

Phyton (Horn, Austria)	Vol. 45	Fasc. 2	305–318	30. 12. 2005
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## ***Frigidopyrenia* – a New Genus for a Peculiar Subarctic Lichen, with Notes on Similar Taxa**

By

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With 1 Figure

Received November 14, 2005

Key words: *Ascomycota*, *Collemopsidium*, *Collemopsidium cephalodiorum* comb. nova, *Frigidopyrenia* gen.nov., *Frigidopyrenia bryospila* comb. nova, *Magmopsis*, *Pyrenocollema*, terricolous lichens. – Taxonomy.

### Summary

GRUBE M. 2005. *Frigidopyrenia* – a new genus for a peculiar subarctic lichen, with notes on similar taxa. – *Phyton* (Horn, Austria) 45 (2): 305–318, 1 figure, – English with German summary.

The new genus *Frigidopyrenia* is introduced to accommodate the peculiar lichen-forming fungus originally described as *Verrucaria bryospila*. *Frigidopyrenia bryospila* (NYL.) GRUBE, comb. nova, has a unique thallus morphology when well-developed, which consists of loose to aggregated thallus squamules that are connected by dark and thick-walled hyphae. The squamules contain coccale cyanobacteria. The type species of the superficially similar genera *Collemopsidium*, *Magmopsis* and *Pyrenocollema* are compared with *F. bryospila*. *F. bryospila* could be widely distributed on subarctic soils and similar alpine habitats, but has rarely been collected. The new combination *Collemopsidium cephalodiorum* (TRIEBEL & GRUBE) GRUBE is proposed.

### Zusammenfassung

GRUBE M. 2005. *Frigidopyrenia* – eine neue Gattung für eine eigenartige subarktische Flechte, mit Bemerkungen über ähnliche Gattungen. – *Phyton* (Horn, Austria) 45 (2): 305–318, 1 Abbildung, – Englisch mit deutscher Zusammenfassung.

Die neue Gattung *Frigidopyrenia* wird für den eigenartigen, lichenisierten Pilz, der ursprünglich als *Verrucaria bryospila* beschrieben wurde, eingeführt. *Frigido-*

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*pyrenia bryospila* (NYL.) GRUBE, comb. nova, hat bei guter Entwicklung eine einzigartige Morphologie der Thalli. Sie bestehen aus lockeren bis gedrängten Lagerschuppen, die durch dunkel gefärbte und dickwandige Hyphen untereinander verbunden sind. Die Lagerschuppen enthalten coccale Cyanobakterien. Die Typusarten der scheinbar ähnlichen Gattungen *Collemopsidium*, *Magnopsis* und *Pyrenocollema* werden mit *F. bryospila* verglichen. *F. bryospila* wurde selten gesammelt, könnte aber weit verbreitet in subarktischen Böden oder in ökologisch ähnlichen alpinen Habitaten vorkommen. Die neue Kombination *Collemopsidium cephalodiorum* (TRIEBEL & GRUBE) GRUBE wird vorgeschlagen.

## 1. Introduction

The classification of pyrenocarpous ascomycetes is still a broad field of taxonomic challenges. While many economically important phytopathogenic or lichenized pyrenomycetes are increasingly well understood, many rarely sampled fungi in remote places of the world are mysterious. Particularly, inconspicuous microfungi in arctic-alpine habitats on soil, and other ecological niches, such as lichens and bryophytes or decaying vegetation, are either cryptic or overlooked in forays, despite their possible wide geographic distribution. Modern collections of such fungi remain often unrecognized at the genus or species level (because experts are comparatively rare), while names may exist in the older mycological literature for similar fungi.

