Taxonomic studies of lichenicolous fungi in Japan

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Chapter 1

Introduction

– Significance of taxonomic studies of Japanese lichenicolous fungi –

Lichens are taxonomically classified as fungi. While lichens used to be regarded as a type of plant, they have now become a member of the fungus family because of their symbiotic relationship with green algae and cyanobacteria.

Symbionts provide photobionts (symbiotic algae) with a stable place to live and obtain water, and the photobiont provides the fungi with nutrients obtained via photosynthesis. It was in the middle of the 19th century that lichens became known as a symbiote for algae. At that time, it was not well-known that there was a symbiotic relationship between fungi and algae; thus, before 1960, lichens were considered to be in the same group of plants as mosses and ferns. However, in 1952, it was decided that the scientific name of lichens would be given to fungi that coexist internationally, thus lichens became a part of the fungi. Subsequently, lichen culture and chemical research progressed. The fungi that make up the lichen are not very different from the ascomycetes and basidiomycetes that live alone. Therefore, the idea that lichens are fungi that are nourished by a special method, is currently supported (Kashiwadani 2009).

Lichens grow on stable substrate, such as bark, rocks, and soil, and approximately 30,000 species have been confirmed worldwide, with approximately ca 1,800 species in Japan (Ohmura 2016). There is a wide global distribution of lichens as they grow not only in temperate zones, but also in tropical and boreal zones, the Arctic, and Antarctica. Furthermore, a wide variety of species grow in harsh conditions such as high temperatures, low temperatures, dryness, and excess wetness. However, they do not grow in water, snow, or caves. Japan is an elongated archipelago that stretches 3,000 km from north to south. There are various types of

environments in Japan, including mountainous, alpine, coastal, and subtropical areas; as well as cool temperate zones; deciduous forests; and evergreen forests. In addition to these environments, lichens may also be found growing in artificial environments such as on concrete structures, roof tiles, and roadside trees (Kashiwadani 2009).

Lichenicolous fungi are symbiotic or parasitic fungi that specialize in lichens. (Lawrey and Diederich 2003). Lichenicolous fungi have been identified worldwide and have been found not only in deserts, the tropics, and alpine areas, but also in Polar Regions such as the Arctic Circle and Antarctica. They have also been collected from a variety of lichens. Lichenicolous fungi are defined as those that use only lichens as hosts. Therefore, fungi that are considered lichenicolous are not only collected from lichens, but also from rocks, bark, plants, and other places. Lichens that parasitize lichens are also treated as lichenicolous fungi (lichenicolous lichen).

Often, the effects of lichenicolous fungi on lichen have been mistaken for lichen body features. For example, a famous species *Biatoropsis usnearum* is a fungus that parasitizes *Usnea* and forms pink- to brown-colored galls on its body. For a long time, this gall was viewed as a characteristic of *Usnea*, but it was actually a nodule caused by the parasitism of *B. usnearum*, a basidiomycete (Diederich and Christiansen 1994). Therefore, to determine the lichenicolous fungi that parasitize lichens, it is necessary to know the characteristics and structure of the lichen itself. Moreover, to distinguish between the two, knowledge of morphological taxonomy is especially important (Diederich and Christiansen 1994).

Currently, there are over 2,000 known species of lichenicolous fungi. These fungi include ascomycetes and basidiomycetes, which account for approximately 2% of all fungal species in Kingdom Fungi. Furthermore, an estimate has described 3,000–5,000 species (Diederich et al. 2018). Over 95% of all lichenicolous fungi belong to ascomycetes, representing

19 orders and 7 classes. While less than 5% are basidiomycetes, they are phylogenetically diverse and fall into eight different orders and four classes (Lawrey and Diederich 2003). Nevertheless, many of the currently identified species have unknown phylogenetic positions. In Japan, approximately 150 species have been reported (Zhurbenko et al. 2015, 2017; Tadome et al. 2018; Zhurbenko and Ohmura 2019). However, it has been estimated that only approximately 30% of Japanese lichenicolous fungi have been discovered thus far (Zhurbenko et al. 2015). Many of these studies were conducted by Zhurbenko M.P., who examined and described specimens from the National Museum of Nature and Science, as well as lichen specimens from Uppsala University in Sweden.

Chemical components presenting antibacterial activity have been identified in lichens (Friardi et al. 2018). In recent years, it has been reported that both lichens and lichenicolous fungi (especially lichen endophytes) possess useful chemical components, and more useful ingredients are expected to be found in the future (Haiyin et al. 2005). However, because it is difficult to identify lichens and lichenicolous fungi, the progress of these studies is hindered. Therefore, the purpose of this study was to make detailed records of the morphological characteristics of Japanese species, especially those that are parasitic, among the lichenicolous fungi that are expected to be useful.

