospores** present in the telia, subglobose to ellipsoid, 21-28 × 17-23 µm, wall yellowish brown, 1.5 µm thick, echinulate, spines at 2-4 µm spacing, pore 1, apical. **Telia** amphigenous, sparsely scattered, punctiform, round, diameter ca. 0.5 mm, pulverulent, dark brown. Spores 2-celled, oblong, apex obtuse, base rounded or rarely tapering, not or barely constricted at septum, 34-45 × 16-24 µm, wall brown, 1-1.5 µm thick, smooth, pore of upper cell apical and covered with a 4 µm, subhyaline or yellowish cap, pore of lower cell against septum and covered with a slightly smaller, subhyaline cap, pedicel hyaline, 1× spore length, deciduous.

Host plants

I-III, **Primulaceae:** *Primula nutans* (*P. sibirica*, *P. finnmarchica*).

Distribution

Arctic; Eurasian; type 13; only recorded from a few places in Norway, Finland, and westernmost Russia.



Puccinia: Pucciniaceae: Pucciniales

Puccinia arenariae **N. Hartz; C-F-8524**

Puccinia arenariae (Schumach.) Wint.

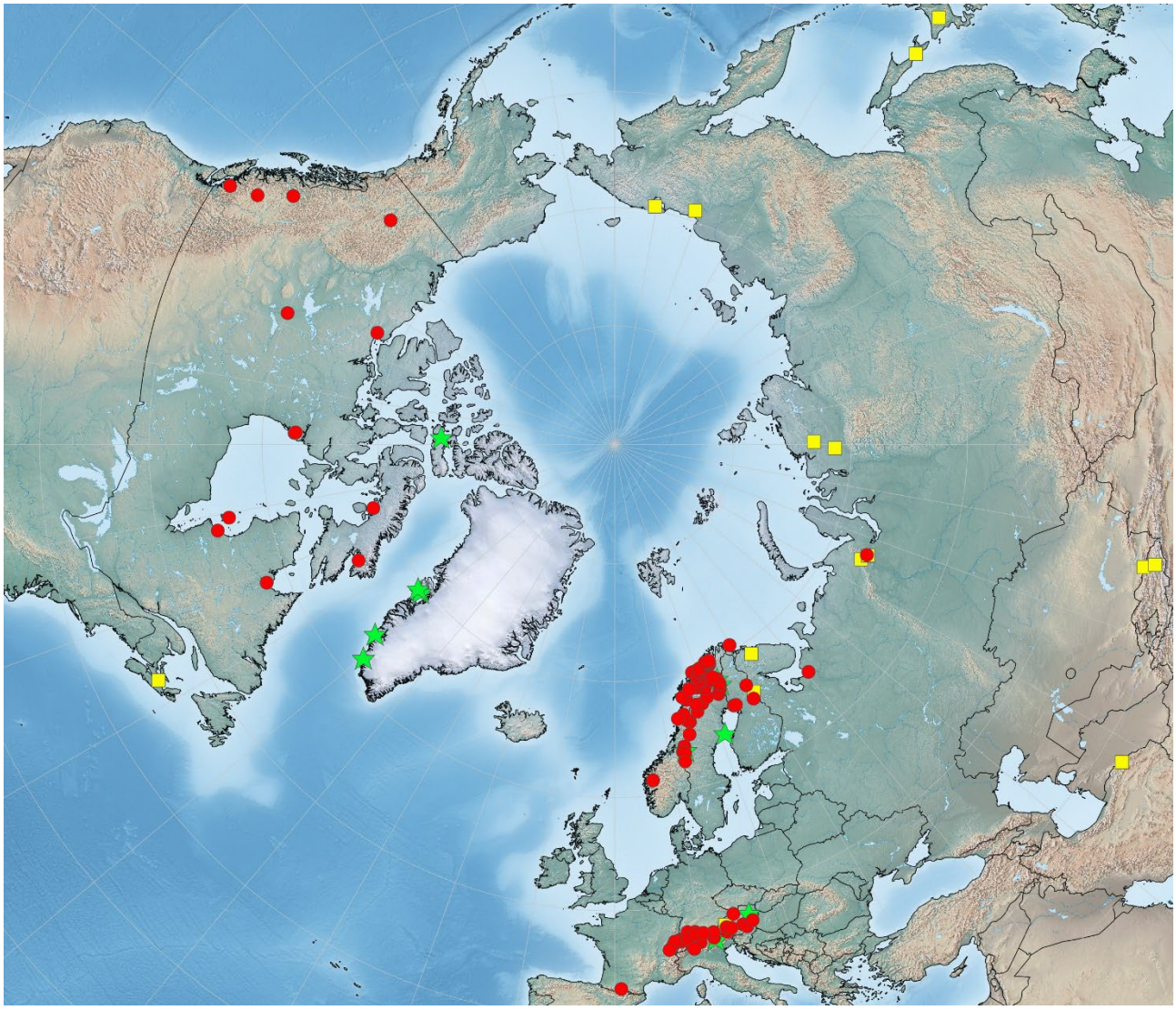
Microcyclic form – IIIg. Telia mainly hypophyllous, also amphigenous, and on the stems, often on light yellow spots, scattered or in concentric groups, round to oblong, diameter 0.25-1 mm, rather soon naked and surrounded by the ruptured epidermis, firm, pulvinate, pale brown, brown or blackish brown, later pulverulent-grey by presence of basidiospores. Spores germinating readily except when formed late in the season, 2(-3)-celled, fusoid or clavate, apex rounded or pointed, base tapering or rarely rounded, germinating spores somewhat pointed at apex, slightly constricted at septum, varying considerably in size (host-dependent), 30-50(-63) × 13-22 µm, mature spores may fall apart easily and then seemingly 1-celled, wall yellow-brown, golden brown or cinnamon brown, 1-2 µm, at apex up to 12 µm thick, smooth, pore of upper cell apical or slightly subapical, pore of lower cell against septum, caps inconspicuous, pedicel hyaline, yellow near spore attachment, 1-2× spore length, persistent.

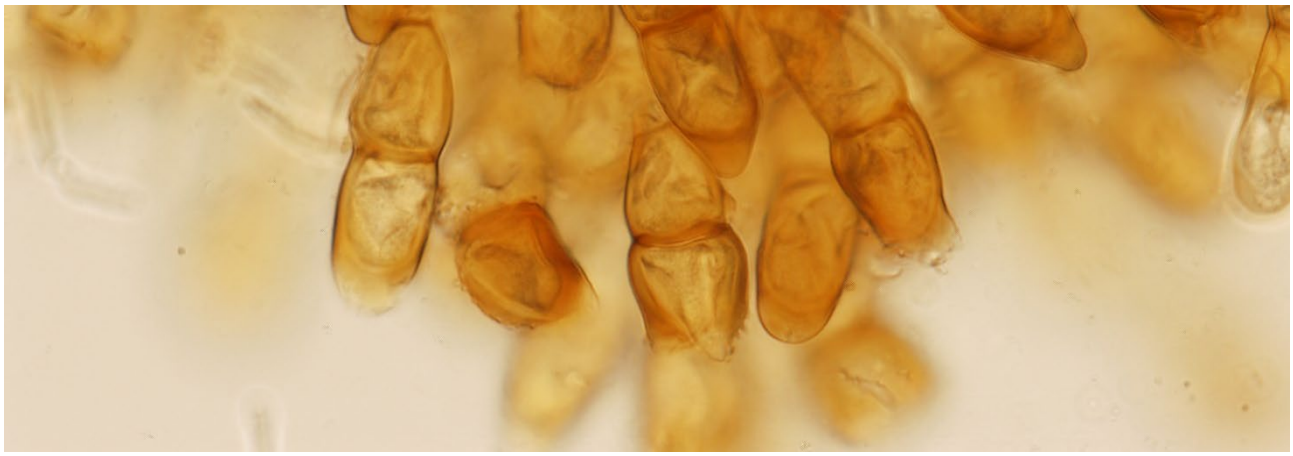
Host plants

III, **Caryophyllaceae:** *Arenaria capillaris*, *A. peploides*, *Cerastium dahuricum*, *C. maximum*, *Dianthus macronyx*, *Minuartia verna*, *Sagina procumbens*, *S. saginoides*, *Silene dioica*, *Stellaria edwardsii*, *S. graminea*, *S. longipes*, *S. nemorum*, *S. songarica*, and *Wilhelmsia physodes*.

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic CAN, GR, NO, SE, FI, and RU, and from alpine regions of the Alps (DE, FR, CH, AT, IT), the Pyrenees (ES), Dovre (NO), the Scandinavian Mts. (SE), the Urals and Sakhalin (RU), Kazakhstan, C-Asia, and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia arnicae-scorpioidis **Poelt & Steiner, Crypt. ex. 4614; C-F-155149; Switzerland**

Puccinia arnicae-scorpioidis (DC.) Magnus

Microcyclic form – III. Telia amphigenous, surrounded by a yellowish margin, scattered, diameter up to 4 mm, pulverulent, blackish. Spores 2-celled, broadly ellipsoid, ends rounded, usually not, less frequently barely constricted at septum, (26-)33-36(-40) × (15-)20-23(-28) µm, wall ca. 2 µm thick, finely verrucose, pore of upper cell subequatorial, pore of lower cell more or less equatorial, both pores covered with indistinct cap, pedicel hyaline, up to 70 µm long, fragile.

Host plants

III, **Asteraceae:** On species of *Arnica* and *Doronicum.*

Distribution

Alpine; Eurasian; type 15; only recorded from the Alps (DE, CH, AT), the Carpathians (SK), and the Pyrenees (ES).

Puccinia: Pucciniaceae: Pucciniales

Puccinia arnicalis **W. G. Solheim & Jr. 2170; CP1005836; USA (Wyoming)**

Puccinia arnicalis Peck

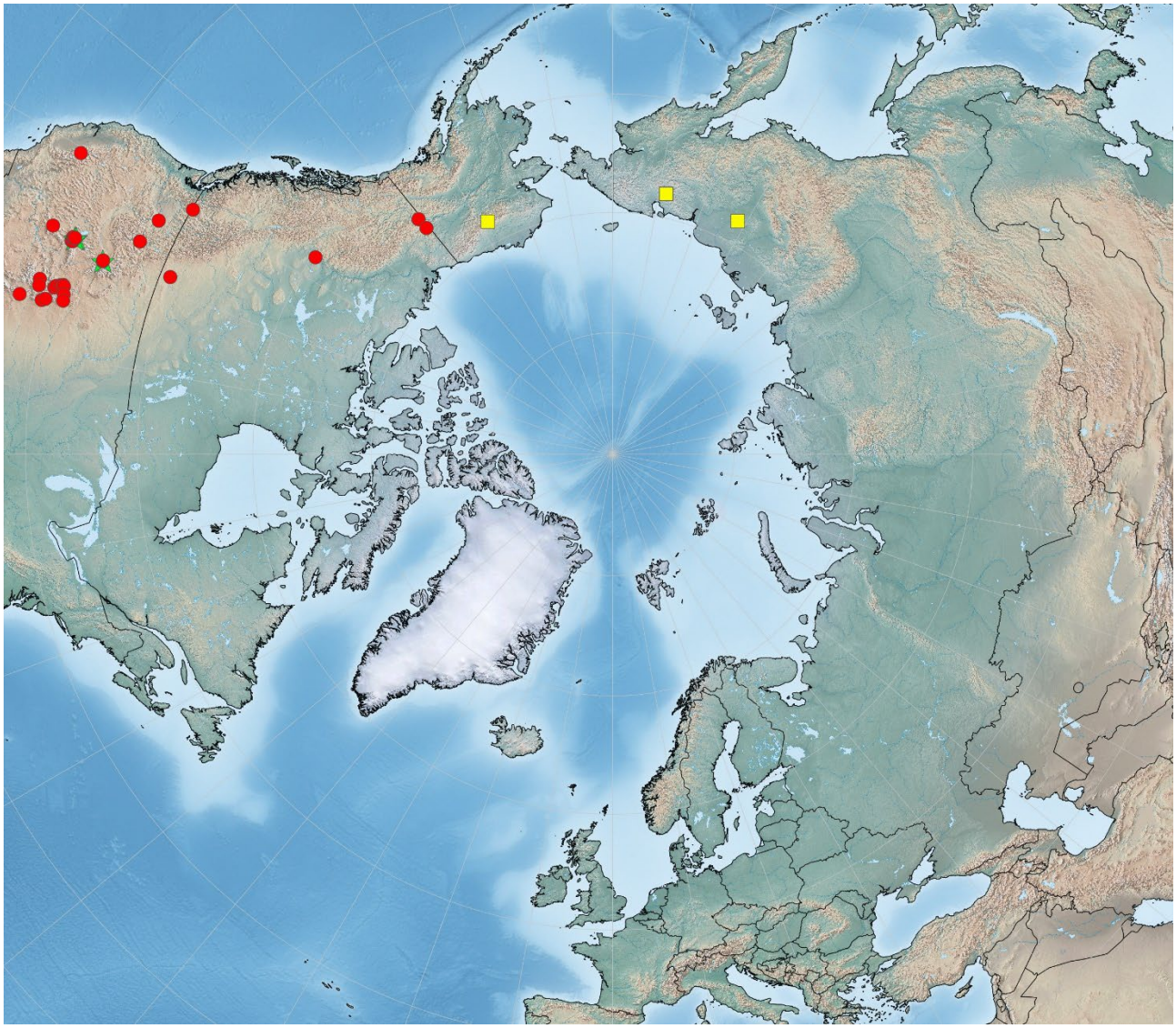
Hemicyclic form – II-III. Uredinia amphigenous and on the petioles, scattered or in groups, sometimes confluent, round to ovoid, diam. 0.2-0.5 mm, soon naked and surrounded by the ruptured epidermis, chestnut brown or dark brown. Spores subglobose or ellipsoid, laterally moderately to strongly flattened, (22-)24-34(-38) × (20-)22-30(-32) µm, in side-view 16-21(-23) µm wide, wall yellow-brown to light chestnut brown, 1.5-2.5 µm thick, at base and near pores 2.5-3.5 µm thick, very finely and densely echinulate with spines 0.3-0.6 µm high and at (1.2-)1.5-2.8 µm spacing, except for a smooth area of diameter 12-18(-20) µm below each pore, pores 2, supraequatorial, caps inconspicuous. **Telia** initially epiphyllous, then amphigenous, also on the petioles, scattered or in irregular, diameter 2-5 mm groups, round, diameter 0.4-0.8 mm, soon naked, ruptured epidermis inconspicuous, pulverulent, chestnut brown. Spores ovoid to ellipsoid, apex rounded, base rounded or narrowed, (1-)2-celled, the 2-celled not or slightly constricted at septum, 25-45 × 18-27(-30) µm, wall light chestnut brown to chestnut brown, 1.3-2.3 µm thick, at pores 2.3-3(-3.3) µm thick, verrucose with warts 0.3-0.7 µm high and diameter (0.5-)0.7-1.5(-1.8) µm, often elongate, randomly dispersed, in part of the spore tending to be in longitudinal rows, pore of upper cell usually 1/6-1/2 depressed from apex, sometimes up to 2/3 depressed or apical, pore of lower cell 1/4-3/4 depressed from septum, sometimes near septum or near pedicel, both often covered with shallow, yellow, 0.7 µm high cap, pedicel hyaline, short, fragile, deciduous close to spore attachment.

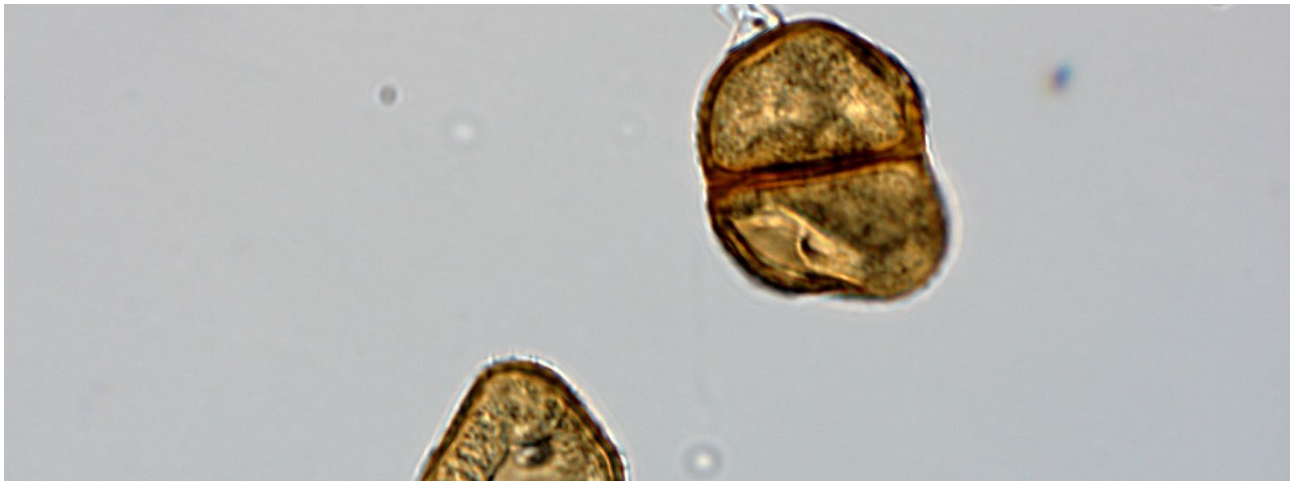
Host plants

II-III, **Asteraceae:** *Arnica* species, e.g. *Arnica cordifolia*, *A. griscomii*, and *A. louiseana.*

Distribution

Arctic-alpine; circumpolar; type 2; recorded from arctic AK and RU, and from the alpine Rocky Mts. (CAN, USA).





Puccinia: Pucciniaceae: Pucciniales

Puccinia artemisiae-norvegicae **Tranzschel & Woronin; S-F33598; Russia (Kamchatka)**

Puccinia artemisiae-norvegicae Tranzschel & Woron.

Hemicyclic form – II-III. Uredinia hypophyllous and on the stems, in small compact groups or scattered, red-brown. Spores ellipsoid, 25-35 × 19-26 µm, wall 1-1.6 µm thick, pale yellow, echinulate except for a smooth equatorial band, pores (2-)3, equatorial, covered with hyaline, 3-4 µm high, 10-17 µm broad caps. **Telia** associated with the uredinia, surrounded by the ruptured epidermis, pulverulent, dark brown. Spores 2-celled, narrowly to broadly ellipsoid, not or slightly constricted at septum, 27-42 × 17-27 µm, wall dark brown, 2-2.5 µm thick, completely and densely verrucose with warts apparently joined together, pores inconspicuous, pedicel hyaline, deciduous, breaking near spore attachment.

Host plants

II-III, **Asteraceae:** *Artemisia arctica* and *Artemisia richardsoniana.*

Distribution

Arctic-alpine; circumpolar, amphiberingian; type 1; recorded from arctic CAN and RU, and from the alpine Rocky Mts. (CAN), Chukotka and Kamchatka (RU).

Puccinia: Pucciniaceae: Pucciniales

Puccinia athamantina **O. Jaap, Fungi sel. ex. 438; S-F439375; Switzerland**

Puccinia athamantina P. Syd. & Syd.

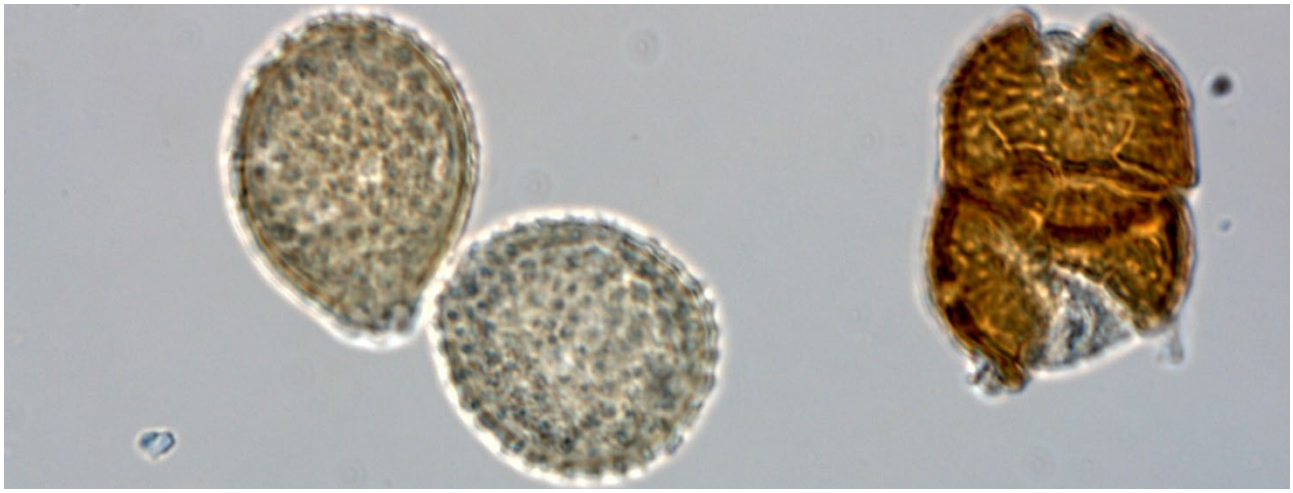
Macrocyclic auteuform – 0-I-II-III. Spermogonia in small numbers between the aecia. **Aecia** hypophyllous on the veins on small pustular malformations, loosely and irregularly aggregated, cupulate, yellow, peridium rudimentary. Spores subglobose to ellipsoid, angular, 19-31 × 13-21 µm, wall yellowish, thin, finely verrucose. **Uredinia** scattered, very small, inconspicuous, pulverulent, light brown, brown or chestnut brown. Spores subglobose, ovoid or ellipsoid, angular or not, 23-30 × 19-25 µm, wall yellowish, yellowish brown or light brown, 1.5-2.5 µm thick, densely and finely echinulate, pores 3, caps inconspicuous. **Telia** on the stems ellipsoid to oblong and there somewhat confluent, initially covered by the epidermis, small, roundish, then naked and surrounded by the ruptured epidermis, dark brown to black. Spores 2-celled, ovoid to ellipsoid, ends rounded, slightly to barely constricted at septum, 29-38 × 20-30 µm, wall brown, up to 4.5 µm thick, reticulate with 1.5-2 µm spacing, pore of upper cell apical, pore of lower cell subequatorial, caps inconspicuous, pedicel hyaline or subhyaline, 1× spore length, fragile.

Host plants

0-I-II-III, **Apiaceae:** *Athamanta* species, e.g. *Athamanta cretensis* and *A. hirsuta.*

Distribution

Alpine; Eurasian; type 15; only recorded from the Alps (FR, CH, AT, IT).



Puccinia: Pucciniaceae: Pucciniales

Puccinia atragenicola **P. Sydow; S-F-169443; Austria**

Puccinia atragenicola (Bubák) P. Syd. & Syd.

Microcyclic form – III. Telia mainly hypophyllous, also epiphyllous, rarely on the petioles, in confluent to ± round, 1-5 mm large groups, small, long covered by the epidermis, compact, firm, dark brown to black, divided in locules by brown, up to 70 µm long paraphyses. Spores 2-celled, clavate, apex rounded or obtuse, base tapering, slightly to moderately constricted at septum, lower cell usually conspicuously longer and narrower than the upper cell, 44-82 × 15-24 µm, lower cell wall hyaline to light brown and 1-1.5 µm thick, upper cell brown and gradually thickened towards the apex to 8-12 µm, smooth, pore of upper cell apical or subapical, pore of lower cell against septum, caps inconspicuous, pedicel brownish, short, persistent.

Host plants

III, **Ranunculaceae:** *Clematis alpina.*

Distribution

Alpine; Eurasian; type 15; only recorded from the eastern Alps (CH, AT, IT) and the Carpathians (RO).

Puccinia: Pucciniaceae: Pucciniales

Puccinia bistortae **HK 16.159; C-F-108393**

Puccinia bistortae (F. Strauss) DC.

Syn.: *Puccinia polygoni-vivipari* P. Karst.

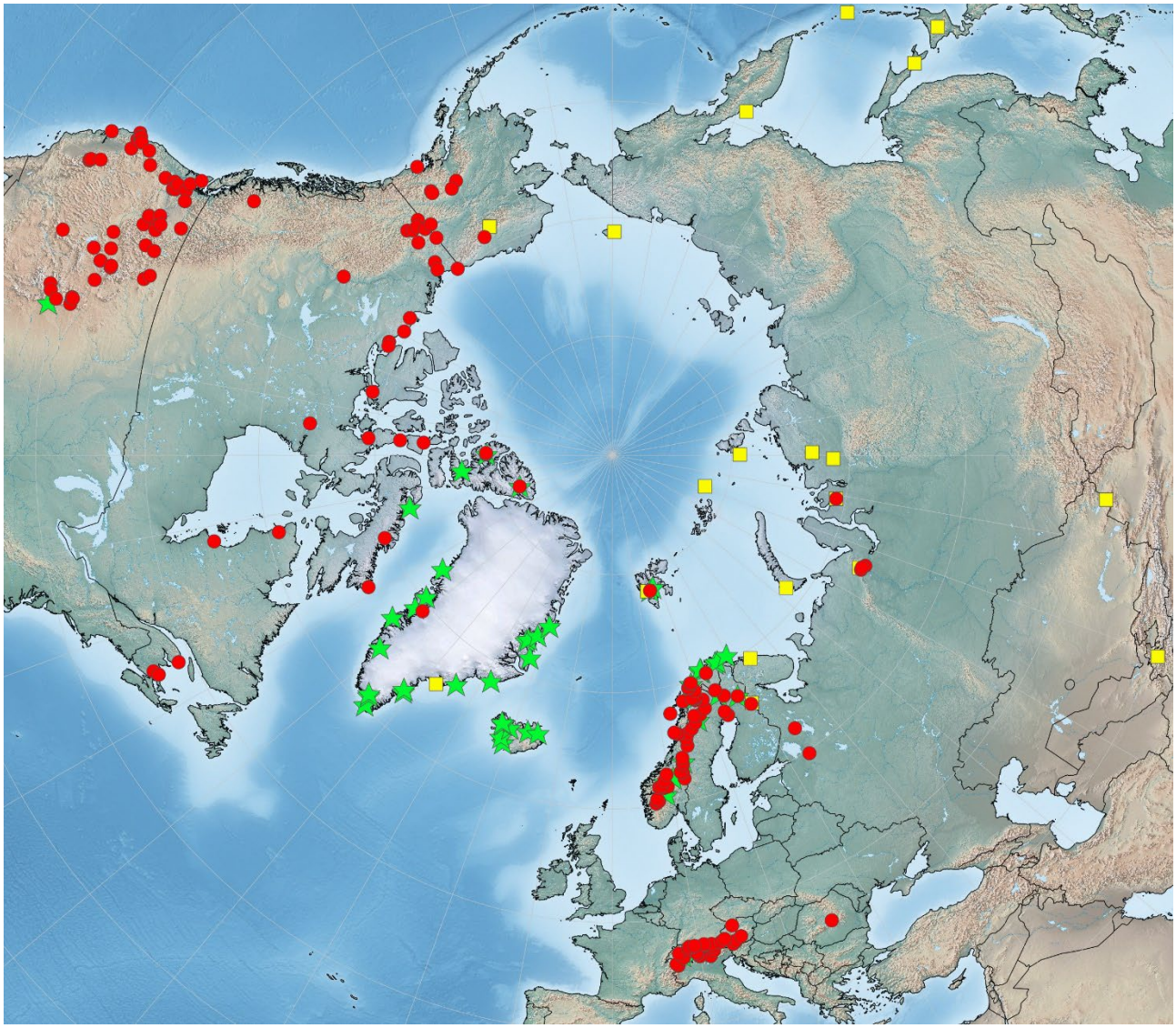
Macrocyclic hetereuform – 0-I / II-III. Spermogonia amphigenous, honey-coloured. **Aecia** hypophyllous in circular clusters on thickened, yellow to orange, diameter 3-4 mm spots, on the petioles and stems in elongate clusters, deeply embedded in host tissue, not confluent, pustulate, hemispheric, diameter 0.3-0.7 mm, long covered by the epidermis, opening with a pore or split, peridium fragile. Spores yellow-orange, subglobose to ovoid, 18-32 × 15-28 µm, wall 2-4 µm thick, finely verrucose. **Uredinia** hypophyllous, on light yellow spots, scattered, round, diameter 0.3-1 mm, soon naked, ruptured epidermis not apparent, pulverulent, yellow-red or cinnamon brown. Spores subglobose to broadly ellipsoid, 20-32 × 14-26 µm, wall pale yellow or cinnamon brown, 1.5-2.5 µm thick, finely echinulate, pores 5-7, inconspicuous, scattered. **Telia** hypophyllous, on pale or yellowish spots, scattered or in circinate groups, round, diameter 0.3-0.5 mm, soon naked, ruptured epidermis inconspicuous, pulverulent, dark brown or almost black. Spores 2-celled, ellipsoid to oblong, ends rounded, not or slightly constricted at septum, yellow-brown, 18-42 × 14-25 µm, wall chestnut brown, 1-2 µm thick, smooth or with a few fine warts arranged in straight or curved lines in various directions, pore of upper cell apical to 1/3 depressed, pore of lower cell 1/4 to 3/4 depressed from septum, sometimes elsewhere, caps indistinct, pedicel hyaline, short to very short, fragile, deciduous.

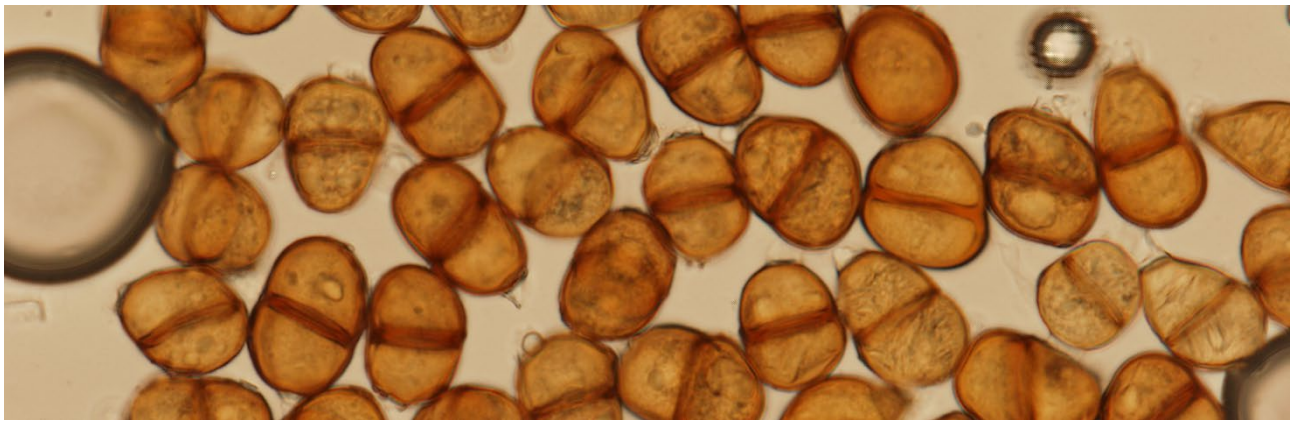
Host plants

0-I, **Apiaceae**.*
II-III, **Polygonaceae**.*

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic AK, CAN, GR, IS, Svalbard, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (AK, CAN, USA), the Alps (DE, FR, CH, AT, SI, IT), the Carpathians (RO), Dovre (NO), the Scandinavian Mts. (SE), the Urals, the Altai Mts., Kamchatka, and Sakhalin (RU), C-Asia, and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia brachypodii **J. Lind; C-F-155819; Sweden**

Puccinia brachypodii G.H. Otth

Syn.: *Puccinia poae-nemoralis* G.H. Otth; *P. deschampsiae* Arthur, incl. *P. arrhenatheri* (Kleb.) Erikss., *P. airae* (Lagerh.) Mayor & Cruchet; *P. poae-sudeticae* Jørst.; *P. distichophylli* E. Fisch.

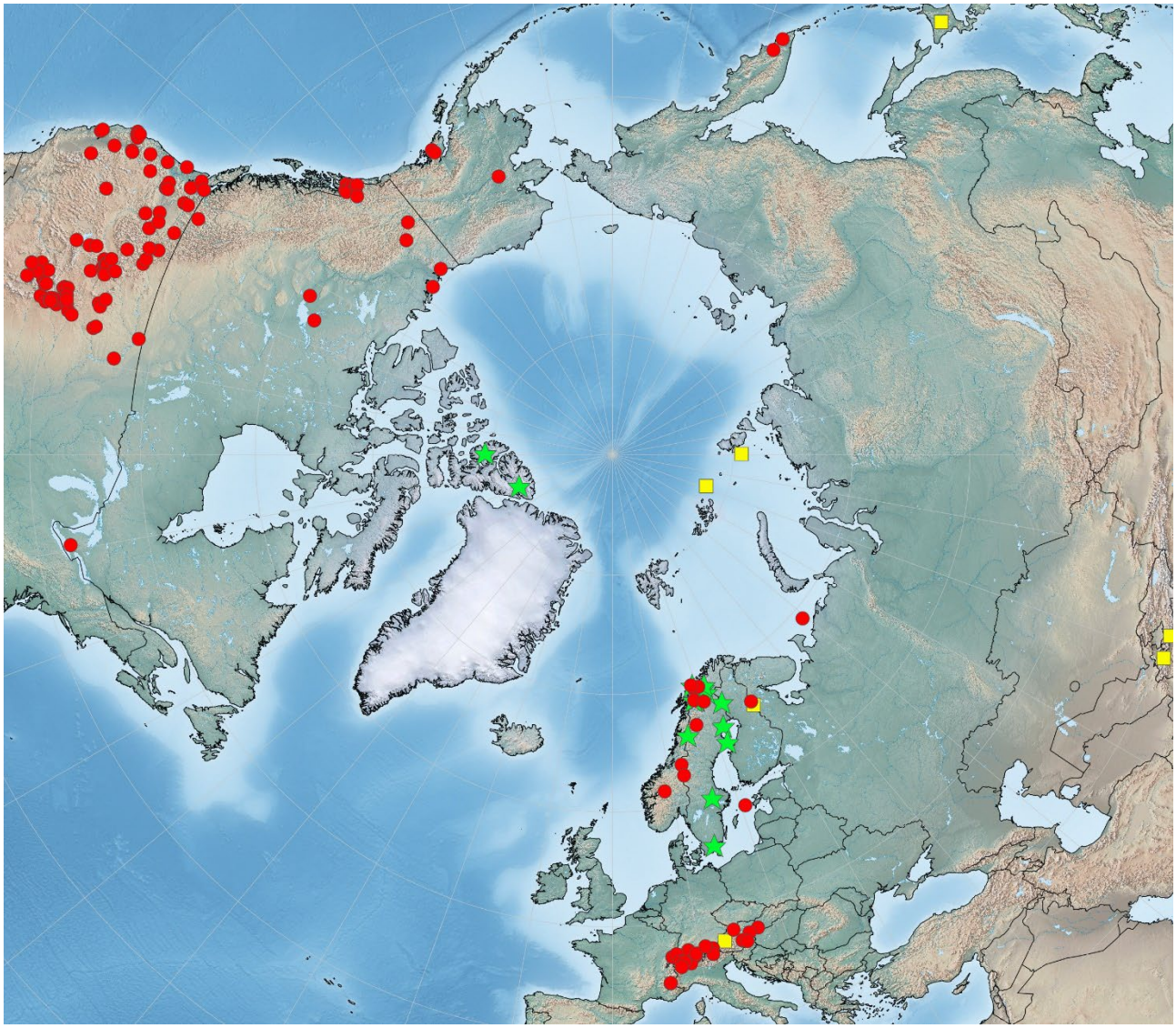
Macrocyclic hetereuform – [0-Is] / II-III. Infections local or systemic and then initiating witches' brooms. **Spermogonia** epiphyllous or amphigenous, occasionally also on the flowers, on orange-red spots, scattered, yellow or brown-black. **Aecia** usually hypophyllous, on small, yellow spots, usually scattered, on older leaves occasionally also in groups, cylindrical or cupulate, peridium pale yellow, rather thick, not revolute, slightly or not torn. Spores subglobose to ellipsoid, (19-)22-32 × 16-24 µm, wall yellow to hyaline, 1 µm thick, finely verrucose. **Uredinia** mostly epiphyllous, scattered or in rows (*Brachypodium*), often on pale yellow or violet brown spots, long covered by the epidermis, then naked, pulverulent, yellow-brown to orange-brown, mixed with many clavate to capitate paraphyses, often with a neck under the head, hyaline to light yellow-brown, 30-80(-100) × 11-19(-28) µm, wall 2.5-5 µm thick, at the apex sometimes thickened to 10(-15) µm. Spores ellipsoid or obovoid, (17-)22-30(-36) × 17-25(-29) µm, wall approx. (1-)2-2.5 µm thick, finely echinulate, pores (5-)7-12, scattered. **Telia** usually hypophyllous, occasionally amphigenous, confluent, punctate or linear, up to 0.5 mm long, long covered by the epidermis, then naked and pulverulent, dark brown. Spores (1-)2-celled, the 2-celled irregular of shape, ellipsoid, subclavate, ovoid, apex truncate, pointed, often laterally, undulate, base tapering, barely constricted at septum, yellow-brown, at apex darker, 25-50(-80) × 15-25 µm, wall light brown, 1-1.5 µm, apex up to 2.5-10 µm thick, smooth, pores inconspicuous, pedicel pale brown but brown at spore attachment, short, persistent.

Host plants

[0-I, Berberidaceae: *Berberis* and *Mahonia*; these hosts are absent in cold regions and not obligatory to complete the life cycle**]**
II-III, **Poaceae**.*

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic AK, CAN, NO, SE, FI, and RU, and from alpine regions of the Alps (DE, FR, CH, AT, SI, IT), Dovre (NO), the Scandinavian Mts. (SE), C-Asia, Kamchatka (RU), and Hokkaido (JP).



Puccinia: Pucciniaceae: Pucciniales

Puccinia campanulae **A. & P. Koskela; C-F-156022; Finland**

Puccinia campanulae Carmich.

Syn.: *Puccinia campanulae-scheuchzeri* Gaüm. & Jaag

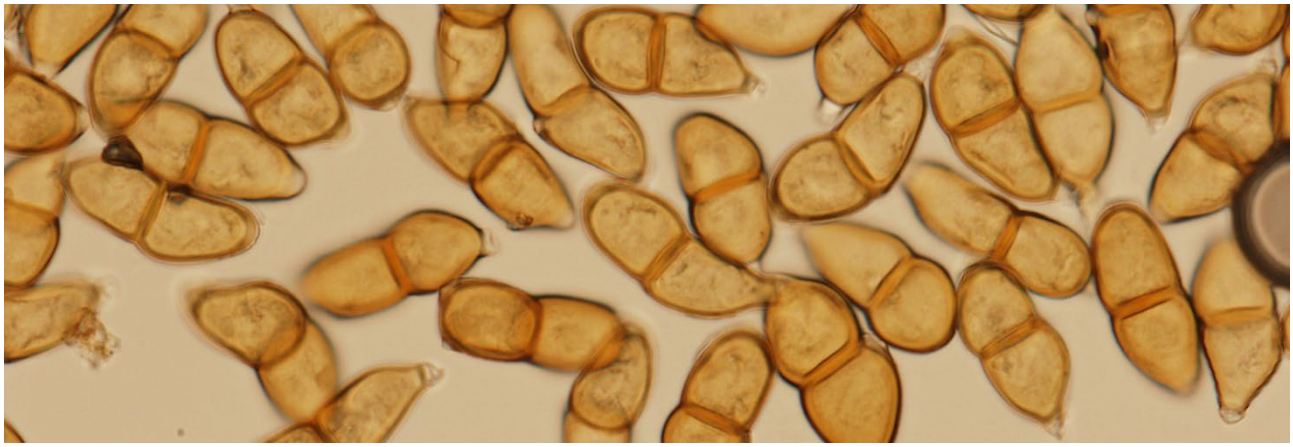
Microcyclic form – III. Telia hypophyllous, occasionally epiphyllous and on the petioles and stems, scattered or frequently in concentric groups, mainly on the stems confluent, long covered by the epidermis, then surrounded by the persistent epidermis, pulverulent, rusty brown or dark brown. Spores (1-)2-celled, the 2-celled ellipsoid, oblong or short fusoid, often irregular, moderately constricted at septum, (19-)25-45 × (10-)12-22 µm, wall pale yellow, pale brown or golden brown, 1.5-2.5 µm, at apex 4-6 µm thick, finely verrucose especially in top cell, pore of upper cell apical and covered with a hyaline or subhyaline, 2-4 µm high cap, pore of lower cell against or close to septum and covered with a similar cap or cap inconspicuous, pedicel hyaline, 0.5× spore length or shorter, fragile.

Host plants

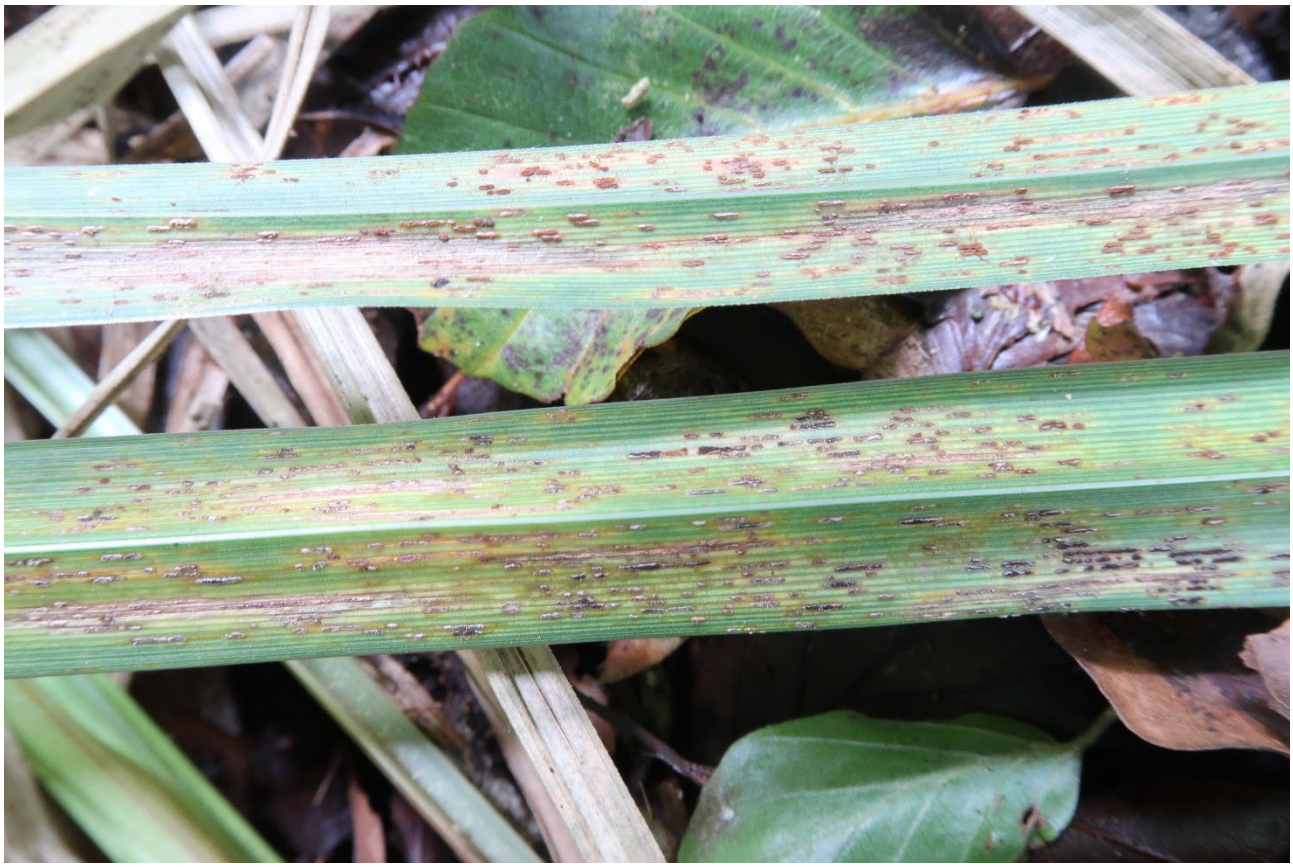
III, **Campanulaceae:** *Campanula* species, e.g. *Campanula rotundifolia*; and *Jasione montana.*

Distribution

Arctic-alpine; Cosmopolitan; type 1; recorded from arctic NO, SE, and RU, and from alpine regions of the Rocky Mts. (CAN, USA), the Alps (CH), the Scandinavian Mts. (SE), and Hokkaido (JP).



Puccinia: Pucciniaceae: Pucciniales



Puccinia caricina **HK (mat. lost); Fungi Ex. Fenn. 810 (micro); C-F-165752; Finland**

Puccinia caricina DC.

Syn.: *Puccinia pringsheimiana* Kleb.

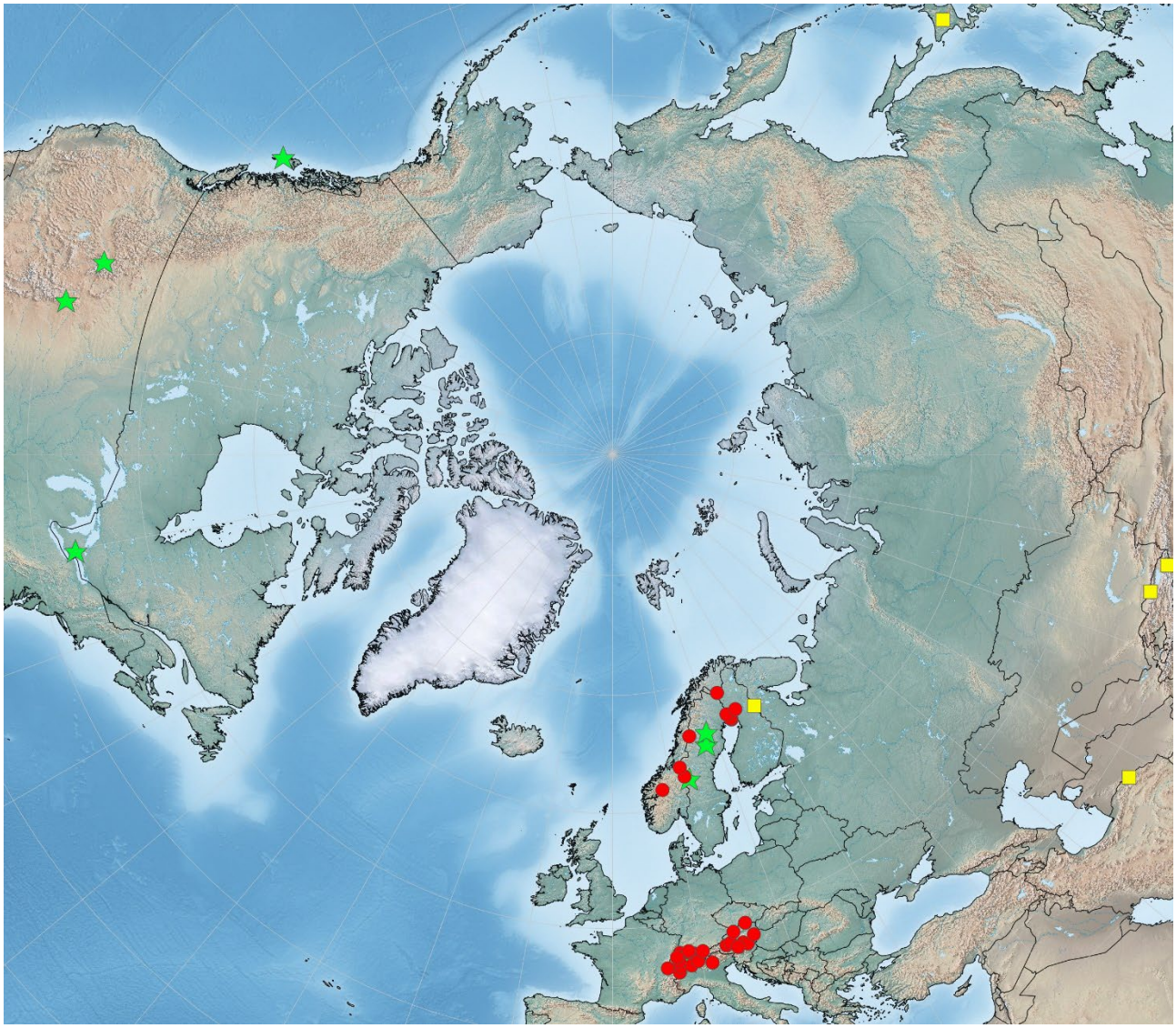
Macrocyclic hetereuform – 0-I / II-III. Spermogonia epiphyllous, honey-coloured. **Aecia** usually hypophyllous, often on the petioles and stems, there causing strong swellings and malformations, also on the fruits of *Ribes*, on red, yellow to purple spots, in dense, often large groups, cupulate, peridium revolute, torn, white. Spores ovoid or ellipsoid, 16-26 × 12-20 µm, wall hyaline, 1 µm thick, very finely and very densely verrucose. **Uredinia** usually hypophyllous, also epiphyllous, opposite to yellow spots, scattered, oblong, 0.2-0.5(-1) mm long, surrounded by the ruptured epidermis, pale to dark brown. Spores yellow-brown, subglobose to ovoid, 24-36(-40) × 15-25 (-30) µm, wall light brown, 1.2-1.7(-3) µm thick, sparsely echinulate, pores 2-3(-4), equatorial. **Telia** usually hypophyllous, scattered or in linearly arranged groups, punctate, confluent, up to 1 mm long, firm, somewhat pulvinate, soon naked and surrounded by the ruptured epidermis, dark brown. Spores (1-)2-celled, the 2-celled clavate, apex rounded, base tapering, the upper cell usually wider and shorter than the lower cell, 33-71 × 13-23 µm, slightly to moderately, less frequently barely constricted at septum, wall brown, darker at apex, 1.5-2 µm, at apex up to 4-15 µm thick, smooth, pores inconspicuous, pedicel yellowish, 0.5-1× spore length or somewhat longer, persistent.

Host plants

0-I, **Grossulariaceae:** *Ribes alpinum* and *Ribes spicatum*; host change is not necessary to complete the life cycle.
II-III, **Cyperaceae**.*

Distribution

Alpine-boreal; circumpolar; type 7; recorded from alpine regions of the Rocky Mts. (CAN, USA), the Alps (DE, FR, CH, AT, SI, IT), Dovre (NO), the Scandinavian Mts. (SE), Kazakhstan, C-Asia, and Hokkaido (JP).



Puccinia: Pucciniaceae: Pucciniales

Puccinia claytoniae **Kharkevich & Booch; VLA-5774; Russia (Kamchatka)**

*Puccinia claytoniae** Thüm.

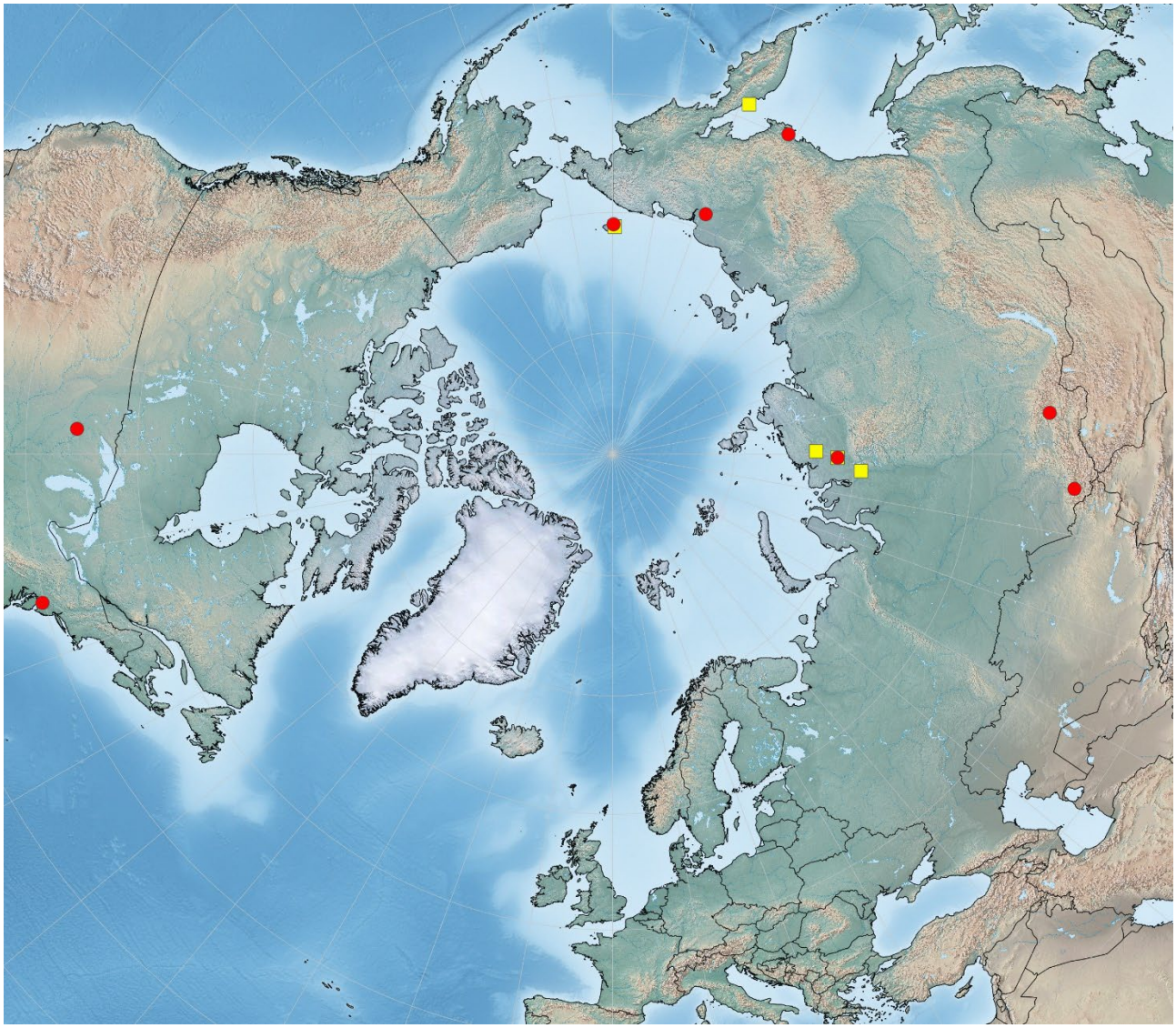
Brachycyclic form – I-III. Aecia amphigenous or on the petioles and fruits, peridium bullate to short-cupulate. Spores globose to ellipsoid, 17-26 × 14-21 µm, wall hyaline, 0.5-1 µm thick, finely verrucose, pores inconspicuous. **Telia** amphigenous and on the petioles and fruits, pulverulent, dark brown. Spores 2-celled, narrowly to broadly ellipsoid, ends rounded, base rarely tapering, not or slightly constricted at septum, 25-34 × 17-24 µm, wall yellow-brown or paler, 1-1.6 µm thick, smooth, pore of upper cell apical or slightly depressed and covered with a small, hyaline cap, pore of lower cell 1/4 to 3/4 depressed from septum and covered with an inconspicuous cap, pedicel hyaline, fragile, deciduous.

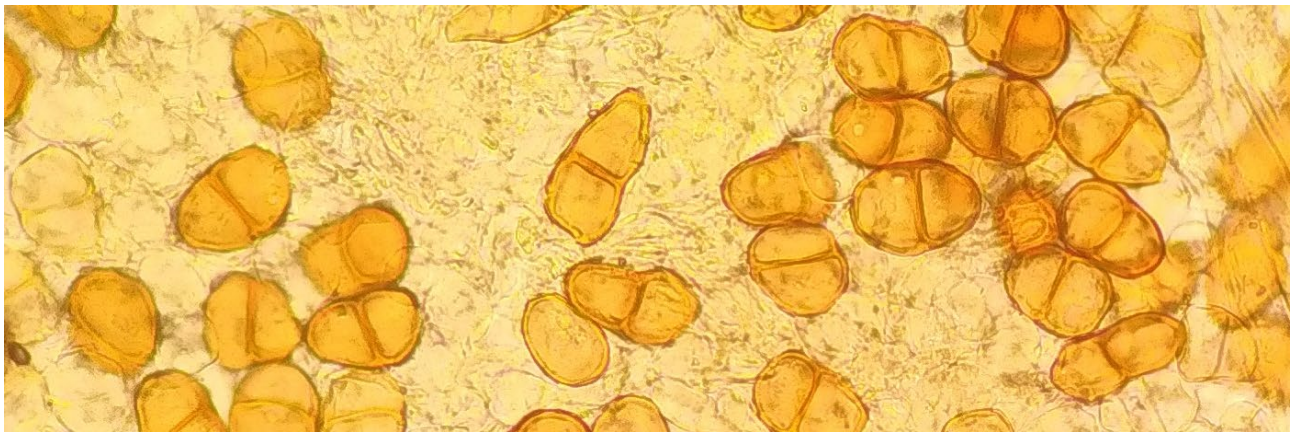
Host plants

I-III, **Montiaceae:** *Claytonia* species, e.g. *Claytonia acutifolia*, *C. arctica*, and *C. joanneana*.

Distribution

Arctic-alpine; circumpolar; type 5; recorded from arctic central Russia and Chukotka (RU), and from the (sub)alpine USA, the Altai Mts. and Kamchatka (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia claytoniicola **Calder & Savile, DAOM 38953; C-F-155385; Canada**

Puccinia claytoniicola Cummins

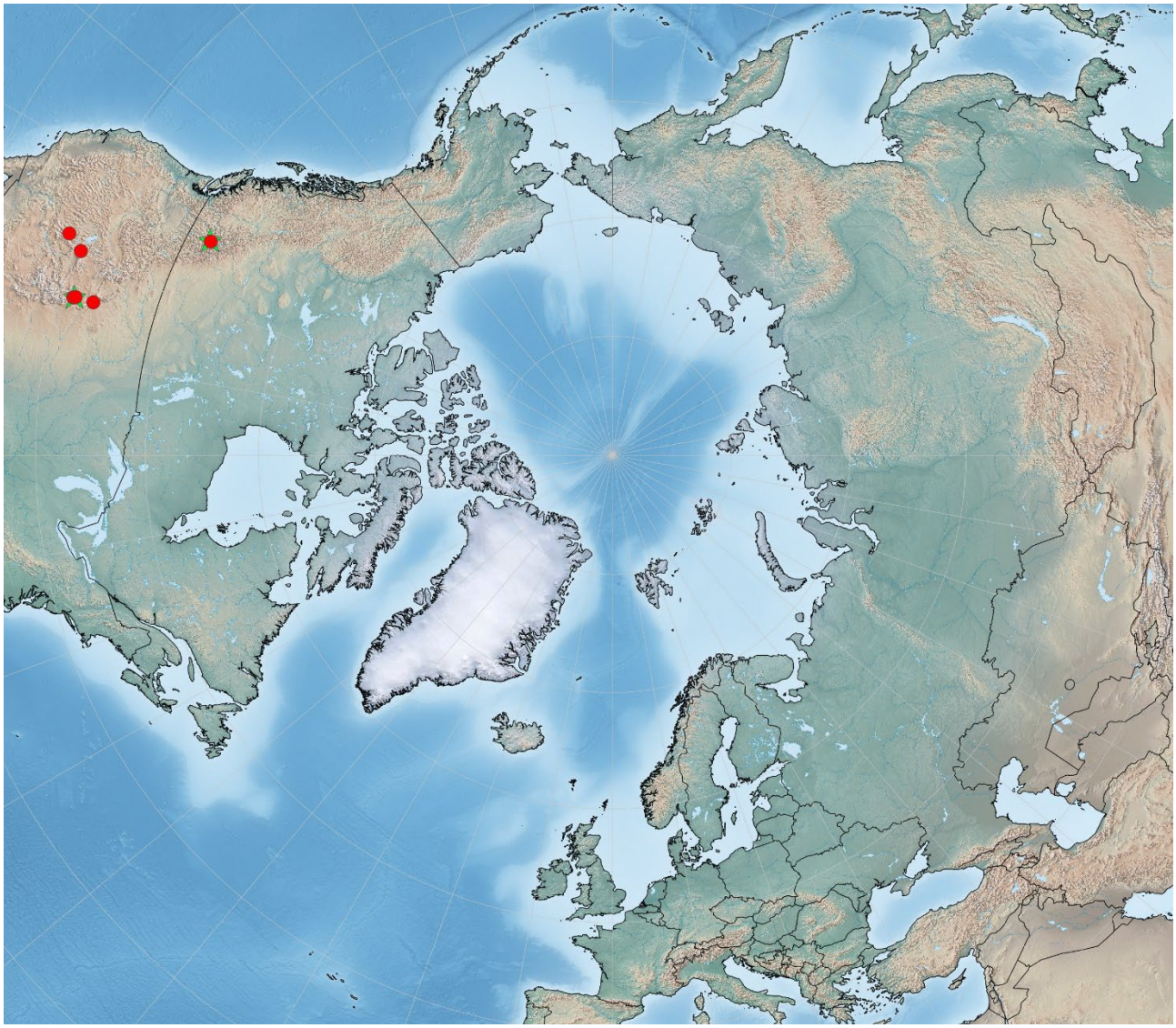
Microcyclic form – IIIs. Systemic, plants somewhat malformed. **Telia** amphigenous, densely crowded in up to diameter 2 cm groups or covering the whole surface, pulverulent, cinnamon brown. Spores 2-celled, ellipsoid, rarely oblong-ellipsoid, barely constricted at septum, 22-31 × 14-18 µm, wall cinnamon brown, 1.5 µm thick, verrucose with warts in 4-8 longitudinal lines, pore of upper cell apical, pore of lower cell basal, both pores covered with a small cap, pedicel hyaline, short, fragile.

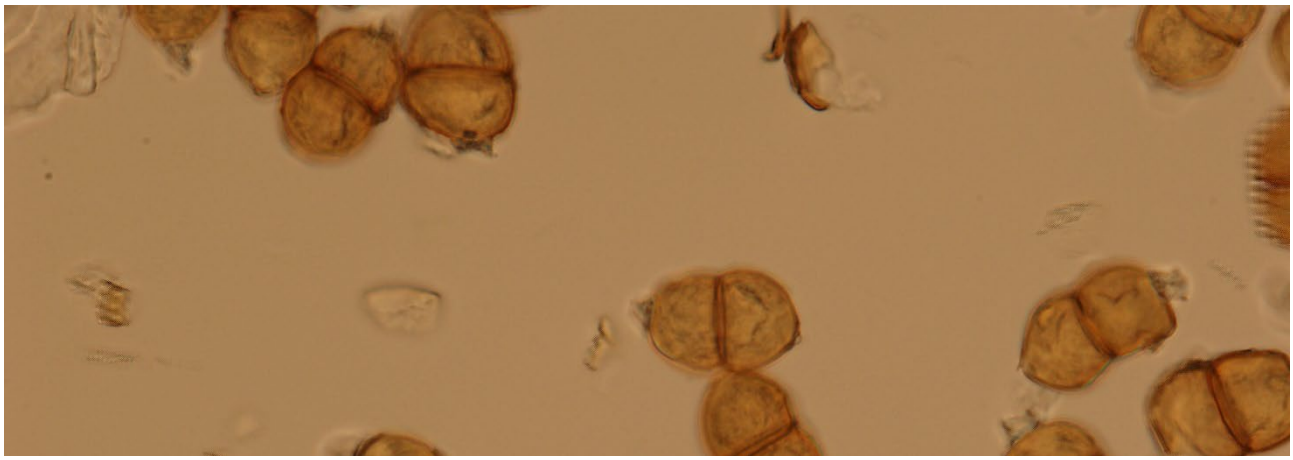
Host plants

III, **Montiaceae:** *Claytonia* species, e.g. *Claytonia lanceolata.*

Distribution

Alpine; North American; type 14; only recorded from the alpine Rocky Mts. in Canada and the USA.





Puccinia: Pucciniaceae: Pucciniales

Puccinia cnici-oleracei **E. Ohenoja; C-F-156708; Finland**

Puccinia cnici-oleracei Pers.*

Syn: *P. asteris* Duby

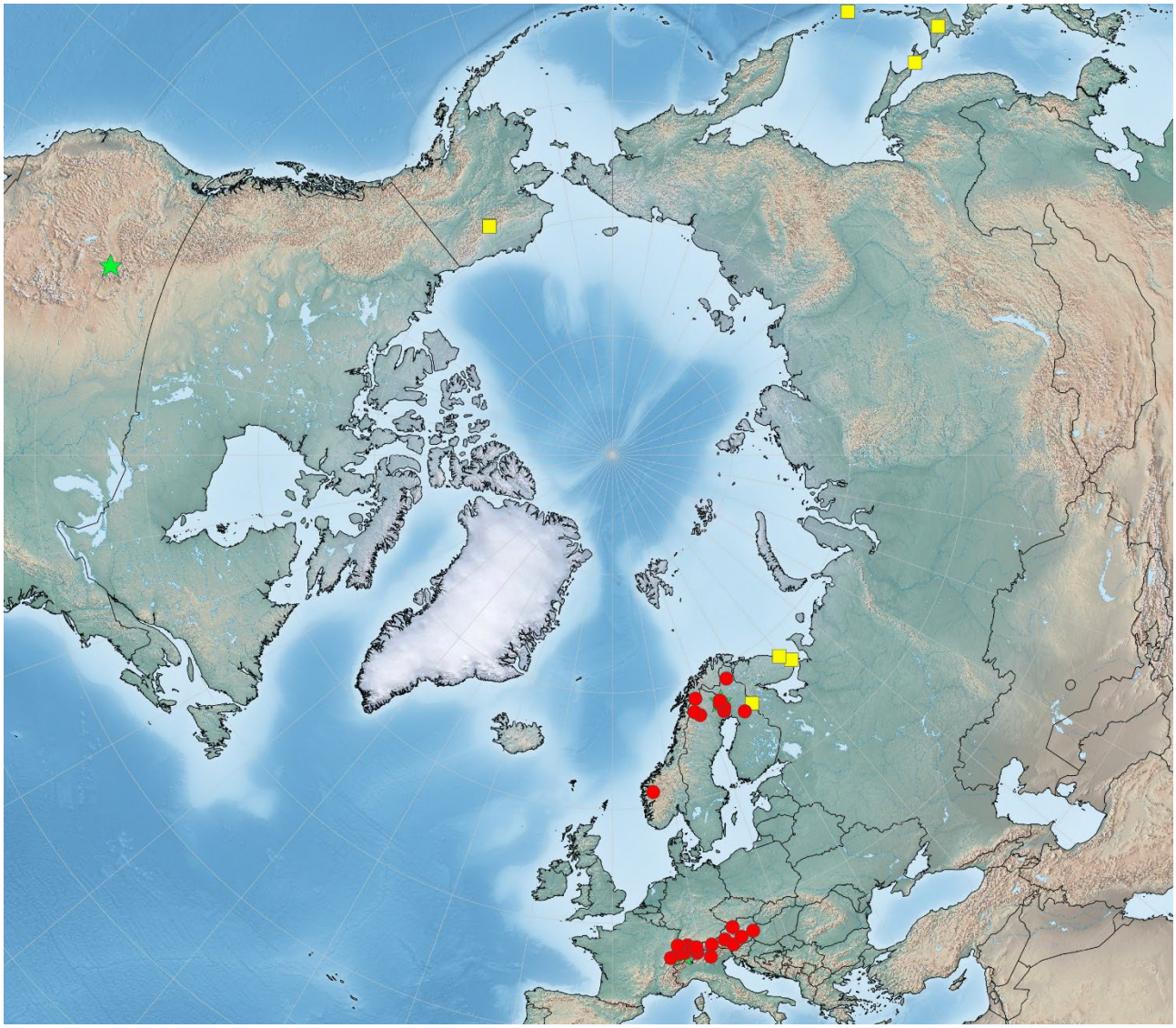
Microcyclic form – IIIg. Telia hypophyllous, a few epiphyllous, and on the stems, on pale yellow spots of diameter 2-10 mm, in large circinate groups, confluent, on the leaves also scattered, round, diameter 0.2-0.5 mm, rather long covered by the epidermis, compact, pulvinate, dark brown, later cinereous by presence of basidiospores. Spores germinating readily, (1-)2-celled, the 2-celled ellipsoid, oblong or clavate, apex rounded, acute or obtuse, base usually tapering, moderately constricted at septum, yellow-brown, 30-58(-65) × 14-23(-25) µm, lower cell somewhat longer than the upper cell, wall pale yellow-brown to pale red-brown, apex often darker, (1-)1.5-2.5 µm, at apex up to 5-14 µm thick, smooth, pore of upper cell apical, pore of lower cell against septum, but sometimes inconspicuous, caps inconspicuous, pedicel hyaline, subhyaline or yellowish, about 0.5-1× spore length, persistent.