Own studies of lichenicolous fungi were the starting point to study some of the old generic names of pyrenomycetes, which contain pertinent paraphysoids and produce one-septate, hyaline ascospores. Lichenicolous fungi with such characters were in former times assigned to the genus *Didymella* (SACC.) SACC. In fact, they have little in common with the phytopathogenic *Didymella* species and are more conveniently classified in different genera. As a consequence, species on lichens with coccale green algae are now assigned to the genera *Zwackhiomyces* GRUBE & HAFELLNER and *Lichenochora* HAFELLNER, whereas species parasitic on cyanobacterial host lichens have been placed in the genus *Didymellopsis* (SACC.) CLEMENTS & SHEAR. "*Didymella*" *brunii* DE LESD., which apparently undergoes associations with epilichenic cyanobacteria on an aquatic *Verrucaria* species was transferred to *Collemopsidium* NYL. owing to morphological similarities (GRUBE & HAFELLNER 1990). It apparently represents a borderline lichen in the sense of KOHLMAYER & al. 2004. "*Didymella*" *bryospila* (NYL.) H. MAGN. (Basion. *Verrucaria bryospila* NYL.), which can develop more distinct thallus structures remained with unclear placement in GRUBE & HAFELLNER 1990. This species is widely distributed in arctic regions of the Northern Hemisphere, but only a few and mostly old collections exist. The species is found at moist situations over decaying bryophytes and plant debris, where it forms thalli of scattered to crowded and dark olivaceous to brownish black squamules. The species experienced a

history of taxonomic changes and has been included in six different genera in the past, more lately in *Pyrenocollema* REINKE by COPPINS 1992, and recently in *Collemopsidium* (FRYDAY 2004). However, as has been pointed out in GRUBE & HAFELLNER 1990, this species is neither closely related to *Collemopsidium* nor to *Pyrenocollema* in a morphological sense, as these differ in peridial structures and thallus morphology. No old name is available to accommodate this rather unusual and apparently isolated species, and a new genus is here introduced to account for this fact.

## 2. Material and Methods

Sections were prepared using a Leitz Freezing Microtome. Optical equipment included a Wild stereomicroscope and a Leitz Axioskop compound microscope. Toluidine Blue was applied as a 1% aqueous solution. The study is mainly based on collections in GZU, H-NYL, UPS, and S.

## 3. Results

Material of a species that corresponded well in ascomatal characters with the type specimen of *Verrucaria bryospila*, revealed an unusual type of thallus in this species. The thallus consists of roundish to cushion-like squamules in well developed specimens (Fig.1A), which grow over plant debris, decaying mosses, or cyanobacterial carpets. The structure of these squamules is unique and described in detail below. The squamules are connected among each other and with the pseudothecia of this species by brownish and thick-walled hyphae (Fig. 1B). Owing to these pronounced morphological differences, a new genus is here described for the species originally described as *Verrucaria bryospila*, as follows:

### 3.1. *Frigidopyrenia* GRUBE genus novum

Diagnosis: Thallus squamulosus in stato bene evolute. Squamulae ad 0.5 mm diametro, globosae vel applanatae, obscure olivaceae vel fusconigrae, extus strato cellularum pseudoparenchymaticum corticatae, intus cyanobacteriis impletae, ascomatibus hyphis brunneis, c. 5–7  $\mu\text{m}$  latis connexae. Cyanobacteria chroococcoidea. Ascomata perithecioidea (“pseudothecia”), globosa vel pyriformia, ostiolo praeformato. Peridium obscure castaneum, substratum versus distincte delimitatum. Pigmentum praecipue in spatiis intercellularibus depositum. Hamathecium paraphysoides numerosis, filiformibus, ramificantibus anastomosantibusque compositum. Asci fissitunicati, cylindrici, rigidi. Endotunica apicem versus sensim incrassata, sed centraliter attenuata (“chambre oculaire”), in sectione optica longitudinali late rotundato. Ascosporae hyalinae. Parietes cellularum substantia “Toluidine Blue” adjuvante non reagentes.

Typus generis: *Verrucaria bryospila* NYL.

Icones: Fig. 1A-C.

Description: Thallus squamulose when well-developed. Squamules up to 0.5 mm in diameter, globose to flattened, dark olive to brownish black, with pseudoparenchymatic outer wall; thallus squamules interconnected with the ascomata by brown hyphae, hyphae c. 5–7  $\mu\text{m}$  thick. Lichenized with chroococcale cyanobacteria. Pseudothecia globose to broadly pear-shaped, with preformed ostiole. Peridium dark chestnut-brownish, distinctly delimited at the outer edge; pigments distinctly in intercellular spaces. Hamathecium of filamentous, strongly branched and anastomosing hyphae (paraphysoids). Asci fissitunicate, rigid and cylindrical; endotunica layers becoming thicker towards the top but without abrupt thickening in the upper half of the ascus; ocular chamber distinct. Ascospores hyaline. Cell walls not reacting with Toluidine Blue.