Chapter 2

Specimen survey of *Ochrolechia, Rusavskia*, *Xanthoria* species.

2–1. Materials and methods

In order to search for lichenicolous fungi from Japan, i observed specimens of *Ochrolechia*, *Rusavskia* and *Xanthoria*, which are said to be susceptible to these. As for the specimens, 729 specimens of *Ochrolechia* (*O. akagiensis* Yasuda ex Vain., *O. androgyna* (Hoffm.) Arnold, *O. pallescens* (L.) A. Massal., *O. parellula* (Müll.Arg.) Zahlbr., *O. submarginata* (Nyl.) Oshio, *O. tartarea* (L.) A. Massal. *O. trochophora* (Vain.) Oshio, *O. upsaliensis* (L.) A. Massal., *O. yasudae* Vain.) and 42 specimens of *Xanthoria* (*X. mandschurica* (Zahlbr.) Asahina, *X. elegans* (Link) Th.Fr. [=*Rusavskia elegans*], *X. fallax* (Hepp) Arnold [=*Xanthomendoza fallax*]) housed in the National Museum of Nature and Science (TNS, Tsukuba Japan.), were examined.

Morphological observations were made using a dissecting microscope (Olympus SZX16) and a differential interference contrast microscope (Olympus BX51). Anatomical examinations were made on hand-cut sections mounted in water. Chemical reactions were observed by the use of 10% KOH (K). The amyloidity of the hymenial gels was observed in 1.5% Lugol's iodine solution directly (I) or after a 10% KOH pretreatment (K/I). Spore measurements are given as (minimum–) average ± standard deviation (–maximum) (n = number of measurements). Morphological and chemical features were compared with reference to Exicata specimens (Santesson: Fungi Lichenicoli Exs) from the National Museum of Nature and Science to accurately identify the species.

2–2. Result and Discussion

Arthonia molendoi (Heufl. ex Frauenf.) R. Sant.

[Fig. 1]

Ascomata developing on apothecial margin and upper surface of thallus (young ascomata in the cortex with algal layer) of the host lichen, round, black, convex, 0.1–0.15 mm. **Epihymenium** dark brown with a red brown tinge, 15 μm tall, K−. **Hymenium** pale brown, without inspersion, up to 60 μm, I+ red, K/I+ blue. **Paraphysoids** branched and anastomosed, the tips brown, not enlarged, extending above the asci. **Asci** clavate, Arthonia-type, 23–26 × 13–16 μm, 8-spored; ascus apex with a K/ I+ blue ring structure in the innermost layer of the endoascus. **Ascospores** oblong, hyaline, 1-septate, constricted at the septum, (9.7–)9.9– 11.1(–12.0) × (3.6–)4.0–4.6(–5.0) μm (n = 35).

specimen examined: JAPAN. Hokkaido. Prov. Kushiro: Marine laboratory of Hokkaido University, Akkeshi. On rock (concrete) along the coast; elevation 3 m. July 27, 2003, H. Kashiwadani 45809 (TNS).

Exsiccata examined. AUSTRIA. Oberösterreich: Nördliche Kalkalpen, Dachstein-Gruppe, Lackenmoosalm N of Feisterscharte. Alt. ca. 2000 m. On horizontal and vertical surfaces of a bird-rock on the top of a rock. On *Xanthoria elegans* (thallus and apothecia). (Santesson: Fungi Lichenicoli Exs. 54, TNS).

The following discussion is also described in Tadome et al. (2018). The features mentioned above for the examined Japanese specimen agree well with the protologue, the diagnostic features provided by Fleischhacker et al. (2016), and an exsiccata specimen of *Arthonia molendoi* [Santesson: Fungi Lichenicoli Exs. 54 (TNS!)]. Fleischhacker et al. (2016)