Host plants

III, **Asteraceae:** *Achillea millefolium*, *A. ptarmica*, *Artemisia* species, e.g. *Artemisia abrotanum*, *A. campestris*, and *A. vulgaris*, *Aster linosyris*, *A. tripolium*, *Chrysanthemum parthenium*, and *Cirsium* species, e.g. *Cirsium helenioides*, *C. heterophyllum*, and *C. oleraceum*.

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic AK, NO, FI, and RU, and from alpine regions of the Rocky Mts. (USA), the Alps (FR, CH, AT), Dovre (NO), the Scandinavian Mts. (SE), Sakhalin (RU), and Hokkaido (JP).



Puccinia: Pucciniaceae: Pucciniales

Puccinia columbiensis **J. A. Parmelee, DAOM 130310; C-F-155191; Canada (Alberta)**

Puccinia columbiensis Ellis & Everh.

Microcyclic form – III. Telia chiefly hypophyllous on yellowish, slightly thickened spots, crowded in circinate groups of diameter 2-10 mm, round, diameter 0.25-1.5 mm, erumpent, soon naked and surrounded by the ruptured epidermis, dark brown to black. Spores 2-celled, clavarioid, oblong or ellipsoid, apex truncate or tapering, base rounded or tapering, slightly constricted at septum, 32-55 × 15-24 µm, wall chestnut brown in upper cell, paler in lower cell, 1-2 µm, at apex 7-15 µm thick, smooth, pores inconspicuous, pedicel hyaline or subhyaline, up to 1× spore length.

Host plants

III, **Asteraceae:** *Agoseris aurantiaca*, *A. glauca, Hieracium* species, e.g. *Hieracium albertinum*, *H. cynoglossoides* and *H. scouleri*, *Krigia biflora, Nabalus racemosus,* and *N. trifoliolatus.*
Onagraceae: *Oenothera biennis*.

Distribution

Alpine; North American; type 8; only recorded from the Rocky Mts. and Canada (CAN, USA).

Puccinia: Pucciniaceae: Pucciniales

Puccinia conglomerata **HK 20.066; C-F-135621; Bulgaria**

Puccinia conglomerata (F. Strauss) Röhl.

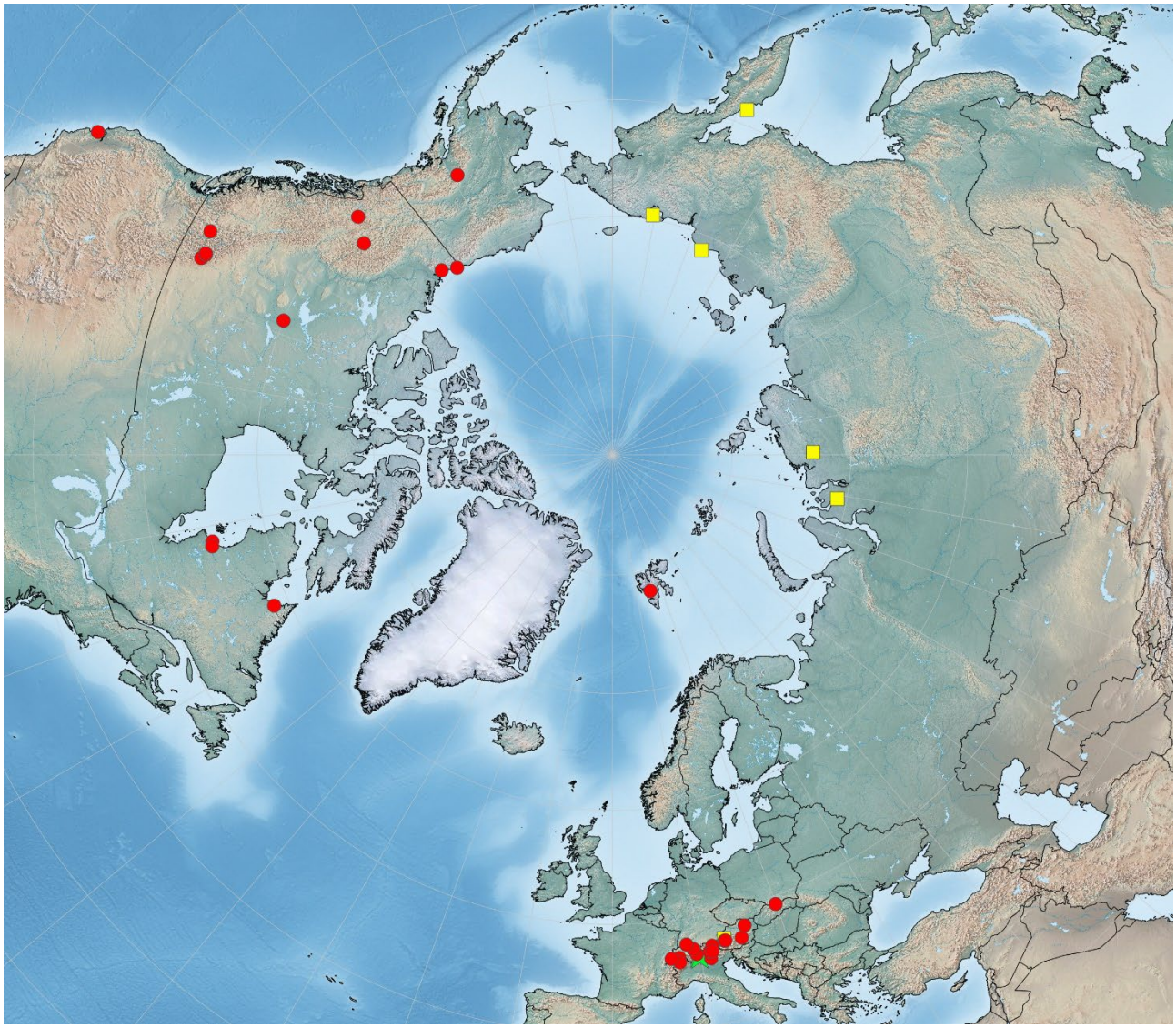
Microcyclic form – III. Telia hypophyllous, occasionally epiphyllous and on the petioles, crowded in concentric, diameter 1 cm groups on pale, whitish or yellowish spots, diameter 0.2-0.5 mm, soon naked and surrounded by the ruptured epidermis, pulverulent, chestnut brown. Spores 2-celled, shape variable, narrowly to broadly ellipsoid or oblong, apex obtuse or tapering, base rounded, not or barely constricted at septum, 20-42 × 12-21 µm, wall pale brown, yellowish brown or cinnamon brown, 1-2 µm thick, smooth, pore of upper cell usually apical, pore of lower cell against or close to septum, occasionally somewhat lower, both pores covered with a conspicuous, 2-4 µm high, hyaline to pale yellow cap, pedicel hyaline, short, deciduous.

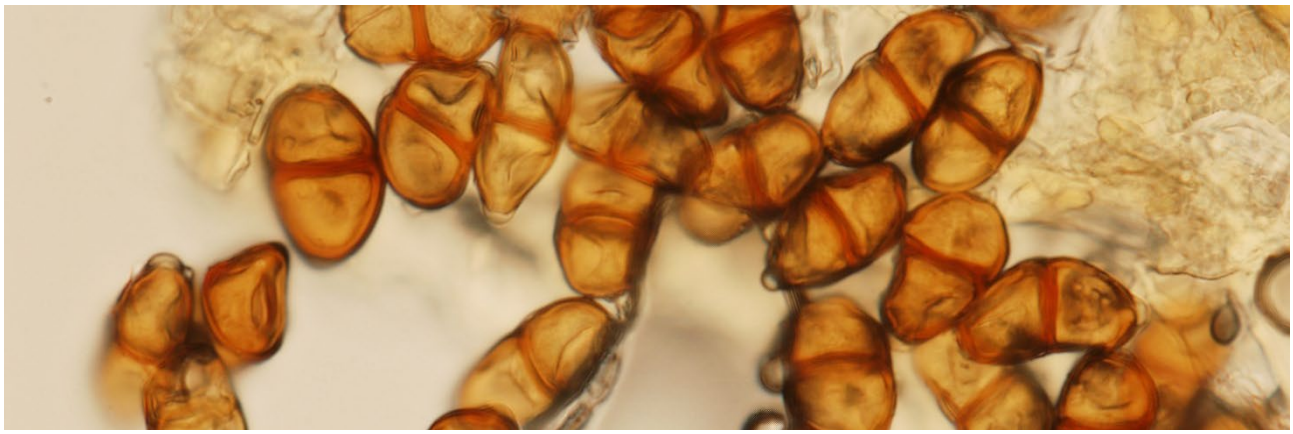
Host plants

III, **Asteraceae:** In the Alps and Asia: *Endocellion glaciale*, *Homogyne alpina*, *H. discolor*, *Senecio* species, e.g. *Senecio cordatus*, *S. doronicum*, *S. nemorensis*, and *S. ovatus.* In North America: *Petasites frigidus*, *P. palmatus*, *P. sagittatus*, *Prenanthes* species, *Senecio aureus*, *S. lugens*, and *S. taraxacoides.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic CAN, Svalbard, and RU, and from alpine regions of the Alps (DE, FR, CH, AT), the Tatras (PL), and Taymir, Chukotka and Kamchatka (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia crepidicola **Calder & Savile 9270, DAOM 175977; C-F-155398; Canada (BC)**

Puccinia crepidicola Syd. & P. Syd.

Syn.: *Puccinia alpestris* Syd.; *P. blattarioidis* Hazsl.; *P. crepidis-aureae* Syd. & P. Syd.; *P. crepidis-grandiflorae* Hasler; *P. crepidis-montanae* Magnus; *P. crepidis-sibiricae* Lindr.

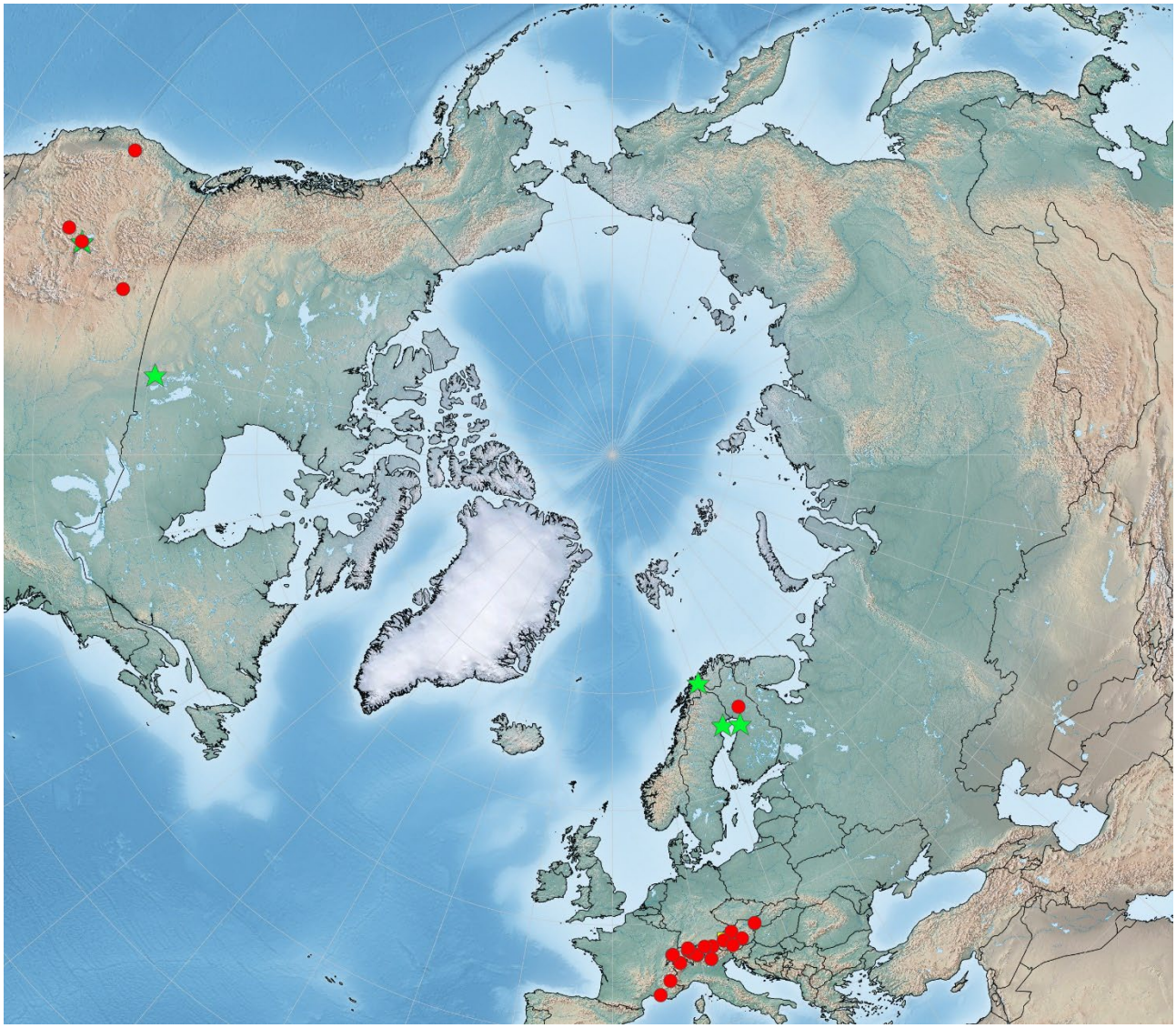
Macrocyclic auteuform – IIs-IIIs. Systemic, shoots grow poorly and do not flower. **Uredinia** amphigenous and on the stems, scattered, small, punctiform, pulverulent, pale brown or cinnamon brown. Spores subglobose to ellipsoid, pale brown, 16-32 × 16-27 µm, wall 1.5-2.5 µm thick, light brown, echinulate, pores 2-3, equatorial. **Telia** as uredinia, but long covered by the epidermis, dark brown to almost black. Spores 2-celled, ellipsoid, ovoid or oblong ovoid, ends rounded, dark brown, not or slightly constricted at septum, 21-45 × 16-31 µm, wall brown, 1-2 µm thick, very finely to finely verrucose, pore of upper cell supraequatorial, pore of lower cell often equatorial, covered with a usually inconspicuous cap, pedicel hyaline, short, deciduous.

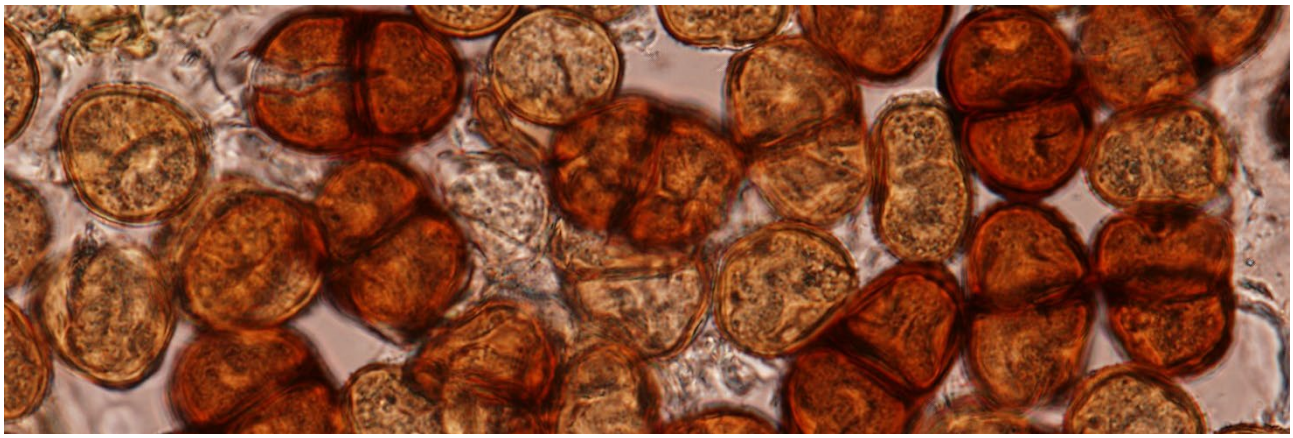
Host plants

II-III, **Asteraceae:** *Crepis*.*

Distribution

(Arctic-)alpine-boreal; circumpolar; type 5; recorded from arctic NO, and from alpine regions of the Rocky Mts. (CAN, USA) and the Alps (DE, FR, CH, AT).





Puccinia: Pucciniaceae: Pucciniales

Puccinia cruciferarum **T. Sørensen; C-F-108049**

*Puccinia cruciferarum** F. Rudolphi, including subsp. *nearctica* Savile & Parmelee, subsp. *borealis* Savile, and subsp. *wyomingensis* Savile

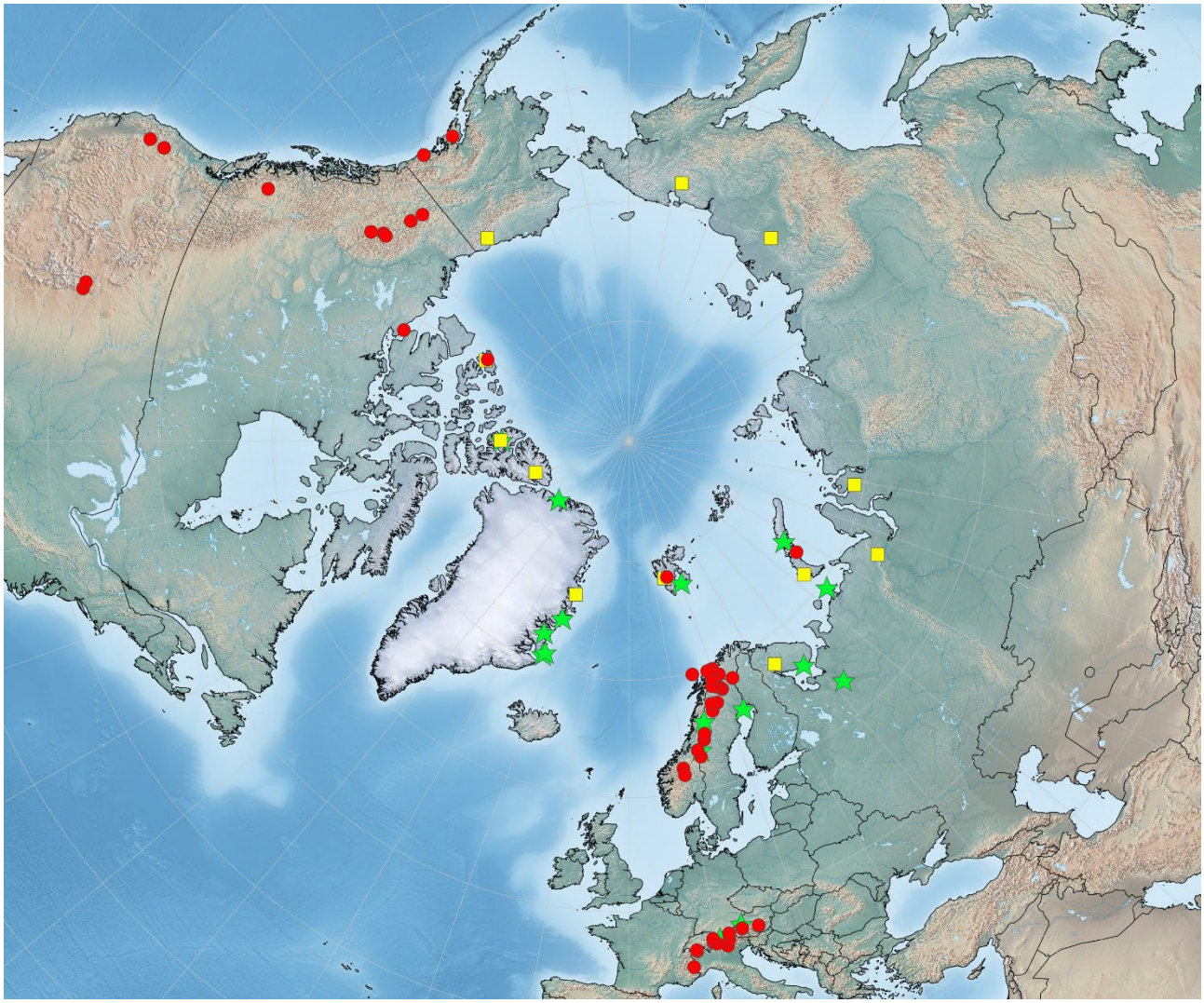
Microcyclic form – IIIg. Telia on all plant parts, scattered, not confluent, roundish or irregular, diameter 1-3 mm, soon naked, pulverulent, reddish brown, chestnut brown or brown, later cinereous by presence of basidiospores, pulverulent. Spores germinating readily, 2-celled, ellipsoid, ends rounded, strongly constricted at septum, 26-45 × 12-24 µm, wall light brown to yellow-brown, 1-2 µm thick, the top part finely verrucose, downward smooth or nearly so, pore of upper cell apical, pore of lower cell against septum or supraequatorial, both pores covered with a conspicuous, hyaline, up to 4.5 µm high cap, pedicel hyaline, short, spores deciduous.

Host plants

III, **Brassicaceae:** *Cardamine* species, i.e. *Cardamine bellidifolia*, *C. cordifolia, C. pratensis*, *C. resedifolia*, and *Lesquerella arctica.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic AK, CAN, GR, Svalbard, NO, and RU, from alpine regions of the Alps (FR, CH, AT), Dovre (NO), the Scandinavian Mts. (SE), and the Urals (RU), and from Novaja Zemlja, Severnaja Zemlja, and Chukotka (RU).



Puccinia: Pucciniaceae: Pucciniales

Puccinia dioicae **Nannfeldt, Fungi Ex. Suec. 1241 & 1242; C-F-155395 & 155397; Sweden**

Puccinia dioicae Magnus

Syn.: *Puccinia firma* Dietel; *P. rupestris* Juel

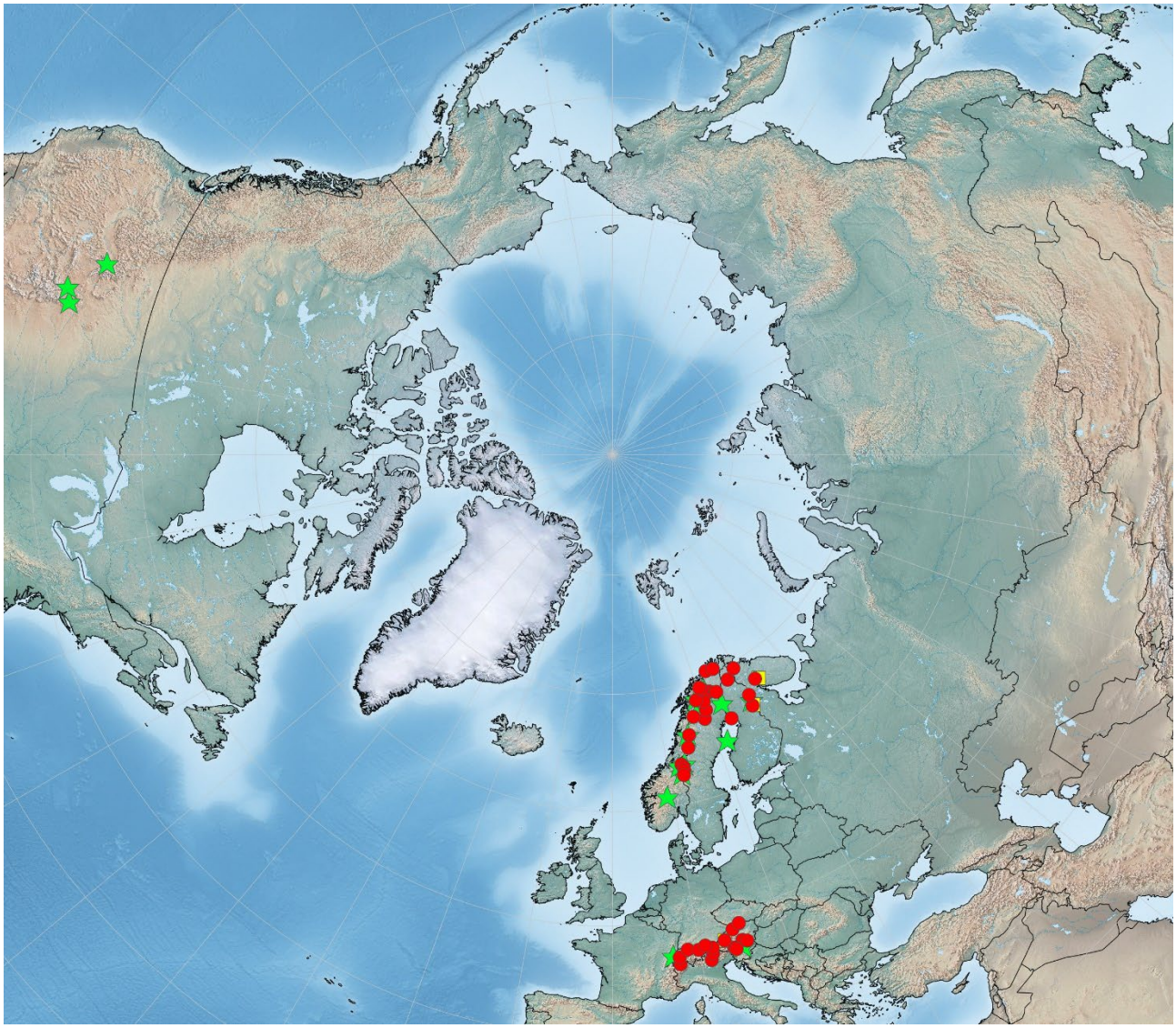
Macrocyclic hetereuform – 0-I / II-III. **Spermogonia** amphigenous, in small clusters on red-yellow spots, honey-coloured. **Aecia** hypophyllous, on round, yellow to brown spots, in groups of diameter 2-5 mm, cupulate, peridial cells up to 25 µm wide. Spores orange, angular-subglobose, 17-25 × 14-19(-21) µm, finely verrucose. **Uredinia** usually hypophyllous, scattered, small, punctate, brown. Spores pale brown, subglobose or broadly ellipsoid, 22-28 × 16-24 µm, wall 2 µm thick, finely echinulate, pores 2, supraequatorial, surrounded by a smooth zone. **Telia** common only if the aecial host is nearby, hypophyllous, scattered, pulvinate, soon naked, black. Spores (1-)2-celled, the 2-celled clavate, chestnut brown, near the apex darker, slightly constricted at septum, 32-60 × 12-22(-25) µm, wall 1.5-2 µm, at apex 4-12 µm thick, smooth, pore of upper cell subapical, pore of lower cell against or close to septum, caps inconspicuous, pedicel hyaline to light brown, up to 50 µm long, persistent.

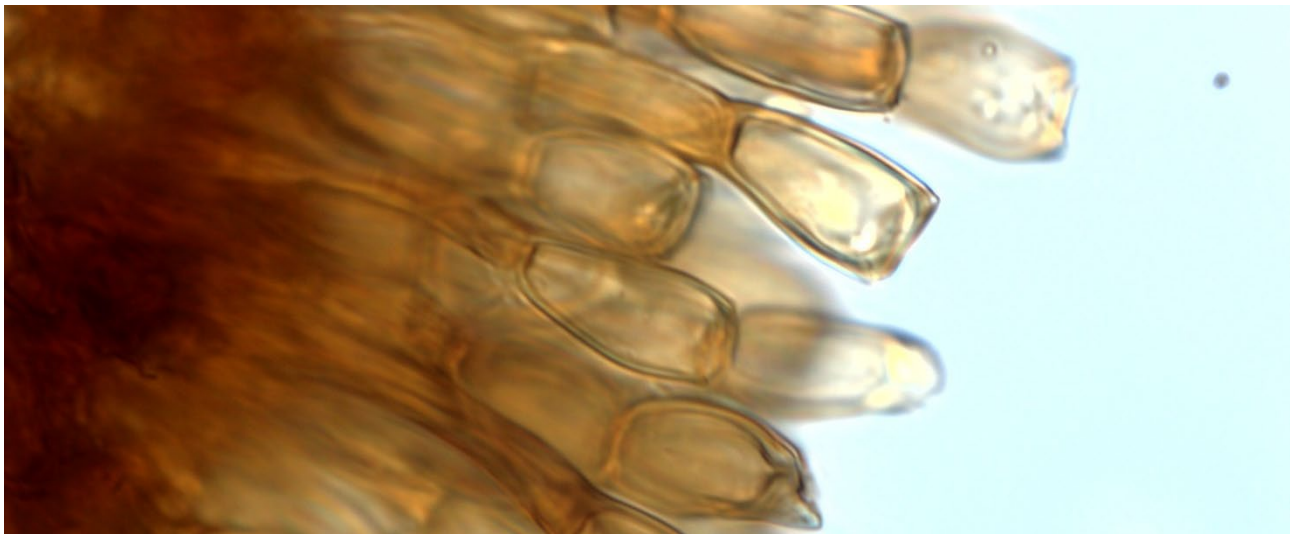
Host plants

0-I, **Asteraceae*** and **Onagraceae**.*
II-III, **Cyperaceae:** *Carex.**

Distribution

Arctic-alpine-boreal; circumpolar; type 5; recorded from arctic NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (USA), the Alps (FR, CH, AT, SI, IT), Dovre (NO), and the Scandinavian Mts. (SE).





Puccinia: Pucciniaceae: Pucciniales

Puccinia dolomitica **G. Negrean, Herb. Mycol. Roman. 2401; C-F-155407; Romania**

Puccinia dolomitica Kabát & Bubák

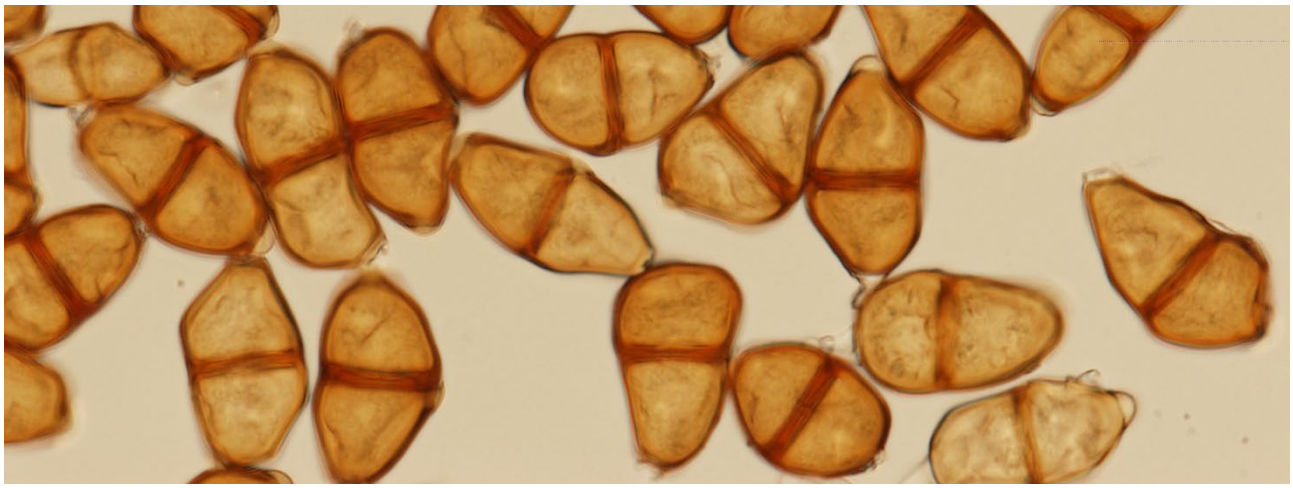
Microcyclic form – III. Telia hypophyllous, mainly on the veins of the lower leaves, and on distorted petioles and stems, confluent to large groups, long covered by the epidermis, opening by a split, cinnamon brown. Spores 2(-3)-celled, ellipsoid, ovoid, oblong or irregular, apex rounded or slightly tapering, not or slightly constricted at septum, lower cell often somewhat longer than the upper cell, 26-44 × 15-26(-40) µm, wall brown or chocolate brown, 1-2 µm thick, smooth or inconspicuously punctate, pore of upper cell apical or slightly depressed, pore of lower cell near septum or to 1/3 depressed, both pores covered with a conspicuous, hyaline, 1.5-2 µm high cap, pedicel hyaline, short, up to 40 µm long, deciduous.

Host plant

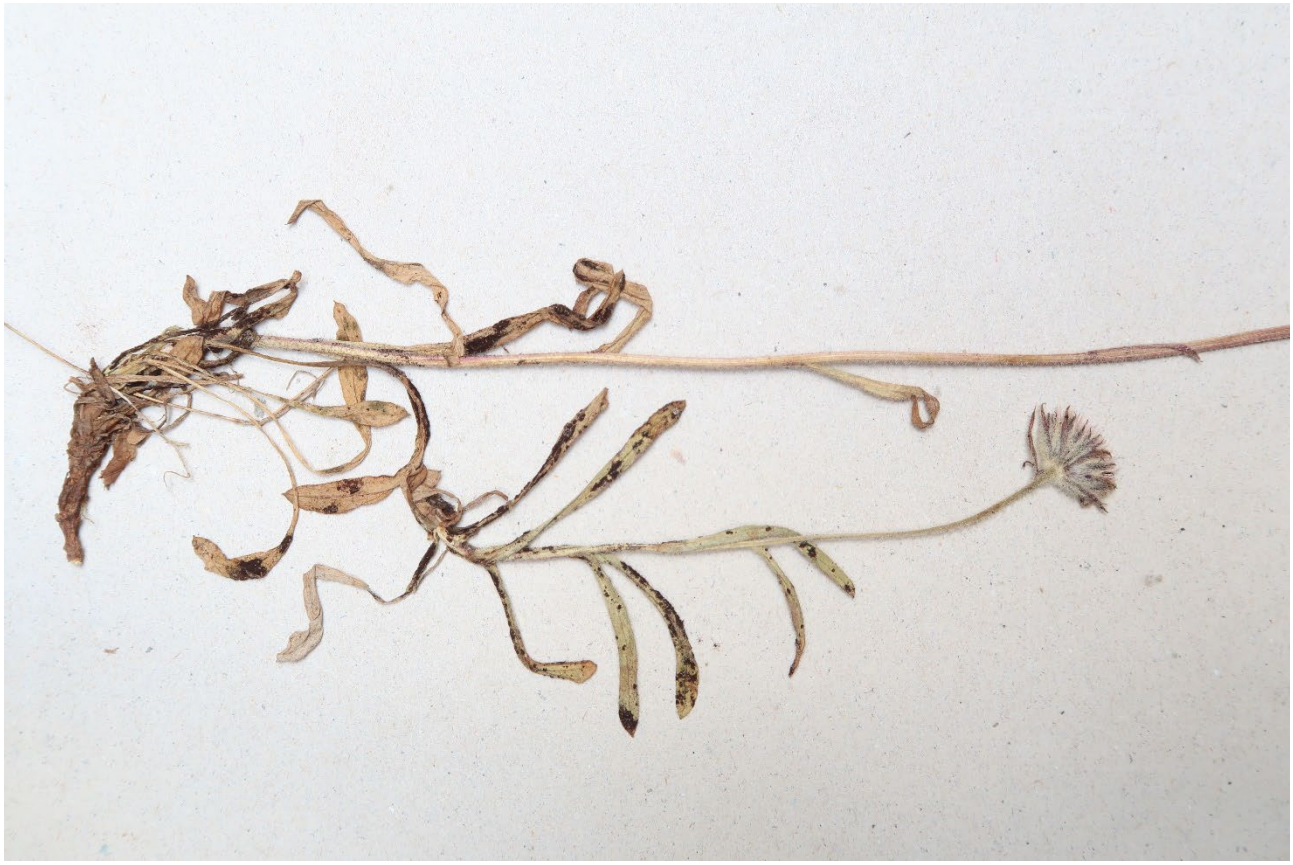
III, **Apiaceae:** *Anthriscus sylvestris.*

Distribution

Alpine; Eurasian; type 15; only recorded from the Alps (IT), apparently very rare.



Puccinia: Pucciniaceae: Pucciniales



Puccinia dovrensis **L. Holm 353, Fungi Ex. Suec. 1625; C-F-155206; Sweden**

Puccinia dovrensis A. Blytt

Microcyclic form – III. Telia amphigenous, soon confluent to larger groups, roundish to elongate, soon naked, pulverulent, dark brown. Spores 2-celled, ellipsoid, ends usually rounded, moderately constricted at septum, 32-52 × 19-25 µm, wall ca. 2 µm, in upper cell gradually thickening to 3-5 µm thick at apex, finely and densely, towards the base very finely verrucose, pore of upper cell apical, pore of lower cell against septum, caps indistinct, pedicel often yellowish, fragile.

Host plants

III, **Asteraceae:** *Erigeron* species, e.g. *Erigeron acre*, *E. alpinus*, *E. boreale*, *E. politum*, *E. unalaschkense*, and *E. uniflorum*.

Distribution

Arctic-alpine; circumpolar; type 5; recorded from arctic NO, and from alpine regions of the Rocky Mts. (USA), the Alps (CH), Dovre (NO), the Scandinavian Mts. (NO), the Altai Mts. (RU), and Hokkaido (JP).

Puccinia: Pucciniaceae: Pucciniales

Puccinia drabae **HK 18.127; C-F-111269**

Puccinia drabae F. Rudolphi

Syn.: *Puccinia ambiens* Rostr. (cf. Rostrup in Grønlund 1879); *P. cardamines-bellidifoliae* Dietel

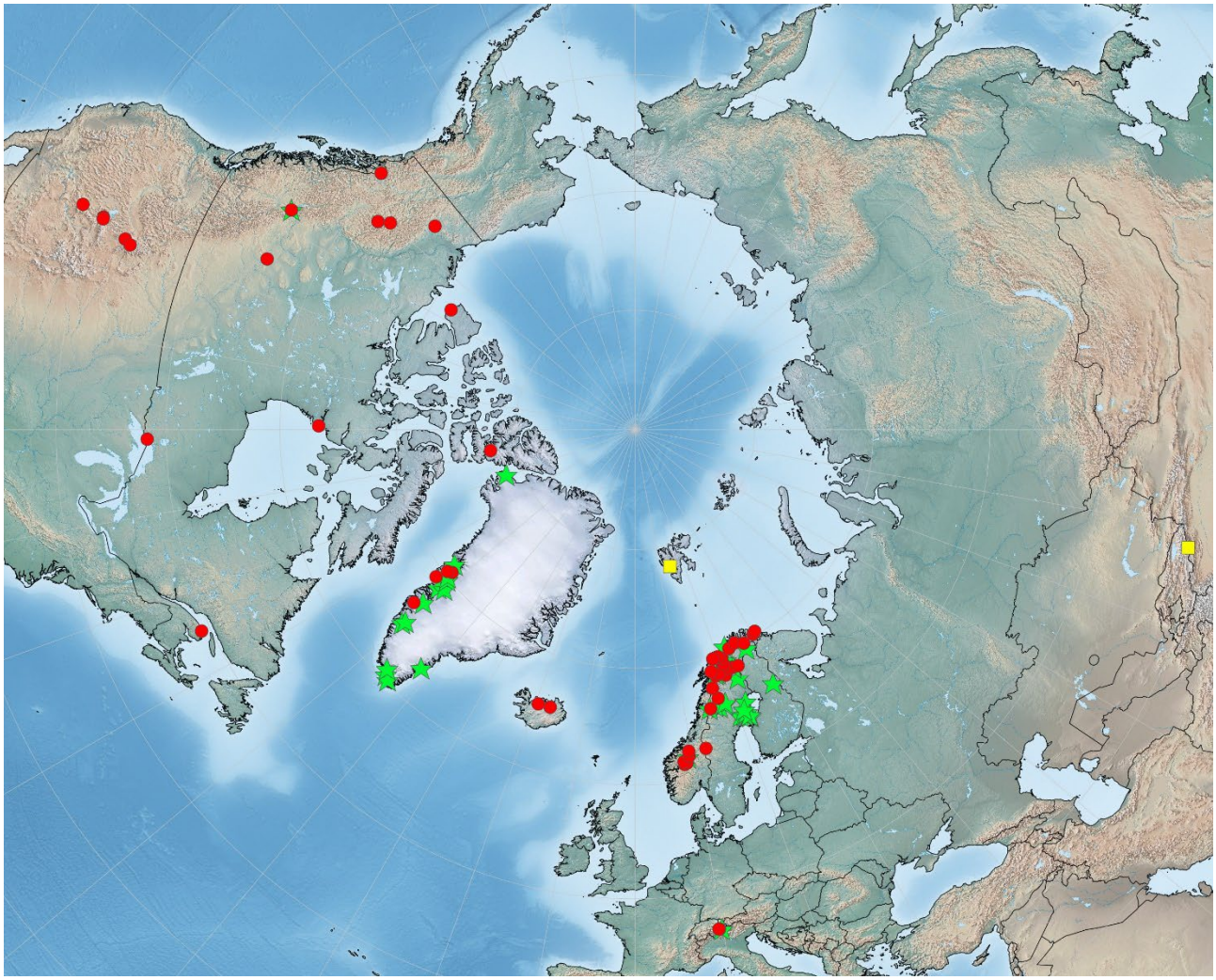
Microcyclic form – IIIs. Telia systemic, on the stems and fruits, rarely on the leaves, often confluent, round, ellipsoid or oblong, long covered by the epidermis, then naked and surrounded by the ruptured epidermis, pulverulent, brown. Spores (1-)2(-4)-celled, the 2-celled narrowly to moderately ellipsoid, rounded at ends, slightly to moderately constricted at septum, 20-48 × 13-26 µm, wall evenly 1.5-3 µm thick, yellow-brown, strongly verrucose, warts 0.4-1 µm high and diameter 0.6-2 µm, pore of upper cell usually apical, sometimes to 1/3 depressed, covered with a more or less conspicuous hyaline cap, pore of lower cell usually 1/2 to 7/8 depressed from septum, cap inconspicuous, pedicel hyaline, fragile, deciduous.

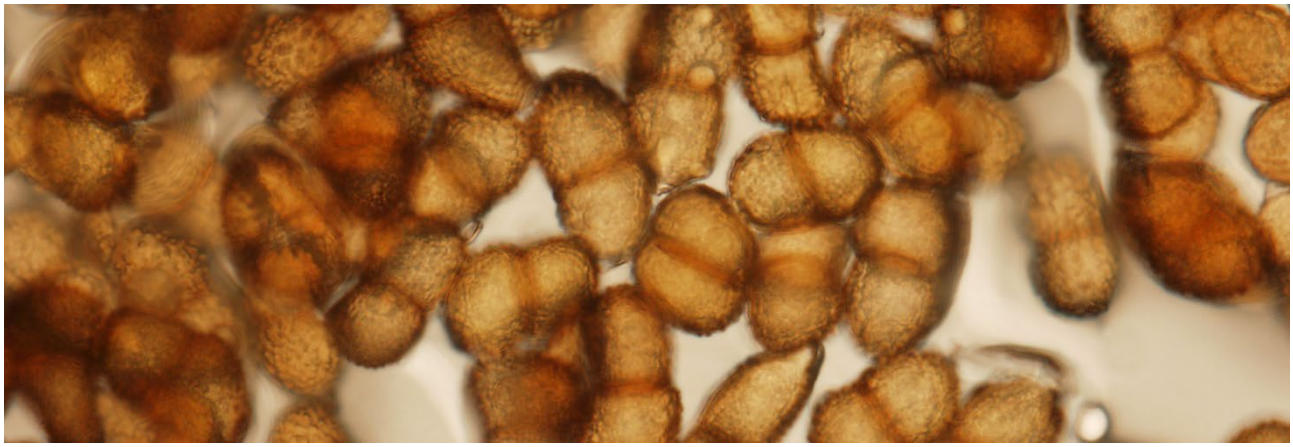
Host plants

III, **Brassicaceae:** *Draba* species, e.g. *Draba aizoides*, *D. alpina*, *D. altaica*, *D. aurea*, *D. bellii*, *D. cinerea*, *D. daurica*, *D. dovrensis*, *D. fladnizensis*, *D. glacialis, D. hirta*, *D. incana*, *D. lactea, D. lanceolata*, *D. nivalis*, *D. norvegica*, and *D. rupestris*, *Eutrema integrifolium*, and *Lesquerella arctica.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic CAN, GR, IS, Svalbard, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (CAN, USA), the Alps (CH), Dovre (NO), the Scandinavian Mts. (SE), and C-Asia, and from Novaja Zemlja (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia dubyi **E. Mayor, Micromycetes rar. sel. 1710; UPS-699825; Switzerland**

Puccinia dubyi Müll. Arg.

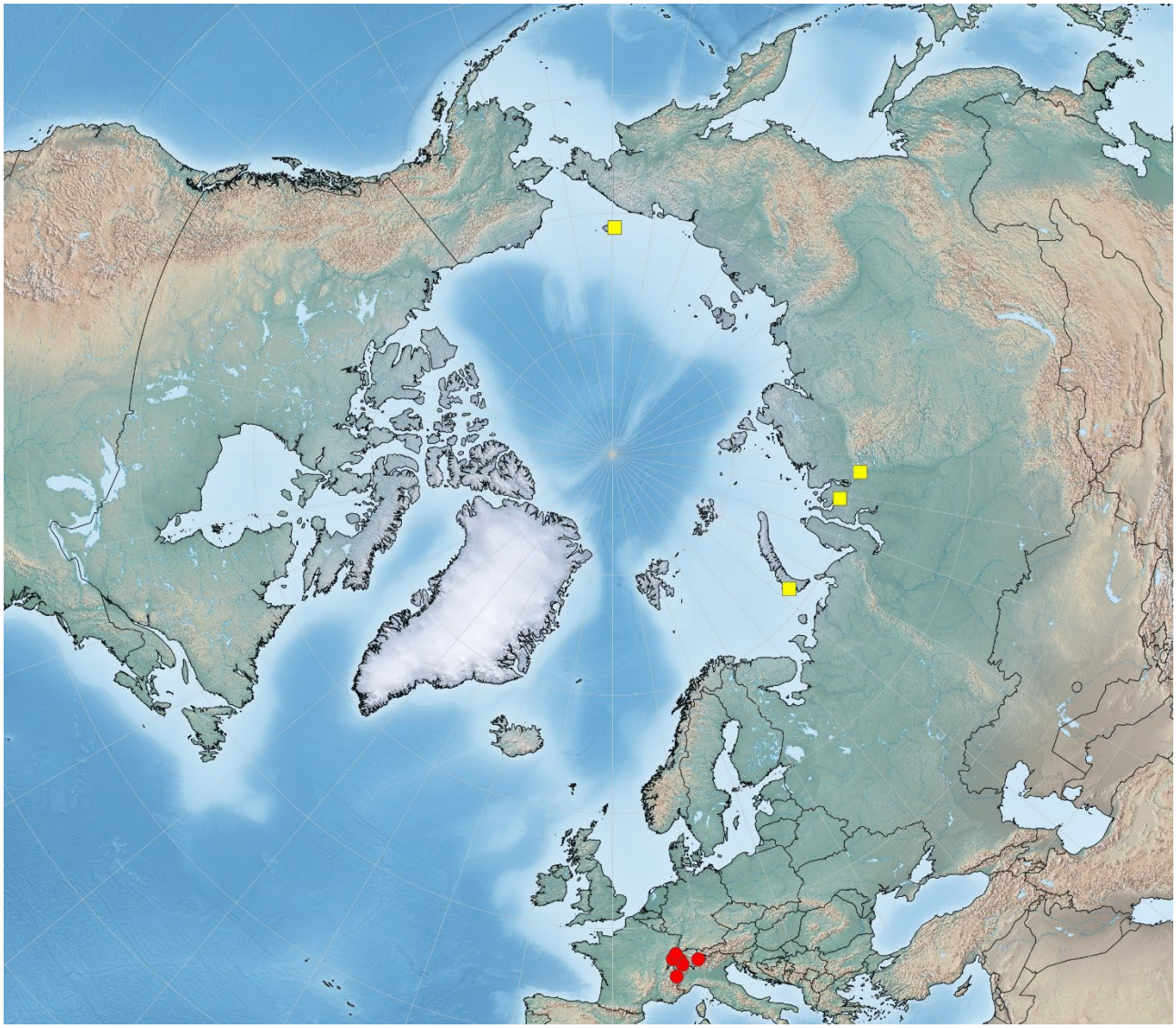
Microcyclic form – III. Telia amphigenous and on the flower stalks, roundish or elongate, long covered by the epidermis, then naked, pulverulent, dark brown. Spores 2-celled, ellipsoid, ends rounded, moderately constricted at septum, 25-38 × 16-21 µm, wall light brown, ca. 2 µm thick, smooth, pore of upper cell apical, pore of lower cell subequatorial, both pores covered with a hyaline, low cap, pedicel hyaline, short, deciduous.

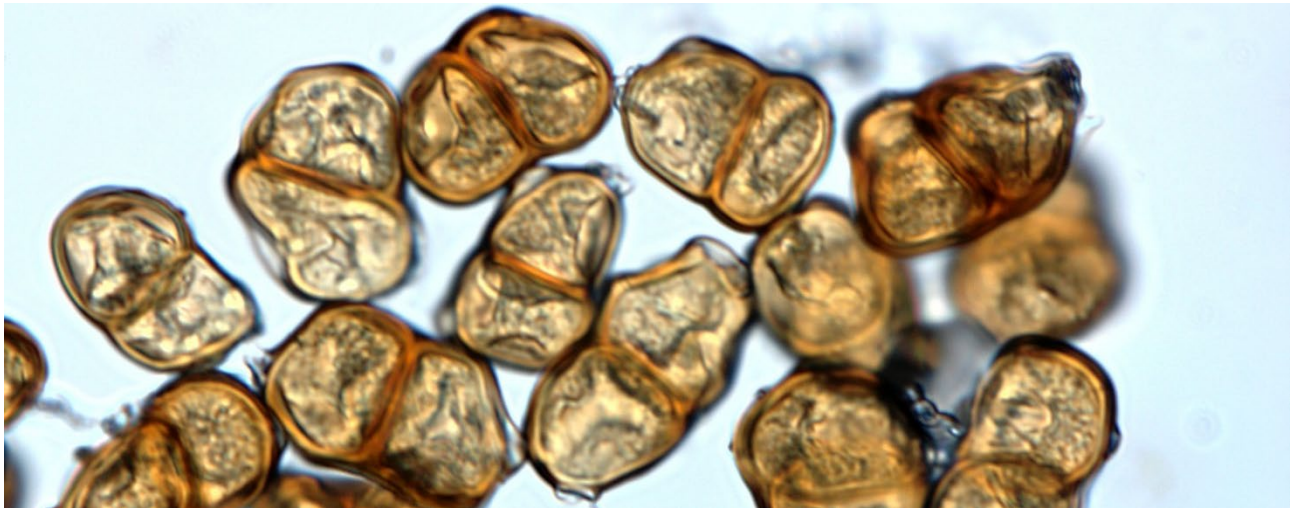
Host plants

III, **Primulaceae:** *Androsace* species, e.g. *A. chamaejasme*, *A. helvetica*, and *A. obtusifolia.*

Distribution

Arctic-alpine; Eurasian; type 9; recorded from arctic Novaja Zemlja, Taymir, and Wrangel Island (RU), IS, Svalbard, NO, SE, FI, RU, and from the Alps (FR, CH).





Puccinia: Pucciniaceae: Pucciniales

Puccinia enormis **G. Winter, Fungi europaei 2615; S-F-31024; Switzerland**

Puccinia enormis Fuckel

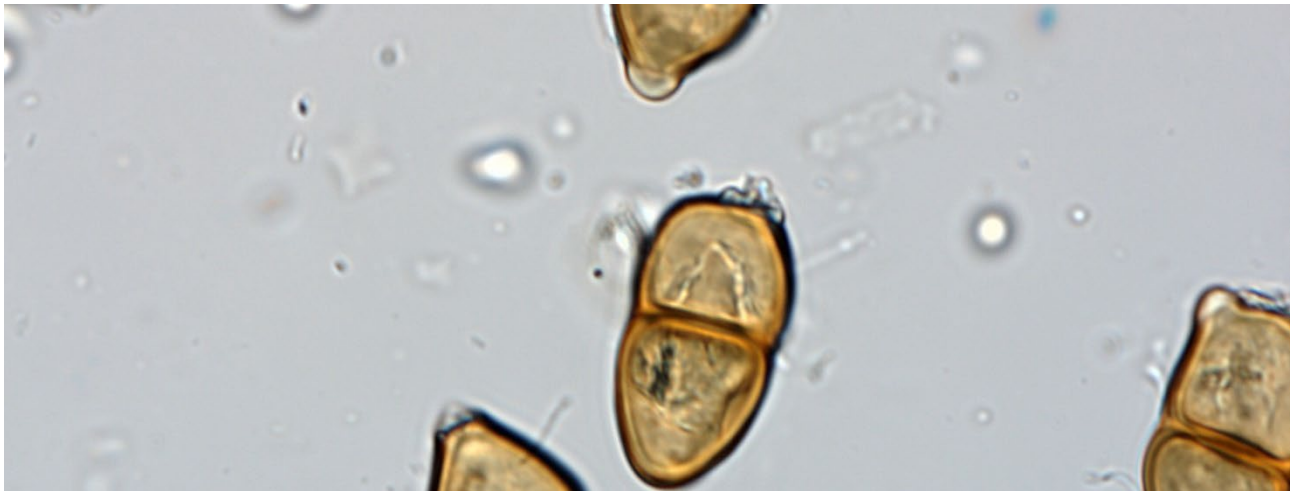
Microcyclic form – III. Telia on swollen places on the stems, petioles and leaves, causing curvatures, confluent in elongate groups of 2-6 cm, roundish, diameter 0.5-1 mm, initially covered by the epidermis as well as by a brownish, ± 25 µm thick hyphal mat, rupturing by a pore, then naked, pulverulent, reddish brown, chestnut brown or dark brown. Spores 2-celled, size and shape quite variable, ellipsoid or clavate, apex rounded or slightly pointed, base rounded or tapering, slightly constricted at septum, 27-52 × 14-24 µm, wall yellow-brown, 1.5-2.5 µm thick, smooth or with some very fine points arranged in rows, pore of upper cell usually apical, pore of lower cell close to or against pedicel, both covered with a hyaline, hemispherical cap, pedicel hyaline, short, deciduous.

Host plant

III, **Apiaceae:** *Chaerophyllum villarsii.*

Distribution

Alpine; Eurasian; type 15; only recorded from the Alps (CH, AT).



Puccinia: Pucciniaceae: Pucciniales

Puccinia epilobii **N. Hartz; C-F-8674**

Puccinia epilobii DC.

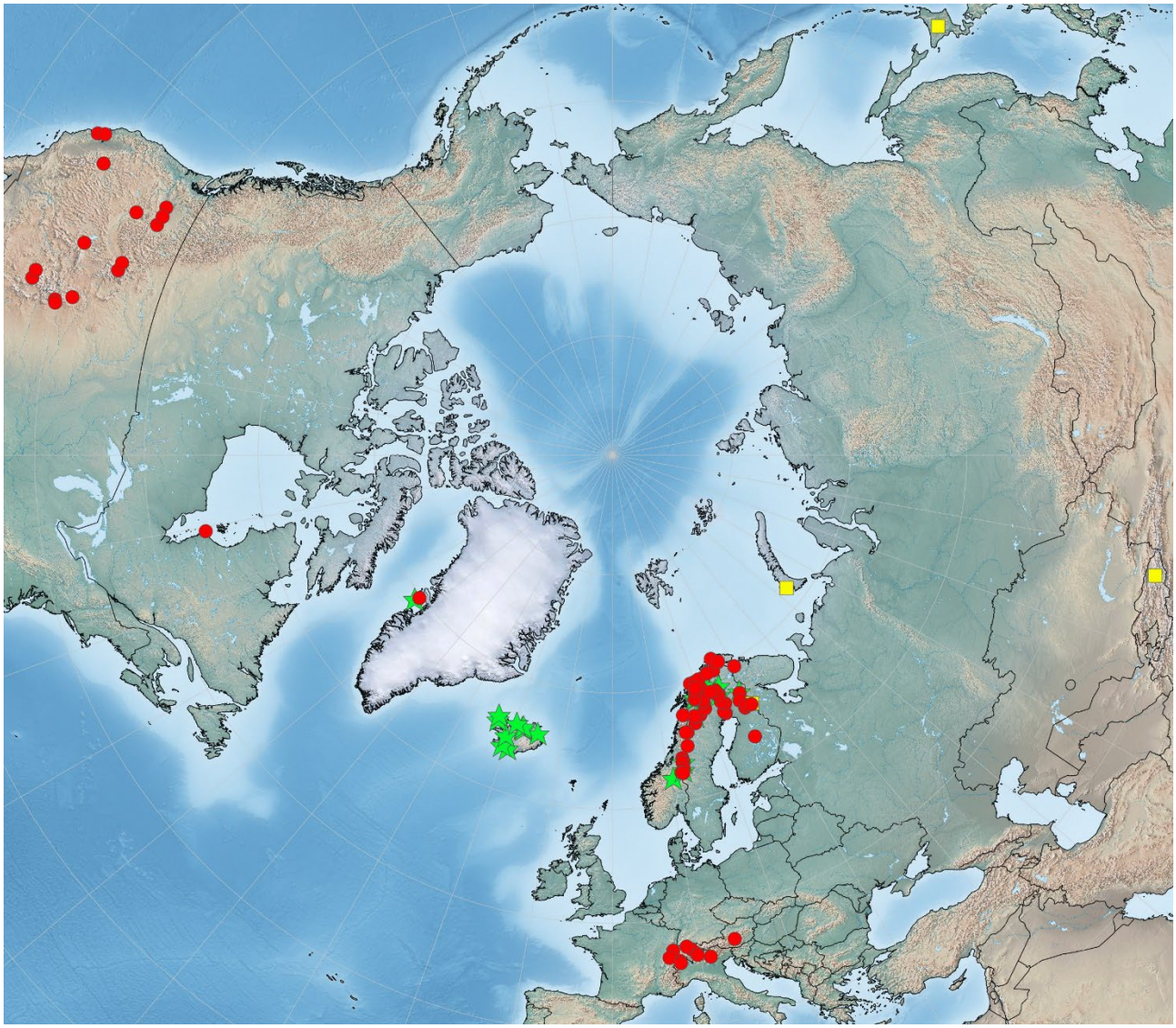
Microcyclic form – IIIs. Systemic, the leaves of infected shoots are whitish to yellow-green, thicker and more compact; such shoots usually do not flower. **Telia** hypophyllous or amphigenous, scattered or in groups, often regularly distributed over the whole surface, confluent to rather large groups, which are surrounded by a thickened layer of host cells, round, diameter 0.5 mm, soon naked, initially pulvinate, becoming pulverulent, red-brown. Spores 2-celled, shape variable, usually ellipsoid or pyriform, ends rounded, moderately to strongly constricted at septum, pale brown, 26-45 × 13-25 µm, wall light brown, 1.5-2.5 µm thick, the apex rarely somewhat thickened, finely verrucose, pore of upper cell apical or slightly depressed, covered with a sometimes inconspicuous, hyaline, flat, 1 µm high and 10 µm broad cap, pore of lower cell subequatorial, covered with an often inconspicuous cap, pedicel hyaline, short, deciduous.

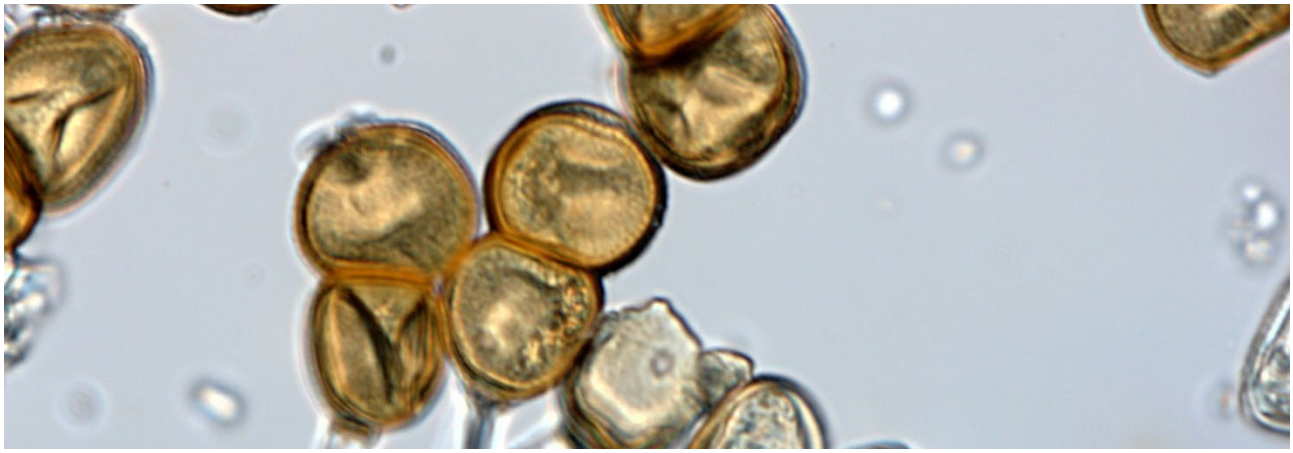
Host plants

III, **Onagraceae:** *Epilobium* species, e.g. *E. alpestre*, *E. alsinifolium*, *E. anagallidifolium*, *E. davuricum*, *E. hornemannii*, *E. lactiflorum*, and *E. palustre.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic CAN, GR, IS, NO, SE, FI, and RU, from alpine regions of the Rocky Mts. (USA), the Alps (FR, CH, AT), the Scandinavian Mts. (SE), C-Asia, and Hokkaido (JP), and from Novaja Zemlja (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia epilobii-fleischeri **O. Jaap; C-F-155409; Switzerland**

Puccinia epilobii-fleischeri E. Fisch.

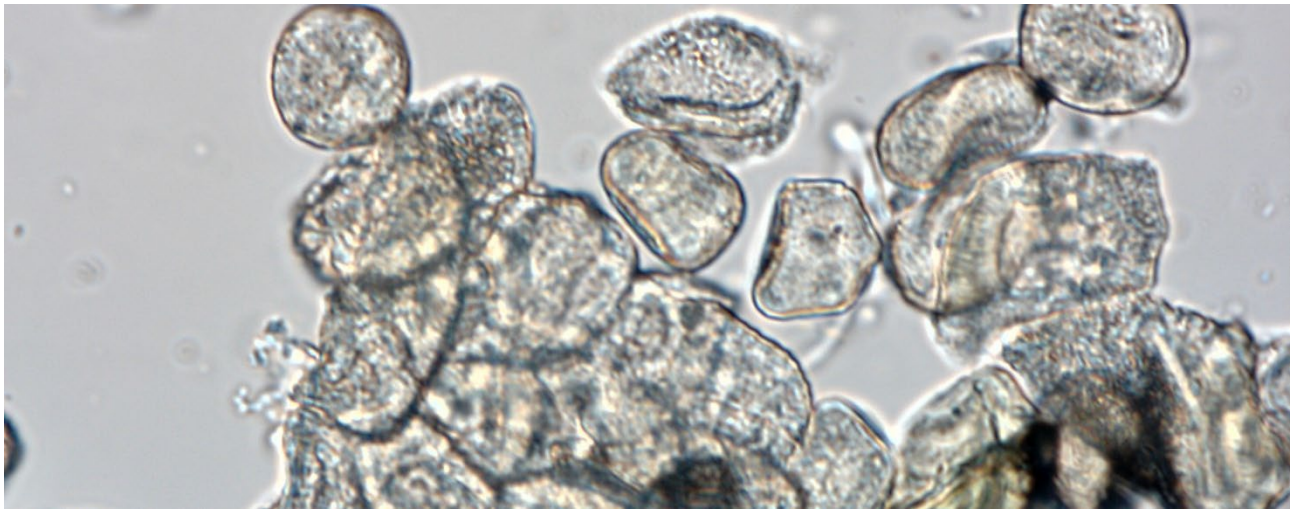
Demicyclic autopsisform – I-III. Spermogonia not described. **Aecia** hypophyllous, densely covering the whole surface, cupulate, peridium revolute, laciniate, yellowish white. Spores subglobose, angular, diameter 17-21 µm, wall hyaline, thin, finely and densely verrucose. **Telia** amphigenous, between the aecia and on other leaves, scattered, roundish, soon naked, dark brown. Spores 2-celled, ellipsoid or pyriform, base tapering, moderately constricted at septum, upper cell usually somewhat shorter and wider than the lower cell, 28-40 × 15-21 µm, wall light brown, 1-2 µm, at apex 3-4 µm thick, smooth, pore of upper cell apical, rarely with an additional pore, covered with a conspicuous, hyaline cap, pore of lower cell subequatorial, occasionally with an additional pore, covered with a hyaline, flat cap, pedicel hyaline, long, deciduous.

Host plants

I-III, **Onagraceae:** *Epilobium fleischeri.*

Distribution

Alpine; Eurasian; type 15; only recorded from the Alps (FR, CH). A record from temperate Sweden is considered doubtful.



Puccinia: Pucciniaceae: Pucciniales

Puccinia eutremae **C. Kruuse; C-F-108013**

Puccinia eutremae Lindr.

Syn.: *Puccinia cochleariae* Lindr.

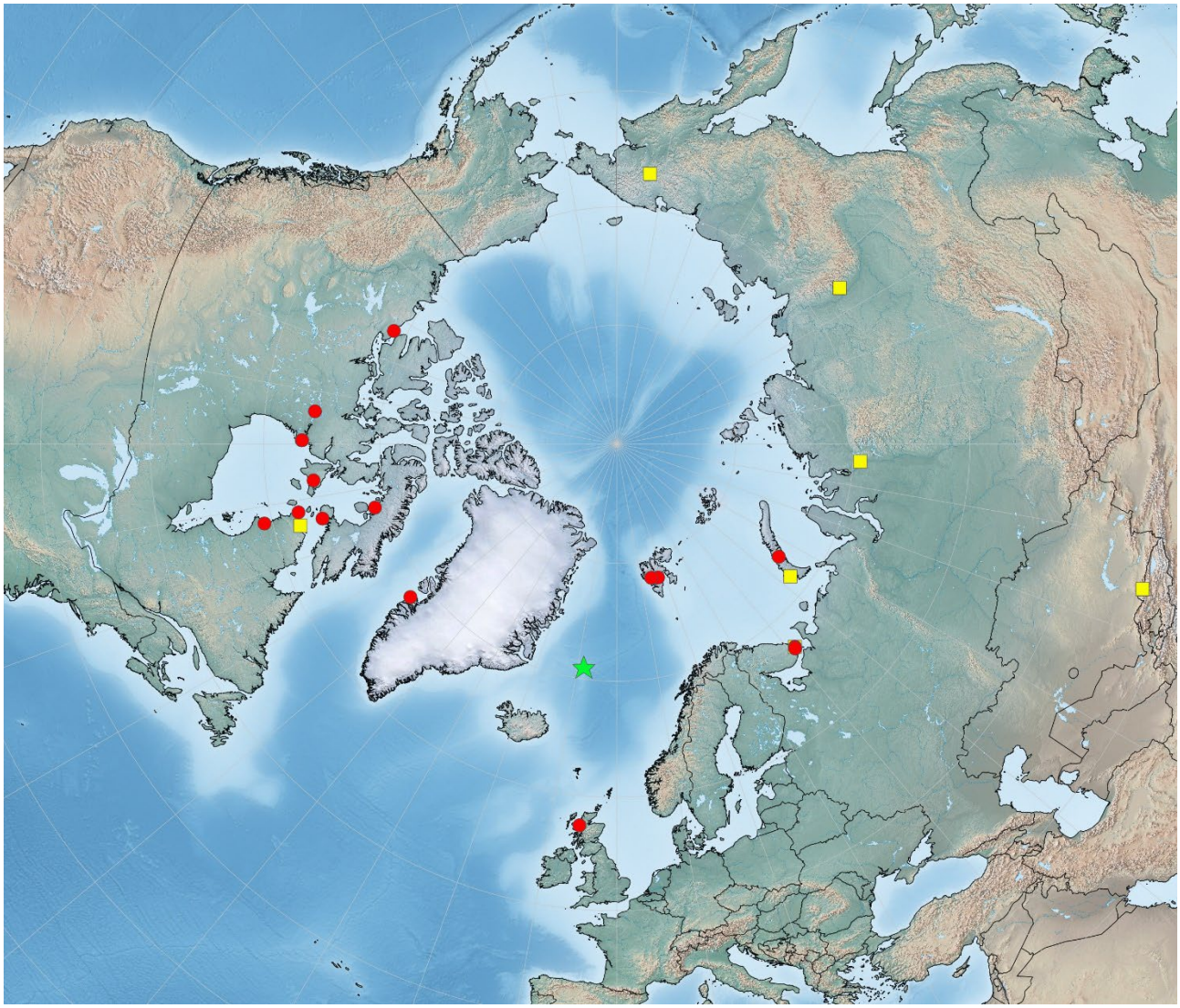
Microcyclic form – III. Telia amphigenous and on the petioles and stems, scattered, diameter 0.5-1.5 mm, long covered by the silver-grey, bullate epidermis, then naked, pulverulent, dark brown to almost black. Spores 2-celled, often falling apart and then seemingly 1-celled, ellipsoid, apex rounded, base rounded or tapering, moderately to strongly constricted at septum, 27-50 × 12-21 µm, wall cinnamon brown to dark yellow-brown, 1.5-2 µm thick, smooth or finely striate, pore of upper cell apical, covered with a hyaline or subhyaline, 2-6 µm high, hemispherical or obtuse cap, pore of lower cell against septum, cap smaller, pedicel hyaline, up to 60 µm long, fragile, deciduous.