*Frigidopyrenia bryospila* (NYL.) GRUBE comb. nova

Basionym: *Verrucaria bryospila* NYL., Flora 47: 357 (1864).

Isotype: Norway, Finmark Alten, Mt. over Kaafjord, 1863, J. CARROLL (UPS!).

Synonyms: *Arthopyrenia bryospila* (NYL.) ARNOLD, Flora 53: 484 (1870); *Thelidium bryospilum* (NYL.) BLOMB. & FÖRSSELL, Enumer. Plant. Scand.: 99 (1880); *Didymella bryospila* (NYL.) H. MAGN., Fört. Skand. Växter 4: 10 (1937); *Pyrenocollema bryospila* (NYL.) COPPINS ex H.F. FOX in H.F. FOX & M.J.P. SCANNELL, Glasra 4: 69 (2000); *Collemopsisidium bryospilum* (NYL.) COPPINS [in FRYDAY], Bryologist 107: 174. 2004.

Description: Thallus on dead mosses or plant detritus, composed of scattered to crowded squamules; squamules up to 0.5 mm in diameter, globose to flattened, dark olivaceous to brownish black, with pseudoparenchymatic outer wall, the inner part with thick-walled hyaline fungal cells (up to 25  $\mu\text{m}$  in diam.), becoming more elongated towards the periphery and intermingled with unicellular cyanobacteria, especially towards the periphery, haustoria not observed; thallus squamules connected with the ascomata by brown, c. 5–7  $\mu\text{m}$  thick hyphae, with c. 1.5–2  $\mu\text{m}$  thick cell walls; connecting hyphae emerging from the central part of the squamule's lower surface and from the immersed parts of the ascomata. Cyanobacterial cells 4–5(8)  $\times$  3–4  $\mu\text{m}$ , with thin walls. Pseudothecia globose to broadly pear-shaped, 400–450  $\mu\text{m}$  in diameter, erumpent between the thallus squamules, with preformed ostiole. Peridium dark chestnut-brownish, distinctly delimited at the outer edge, apical layers 55–65  $\mu\text{m}$  thick, basal layers 25–35  $\mu\text{m}$  thick; cells in basal parts in section tangentially flattened (ellipsoid), in apical parts more roundish; pigments distinctly in intercellular spaces; intercellular pigment becoming confluent in