described a new species, *Arthonia parietinaria* Hafellner & Fleischhacker, for specimens of *A. molendoi* auct. growing on *Xanthoria parietina*. *Arthonia parietinaria* is distinguished from *A. molendoi* mainly by the dull black, often clearly aggregated ascomata, the greyish olive pigmentation of the epihymenium and hymenium turning chestnut brown in K, and the different host. *Arthonia parietinaria* has not been found in Japan so far. *Arthonia molendoi* is the fifth parasitic *Arthonia* species known from Japan besides *A. almquistii* Vain. (Zhurbenko et al. 2015), *A. biatoricola* Ihlen & Owe-Larss., *A. graphidicola* Coppins (Frisch et al. 2014), and *A. lopingensis* Zahlbr. (Frisch et al. 2018). Of these species, only *A. almquistii* appears closely related to *A. molendoi*, from which it differs morphologically by the olive to dark brown epihymenium, slightly larger ascospores [10.5– 15.0 × 4.0–5.5(–6.0) µm], and *Amygdalaria*, *Koerberiella*, *Porpidia* and *Trapelia* as host taxa (Triebel 1989, Lawrey and Diederich 2018). *Arthonia biatoricola* differs morphologically by the hyaline hymenium (Ihlen et al. 2004). *Arthonia graphidicola* differs morphologically by the elliptical to elongated, flat, immersed ascomata and diff erent ascospores [2–3-septate, (13–)14–17 × 4.5–5.5 µm, at first hyaline, smooth and often with a thin epispore but later becoming covered in dark brown granular warts]. This species occurs on *Graphis scripta* (L.) Ach. (Coppins 1989). *Arthonia lopingensis* is distinguished by the brown to brownish black, lirellate to star-shaped ascomata that are often weakly covered with an orange, K+ purple pruina (parietin present), and juvenile parasitic growth on several *Graphis* spp. (Frisch et al. 2018). *Arthonia molendoi* is widely distributed in bipolar temperate to arctic-alpine zones (Fleischhacker et al. 2016). It was also reported in coastal habitats in Korea (Kondratyuk et al. 2015, 2016). In Japan, this species is currently only found on a single collection from Hokkaido, but I expect it to be more widely distributed in boreal-alpine habitats of this country, too (Tadome et al. 2018).