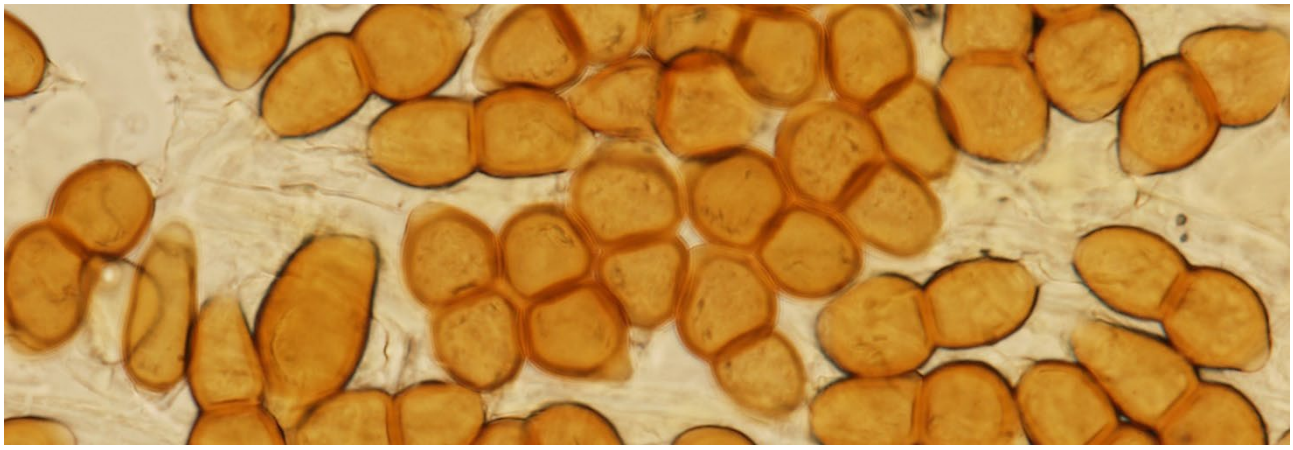
Host plants

III, **Brassicaceae:** *Cochlearia* species, e.g. *Cochlearia arctica*, *C. groenlandica*, *C. officinalis*, and *Eutrema edwardsii.*

Distribution

Arctic-alpine; circumpolar; type 4; recorded from arctic CAN, GR, Bjørnøya (NO), Svalbard, the Kola Peninsula, Novaja Zemlja, Taimyr, and Chukotka (RU), and alpine C-Asia.





Puccinia: Pucciniaceae: Pucciniales

Puccinia fergussonii **J. A. Nannfeldt 5909, Fungi Ex. Suec. 1244a; C-F-168112; Sweden**

Puccinia fergussonii Berk. & Broome

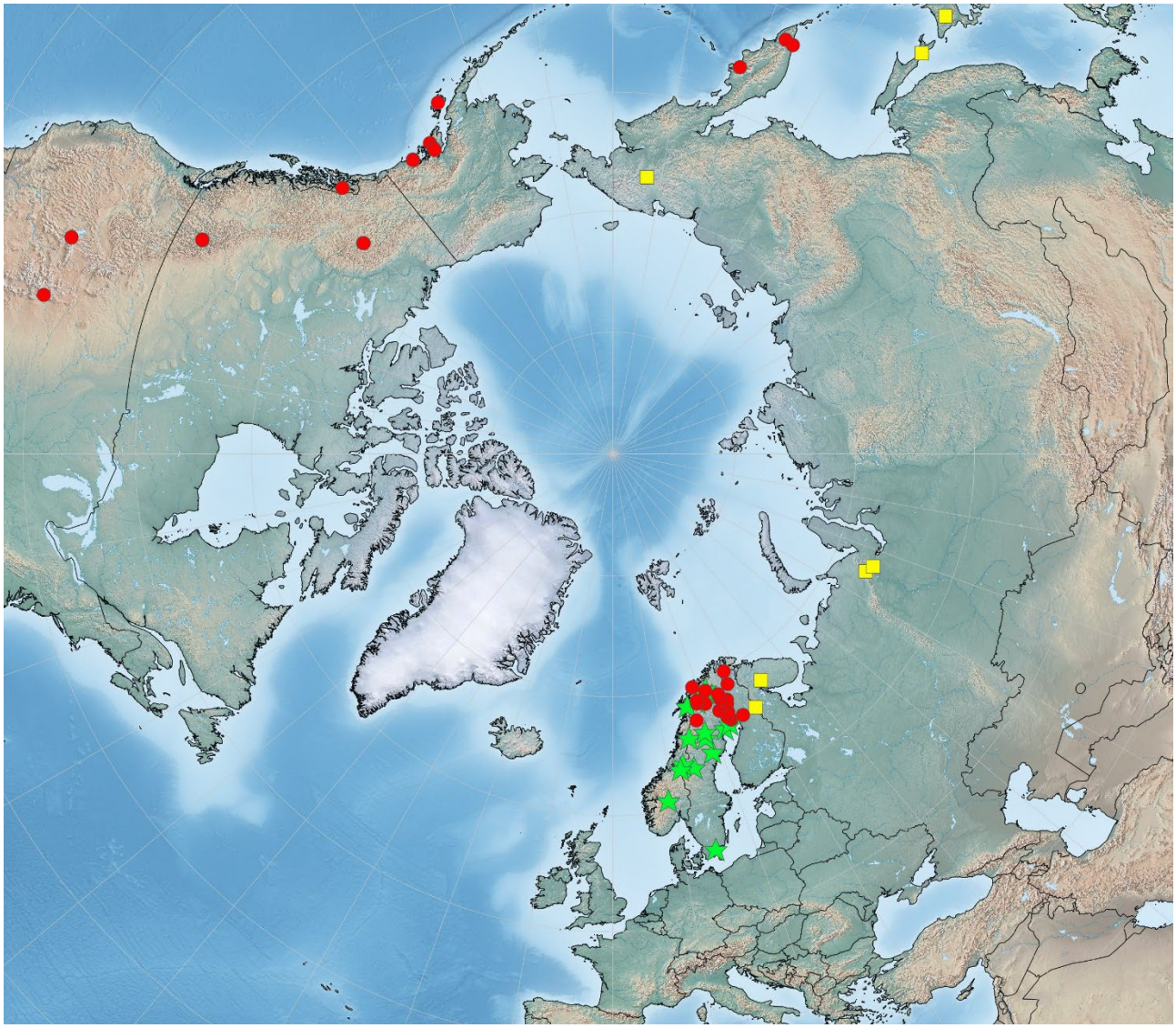
Microcyclic form – III. Telia hypophyllous and on the petioles, on large, round to irregular, yellow spots, on the leaves in ± circular clusters, diameter 1-2 mm, on the petioles in elongate, up to 1.5 cm long clusters, crowded, confluent, long covered by the bullate epidermis, then naked, pulverulent, chocolate brown. Spores (1-)2-celled, the 2-celled oblong to oblong ellipsoid, base somewhat tapering, sometimes irregularly shaped, moderately constricted at septum, 26-46 × 12-21 µm, wall pale brown, 1.5-2.5 µm, at apex 3-7 µm thick, smooth, pore of upper cell apical, covered with a pale cap, pore of lower cell against septum, cap indistinct, pedicel hyaline, up to 30 µm long, deciduous.

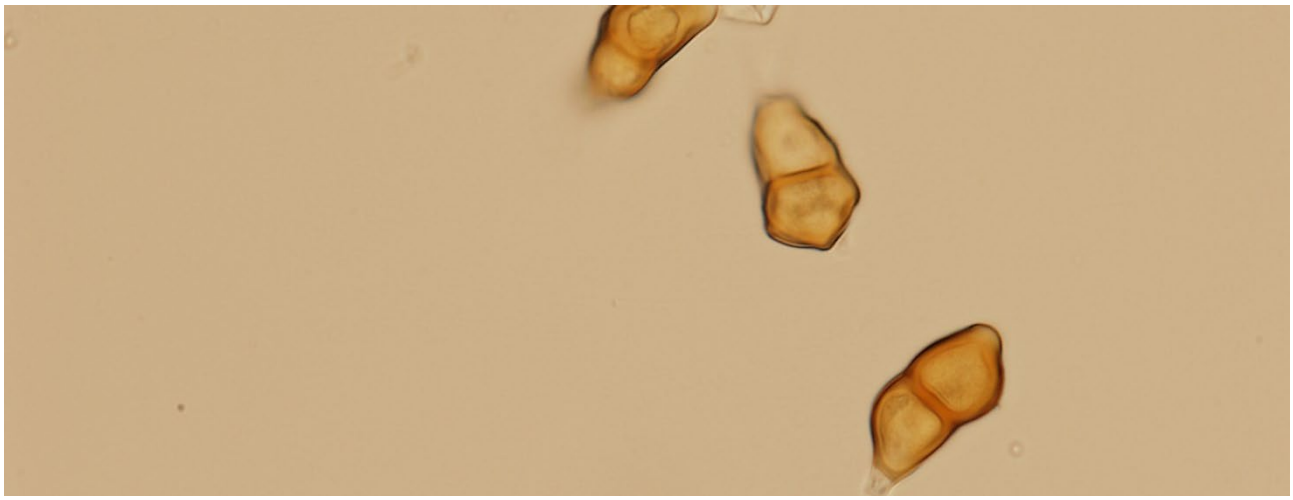
Host plants

III, **Violaceae:** *Viola* species, e.g. *Viola epipsila*, *V. epipsiloides*, *V. langsdorffii*, *V. palustris*, and *V. selkirkii.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (AK, CAN, USA), Dovre (NO), the Scandinavian Mts. (SE), the Urals, Chukotka, Kamchatka and Sakhalin (RU), and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia fischeri **J. Lid; S-F233960; Svalbard**

Puccinia fischeri Cruchet & Mayor

Syn.: *Puccinia lyngei* Jørst.

Microcyclic form – IIIs. Inducing abortion of flower formation, paler colour and slight elongation of internodes. **Telia** systemic, perennial, epiphyllous or amphigenous, diameter up to 1 mm, scattered or in groups, initially covered by the epidermis, then naked, pulverulent, light to dark brown. Spores 2-celled, ellipsoid, ends rounded, not to slightly, sometimes moderately constricted at septum, 30-53(-58) × (15-)17-27(-30) µm, wall pale brown to pale red-brown, 1-2 µm thick, smooth, pore of upper cell apical, pore of lower cell at variable places, often nearly against pedicel, both covered with a small, hyaline cap, pedicel hyaline, deciduous.

Host plants

III, **Saxifragaceae:** *Saxifraga* species, e.g. *Saxifraga aizoides*, *S. biflora*, *S. flagellaris*, and *S. oppositifolia.*

Distribution

Arctic-(alpine); circumpolar; type 4; recorded from arctic CAN, Svalbard, Novaja Zemlja and Taimyr (RU), and one record from the Alps (CH).

Puccinia: Pucciniaceae: Pucciniales

Puccinia geranii-silvatici **T. Ulvinen; C-F-155436; Finland**

Puccinia geranii-silvatici P. Karst.

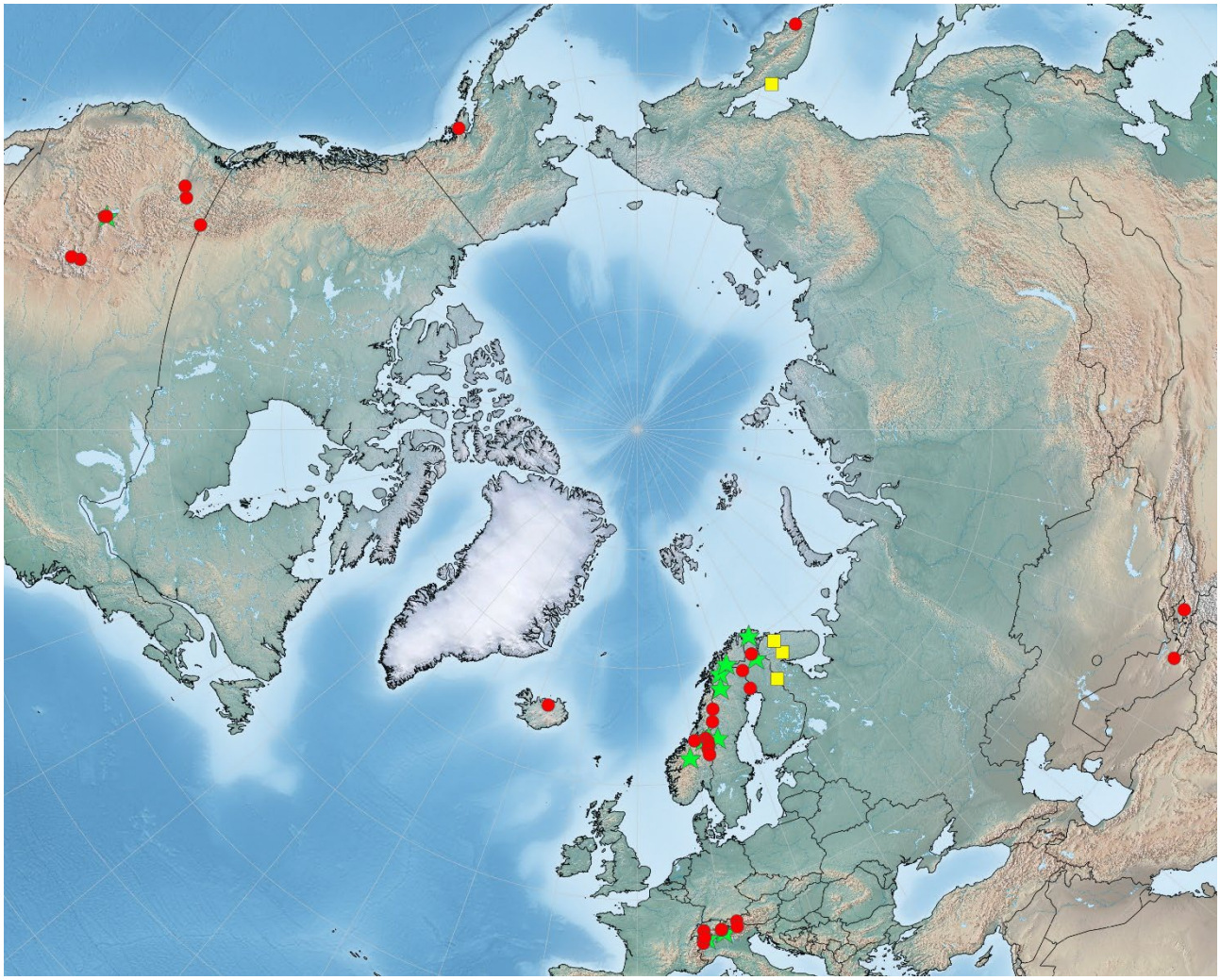
Microcyclic form – III. Telia hypophyllous or on the stems, rarely epiphyllous, often on the main veins causing considerable swellings and distortions, crowded on round, purplish spots, on petioles and stems elongate to 1-3 cm long groups, confluent, round to elongate, 0.5-0.8 mm long, soon naked and surrounded by the ruptured epidermis, pulverulent, chestnut brown. Spores (1-)2-celled, the 2-celled ellipsoid or ovoid, apex rounded, base rounded or somewhat tapering, not or barely constricted at septum, 22-40 × 14-22 µm, wall light brown, 2-3 µm thick, upper cell strongly verrucose, lower cell finely verrucose, pore of upper cell apical, pore of lower cell (sub)equatorial or inferior, both pores covered with a hyaline, flat and wide, verrucose cap, pedicel hyaline, up to 50 µm long, deciduous, leaving 7-10 µm attached to the spores.

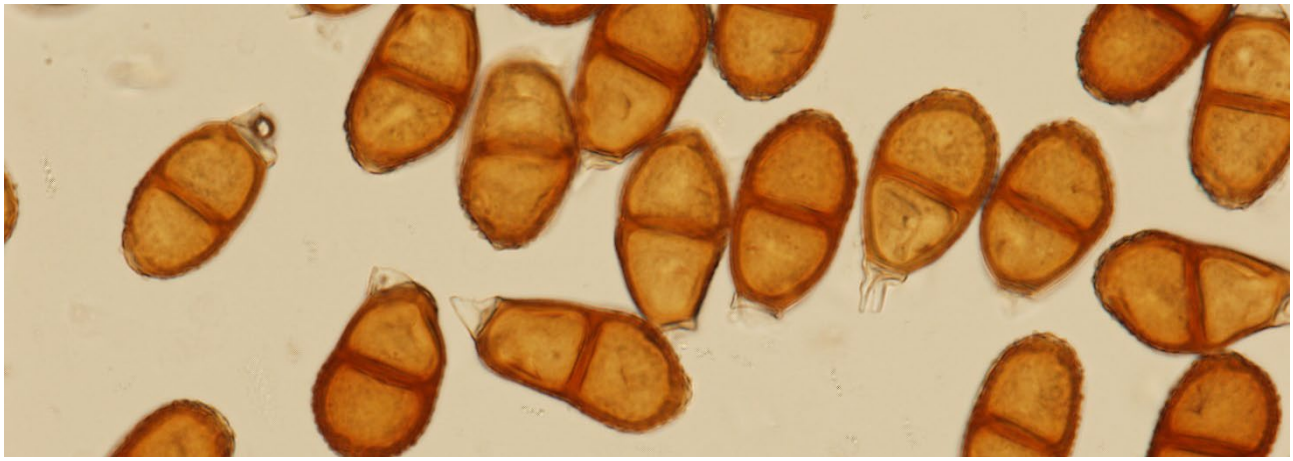
Host plants

III, **Geraniaceae:** *Geranium* species, e.g. *Geranium albiflorum*, *G. collinum*, *G. erianthum*, *G. rectum*, *G. saxatile*, and *G. sylvaticum.*

Distribution

Arctic-alpine; circumpolar; type 5; recorded from arctic AK, IS, NO, SE, FI, and RU, and from alpine regions of the Alps (CH, AT), Dovre (NO), the Scandinavian Mts. (SE), C-Asia and Kamchatka (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia gibberulosa **T. W. Böcher 1033; C-F-156064**

Puccinia gibberulosa J. Schröt.

Syn.: *Puccinia blyttiana* Lagerh.; *P. ranunculi* A. Blytt, non Seym.

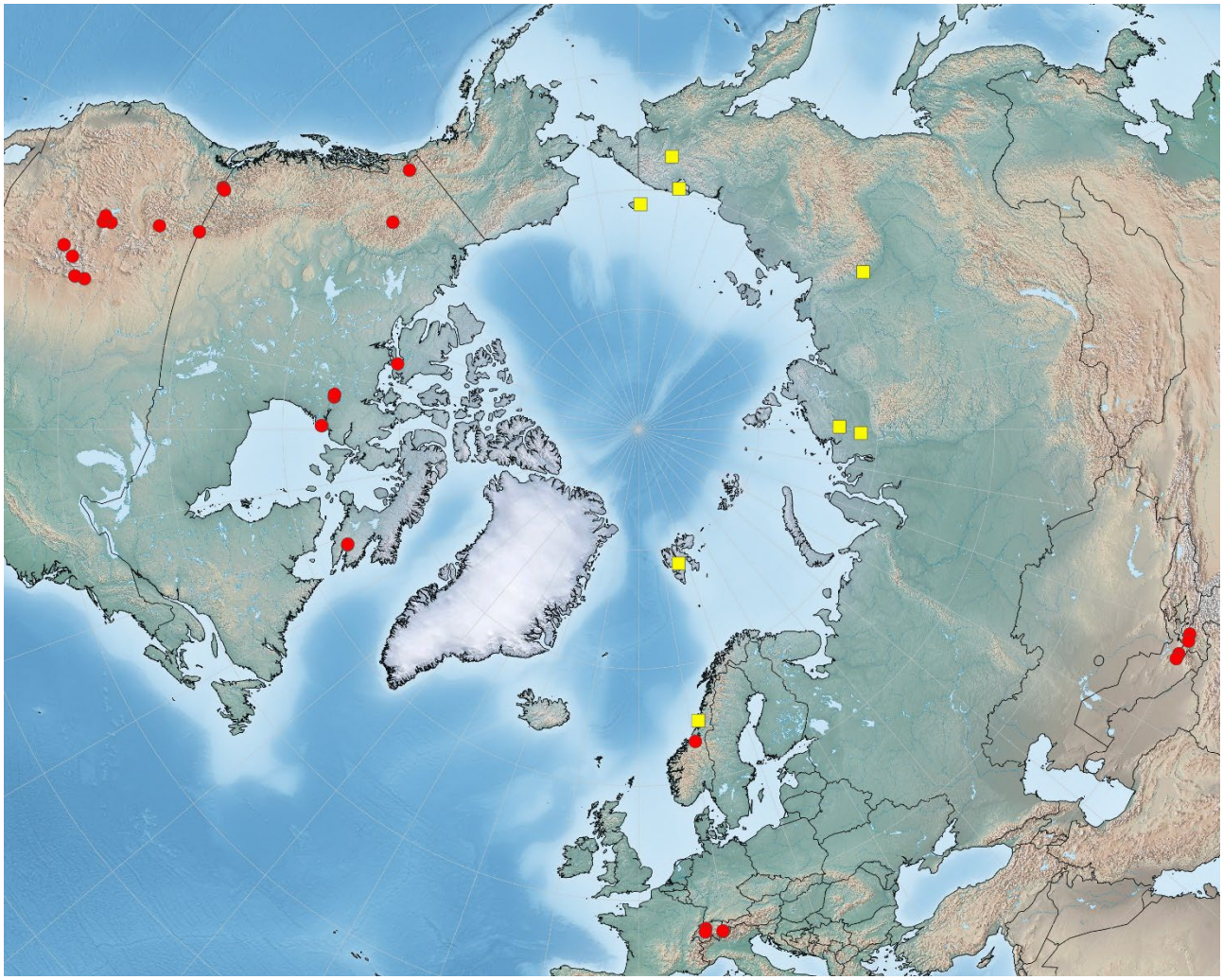
Microcyclic form – III. Telia amphigenous and on the petioles and stems, scattered or confluent to round diameter 0.5-2.5 mm groups, roundish, diameter 0.5 mm, soon naked and surrounded by the ruptured epidermis, pulverulent, brown, dark brown or blackish brown. Spores 2-celled, shape rather variable, ellipsoid, somewhat angular, apex rounded or obtuse, rarely pointed, base often tapering, not or barely constricted at septum, size variable, (23-)25-58 × 12-31(-33) µm, wall yellow-brown, 1.5-4 µm thick, provided with coarse, longitudinal, short ridges and smaller irregularities, pore of upper cell apical, covered with a conspicuous, hyaline or pale yellow, hemispherical ca. 3 µm high cap, pore of lower cell usually against septum or to 1/2 depressed, covered with a similar or somewhat smaller cap, pedicel hyaline, up to 35 µm long, fragile, deciduous.

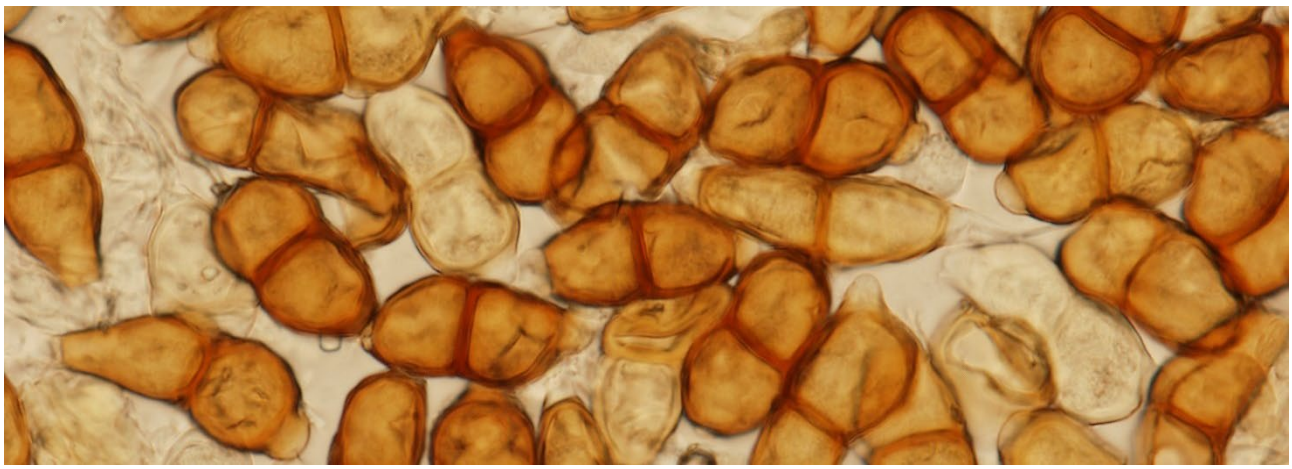
Host plants

III, **Ranunculaceae:** *Ranunculus* species, e.g. *Ranunculus affinis*, *R. alpestris*, *R. auricomus*, *R. cardiophyllus*, *R. lapponicus*, *R. propinquus*, and *R. pygmaeus.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic CAN, Svalbard, and RU, and from alpine regions of the Alps (CH), the Scandinavian Mts. (SE), and C-Asia, and from Taymir, Chukotka, and Wrangel Island (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia gigantea **E. Rostrup; C-F-155281; Norway**

Puccinia gigantea P. Karst.

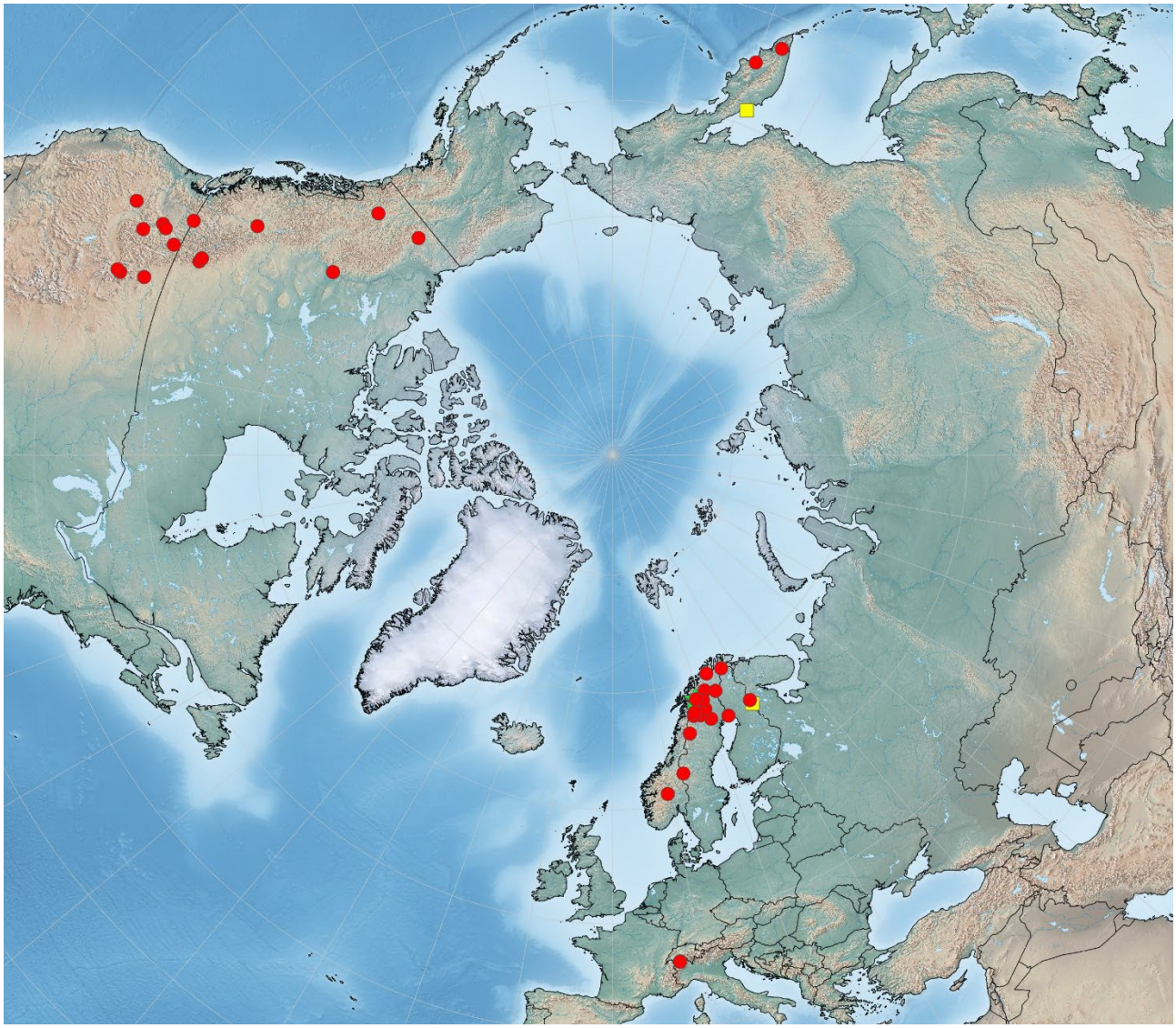
Microcyclic form – IIIs. Systemic, plants show limited flowering. **Telia** hypophyllous, and on the stems, scattered or crowded opposite on somewhat swollen, reddish to brownish, diameter 1-3 mm spots on the leaves, considerably larger on the stems, the leaf midribs with conspicuous distortions, round or oblong, hemispherical, diameter 0.5-1.5 mm, compact, initially covered by the epidermis, soon naked and surrounded by the ruptured epidermis, pulvinate, blackish. Spores 2-celled, clavate or cylindrical-clavate, apex rounded or pointed, base tapering, lower cell often longer and narrower than the top cell, slightly to moderately constricted at septum, top cell light brown, lower cell hyaline, 31-56 × 10-20 µm, wall golden brown or chestnut brown, 1-1.5 µm, at apex 6-12 µm thick, smooth, pore of upper cell subapical, pore of lower cell inconspicuous, caps inconspicuous, pedicel hyaline, 0.5-1× spore length, persistent.

Host plants

III, **Onagraceae:** *Epilobium angustifolium.*

Distribution

Arctic-alpine; circumpolar; type 5; recorded from arctic NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (CAN, USA), the Alps (CH), Dovre (NO), the Scandinavian Mts. (SE), and Kamchatka (RU).



Puccinia: Pucciniaceae: Pucciniales

Puccinia gymnandrae **O. Paulsen; C-F-155430; Tajikistan**

Puccinia gymnandrae Tranzschel

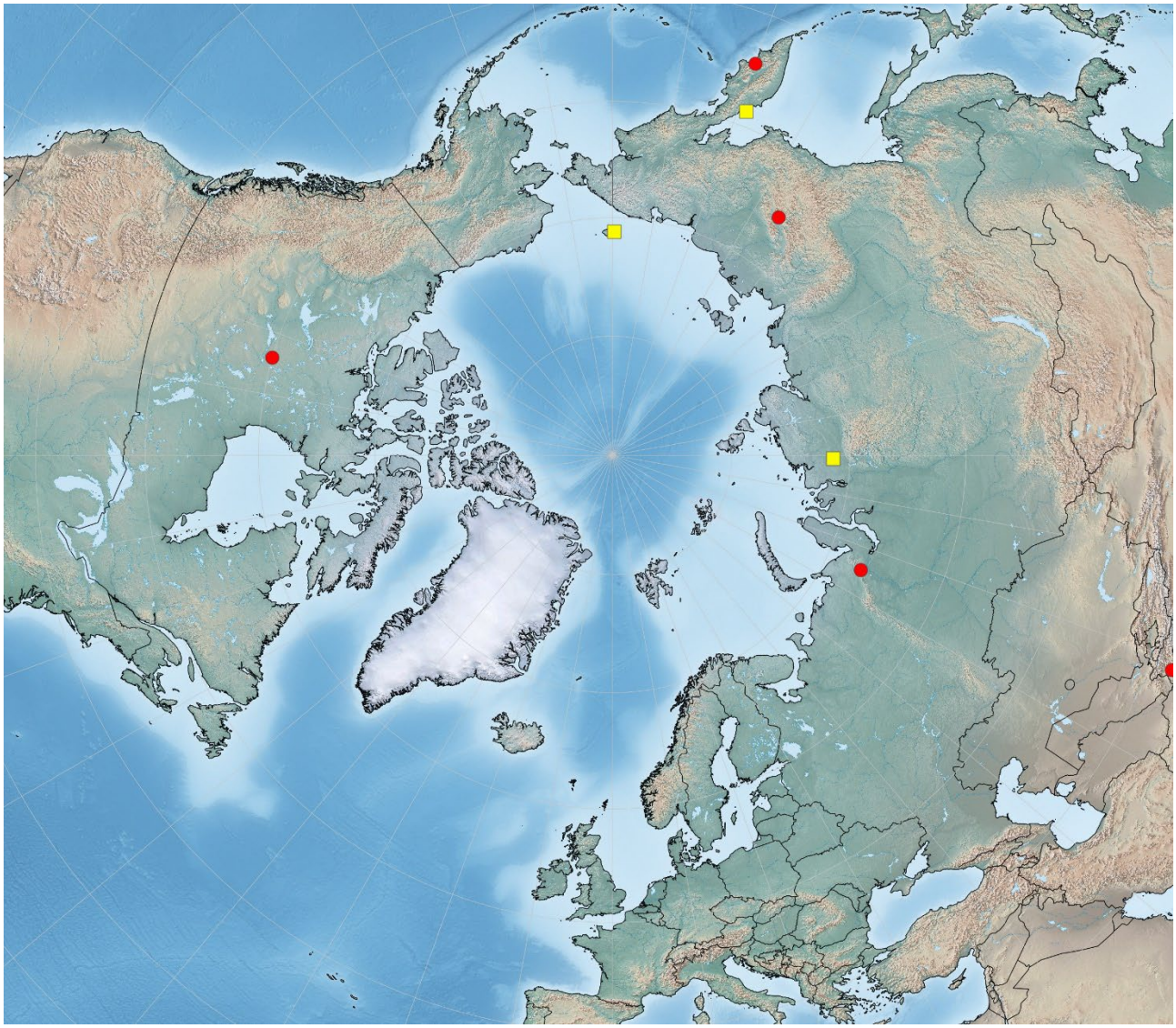
Microcyclic form – III. Telia amphigenous on brown spots, roundish to ellipsoid, diameter 1-1.5 mm, scattered, surrounded by the ruptured epidermis, pulverulent, brown. Spores 2-celled, ellipsoid or obovoid, apex rounded, slightly to moderately constricted at septum, (21-)28-38 × 13-22 µm, wall yellow-brown, 1.2-2.2 µm thick, apex not or slightly thickened, evenly verrucose but sometimes in part of spore in longitudinal lines, warts 0.2-0.8 µm high, diameter 0.4-1.2 µm at 1-2.3 µm spacing, pore of upper cell apical to 1/3(-3/4) depressed and covered with yellow, 1-2 µm high cap, pore of lower cell against septum to 3/4 depressed, sometimes against pedicel and covered with smaller cap, pedicel hyaline, up to 40 µm long, deciduous.

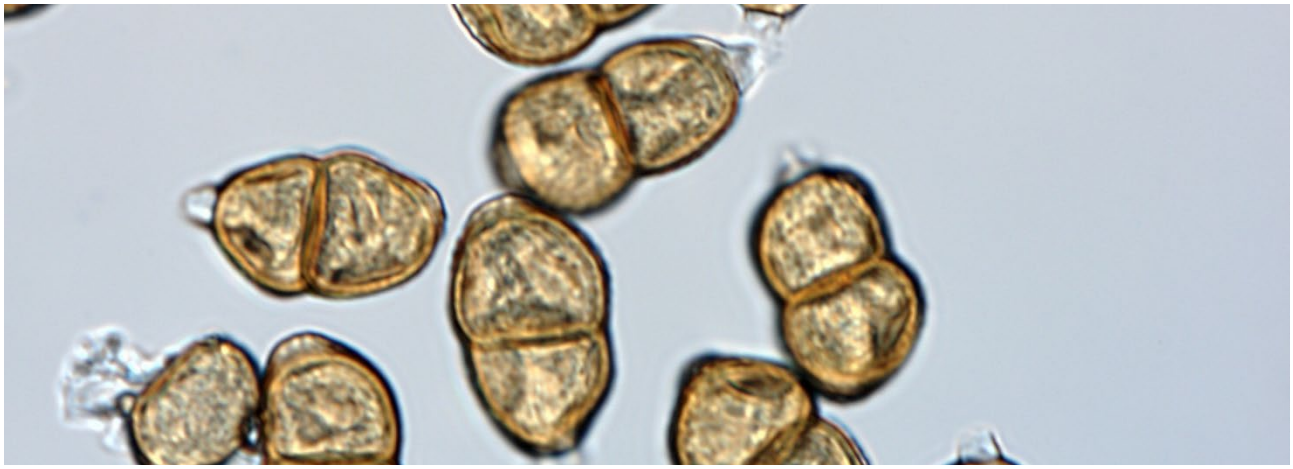
Host plants

III, **Plantaginaceae:** *Lagotis* species, e.g. *Lagotis glauca, L. minor*, and *L. yunnanensis.*

Distribution

Arctic, circumpolar; type 5; recorded from arctic CAN, the Urals, Taimyr, Wrangel Island, Magadan, and Kamchatka (RU), and from C-Asia.





Puccinia: Pucciniaceae: Pucciniales

Puccinia halosciadis **L. E. Kari, Fungi Exs. Fenn. 400; C-F-155289; Russia**

Puccinia halosciadis Syd. & P. Syd.

Microcyclic form – III. Telia hypophyllous and on the petioles and stems, in groups up to 5 mm long, round or oblong, convex, initially covered by the epidermis, then opening with a central pore, pulverulent, brown or brown-black. Spores (1-)2(-3)-celled, the 2-celled ellipsoid, ovoid or oblong, sometimes irregular and angular, slightly constricted at septum, 25-43 × 15-25 µm, pore of upper cell apical or slightly subapical, covered with an up to 2 µm high cap, pore of lower cell subequatorial, covered with a similar or smaller cap, pedicel hyaline, deciduous.

Host plant

III, **Apiaceae:** *Ligusticum scoticum.*

Distribution

Arctic; Eurasian; type 13; only known from the type area in the Petsamo region of the Kola Peninsula (RU).

Puccinia: Pucciniaceae: Pucciniales

Puccinia helicalis **D. B. O. Savile 4600, DAOM 92332; C-F-155428; Canada (NU)**

Puccinia helicalis Savile

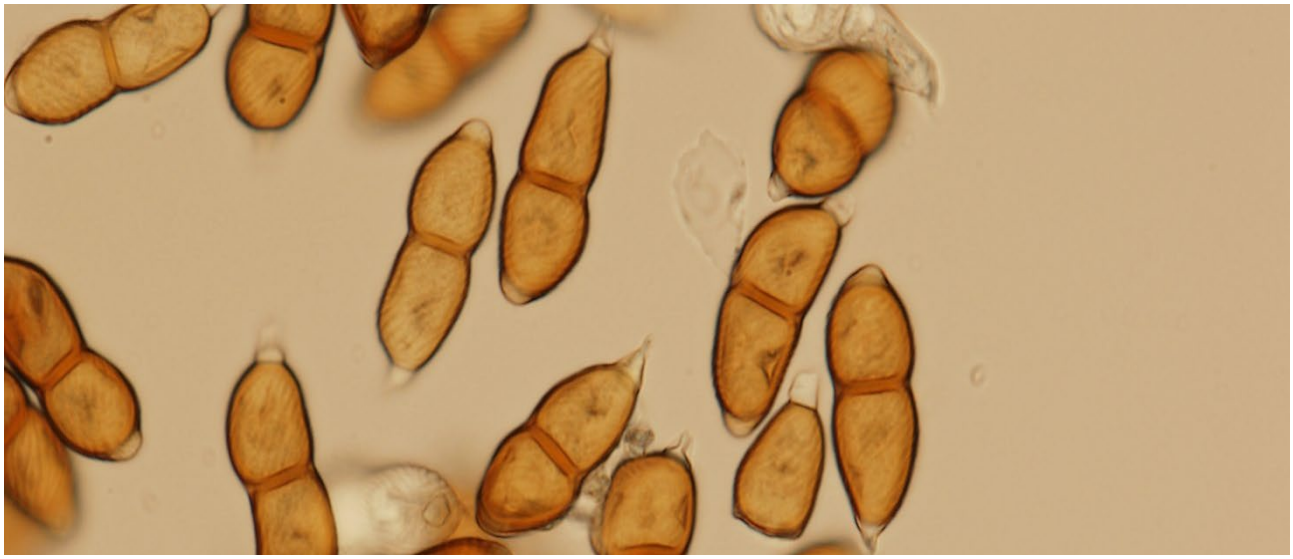
Microcyclic form – III. Telia mostly hypophyllous, also amphigenous and on the petioles and calyxes, becoming pulverulent, dark yellow-brown. Spores 2-celled, narrowly ellipsoid, ends somewhat tapering, slightly constricted at septum, 28-49 × 12-19 µm, wall yellow-brown, 1.4-2.0 µm thick, provided with conspicuous, spirally arranged, 0.2-0.6 µm high at 1.4-2 µm spacing ridges, pore of upper cell apical and covered with a hyaline, up to 4.5 µm high cap, pore of lower cell against septum and cap usually inconspicuous, pedicel hyaline, usually breaking at 5-10 µm from the spore, fragile, deciduous.

Host plant

III, **Scrophulariaceae:** *Pedicularis capitata.*

Distribution

Arctic(-alpine); circumpolar; type 2; only recorded from arctic AK, CAN, Wrangel Island and Kamchatka (RU).



Puccinia: Pucciniaceae: Pucciniales

Puccinia hieracii **H. F. Gøtzsche; micro HK 18.074A; C-F-111267**

Puccinia hieracii (Röhl.) H. Mart.

Syn.: *Puccinia jaceae* G.H. Otth; *P. leontodontis* Jacky; *P. picridis* Hazls.; *P. taraxaci* Plowr.

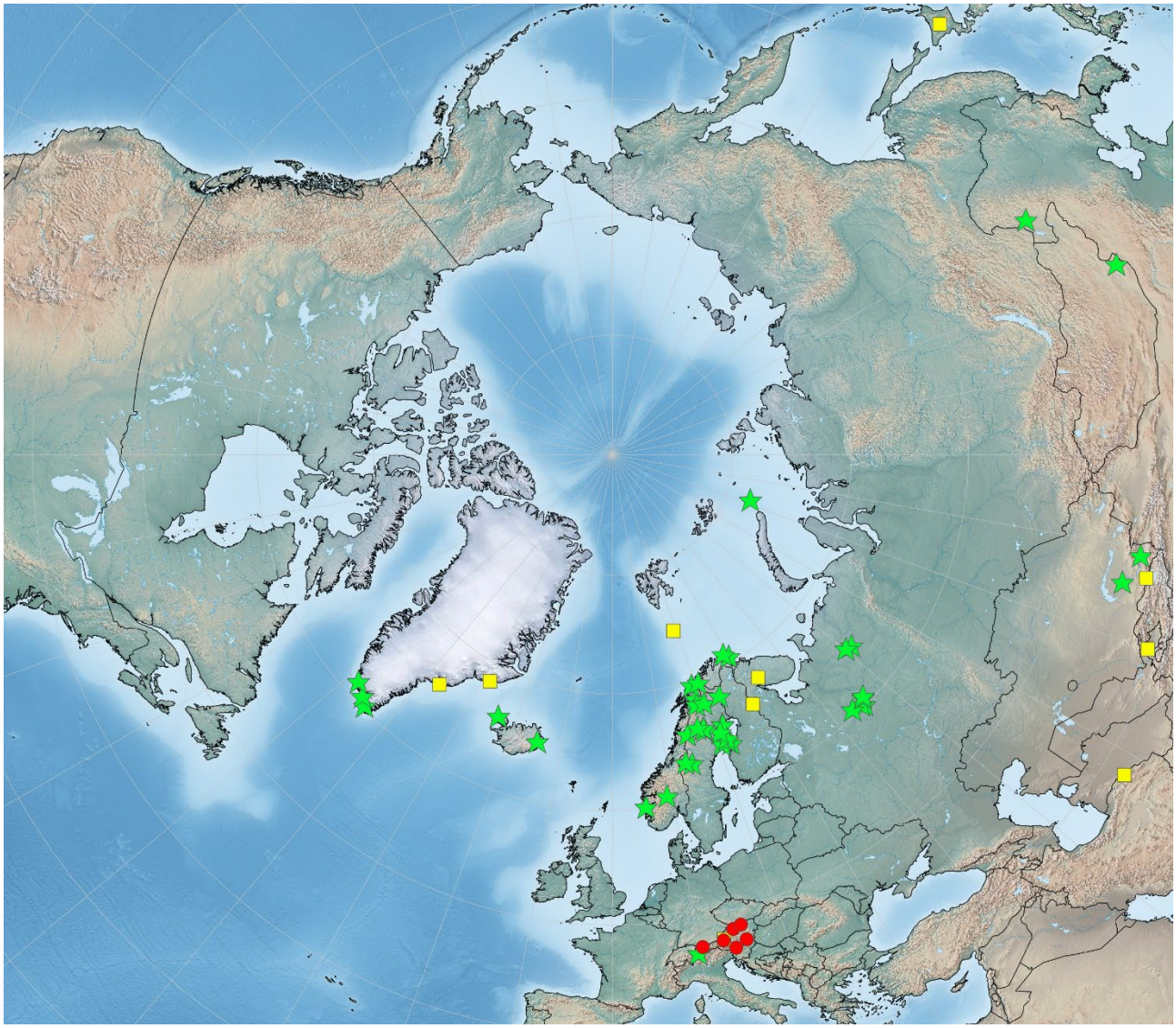
Macrocyclic auteuform – 0–Iu-II-III. Spermogonia amphigenous, usually on the veins, abundant, in groups between the aecia on pale yellow, oval, diameter 5 mm spots, honey-coloured. **Aecia** uredinioid, amphigenous, mostly on the veins and midribs, on red-yellow, circular to oval, thickened, malformed spots of a few mm, occasionally confluent, diameter 0.25-0.5(1) mm, soon naked, pulverulent, cinnamon brown to dark brown. Spores as urediniospores. **Uredinia** amphigenous and on the stems, on small, yellow spots, scattered, occasionally confluent, diameter 0.25-0.5 mm, pulverulent, yellow-brown to dark brown. Spores subglobose to ellipsoid, sometimes somewhat flattened, 21-32 × 15-28 µm, wall yellow-brown, 1-2 um thick, distantly echinulate, spines at 2.5-3 µm spacing, pores 2, supraequatorial. **Telia** as uredinia, but more on the stems, blackish brown, pulverulent. Spores 2-celled, ellipsoid, apex rounded, base rounded or tapering, not or barely constricted at septum, 26-42 × 18-29 µm, wall dark yellow-brown to chestnut brown, 1-3 µm thick, finely verrucose, pore of upper cell apical or 0.25-0.75 µm depressed, pore of lower cell equatorial, caps inconspicuous, pedicel hyaline, usually short, deciduous.

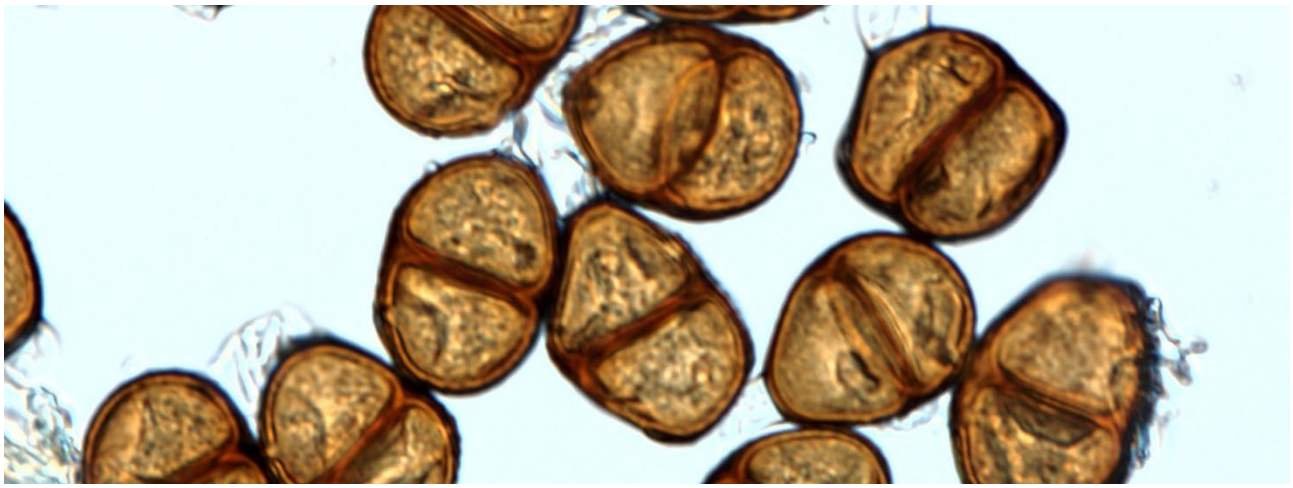
Host plants

I-II-III-IV: Asteraceae.*

Distribution

Arctic-alpine-boreal-temperate; Eurasian and Greenland; type 4; recorded from arctic GR, IS, NO, SE, FI, RU, and from alpine regions of the Alps (CH, AT), Dovre (NO), the Scandinavian Mts. (SE), the Altai Mts. (RU), and Hokkaido (JP). Common in the arctic and alpine zones, as well as in warmer areas.





Puccinia: Pucciniaceae: Pucciniales

Puccinia holboellii **J. A. Parmelee 1040, DAOM 93714; C-F-155309; Canada (NU)**

Puccinia holboellii (Hornem.) Rostr.

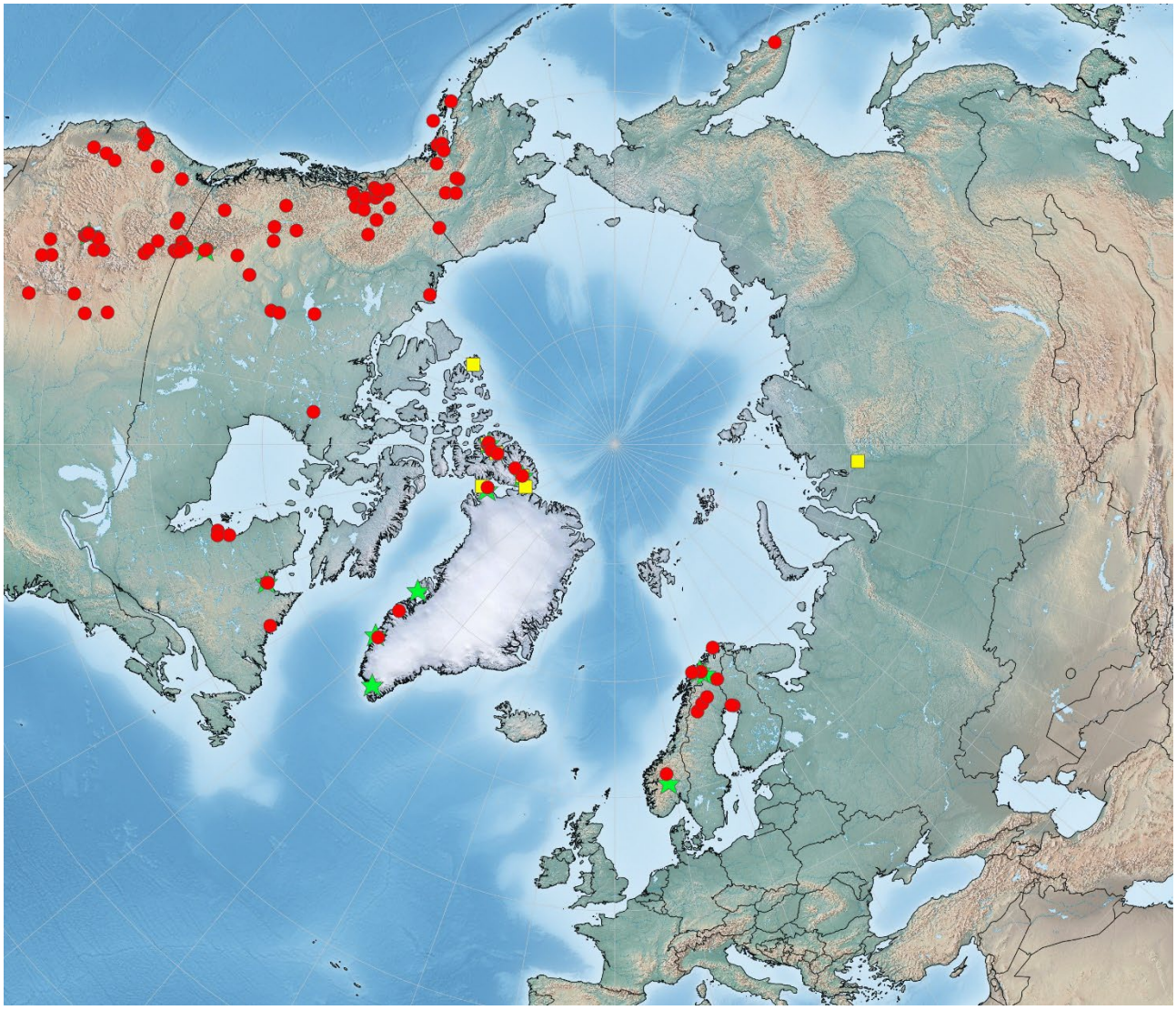
Microcyclic form – (0)-IIIsg. Spermogonia rare, poorly developed. **Telia** systemic, mainly hypophyllous, rarely epiphyllous, abundant, occasionally on the stems and inflorescences, diameter 0.2-0.6 mm, pulvinate, dark brown, becoming cinereous by the presence of basidiospores. Spores germinating readily, 2-celled, ellipsoid or somewhat clavate, apex rounded or slightly conic, base rounded or slightly tapering, not or slightly constricted at septum, 30-60(-64) × 14-28 µm, wall pale yellow, yellow-brown or chestnut brown, 1-2 µm, at apex 3-9(-11) µm thick, smooth or obscurely and sparsely striate, pore of upper cell apical, pore of lower cell inconspicuous against septum, caps inconspicuous, pedicel hyaline, rarely yellowish, 1-2× spore length, persistent.

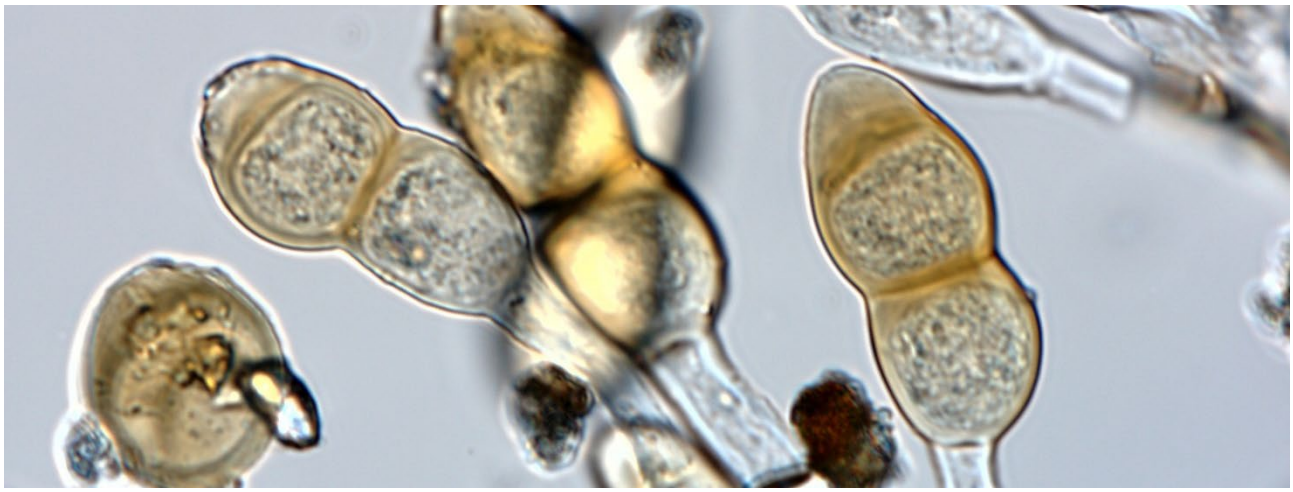
Host plants

0-III, **Brassicaceae:** *Arabidopsis arenicola*, *A. lyrata*, *A. thaliana*, *Arabis alpina*, *A. nuttallii, Boechera divaricarpa*, *B. drummondii*, *B. holboellii*, *B. lyallii*, *B. platysperma*, *B. retrofracta*, *Braya humilis*, *Erysimum cheiranthoides*, *E. cuspidatum*, *E. crepidifolium*, *Lepidium ruderale*, *Sisymbrium linifolium*, and *Smelowskia calycina.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic NO, SE, FI, and RU, common in the Rocky Mts., but missing in alpine Europe except in Dovre (NO) and the Scandinavian Mts. (SE), also occurring in the Urals and Kamchatka (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia hydrophylli **D. B. O. Savile & C. T. Watts 1051; C-F-155438; Canada (NU)**

Puccinia hydrophylli Peck & Clinton

Syn.: *Puccinia mertensiae* Peck

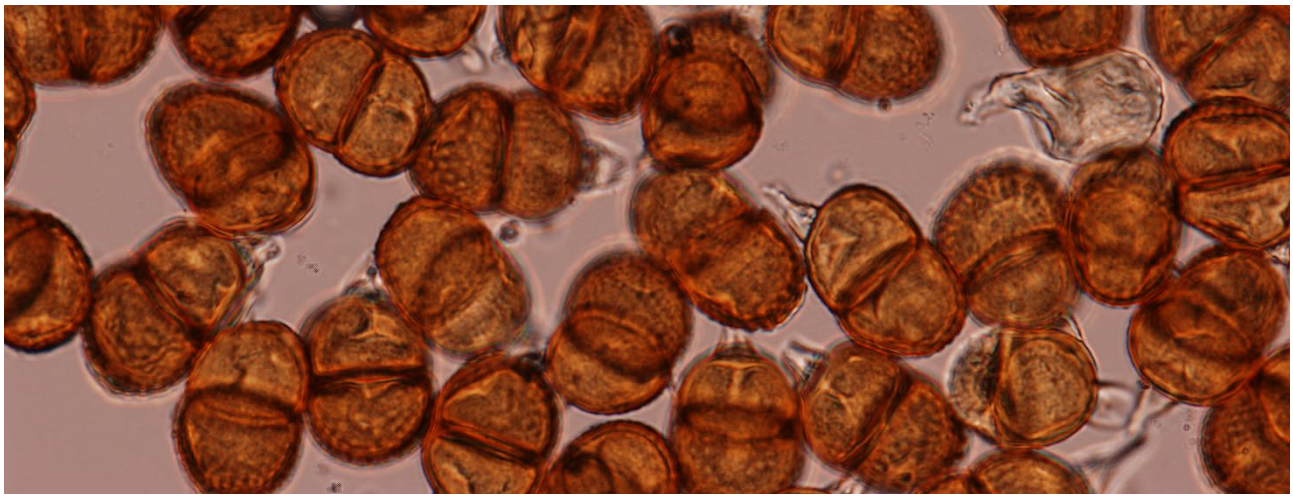
Microcyclic form – III. Telia mainly hypophyllous, also amphigenous, also on the petioles and stems, round, diameter 0.5-1 mm, scattered or in groups on yellowish spots of diameter 2-10 mm, soon naked, surrounded by the ruptured epidermis, becoming pulverulent, reddish brown to dark red-brown. Spores 2-celled, ellipsoid, ends rounded, slightly constricted at septum, 25-37 × 17-25 µm, wall dark yellow-brown, 1.5-2.5 µm thick, densely verrucose in upper cell, less so in lower cell, pore of upper cell apical to 1/3 depressed, pore of lower cell against septum to 0.75 depressed, both with or without flat cap, pedicel hyaline, fragile, breaking near attachment of spore.

Host plants

III, **Boraginaceae:** *Hackelia floribunda*, *Hydrophyllum capitatum*, *H. occidentale*, *H. virginianum*, *Mertensia arizonica*, *M. ciliata*, *M. maritima*, *M. oblongifolia*, *M. sibirica*, and *M. viridis.*

Distribution

Arctic-alpine; circumpolar; type 1; very rarely recorded in arctic AK, CAN, and RU, and a few alpine records from C-Asia, but common in the central Rocky Mts (USA).



Puccinia: Pucciniaceae: Pucciniales

Puccinia hysteriiformis **HK 21.018; C-F-152073; Germany**

Puccinia hysteriiformis Peck

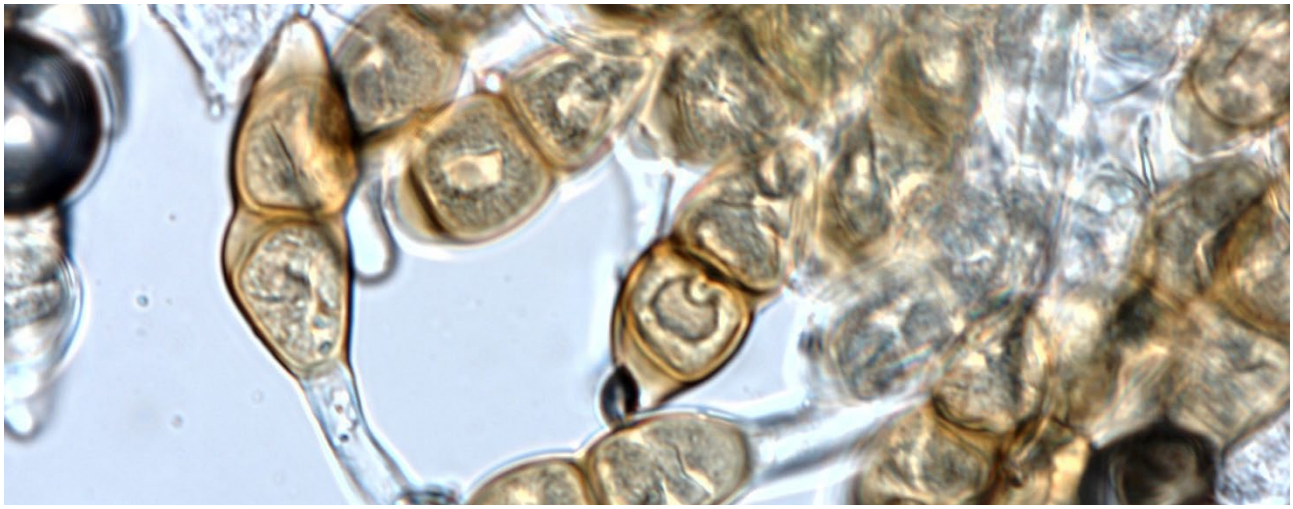
Microcyclic form – III. Telia hypophyllous or amphigenous, scattered or confluent to form groups of ca. 0.5-1.5 cm long, long covered by the epidermis, then naked and surrounded by the ruptured epidermis, pulverulent, black. Spores 2-celled, ellipsoid, oblong or clavarioid, ends rounded, 30-61 × 12-21 µm, slightly constricted at septum, wall light cinnamon brown, 1-2.5 µm, apex 4-9(-15) µm thick, smooth, pore of upper cell apical or slightly subapical, pore of lower cell against septum, caps inconspicuous, pedicel hyaline, but brownish near spore attachment, up to 2× spore length, persistent.

Host plants

III, **Caryophyllaceae:** *Cerastium carinthiacum*, *Eremogone kingii*, *E. congesta*, *Gypsophila* spp., *Minuartia verna*, *Stellaria chrysopetala*, and *S. kotschyana*.

Distribution

Alpine; circumpolar; type 7; recorded from the Alps (DE), C-Asia and the Rocky Mts. (USA). Very rare or overlooked.



Puccinia: Pucciniaceae: Pucciniales

Puccinia imperatoriae **P. Sydow; S-F-29370; Austria**

Puccinia imperatoriae Jacky

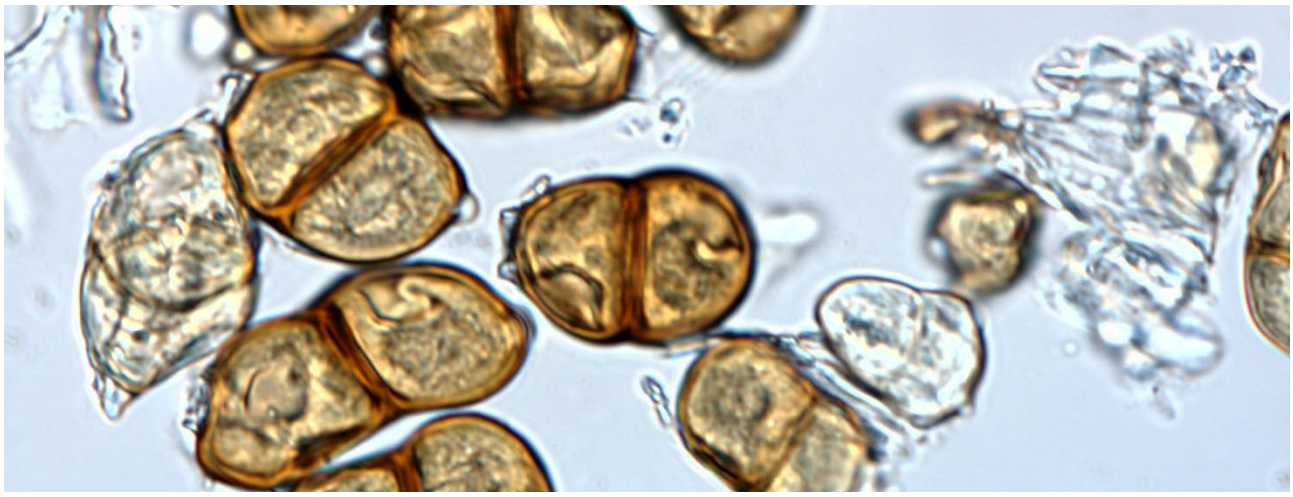
Microcyclic form – III. Telia hypophyllous, small, pustular, and on strongly swollen petioles, confluent to 1 cm large groups, long covered by the epidermis which ruptures first with a pore, then irregularly, chocolate brown. Spores 2-celled, ellipsoid, ends usually rounded, slightly constricted at septum, 25-45 × 18-25 µm, wall yellow-brown, ca. 2 µm thick, smooth, pore of upper cell apical, pore of lower cell at variable position, both pores covered with a conspicuous, hyaline, hemispherical cap, pedicel hyaline, short, deciduous.

Host plants

III, **Apiaceae:** *Peucedanum ostruthium.*

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (DE, FR, CH, AT, SI, IT), but apparently nowhere else. The host is native to central and southern Europe.



Puccinia: Pucciniaceae: Pucciniales

Puccinia japonensis **V. Hamp & J. Poelt, Reliq. Petrak. 1126; S-F472685; Germany**

Puccinia japonensis Jing X. Ji & Kakish.

Syn.: *Uromyces japonicus* Berk. & M.A. Curtis; non *Puccinia japonica* Dietel

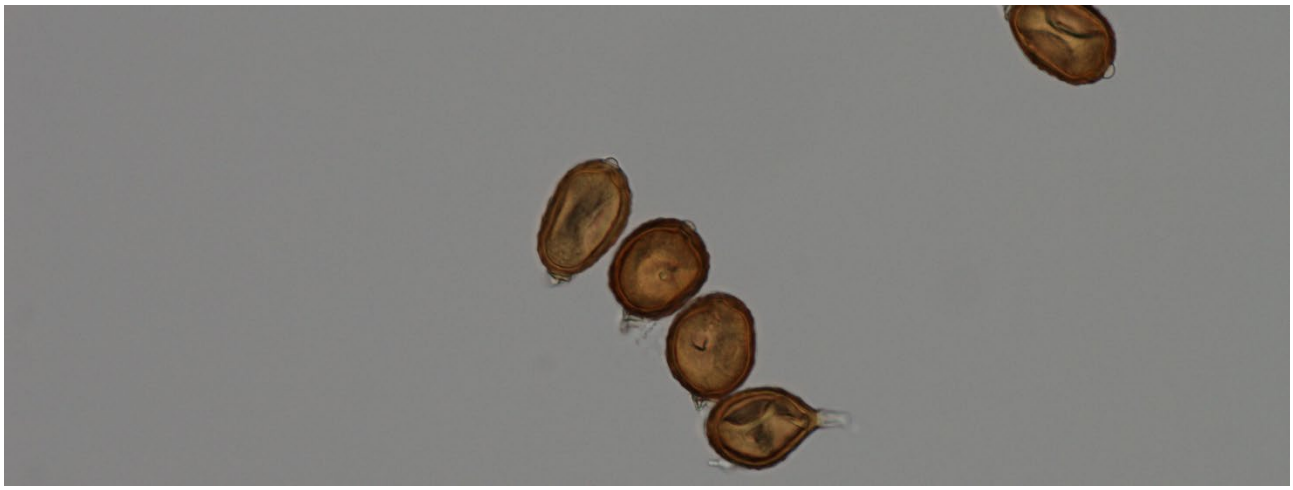
Macrocyclic auteuform – I-(II)-III. Aecia in circular groups, cupulate, peridium rudimentary. Spores angular, diameter 14-27 µm, wall thin, very finely and densely verrucose. **Urediniospores** occasionally present in the telia, 21-28 × 20-24 µm, verrucose, pores inconspicuous**. Telia** amphigenous, roundish, soon naked, pulverulent, dark brown. Spores 1-celled, subglobose to ellipsoid, ends rounded or somewhat tapering, 18-36 × 15-24 µm, wall yellow-brown to brown, uniformly thick or somewhat thickening towards the apex, distantly verrucose, pore apical, covered with a conspicuous, hyaline, hemispherical cap, pedicel hyaline, fragile, deciduous.