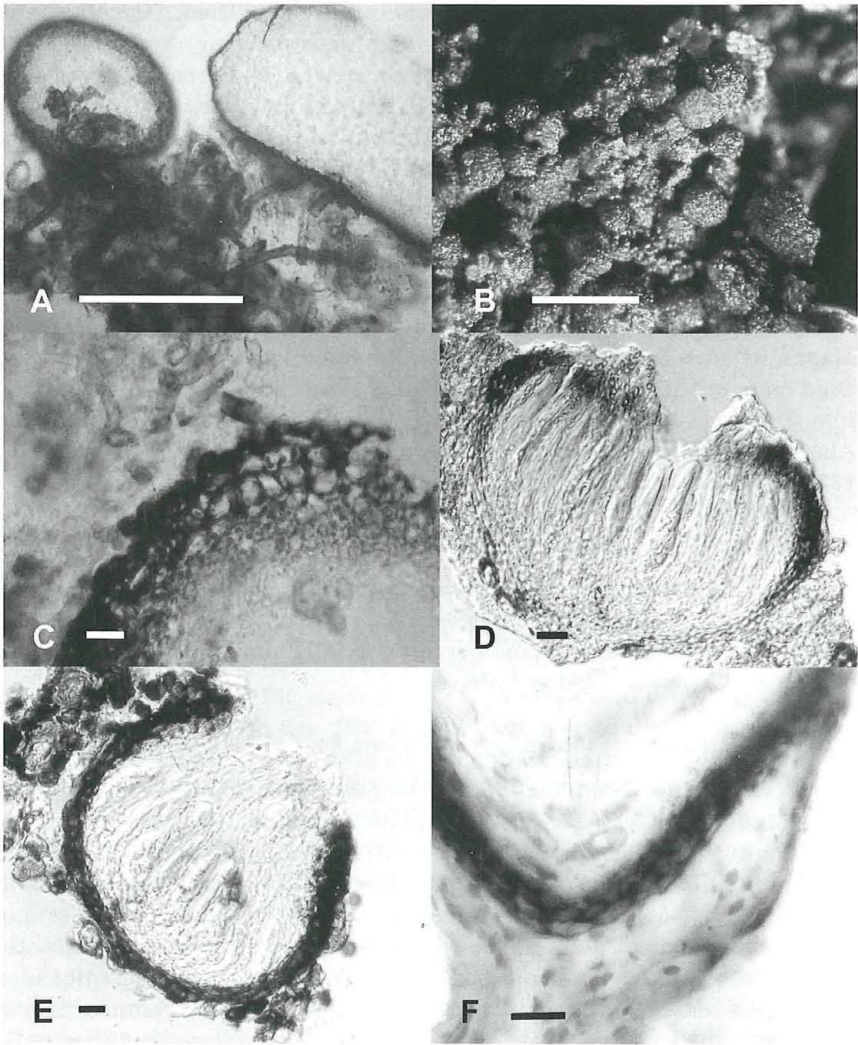


Fig. 1. – A–C: *Frigidopyrenia bryospila*. A: two thallus squamules in longitudinal section, with brown connecting hyphae (scale bar = 0.2 mm); B: external view showing thallus squamules (scale bar = 0.5 mm); C: peridium detail in longitudinal section (scale bar = 10  $\mu$ m). – D: ascomata of *Collemopsidium iocarpum* in longitudinal section (scale bar = 20  $\mu$ m). – E: ascomata of *Magmopsis pertenella* in longitudinal section (scale bar = 10  $\mu$ m). – F: peridium of *Pyrenocollema epigloea* in longitudinal section (scale bar = 15  $\mu$ m).

outer layers of the peridium. Subhymenium 15–25  $\mu\text{m}$  thick. Hamathecium of filamentous, strongly branched and anastomosing hyphae (paraphysoids); cells 6–10  $\mu\text{m}$  x c. 1  $\mu\text{m}$ , not constricted at the septa. Asci fissitunicate, rigid and cylindrical, 130–140 x 18–22  $\mu\text{m}$ , 8-spored; endotunica layers becoming thicker towards the top but without abrupt thickening in the upper half of the ascus; ocular chamber distinct. Ascospores hyaline, 1-septate, (25)28–35 x 10–12  $\mu\text{m}$ , slightly thickened at the septae, becoming brownish and faintly warted when old.

Additional material studied: Sweden, Torne Lappmark, Vassijaure, c. 2 km N of Vassijaure, trail around Vartutjak, tree-less plain, on earth, c. 500 m, 10. VIII. 1989, M. GRUBE & I. BASTL (GZU); Slovakia, Tatra Magna, Montes Belanské Tatry, in alpe Zdiarska Vidla, c. 2100–2150 m. on dead mosses. VIII. 1958, A. VĚZDA (UPS, 2 specimens); USA, Alaska, Fretum Behring, Port Clarence, Exped. Vega 1879 (H-Nyl. 8156); USA, Alaska: Port Clarence ad fretum Bering, 65°15'N/166°30'W, 21.–26. VII. 1879, E. ALMQUIST (S).

### 3.2. Superficially Similar Genera

Because *Frigidopyrenia bryospila* has previously been placed in the genera *Pyrenocollema* and *Collemopsisidium*, descriptions of the type species of these genera and of another superficially similar genus, viz. *Magmopsis* NYL., are provided as follows.

#### 3.2.1. *Collemopsisidium iocarpum* NYL., Flora 64: 6 (1881).

Lectotypus (HENSSSEN 1980: 484): Finland, Kristinestad, “ad mare prope ipsam aquam”, A.J. MALMGREN (H-Nyl. 42858!).

Synonyms: *Pyrenopsis iocarpa* (NYL.) NYL. [in MALMGREN], Förteckning: 68 (1886); *Cryptothele iocarpa* (NYL.) Th. Fr., Bot. Not.: 59 (1886).