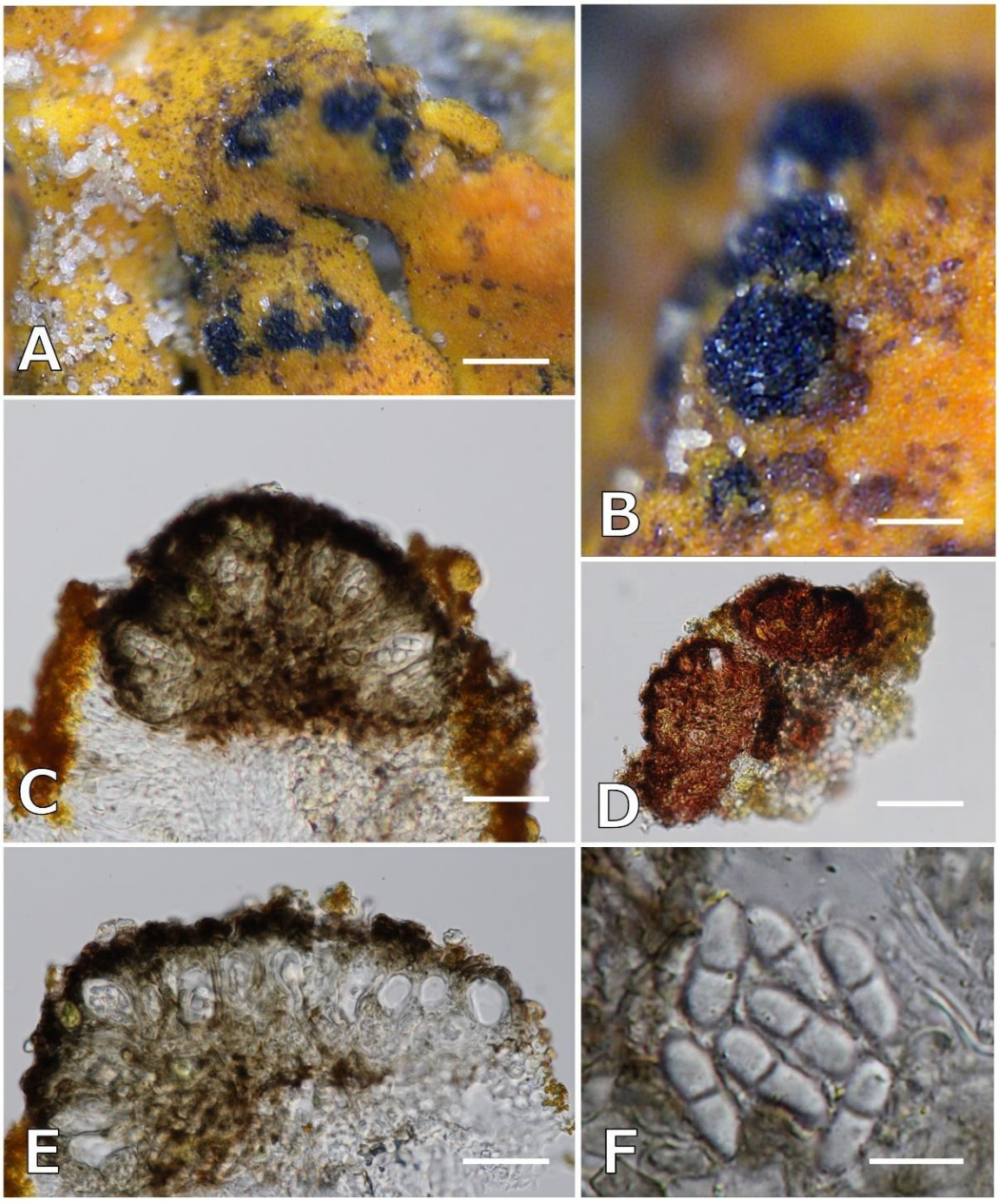

Fig. 1. *Arthonia molendoi* (Heufl. ex Frauenf.) R. Sant. (H. Kashiwadani 45809, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. I+red reaction (Cross section of an ascomata). E. Hymenium. F. Ascospore. Scale bars: A=0.5 mm, B＝0.1 mm, C＝25 μm, D＝50 μm, E＝25 μm, F＝10 μm.

Lichenodiplis anomala Etayo & Pérez-Vargas [as 'anomalus'], Phytotaxa 99(2): 60 (2013).

[Fig. 2]

Conidiomata pycnidial, globose to obpyriform, scattered, immersed host ascomata and margin, erumpent, opening pore, black, 0.3–0.5 mm diam. **Pycnidial wall** hyaline to brown, 20.0–30.0 µm thick. **Conidiophores** absent. **Conidiogenous cells** normally lageniform to cylindrical, smooth, simple, strongly branched, with annellations, hyaline to pale brown, 8.0–9.0 × 1.5–3.0 µm. **Conidia** ellipsoid, 1-septate, smooth, truncate base, pale olivaceous brown to brown, (4.7−)5.4−6.4(−7.9) × (2.2−)2.5−2.9(−3.1) µm (n=53).

Specimen examined: JAPAN, Hokkaido, Prov. Kushiro, ca. 4 km NW of Miyajima-misaki, Tsurui-mura, Akangun, 43°10′N, 144°20′E, elev. ca. 10m asl, on *Ochrolechia trochophora* (apothecia), 02.09.1992, H. Kashiwadani 36630 (TNS).

Lichenodiplis lecanorae (Vouaux) Dyko & D. Hawksw., in Hawksworth & Dyko, Lichenologist 11(1): 52 (1979).

[Fig. 3]

Conidiomata pycnidia, subglobose, immersed host ascomata and thallus, erumpent, singly, dark brown, 0.1−0.2 mm diam. **Conidiomatal wall** brown, 20.0−30.0 µm thick. **Conidiophores** absent. **Conidiogenous cells** lageniform to subcylindrical, with annellations, hyaline to pale brown, 4.0−8.0 × 1.6−2.5 µm. **Conidia** ellipsoid, 1-septate, smooth, truncate at the base, pale brown, (4.9−)5.5−6.7(−7.5) × (2.2−)2.3−2.9(−3.2) µm (n=33).

Specimen examined: JAPAN, Honshu, Pref. Nagano, Daidoushin (Mt. Yoko-dake), Yatsuga-take Mts, Chino-city, 35°59′N, 138°22′E, elev. ca. 2700m asl, on *Ochrolechia upsaliensis* (apothecia), 05.08.1990, K. Yoshida 10287 (TNS).