Host plants

I-II-III, **Alliaceae:** *Allium victorialis* (Europe) and *A. ochotense* (Eastern Asia).

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (DE, FR, CH, AT, SI, IT), and from eastern Asia including Kamchatka and Sakhalin (RU), and Hokkaido (JP).



Puccinia: Pucciniaceae: Pucciniales

Puccinia karelica **R. L. Taylor 657, DAOM 105910; C-F-155431; J. A. Calder 23487, DAOM 105898; C-F-155426; Canada (BC)**

Puccinia karelica Tranzschel including subsp. *laurentina* Savile

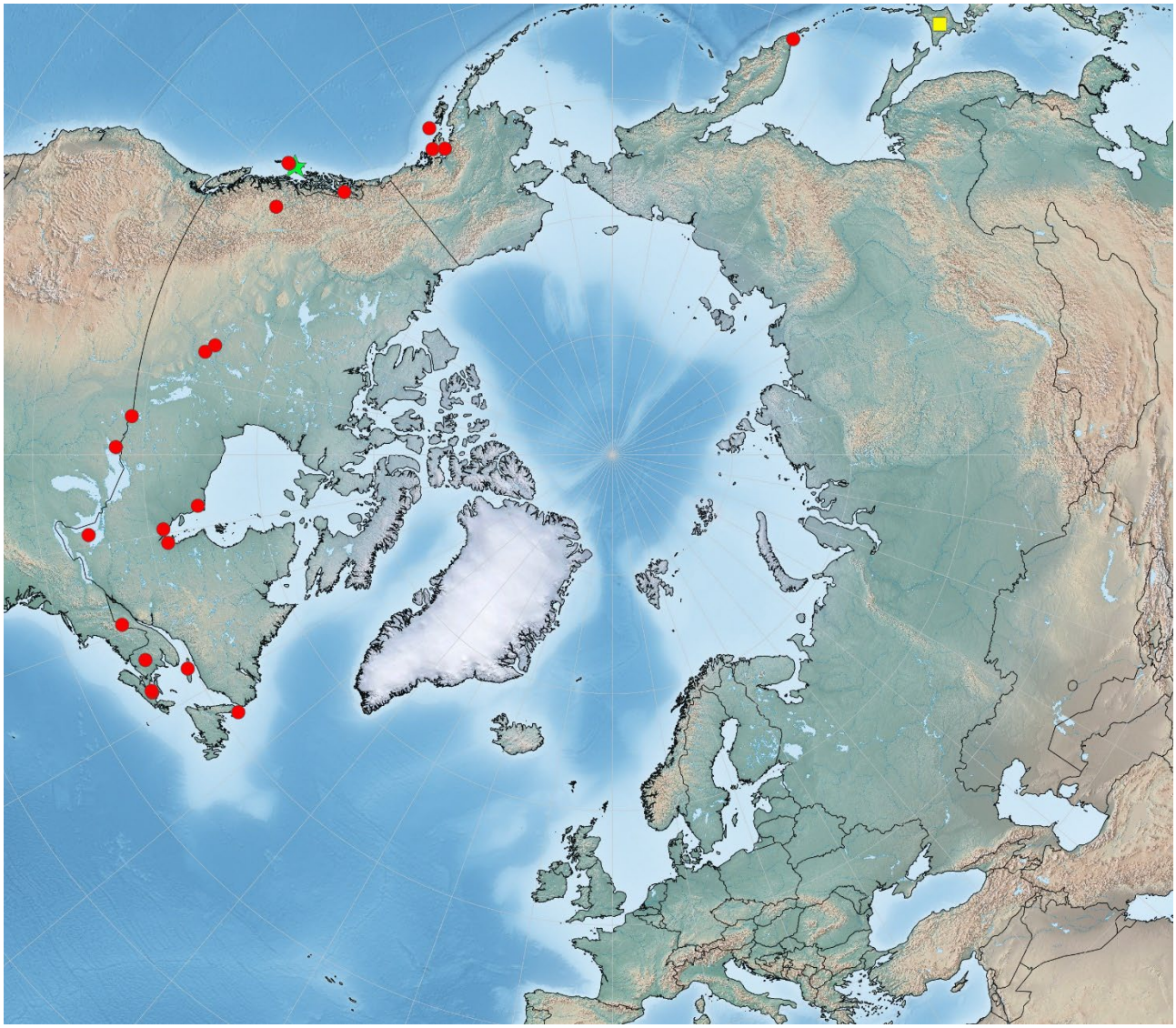
Demicyclic heteropsisform – I / II-III. Aecia mainly hypophyllous, also epiphyllous, in small circular groups of diameter 1-4 mm, diameter 0.2 mm, cupulate, peridium delicate, margin revolute and lacerate. Spores subglobose to broadly ellipsoid, angular, 15-22 × 13-19 µm, wall hyaline, 0.5-1.5 µm thick, finely verrucose, pores 2-6, inconspicuous, covered with 1.5-2.5 µm high and 2.5-4 µm broad caps. **Uredinia** mainly hypophyllous on yellow spots, scattered, ovoid or ellipsoid, 0.3-0.6 mm long, rather early naked, somewhat pulverulent, surrounded by the ruptured epidermis, cinnamon brown or brown. Spores subglobose, obovoid or broadly ellipsoid, 20-30 × 16-25 µm, wall yellow-brown, 1.5-2.5 µm thick, echinulate, spines at 1.5-3.5 µm spacing, pores (2-)3-5, usually equatorial and 1 apical, rarely 1 basal. **Telia** mainly hypophyllous, scattered, ovoid, oblong or linear, 0.4-1.5 mm long or longer, soon naked and surrounded by the ruptured epidermis, pulvinate, chestnut brown, dark brown or black. Spores 2-celled, clavate, apex rounded, base rounded or tapering, slightly to moderately constricted at septum, 26-53 × 12-24 µm, wall yellowish brown at base, darkening to dark brown at apex, 1-2 µm, apex 5-12 µm thick, smooth, pores inconspicuous, pedicel hyaline to subhyaline, 0.25-0.75× spore length, firm.

Host plants

I, **Primulaceae:** *Lysimachia* (*Trientalis*) *borealis* and *Lysimachia europaea.*
II-III, **Cyperaceae:** *Carex magellanica* and *Carex pluriflora.*

Distribution

Alpine; circumpolar; type 3; recorded from North America (AK, CAN, USA), Kamchatka (RU) and Hokkaido (JP).



Puccinia: Pucciniaceae: Pucciniales

Puccinia lagerheimii **H. Poeverlein; S-F-456273; Switzerland**

Puccinia lagerheimii Lindr.

Microcyclic form – III. Telia on the leaves and stems, on the stems causing elongate, slight swellings of up to 10 cm long, thick, oval to elongate, ca. 1.5 mm long, soon naked, pulvinate, dark brown. Spores 2(-3)-celled, elongate, clavate or fusoid, apex rounded or somewhat tapering, base tapering, slightly or moderately constricted, 35-70 × 12-22 µm, wall light to dark yellow-brown, 1-1.5 µm, apex 5-10 µm thick, smooth, pore of upper cell apical, pore of lower cell against septum, pores indistinct, pedicel hyaline to yellow, very long, persistent.

Host plants

III, **Rubiaceae:** *Galium* species, e.g. *Galium anisophyllum*, *G. noricum*, and *G. saxatile.*

Distribution

Alpine; Eurasian; type 15; only recorded from a few places in the Alps (CH, AT).

Puccinia: Pucciniaceae: Pucciniales

Puccinia lapponica **Holm 355 & Santesson, Fungi Exs. Suec. 1632; C-F-155434; Sweden**

Puccinia lapponica Rytz, including subsp. *jenissejensis* Tranzschel

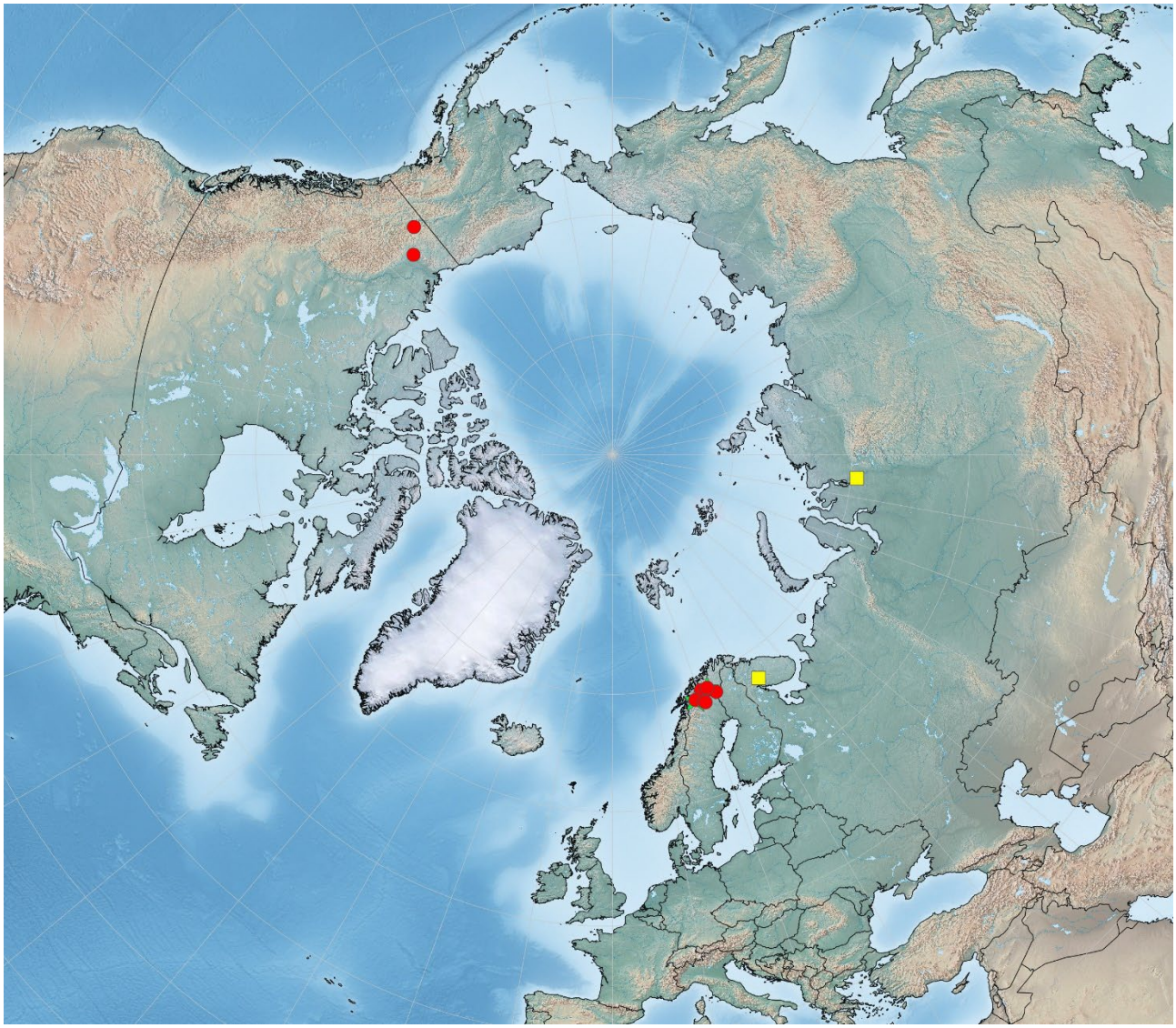
Microcyclic form – III. Telia amphigenous, also on the stems and calyxes, ca. 2-3 × 1 mm, soon naked, firm, pulvinate, dark brown to almost black. Spores (1-)2-celled, the 2-celled clavate, apex rounded, base somewhat tapering, moderately constricted at septum, (29-)42-66(-73) × (16-)19-29 µm, wall brown, the upper cell darker, ca. 1-2 µm thick, slightly thicker in the upper cell, apex 5-10 µm thick, smooth, pore of upper cell apical, pore of lower cell inconspicuous against septum, caps inconspicuous, pedicel hyaline or subhyaline, 1× spore length.

Host plants

III, **Scrophulariaceae:** *Pedicularis labradorica* and *Pedicularis lapponica.*

Distribution

Arctic; circumpolar; type 6; recorded from arctic CAN, NO, SE, and the Kola and Taimyr Peninsulas (RU).



Puccinia: Pucciniaceae: Pucciniales

Puccinia laschii **HK 21.000, photo SAE; C-F-152108; Germany**

Puccinia laschii Lagerh.

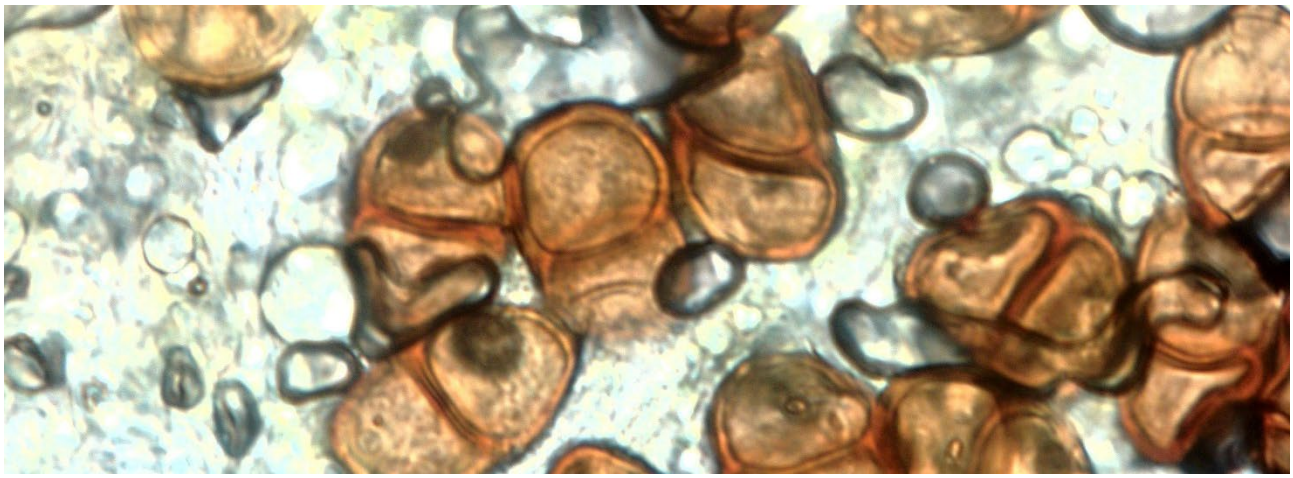
Macrocyclic auteuform – 0-Iu-II-III. Spermogonia amphigenous and on the petioles, mainly hypophyllous on the main veins, often between the aecia, first pale, then orange-red to honey-coloured. **Aecia** uredinioid, epiphyllous, occasionally hypophyllous and then mainly on the midribs and the petioles, occasionally on yellowish, diameter 5 mm spots, scattered or in circular groups, often surrounding the spermogonia, confluent, pulverulent, cinnamon brown. Spores as urediniospores. **Uredinia** hypophyllous, less frequently epiphyllous, scattered, small, pulverulent, brown. Spores 22-30 × 16-28 µm, wall 2-2.5 µm thick, echinulate, pores 3, equatorial, caps inconspicuous. **Telia** hypophyllous, less frequently epiphyllous, occasionally on the midribs, occasionally on the petioles, scattered or in confluent, irregular groups, small, dark brown. Spores 2-celled, 24-50 × 16-27 µm, wall chestnut brown, 2.5-3 µm thick, densely and very finely verrucose, pore of upper cell apical or subapical, pore of lower cell near septum, pedicel up to 40 µm long, deciduous.

Host plants

0-I-II-III, **Asteraceae:** *Cirsium*.*

Distribution

Alpine; circumpolar; type 7; recorded from alpine CAN and USA, the Alps (DE, AT), and northern Sweden and Finland.



Puccinia: Pucciniaceae: Pucciniales

Puccinia mei-mamillata **G. Lagerheim; C-F-155437; Germany**

Puccinia mei-mamillata Semadeni

Syn.: *Puccinia mamillata* Schröt.

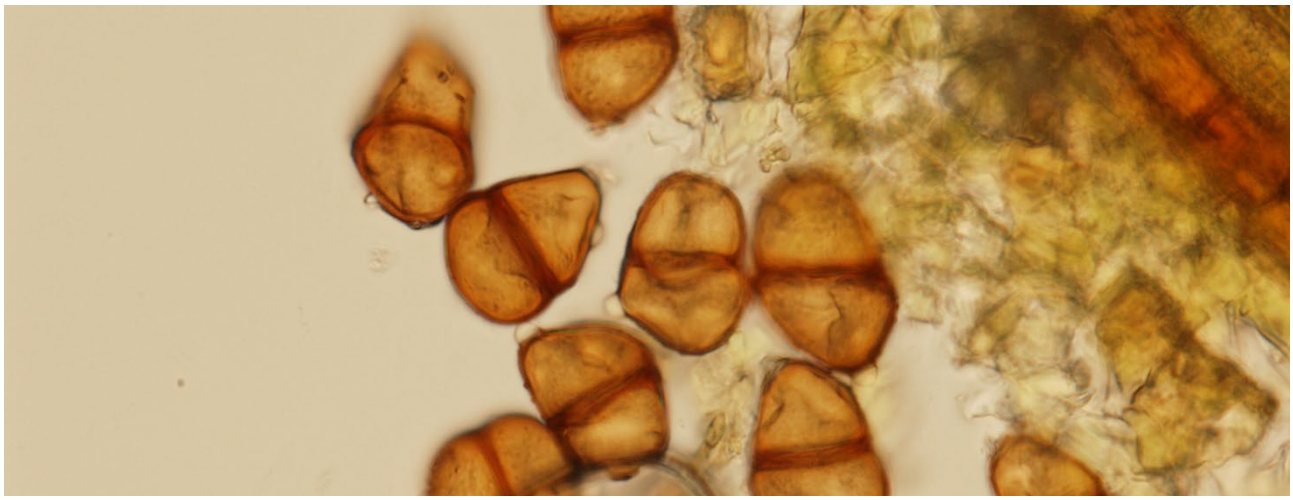
Macrocyclic hetereuform – 0-I / II-III. Spermogonia amphigenous, rather abundant, light yellow or honey yellow. **Aecia** hypophyllous, often on the veins, on the petioles and stems, on somewhat thickened or malformed, yellowish spots, cupulate, peridium firm, margin torn. Spores globose or ellipsoid, angular, 22-28 × 16-26 µm, wall thin, densely and very finely verrucose. **Uredinia** hypophyllous, scattered or less frequently in groups, round, soon naked and surrounded by the ruptured epidermis, pulverulent, red-brown. Spores subglobose, ovoid or short-ellipsoid, 20-30 × 19-24 µm, wall yellow-brown, 2.5-3.5 µm thick, echinulate, pores 4, scattered. **Telia** hypophyllous, scattered, roundish or oblong, soon naked and surrounded by the ruptured epidermis, pulverulent, dark brown. Spores 2-celled, oblong or ellipsoid, ends rounded or rarely somewhat tapering, 24-42 × 17-26 µm, not or slightly constricted at septum, wall yellow-brown, ca. 2-3 µm thick, smooth or provided with some very small warts that are scattered or arranged in rows, pore of upper cell apical, pore of lower cell usually against or close to pedicel, both covered with a conspicuous, hyaline, hemispherical or conical cap, pedicel hyaline, short, spores deciduous.

Host plants

0-I, **Apiaceae:** *Angelica sylvestris* and *Ligusticum mustelina.*
II-III, **Polygonaceae:** *Bistorta officinalis* and *Bistorta vivipara.*

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (FR, CH, AT, IT) and Dovre (NO).



Puccinia: Pucciniaceae: Pucciniales

Puccinia minussensis **N. Martianoff; C-F-155439; Russia (Krasnoyarsk)**

Puccinia minussensis Thüm.

Syn.: *Puccinia lactucicola* Miura; *P. maculosa* Schwein.; *P. prenanthes-purpureae* (DC.) Lindr.

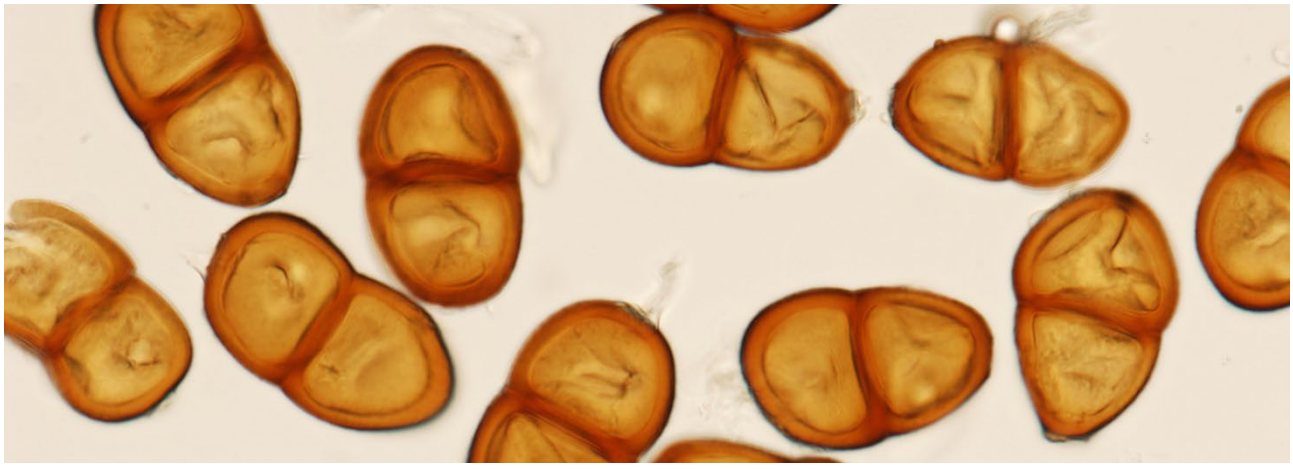
Macrocyclic auteuform – 0s-Is-II-III(s). Two generations: first generation in spring and summer, systemic infection, plant malformed and not flowering, stems twisted, leaves reduced, forming spermogonia, aecia and telia, second generation in summer and autumn, local infection not inducing malformations, forming uredinia and telia. **Spermogonia** epiphyllous or amphigenous, at top leaves, abundant, honey yellow, smelling sweet. **Aecia** amphigenous, on the stems, mainly stem base, and midribs of initially the upper, later also the lower leaves, sunken in the host tissue, diameter 0.3-0.8 mm, peridium absent or rudimentary, covered by the epidermis, opening with a pore, yellow. Spores globose to subglobose, 18-28 × 16-29 µm, wall hyaline, 2-3 µm thick, finely and densely verrucose. **Uredinia** epiphyllous or amphigenous, scattered, subglobose or ovoid, 0.2-0.6 × 0.2-0.4 mm, soon naked and surrounded by the epidermis, pulverulent, golden brown or brown, those of the second generation somewhat darker. Spores ellipsoid, 23-27 × 17-25 µm, wall cinnamon brown, 1-2 µm thick, primary generation spores finely verrucose, secondary generation spores finely and densely echinulate, pores 3-6, sometimes inconspicuous, often 4 with 2 supra- and 2 subequatorial, otherwise scattered. **Telia** mainly hypophyllous, also epiphyllous and on the stems, abundant, subglobose or ovoid, 0.2-1 × 0.2-0.8 mm, soon naked and surrounded by the ruptured epidermis, pulverulent, brown, chestnut brown or black. Spores (1-)2-celled, the 2-celled ellipsoid, ends rounded or base tapering, 30-38 × 19-25 µm, not or slightly constricted at septum, wall chestnut brown to brown, evenly 1.5-2.5 µm thick, finely verrucose, pore of upper cell apical or subapical, pore of lower cell 1/3-1/2 depressed from septum, caps inconspicuous, pedicel hyaline, fragile, short.

Host plants

0-I-II-III, **Asteraceae:** *Lactuca*.*

Distribution

Alpine; circumpolar; type 5; in the Rocky Mts. (CAN, USA), the Alps (FR, CH), the Scandinavian Mts. (NO, SE, FI), the Urals, Altai Mts., Kamchatka and Sakhalin (RU), C-Asia, and Hokkaido (JP).



Puccinia: Pucciniaceae: Pucciniales

Puccinia montivaga **H. Schinz, Krypt. exs. 2403; C-F-155440; Switzerland**

Puccinia montivaga Bubák

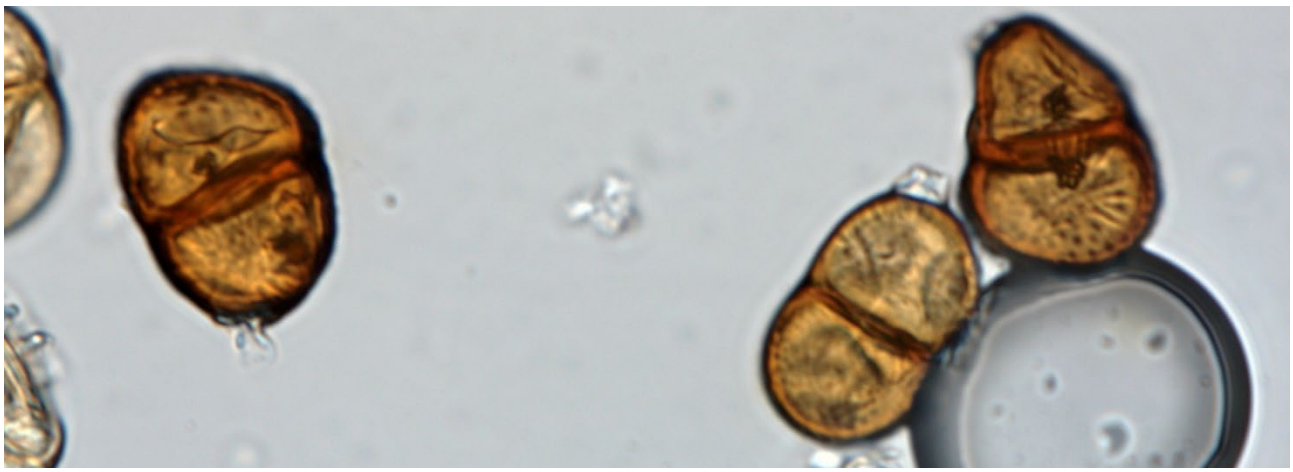
Brachycyclic form – 0-II-III. Spermogonia amphigenous, in small groups at the centre of the primary uredinia groups, honey brown. **Uredinia** primary uredinia amphigenous, roundish or elongate, in circular groups on purplish red spots surrounded by a narrow yellow margin, confluent, soon naked, pulverulent, cinnamon brown, secondary uredinia amphigenous, mostly hypophyllous, scattered, very small, pulverulent, light chestnut brown. Spores ellipsoid, ovoid or oblong, 28-35 × 20-26 µm, wall yellow-brown, echinulate, pores 2, supraequatorial. **Telia** as secondary uredinia but black. Spores 2-celled, ovoid, pyriform or ellipsoid, ends rounded, base rarely tapering, not or slightly constricted at septum, 33-38 × 20-24 µm, wall chestnut brown, finely but conspicuously verrucose, pore of upper cell about 1/3 depressed from apex, pore of lower cell about 1/3 depressed from septum, caps inconspicuous, pedicel hyaline, short, deciduous.

Host plant

0-II-III, **Asteraceae:** *Hypochaeris uniflora.*

Distribution

Alpine-boreal-temperate; Eurasian; type 15; only recorded from the Alps (CH, AT).



Puccinia: Pucciniaceae: Pucciniales

Puccinia morthieri **HK 19.099Db; C-F-152393; Russia (Altai)**

Puccinia morthieri Körn.

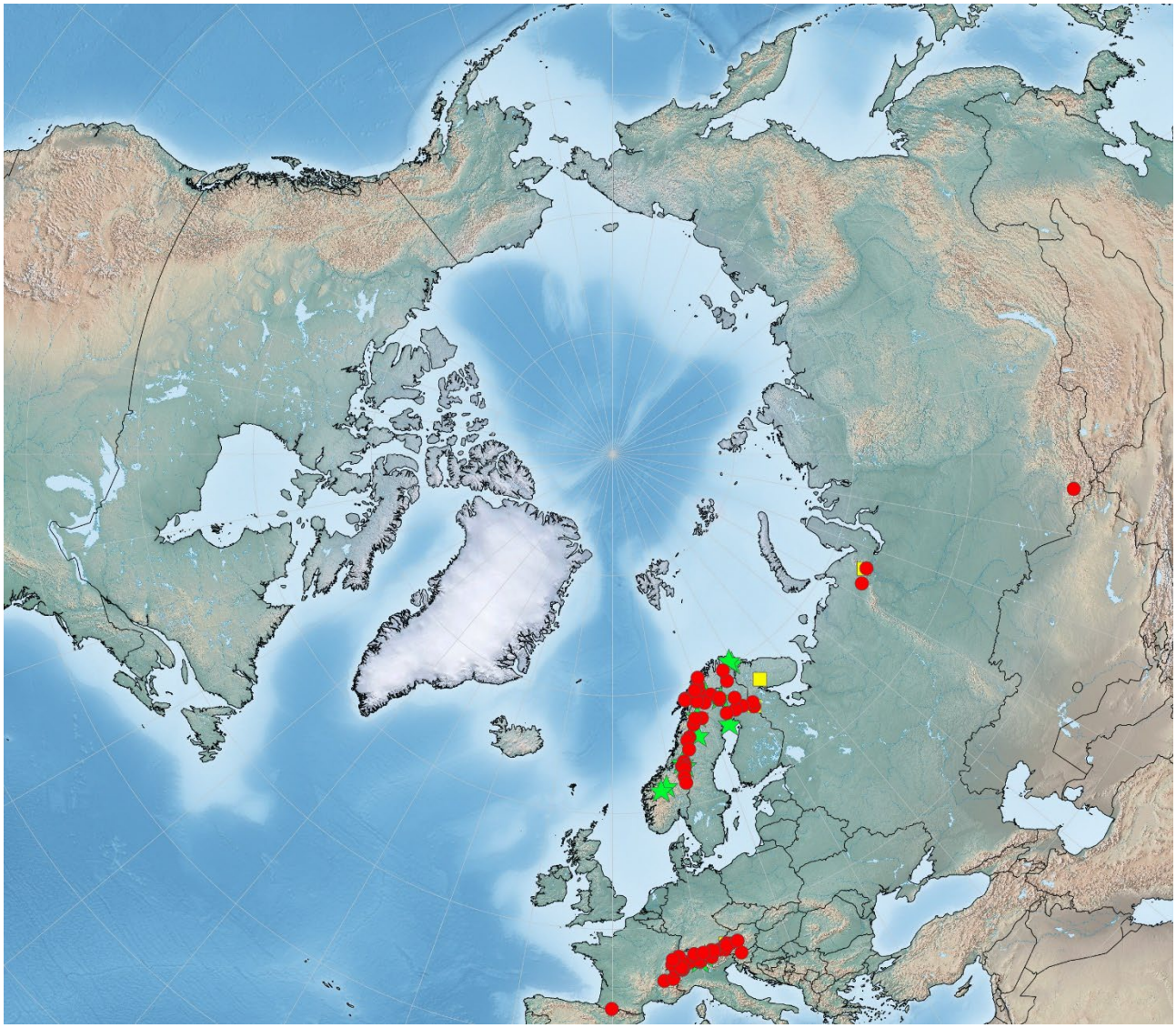
Microcyclic form – III. Telia mostly hypophyllous, occasionally on sharply margined yellow or red spots, confluent in diameter 5-8 mm groups, roundish, small, firm, long covered by the epidermis, then naked, pulvinate, brown or dark brown. Spores 2-celled, subcylindrical or oblong-clavate, apex rounded or pointed, base somewhat tapering, usually moderately constricted at septum, 36-65 × 13-24 µm, wall brown, 2-2.5 µm, at apex 6-12 µm thick, smooth or with only few, faint warts, pores often inconspicuous, pore of upper cell apical, pore of lower cell against septum, caps inconspicuous, pedicel hyaline to yellowish, up to 80 µm long, persistent.

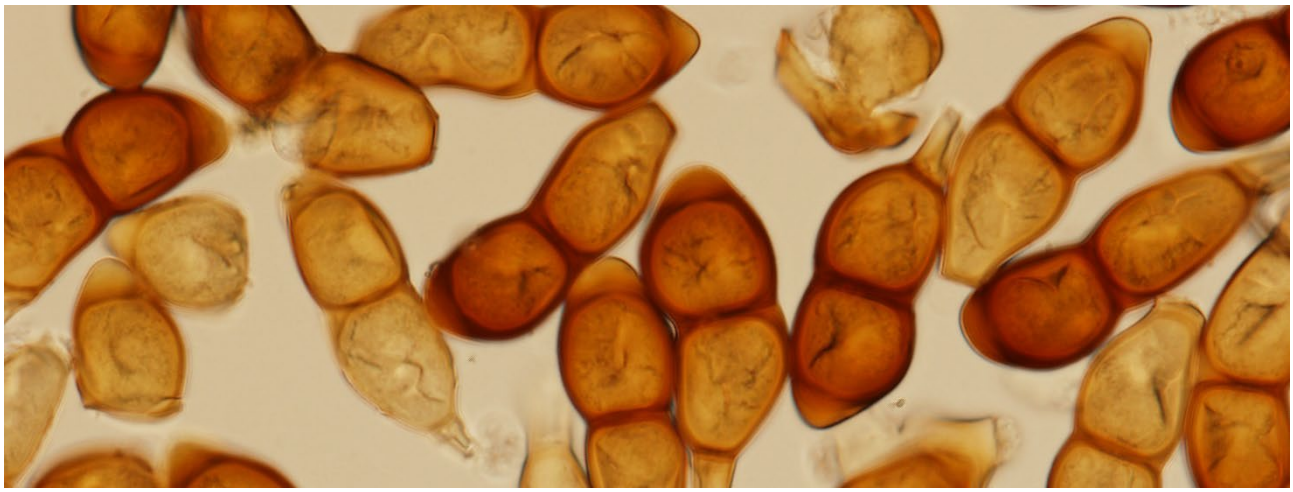
Host plants

III, **Geraniaceae:** *Geranium albiflorum* and *Geranium sylvaticum.*

Distribution

(Arctic-)alpine; Eurasian; type 9; recorded from the Alps (DE, FR, CH, AT, SI), the Pyrenees (ES), Dovre (NO), the Scandinavian Mts. (SE), the Urals and Altai Mts. (RU), and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia mougeotii **E. Mayor, Sydow Uredineen 2574; C-F-156048; Switzerland**

Puccinia mougeotii Lagerh.

Macrocyclic auteuform – I-(II)-III. Aecia hypophyllous and on the stems, irregularly scattered, oblong-cupulate, margin upright. Spores subglobose, angular, diameter ca. 18 µm, wall thin, finely verrucose. **Uredinia** sparse, often lacking, hypophyllous and on the stems, irregularly scattered, roundish or oblong, pulverulent, brown. Spores also formed in the telia, subglobose or short-ellipsoid, diameter 18-24 µm, wall light yellow-brown, 1.5-2 µm thick, distantly echinulate/verrucose, pores 4-5. **Telia** mostly hypophyllous, also on the stems, roundish or oblong, long covered by the epidermis, then naked, sometimes confluent, pulverulent, dark brown. Spores 1-2-celled, the 2-celled ellipsoid or clavate, apex usually rounded, base tapering or rounded, barely to slightly constricted at septum, 28-45 × 15-21 µm, lower cell longer and narrower than the upper cell, wall yellowish brown, ca. 1.5 µm, at apex ca. 3-8 µm thick, smooth, pore of upper cell apical, pore of lower cell against septum, caps inconspicuous, pedicel hyaline or pale yellowish, persistent, > 1× spore length.

Host plants

I-II-III, Santalaceae: *Thesium alatavicum* and *Thesium alpinum.*

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (FR, CH, AT), the Scandinavian Mts. (SE) and C-Asia.

Puccinia: Pucciniaceae: Pucciniales

Puccinia mulgedii **HK 23.069a; C-F-165491; Sweden**

Puccinia mulgedii P. Syd. & Syd.

Macrocyclic auteuform – 0-I-II-III. Spermogonia present, details not known. **Aecia** hypophyllous on small yellow spots, scattered or in small groups, yellowish, peridium cupulate. Spores subglobose to ovoid, diameter 19-25 µm, finely verrucose. **Uredinia** hypophyllous, very small, pulverulent, cinnamon brown to dark brown. Spores subglobose to ellipsoid, diameter 20-28 µm, very finely echinulate, pores 3-4, conspicuous. **Telia** hypophyllous, scattered, very small, moderately long covered by the epidermis, then naked and surrounded by the ruptured epidermis, pulverulent, dark brown. Spores 2-celled, ovoid to oblong, ends rounded, not constricted at septum, 26-40 × 19-24 µm, wall yellow-brown, very finely verrucose, pore of upper cell apical, pore of lower cell at variable position, caps inconspicuous, pedicel hyaline, short, fragile, deciduous.

Host plants

0-I-II-III, **Asteraceae:** *Cicerbita* species, e.g. *Cicerbita alpina*, *C. azurea*, and *C. rosea.*

Distribution

Alpine-boreal; Eurasian; type 9; recorded from the Alps (FR, DE, CH, AT, IT), Dovre (NO), the Scandinavian Mts. (NO, SE, FI), and C-Asia.

Puccinia: Pucciniaceae: Pucciniales

Puccinia myosotidis **W. Tranzschel; S-F28558; Kyrgyzstan**

Puccinia myosotidis Tranzschel

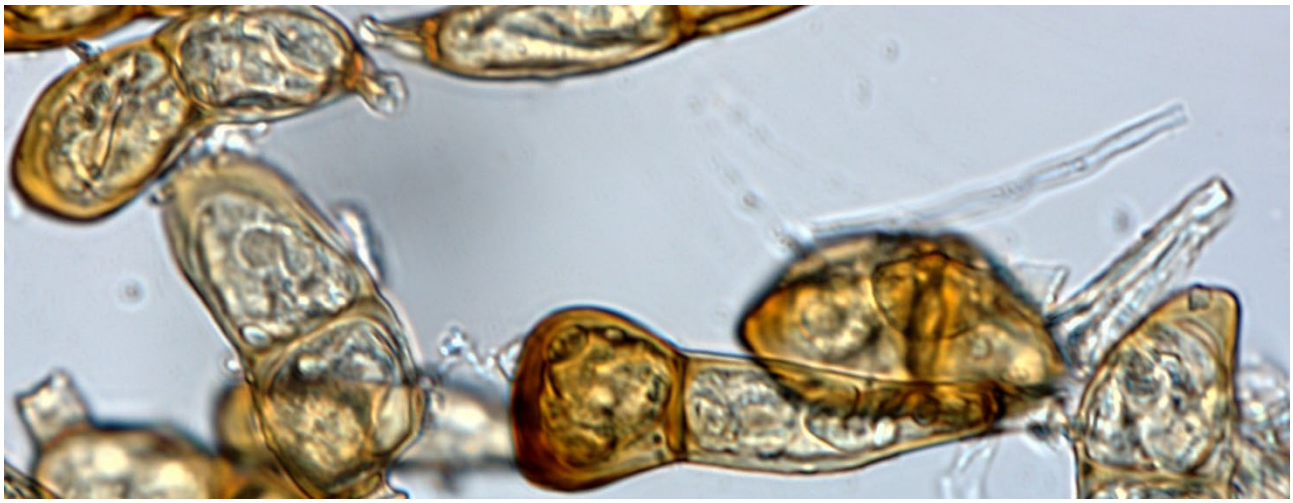
Microcyclic form – III. Telia mainly hypophyllous, also epiphyllous, and on the stems, on yellowish spots, minute, densely arranged in large rounded or elongate, up to 10 mm long groups and finally completely confluent, long covered by the epidermis, then naked, pulvinate, black, surrounded by brown paraphyses. Spores oblong-clavate or clavate, apex rounded or truncate, rarely acute, (1-)2-celled, the 2-celled not or slightly constricted at septum, 40-64 × 14-22 µm, wall smooth, at apex up to 4 µm thick, pedicel brownish, very short, persistent.

Host plants

III Rubiaceae: *Myosotis* species, e.g. *Myosotis asiatica*, *M. silvatica*, and *M. virginica*.
Ranunculaceae: *Ranunculus abortivus.*

Distribution

Arctic, alpine; Eurasian; type 5; recorded from arctic Taymir (RU), and from alpine C-Asia.



Puccinia: Pucciniaceae: Pucciniales

Puccinia novae-zembliae **T. Sørensen; C-F-108017**

Puccinia novae-zembliae Jørst. ("*nova-zembliae*")

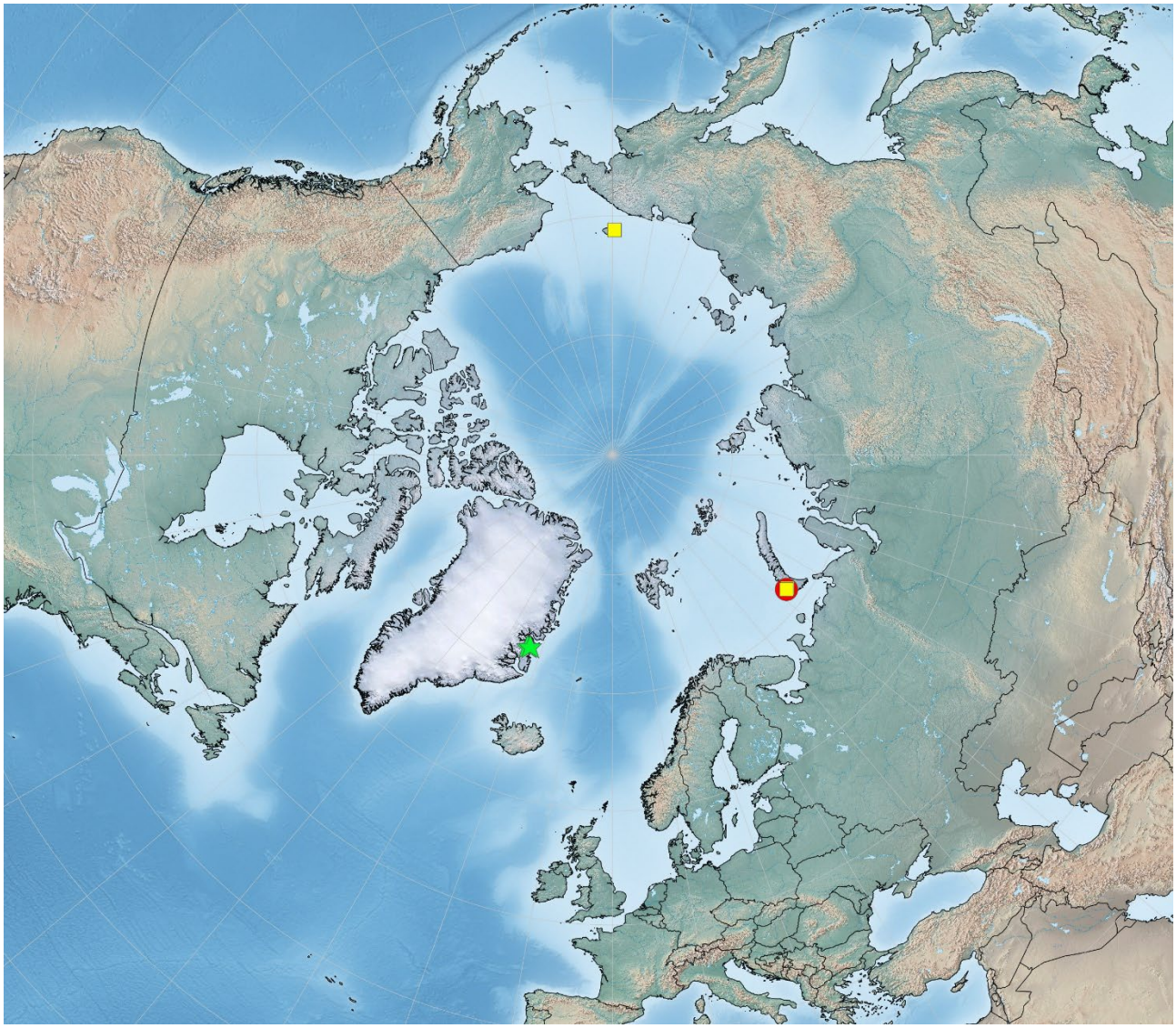
Microcyclic form – III. Telia amphigenous, on the petioles and stems, scattered or somewhat confluent, round, diameter 0.4-0.8 mm, long covered by the epidermis, then naked and surrounded by the ruptured epidermis, moderately pulverulent, chestnut brown. Spores 2-celled, ellipsoid, apex rounded, base rounded or somewhat tapering, slightly or not constricted at septum, 25-33 × 14-22 µm, wall chestnut brown, 1.5-2.5 µm, at apex 4-7 µm thick, smooth, pedicel hyaline, fragile, short, usually deciduous.

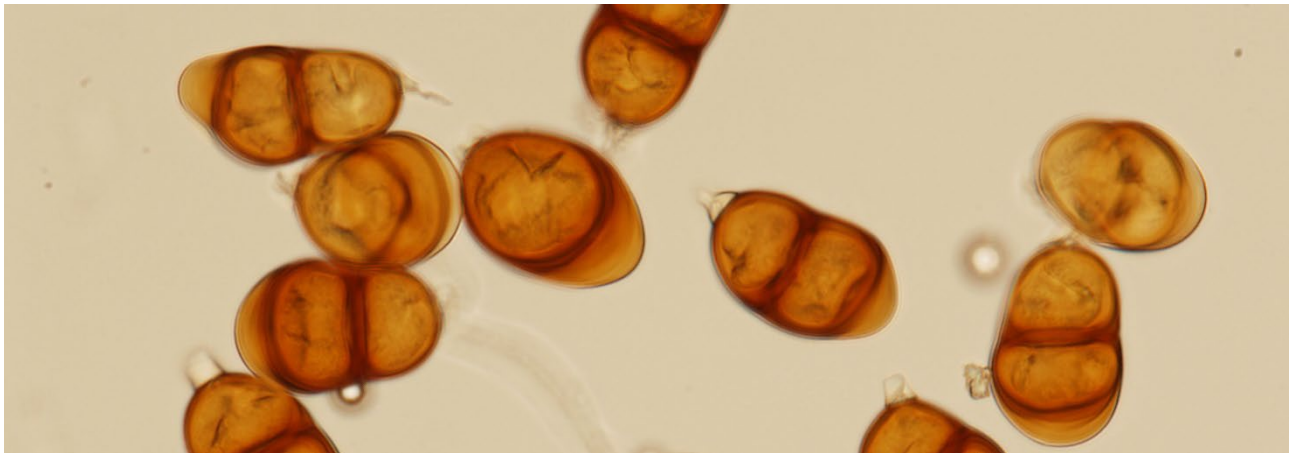
Host plants

III, **Campanulaceae:** *Campanula uniflora* and *Campanula phyctidocalyx.*

Distribution

Arctic; Eurasian; type 13; recorded from arctic GR, Novaya Zemlja and Wrangel Island (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia oudemansii **Nilsson; S-F233623; Russia (Sakha)**

Puccinia oudemansii Tranzschel

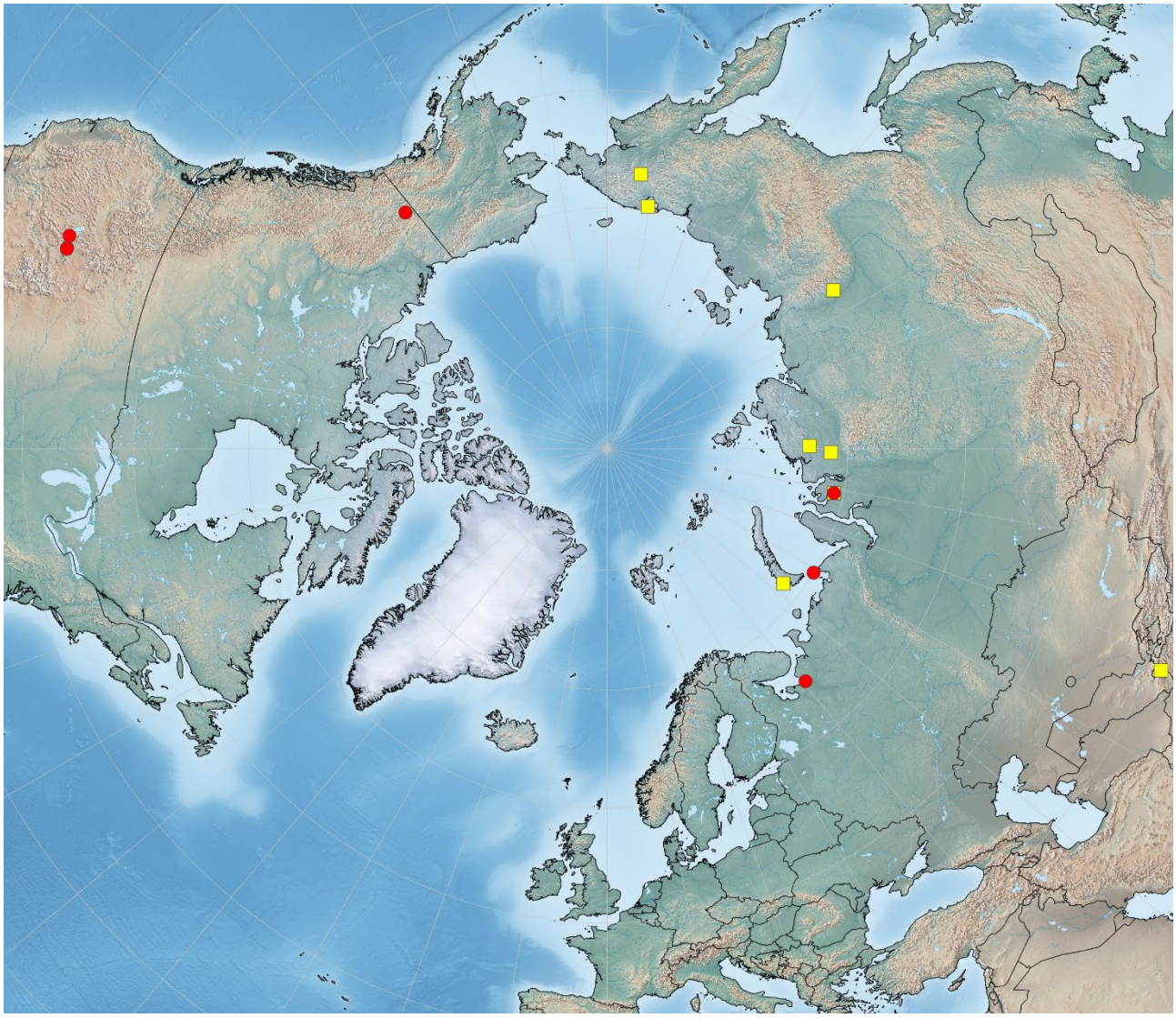
Microcyclic form – III. Telia hypophyllous or amphigenous and on the petioles, diameter 1-4 mm, round or irregular, sometimes confluent, long covered by the epidermis, then naked, pulverulent, chestnut brown or blackish brown. Spores 2-celled, oblong, oblong-clavate or ellipsoid, apex rounded or obtuse, base rounded, obtuse or tapering, slightly to moderately constricted at septum, 27-44 × 14-19(-21) µm, wall yellow-brown, light chestnut brown or chestnut brown, (1-)1.5-2 µm thick, verrucose, warts 0.3-0.5(-0.7) µm high, diameter 0.4-0.7(-1) µm at 1-1.9 µm spacing, usually scattered but sometimes in longitudinal rows and then often slightly oblong, pore of upper cell apical and covered with pale, verrucose, 2-3.5(-5) µm high and 6-9 µm broad cap, pore of lower cell pore against septum or somewhat depressed and covered with smaller cap, pedicel hyaline, deciduous.

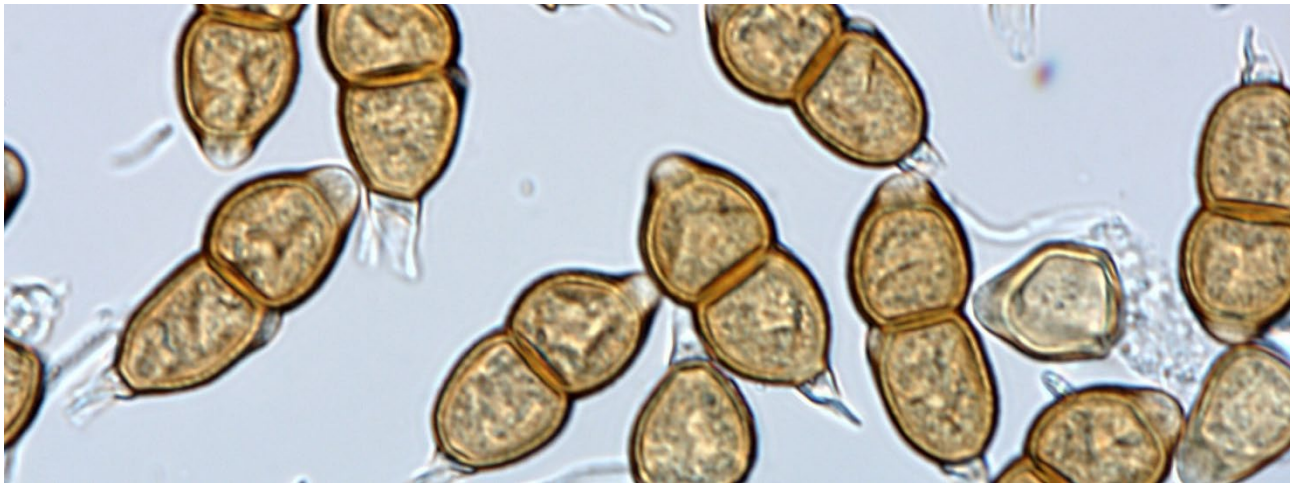
Host plants

III, **Brassicaceae:** *Noccaea fendleri*, *Parrya rydbergii*, *Parrya turkestanica*, and *Teesdalia nudicaulis*.

Distribution

Eurasian arctic-alpine, North American alpine; circumboreal; type 5; recorded from arctic RU (e.g., Novaya Zemlja, Taymir, Chukotka), from the alpine North American Rocky Mts. (CAN, USA), and from C-Asia.





Puccinia: Pucciniaceae: Pucciniales

Puccinia oxyriae **J. Hartz & C. Ostenfeld (micro F. H. Møller; C-F-8808); C-F-8807; Faroe Islands**

Puccinia oxyriae Fuckel

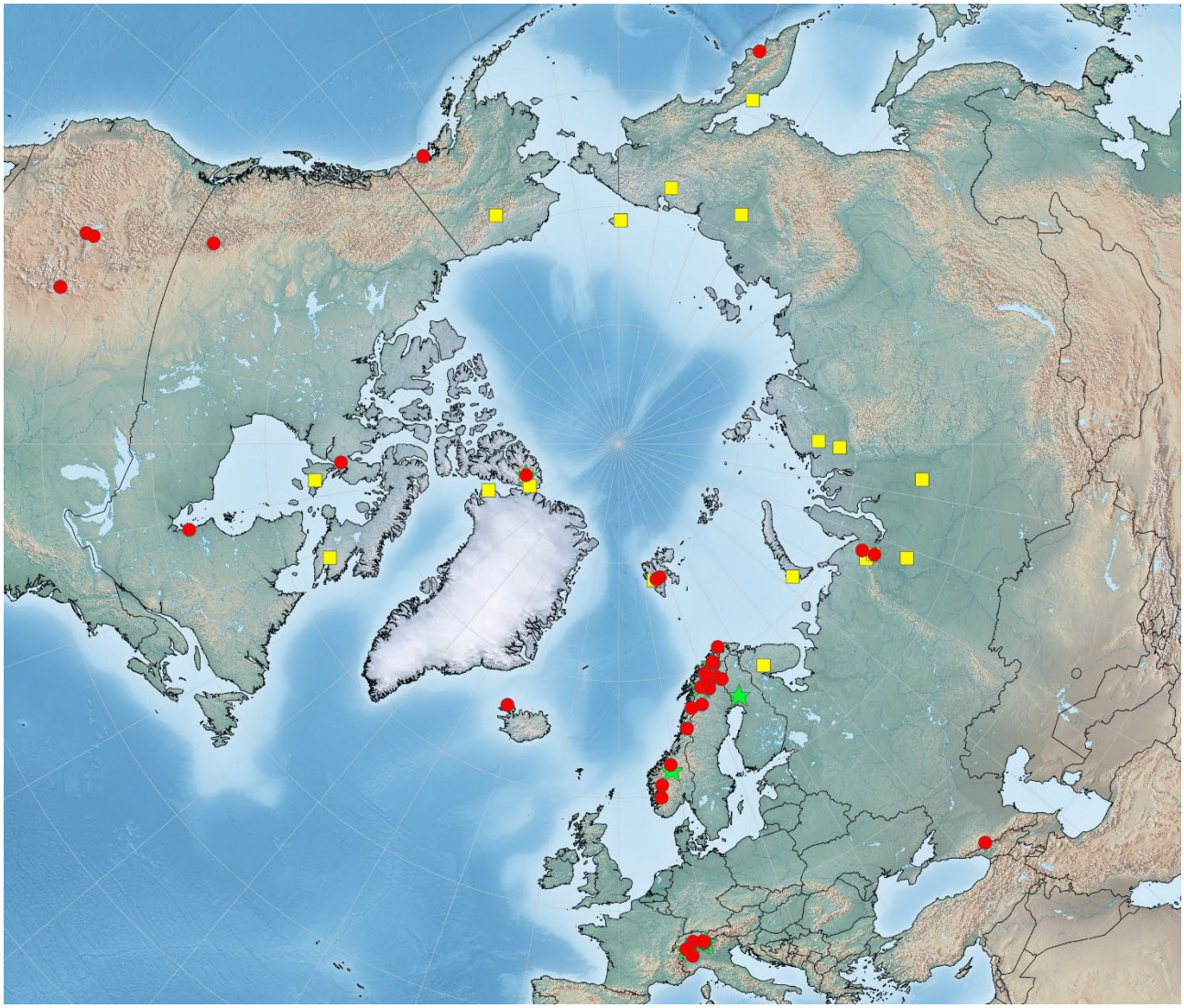
Hemicyclic form – II-III. Uredinia amphigenous on small purplish spots, scattered or in irregular groups, up to diameter 1 mm, rather soon naked, then surrounded by the ruptured epidermis, pulverulent, yellow to cinnamon brown. Spores yellowish brown, ellipsoid or obovoid, 23-35 × 20-28 µm, wall light yellowish, 1.5-2.5 µm thick, distantly echinulate, pores 3-6, inconspicuous, covered with flat, inconspicuous caps. **Telia** mainly hypophyllous, also epiphyllous and on the petioles and stems, on the leaves round, on the petioles and stems more elongate, soon naked and surrounded by the ruptured epidermis, pulverulent, chestnut brown or dark brown. Spores 2-celled, ellipsoid or oblong, ends usually rounded, sometimes base slightly tapering, slightly to moderately constricted at septum, 30-54 × 15-28 µm, wall yellow-brown to light chestnut brown, 1.5-2(-3) µm, at apex 3-6 µm thick, covered with irregular, flat warts giving the surface a corroded look, more so around the pores, sometimes also more so in the upper half, pore of upper cell apical and covered with a conspicuous, yellowish, ca. 1-1.5 µm high and 1.5-2 µm broad cap, pore of lower cell against septum or 1/2 depressed and cap smaller or indistinct, pedicel subhyaline or pale yellow, rather short, fragile, deciduous.

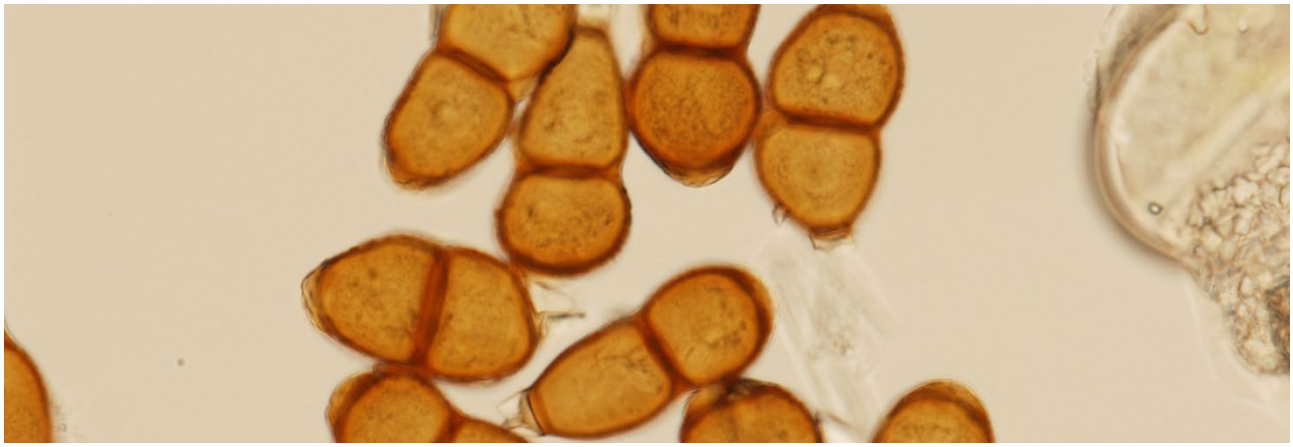
Host plant

II-III, **Polygonaceae:** *Oxyria digyna.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic CAN, IS, Svalbard, NO, SE, FI, and RU, and from the alpine Rocky Mts. (AK, CAN, USA), the Alps (CH, IT), the Pyrenees (ES), Dovre (NO), the Scandinavian Mts. (SE), the Urals and Kamchatka (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia pallidomaculata **Holway, Micromyc. rar. sel. 1123; C-F-155798; Canada (AB)**

Puccinia pallidomaculata Ellis & Everh.

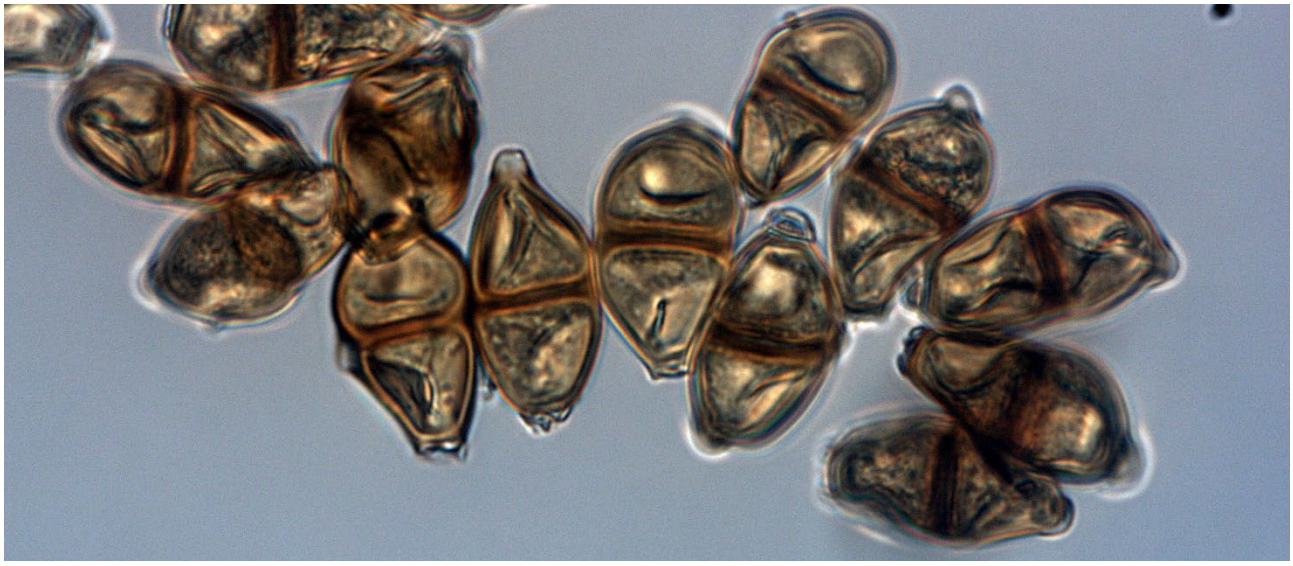
Microcyclic form – III. Telia amphigenous, often in circinate groups on diameter 1-3 mm, pale yellowish spots, confluent, round, diameter 0.5-0.8 mm, soon naked and surrounded with ruptured epidermis, pulverulent, chestnut brown. Spores 2-celled, somewhat irregularly fusoid, more rarely ellipsoid or oblong, ends obtuse, not constricted at septum, 26-38 × 13-16 µm, wall 1.5-2 µm thick, smooth, pore of upper cell apical, pore of lower cell against septum, both pores covered with an abrupt, hyaline, 3-4 µm high cap, pedicel hyaline, short, deciduous.

Host plants

III, **Saxifragaceae:** *Chrysosplenium alternifolium*, and *Saxifraga* species, e.g. *Saxifraga arguta*, *S. lyallii*, and *S. punctata*.

Distribution

Alpine-boreal; circumpolar; type 7; recorded from the Rocky Mts. (CAN, USA), NE Canada, and C-Asia.



Puccinia: Pucciniaceae: Pucciniales

Puccinia parnassiae **A. O. Garrett, Sydow Uredineen 1934; S-F233832; USA (Utah)**

Puccinia parnassiae Arthur

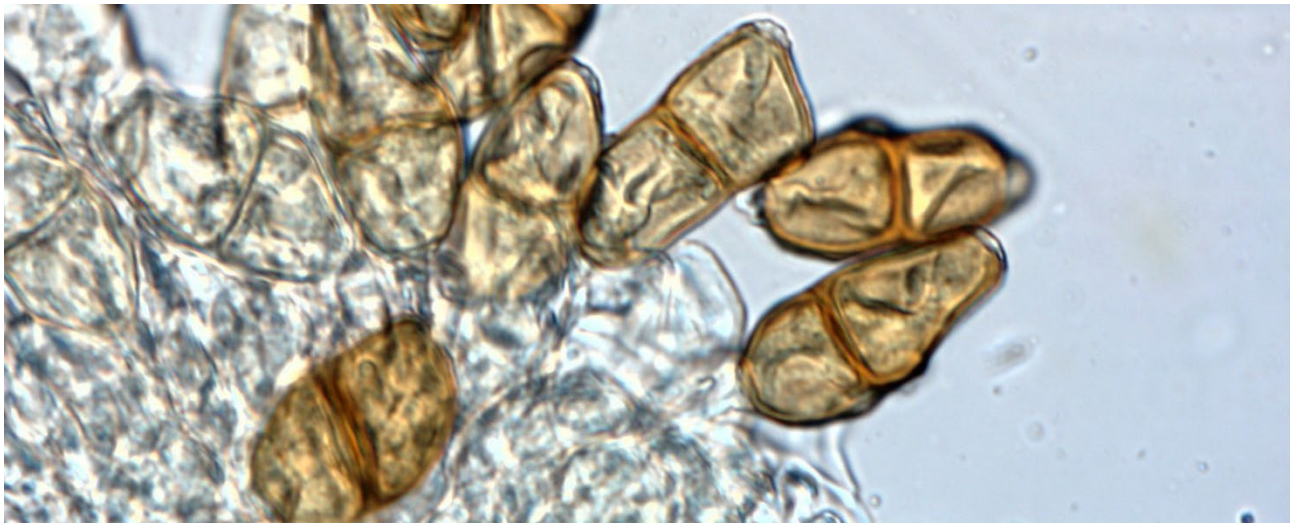
Microcyclic form – III. Telia amphigenous and on the stems, somewhat in groups, confluent, soon naked and surrounded by the ruptured epidermis, pulverulent, dark brown. Spores 2-celled, ellipsoid, oblong or cylindrical, ends rounded or obtuse, not or slightly constricted at septum, 23-44 × 13-23 µm, wall yellow-brown or chestnut brown, 1-2 µm thick, smooth or towards the apex with small, 0.2-0.4 µm high and diameter 0.6-1 µm warts that are connected with very fine lines, pore of upper cell apical or subapical and covered with an up to 2 µm high cap, pore of lower cell against septum to 3/4 depressed and covered with smaller cap, pedicel hyaline, up to 0.5× spore length, deciduous.