Description: Thallus inconspicuous; mycelium intermingled with colonies of cyanobacteria, primarily cf. *Xanthocapsa*, haustoria not observed. Pseudothecia globose to broadly ellipsoid, 130–220  $\mu\text{m}$  in diam., with preformed ostiole; ostiole widening with age. Peridium chestnut-brown, with more or less carbonized pigment layers at the outside; apical parts 10–18  $\mu\text{m}$  thick, basal parts 7–12  $\mu\text{m}$  thick, paler than apical parts; cells often irregularly formed and more or less wavy in section, 3–7 x 2–3  $\mu\text{m}$ , pigments mostly in the intercellular spaces and as clod-like incrustations of the outer cell walls, sometimes finely granular. Subhymenium 15–20  $\mu\text{m}$  thick. Hamathecium of filamentous, strongly branched and anastomosing hyphae (paraphysoids); cells 4–6 x 1–2  $\mu\text{m}$ , irregularly thick. Asci fissitunicate, flexuose, slightly saccate, in later ontogenetic stages more elongate, 60–70 x 12–16  $\mu\text{m}$ ; endotunica thickened in the upper half of the ascus, with more or less developed ocular chamber, 8-spored. Ascospores hyaline,

1-septate, 17–22 x 6–9 µm, with thin walls (0.5 µm); septum median; upper cell broader.

New combination: *Collemopsidium cephalodiorum* (TRIEBEL & GRUBE) GRUBE comb. nova

Basionym: *Cercidospora cephalodiorum* TRIEBEL & GRUBE [in TRIEBEL], Biblioth. Lichenol. 35: 87 (1989).

Holotypus: Sweden, Jämtland, 3re par., Handöl, river Handöldn, waterfall Handölsfallen, E of the river near the foot-bridge, c. 600 m, in cephalodia of *Pilophorus dovrensis*, 11. VIII. 1975, R. MOBERG 2912 (UPS!).

3.2.2. *Magmopsis pertenella* NYL., Flora 58: 102 (1875).

Lectotypus (hoc loco designatus): Finland, Lake Ladoga, Ruskiala, 1874, leg. NORRLIN (H-Nyl. 42836!).

Synonym: *Pyrenopsis pertenella* (NYL.) WILLEY, Enum. Lich. New Bedford: 12 (1892).

Description: Thallus indistinct; mycelium intermingled with dense colonies of nostociform cyanobacteria; hyphae forming numerous haustoria in the cyanobacterial cells, hyphal cells c. 8–10 x 2–5 µm. Pseudothecia globose, 140–155 µm in diam., with preformed ostiole, ostiole not becoming broader with age. Peridium brown, always distinctly delimited at the outside; apical parts 10–15 µm thick, basal parts 8–10 µm thick; cells in outer and basal layers of the peridium rounded, tangentially flattened, in section 5–8 x 2 µm, not wavy; cells in inner peridium layers slightly smaller and more roundish; cells in apical layers of the peridium with thick walls and clod-like pigments in cell walls and intercellular spaces; pigments sometimes fine granular. Subhymenium 10–15 µm thick. Hamathecium of filamentous, strongly branched and anastomosed hyphae (paraphysoids); cells 6–8 x 0.7–2.5 µm, irregularly thick. Asci fissitunicate, flexuose, broadly saccate and with distinct stipe, 45–53 x 17–20.5 µm, endotunica thickened in the upper half of the ascus, ocular chamber more or less developed, 8-spored. Ascospores hyaline, 1-septate, 15–19 x 5–6 µm, with thin walls (0.5 µm); septum median; upper cell larger.

3.2.3. *Pyrenocollema epigloea* (NYL.) R.C. HARRIS, More Florida Lichens: 72 (1995).

Basionym: *Verrucaria epigloea* NYL., Flora 69: 464. (1886).

Isotypus: Bosnia-Herzegowina: "supra *Nostoc saxa dolomitica incolens inundata fluminis Narenta* in Herzegowina, LOJKA" (UPS!) [This material corresponds to LOJKA: Lich. Univ. 249].

Synonyms: *Arthopyrenia epigloea* (NYL.) ZAHLBR., Cat. Lich. Univ. 1: 279. (1921); *Pyrenocollema tremelloides* REINKE, Jahrb. Wiss. Bot. 28: 461 (1895). [also based on LOJKA: Lich. Univ. 249]