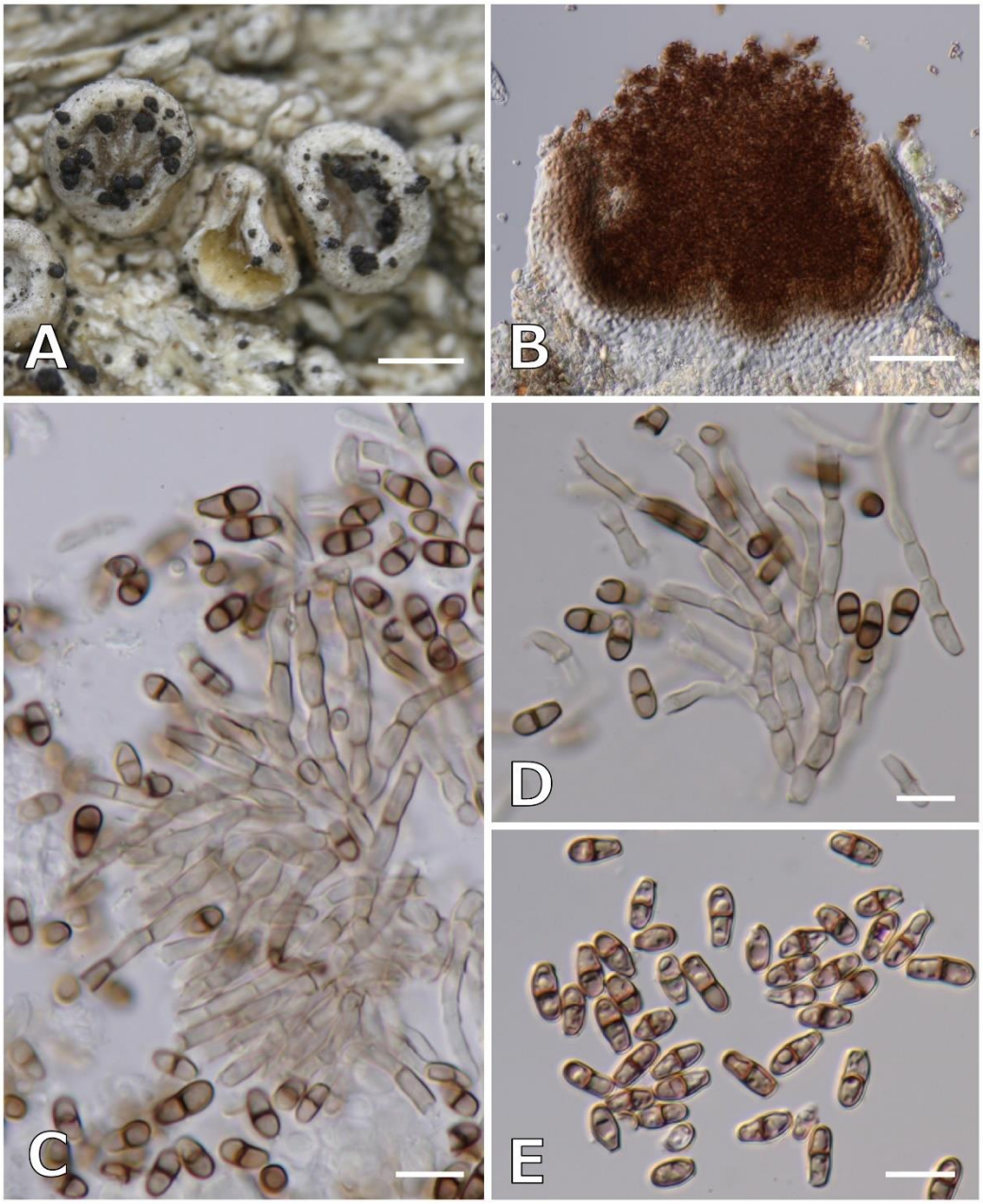

Fig. 2. *Lichenodiplis anomala* Etayo & Pérez-Vargas [as 'anomalus'], Phytotaxa 99(2): 60 (2013). (H. Kashiwadani 36630, TNS). A. Growth habit. B. Cross section of a Conidiomata. C-D. Conidiogenous cells. E. Conidia. Scale bars: A=1 mm, B＝0.1 mm, C-E =10 μm.