Host plant

III, **Parnassiaceae:** *Parnassia fimbriata.*

Distribution

Alpine; North-American; type 14; only recorded from the alpine Rocky Mts. in CAN and USA.



Puccinia: Pucciniaceae: Pucciniales

Puccinia pazschkei **HK 23.064; C-F-165486; Sweden**

Puccinia pazschkei Dietel

Syn.: *Puccinia pazschkei* var. *huteri* (Syd.) Savile, *P. huteri* Syd. & P. Syd.; *P. jueliana* Dietel; *P. pazschkei* var. *jueliana* (Dietel) Savile; *P. pazschkei* var. *oppositifolia* Savile

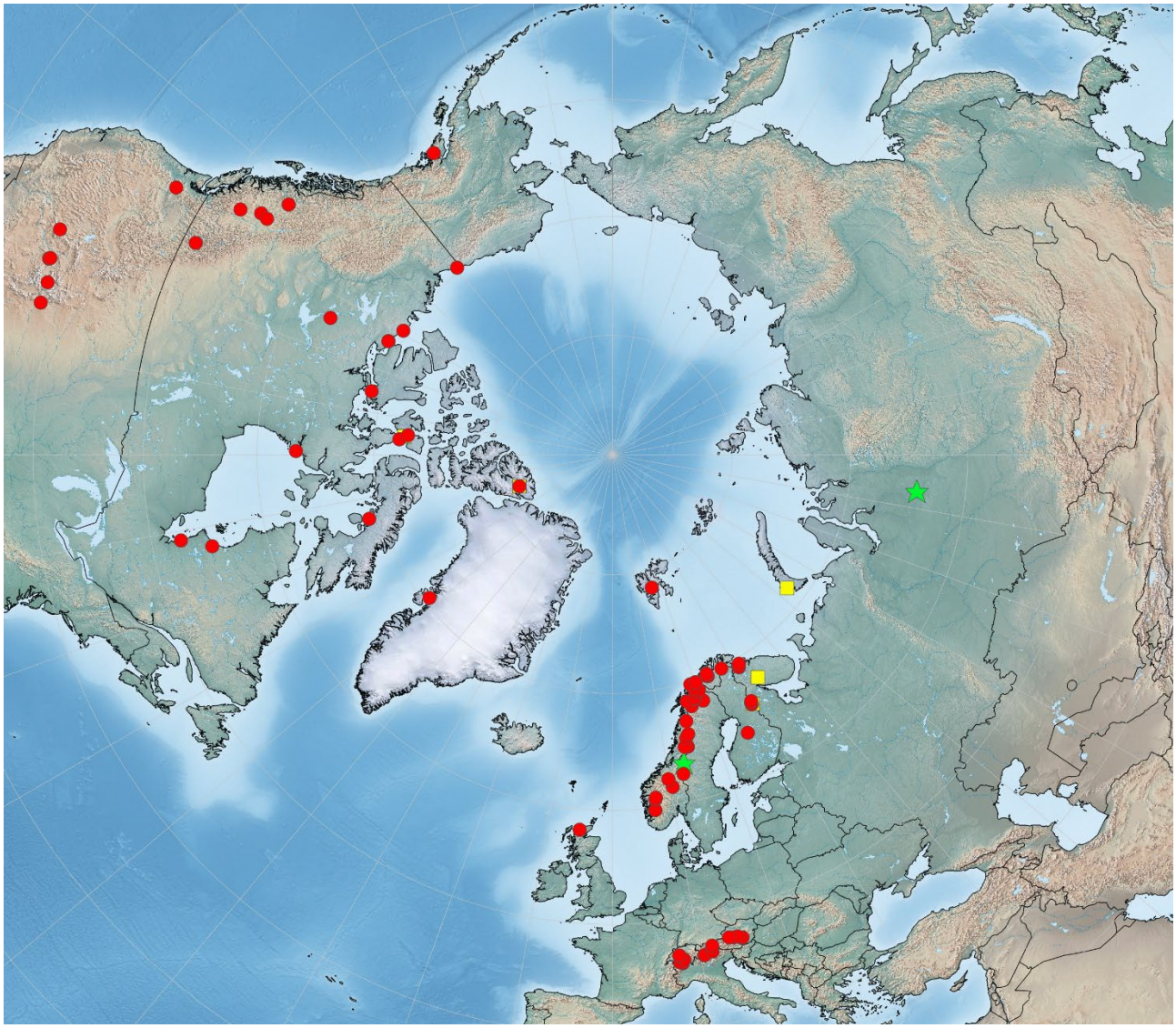
Microcyclic form – III. Telia epiphyllous, occasionally a few hypophyllous, diameter 0.5-1 mm, in circinate groups of diameter 2-3 mm, or less frequently scattered, soon naked, surrounded by the swollen and torn epidermis, pulverulent, dark red-brown. Spores (1-)2-celled, the 2-celled ellipsoid or oblong, ends rounded, slightly to moderately constricted at septum, 25-55(-60) × 13-28(-30) µm, wall yellow-brown or pale brown, 1.5-2.5 µm thick, at apex slightly thicker but sometimes >4 µm thick, finely to coarsely rugose or verrucose, sometimes warts in labyrinthiform ridges, grading to nearly smooth downwards, pore of upper cell apical, pore of lower cell against septum to 1/3(-1/2) depressed, both pores covered with a yellow, 1-3 µm high and 7-14 µm broad cap, pedicel hyaline, short, deciduous.

Host plants

III, **Saxifragaceae:** *Saxifraga*.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic AK, CAN, GR, IS, Svalbard, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (CAN, USA), the Alps (CH, AT), Dovre (NO), the Scandinavian Mts. (SE), and Novaya Zemlja (RU).



Puccinia: Pucciniaceae: Pucciniales

Puccinia pedicularis **M. P. Porsild; C-F-108018**

Puccinia pedicularis Thüm.*

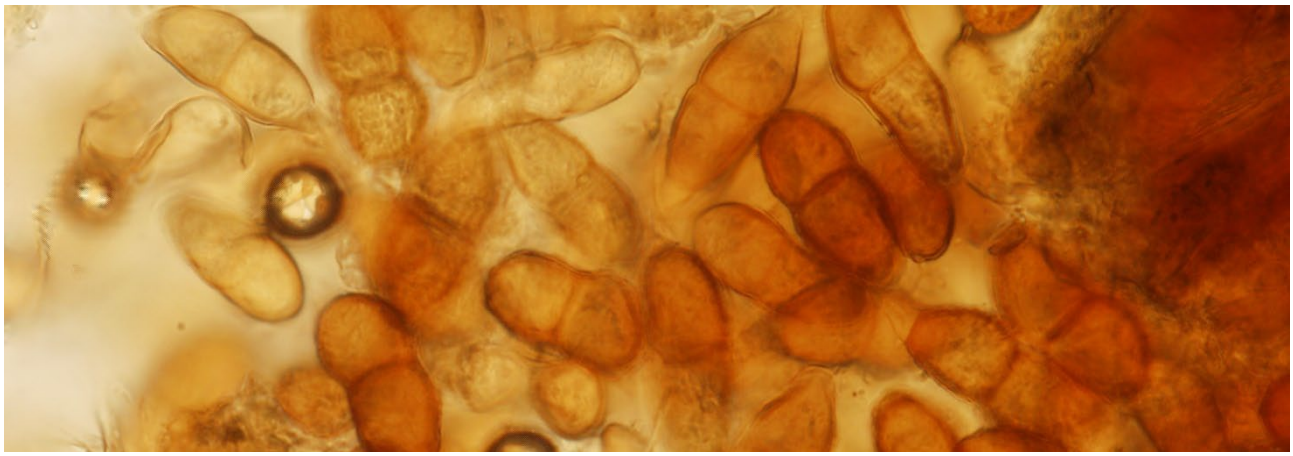
Microcyclic form – III. Telia mainly epiphyllous, occasionally hypophyllous, most along the midrib, and on the petioles and sepals, diameter 1-3 mm, surrounded by the ruptured epidermis, pulverulent, dark cinnamon brown to chestnut brown. Spores (1-)2(-4)-celled, the 2-celled narrowly to moderately ellipsoid, ends rounded to slightly tapering, moderately constricted at septum, 25-47 × 11-20 µm, wall yellow-brown to golden brown 1-2 µm thick, verrucose with irregular warts and labyrinthiform ridges, pore of upper cell apical or subapical and covered with an up to 2.5-5(-7) µm high and 5-14 µm broad cap, pore of lower cell against septum to 1/4 depressed or inconspicuous and covered with smaller cap, or cap inconspicuous, pedicel hyaline, fragile, breaking at 5-10 µm from spore base.

Host plants

III, **Scrophulariaceae:** *Pedicularis flammea* and *Pedicularis oederi.*

Distribution

Arctic-alpine; circumpolar; type 10; recorded from arctic North America (Baffin Island CAN and GR) and from alpine Dovre (NO).



Puccinia: Pucciniaceae: Pucciniales

Puccinia poarum **P. Nielsen; C-F-70908 (lectotype); Denmark**

Puccinia poarum Nielsen

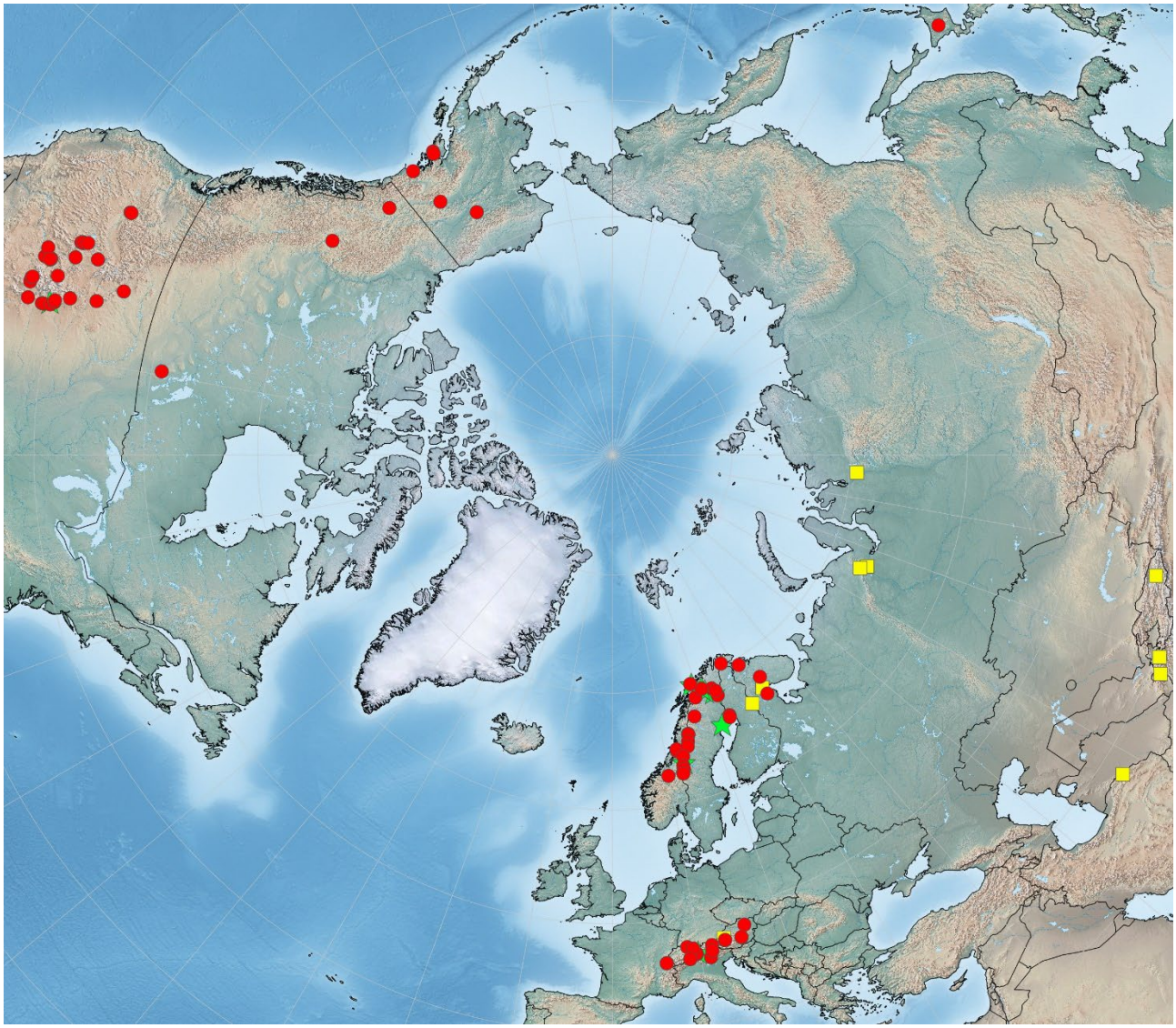
Macrocyclic hetereuform – 0-I / II-III. Spermogonia often very abundant, epiphyllous, pale yellow. **Aecia** hypophyllous, often in dense groups on round, yellow, thickened, diameter 1-2 cm spots with a red or violet margin, rarely scattered, cylindrical-cupulate, margin white, revolute, dentate or lacerate. Spores ellipsoid-polygonal, 18-28 × 14-21 µm, wall 1 µm thick, very finely and densely verrucose. **Uredinia** usually epiphyllous, occasionally on the stems, small, round to ellipsoid, diameter ca. 0.5 mm, long covered by the epidermis, then naked, surrounded by the epidermis, orange-yellow, soon transferring into telia. Spores subglobose to ellipsoid, 17-29 × 16-25 µm, wall pale yellow, 1-1.5 µm thick, pores (5-)7-9, scattered, inconspicuous. **Telia** also developing from the uredinia, usually hypophyllous, oblong to linear, up to 0.5 mm long, surrounded by a pale margin, more or less in short rows, long covered by the epidermis, black, mixed with hyaline or brownish, clavate to capitate paraphyses. Spores (1-)2-celled, the 2-celled oblong-clavate to cylindroid, apex rounded, truncate or rarely attenuated, not or barely constricted at septum, 30-65 × 16-26 µm wall chestnut brown, towards the base paler, 1-1.5 µm, at apex 4-8 µm thick, smooth, pores inconspicuous, pedicel brownish, short, persistent.

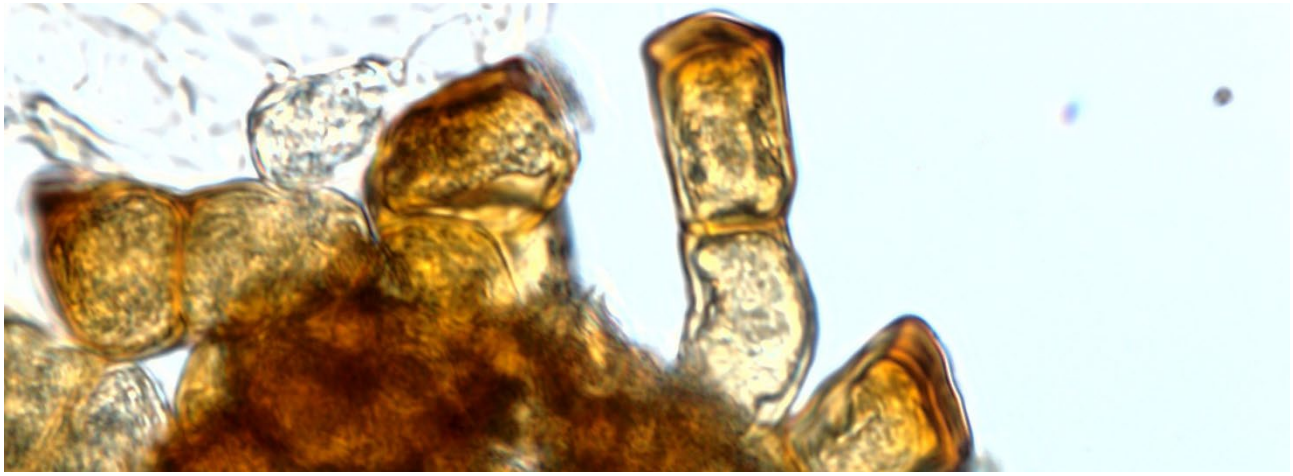
Host plants

0-I, **Asteraceae:** *Hymenoxys hoopesii* and *Petasites* species, e.g. *Petasites frigidus*, and *Tussilago farfara*.
II-III, **Poaceae:** *Poa*,* also *Agrostis scabra*, *Festuca arizonica*, and *F. sororia.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic AK, NO, SE, FI, and RU, and from alpine regions of the Alps (FR, CH, AT), the Scandinavian Mts. (SE), the Urals (RU), C-Asia, and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia polemonii **Calder 14527 & Savile, DAOM 189773; S-F462258; Canada (BC)**

Puccinia polemonii Dietel & Holw.

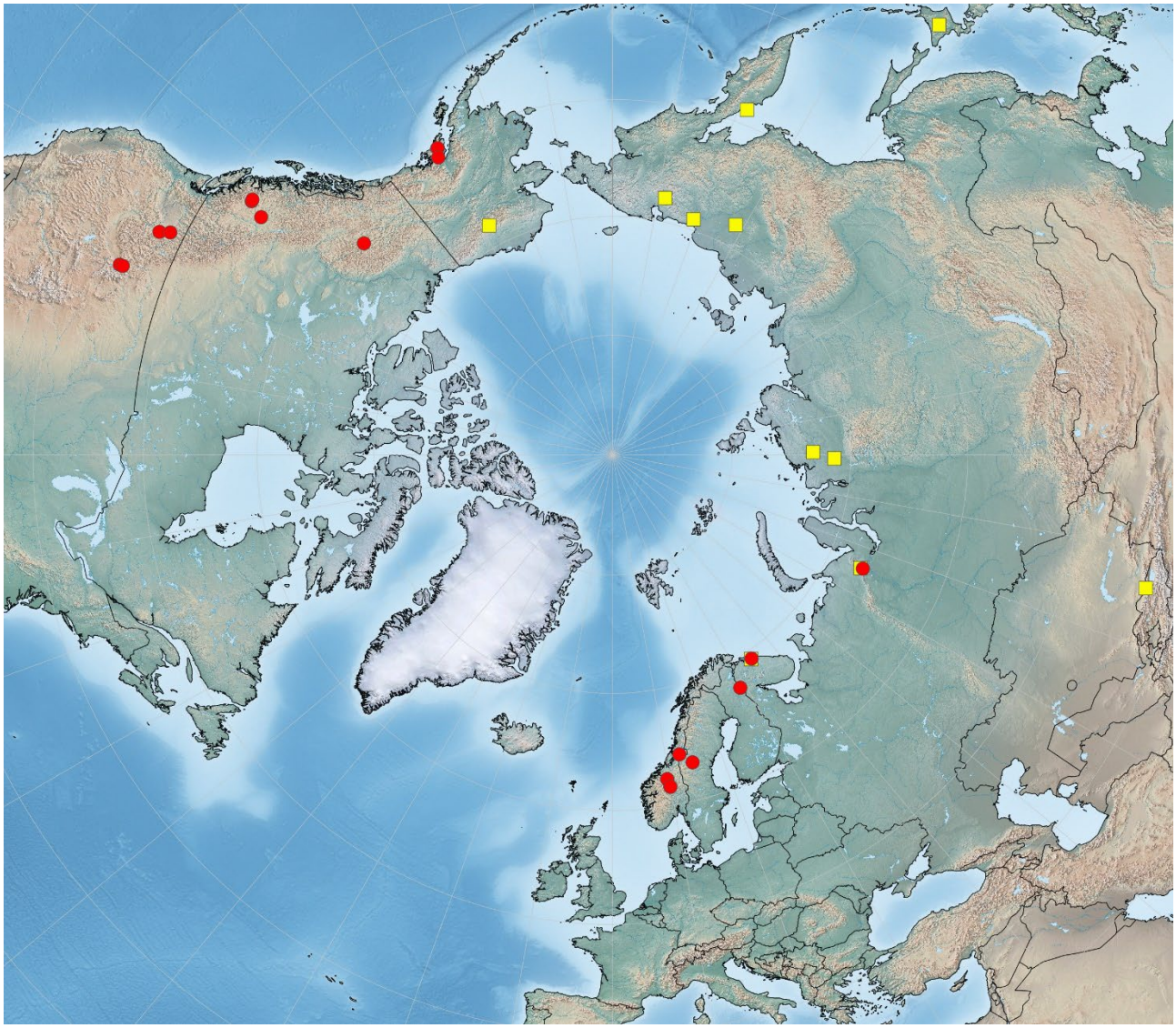
Microcyclic form – IIIg. Telia amphigenous and on the petioles, small, round, confluent in groups of diameter 0.5-2 mm, or more elongate in up to 1 cm long lines, of 2 types: (i) readily germinating spores (leptospores): hypophyllous, also on the veins, pulvinate, cinnamon brown, becoming cinereous by presence of basidiospores, (ii) resting spores: epiphyllous and on the petioles, pulverulent, dark brown. Spores germinating after winter, 2-celled, oblong-cylindrical or clavate, apex somewhat pointed, base rounded or somewhat tapering, not or barely constricted at septum, pale brown (leptospores) or brown (resting spores), (21-)26-42(-53) × 13-19 µm, wall hyaline (leptospores) or brown (resting spores), ca. 3 µm, at apex 4-6 µm thick, smooth, pore of upper cell apical, pore of lower cell supraequatorial, caps inconspicuous, pedicel hyaline, up to 1× spore length, persistent (leptospores) and deciduous (resting spores).

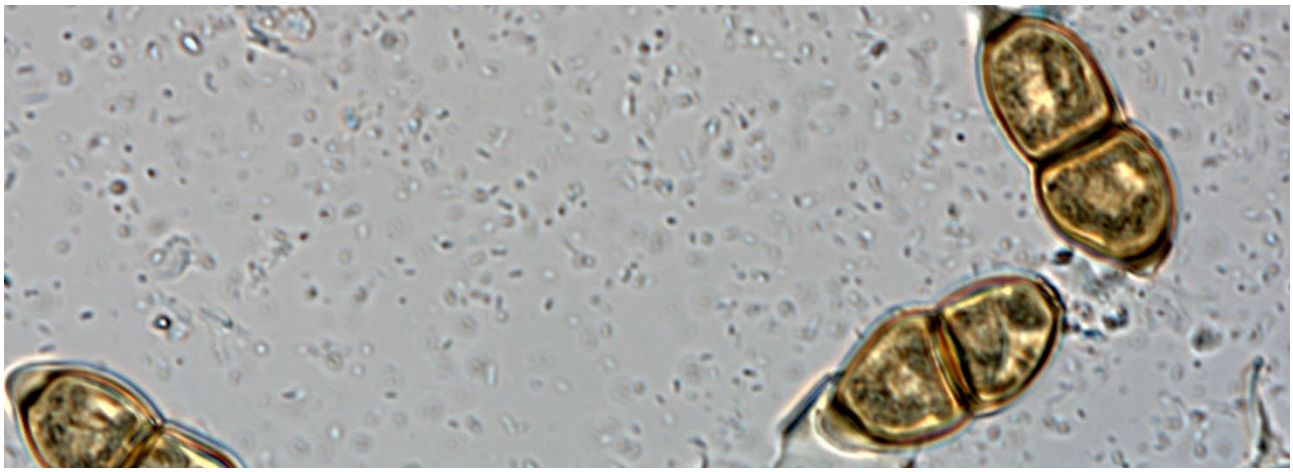
Host plants

III, **Polemoniaceae:** *Polemonium* species, e.g. *P. boreale*, *P. caeruleum*, and *P. villosum.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic AK, FI, and RU (Kola Peninsula, Taymir, Chukotka, Kamchatka), and from the alpine Rocky Mts. (AK, CAN, USA), Dovre (NO), the Urals (RU), C-Asia, and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia polygoni-alpini **Beattie, USDA Mycol. Coll. 71615; C-F-156055; USA (OR)**

Puccinia polygoni-alpini Cruchet & Mayor

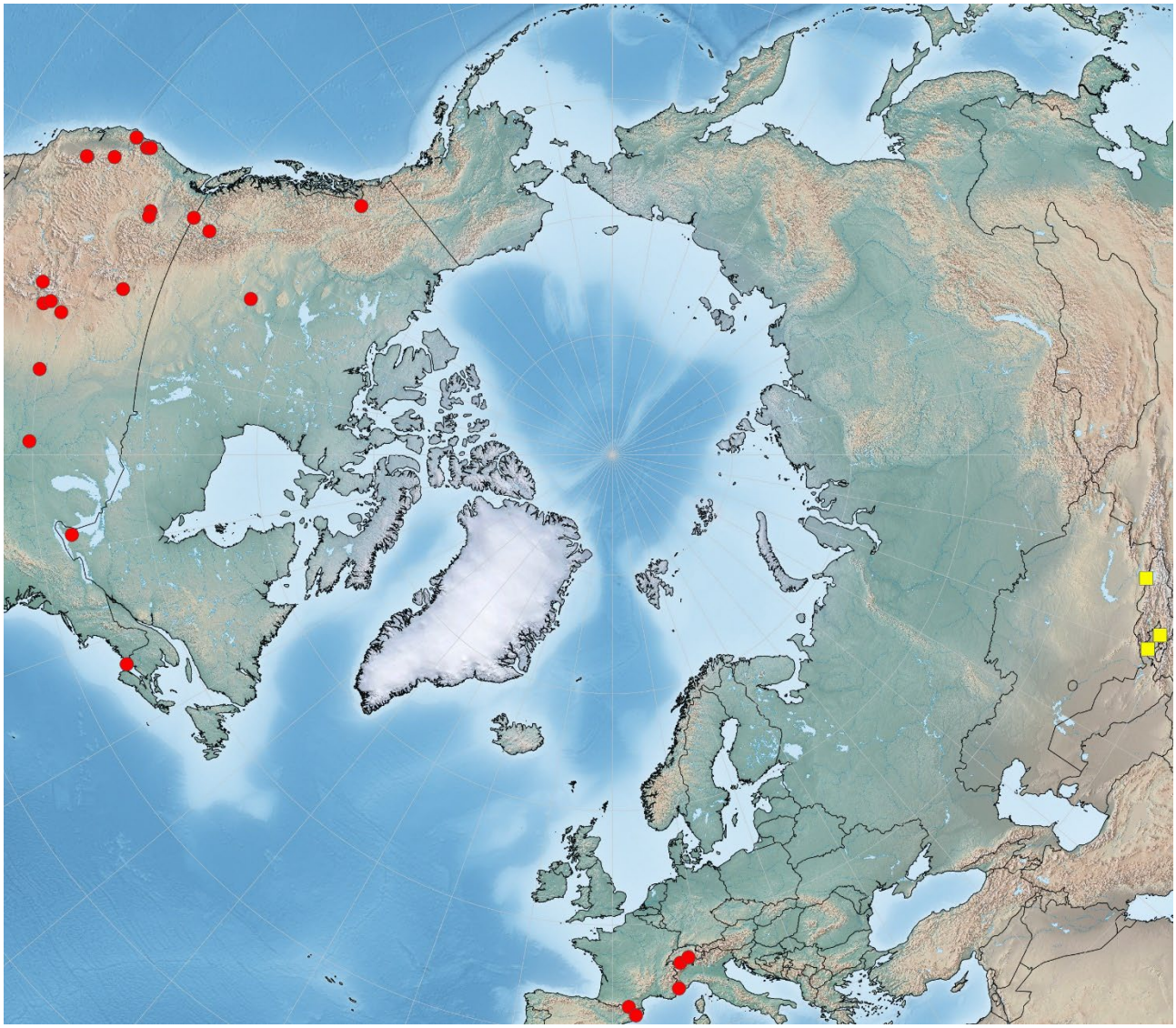
Macrocyclic hetereuform – [0-I] / II-III. Spermogonia epiphyllous, between the aecia. **Aecia** on leaves and stems, causing swellings, cupulate, peridium white, lacerate, revolute. Spores 18-24 µm in diameter. **Uredinia** hypophyllous, scattered, round or ellipsoid, diameter 1 mm, surrounded by the ruptured epidermis, pulverulent, pale brown. Spores subglobose, diameter 17-22 µm, wall pale yellow, 1-2 µm thick, distantly verrucose, pores 3-4, equatorial, covered with a flat cap. **Telia** hypophyllous, very small, later confluent, not covered by the epidermis, dark brown. Spores 2-celled, ellipsoid, clavate or irregular, slightly constricted at septum, 25-38 × 17-27 µm, wall brown, 1-3 µm thick, smooth, but sometimes with a few warts, pore of upper cell apical or subapical, pore of lower cell usually against septum to supraequatorial, both pores covered with a hemispherical cap, pedicel hyaline, very short, fragile.

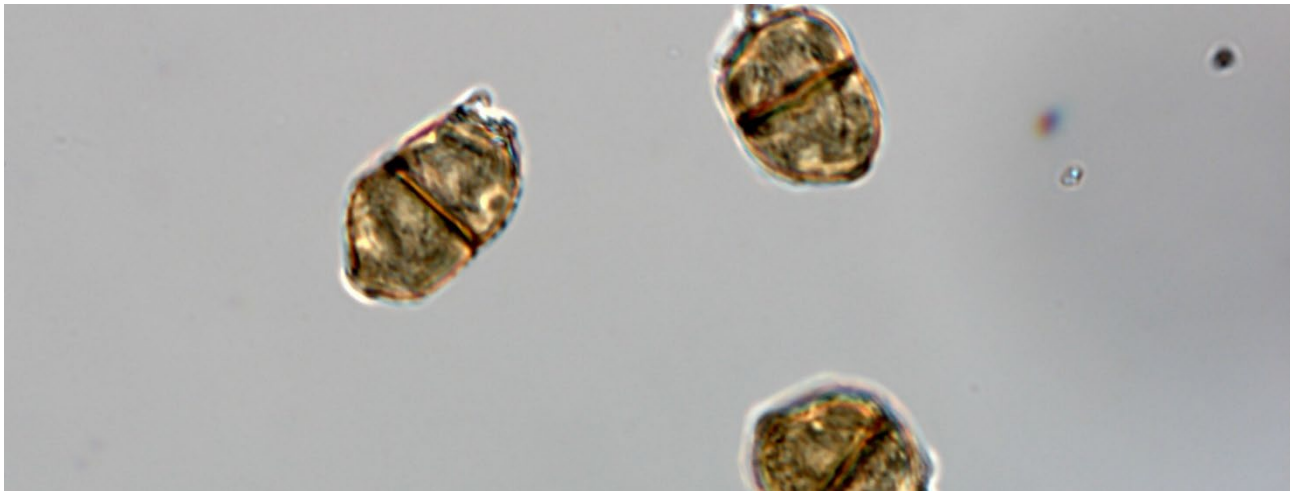
Host plants

[0-I, **Apiaceae:** *Anthriscus* and *Carum***]**
II-III, **Polygonaceae:** *Koenigia* species, e.g. *Koenigia alpina*, *K. coriaria*, *K. phytolaccifolia*, and *K. songarica.*

Distribution

Alpine-boreal; circumpolar; type 7; recorded from alpine regions of the Rocky Mts. (CAN, USA), the Alps (FR, CH), the Pyrenees (SE), and C-Asia.





Puccinia: Pucciniaceae: Pucciniales

Puccinia recondita **HK 19.099E; C-F-152394; Russia (Altai)**

Puccinia recondita Roberge ex Desm.

Syn.: *Puccinia persistens* Plowr.; *P. subalpina* Lagerh.; *P. thulensis* Lagerh.; *P. dietrichiana* Tranzschel; *P. rubigo-vera* (DC.) G. Winter

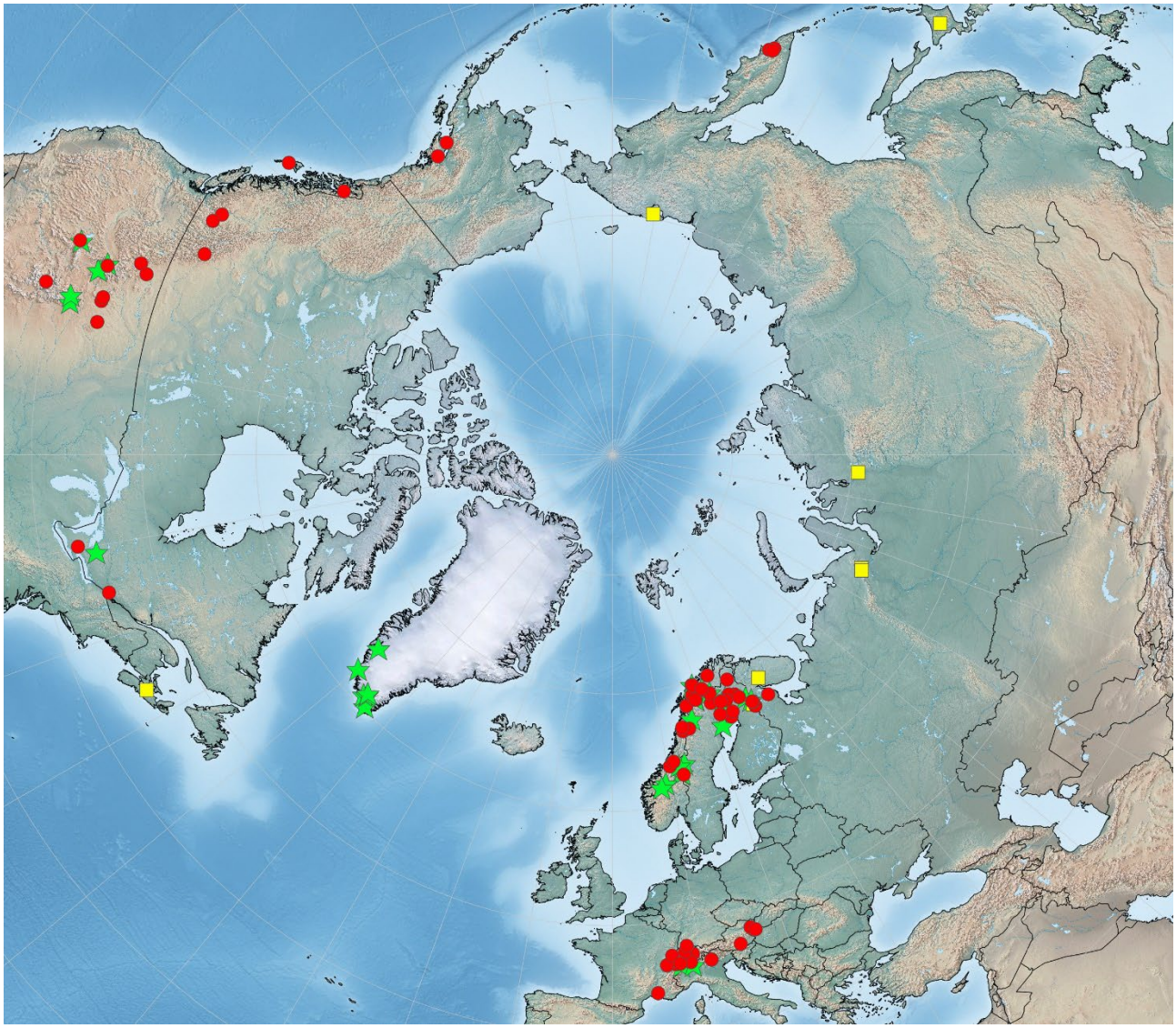
Macrocyclic hetereuform – 0-I / II-III. Spermogonia usually epiphyllous, scattered or in small clusters. **Aecia** hypophyllous, densely crowded in clusters, cupulate, rarely cylindrical. Spores subglobose or ellipsoid, 19-29 × 13-26 µm, wall hyaline, 1-2 µm thick, finely verrucose. **Uredinia** epiphyllous, less frequently hypophyllous, scattered, rarely confluent, oblong or punctiform, 1-2 mm long, cinnamon brown to dark brown. Spores subglobose to broadly ellipsoid, 16-34 × 13-24 µm, wall 1-2 µm thick, yellow brown to cinnamon brown, pores (4-)6-8, scattered, with an usually clearly thickened ring. **Telia** usually hypophyllous, occasionally on the sheaths or epiphyllous, scattered or in irregular groups, rarely arranged in lines, elongate, small, long covered by the epidermis, black, loculate with dark brown paraphyses. Spores (1-)2(-3)-celled, the 1-celled situated at the margins, the 2-3-celled at the centre of the sori, the 2-celled oblong-clavate, ends rounded, truncate or obliquely pointed, slightly constricted at septum, (32-)40-65(-80) × (12-)13-24(-25) µm, wall brown, towards the base paler, 1-1.5 µm, at apex 3-7 µm thick, pores inconspicuous, pedicel pale brown, near the attachment usually chestnut brown, short, rather persistent.

Host plants

0-I, **Ranunculaceae:** *Aconitum*,* *Aquilegia*,* *Clematis*,* *Thalictrum*,* and *Trollius*.*
Boraginaceae: *Hydrophyllum* and *Phacelia.*
II-III, **Poaceae***.

Distribution

Arctic-alpine-boreal-temperate; circumpolar; type 1; recorded from arctic GR, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (AK, CAN, USA), the Alps (DE, FR, CH, AT, IT), Dovre (NO), the Scandinavian Mts. (SE), the Urals, Chukotka and Kamchatka (RU) and Hokkaido (JP).



Puccinia: Pucciniaceae: Pucciniales

Puccinia rhaetica **O. Jaap, Fungi selecti exs. 275; S-F183817; Austria**

Puccinia rhaetica E. Fisch.

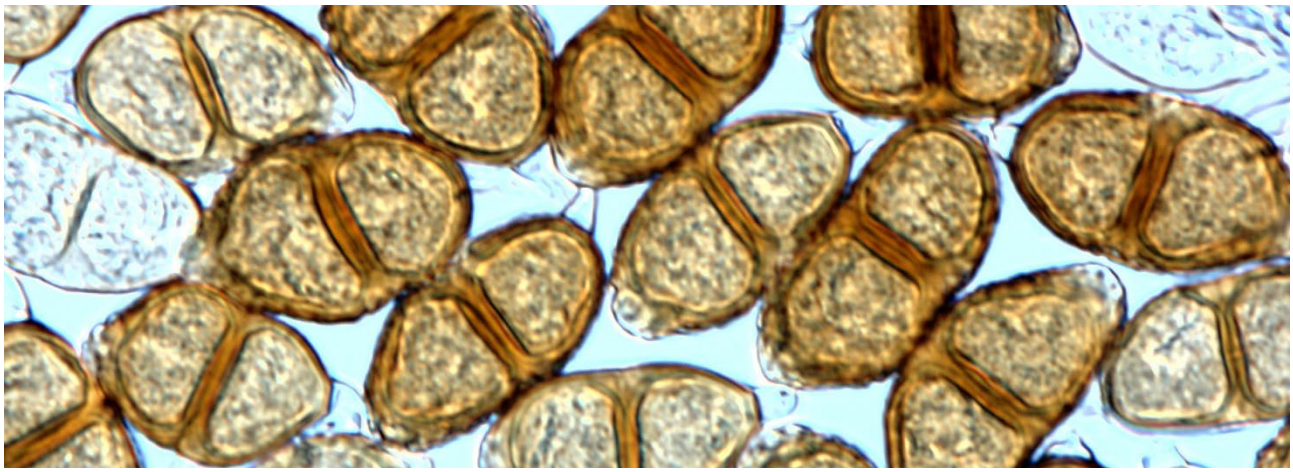
Microcyclic form – III. Telia amphigenous, rarely on the stems, roundish, diameter 1-2 mm, occasionally confluent, initially covered by the epidermis but soon naked, pulverulent, dark brown. Spores ellipsoid or clavate, ends rounded, 2-celled, not to slightly constricted at septum, 25-40(-42) × (13-)15-24 µm, wall yellow-brown, light chestnut brown or brown, 1-2.5 µm thick, near septum somewhat thickened, finely verrucose to verrucose including the caps, warts irregular in ± labyrinthiform ridges, less verrucose or sometimes smooth near the base, pore of upper cell apical, rarely up to 1/3 depressed and covered with a 1.5-4 µm high and 7-12 µm broad, hyaline or light brown cap, pore of lower cell against septum or up to 1/4, rarely to 1/2 depressed and covered with smaller cap, pedicel hyaline, short, deciduous.

Host plants

III, **Plantaginaceae:** *Veronica* species, e.g. *V. bellidioides*, *V. cusickii*, and *V. wormskjoldii.*

Distribution

Alpine; circumpolar; type 7; recorded from the Alps (CH, AT), and the Rocky Mts. (USA).



Puccinia: Pucciniaceae: Pucciniales

Puccinia rhytismoides **J. A. Nannfeldt 4808, Fungi Exs. Suec. 620; C-F-155589; Sweden**

Puccinia rhytismoides Johanson

Microcyclic form – III. Telia amphigenous and on the petioles and occasionally stems, round to somewhat irregular, scattered, becoming confluent, long covered by the epidermis, then naked, dark brown or black, loculate with reddish brown or brown, hypha-like, fused, palisade-like paraphyses. Spores 2-celled, clavate or cylindroid, apex rounded, ± truncate or slightly tapering, base usually tapering, slightly constricted at septum, (28-)31-85(-95) × 10-23(-25) µm, wall reddish brown at apex, paler below, 1-1.5 µm, at apex 3-10 µm thick, smooth, pores indistinct, pedicel pale but brownish near spore attachment, up to 10(-14) µm long, persistent.

Host plant

III, **Ranunculaceae:** *Thalictrum alpinum.*

Distribution

Arctic-alpine; circumpolar; type 4; recorded from arctic AK, NO, SE, and RU, and from alpine Dovre (NO), the Scandinavian Mts. (SE, NO), and the Kola Peninsula, Chukotka and Kamchatka (RU).

Puccinia: Pucciniaceae: Pucciniales

Puccinia ribis **C. G. Alm, Fungi Exs. Suec. 3171; C-F-155840; Sweden**

Puccinia ribis DC.

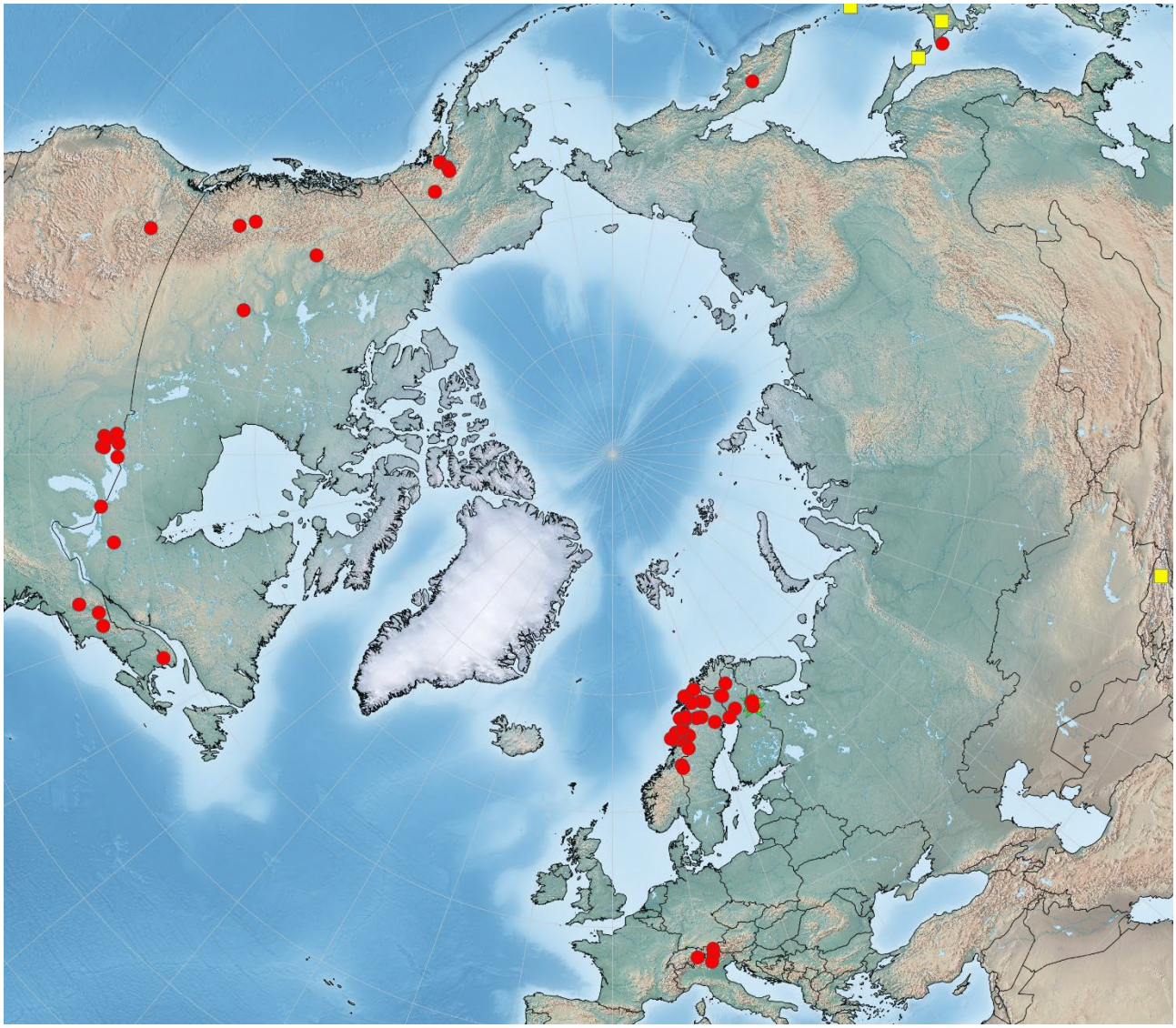
Microcyclic form – III. Telia epiphyllous on yellowish, reddish or brownish, diameter 2-3 mm spots, also on the fruits, in circinate groups, often confluent, round or oblong, diameter 0.3-0.8 mm, rather early naked and surrounded by the ruptured epidermis, pulverulent, chestnut brown. Spores (1-)2-celled, the 2-celled oblong or narrowly ellipsoid, ends rounded, not or slightly constricted at septum, 18-40 × 13-22 µm, wall chestnut brown or dark cinnamon brown, 1.5-2.5 µm thick, verrucose to finely verrucose, pore of upper cell apical and covered with a hyaline or subhyaline, 3-5 µm high cap, pore of lower cell usually near pedicel, caps inconspicuous, pedicel hyaline, 1× spore length, deciduous.

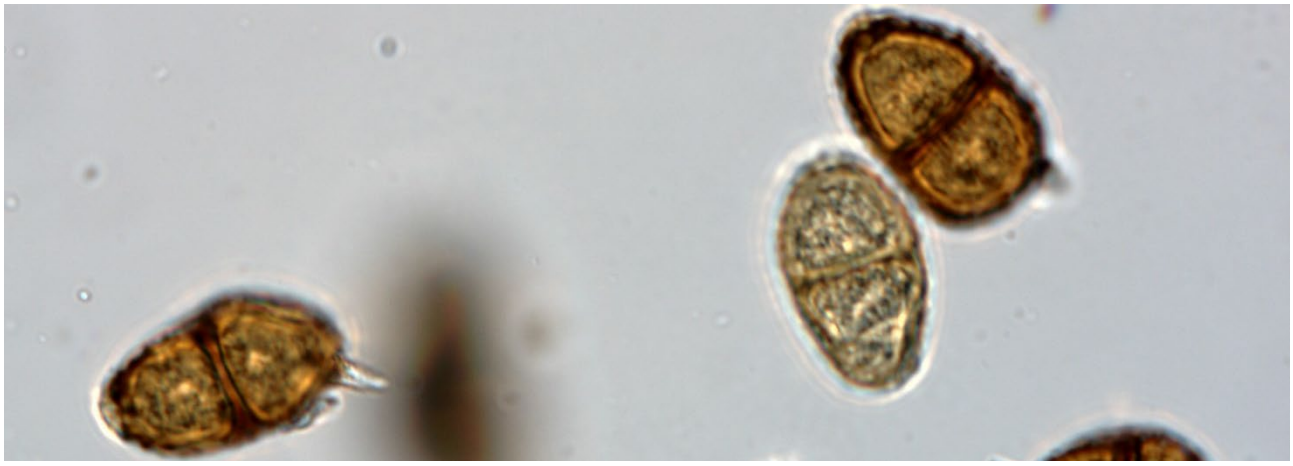
Host plants

III, **Grossulariaceae:** *Ribes* species, e.g. *Ribes alpinum*, *Ribes petraeum*, *Ribes rubrum*, *Ribes spicatum*, and *Ribes triste.*

Distribution

Alpine-boreal; circumpolar; type 7; recorded from the Alps (CH, AT, IT), Dovre (NO), the Scandinavian Mts. (SE), Kamchatka and Sakhalin (RU), C-Asia, and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia rubefaciens **G. Lagerheim, Fungi Exs. Suec. 1266; C-F-156031; Sweden**

Puccinia rubefaciens Johanson

Syn.: *Puccinia pallidefaciens* Lindr.

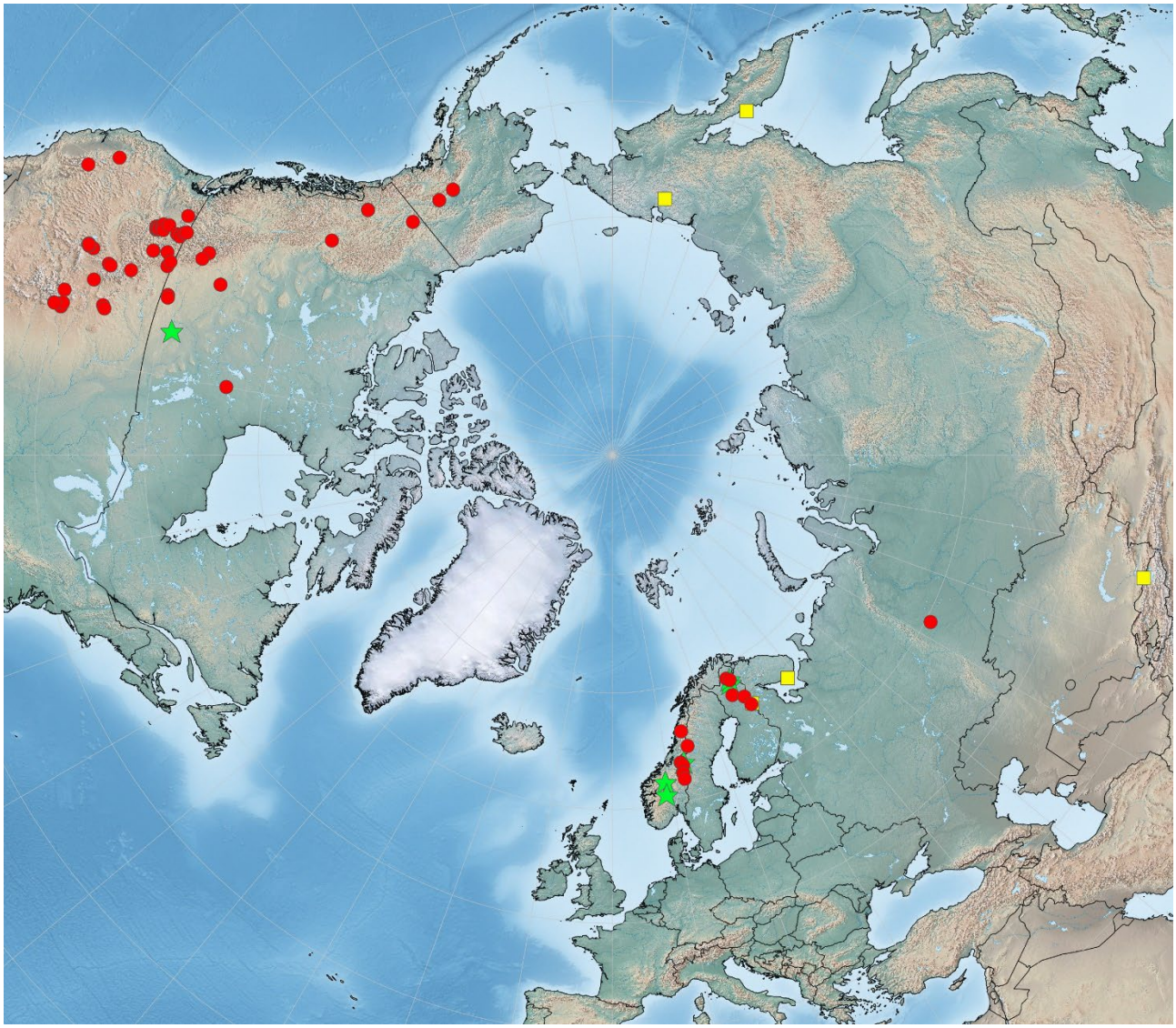
Microcyclic form – III. Telia hypophyllous and on the stems, rarely epiphyllous, on brown-red spots, scattered, up to 1-3 mm long, occasionally confluent, rather long covered by the epidermis, then naked and surrounded by the irregularly ruptured epidermis, pulvinate, dark brown or black. Spores 2-celled, oblong or oblong-clavate, apex rounded or truncate, base narrowed, slightly constricted at septum, pale brown, at apex darker, 30-53 × 14-22 µm, wall cinnamon brown, at apex dark chestnut brown, 1.5-2 µm, at apex 10-14 µm thick, smooth, pore of upper cell apical or subapical or inconspicuous, pore of lower cell inconspicuous, caps inconspicuous, pedicel hyaline or pale brown, up to 30 µm long, persistent.

Host plants

III, **Rubiaceae:** *Galium* species, e.g. *G. bolanderi*, *G. boreale*, *G. californicum*, *G. linearifolium*, and *G. multiflorum*.

Distribution

Arctic-alpine-boreal; circumpolar; type 5; recorded from the arctic Kola Peninsula and Chukotka (RU), and from alpine Dovre (NO), the Scandinavian Mts. (NO, SE, FI), the Urals and Kamchatka (RU), and C-Asia.



Puccinia: Pucciniaceae: Pucciniales

Puccinia saussureae-alpinae **Liro & Roivainen, Mycoth. Fenn. 446; CP1031068; Finland**

Puccinia saussureae-alpinae Lindr.

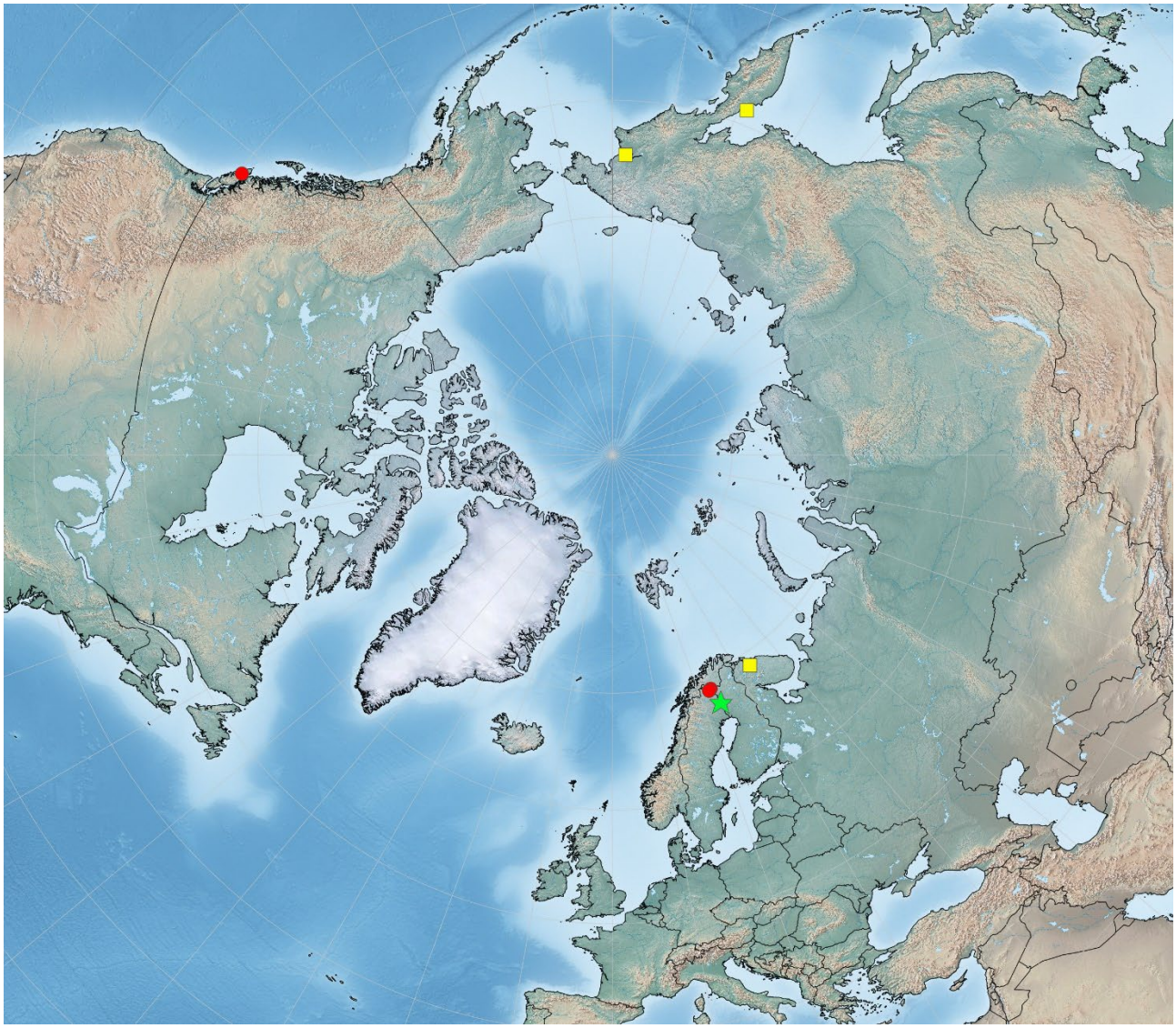
Brachycylic form – II-III. Uredinia mainly epiphyllous, scattered, round, small, brown. Spores globose or subglobose, diameter 20-25 µm, finely echinulate, pores (2-)3(-4), conspicuous. **Telia** mainly epiphyllous, also amphigenous, scattered, diameter 0.3-0.5 mm, pulverulent, dark brown. Spores 2-celled, ellipsoid, ends rounded, barely constricted at septum, 24-38 × 16-25 µm, wall yellowish brown, 1.5 µm thick, finely verrucose, warts often in longitudinal rows, pore of upper cell apical or slightly depressed, pore of lower cell 1/4-2/3 depressed from septum, caps inconspicuous, pedicel hyaline, up to 25 µm long, deciduous.

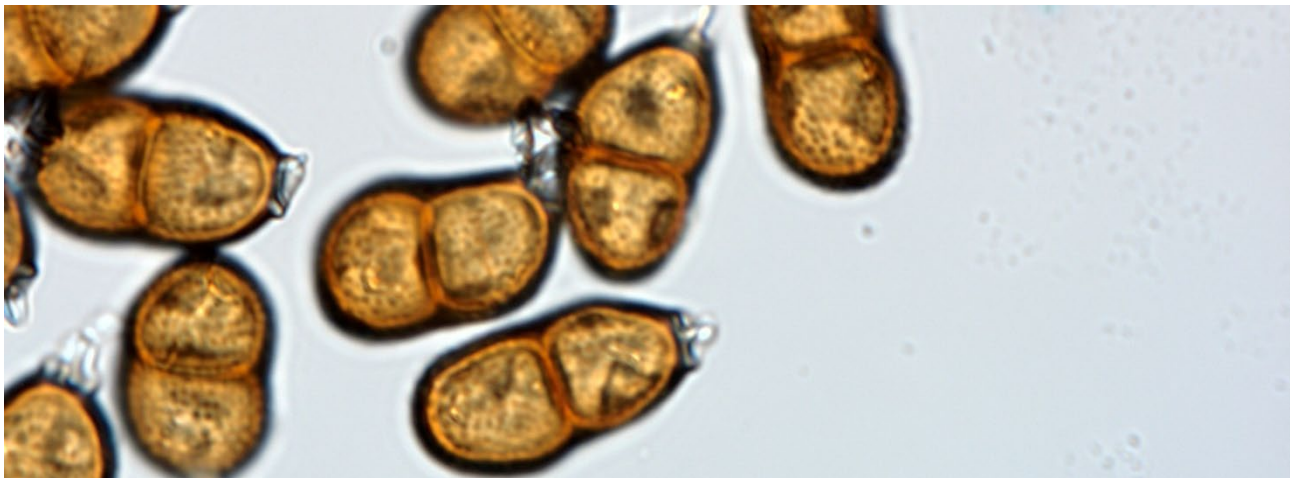
Host plants

II-III, **Asteraceae:** *Saussurea* species, e.g. *Saussurea alpina*, *S. frolowii*, *S. latifolia*, *S. nuda*, *S. oxyodonta*, and *S. subsinuata.*

Distribution

Arctic-alpine; circumpolar; type 11; recorded from the arctic Kola Peninsula and Chukotka (RU), and from alpine regions of the Rocky Mts. (CAN), the Scandinavian Mts. (NO, SE), and Kamchatka (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia saxifragae **HK 16.198; C-F-108449**

Puccinia saxifragae Schltdl.

Syn.: *Puccinia heucherae* var. *saxifragae* (Schlecht.) Savile;
P. heucherae var. *austroberingiana* Savile; *P. saxifragae* var. *curtipes* (Howe) Dietel;
P. curtipes Howe; *P. saxifragae* subsp. *longior* Savile; *P. longior* (Savile) Azbukina

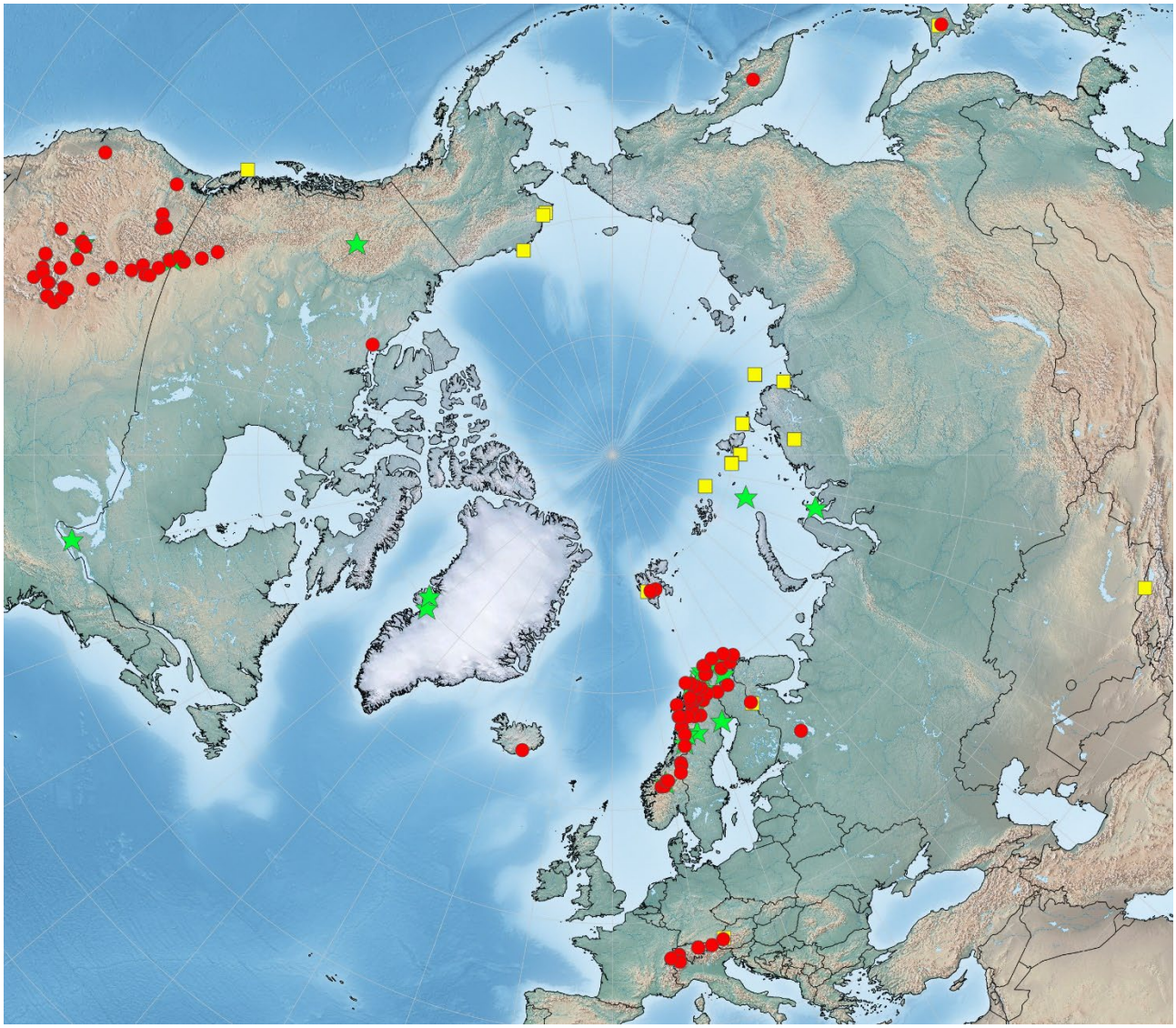
Microcyclic form – III. Telia mostly hypophyllous, also amphigenous, on discolored spots, scattered or in dense groups, often confluent, also on the stems and bracts of inflorescence, soon naked, pulverulent, red-brown to dark brown. Spores 2-celled, subglobose to subcylindrical, slightly constricted at septum, 20-45 × 14-22 µm, wall pale brown or dark yellow-brown, 1-2.5 µm thick, covered with thin, longitudinal, non-anastomosing lines, pore of upper cell apical to 1/3 depressed and covered with a pale, conical, 1.5-4(-5.5) µm thick cap, pore of lower cell near septum to 1/4(-1/2) depressed and covered with a smaller cap, pedicel hyaline, deciduous, short.