Description: Thallus without recognizable structure, in subfoliose *Nostoc*-like colony. Pseudothecia globose, (120)155–175(200)  $\mu\text{m}$  in diam.; in dry stage completely immersed; when moistened appearing as warts; with preformed ostiole, ostiole not becoming broader; up to the ostiole covered with cyanobacteria. Peridium brown, always distinctly delimited at the outside, without carbonized pigment layers at the outside; (8)15–20(25)  $\mu\text{m}$  thick, equally thick in basal and apical parts of the peridium; cells in outer layers of the peridium distinctly angular and tangentially flattened, in section 7–11(15)  $\times$  1.5–3  $\mu\text{m}$ , thin-walled; cells in inner peridium layers more roundish. Subhymenium 10–15  $\mu\text{m}$  thick. Hamathecium of filamentous, strongly branched and anastomosing hyphae (paraphysoids); cells 4–8  $\times$  0.5–1.5  $\mu\text{m}$ , irregularly thick. Asci fissitunicate, flexuose, narrowly clavate to slightly saccate and with distinct stipe, 57–115  $\times$  15–20  $\mu\text{m}$ , endotunica thickened in the upper half of the ascus, ocular chamber inconspicuous. Ascospores hyaline, 1-septate, 17–25  $\times$  6–8  $\mu\text{m}$ , with thin walls (0.5  $\mu\text{m}$ ); septum median, slightly constricted at the septum; upper cell broader.

#### 4. Discussion

*Frigidopyrenia* differs from superficially similar genera by a combination of several characters. The type species *F. bryospila* has comparatively large ascomata, with clod-like pigments deposited in the intercellular spaces of the peridium (Fig. 1C). In contrast to *Zwackhiomyces* and *Anisomeridium* (MÜLL. ARG.) CHOISY, which share this type of pigmentation, the peridial cells are much larger and more or less elliptic in section, and their cell walls do not stain metachromatically red-violet with Toluidine Blue (as in *Collemopsidium*, *Magmaopsis*, and *Pyrenocollema*, i.e. staining type 3 according to GRUBE 1993). Differences are also observed in characters of the asci which are more cylindrical than those in the compared genera *Collemopsidium*, *Magmaopsis*, and *Pyrenocollema* (see also the illustration in GRUBE & HAFELLNER 1990). The phylogenetic relationships of these genera are unknown to date, as molecular analyses would require freshly collected material. Unfortunately, the material from Alaska (BARROW, 2001, FRYDAY 8256, MICH), recently reported in FRYDAY 2004, does not belong to *Frigidopyrenia bryospila*. It represents rather a species of *Zwackhiomyces*, and resembles the lichenicolous *Z. berengerianus* (ARNOLD) GRUBE & TRIEBEL, although no relation to its host *Mycobilimbia berengeriana* were observed.



The genera *Collemopsidium* and *Pyrenocollema* are clearly different from *Frigidopyrenia*. *Collemopsidium iocarpum* is characterized by peridia which are paler in basal layers of the ascomata (Fig. 1D). The peridia contain more or less thick-walled, roundish to irregularly formed cells in transverse section, especially at the outer edge. *Collemopsidium iocarpum* was originally assigned to the tribe "Homopsidei" by NYLANDER 1881 in his classification, which was based on the algal partners, and then transferred by him to the genus *Pyrenopsis* NYL. Already FORSELL 1885: 63 pointed out the similarity of this species with *Arthopyrenia halodytes*, now *Collemopsidium halodytes* (NYL.) GRUBE & B.D. RYAN, but did not consider a close relationship owing to differences of the associated photobionts. Whereas the photobiont of *C. halodytes* is primarily *Hyella caespitosa* (although *Dilabifilum arthopyreniae* may also be present, see TSCHERMAK-WOESS 1976 for details), *C. iocarpum* was found in association with one or several coccale cyanobacteria (see also HENSSEN 1980). It is possible that *C. iocarpum* is preferentially associated with the *Xanthocapsa*-type cyanobacteria in the type specimen. *Collemopsidium brunii* is closely related to *C. iocarpum* and mainly distinguished by smaller ascospores and a smoother thallus (GRUBE & HAFELLNER 1990). It was originally interpreted as a lichenicolous fungus on an aquatic *Verrucaria*, but this species is apparently associated with thin layers of unidentified cyanobacteria found on the host thallus. Although representatives of the intertidal *Collemopsidium halodytes* species group also deviate by the rather distinctly developed carbonization of ascomata, *Collemopsidium* was recently taken up as a genus name for these species (GRUBE & RYAN 2002), as this was regarded as the best solution unless a new genus would be described. MOHR & al. 2004 accepted this view and were the first to provide a molecular investigation of the *C. halodytes* group, which suggests substantial genetic divergence among the studied species. *Collemopsidium pelvetiae* (G.K. SUTHERL.) KOHLM. D. HAWKSW. & VOLKM.-KOHLM., which grows on the maritime alga *Pelvetia canaliculata* (KOHLMAYER & KOHLMAYER 1979, KOHLMAYER & al. 2004), is more similar to the type species of *Collemopsidium*. The pseudothecia develop from a mucilaginous layer which contains a red alga and cyanobacteria (ALMARAZ & al. 1994). Fungal hyphae are in close contact with the cyanobacteria to form a „lichenoid“ association (compare KOHLMAYER 1973). HAWKSWORTH 1988 called this an algicolous relationship, while KOHLMAYER & al. 2004 recently coined the term „borderline“ lichen for this and similar primitive associations. The new combination *Collemopsidium cephalodiorum* is here proposed for an anatomically similar species, a lichenicolous fungus which develops its fruit bodies in the cephalodia of the subarctic soil lichen *Pilophorus dovreensis* (*Lecanorales*). A detailed description of the species has been provided in TRIEBEL 1989. There the species was initially assigned to *Cercidospora* KÖRB.