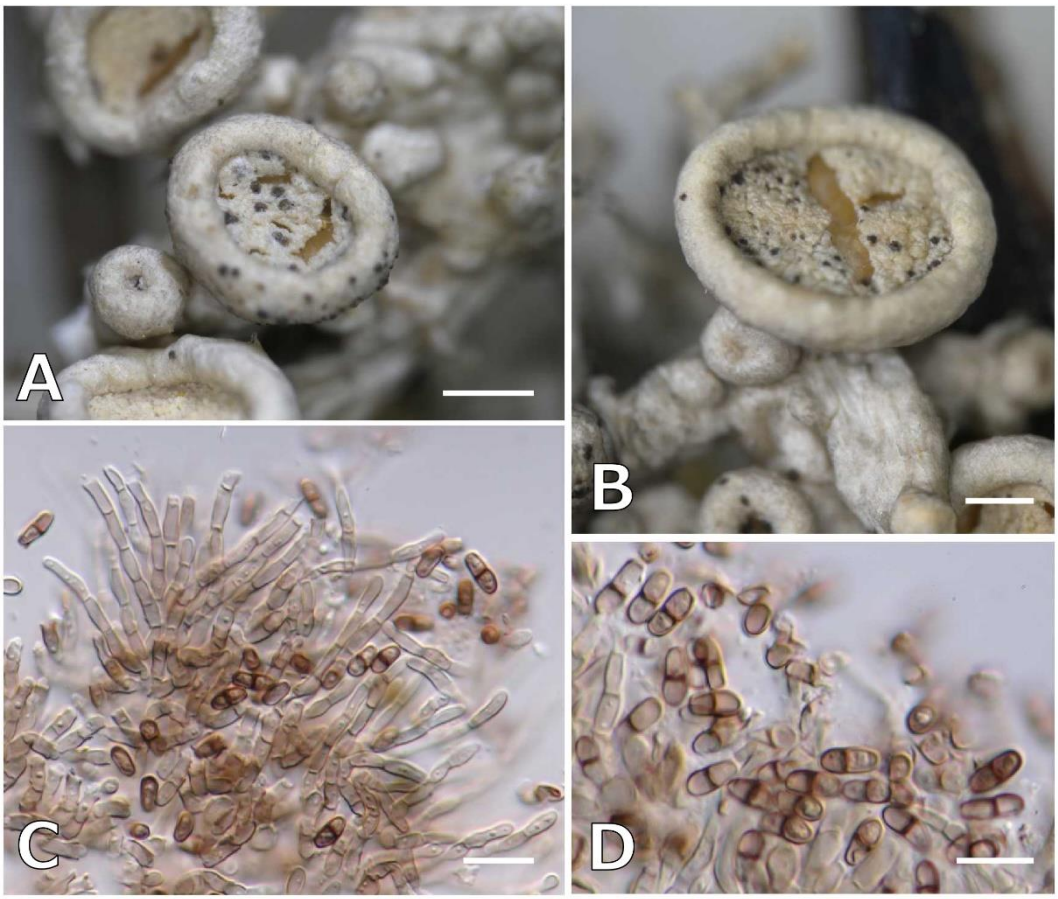

Fig. 3. *Lichenodiplis lecanorae* (Vouaux) Dyko & D. Hawksw., in Hawksworth & Dyko, Lichenologist 11(1): 52 (1979). (K. Yoshida 10287, TNS). A-B. Growth habit. C. Conidiogenous cells. D. Conidia. Scale bars: A-B=0.5 mm, C-D＝10 μm.

Lichenodiplis ochrolechiae Y. Joshi & M. Tripathi, in Joshi, Falswal, Tripathi & Halda, Sydowia 69: 19 (2016).

[Fig. 4]

Conidia simple or very rarely 1-septate, pale to medium brown, (3.8−)4.0−4.8(−5.3) × (2.2−)2.4−2.8(−2.9) µm (n=46). This species is similar to *Lichenodiplis anomala* Etayo & Pérez-Vargas, from which it mainly differs in having simple to 1-septate vs. 1-septate conidia. (Zhurbenko et al. 2018).

Specimen examined: JAPAN, Kyushu, Pref. Miyazaki, Mt. Hirono, Shiiba Research Forest, Kyushu University, Shiiba-son, Higashi-usuki-gun, 32°22′26″N, 131°09′49″E, elev. 1200m asl, on *Ochrolechia submarginata* (thallus) growing on bark of broad-leaf deciduous tree, 12.11.2014, Y. Ohmura 11042 (TNS).

Muellerella lichenicola (Sommerf.) D. Hawksw., Bot. Notiser 132(3): 289 (1979).

[Fig. 5]

Ascomata perithecioid, globose, black, 80−130 µm diam. **Ascomatal wall** dark brown, 10.0−30.0 µm diam. **Interascal tissue** absent. **Asci** ellipsoidal to clavate, 70.0−90.0 × 15.0−20.0 µm, 64 to ca 100 spores. **Ascospores** ellipsoid to ovoid-ellipsoid, 1-septate, not constricted septum, smooth, dark brown, (4.2−)4.8−6.0(−6.8) × (2.0−)2.3−2.7(−3.0) µm (n=56).

Specimen examined: JAPAN, Kyushu, Pref. Ohita, on route from Notohge Pass to Mt. Ichino-dake, Yamakunicho, Shimoge-gun, 33°30′N, 130°58′E, elev. 720−910m asl, on *Ochrolechia trochophora* (apothecia) growing on bark of *Carpinus* sp., 10.10.1996, H. Kashiwadani 39947& Y. Umezu (TNS).