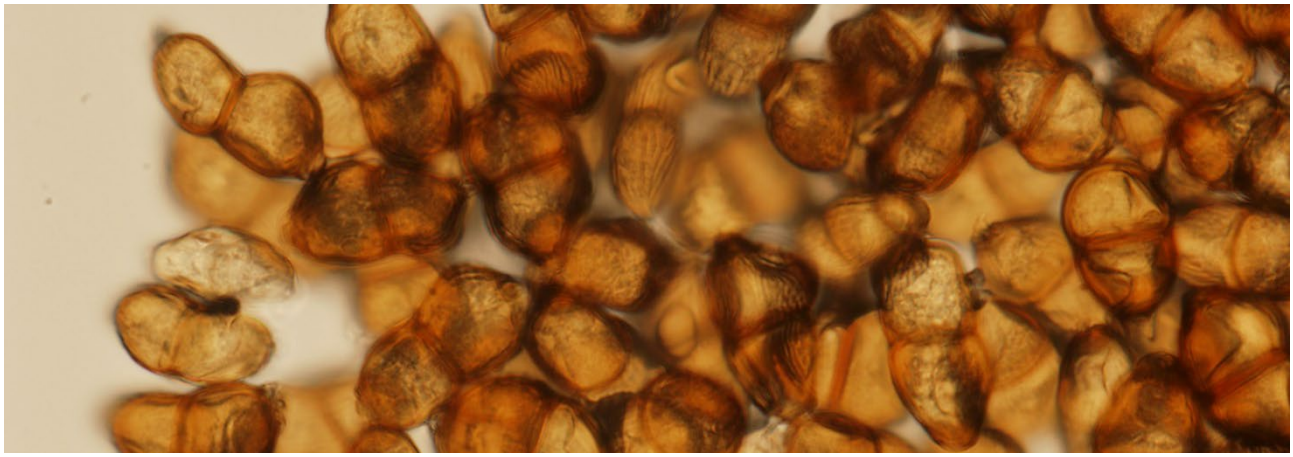
Host plants

III, **Saxifragaceae:** *Saxifraga.**

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic AK, CAN, GR, IS, SVALB, NO, SE, FI, and RU, and from alpine regions of the Alps (CH, AT), Dovre (NO), the Scandinavian Mts. (SE), C-Asia, Kamchatka (RU) and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia scandica **HK 16.197; C-F-108448**

Puccinia scandica Johanson

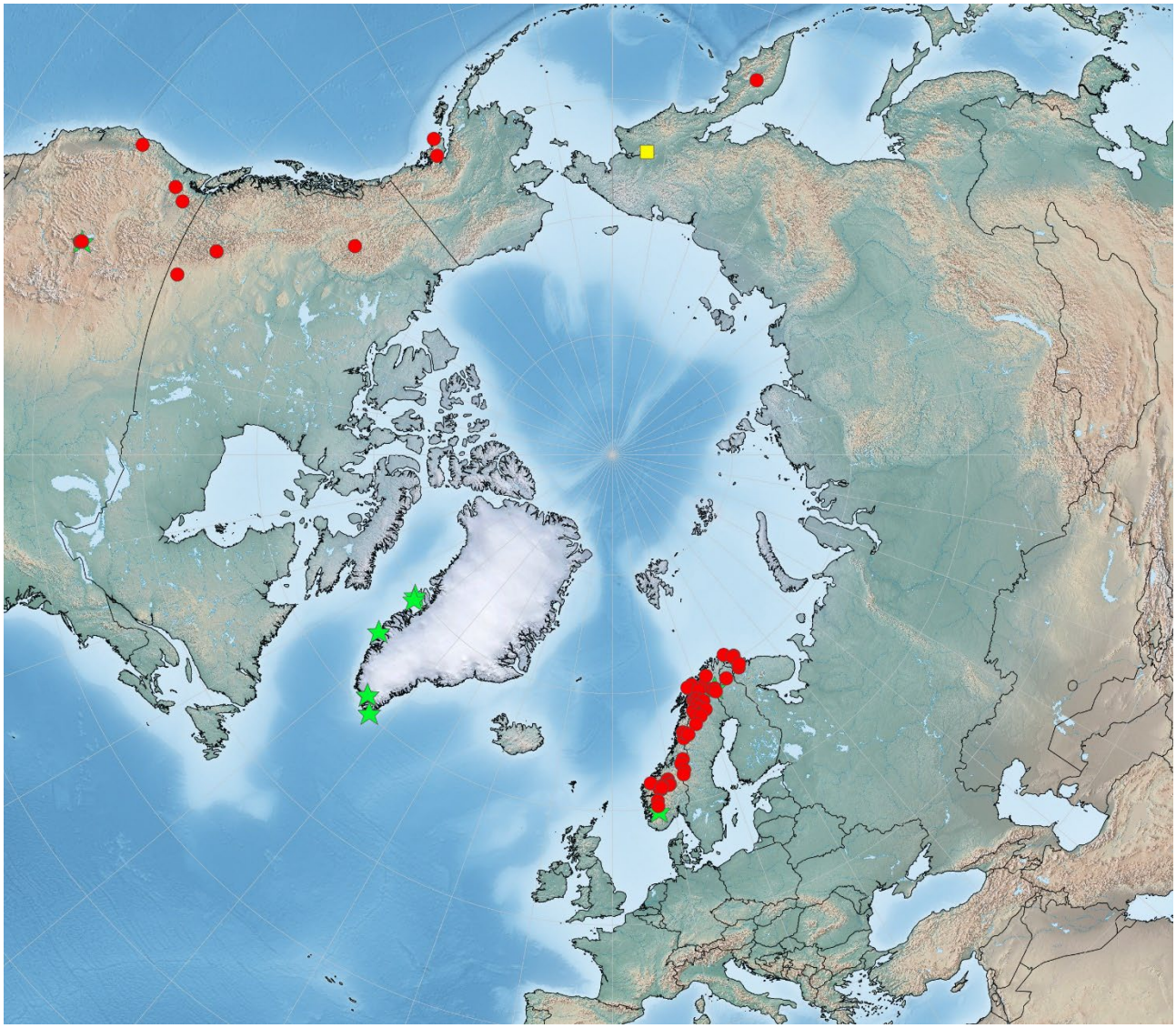
Microcyclic form – III. Leaves crowded at the end of the shoot, bending upward. **Telia** hypophyllous, crowded, round, soon naked, reddish dark brown or dark cinnamon brown. Spores 2-celled, ovoid or oblong, moderately constricted at septum, 24-38 × 11-16 µm, wall 2 µm, at apex up to 5 µm thick, near the apex conspicuously punctate-verrucose, lower smooth or nearly so, pedicel hyaline, up to 20 µm long, deciduous.

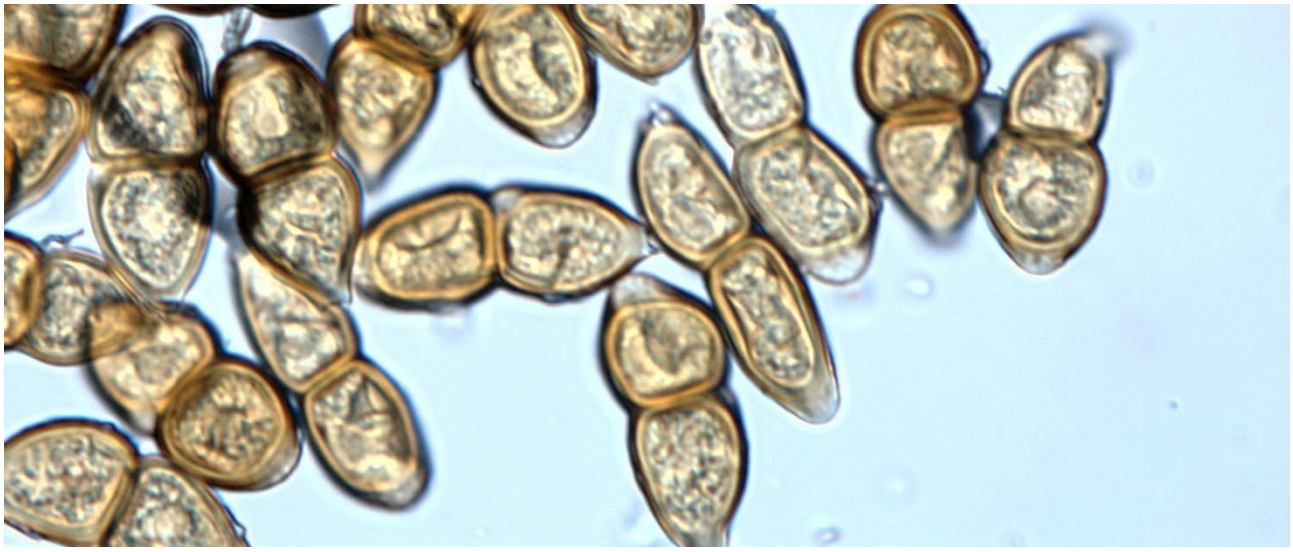
Host plants

III, **Onagraceae:** *Epilobium* species, e.g. *Epilobium alpinum*, *Epilobium alsinifolium*, *E. anagallidifolium*, *E. clavatum*, *E. davuricum*, *E. fastigiatum*, *E. hornemannii*, and *E. lactiflorum.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic GR, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (AK, CAN, USA), Dovre (NO), the Scandinavian Mts. (NO, SE, FI), Chukotka and Kamchatka (RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia senecionis **J. N. Schnabl, Fungi bavarici 312; C-F-156046; Germany**

Puccinia senecionis Lib.

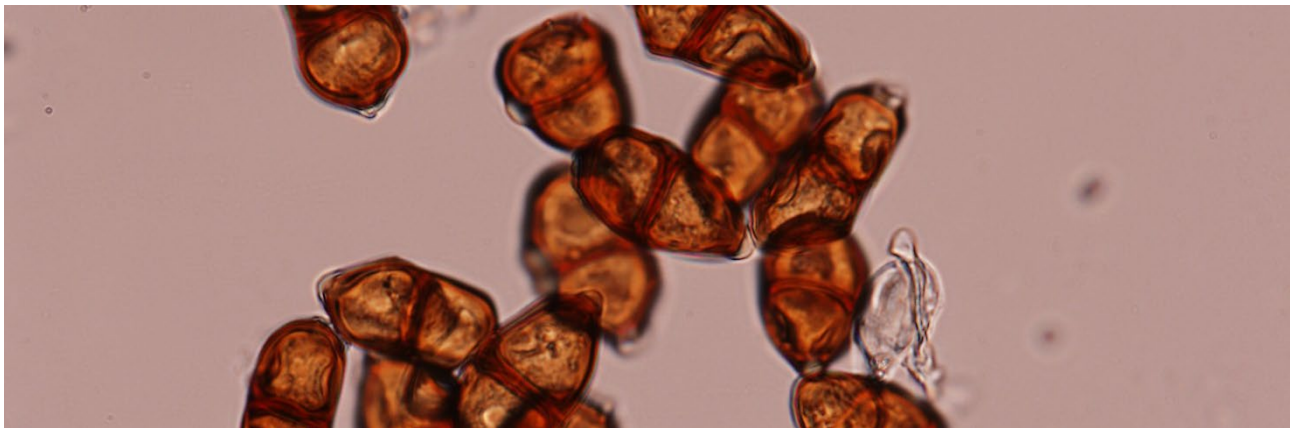
Demicyclic autopsisform – I-IIa-III. Aecia usually amphigenous, also only hypophyllous**,** in small, irregular groups, on yellowish or brown spots, occasionally scattered, cupulate, peridium white, revolute, lacerated. Spores subglobose, diameter 16-21 µm, wall thin, nearly hyaline, finely and densely verrucose. **Uredinia** aecidioid, as aecia but scattered. **Telia** usually amphigenous, occurring simultaneously with the aecia and uredinia, diameter 0.2-0.4 mm, usually scattered between the aecia, also in circular groups around the aecia, diameter 0.5 mm, initially covered by the epidermis, soon naked, opening with a pore, then surrounded by the ruptured epidermis, pulverulent, dark chestnut brown to black. Spores 2-celled, ellipsoid, apex rounded or obtuse, base rounded, barely to slightly, sometimes moderately constricted at septum, (21-)23-38 × (14-)15-26 µm, wall brown or chestnut brown, 1-2.5 µm thick, smooth, upper cell with apical to slightly subapical pore, lower cell with pore against septum, rarely to 1/4-3/4 depressed, both pores covered with a hyaline, hemispherical cap, pedicel hyaline, short, deciduous.

Host plants

I-II-III, **Asteraceae:** *Senecio** and *Tephroseris.**

Distribution

Alpine; circumpolar; type 7; recorded from alpine regions of the Rocky Mts. (CAN, USA), the Alps (FR, CH, AT, IT), Dovre (NO), Kamchatka (RU), and Hokkaido (JP).



Puccinia: Pucciniaceae: Pucciniales

Puccinia septentrionalis **L. Holm, FES 1652 & 1653; C-F-155879 & 155880; Sweden**

Puccinia septentrionalis Juel

Syn.: *Aecidium sommerfeltii* Johanson

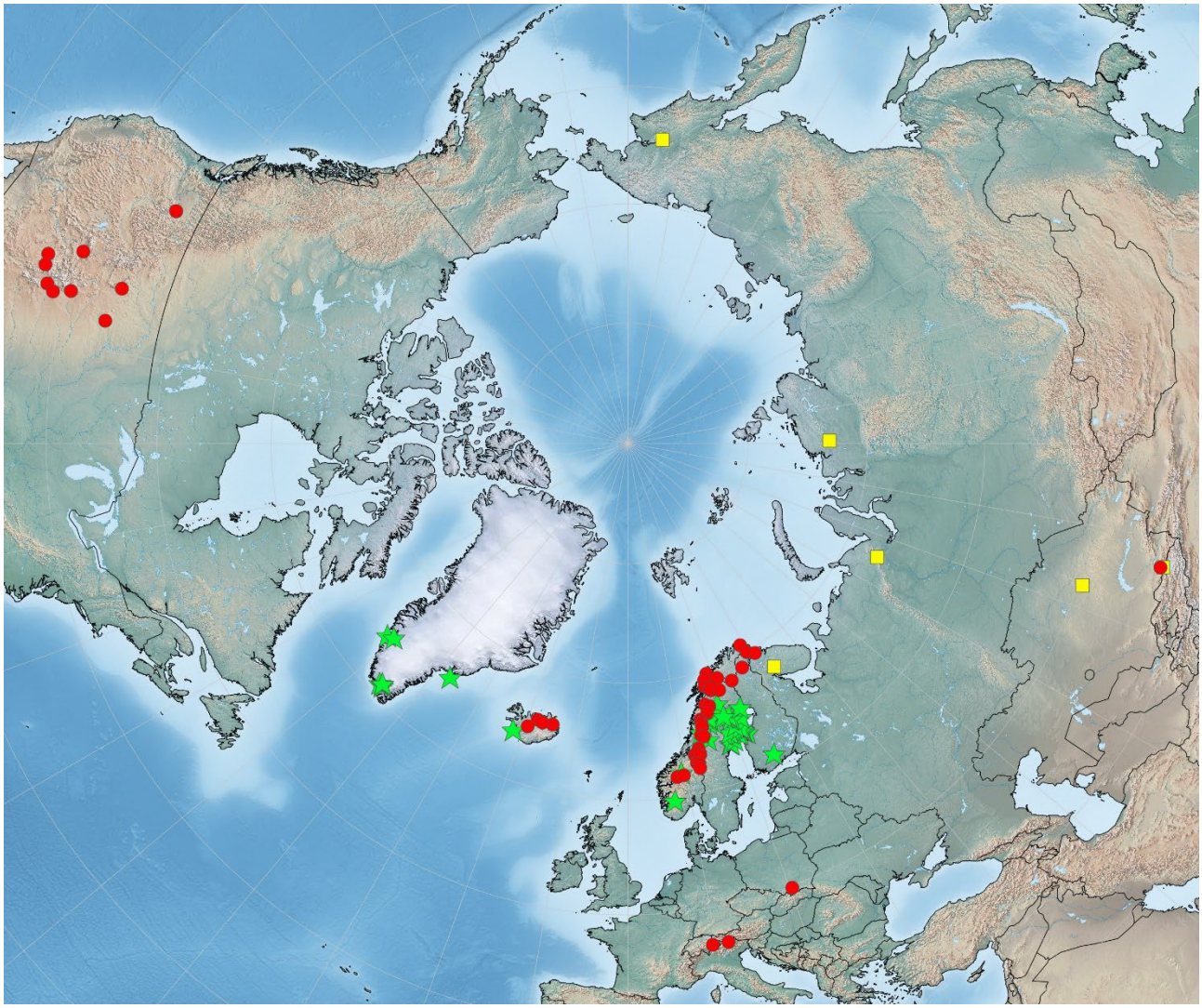
Macrocyclic hetereuform – (0)I / (II)-III. Spermogonia usually lacking. **Aecia** amphigenous and on the petioles, in groups on irregular, swollen, rather large, dark violet or black spots, abundant, diameter 0.2-0.3 mm, cupulate, margin hyaline, fragile, revolute. Spores subglobose or ellipsoid, diameter 18-22 µm, orange, wall hyaline, 1 µm thick, nearly smooth, very finely to finely verrucose. **Uredinia** often scarce, hypophyllous, with opposite pale spots, scattered, round, diameter 0.5 mm, soon naked, pulverulent, yellow, cinnamon brown or light red-brown, also containing teliospores. Spores subglobose or broadly ellipsoid, diameter 23-26 × 19-21 µm, wall light brown to dark cinnamon brown, 1-2.5 µm thick, finely and rather densely echinulate, pores 2-5, inconspicuous, equatorial or slightly supraequatorial. **Telia** hypophyllous, occasionally also epiphyllous, scattered, round, diameter 0.5-1 mm, soon naked, pulverulent, dark chestnut brown or dark brown. Spores first formed in the uredinia, later also in newly formed telia 2-celled, usually ellipsoid, ovoid-ellipsoid or clavate, ends tapering, not or slightly constricted at septum, 26-45 × 13-28 µm, wall cinnamon brown or light chestnut brown, 1.5-2 µm thick, smooth, pore of upper cell apical, pore of lower cell against septum, both pores covered with a hyaline, 4-5 µm high cap, pedicel hyaline, short, fragile.

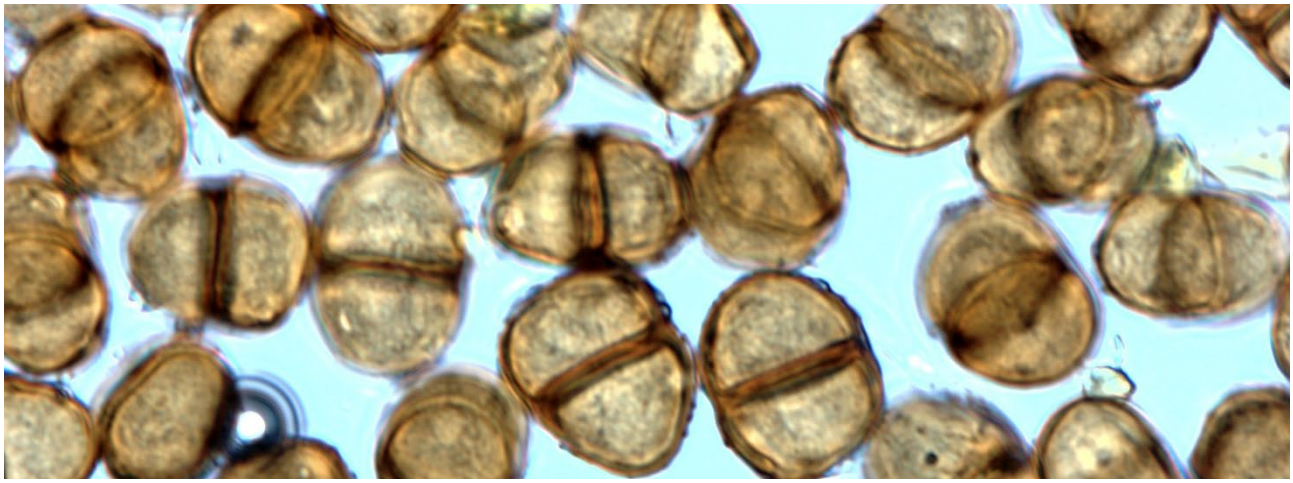
Host plants

0-I, **Ranunculaceae:** *Thalictrum*.*
II-III, **Polygonaceae:** *Bistorta officinalis* and *Bistorta vivipara.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic GR, IS, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (USA), the Alps (CH, AT), the Carpathians (SK), Dovre (NO), the Scandinavian Mts. (NO, SE, FI), the Kola Peninsula, the Urals, Taymir, and Chukotka (RU), and C-Asia.





Puccinia: Pucciniaceae: Pucciniales

Puccinia sieversiae **Baxter; S-F243787; USA (Alaska)**

Puccinia sieversiae Arthur including subsp. *tatrensis* (Urban) Urban

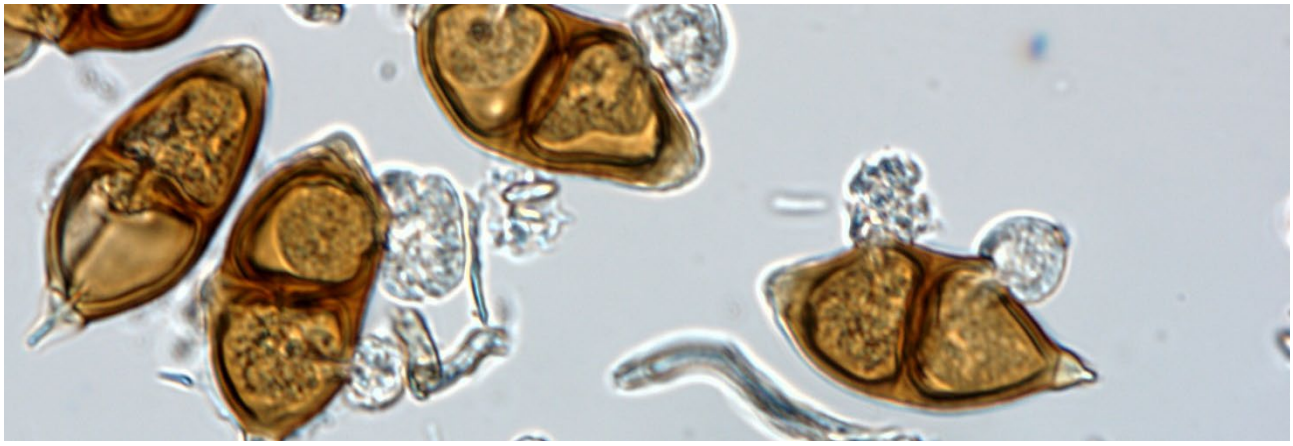
Microcyclic form – III. Telia mainly hypophyllous, also epiphyllous, scattered, round or oblong, diameter 0.3-1 mm, initially bullate and covered by the epidermis, soon naked and surrounded by the ruptured epidermis, pulverulent, chestnut brown. Spores 2-celled, ellipsoid or ellipsoid-oblong, ends rounded, not or slightly constricted at septum, 32-40 × 20-26 µm, wall cinnamon brown, 1.5-2.5 µm, at apex 4-6 µm thick, inconspicuously rugose, pore of upper cell apical, pore of lower cell against septum, caps inconspicuous, pedicel subhyaline, up to 0.5× spore length, fragile.

Host plant

III, **Rosaceae:** *Geum turbinatum.*

Distribution

Arctic-alpine; North-American; type 8; recorded from arctic AK, and from the alpine Rocky Mts. (AK, USA). Very close to or possibly conspecific with *Puccinia urbanii* Savile on *Geum* and *Sieversia* (see below).



Puccinia: Pucciniaceae: Pucciniales

Puccinia soldanellae **O. Pazschke, Fungi europaei 3620 (micro C-F-165753); C-F-155616; Austria**

Puccinia soldanellae Unger

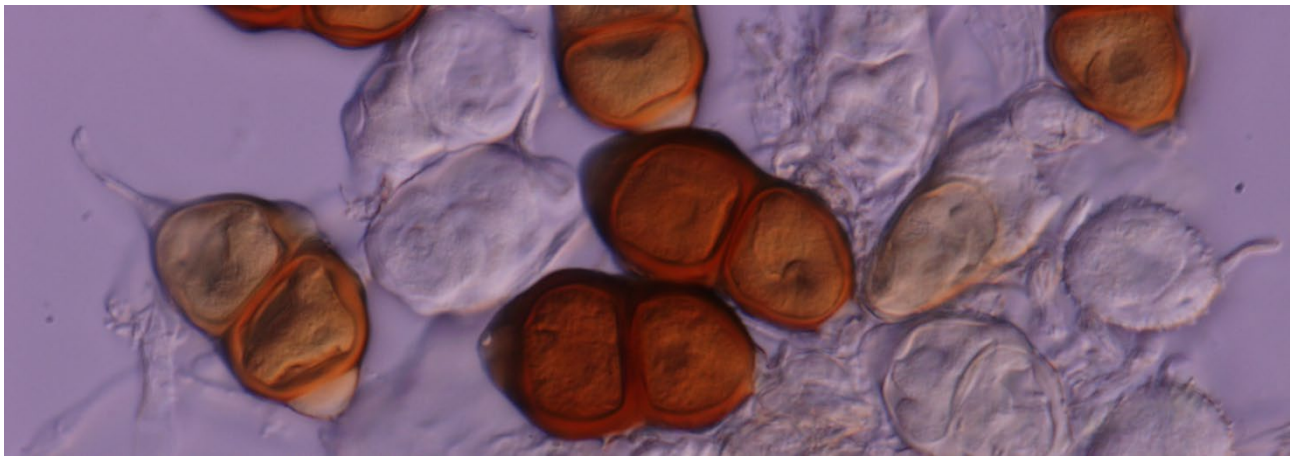
Macrocyclic auteuform – 0-Is-II-III. Mostly on the basal leaves. **Spermogonia** hypophyllous, abundant, subepidermal, honey yellow. **Aecia** systemic, hypophyllous, leaves locally malformed, smaller, paler and longer stalked, cupulate, urceolate or short-cylindrical, peridium white, margin revolute, denticulate. Spores subglobose-angular, diameter 18-26 µm, wall hyaline, thin, densely and finely verrucose. **Uredinia** epiphyllous on older leaves, also amphigenous, leaves not malformed, roundish or oblong, often in circular groups, also scattered, very small, long covered by the epidermis, then naked and surrounded by the ruptured epidermis, pulverulent, brown. Spores subglobose to ovoid, 20-32 × 18-28 µm, wall yellow-brown, 2-3 µm thick, distantly echinulate, spines at 3-4 µm spacing, pores 3. **Telia** as uredinia but dark brown to blackish. Spores 2-celled, ellipsoid or ovoid-oblong, apex rounded, base rounded or sometimes tapering, slightly constricted at septum, 35-58 × 20-34 µm, wall yellowish brown or chestnut brown, 3 µm thick, smooth, pore of upper cell apical, pore of lower cell at variable position, both pores covered with a prominent, hyaline 5-8 µm high and 7-10 µm wide cap, pedicel hyaline, about 1-1.5× spore length, deciduous.

Host plants

0-I-II-III, **Primulaceae:** *Soldanella* species, e.g. *S. alpina*, *S. hungarica*, *S. montana*, and *S. pusilla.*

Distribution

Alpine; Eurasian; type 15; only recorded from the Alps (DE, FR, CH, AT, IT) and the Carpathians (SK).



Puccinia: Pucciniaceae: Pucciniales

Puccinia svendsenii **I. Jørstad; O-F-237631; Norway**

Puccinia svendsenii Lindr.

Microcyclic form – III. Telia hypophyllous and on the petioles, occasionally causing small, white swellings, solitary or in loose groups, round, diameter 0.3-0.4 mm, very long covered by the silvery epidermis, then opening by a central pore, pulverulent, dark brown to black. Spores 2-celled, not or barely constricted at septum, 26-37 × 16-24 µm, wall brown, 2-3 µm thick, smooth or with two rows of minute warts, pore of upper cell apical to subapical, pore of lower cell near septum, both covered with a hyaline, 1-5 µm high cap, pedicel ca. 1× spore length, deciduous.

Host plant

III, **Apiaceae:** *Anthriscus sylvestris.*

Distribution

Arctic; Eurasian; type 13; only recorded a few times from arctic NO.

Puccinia: Pucciniaceae: Pucciniales

Puccinia swertiae **Allescher & Schnabl, Fungi bavarici 21; C-F-156019; Germany**

Puccinia swertiae (Opiz) Winter ("*sweertiae*")

Macrocyclic auteuform – I-II-III. Spermogonia not described. **Aecia** hypophyllous, diameter 0.25-0.3 mm, in circular or elongate groups of 1.5-4 mm, cupulate or urceolate, peridium white, margin upright, denticulate. Spores subglobose-angular, diameter 19-28 µm, wall hyaline, 1-1.5 µm thick, very finely verrucose. **Uredinia** irregularly scattered or in circinate groups, on petioles elongate, on pale yellow spots, long covered by the epidermis, then naked, sometimes confluent, blackish brown. Spores globose or subglobose, diameter 19-26 µm, finely punctate. **Telia** mainly epiphyllous or amphigenous, scattered or in circular groups, sometimes confluent, diameter 0.3-1 mm, soon naked and surrounded by the ruptured epidermis, pulverulent, chestnut brown. Spores 2-celled, ellipsoid to ovoid, ends rounded, not or slightly constricted at septum, 32-42 × 20-30 µm, wall yellow-brown or dark cinnamon brown, 1.5-2 µm thick, smooth, pores not at a fixed location, caps inconspicuous, pedicel hyaline, short, deciduous, fragile.

Host plants

I-II-III, **Asteraceae:** *Swertia*.*

Distribution

(Arctic)-alpine; circumpolar; type 7; recorded once from arctic AK, and from alpine regions of the Rocky Mts. (AK, USA), the Alps (DE, FR, CH, AT), and C-Asia.

Puccinia: Pucciniaceae: Pucciniales

Puccinia terrieri **H. Poeverlein, Crypt. exs. 3413; C-F-156032; Germany**

Puccinia terrieri Gäum.

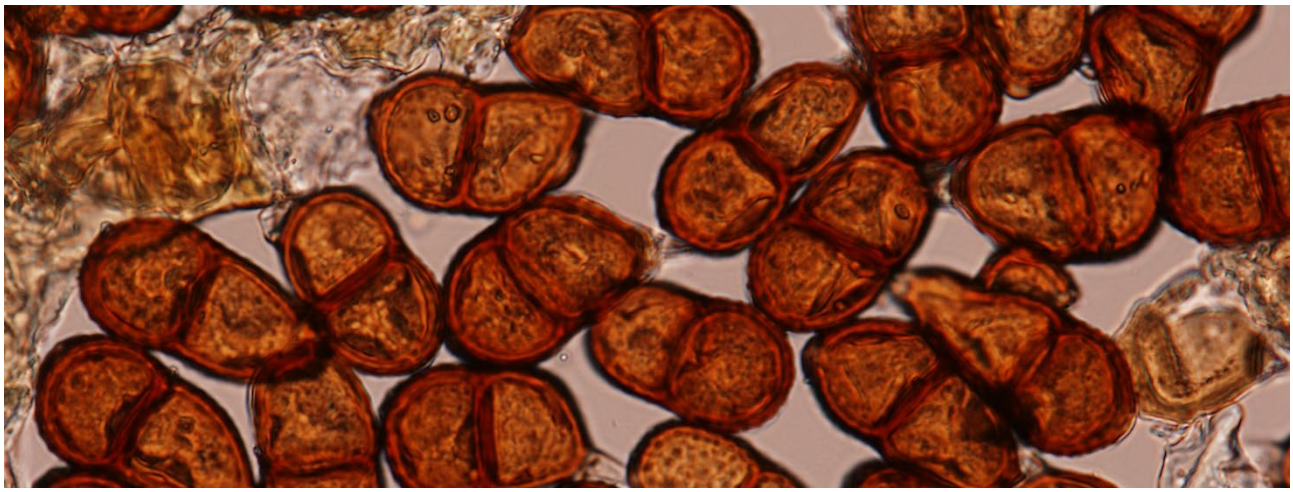
Brachycyclic form – 0-II-III. Spermogonia epiphyllous, in small groups, honey-coloured. **Uredinia** hypophyllous, occasionally on the stems, scattered, cinnamon brown, pulverulent. Spores (25-)31-34(-40) × (21-)24-27(-32) µm, wall pale brown, 3-4 µm, at apex 5-6 µm thick, distantly verrucose with acute warts, pores 2-3, equatorial, covered with a flat cap. **Telia** as uredinia, but dark brown. Spores 2-celled, ellipsoid, ovoid-oblong or somewhat clavate, slightly constricted at septum, (29-)37-44(-56) × (16-)20-24(-28) µm, wall chestnut brown, rather distantly verrucose, pore of upper cell apical, pore of lower cell 1/3-2/3 depressed from septum, both pores covered with an inconspicuous, flat cap, pedicel hyaline, short, fragile, deciduous.

Host plants

0-II-III, **Apiaceae:** *Peucedanum altissimum* and *Peucedanum verticillare.*

Distribution

Alpine; Eurasian; type 15; only recorded from the Alps (CH, AT, SI, IT).



Puccinia: Pucciniaceae: Pucciniales

Puccinia thlaspeos **E. Julin, Fungi Exs. Suec. 3173; C-F-156033; Sweden**

Puccinia thlaspeos Ficinus & C. Schub.

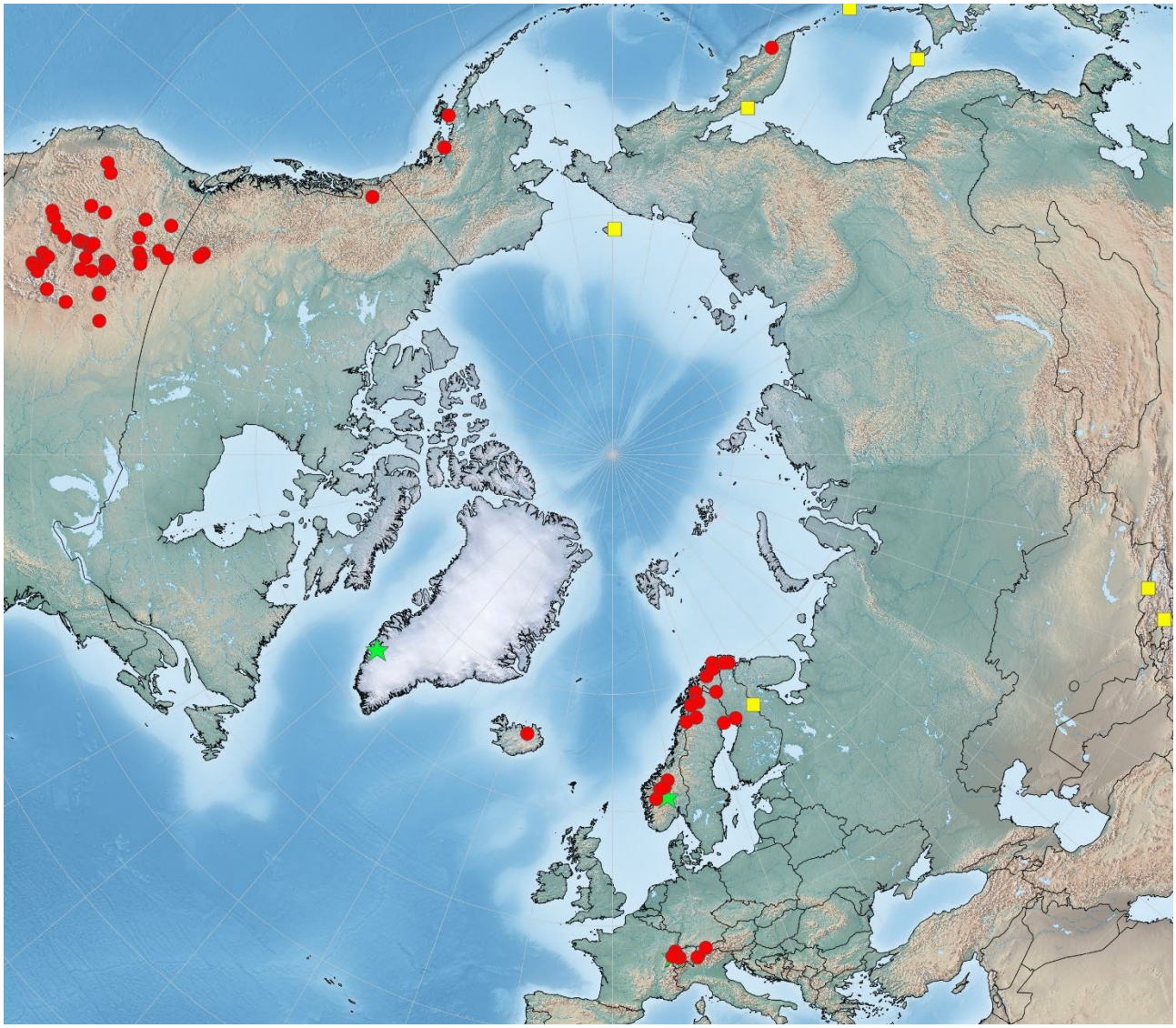
Microcyclic form – IIIsg. Systemic, affected plants are malformed, paler (yellow-green) and often sterile. **Telia** hypophyllous, occasionally epiphyllous, covering the whole surface, rarely on the stems and flowers, crowded, roundish, diameter 0.3-0.5 mm, not confluent, soon naked, ruptured epidermis not conspicuous, pulvinate, initially brown, then cinereous by the presence of basidiospores. Spores germinating readily, (1-)2-celled, the 2-celled oblong or clavate, apex rounded or slightly pointed, base rounded or tapering, slightly constricted at septum, 35-55 × 12-21 µm, wall yellow to golden brown, 1-1.5 µm, at apex 3-11 µm thick, smooth, pore of upper cell apical, pore of lower cell against septum, caps inconspicuous, pedicel hyaline, up to spore length, persistent.

Host plants

III, **Brassicaceae:** *Arabidopsis lyrata*, *Arabis alpina*, *Boechera holboellii*, *Cochlearia groenlandica*, *Draba daurica*, *D. gracillima*, *Erysimum cuspidatum*, *Noccaea caerulescens*, *N. cochleariformis*, *N. fendleri*, *N. granatensis*, *N. montanum*, *N. macrantha*, and *N. praecox.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic Wrangel Island (RU), and from alpine regions of the Rocky Mts. (AK, CAN, USA), the Alps (CH, AT), Dovre (NO), the Scandinavian Mts. (SE), C-Asia, Kamchatka and Sakhalin (RU).



Puccinia: Pucciniaceae: Pucciniales

Puccinia thymi **C. H. Ostenfeld (micro Rosenvinge; C-F-8860); C-F-8864; Iceland**

Puccinia thymi (Fuckel) P. Karst.

Syn.: *Puccinia schneideri* J. Schröt.

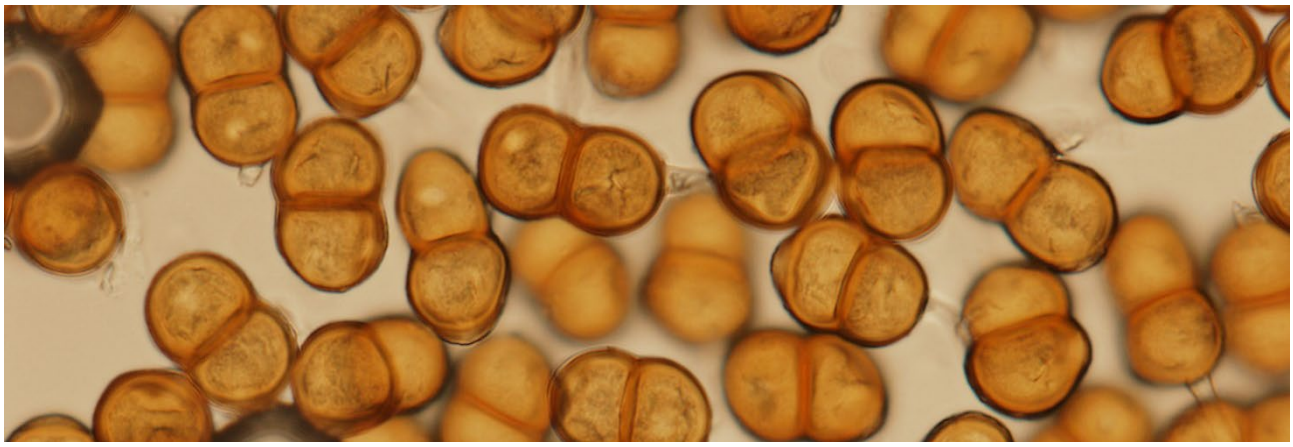
Microcyclic form – IIIs. Systemic, causes conspicuous, annual witches' brooms, the leaves stand farther apart, are narrower and the affected branches do not flower. **Telia** on the petioles and stems, especially near leaf attachment, less frequently on the midribs of the leaves, scattered, roundish, oblong or linear, occasionally confluent, 1-3 mm long, long covered by the epidermis, then naked and surrounded by the ruptured epidermis, pulverulent, cinnamon brown or dark brown. Spores (1-)2-celled, the 2-celled ellipsoid, apex rounded or slightly tapering, base rounded, slightly constricted at septum, 24-35 × 15-24 µm, wall yellow-brown or golden brown, 1.5-3 µm thick, very finely verrucose to smooth, pore of upper cell apical or subapical and covered with a 5 µm high cap, pore of lower cell at variable position, often subequatorial, cap inconspicuous, pedicel hyaline, up to 2× spore length, deciduous.

Host plants

III, **Lamiaceae:** *Origanum vulgare*, *Teucrium chamaedrys*, *Thymus*, e.g. *Thymus praecox* and *Thymus serpyllum.*

Distribution

(Arctic)-alpine; (North American)-Eurasian; type 4; recorded from arctic GR and IS, and from alpine regions of the Alps (DE, FR, CH, AT), the Pyrenees (ES), the Scandinavian Mts. (SE, FI), and C-Asia.



Puccinia: Pucciniaceae: Pucciniales

Puccinia trollii **J. Lind; C-F-155639; Sweden**

Puccinia trollii P. Karst.

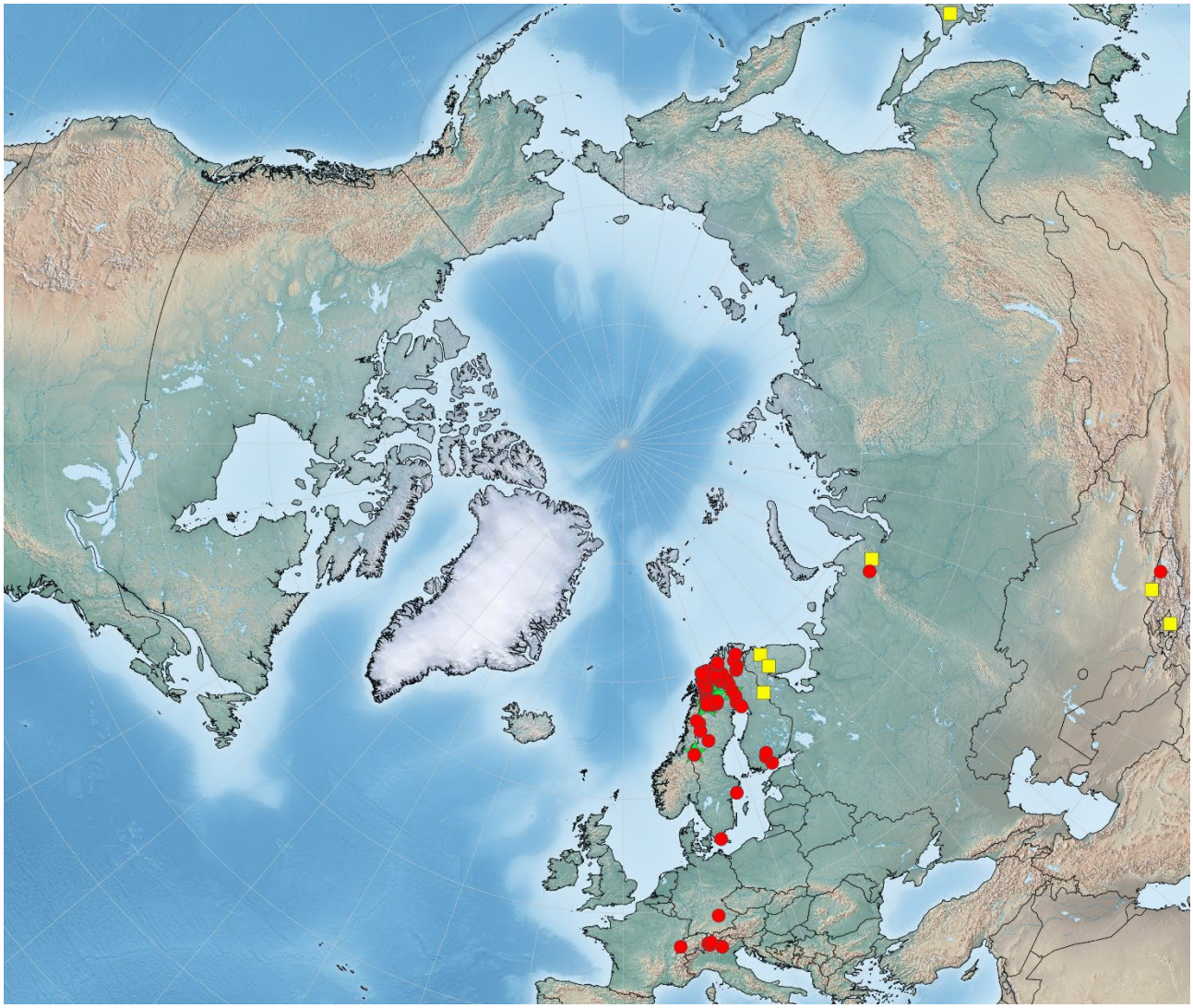
Microcyclic form – III. Telia hypophyllous, scattered or with 2-3 together, roundish or elongated, diameter 2-3 mm, and on somewhat distorted petioles, elongated up to 5 mm long, initially surrounded by a white margin and covered by the epidermis, then naked, pulverulent, dark brown. Spores variable in shape, ± ellipsoid to obovoid, slightly constricted at septum, 30-50 × 15-21 µm, ends rounded or somewhat narrowed, wall light brown, 1.5-2 µm thick, smooth, pore of upper cell usually apical, covered with a hyaline, hemispherical, up to 6-7 µm high cap, pore of lower cell close to septum, covered with a similar but slightly smaller cap, pedicel hyaline, short.

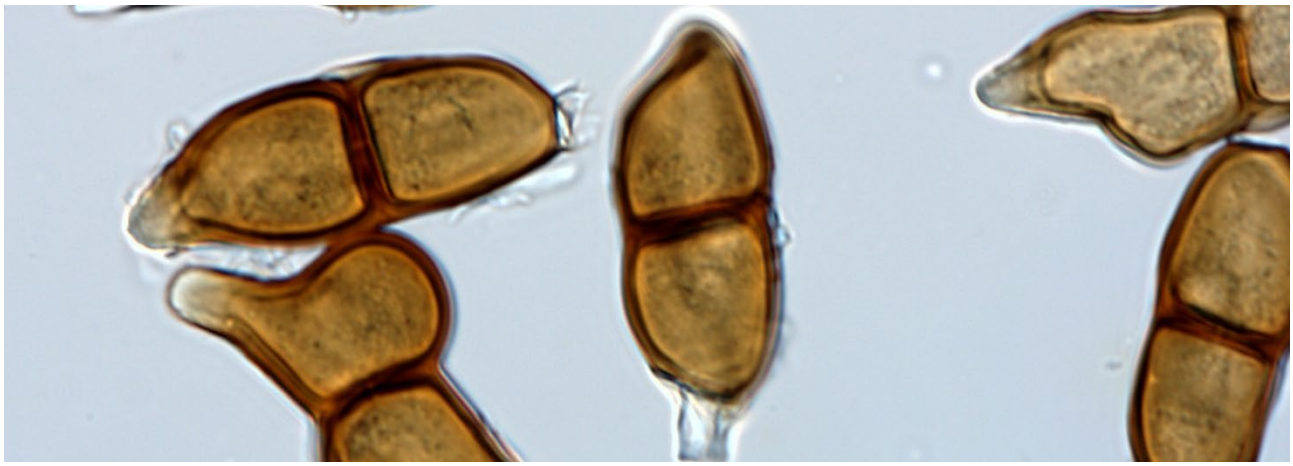
Host plant

III, **Ranunculaceae:** *Trollius europaeus.*

Distribution

Arctic-alpine-boreal; (North-American)-Eurasian; type 9; recorded from arctic NO, SE, FI, and RU, and from alpine regions of the Alps (DE, FR, CH, IT), the Scandinavian Mts. (SE), the Urals (RU), C-Asia, and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia umbilici **L. & H. Roivainen; C-F-155460; Finland**

Puccinia umbilici Guépin

Syn.: *Puccinia rhodiolae* A. Blytt

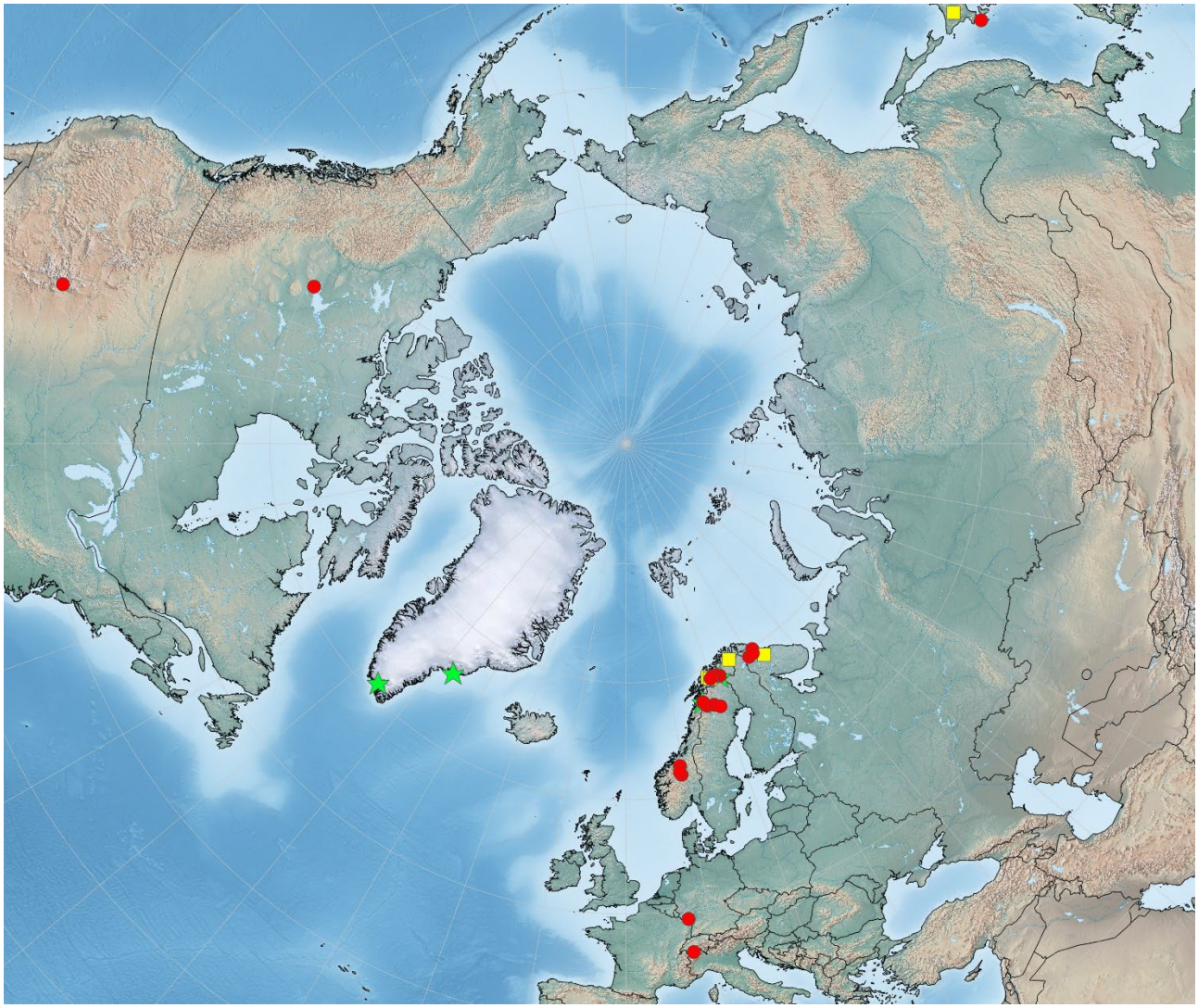
Microcyclic form – III. Telia most hypophyllous, but also amphigenous and on the petioles and stems, confluent to up to 2 × 0.8 cm groups, circular, diameter 0.2-0.7 mm, soon naked and surrounded by the ruptured epidermis, pulverulent, cinnamon brown, dark red-brown or dark brown. Spores 2-celled, broadly ellipsoid or oval, ends rounded, not or barely constricted at septum, 20-35 × 17-26 µm, wall cinnamon brown, 1.5-2 µm thick, smooth or sometimes with some small warts arranged in lines, pore of upper cell apical and covered with a 2 µm high and 3-4 µm broad, often somewhat flattened cap, pore of lower cell near pedicel and sometimes covered with a small cap, pedicel hyaline, short, fragile, deciduous.

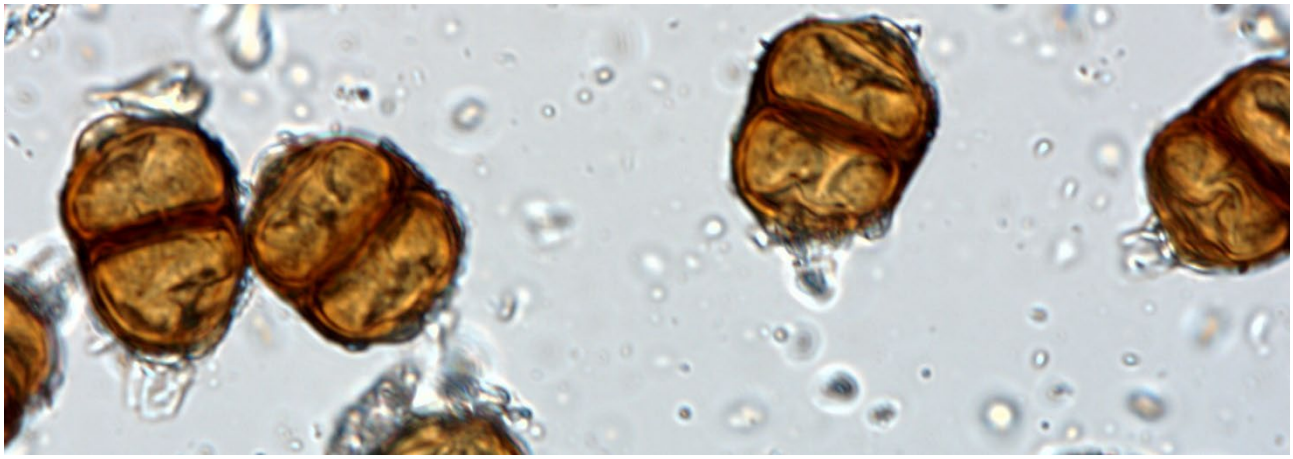
Host plant

III, **Crassulaceae:** *Rhodiola rosea.*

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic GR, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (CAN, USA), the Alps (FR, CH), Dovre (NO), the Scandinavian Mts. (NO, SE), and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia uralensis **F. Bubák, Sydow Uredineen 2183; C-F-155644; Bulgaria**

Puccinia uralensis Tranzschel*

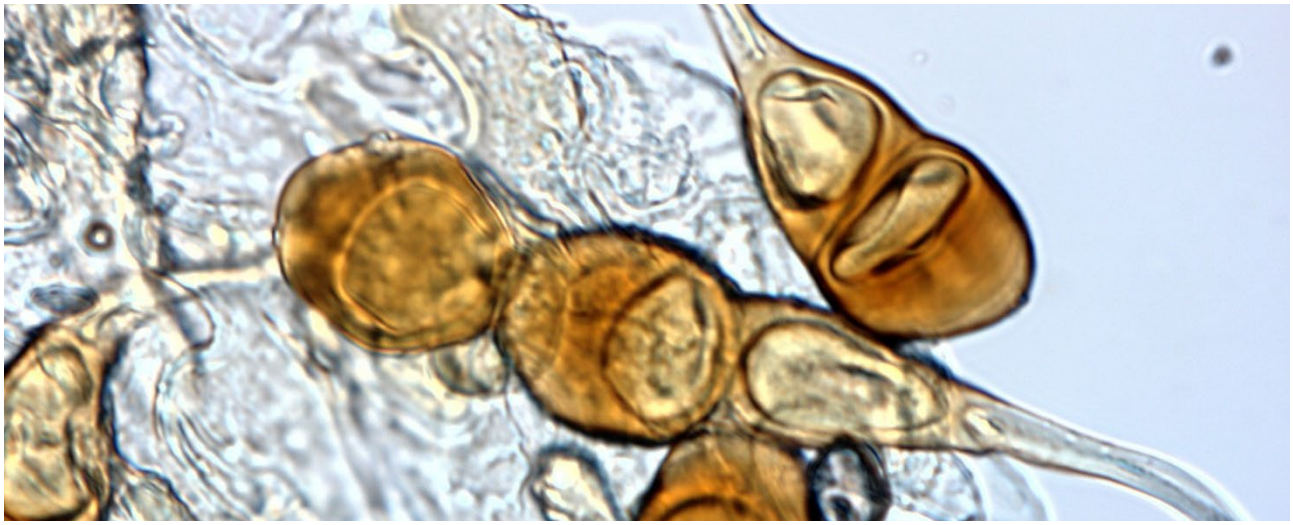
Microcyclic form – III. Telia hypophyllous, on 5-15 mm large, round or irregularly formed brown to yellow-brown spots, more or less circular, small, long covered by the epidermis, then naked, in dense groups of up to 10 mm, compact, black. Spores 1-2-celled, the 2-celled clavate or oblong, apex rounded, tapering or more rarely conical-pointed, base usually tapering, barely or slightly constricted at septum, 36-70 × 16-30 µm, 1-celled 30-35 × 17-23 µm, wall chestnut brown, ca. 2 µm, at apex up to 11 µm thick, smooth, pore of upper cell apical, pore of lower cell against septum, caps inconspicuous, pedicel brown, up to 1× spore length, persistent.

Host plants

III, **Asteraceae:** *Cacalia hastata*, *Cacalia yatabei*, *Hieracium* species, *Senecio nemorensis*, and *Senecio ovatus.*

Distribution

Arctic-alpine-boreal; circumpolar; type 5; recorded from the arctic Kola Peninsula and Chukotka (RU), and from alpine regions of the Rocky Mts. (USA), the Alps (BG, CH), the Urals (RU), and Hokkaido (JP). Distribution very scattered, suggesting its identity has been confused with related species.



Puccinia: Pucciniaceae: Pucciniales

Puccinia urbanii **L. N. Vasiljeva (photo A. Bogatjova); VLA-8699; Russia (Magadan)**

Puccinia urbanii Savile

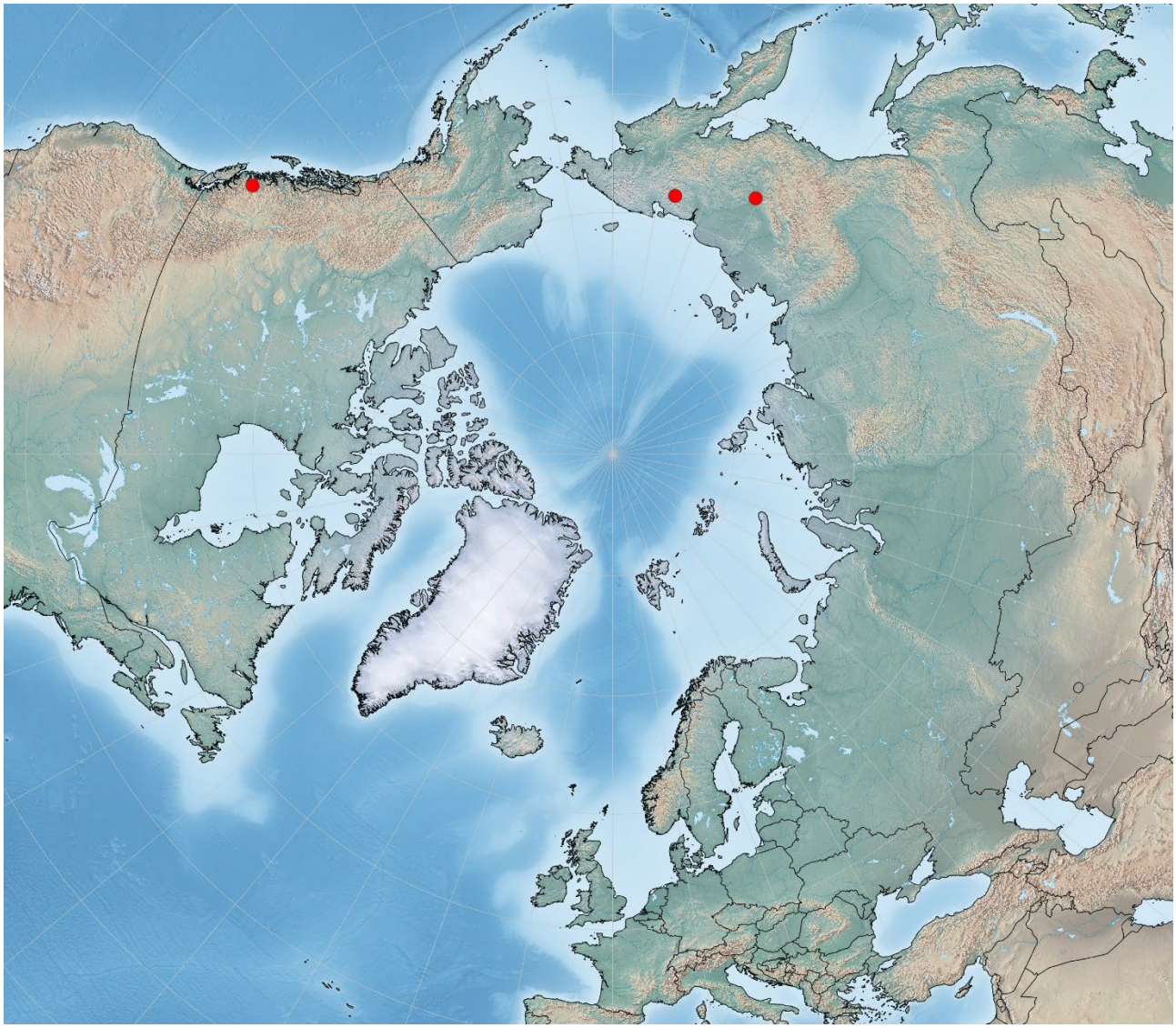
Microcyclic form – III. Telia mainly hypophyllous, initially covered by the epidermis, dark brown, pulverulent. Spores 2-celled, short-ellipsoid to long-cylindrical, not or barely constricted at septum, 28-52(-54) × 12-21(-24) µm, wall orange-brown or chestnut brown, 1.5-2.2 µm thick, faintly verrucose to somewhat irregular reticulate, pore of upper cell apical to 1/3 depressed and covered with a yellowish, 2-3.5(-5) µm high, 6.5-8 µm broad cap, pore of lower cell pore against septum to 1/6 depressed and covered with smaller cap, pedicel hyaline, deciduous.

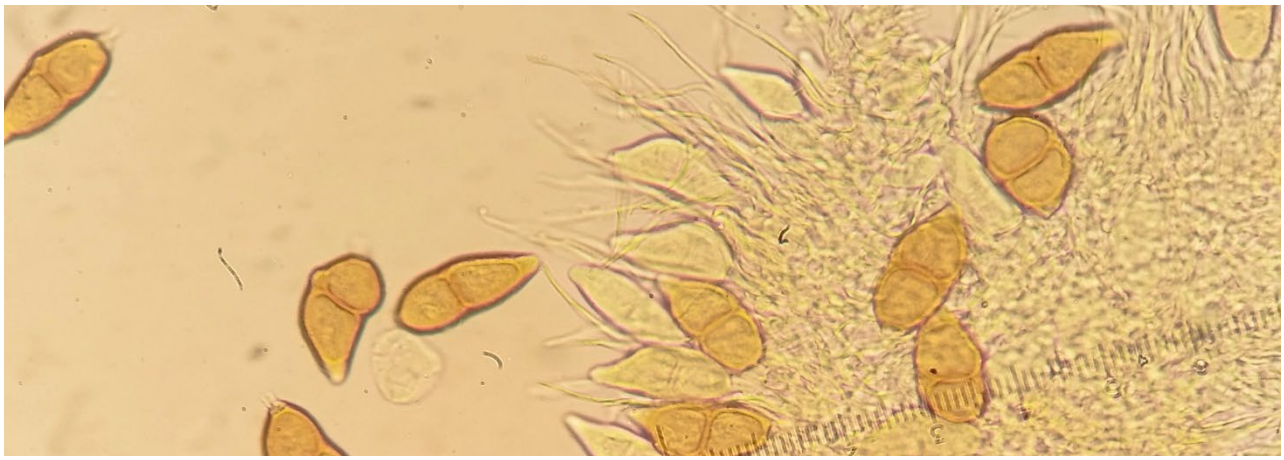
Host plants

III, **Rosaceae:** *Geum calthifolium* and *Sieversia glacialis.*

Distribution

Arctic-alpine; amphiberingian circumpolar; type 11; only recorded from arctic Chukotka (RU), and from the alpine Rocky Mts (CAN). The species is very close to and possibly conspecific with *Puccinia sieversiae* Arthur (see above). In that case the latter name has priority.





Puccinia: Pucciniaceae: Pucciniales

Puccinia vaginatae **J. A. Nannfeldt, FES 1270 & 1271; C-F-155651 & 155652; Sweden**

Puccinia vaginatae Juel

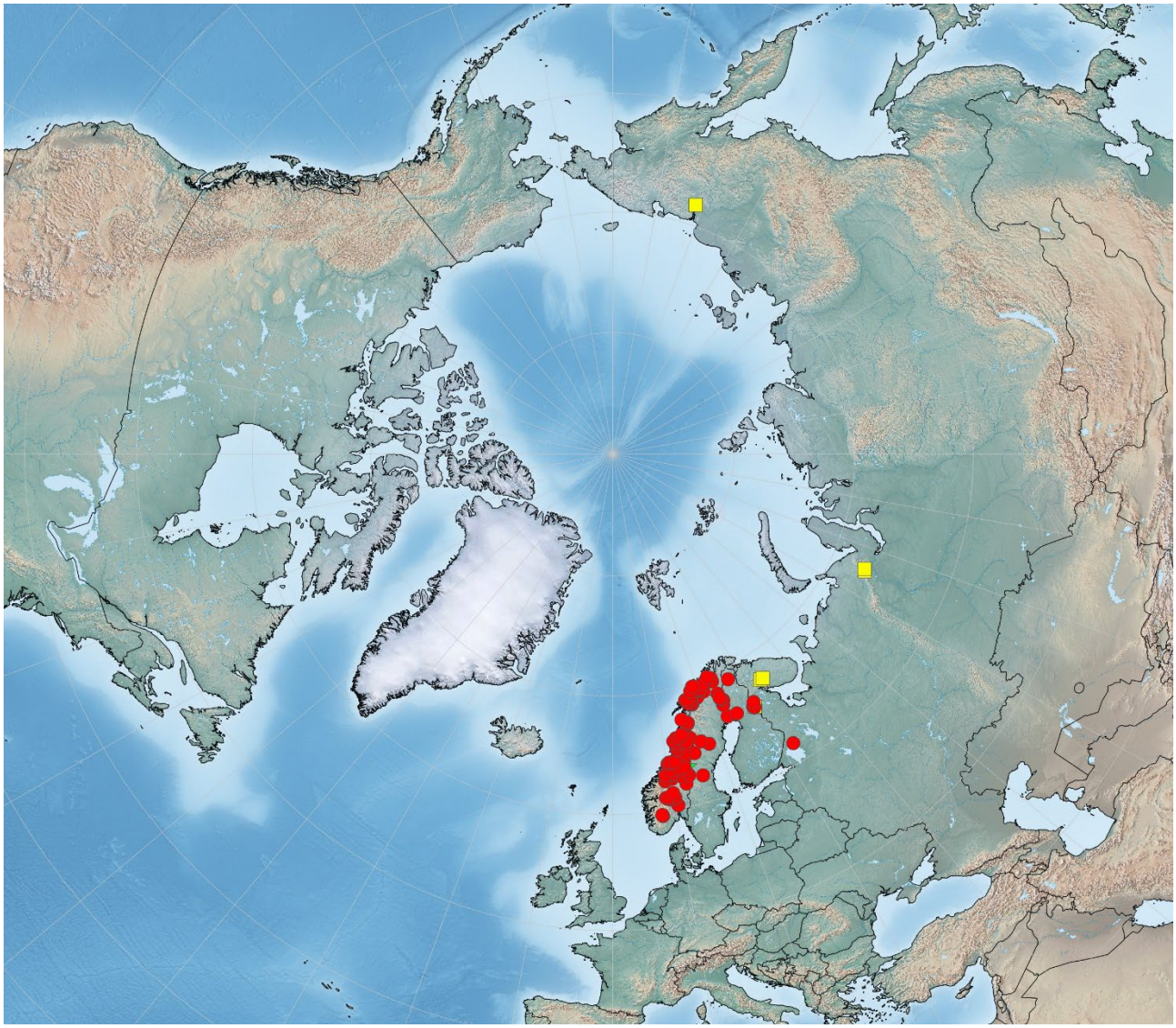
Macrocyclic hetereuform – 0-I / II-III. Spermogonia epiphyllous on yellow spots. **Aecia** hypophyllous, abundant, in irregular groups, peridium yellowish white, revolute, peridial cells 27-34 µm wide. Spores ellipsoid, slightly angular, 14-20 × 14-18 µm, wall hyaline, 1 µm thick echinulate/verrucose. **Uredinia** in short to long stripes of two types, (i) pale brown, spores subglobose to ellipsoid, 19-21 × 18-20 µm, wall light yellowish brown, 3-4.5 µm thick, pores 2, equatorial, and (ii) brown spores, ellipsoid to ovoid, 23-32 × 18-23 µm, wall brown, 1.5-2 µm thick, pores 2-3, equatorial. **Telia** in shorter or longer stripes, firm, dark brown. Spores (1-)2-celled, the 2-celled clavate, apex rounded, rarely tapering, 34-48 × 14-16 µm, upper cell wider and shorter than lower cell, wall light brown, 1-1.5 µm, at apex up to 11 µm thick, pedicel yellowish brown, persistent.