emend. HAFELLNER. However, the ascomata lack the typical blue-green pigments and also the endoascal thickenings are not typical for *Cercidospora* (HAFELLNER 1987). The similarities of the peridium pigmentation, ascus structure, and the association with cyanobacteria rather suggest that the species is better placed in *Collemopsidium*.

*Magmopsis* is distinguished from other species studied by peridial structure. The peridial cells are roundish in cross-sections, and the pigments are distributed in the cell walls as well as in the intercellular spaces, especially at the outer edge of the peridium (Fig. 1E). NYLANDER 1875 was uncertain about the placement of the genus, and later interpreted members of the genus as parasites (as stated by CROMBIE 1894). *Magmopsis* remained a rather obscure case in the later lichenological history. MINKS 1880 recognized a mixture of 3 „Flechtengebilden“ („lichen entities“) in the type collection of *Magmopsis pertenella*. One of them is now known as *Toninia athallina*, whereas the two others represent thalli of *Nostoc*-like and chroococcal cyanobacteria. Apparently, MINKS did not observe the pseudothecia of *Magmopsis pertenella* sensu NYLANDER, which are associated with the *Nostoc*-like colonies. Another specimen, determined as *Magmopsis pertenella* by NYLANDER (Grand Manan, WILLEY 1879, H-Nyl) represents in fact *Collemopsidium iocarpum* (this collection was not considered in the protologue of *Collemopsidium*). Later, a second species, viz. *Magmopsis argilospila* (NYL.) NYL. (Bas. *Verrucaria argilospila* NYL.) was transferred to *Magmopsis* (H-Nyl 42834!), but this species is not closely related to the type species, according to the characters of the peridium, which resemble more those of *Zwackhiomyces*. After the combination of the type species in *Pyrenopsis* (WILLEY 1892), *Magmopsis* was completely neglected as a genus name by subsequent authors.

Another similar species, viz. „*Didymella*“ *lenormandii* (BORNET) HENSSEN (Type: Peru, LECHLER, on *Stigonema*, UPS!-Isotype), might be mentioned at this point. This species grows superficially on trichomes of a *Stigonema* species. „*D.*“ *lenormandii* was treated under excluded and poorly studied taxa by GRUBE & HAFELLNER 1990 and has some similarities in peridial characters with *Magmopsis pertenella*. However, additional material is required for more detailed comparisons. According to the description and the photographs in HENSSEN 1977, „*Didymella*“ *parvispora* HENSSEN seems also similar, but the type was not available.