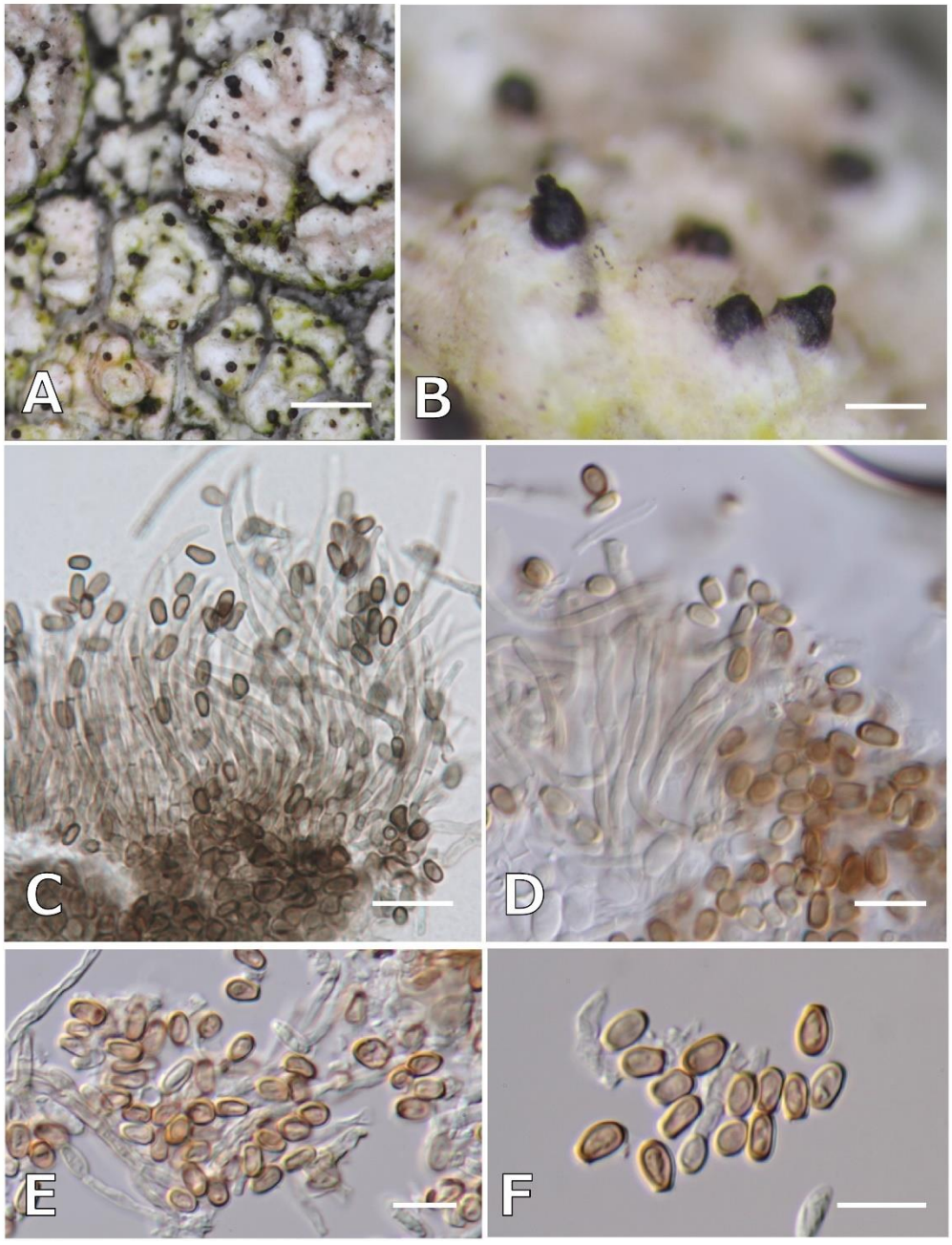

Fig. 4. *Lichenodiplis ochrolechiae* Y. Joshi & M. Tripathi, in Joshi, Falswal, Tripathi & Halda, Sydowia 69: 19 (2016). (Y. Ohmura 11042, TNS). A. Growth habit. B. Conidiomata. C-D. Conidiogenous cells. E-F. Conidia. Scale bars: A=1 mm, B＝0.5 mm, C＝15 μm, D-F＝10 μm.