Host plants

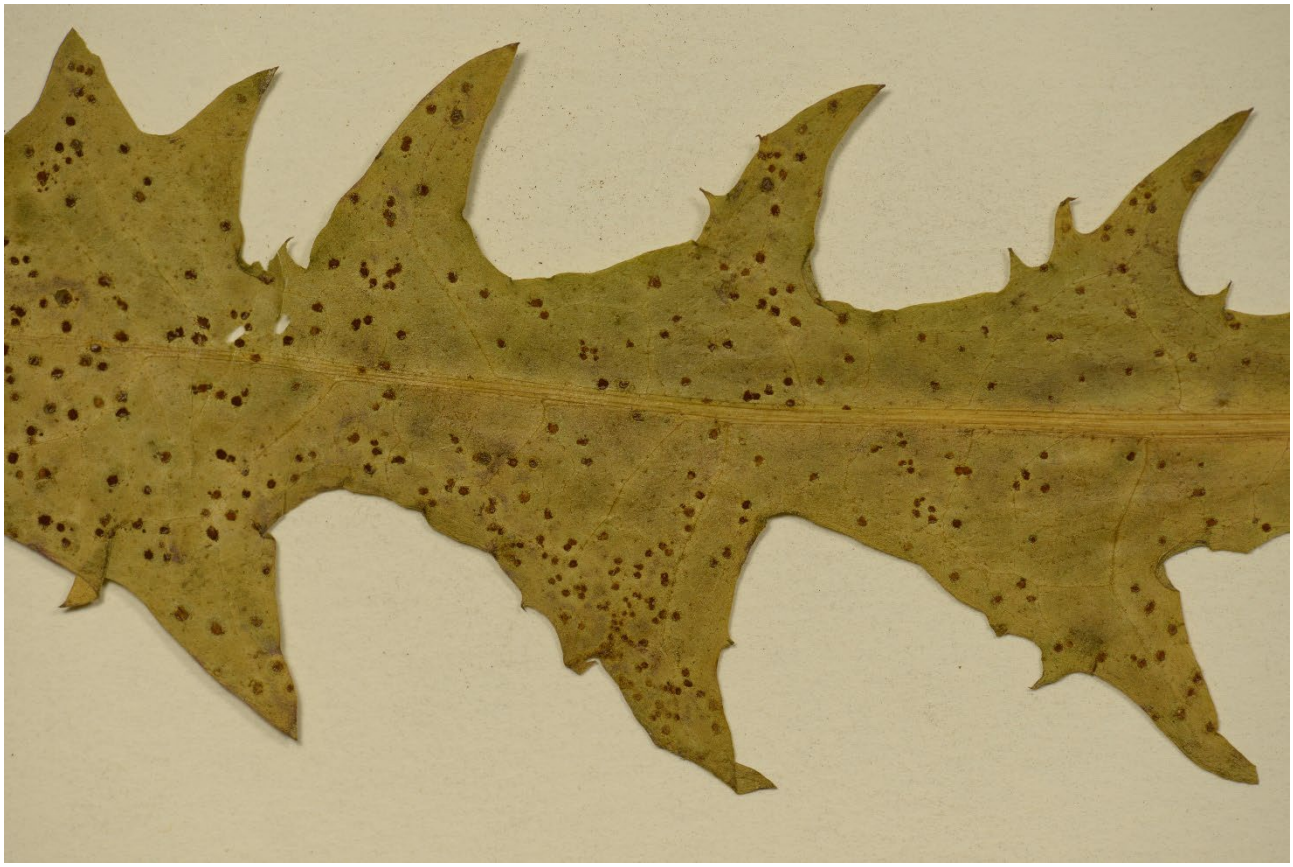
0-I, **Asteraceae:** *Saussurea alpina.*
II-III, **Cyperaceae:** *Carex vaginata.*

Distribution

Arctic(-alpine); Eurasian; type 9; recorded from arctic NO, SE, FI, and RU, and from alpine Dovre (NO), the Scandinavian Mts. (NO, SE, FI, RU), the Urals and Chukotka (RU).



Puccinia: Pucciniaceae: Pucciniales



Puccinia variabilis **K. Jessen; C-F-8926**

Puccinia variabilis Grev.

Syn.: *Puccinia insperata* H.S. Jacks.

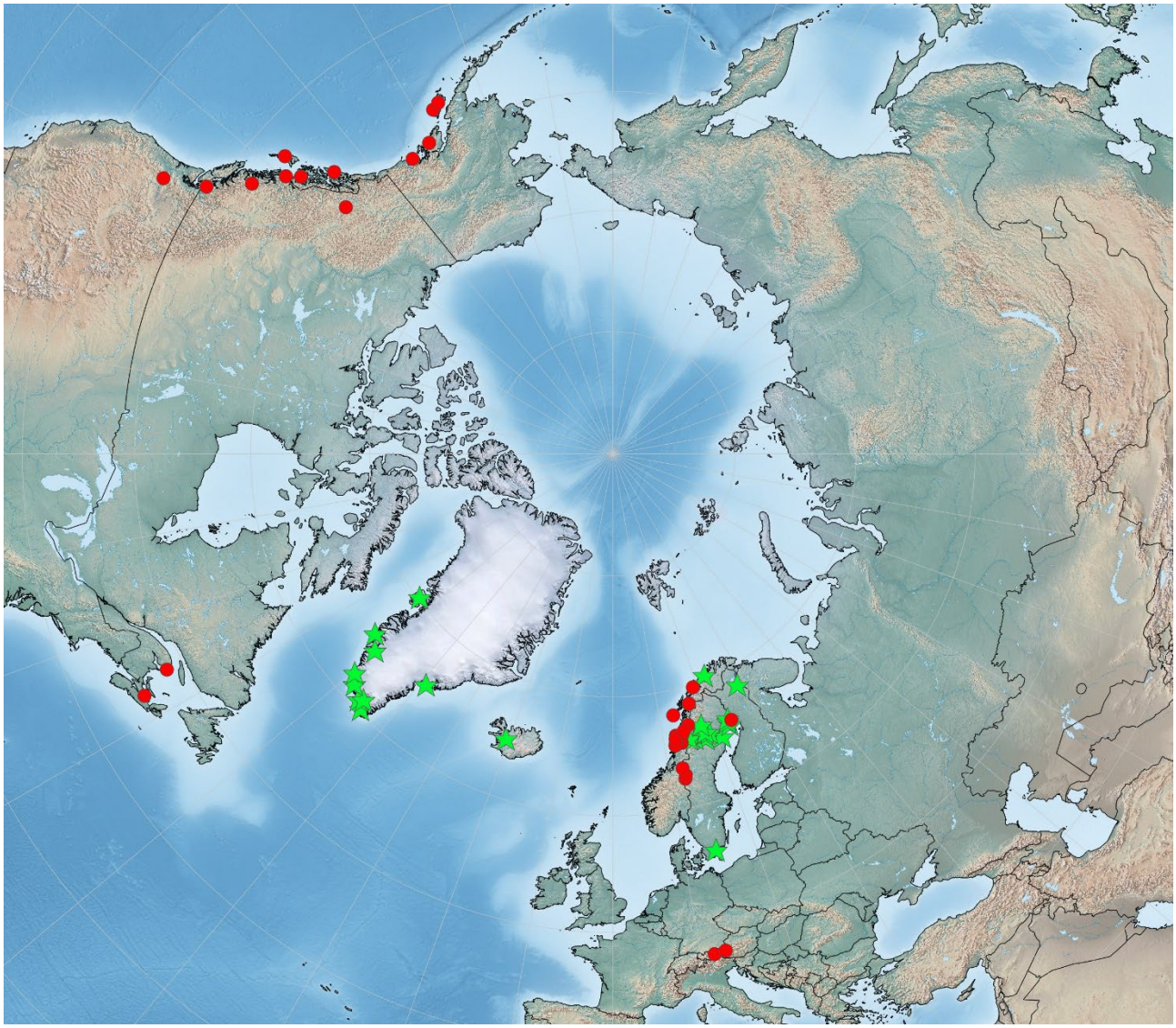
Macrocyclic auteuform – (0)-I-II-III. Spermogonia amphigenous, often lacking. **Aecia** hypophyllous or amphigenous on discolored spots, scattered or in small, loose groups, short-cupulate, peridium white, lacerate. Spores subglobose or ovoid, somewhat angular, 20-25 × 15-20 µm, wall 1 µm thick, very finely verrucose. **Uredinia** amphigenous, on small, yellow or purple spots, scattered, punctate, diameter 0.1-0.3 mm, soon naked and loosely surrounded by the ruptured epidermis, pulverulent, brown. Spores not abundant, subglobose, ovoid, ellipsoid, or irregularly shaped, 20-32 × 16-26 µm, wall light brown or cinnamon brown, 1.5-2 µm thick, distantly echinulate, spines at 2.5 µ spacing, pores 2-3, equatorial. **Telia** as uredinia, but chestnut brown, dark brown or blackish brown. Spores 2-celled, subglobose, ovoid or ellipsoid, ends usually rounded, not or barely constricted at septum, 28-40 × 18-24 µm, wall brown or chestnut brown, 1.5-2 µm, at apex not thickened or occasionally 3-4 µm thick, finely verrucose, pore of upper cell subapical, pore of lower cell close to septum, caps inconspicuous, pedicel hyaline, up to 1× spore length, deciduous.

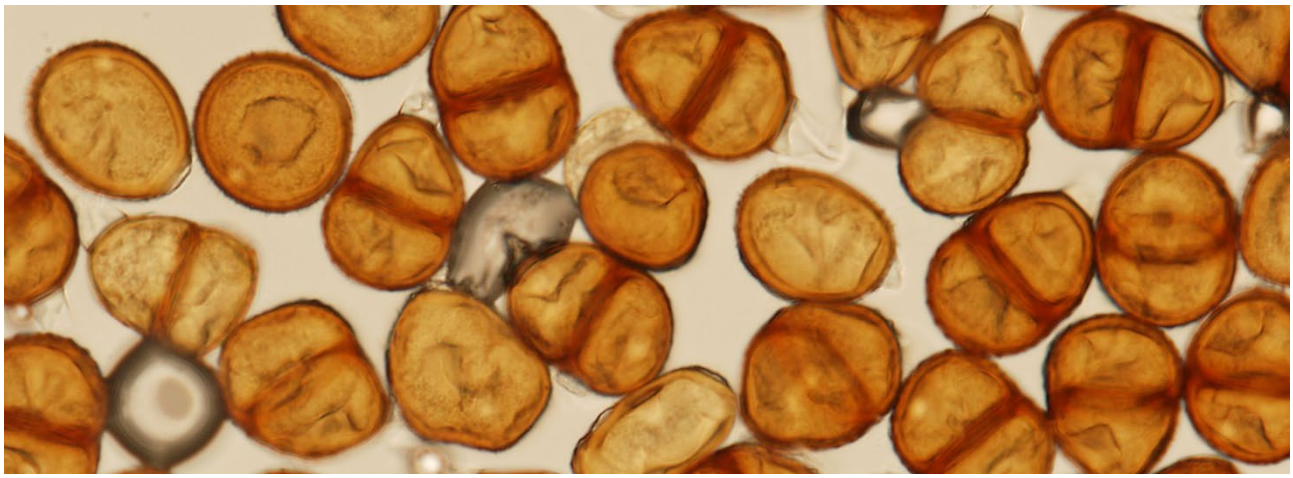
Host plants

0-I-II-III, **Asteraceae:** *Nabalus hastatus*, *Prenanthes alata*, and *Taraxacum* species.

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic GR, IS, NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (AK, CAN, USA), the Alps (AT), and the Scandinavian Mts. (NO, SE, FI, RU).





Puccinia: Pucciniaceae: Pucciniales

Puccinia veratri **de Thümen, Mycoth. Univ. 634; C-F-155653; Italy**

Puccinia veratri (DC.) Duby

Syn.: *Endophyllum alaskanum* Savile*

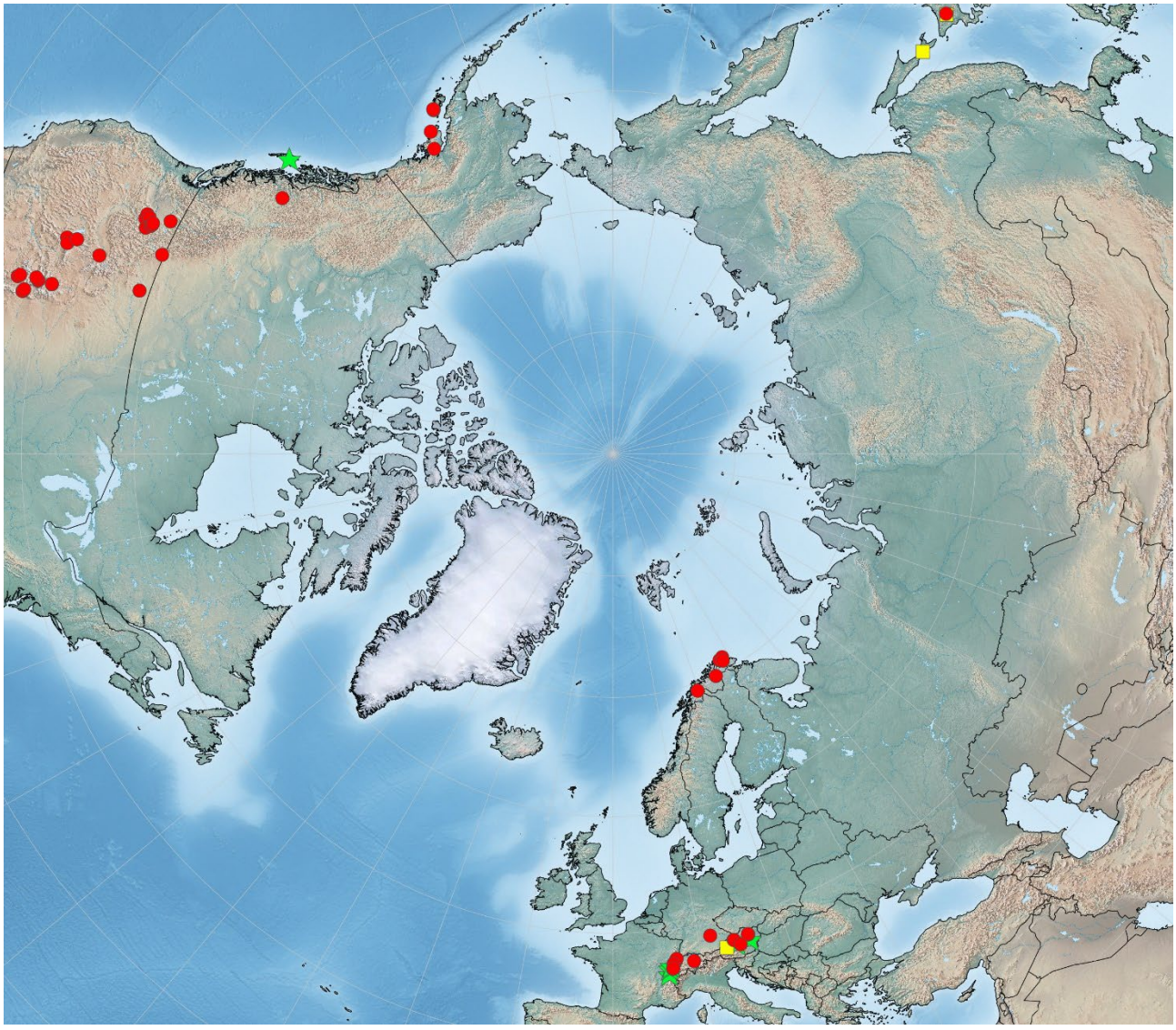
Macrocyclic hetereuform – 0-I / II-III. Spermogonia hypophyllous, between the aecia. **Aecia** abundant, hypophyllous, cupulate, diameter 0.3-0.6 mm, peridium white, recurved, margin lacerate. Spores subglobose to ovoid, 16-24 × 14-18 µm, wall light yellow, 1 µm thick, densely verrucose. **Uredinia** hypophyllous or amphigenous, scattered, round, oval or oblong, up to 2 mm long, soon naked and surrounded by the ruptured epidermis, pulverulent, cinnamon brown or chestnut brown. Spores ellipsoid, 20-28 × 17-23 µm, wall light yellow-brown, 1.5-2 µm thick, distantly echinulate, pore usually 1. **Telia** as uredinia. Spores 1-2-celled, the 2-celled ellipsoid, ends rounded, strongly constricted, tending to fall apart, 28-46 × 16-24 µm, wall yellow-brown or cinnamon brown, distantly echinulate-verrucose, pore of upper cell apical, pore of lower cell at variable position, both pores covered with a low, rather inconspicuous, echinulate-verrucose cap, usually equatorial, the 1-celled spores common, with apical pore, pedicel hyaline, short, fragile, deciduous.

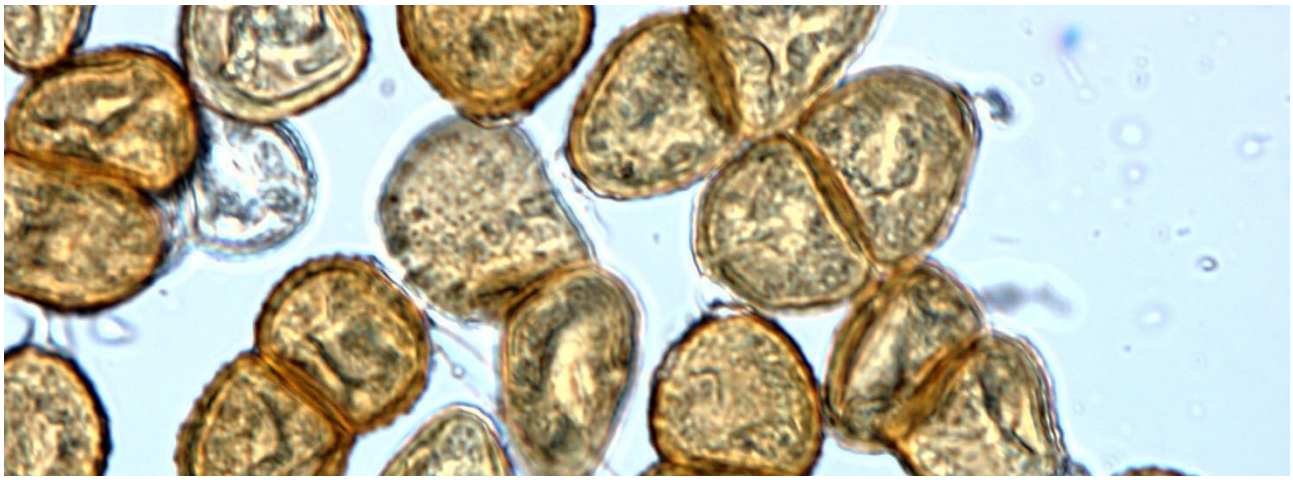
Host plants

0-I, **Onagraceae:** *Epilobium anagallidifolium* and *Epilobium glandulosum.*
II-III, **Melanthiaceae:** *Veratrum album.*

Distribution

(Arctic)-alpine; circumpolar; type 5; recorded from arctic NO, and from alpine regions of the Rocky Mts. (AK, CAN, USA), the Alps (DE, FR, CH, AT), Sakhalin (RU), and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia virgae-aureae **C. J. Johansen, Fungi parasitici scand. 273; C-F-155670; Sweden**

Puccinia virgae-aureae (DC.) Lib.

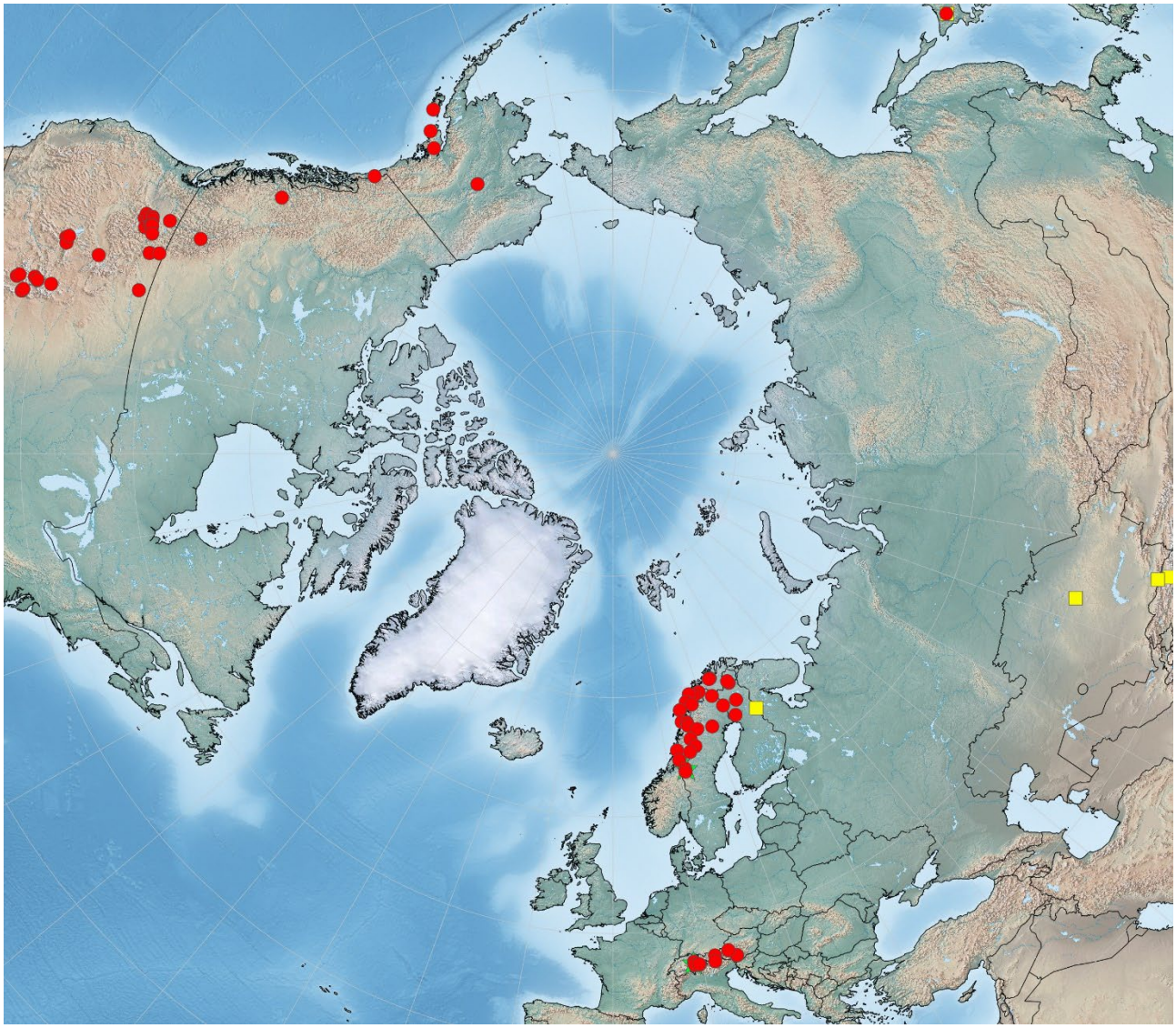
Microcyclic form – III. Telia hypophyllous, crowded along the veins, less dense elsewhere, later forming dendritic or radiating groups on round, yellow, purple or black spots which are surrounded by a dark crust of cells, compact, punctiform, diameter 0.2-0.3 mm, immersed in leaf tissue, permanently covered by the epidermis, then naked, shining, black, usually surrounded by a dense layer of brown paraphyses, sometimes dividing the larger telia in locules. Spores 1-3-celled, the 2-celled somewhat irregular, oblong or ellipsoid, clavate or fusoid, apex rounded, truncate or tapering, base tapering, not or barely constricted at septum, 28-56 × 12-22 µm, wall light brown or cinnamon brown, apex paler, 1-2 µm, at apex 4-12 µm thick, smooth, pores inconspicuous, 1-celled spores can be common, 3-celled spores rare or absent, pedicel subhyaline, up to 0.5× spore length, firm.

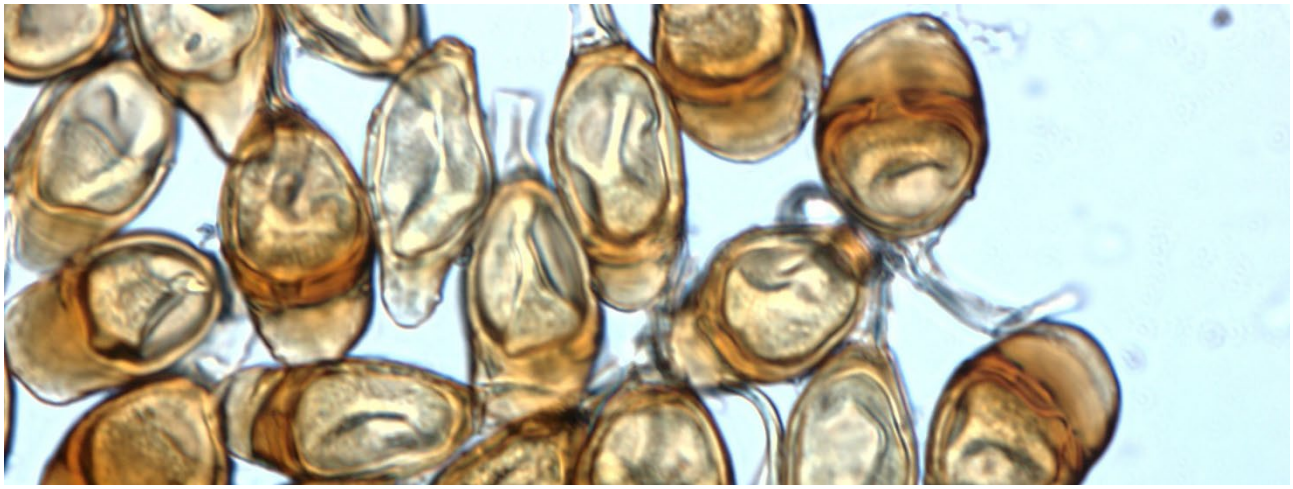
Host plants

III, **Asteraceae:** *Solidago* species, e.g. *S. altissima*, *S. linearifolia, S. puberula*, *S. rugosa*, and *S. virgaurea.*

Distribution

(Arctic-)alpine; circumpolar; type 5; recorded from arctic NO, SE, FI, and RU, and from alpine regions of the Rocky Mts. (AK, CAN, USA), the Alps (CH, AT), C-Asia, and Hokkaido (JP).





Puccinia: Pucciniaceae: Pucciniales

Puccinia volkartiana **W. Rytz; S-F283849; Switzerland**

Puccinia volkartiana E. Fisch.

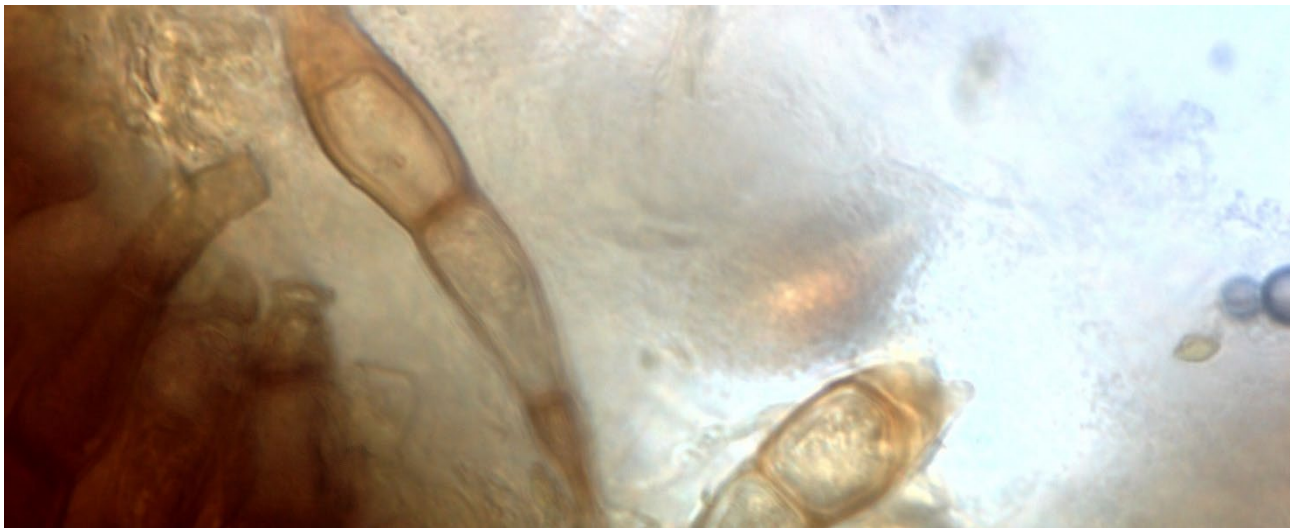
Microcyclic form – III. Telia hypophyllous on the rosette leaves, causing local red discoloration of surrounding leaf tissue, flower stems and bracts, scattered or confluent, round to oblong, pulvinate, becoming somewhat gelatinous when wet, dark brown. Spores 2-celled, narrowly ellipsoid or clavate, apex ± coronate with 2(-3) irregular protrusions or rounded, base tapering, slightly constricted at septum, 35-71 × 12-20 µm, lower cell longer and narrower than the upper cell, wall yellow-brown, 1-1.5 µm, at apex including protuberances 11-20 µm thick, smooth, pores indistinct, pedicel concolorous with spore base, persistent, usually < 1× spore length.

Host plants

III, **Primulaceae:** *Androsace chamaejasme.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic AK and Chukotka (RU), and from alpine regions of the Rocky Mts. (CAN) and the Alps (CH).



Uredo: Pucciniaceae: Pucciniales

Uredo alpestris **P. Morthier, Mycoth. univ. 2040; C-F-148648; Switzerland**

Uredo alpestris J. Schröt.

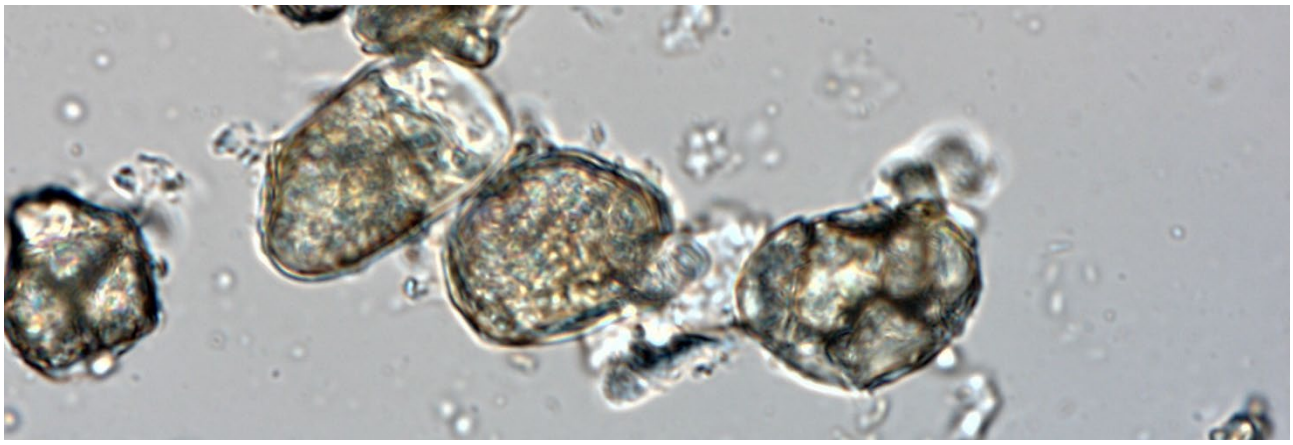
Only known in the uredo-stage – II. Uredinia hypophyllous, irregularly scattered, often confluent, roundish, oblong or irregular, orangish, of 2 types (but transitions commonly occur): (i) primary uredinia formed till summer, diameter ca. 0.5 mm, initially covered by the epidermis, then naked and surrounded by the ruptured epidermis. Spores oblong, fusoid, ends tapering, 21-28 × 10-14 µm (excl. spine), wall hyaline, 1 µm thick, apex with up to 5 µm long, narrow spine, smooth, (ii) secondary uredinia formed in autumn, diameter up to 1 mm, long covered by the epidermis, surrounded by short paraphyses. Spores oblong-ellipsoid, apex rounded, base tapering, 21-28 × 10-14 µm, wall hyaline, 1.2-1.5 µm thick, apex sometimes slightly thicker.

Host plant

II, **Violaceae:** *Viola biflora.*

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (DE, FR, CH, AT, SI, IT) and the Pyrenees (ES).



Uromyces: Pucciniaceae: Pucciniales

Uromyces airae-flexuosae **L. & H. Roivainen; C-F-155521; Finland**

Uromyces airae-flexuosae Ferd. & Winge*

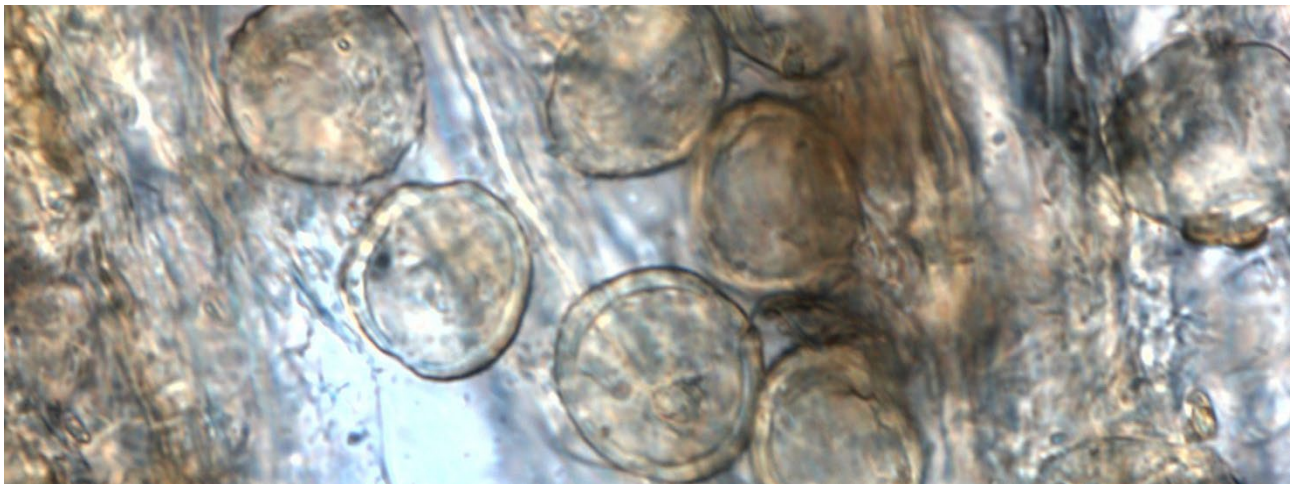
Hemicyclic form – II-(III). Uredinia usually epiphyllous, between the veins, with opposite conspicuous, orange-yellow 1-5 mm long spots with purple-violet margin, scattered or in short rows, long covered by the epidermis, orange-yellow. Spores broadly ellipsoid, (20-)24-28(-30) × (16-)18-25(-26) µm, wall hyaline to yellowish, 2-3 µm thick, finely echinulate, pores 3-8(-9), scattered, conspicuous. **Telia** amphigenous on wilting leaves and sheaths, chestnut brown or dark brown. Spores 1-celled, ovoid, pyriform or broadly ellipsoid, towards the apex darker, (25-)30-37(-40) × (15-)16-25 µm, wall yellow-brown, 1-3 µm, at apex up to 4.5 µm thick, smooth, pore inconspicuous, pedicel hyaline, yellowish or brownish, 1× spore length or slightly longer, persistent.

Host plant

II-III, **Poaceae:** *Deschampsia flexuosa.*

Distribution

Arctic-alpine-boreal; Eurasian; type 9; recorded from arctic NO, SE, FI, and RU, and from alpine Dovre (NO) and the Scandinavian Mts. (NO, SE, FI, RU).



Uromyces: Pucciniaceae: Pucciniales

Uromyces allii-sibirici **H. B. Gjærum; TROM-F-26057 (type); Norway**

Uromyces allii-sibirici Gjaerum

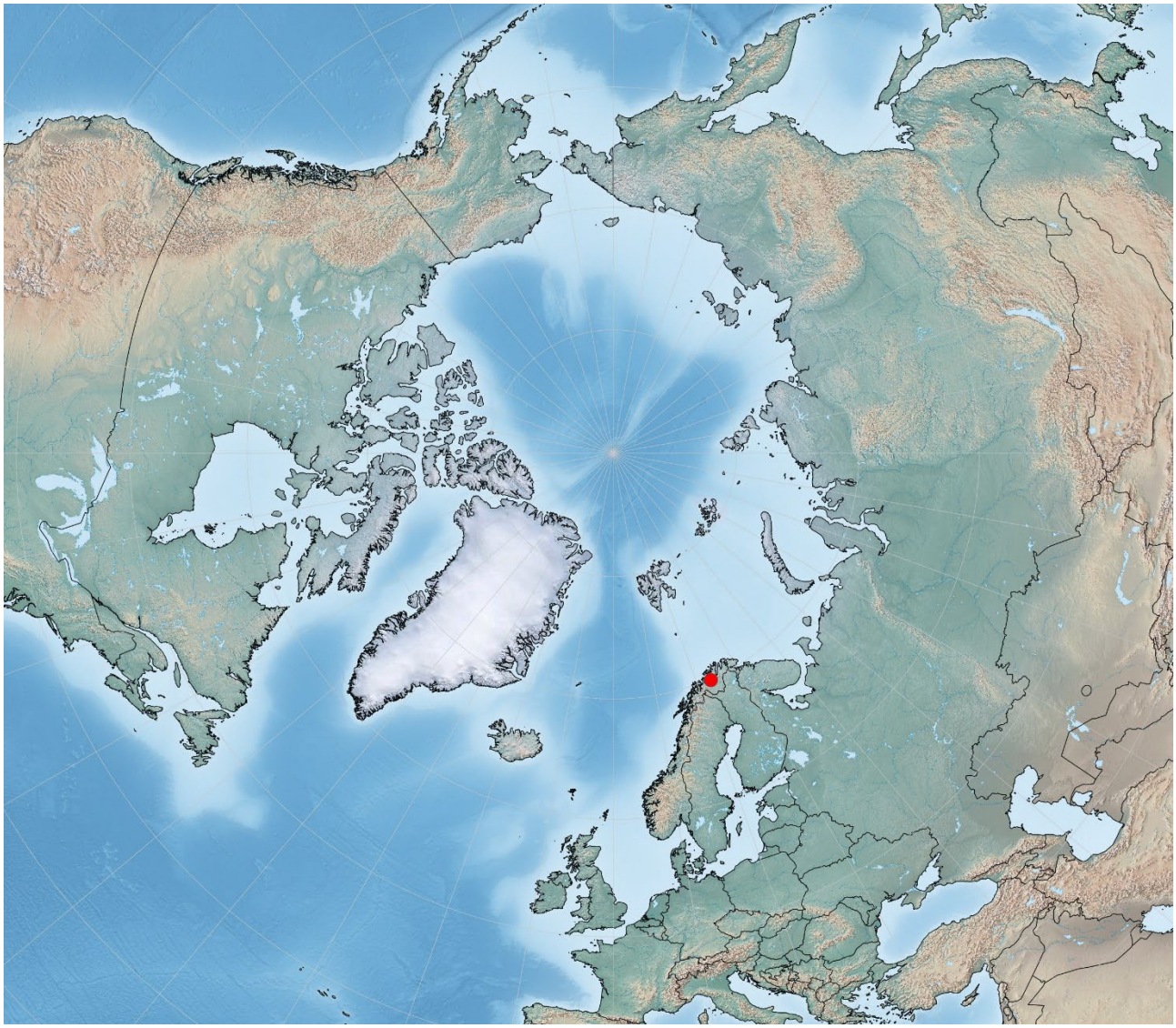
Microcyclic form – III. Telia on the leaves, oblong, surrounded by the ruptured epidermis, pulverulent, brown or cinnamon brown. Spores 1-celled, subglobose, ovoid or ellipsoid, sometimes slightly flattened at 1 side, 18-26 × 14-19 µm, wall brown, 1.5-2 µm thick, with longitudinal stripes, pore apical and covered with a hyaline cap, pedicel hyaline, short.

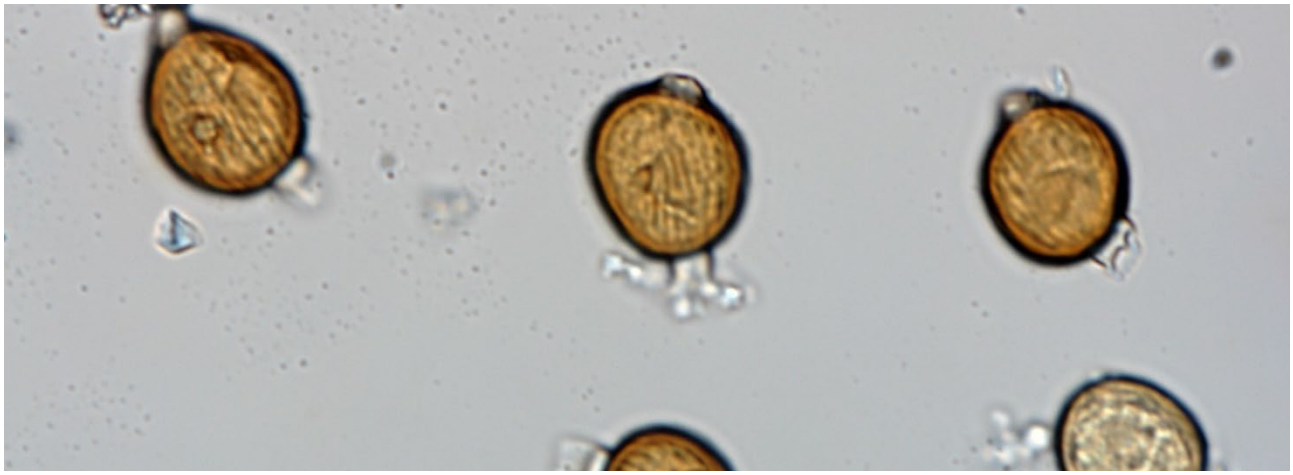
Host plant

III, **Alliaceae:** *Allium sibiricum*.

Distribution

Arctic; Eurasian; type 13; so far only known from the type in arctic Norway.





Uromyces: Pucciniaceae: Pucciniales

Uromyces alpestris **M. Steiner, Crypt. exs. 4531; C-F-155524; Italy**

Uromyces alpestris Tranzschel

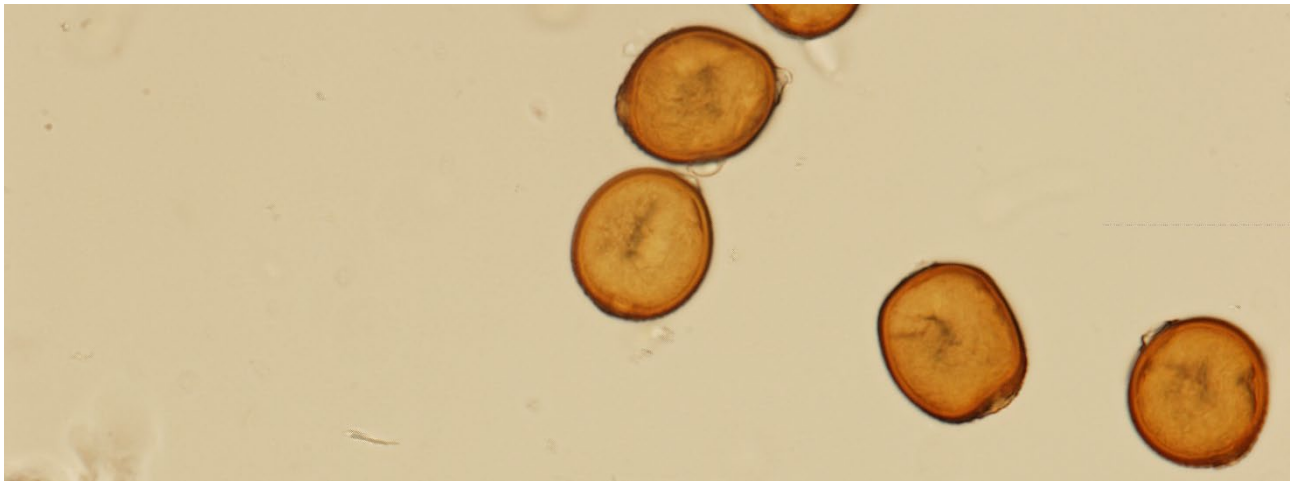
Macrocyclic auteuform, strongly tending to **microcyclic form – (0-I-II)-III.** Plants usually do not malform, but if so, only the lower part. **Spermogonia** often lacking. **Aecia** lacking or sparsely present, rudimentary. Spores sparsely present. **Uredinia** rarely observed and if present, sparse. Spores also occasionally formed in the aecia. **Telia** pustulate, opening with a pore, chestnut brown. Spores 1-celled, shape variable, (18-)24-35(-48) × 18-28 µm, wall yellow-brown, ca. 1-1.5 µm thick, densely and very finely verrucose, pore apical, covered with a small, brown, densely and finely verrucose cap.

Host plant

0-I-II-III,**Euphorbiaceae:** *Euphorbia cyparissias*.

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (FR, CH, AT, SI) and C-Asia.



Uromyces: Pucciniaceae: Pucciniales

Uromyces cacaliae **K. H. Rechinger, Crypt. exs. 4533; C-F-155975; France**

Uromyces cacaliae (DC.) Unger

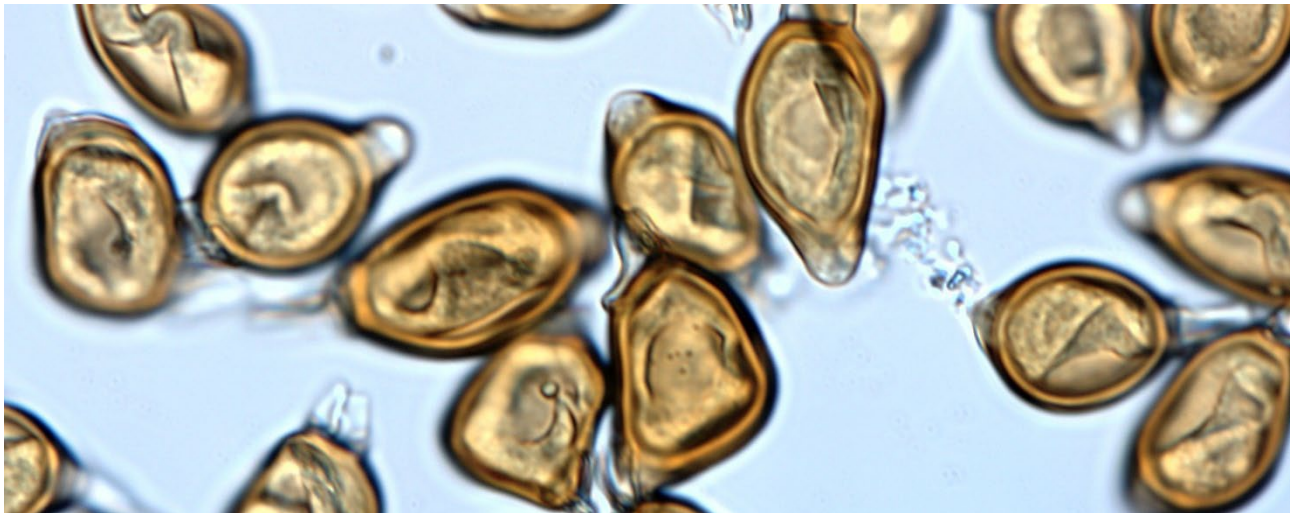
Microcyclic form – III. Telia mainly hypophyllous, crowded in diameter 5 mm groups, adjoining leaf tissue and opposite side discoloured but not swollen, diameter 0.5-1 mm, initially covered by the epidermis, then naked, pulverulent, chestnut brown or dark brown. Spores 1-celled, ovoid to ellipsoid, rarely subglobose, often irregular and asymmetric, 20-36 × 14-25 µm, wall light brown, 2-2.5 µm thick, smooth, pore apical, covered with a 4-7 µm high cap, pedicel hyaline, 1× spore length or slightly longer, fragile.

Host plants

III, **Asteraceae:** *Adenostyles alliariae* (*A. alpina*), and *Adenostyles glabra.*

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (DE, FR, CH, AT, IT), Sakhalin (RU), and Hokkaido (JP).



Uromyces: Pucciniaceae: Pucciniales

Uromyces caricis-sempervirentis **H. Poeverlein (I); C-F-156012; Austria; E. Fischer (III); C-F-156045; Switzerland**

Uromyces caricis-sempervirentis E. Fisch.

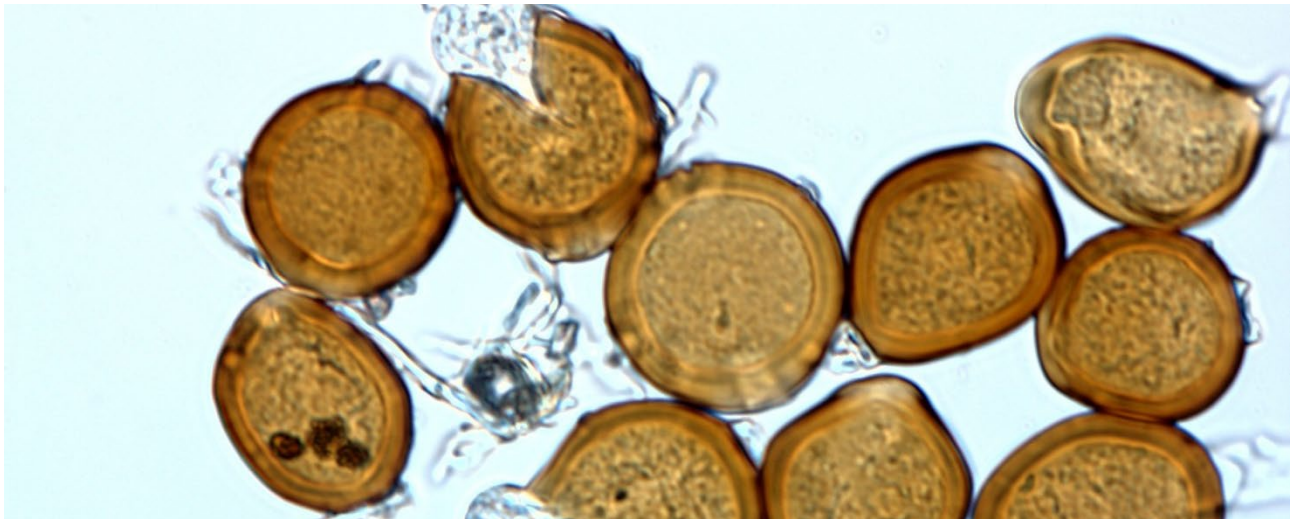
Macrocyclic hetereuform – 0-Is / II-III. Systemic, plants often malformed, not flowering. **Spermogonia** hypophyllous, between the aecia. **Aecia** hypophyllous, also amphigenous, covering the whole surface, not crowded, cupulate, peridium revolute, lacerate, yellowish white or orange-yellow. Spores subglobose-angular, diameter 18-24 µm, wall thin, very finely and very densely verrucose. **Uredinia** amphigenous and on the upper part of the stems, small, long covered by the epidermis, then naked, brown. Spores globose to ellipsoid, 20-28 × 18-24 µm, wall brown, very finely and distantly echinulate, pores 2-3. **Telia** also developing from the uredinia, amphigenous and on the upper part of the stems, sometimes confluent, up to 1 mm long, long covered by the epidermis, then naked, blackish. Spores 1-celled, subglobose to ovoid, 20-35 × 18-25 µm, wall brown, 2-3 µm thick, pore apical, covered with a 3-8 µm high, light brown cap, pedicel hyaline, fragile, length variable, usually 1× spore length.

Host plants

0-I, **Campanulaceae:** *Phyteuma* species, e.g. *Phyteuma betonicifolium*, *P. confusum*, *P. hemisphaericum*, *P. orbiculare*, *P. ovatum*, and *P. spicatum.*
II-III, **Cyperaceae:** *Carex sempervirentis.*

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (DE, FR, CH, AT, IT) and the Pyrenees.



Uromyces: Pucciniaceae: Pucciniales

Uromyces dactylidis **J. A. Nannfeldt, FES 843a & 844; C-F-169363 & 169362; Sweden**

Uromyces dactylidis G.H. Otth

Syn.: *Nielsenia dactylidis* (G.H.Otth) Syd.; *Nielsenia festucae* (Syd. & P. Syd.) Syd.; *Nielsenia poae* (Rabenh.) Syd.; *Aecidium ficariae* Pers.; *Puccinia lycoctoni* Fuckel

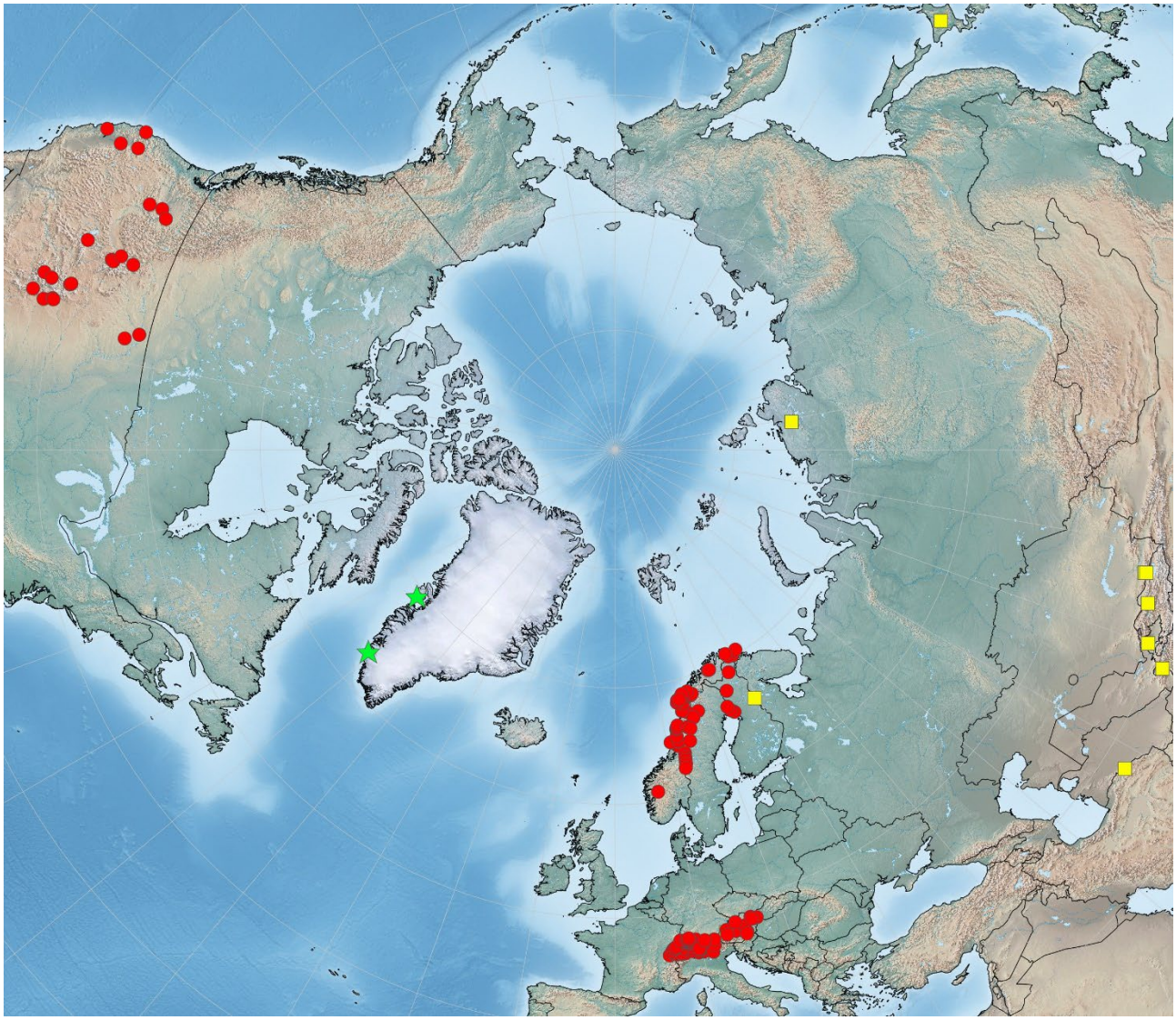
Hetereuform macrocyclic – 0-I-II-III. Spermogonia usually epiphyllous, occasionally hypophyllous, honey yellow. **Aecia** hypophyllous and on the petioles, in circular clusters, on yellow spots, often elongate on the stems, short-cupulate. Spores globose, slightly angular, diameter 17-25 µm, wall hyaline, 1-2 µm thick, finely verrucose. **Uredinia** amphigenous, scattered or in rows, 0.2-1 mm long, later also containing teliospores, yellow-brown, paraphyses lacking. Spores globose to ovoid, (14-)20-32 × (14-)18-25 µm, wall hyaline to yellowish, 1.5-3 µm thick, finely echinulate, pores 4-9, scattered, often with a thickened ring; also teliospores may be present. **Telia** usually hypophyllous, arranged in linear rows, often confluent, small, oblong, long covered by the epidermis, then naked, shiny brown to black, loculate with hyaline or brown, columnar paraphyses. Spores first formed in the uredinia, later in newly formed sori, 1-celled, globose to ovoid, sometimes somewhat flattened, base somewhat tapering, yellow-brown, 17-30 × 14-24 µm, wall light brown, 1-1.5 µm, at apex 2-4(-6) µm thick, smooth, pore inconspicuous, pedicel brownish, roughly 1× spore length.

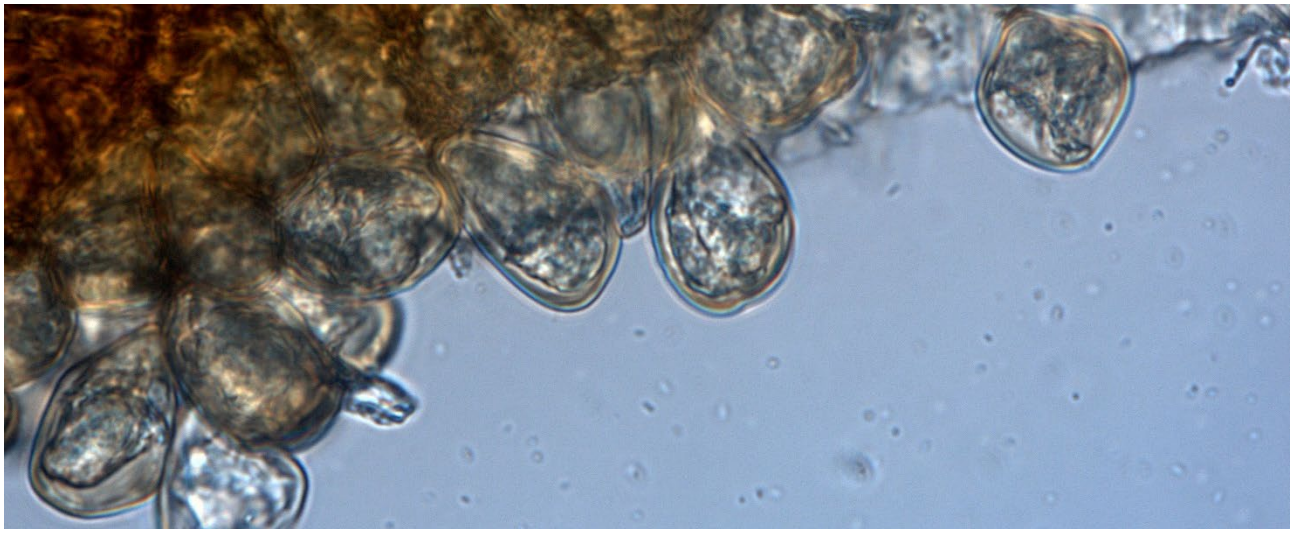
Host plants

0-I, **Ranunculaceae:** *Ranunculus** (incl. *Ficaria*). **II-III**, **Poaceae:** *Alopecurus*, *Dactylis glomerata*, *Festuca* species and *Poa* species.

Distribution

Arctic-alpine-boreal; circumpolar; type 1; recorded from arctic NO, SE, FI, and the Kola Peninsula and Taymir (RU), and from alpine regions of the Rocky Mts. (USA), the Alps (DE, FR, CH, AT, IT), Dovre (NO), the Scandinavian Mts. (NO, SE, FI), Kazakhstan, C-Asia, and Hokkaido (JP)..





Uromyces: Pucciniaceae: Pucciniales

Uromyces fischerianus **E. Mayor (micro S-F436970, Kamchatka); S-F34452; France**

Uromyces fischerianus Mayor*

Syn.: *Puccinia ustalis* Berkeley; *Uromyces ustalis* Tranzschel

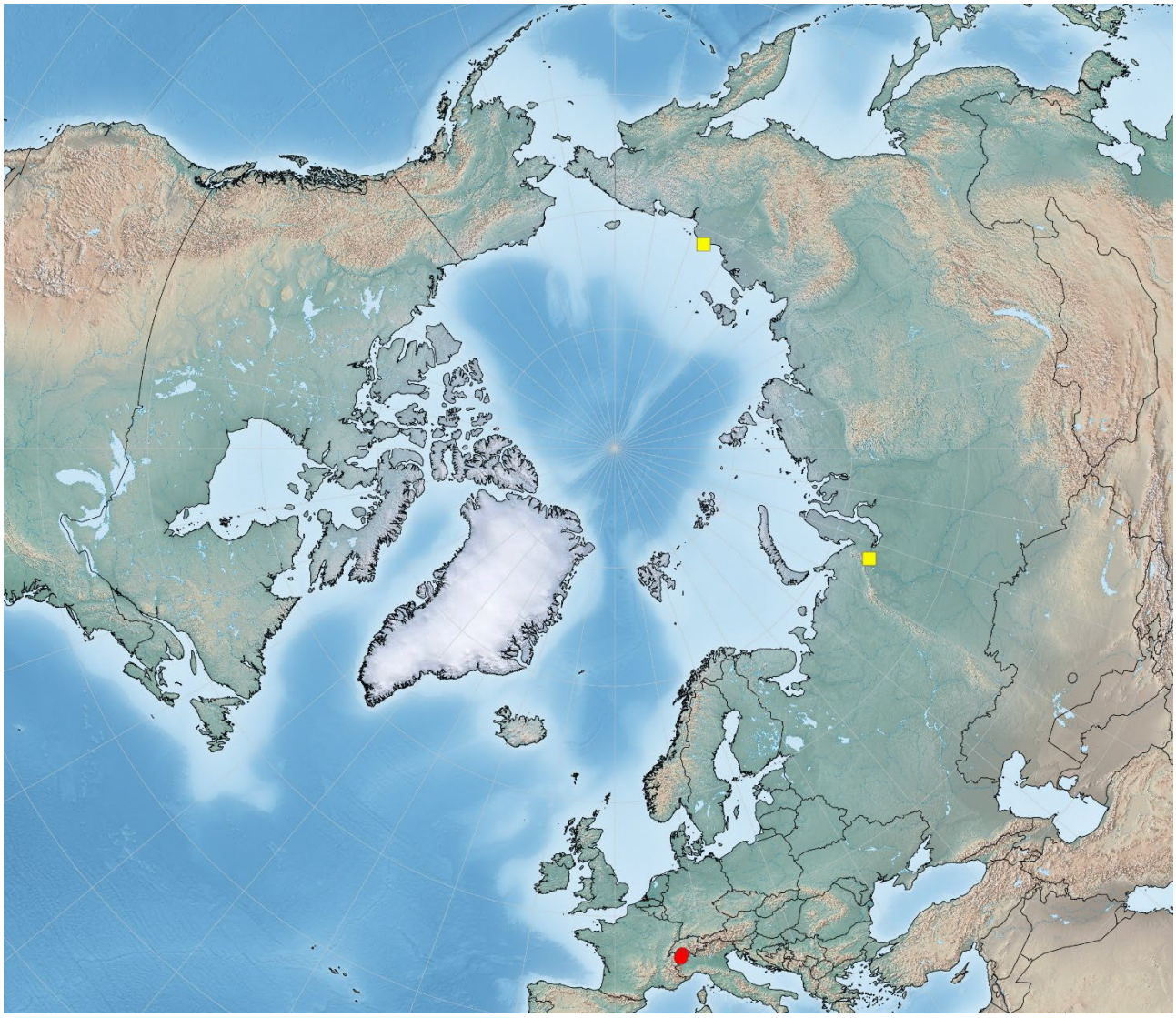
Hemicyclic form – II-IIIs. Systemic, plants are yellowish green. **Uredinia** scattered, long covered by the epidermis, then naked, yellow-brown. Spores subglobose, 17-23 × 17-21 µm, wall subhyaline to pale yellow, 2 µm thick, finely echinulate. **Telia** epiphyllous, on the petioles elongate up to 3 mm long, scattered, rarely confluent, diameter 1-2 mm, long covered by the epidermis, then naked, brown, loculate with light brown, apex darker coloured, 47-66 µm long and diameter ca. 3-5 µm, at apex 4-8 µm paraphyses. Spores 1-celled, ovoid to ellipsoid, 19-28 × 12-19 µm, wall light brown, 1 µm, at apex ca. 2 µm thick, smooth, pore inconspicuous, pedicel hyaline or subhyaline, up to 1× spore length.

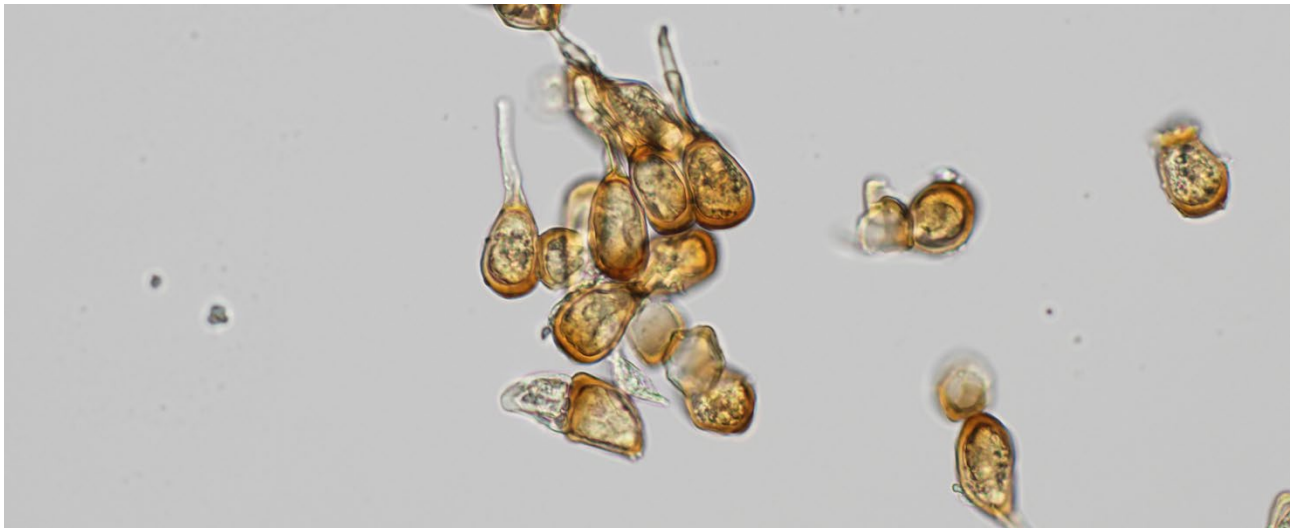
Host plant

II-III, **Ranunculaceae:** *Ranunculus glacialis.*

Distribution

Arctic-alpine; Eurasian; type 9; recorded from arctic Chukotka (RU), and from alpine regions of the Alps (CH) and the Urals (RU).