*Pyrenocollema epigloea* is distinguished from all other species treated here by peridial cells with thin-walled, large and angulate cells at the periphery of the peridia (Fig. 1F), which are conspicuous in a squash preparation. The peridia are uniformly pigmented at the apical and basal layers of the ascomata. The ascomata are completely immersed in a foliose *Nostoc* colony. Still today this species is known only from the type collection, which corresponds to the exsiccate collection LOJKA, Lich. Univ. 249. However, the last two numbers of LOJKA'S Lichenotheca Universalis (249 &

250) have never been distributed officially. The specimen of this exsiccate collection studied by REINKE and present in UPS have only the numbers written on the label, whereas the material in MICH (studied by HARRIS 1975) included data about the collection locality, which corresponds to the type information of *Verrucaria epigloea* in NYLANDER 1886. Thus, *Verrucaria epigloea* and *Pyrenocollema tremelloides* are based on the same material. This fact was apparently not recognized by KEISSLER. While KEISSLER 1930 interpreted *Pyrenocollema tremelloides* as a possible synonym of *Sphaerulina dolichotera* (NYL.) VOUAUX, KEISSLER 1938 included *Arthopyrenia epigloea* (NYL.) A. ZAHLBR. as possible synonym of *Cyrtidula nostochinea* MINKS. Finally, HARRIS 1975, 1995 suggested that the correct name for this species should be *Pyrenocollema epigloea* (NYL.) R.C. HARRIS. As far as I am aware, none of the other species currently placed in this genus has a similar structure of the ascomata. However, the genus *Pyrenocollema* was nevertheless adopted in a broad sense, particularly after the monograph of HARRIS 1975. The British Lichen Flora included 13 species (COPPINS 1992), while 23 species were placed in *Pyrenocollema* world-wide at that time. As additional species were described since then (APTROOT & VAN DEN BOOM 1998, HARADA 1999, MCCARTHY & KANTVILAS 1999, 2000), a critical revision of the genus would be overdue.

Of the type species discussed here, only *Frigidopyrenia bryospila* is clearly lichenized (in well-developed specimens) and may develop a conspicuous thallus morphology. The remarkable thallus squamules of *Frigidopyrenia bryospila* might be classified as goniocysts in the original sense of NORMAN, i.e. when he used the term for thallus organs of *Moriola* NORMAN (NORMAN 1872; for the term usage see also SÉRUSIAUX 1985). Nevertheless, *Moriola*, with the suggested type species *M. pseudomyces* (NORMAN) NORMAN (ERIKSSON 1981), is not closely related to *Frigidopyrenia*, as confirmed by an examination of isotype material ("in Alten ad Skaidi copiose supra truncos Pini dejectos putrescentes", S!). The lack of paraphysoids and the plurilocular to muriform brownish spores rather suggest a relationships with *Merismatium* ZOPF, which was already noticed by TRIEBEL 1989. This genus of the *Verrucariales* (*Chaetothyriomycetidae*) includes species growing on various lichens, but without strong selectivity for their hosts. *Merismatium* species often form associations with epilichenic algal colonies, which can be incorporated in goniocysts.

The unicellular cyanobacteria in *Frigidopyrenia bryospila* are morphologically peculiar, which could indicate that a rather specific association exists with the fungal partner. The situation in the other genera is less clear, but all species discussed here seem to have a preference for cool and periodically wet habitats. In these habitats, e.g. compact soil surfaces, composed of decaying plants and cryptogams, a greater diversity of interesting pyrenomycetes with interesting biological relations may still be hidden.

5. Key to the Discussed Genera

- 1 Thick-walled, more or less straight and dark-coloured hyphae present, connecting the ascomatal base with the squamulose thallus (lichenized species) . . . . . *Frigidopyrenia*
- 1\* Conspicuous hyphae extending from the ascomatal base absent, thallus different, smooth or indistinct (species with varying relationships to cyanobacteria) . . . . . 2
- 2 Peridium with brown pigmentation to distinctly carbonized and surrounded by an involucrellum, usually paler coloured in the basal part, ostiole becoming wider with age (when a carbonaceous involucrellum is lacking); periphtric cells of the peridium slightly sinuous (if discernible), thick-walled and with narrow lumina in surface view . . . . . *Collemopsidium*
- 2\* Brown pigments uniformly distributed throughout the peridium . . . . . 3
- 3 Periphtric cells of the peridium angular . . . . . *Pyrenocollema*
- 3\* Periphtric cells of the peridia rounded . . . . . *Magnopsis*

6. Acknowledgments

I wish to thank Josef HAFELLNER (Graz) for continued inspiring discussions on lichen taxonomy. Christian SCHEUER (Graz) is acknowledged for help with the latin diagnosis, and Ove ERIKSSON (Umeå) for comments on the manuscript.

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Autor(en)/Author(s): Grube Martin

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