Uromyces: Pucciniaceae: Pucciniales

Uromyces hedysari-obscuri **Carestia, Nigro & Piccone; C-F-155523; Italy**

Uromyces hedysari-obscuri (DC.) Carestia & Picc.*

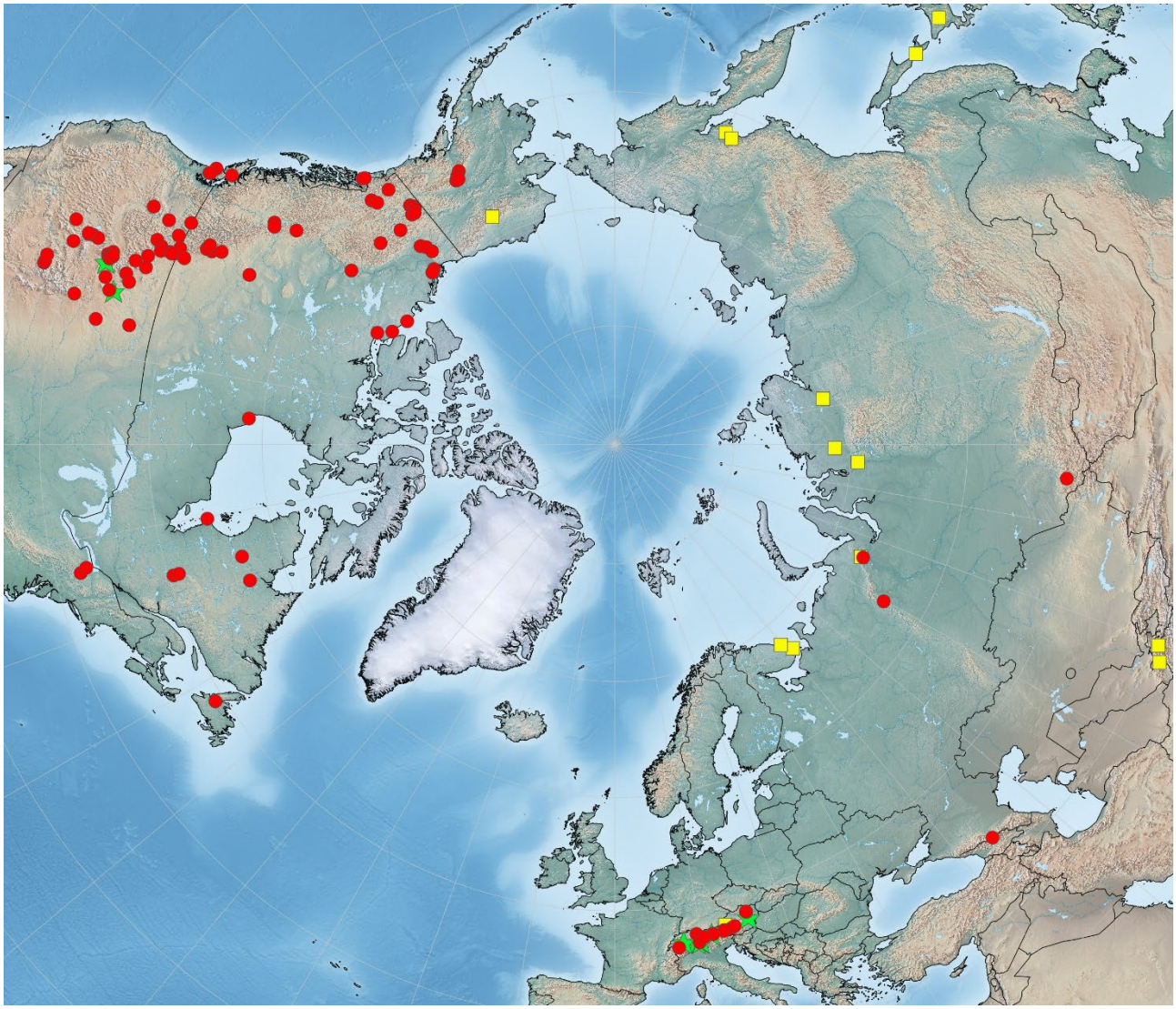
Macrocyclic auteuform – 0-I-IIa-III. Spermogonia epiphyllous, amphigenous or on the petioles, in groups, orange. **Aecia** on the petioles and stems in large, compact groups, causing slight to moderate swellings. Spores subglobose to ellipsoid, sometimes angular, 14-22 × 12-19 µm, wall hyaline, 0.5-1 µm thick, finely verrucose. **Uredinia** aecidioid, as aecia, but epiphyllous and scattered or in small groups. Spores as aeciospores. **Telia** mainly epiphyllous, also hypophyllous, surrounding the uredinia or scattered, roundish to oblong, small, soon naked, pulverulent, dark brown or dark chocolate brown. Spores 1-celled, obovoid or ellipsoid, 17-30 × 12-18(-21) µm, wall chestnut brown, 1-2.5 µm thick, densely verrucose, pore apical, covered with a conspicuous, hemispherical, hyaline to pale yellow, 2-4 µm high and 3-7 µm broad cap, pedicel hyaline, fragile, short, deciduous.

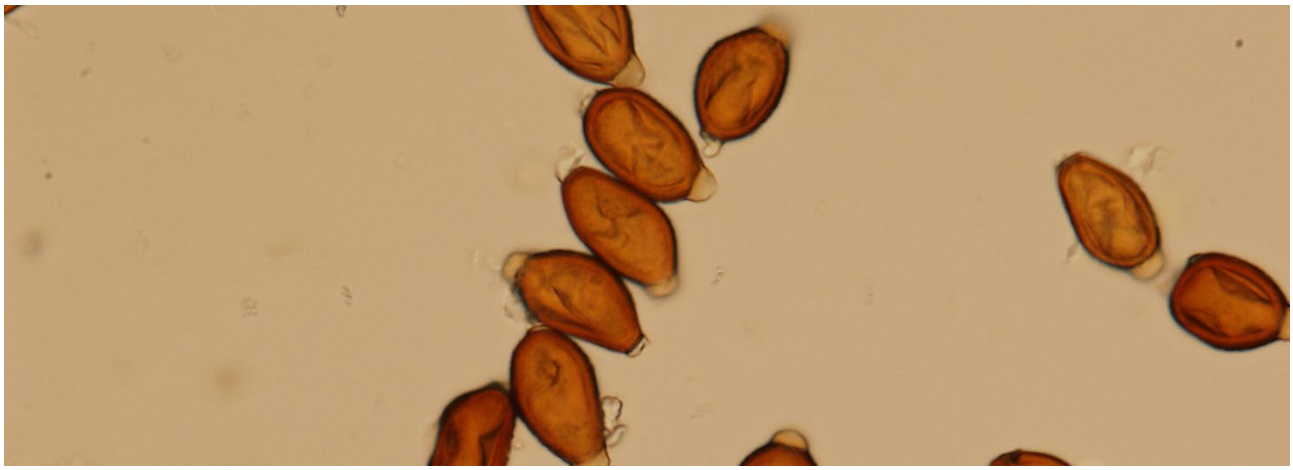
Host plants

0-I-II-III, **Fabaceae:** *Hedysarum* species, e.g. *H. gmelinii*, *H. hedysaroides*, *H. marginatum*, and *H. occidentale.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic AK, CAN, and the Kola Peninsula, Taymir and Magadan (RU), and from alpine regions of the Rocky Mts. (AK, CAN, USA), the Alps (CH, AT), the Urals, Altai and Sakhalin (RU), C-Asia, and Hokkaido (JP).





Uromyces: Pucciniaceae: Pucciniales

Uromyces lapponicus **I. Karaila; Mycoth. Fenn. 742; C-F-155541; Finland**

Uromyces lapponicus Lagerh.

Syn.: *Uromyces carneus* (Nees) Har.; *U. lapponicus* var. *splendens* (A. Blytt) Jørstad; *U. splendens* A. Blytt

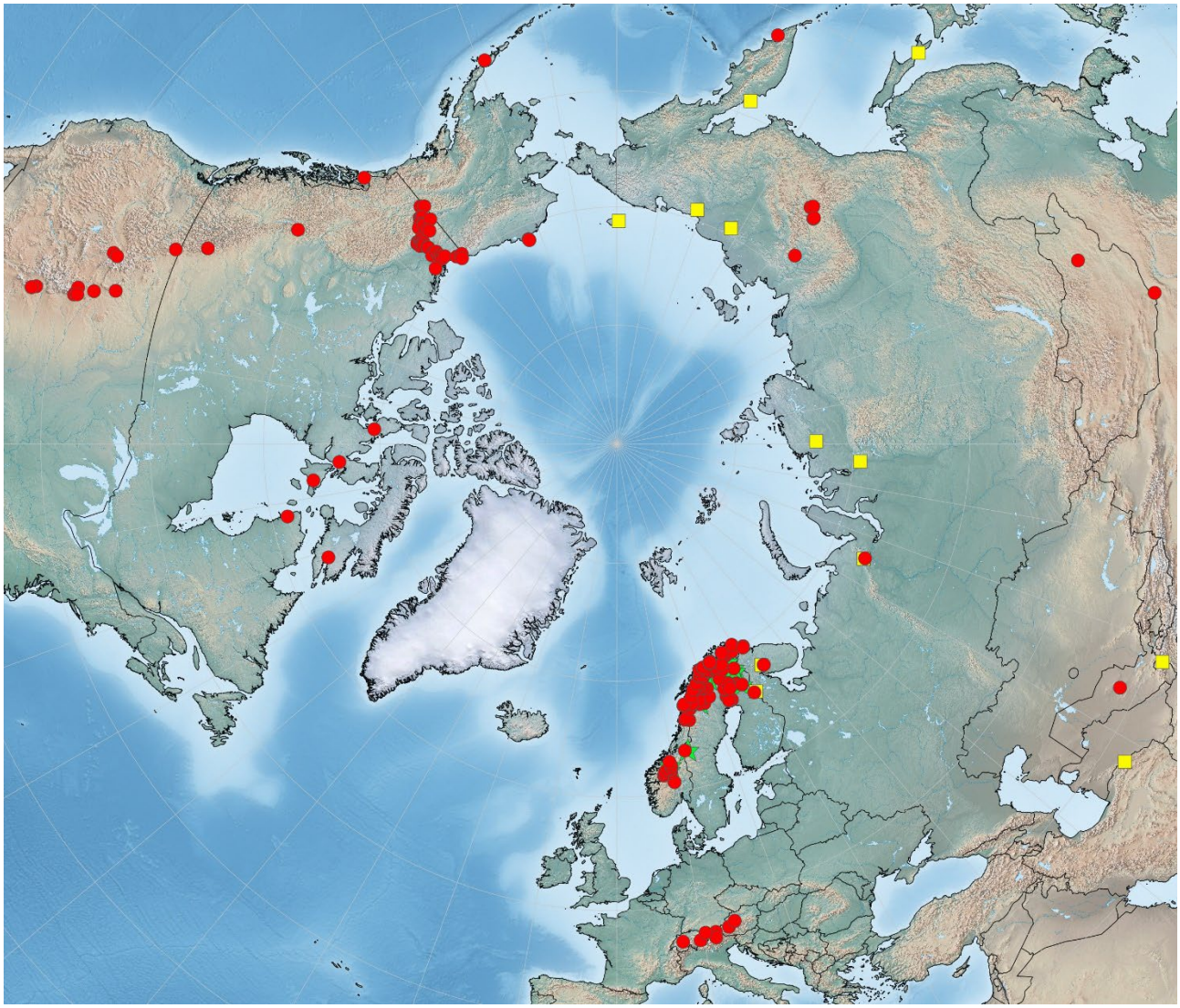
Brachycyclic form – 0s-Is-(III). Spermogonia systemic, hypophyllous, abundant, between the aecia, smelling sweet, orange. **Aecia** systemic, inciting pale leaves, mainly hypophyllous, abundant, crowded, short cupulate, whitish. Spores ellipsoid to subglobose, 16-28 × 12-20 µm, wall hyaline, 0.4-1.5 µm thick, finely verrucose. **Telia** rare in the arctic, if present often remaining immature, mainly hypophyllous, also epiphyllous, sometimes also on the petioles, scattered, soon naked and surrounded by the ruptured epidermis, pulverulent, chestnut brown or dark brown. Spores 1-celled, subglobose, ellipsoid or subpyriform, 17-33 × 15-25 µm, wall yellow-brown or cinnamon brown, 1-2.5 µm thick, apparently smooth, but when dry slightly verrucose, the warts sometimes in short lines, pore apical to 1/2 depressed, covered with a hyaline, 0.7-1.4 µm high and 6-10 µm wide cap, pedicel hyaline, short, fragile, deciduous.

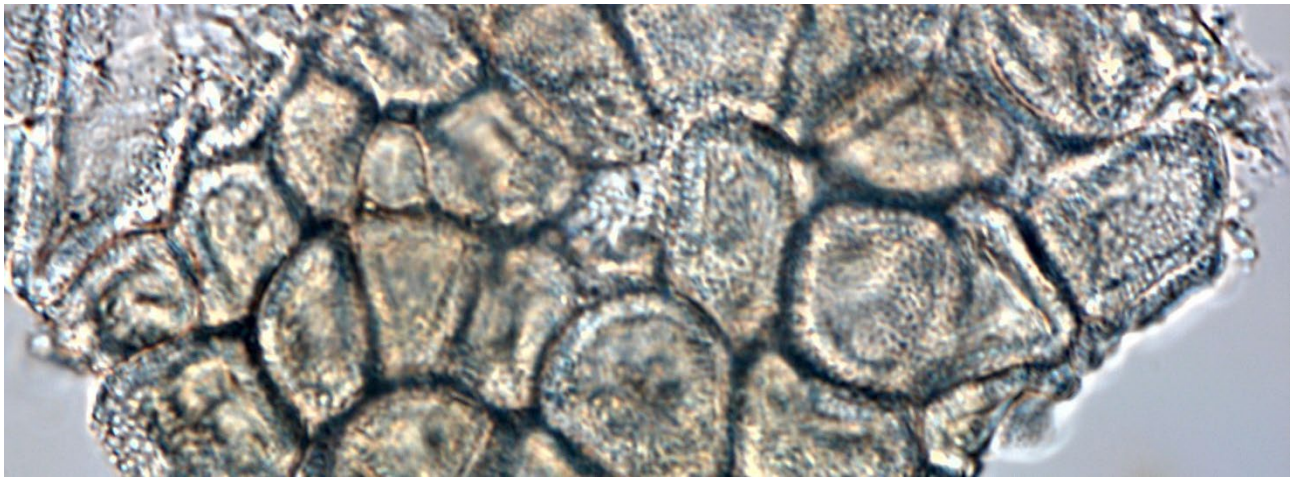
Host plants

0-I-III, **Fabaceae:** *Astragalus** and *Oxytropis*.*

Distribution

Arctic-alpine; circumpolar; type 1; recorded from arctic AK, CAN, NO, SE, FI, and RU, and from alpine AK, CAN, USA, the Alps (CH, AT), the Pyrenees (ES), Dovre (NO), the Scandinavian Mts. (NO, SE, FI), the Urals, Taymir, Chukotka, Wrangel Island, Kamchatka, and Sakhalin (RU), and C-Asia.





Uromyces: Pucciniaceae: Pucciniales

Uromyces phacae-frigidae **J. A. Nannfeldt, Fungi Exs. Suec. 1547; C-F-155551; Sweden**

Uromyces phacae-frigidae (Wahlenb.) Har.

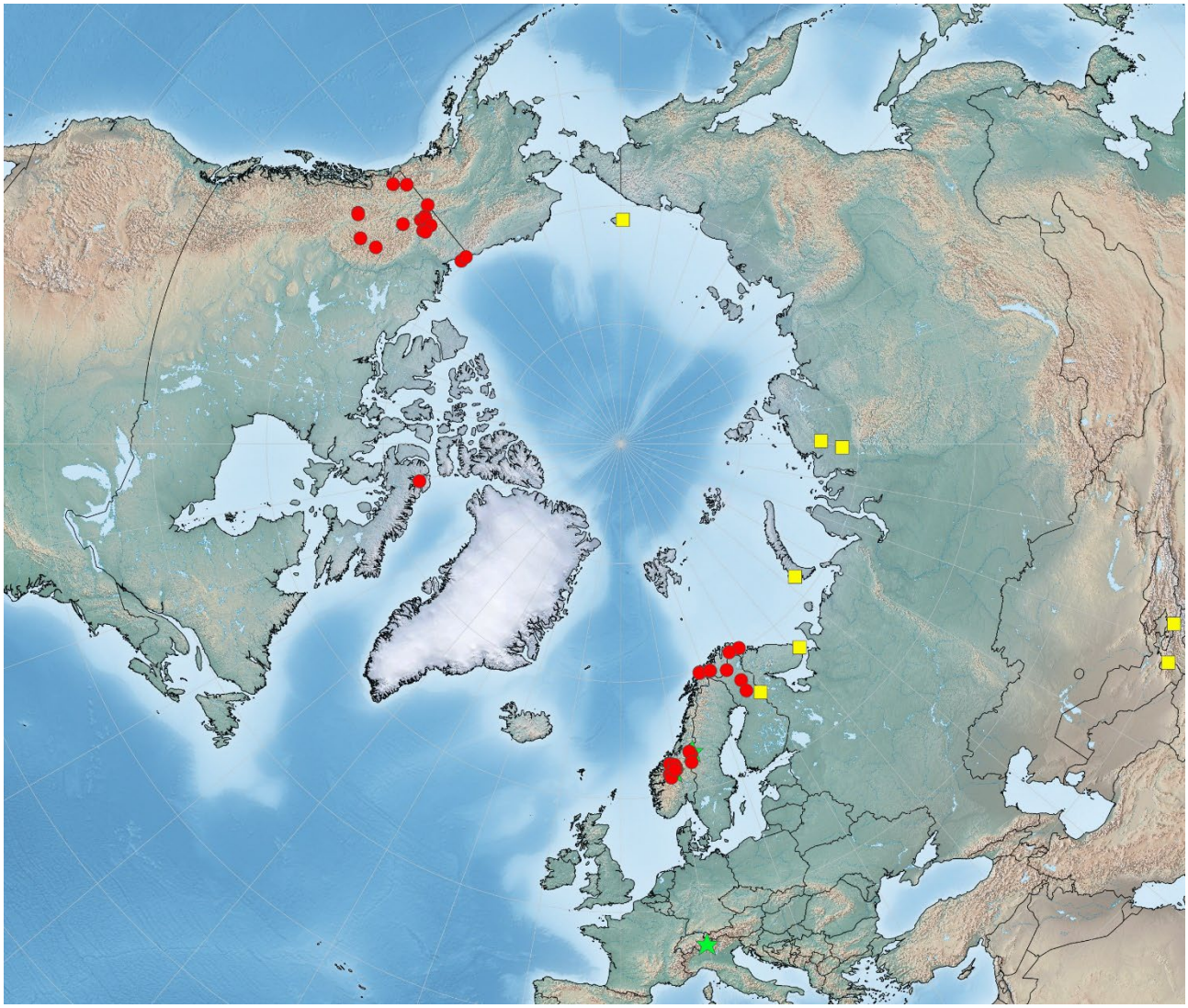
Microcyclic form – IIIs. Systemic, plants do not flower. **Telia** mainly hypophyllous and on the calyxes, covering the whole surface, small, round, soon naked and surrounded by the ruptured epidermis, becoming pulverulent, cinnamon brown or dark red-brown. Spores 1-celled, subglobose, ellipsoid or subpyriform, rarely subcyclindrical, 20-41 × 14-28 µm, wall yellow-brown, 1-2.5 µm thick, punctate to verrucose, warts (0.3-)0.5-0.7(-1) µm high and 0.5-1.2(-1.5) µm in diameter, often in widely spaced, nearly longitudinal rows which tend to anastomose, pore apical to equatorial, covered with a small, yellow cap, 1-2(-2.5) µm high and (4-)5-8 µm wide, pedicel hyaline, short, fragile.

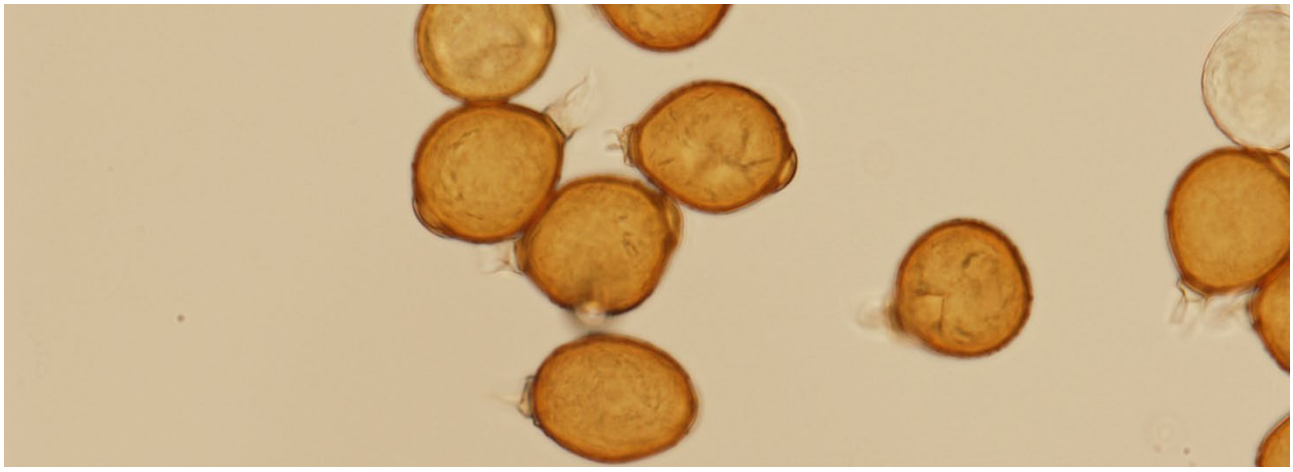
Host plants

III, **Fabaceae:** *Astragalus frigidus* and *Astragalus umbellatus.*

Distribution

Arctic-alpine; circumpolar, type 1; recorded from arctic CAN, NO, FI, and the Kola Peninsula, Novaya Zemlja, Taymir, and Wrangel Island (RU), and from alpine regions of the Rocky Mts. (CAN), the Alps (CH), Dovre (NO), the Scandinavian Mts. (NO, FI, RU), and C-Asia.





Uromyces: Pucciniaceae: Pucciniales

Uromyces phyteumatum **H. Hupke; C-F-156060; Germany**

Uromyces phyteumatum (DC.) Niessl*

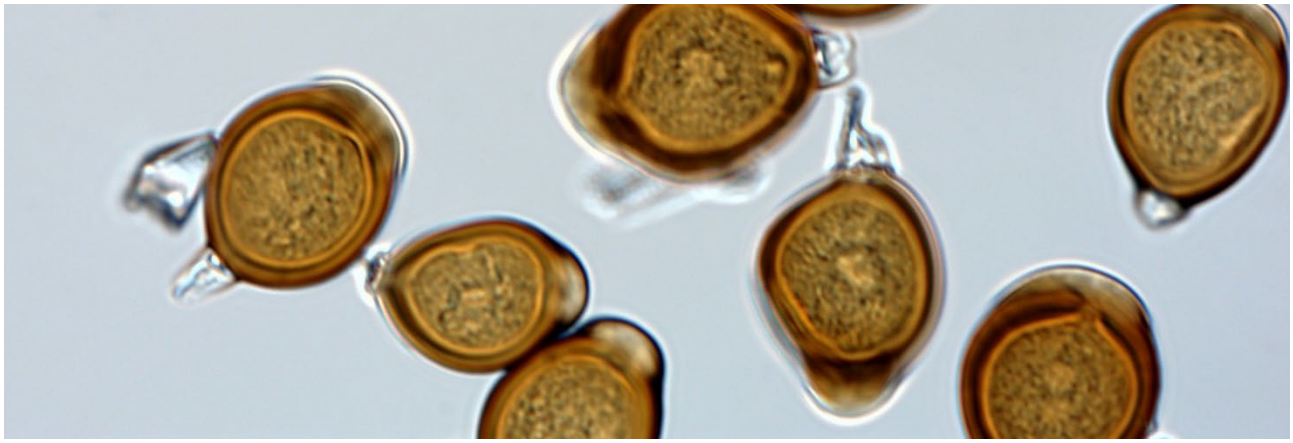
Microcyclic form – IIIsg. Systemic, leaves are wider and shorter, stronger dentate, and have longer petioles. **Telia** mainly hypophyllous, also epiphyllous, crowded over the whole surface, often confluent, small, soon naked, pulverulent, dark brown. Spores germinating readily, 1-celled, subglobose, obovoid or ellipsoid, 20-48 × 17-26 µm, wall brown, 2-3 µm thick, smooth, pore apical, covered with a large, hyaline, 3-8 µm high, hemispherical cap, pedicel hyaline, up to 40-70 µm long, deciduous.

Host plants

III, **Campanulaceae:** *Phyteuma* species, e.g. *Phyteuma betonicifolium*, *P. confusum*, *P. hemisphaericum*, *P. orbiculare*, *P. ovatum*, *P. spicatum*, and *P. zahlbruckneri.*

Distribution

Alpine-boreal; Eurasian; type 15; recorded from the Alps (DE including Erzgebirge, FR, CH, AT, IT), and the Pyrenees (ES).



Uromyces: Pucciniaceae: Pucciniales

Uromyces primulae-integrifoliae **R. Wettstein; C-F-156005; Austria**

Uromyces primulae-integrifoliae (DC.) Niessl

Syn.: *Uromyces apiosporus* Hazsl.; *U. auriculae* (Magnus) A. Buchheim; *U. primulae* (DC.) Fuckel

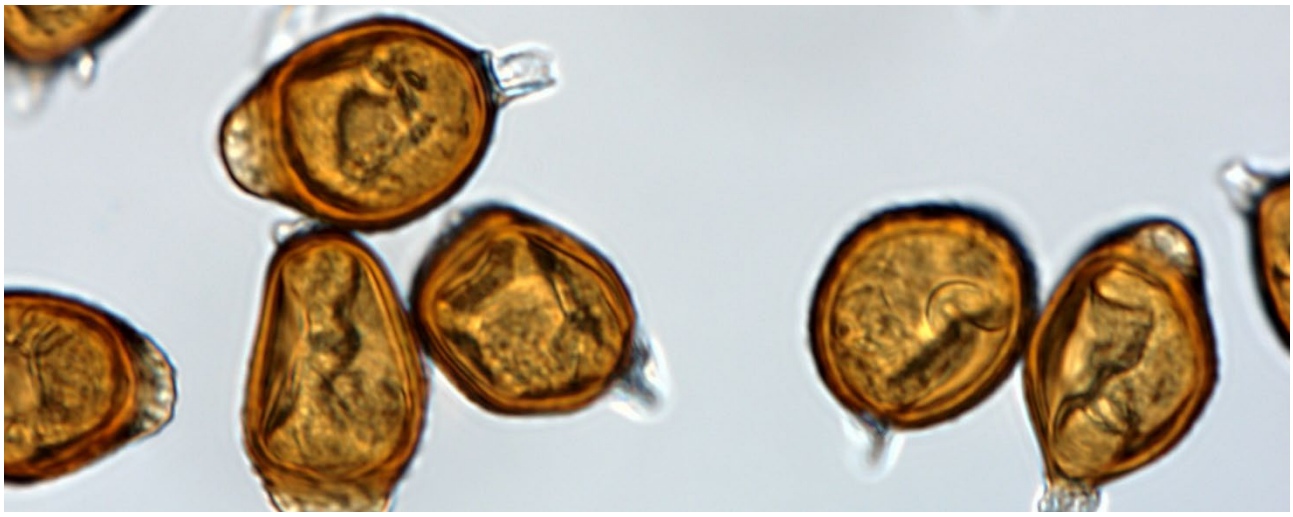
Demicyclic autopsisform – I-(II)-IIIs. Systemic, leaves are somewhat elongate and narrowed. **Aecia** hypophyllous, evenly covering the surface, cupulate, peridium somewhat revolute, irregularly laciniate, yellowish. Spores subglobose-angular, diameter 14-24 µm, wall 1 µm thick, densely and finely verrucose. Urediniospores formed in the telia, 25-35 × 21-28 µm, wall hyaline to pale brown, up to 4 µm thick, distantly echinulate, pores 2(-3). **Telia** most epiphyllous, also amphigenous, scattered or sometimes aggregated, soon naked and surrounded by the ruptured epidermis, pulverulent, chestnut brown or dark brown. Spores 1-celled, subglobose, obovoid or ellipsoid, 24-42(-49) × 21-28 µm, wall hyaline, pale brown or brown, 1.5-2.5 µm thick, completely or especially at the apex verrucose or distantly verrucose, pore apical, covered with a hyaline, verrucose cap, pedicel hyaline, about 1× spore length, fragile, deciduous.

Host plants

I-II-III, **Primulaceae:** *Primula auriculae*, *P. integrifolia*, and *P. minima.*

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (CH, AT, IT) and the Pyrenees (ES).



Uromyces: Pucciniaceae: Pucciniales

Uromyces sommerfeltii **Y. Mäkinen, Fungi Exs. Fenn. 561; C-F-156003; Finland**

Uromyces sommerfeltii Hyl., Jørst. & Nannf.

Syn.: *Puccinia solidaginis* Niessl., non Fuckel

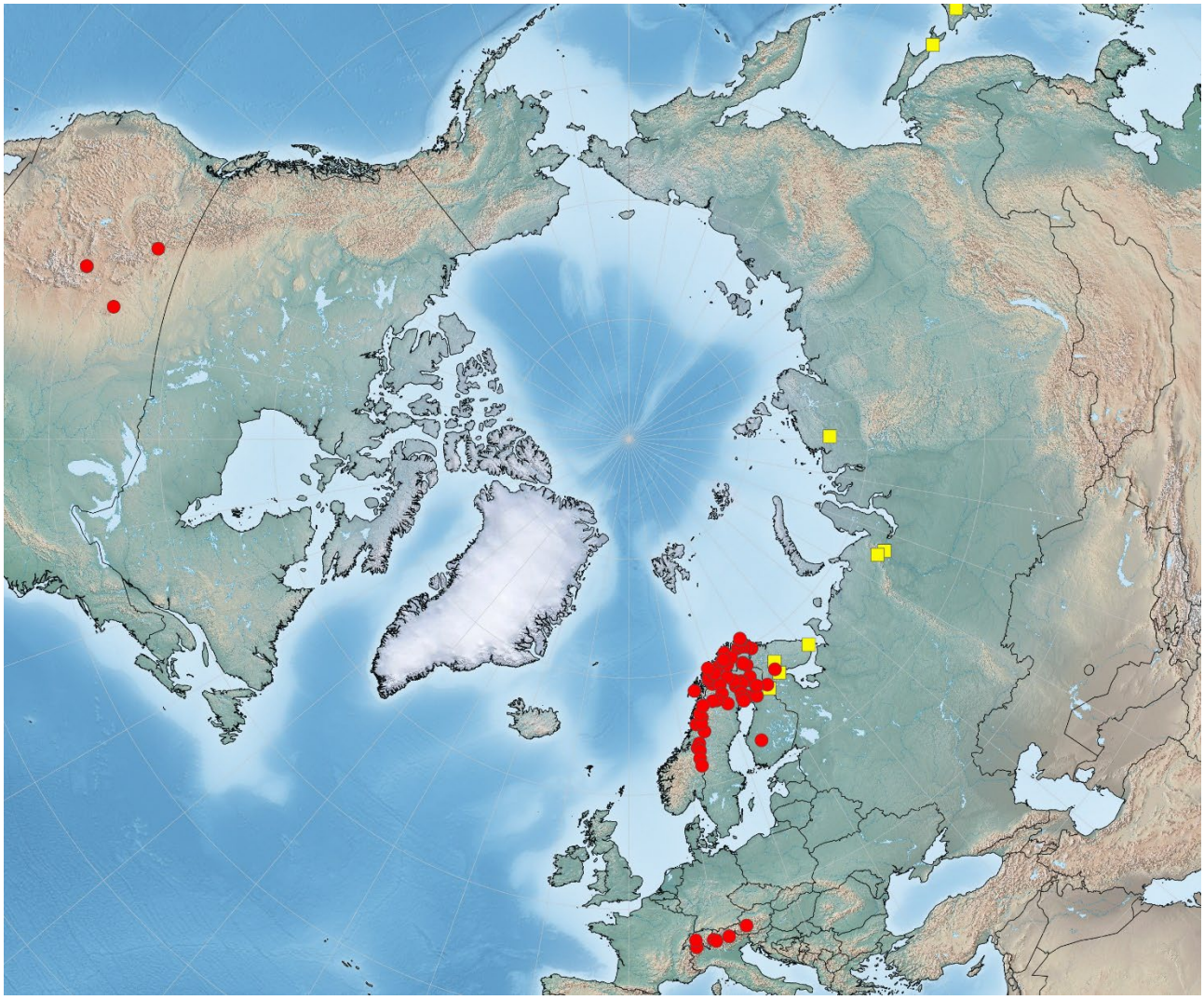
Microcyclic form – III. Telia on the leaves and petioles, mostly in groups on yellow spots, on the leaves ± round and diameter 1 mm, on the petioles and stems elongate up to 5 mm long, soon naked, pulverulent, dark brown. Spores 1-celled, ellipsoid, apex rounded, base somewhat tapering, 22-38 × 13-22 µm, wall brown, 1-2 µm, at apex 9-11 µm thick, smooth, pore subapical, cap inconspicuous, pedicel hyaline, 2× spore length or more.

Host plants

III, **Asteraceae:** *Solidago dahurica* and *Solidago virgaurea.*

Distribution

Arctic-alpine; circumpolar; type 5; recorded from arctic NO, SE, FI, and the Kola Peninsula and Taymir (RU), and from alpine regions of the Alps (CH, AT), the Scandinavian Mts. (NO, SE, FI), the Urals and Sakhalin (RU), and Hokkaido (JP).



Uromyces: Pucciniaceae: Pucciniales

Uromyces striolatus **P. Zwetko; S-F21578; Austria**

Uromyces striolatus Tranzschel

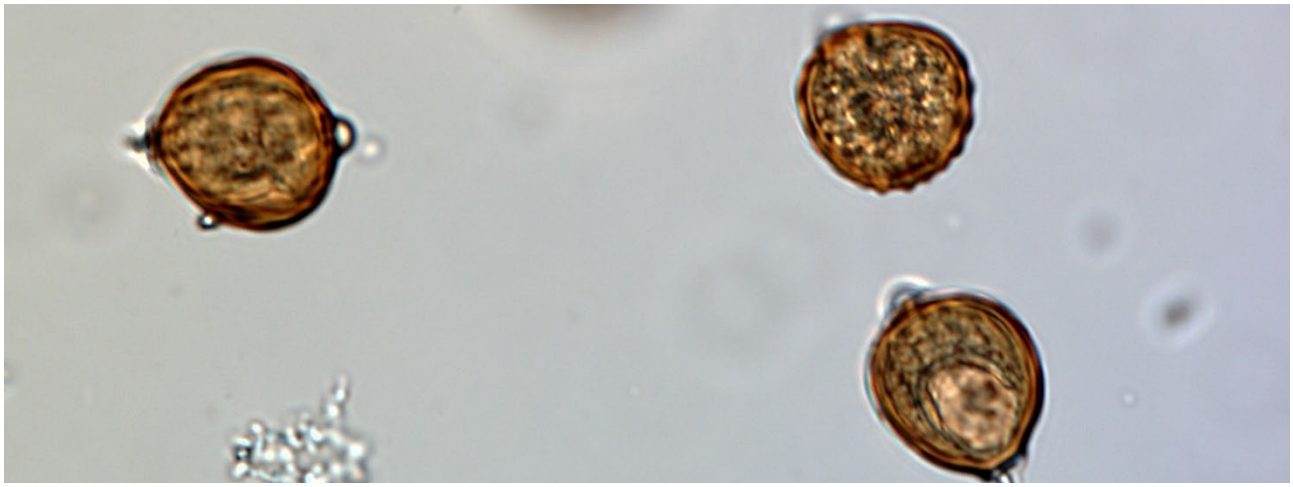
Microcyclic form – 0-IIIs. Systemic, sprouts malformed and the leaves broadened. **Spermogonia** abundant, hypophyllous, between the telia. **Telia** hypophyllous, embedded, pustulate, opening with a pore, light brown to brown. Spores 1-celled, ovoid or pyriform, apex rounded, base tapering, (16-)25-28(-40) × (15-)17-20(-23) µm, wall light brown, thin, provided with longitudinal ridges which anastomose occasionally, pore apical, covered with a hyaline, small, hemispherical papilla, pedicel short.

Host plants

0-III, **Euphorbiaceae:** *Euphorbia* species, e.g. *E. alatavica*, *E. cyparissias*, and *E. soongarica.*

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (DE including Erzgebirge, CH, AT, IT), and C-Asia.



Uromyces: Pucciniaceae: Pucciniales

Uromyces veratri SAE-2021.058-DE; C-F-152082; Germany

Uromyces veratri (DC.) J. Schröt.*

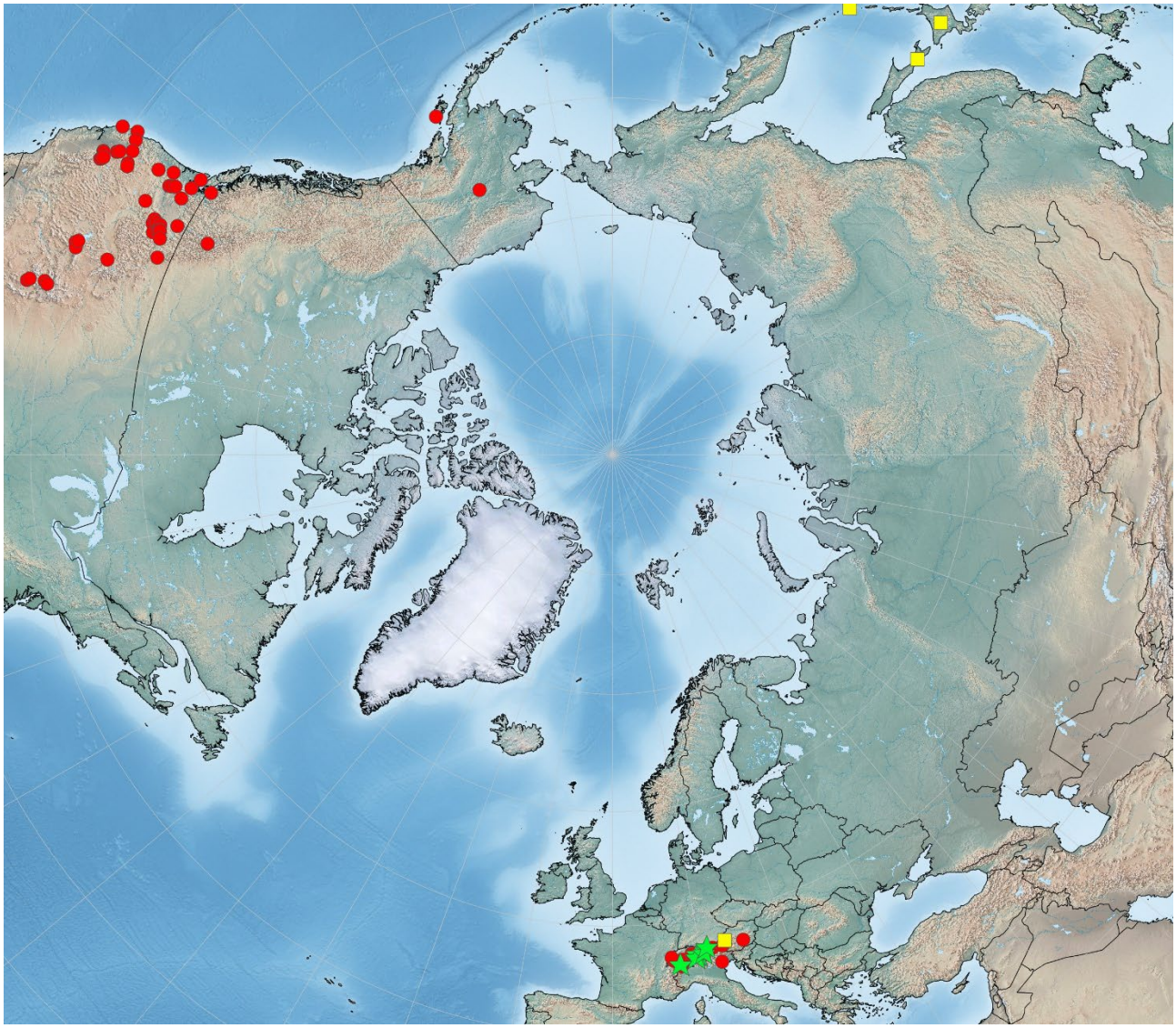
Macrocyclic hetereuform – 0-I / II-III. Spermogonia epiphyllous, also amphigenous in the middle of the aecia, deeply embedded in host tissue, very small, honey yellow. **Aecia** hypophyllous, crowded in circinate groups, short cupulate, peridium margin revolute. Spores subglobose or ellipsoid, angular, diameter 18-24 µm, wall thin, very densely and finely verrucose. **Uredinia** hypophyllous, often in large groups, scattered or aggregated, ± round, often confluent, surrounded by the ruptured epidermis, pulverulent, chestnut brown. Spores ellipsoid, 20-28 × 17-22 µm, wall light yellowish or light brown, distantly and finely echinulate, pores 2-3, equatorial, opposite. **Telia** also developing from the uredinia, hypophyllous, scattered, abundant, diameter up to 3 mm but usually smaller, leaf tissue bordering the telia bright green, initially covered by the epidermis but soon naked, dark chestnut brown. Spores 1-celled, roundish, ellipsoid, ovoid or somewhat irregular, ends rounded, 20-40 × 13-23 µm, wall brown, smooth, pore apical, covered with a hyaline, conical, 7 µm high cap, pedicel hyaline, long but deciduous with only a small part remaining attached to the spore.

Host plants

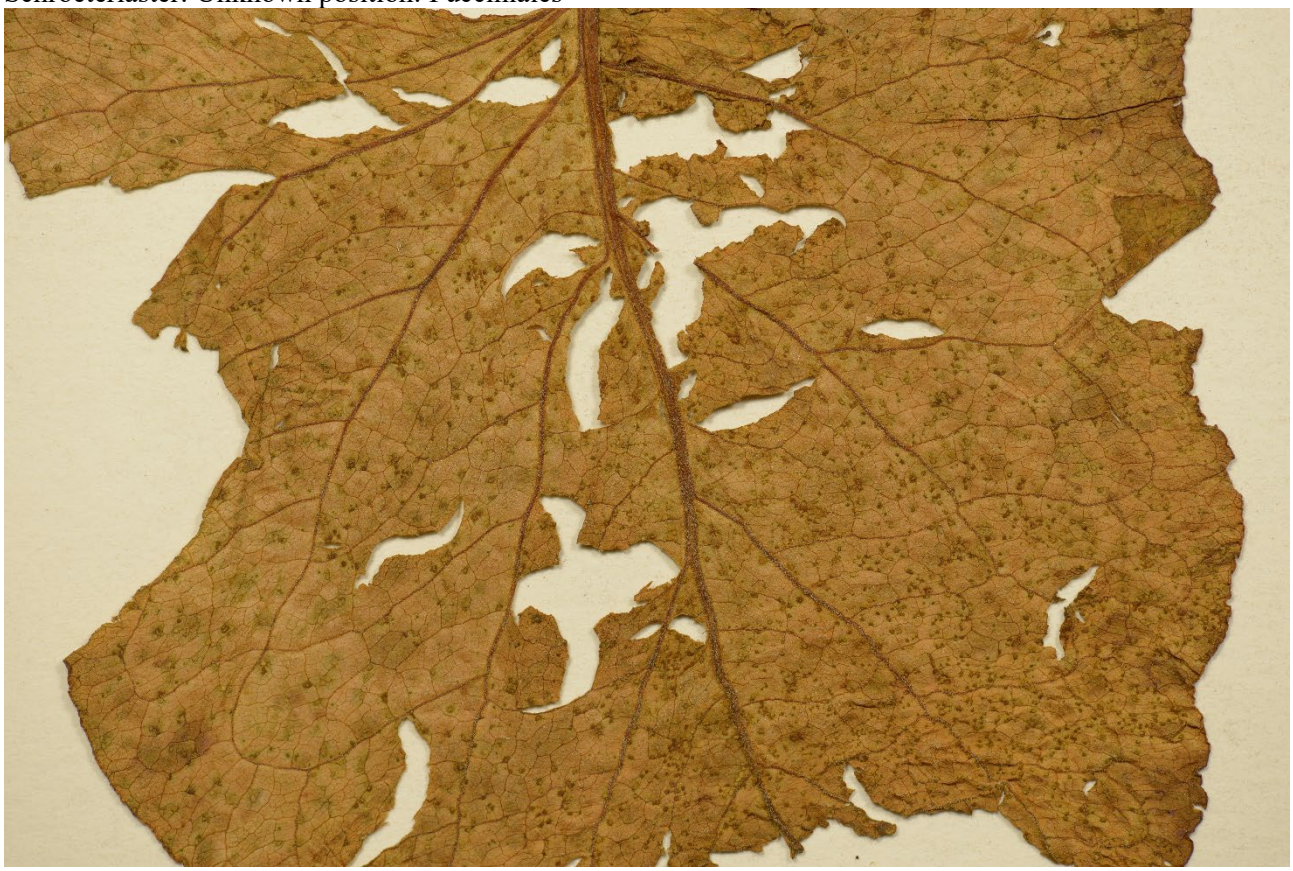
0-I, **Asteraceae:** *Adenostyles alliariae*, *A. alpina*, *A. glabra*, and *Homogyne* species.
II-III, **Melanthiaceae:** *Veratrum album.*

Distribution

Alpine; circumpolar; type 7; recorded from alpine regions of the Rocky Mts. (AK, CAN, USA), the Alps (CH, AT, IT), Sakhalin (RU), and Hokkaido (JP).



Schroeteriaster: Unknown position: Pucciniales



Schroeteriaster alpinus **O. Jaap; C-F-155515; Austria**

Schroeteriaster alpinus (J. Schröt.) Magnus

Macrocyclic hetereuform – 0s-Is / II-III. Systemic, inciting conspicuous deformations of the leaves and petioles. **Spermogonia** epiphyllous and on the petioles, in large, up to diameter 8 mm groups, strongly protruding, honey-coloured. **Aecia** hypophyllous and on the petioles, strongly protruding, especially on the petioles and leaf veins in large and dense, yellow, 26 × 8 mm groups, cupulate, peridium revolute, laciniate. Spores blunt -polyhedric, 16-20 × 13-17 µm, wall 1 µm thick, densely and finely verrucose. **Uredinia** mainly hypophyllous, also epiphyllous, on small, yellow to brown-red spots, often with a red border, scattered, up to diameter 0.3-0.5 mm, soon naked and surrounded by the ruptured epidermis, pulverulent, cinnamon brown or dark brown. Spores 19-27 × 17-22 µm, wall yellow-brown, 1.5-2 µm thick, echinulate, spines fragile, pores usually 4. **Telia** also developing from the uredinia, mainly hypophyllous, also epiphyllous, diameter 0.3-0.7 mm, permanently covered by the epidermis, waxy to gelatinous, initially light brown, later dark brown. Spores 1-celled, in up to 5 layers, irregular, ellipsoid to ovoid, ends rounded or slightly tapering, 22-32(-45) × 10-17 µm, wall pale brown, 1-1.5 µm, at apex up to 8 µm thick, smooth, pore apical, inconspicuous, cap inconspicuous, pedicel lacking.

Host plants

0-I, **Ranunculaceae:** *Ranunculus* species, e.g. *Ranunculus grenerianus*, *R. lanuginosus*, *R. montanus*, and *R. radicescens.*
II-III, **Polygonaceae:** *Rumex* species, e.g. *Rumex alpinus.*

Distribution

Alpine; Eurasian; type 15; recorded from the Alps (CH, AT, IT) and the Carpathians (RO).

Notes and observations

Endophyllum alaskanum

See next species.

Endophyllum sempervivi

Similar to microcyclic *Puccinia* species, but the aeciospores undergo karyogamy and germinate directly with a basidium, and thus behave functionally like teliospores. Without proper teliospores it is difficult to refer a certain species to a genus, and the few species behaving in this way end up as an unnatural group, *Endophyllum*. Apart from the species treated here, *E. alaskanum* (a synonym of *Puccinia veratri*), also behaves in this way.

Gymnosporangium cornutum

Description mainly based on Arthur (1934: 370, as *Gymnosporangium aurantiacum*), Kern (1973: 37), Parmelee in Fungi Canadenses 117 (1978) and Zhao et al. (2020: 84).

According to Parmelee (l.c.) telia only on the needles.

0-I, **Rosaceae**, recorded from species of mountain ash (*Sorbus americana*, *S. aucuparia*, *S. decora*, *S. discolor*, *S. groenlandica*, *S. sambucifolia*, and *S. tianschanica*) and related genera like *Hedlundia* (*H. meinichii*, *H. neglecta*) and *Scandosorbus intermedia.*

III, Pinaceae, recorded from species of juniper (*Juniperus communis*).

Gymnosporangium gaeumannii H. Zogg 1949 (Gäumann 1959: 1151) is not included, due to insufficient data. In the alpine region, it is known from the type in Switzerland and from *Juniperus communis* in the Canadian Rocky Mts. (Parmelee 1969).

Melampsora arctica

Description based on Klenke & Scholler (2015: 709, 723) and Zhao et al. (2017: 391). Regarded by various authors as synonymous with *Melampsora epitea* (e.g., Wilson & Henderson 1966: 83), but Zhao et al. (l.c.) provided evidence for separate treatment at the species level, with the teliospores of *M. arctica* having a thickened wall at the apex and those of *M. epitea* without a thickened wall at the apex. The minimal differences in width/length ratio of the urediniospores mentioned by Zhao et al. (0.840-0.885 for *M. arctica* and 0.870-0.885 for *M. epitea*) are not included in the key.

I, Saxifragaceae, recorded from *Saxifraga adscendens*, *S. aizoides*, *S. androsacea*, *S. biflora*, *S. blepharophylla*, *S. caespitosa*, *S. cernua*, *S. exarata*, *S. groenlandica*, *S. hypnoides*, *S. nelsoniana*, *S. oppositifolia*, *S. rivularis*, and *S. rotundifolia.*

II-III, Salicaceae, recorded from *Salix arbuscula*, *S. arctica*, *S. borealis*, *S. caprea*, *S. chamissonis*, *S. coaetanea*, *S. glauca*, *S. hastata, S. herbacea*, *S. lanata*, *S. lapponum*, *S. myrsinifolia*, *S. myrsinites*, *S. phlebophylla*, *S. phylicifolia*, *S. polaris*, *S. pulchra*, *S. reticulata*, *S. sphenophylla*, and *S. xerophila.*

Melampsora bigelowii

Description based on Arthur (1907: 100) and Arthur (1934: 54).

II-III, **Salicaceae**, recorded from *Salix amygdaloides*, *S. astatulana*, *S. bicolor*, *S. breweri*, *S. cordata, S. coulteri*, *S. discolor*, *S. flavescens*, *S. geyeriana*, *S. gooddingii*, *S. hookeriana*,

S. jepsonii, *S. laevigata*, *S. lasiandra*, *S. lasiolepis*, *S. linearifolia*, *S. longifolia*, *S. lucida*, *S. melanopsis*, *S. nigra*, *S. parksiana*, *S. piperi*, *S. rostrata*, *S. scouleriana*, and *S. wolfii.*

Melampsora epitea

Description based on Zhao et al. (2017: 391), Parmelee (1989: 3327) and Termorshuizen & Swertz (2011: 196).

A clear host specialisation has been observed, but there seems to be no morphological differentiation.

0-I Saxifragaceae, recorded from *Saxifraga aizoides*, *S. caespitosa*, *S. decipiens*, *S. hypnoides*, *S. oppositifolia*, *S. rivularis*, and *S. stellaris.*

II-III, Salicaceae, recorded from *Salix alpina*, *S. arbuscula*, *S. arctica*, *S. arctophila*, *S. bebbiana*, *S. bonplandiana*, *S. borealis*, *S. cinerea*, *S.coaetanea*, *S. cuneata*, *S. daphnoides*, *S. drummondiana*, *S. elaeagnos*, *S. geyeriana*, *S. glabra*, *S. glauca*, *S. hastata*, *S. helvetica*, *S. herbacea*, *S. hultenii*, *S. krylovii*, *S. laevigata*, *S. lanata*, *S. lapponum*, *S. macrolepis*, *S. myrsinifolia*, *S. myrsinites*, *S. myrtilloides*, *S. parallelinervis*, *S. phylicifolia*, *S. polaris*, *S. pseudocordata*, *S. pseudopolaris*, *S. pulchra*, *S. purpurea*, *S. reticulata*, *S. retusa*, *S. sachalinensis*, *S. scouleriana*, *S. serpyllifolia*, *S. udensis*, *S. waldsteiniana*, and *S. xerophila.*

Melampsorella elatina

Caryophyllaceae, recorded from *Cerastium alpinum*, *C. cerastioides*, *C. fontanum*, *Stellaria alsine*, *S. graminea*, *S. holostea*, *S. longipes*, *S. nemorum*, and *S. palustris*.

Melampsoridium betulinum

Description based on Kaneko & Hiratsuka (1981: 463).

II-III, Betulaceae, recorded from *Betula ermanii*, *B. exilis*, *B. humilis*, *B. japonica*, *B. nana*, *B. papyrifera*, *B. pendula*, *B. platyphylla*, *B. pubescens* s.l., and *B. tianschanica.*

Phragmidium ivesiae

Rosaceae, recorded from *Potentilla basaltica, P. blaschkeana*, *P. diversifolia*, *P. flabelliformis*, *P. glandulosa*, *P. glaucophylla*, *P. gracilis*, *P. nuttallii*, *P. pulcherrima*, and *P. recta*.

Phragmidium montivagum

Rosaceae, recorded from *Rosa arkansana* (*R. suffulta*), *R. davurica*, *R. nutkana*, *R. rugosa*, and *R. woodsia.*

Phragmidium potentillae

Description mainly based on Savile in Fungi Canadenses 41 (1974).

According to Parmelee, the pedicel of the teliospores is not swollen and teliospores smooth.

Rosaceae, recorded from *Potentilla argentea*, *P. aurea*, *P. centigrana*, *P. crantzii*, *P. cryptotaeniae*, *P. multifida*, *P. nivea*, *P. reptans*, *P. stolonifera*, *P. thuringiaca*, *P. tridentata*, *P. verna*, and *P. virgata.*

Puccinia (omitted species):

Puccinia drabicola Savile 1974, Can. J. Bot. 52(7): 1504, is only known from a few localities in Canada (British Columbia) on *Draba cruciata.*

Puccinia frigida Kom. 1895, Scripta Bot. Horti Univ. Imper. Petrop. 4(2): 264; on *Neogaya simplex*.

Puccinia nitidula Tranzschel 1911, Mycotheca Rossica 3 & 4: 158; on *Heracleum* (I) and *Polygonum* (III).

Puccinia paulii Poelt 1961, Ber. bayer. bot. Ges. 34: 80, only known from the type in Austria.

Puccinia pyrenaea Durrieu 1965, Bull. Soc. Hist. nat. Toulouse 100: 179, only known from the type in the Pyrenees.

Puccinia remoti-montis Durrieu 1965, Bull. Soc. Hist. nat Toulouse 100: 175, only known from the type in the Pyrenees.

Puccinia thomasii Gäum. 1940[1941], Ber. schweiz. bot. Ges. 51: 158, only known from the type in Switzerland.

Puccinia tombeana Gäum. & Terrier 1951, Revue Mycol. 16: 77, only known from a few localities in the Alps on *Leontodon incanus*.

Puccinia utahensis Garrett in Holway 1906, North American Uredinales 1: 46, only known from a few alpine sites in the Rocky Mts. (Colorado, Utah) on *Thlaspi fendleri*, *T. glaucum* and *T. montanum*.

Puccinia wyomensis Arthur 1918, Bull. Torrey Bot. Club 45: 143, only known from the type in Wyoming on *Scirpus americanus*.

Puccinia xatartiae Durrieu 1953, Revue Mycol. 18(3): 188, only known from a record in the Pyrenees on *Xatartia scabra.*

Puccinia bistortae

0-I, **Apiaceae**, recorded from *Angelica silvestris*, *Astrantia* spp., *Carum* spp., *Conopodium majus, Ligusticum* spp., and *Pimpinella major.*

II-III, **Polygonaceae**, recorded from *Bistorta bistortoides*, *B. elliptica*, *B. major*, *B. officinalis*, *B. vivipara*, *Koenigia alpina*, *K. davisiae*, and *Pleurospermum uralense.*

Puccinia brachypodii

Description based on Parmelee (1989: 3350), who also stated that telia are lacking in the Arctic.

A species-complex, which is treated here in the broad sense.

II-III, **Poaceae**, recorded from *Anthoxanthum odoratum*, *Arctagrostis latifolia*, *Arrhenatherum elatius*, *Brachypodium japonicum*, *B. pinnatum*, *B. rupestre*, *B. sylvaticum*, *Koeleria cristata*, *K. spicata*, *Milium effusum*, *Poa alpina*, *P. annua*, *P. compressa*, *P. glauca*, *P. macrocalyx*, *P. nemoralis*, *P. pratensis*, and *P. vaseochlya.*

Puccinia caricina

Interpreted *sensu lato*, embracing numerous cryptic species which are not or barely discernable using morphological characteristics.

II-III, **Cyperaceae**, recorded from *Carex aquatilis*, *C. atrata*, *C. bicolor*, *C. bigelowii*, *C. corynephora*, *C. flava*, *C. juncella*, *C. panicea*, *C. rostrata*, and *C. senta*.

Puccinia claytoniae

Description based on Parmelee (1986: 128).

Puccinia cnici-oleracei

Description based on Arthur (1922: 575, as *Micropuccinia asteris*; 582, as *Micropuccinia millefolii*), Săvulescu (1953: 983, as *Puccinia millefolii*; 984), Gäumann (1959: 649, as *Puccinia millefolii*; 650, as *Puccinia ptarmicae*; 682), Wilson & Henderson (1966: 197) and Parmelee (1989: 3347, as *P. millefolii*). Interpreted in the wide sense according to Wilson & Henderson (l.c.).

Puccinia crepidicola

Description based on Arthur (1934: 353, as *Puccinia crepidis-montanae*), Gäumann (1959: 1078, as *Puccinia alpestris*; 1079, as *P. crepidis-aureae*; 1081, as *P. crepidis-blattaroides*; 1082, as *P. crepidis-grandiflorae*; 1084 & 1087, as *P. crepidis-montanae*).

Wilson & Henderson (1966: 200) give a cell wall thickness of the teliospores of 3-4 µm. This deviates from the other sources we used. Also the drawing in Wilson & Henderson indicates a thin wall.

III, **Asteraceae**, recorded from *Crepis acuminata*, *C. alpestris*, *C. aurea*, *C. capillaris*, *C. conyzifolia*, *C. dioscoridis*, *C. foetidae*, *C. incarnata*, *C. neglecta*, *C. occidentalis*, *C. pleurocarpa*, *C. pontana*, *C. pyrenaica*, *C. setosa*, and *C. taraxacifolia*.

Puccinia cruciferarum

Description based on Savile (1964: 241) and Parmelee (1989: 3338, subsp. *nearctica*).

Savile (l.c.) distinguished four subspecies on the basis of distribution and size of the warts on the teliospores, with subsp. *cruciferarum* in the European Alps, subsp. *borealis* in northern Europe and North America, subsp. *nearctica* in North America and Greenland, and subsp. *wyomingensis* in North America.

Puccinia dioicae

Interpreted *sensu lato*, embracing numerous cryptic species which are not or barely discernable using morphological characteristics.

0-I, **Asteraceae**, recorded from *Achillea ptarmica*, *Agoseris glauca*, *A. parviflora*, *Artemisia carruthi*, *Aster adscendens*, *A. canbyi*, *Centaurea jacea*, *C. subtilis*, *Cirsium acaule*, *C. heterophyllum*, *C. japonicum*, *C. kamtschaticum*, *C. monspessulanum*, *C. oleraceum*, *C. palustre*, *C. pannonicum*, *C. rivulare*, *C. spicatum*, *C. tuberosum*, *Crepis biennis*, *Dirca palustris*, *Erigeron philadelphicus*, *Eurybia annuus*, *E. macrophylla*, *E. sibirica*, *Euthamia graminifolia*, *Jacobaea pseudoarnica*, *Lactuca pulchella*, *Lycoseris trinervis*, *Mulgedium sibiricum*, *Phryma leptostachya*, *Saussurea alpina*, *S. nuda*, *S. riederi*, *S. tilesii*, *Senecio ovatus*, *Serratula tinctoria*, *S. serrata*, *Solidago canadensis*, *S. gigantea, S. missouriensis*, *S. rigida*, *S. sparsiflora*, *S. virgaurea*, *Symphyotrichum cordifolium, S. drummondii*, *S. foliaceum*, *S. spathulatum*, *S. undulatum*, *Taraxacum* spp., *Tephroceris subdentata*, and *Tripolium cannonicum.*

II-III, **Cyperaceae**, recorded from many species of *Carex*, e.g. in Fungarium C from: *Carex chordorrhiza*, *C. davalliana*, *C. digitata*, *C. dioica*, *C. extensa*, *C. flava*, *C. humilis*, *C. leporina*, *C. liparocarpus*, *C. muricata*, *C. oederi*, *C. pallescens*, *C. praecox*, *C. rupestris*, *C. sylvatica*, and *C. tumida.*

Puccinia hieracii

Description based on Termorshuizen & Swertz (2011) and references therein, and on Parmelee (1989: 3343).

Puccinia hieracii is interpreted here in the wide sense (see Termorshuizen & Swertz 2011: 288, and Wilson & Henderson 1966: 203-206) and is characterized by its relatively large urediniospores with usually two pores.

According to Parmelee (1989), spermogonia and (uredinioid) aecia are lacking in the Arctic; this is probably a host characteristic not influenced by climatic conditions, as in the Netherlands spermogonia and aecia are also absent on chicory and endive.

0-I-II-III, **Asteraceae**, recorded from *Agoseris glauca*, *Centaurea jacea*, *C. phrygia*, *Cichorium intybus*, *Cirsium undulatum*, *Hieracium flororum*, *H. groenlandicum*, *H. hyparcticum*, *H. islandicum*, *H. ivigtutense*, *H. lividorubens*, *H. murorum*, *H. nigrescens*, *H. pilosella*, *H. rigorosum*, *H. scholanderi*, *H. stipticaule*, *H. sylvaticum*, *H. vulgatum*, *Hypochaeris glabra*, *H. maculata*, *H. uniflora*, *Lygodesmia grandiflora*, *Nabalus hastatus*, *Picris stricta*, *Scorzoneroides* (*Leontodon*) *autumnalis*, *Serratula nudicaulis*, *S. tinctoria*, *Stephanomeria pauciflora*, and *Taraxacum* spp., e.g. *T. croceum* and *T. sibiricum.*

Puccinia laschii

0-I-II-III, **Asteraceae**, recorded from *Cirsium*, e.g. *C. acaule*, *C. arvense*, *C. canescens*, *C. coloradense*, *C. congestissimum*, *C. discolor*, *C. flodmanii*, *C. heterophyllum*, *C. hookerianum*, *C. incarnatum*, *C. longistylum*, *C. muticum*, *C. oleraceum*, *C. parryi*, *C. pitcheri*, *C. scariosum*, *C. spinosissimum*, *C. tioganum*, *C. undulatum*, and *C. yoshinoi.*

Puccinia minussensis

0-I-II-III, **Asteraceae**, recorded from species of *Lactuca*, e.g. *L. brevirostris*, *L. canadensis*, *L. laciniata*, *L. pulchella*, *L. raddeana*, and *L. sibirica***.**

Puccinia pazschkei

Recorded from *Saxifraga aizoides*, *S. cotyledon*, *S. oppositifolia*, *S. paniculata*, and *S. stellaris.*

Puccinia pedicularis

Description mainly based on Parmelee (1989: 3349) and Klenke & Scholler (2015: 601).

Klenke & Scholler described the pedicel of teliospores as persistent and up to 70 µm long, which does not agree with our material, nor with Gäumann (1959) or Parmelee (1989).

Puccinia poarum

II-III, **Poaceae**, recorded from *Poa alpigena*, *P. alpina*, *P. annua*, *P. nemoralis*, *P. pratensis*, and *P. trivialis.*

Puccinia recondita

0-I, **Ranunculaceae**, recorded from *Aconitum napellus*, *A. septentrionale*, *A. variegatum*, *Aquilegia atrata*, *A. chrysantha*, *A. nigricans*, *A. vulgaris*, *Clematis alpina*, *C. drummondii*, *C. ligusticifolia*, *Thalictrum alpinum*, *T. aquilegiifolium*, *T. fendleri*, *T. minus*, *T. rariflorum*, and *Trollius europaeus.*

Boraginaceae, recorded from *Hydrophyllum capitatum*, *Phacelia heterophylla*, *P. leucophylla* and *P. magellanica.*

II-III, **Poaceae**, recorded from *Achnatherum calamagrostis*, *Agrostis canina*, *A. gigantea*, *A. idahoensis*, *A. mertensii*, *Anthoxanthum odoratum*, *Bromus anomalus*, *B. arvensis*, *B. ciliatus*,

Calamagrostis stricta, *Elymus arizonicus*, *E. elymoides*, *E. macrourus*, *E. repens*, *E. violaceus*, *Hierochloë odorata*, and *Leymus triticoides.*

Puccinia saxifragae

Description mainly based on Parmelee (1989: 3352) and Savile (1973: 2358). According to Parmelee, in addition to var. *saxifragae*, two varieties occur in the Arctic, var. *curtipes* and var. *longior* (see also Savile, l.c.). We find no differences to *P. austroberingiana* and have therefore synonymized it with *P. saxifragae*.

Recorded from *Saxifraga arguta*, *S. cernua*, *S. granulata*, *S. groenlandica*, *S. hieraciifolia*, *S. nivalis*, *S. punctata*, *S. rivularis*, *S. rotundifolia, S. seguieri*, *S. sibirica*, *S. stellaris*, *S. tenuis*, *S. tricuspidata*, and *S. unalaschkensis.*

Puccinia senecionis

I-II-III, **Asteraceae**, recorded from *Senecio crassulus*, *S. cymbalarioides*, *S. dispar*, *S. fuchsii*, *S. hydrophilus*, *S. integerrimus*, *S. lugens*, *S. nemorensis*, *S. ovatus*, *S. palmatus*, *S. triangularis*, *S. umbrosus*, *Tephroseris atropurpurea,* and *T. palustris.*

Puccinia septentrionalis

0-I, **Ranunculaceae**, recorded from *Thalictrum alpinum*, *T. fendleri*, *T. minus*, *T. polycarpum*, and *T. purpurascens.*

II-III, **Polygonaceae**, recorded from *Bistorta officinalis* and *B. vivipara* (*Polygonum viviparum*).

Puccinia swertiae

0-I-II-III, **Asteraceae**, recorded from *Swertia connata*, *S. fritillaria*, *S. lactea*, *S. palustris*, *S. perennis*, *S. petiolata*, *S. scopulina*, and *S. thomsonii.*

Puccinia uralensis

Description based on Săvulescu (1953: 986) and Gäumann (1959: 698). Synonymized by Karatygin et al. (1999) with *P. cnici-oleracei*, but here maintained as a separate species because of the presence of readily germinating teliospores, less constricted teliospores and shorter and lighter coloured pedicels in *P. cnici-oleracei*, and differences in hosts, which agrees with Săvulescu.

Pucciniastrum pyrolae

Scholler et al. (2022) have "*P. pyrolae* (H. Mart.) J. Schröt.," but since only one stage exists, that is what Gmelin must have described (as *Aecidium*), and he is thus the correct author.

Rossmanomyces pyrolae

Description mainly from Crane (2000: 73).

II-III, **Pyrolaceae**, recorded from *Pyrola chlorantha*, *P. grandiflora*, *P. incarnata*, *P. media*, *P. minor*, *P. norvegica*, *P. rotundifolia*, and *P. virens.*

Trachyspora alchemillae

Overwinters in the rhizomes; from these infected as well as non-infected rosettes appear.

In the Arctic, aecia and to a lesser extent uredinia are rare; in the single specimen studied by Parmelee (1989) both stages were lacking.

I-III, **Rosaceae**, recorded from *Alchemilla borealis*, *A. filicaulis*, *A. glabra*, *A. glomerulans*, *A. minor*, *A. murbeckiana*, *A. retropilosa*, *A. sibirica*, *A. vestita*, *A. wichurae*, and *A. vulgaris*.

Uromyces airae-flexuosae

It is not certain if paraphyses are indeed present in the telia; the paraphyses mentioned in the original description could also be pedicels with the spores detached.

Uromyces dactylidis

Cannot be distinguished from *Puccinia recondita* and *Uromyces rumicis* in its aecial stage.

Seems to depend heavily on host alternation.

0-I, **Ranunculaceae**, recorded from *Ranunculus* (including *Ficaria*), e.g. *R. aconitifolius*, *R. acris*, *R. alpestris*, *R. auricomus*, *R. bulbosus*, *R. lanuginosus*, *R. nemorosus* and *R. repens.*

Uromyces fischerianus

Description based on the original description by Mayor (1906: 1015), Parmelee & Savile (1984), Parmelee (1989: 3353), and Klenke & Scholler (2015: 679).

Uromyces hedysari-obscuri

Description based on Arthur (1920: 450), Arthur (1934: 303) and Parmelee (1989: 3359).

Uromyces lapponicus

Description based on Arthur (1921: 449, as *Pucciniola carnea*), Arthur (1934: 302), Savile & Parmelee (1974) and Parmelee (1989: 3360).

Parmelee (l.c.: 3361) also described *Uromyces lapponicus* var. *oxytropis* with spermogonia lacking and slightly larger aeciospores (19-30(-37) × 16-24(-26) µm) from *Oxytropis* (var. *lapponicus* on *Astralagus*).

0-I-III, **Fabaceae**, recorded on *Astragalus alopecurus*, *A. alpinus*, *A. australis*, *A. frigidus*, *A. jarmolenkoi*, *A. melilotoides*, *A. quisqualis*, *A. rugosus*, *A. rytidocarpus*, *A. schanginianus*, *A. sieversianus*, and *Oxytropis albiflora*, *O. campestris*, *O. czucotica*, *O. glabra*, *O. mertensiana*, *O. middendorfii*, *O. nigrescens*, *O. revoluta*, and *O. sordida.*

Uromyces phyteumatum

Gäumann (1959: 203) and Klenke & Scholler (2015: 624) mention a 4-8 µm thickened apex of the teliospores, but Fischer (1904: 53) and Săvulescu (1953: 673) both show in their figures as well as in their descriptions the presence of a cap over the apical pore rather than a thickened cell wall.

Uromyces veratri

Description based on Arthur (1934: 273).

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