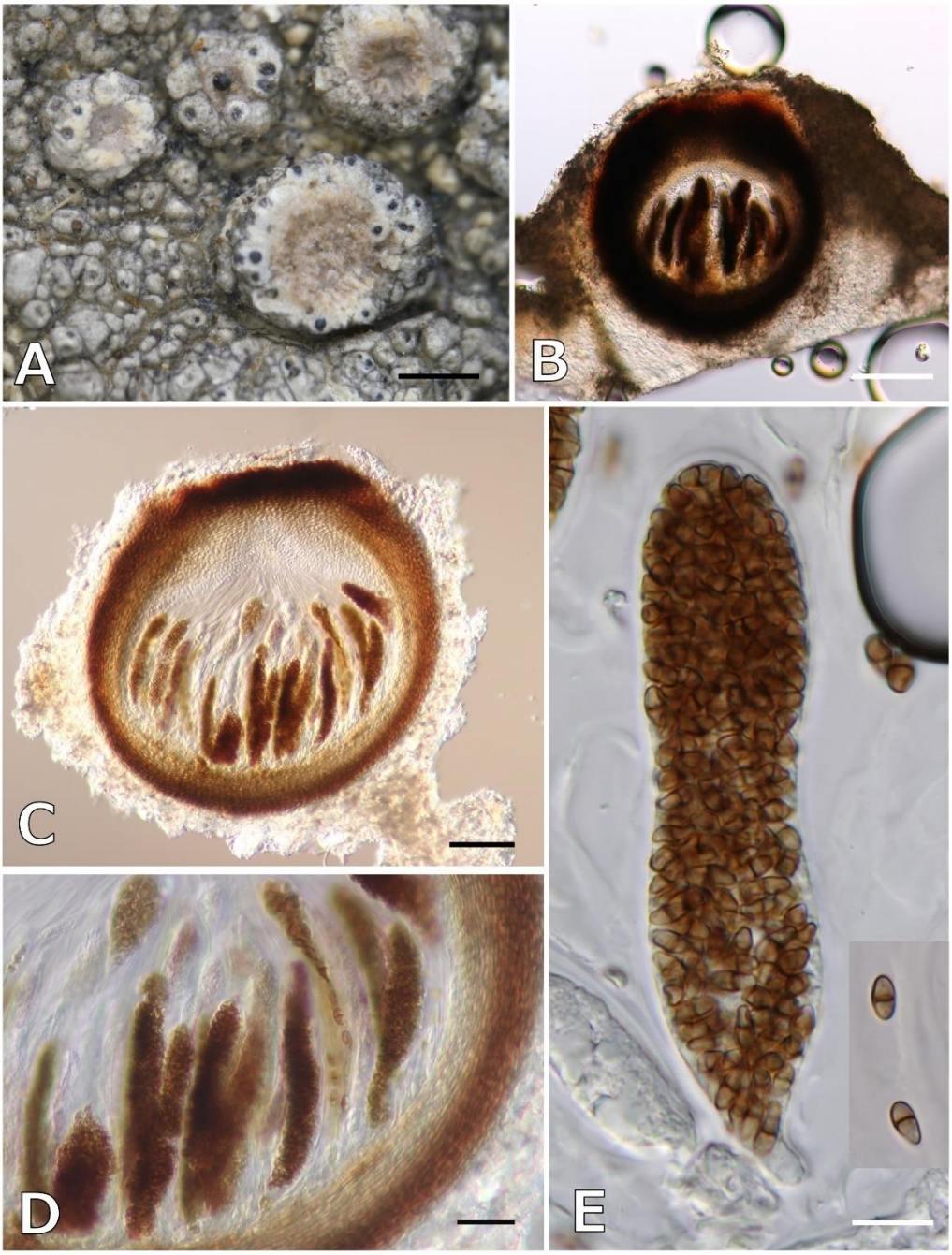

Fig. 5. *Muellerella lichenicola* (Sommerf.) D. Hawksw., Bot. Notiser 132(3): 289 (1979). (H. Kashiwadani 39947& Y. Umezu, TNS). A. Growth habit. B-C. Cross section of an ascomata. D. Hymenium. E. Asci and ascospore. Scale bars: A=0.5 mm, B＝30 μm, C＝10 μm, D＝20 μm, E＝10 μm.

Sagediopsis campsteriana (Linds.) D. Hawksw. & R. Sant., in Alstrup & Hawksworth, Meddr Grønland, Biosc. 31: 63 (1990).

[Fig. 6]

Ascomata perithecioid, black, glossy, rounded, 300−500 µm diam. **Ascomatal wall** dark brown, 50.0−150 µm thick. **Asci** cylindrical to narrowly clavate, bitunicate, 8-spored, 50.0−60.0 × 10.0−12.0 µm. Ascospore narrowly elliptsoid, 3(−5)-septate, not constricted septate, smooth, hyaline, (13.5−)14.5−17.3(−18.7) × (3.6−)3.9−4.7(−5.0) (n=23). **Conidiomata** not observed.

Specimen examined: JAPAN, Hokkaido, Prov. Ishikari, Mt. Jukaihou, the upper Ishikari, 43°41′N, 143°03′E, elev. 900−1200m asl, on *Ochrolechia* sp. (thallus) growing on *Picea glehnii*, 19.08.1953, M. Tatewaki 227 (TNS).

Sclerococcum glaucomarioides (Willey ex Tuck.) Ertz & Diederich, in Diederich, Lawrey & Ertz, Bryologist 121(3): 398 (2018) =Synonymy: *Dactylospora glaucomarioides*.

[Fig. 7]

Ascomata apothecia, sessile, round, black, 0.3−0.4 mm diam. **Hymenium** hyaline, 50.0−70.0 µm tall. **Hypothecium** dark brown. Exciple reddish brown. **Paraphyses** septate, mostly thin, 1.5−2.5 µm wide. **Asci** broadly cylindrical to subclavate, with apical cap, 8-spored, 50.0−65.0 × 10.0−15.0 µm. **Ascopores** brown, 3−5 septate and occasionally a longiseptum in central segment, (9.7−)11.4−13.6(−14.3) × (3.6−)3.9−5.1(−5.9) µm (n=27).

Specimen examined: Japan, Kyushu, Pref. Ohita, on route from Hanamure to Oike, Shonai-cho, Ohita-gun, 33°08′N, 131°17′E, elev. 920m asl, on *Ochrolechia akagiensis* (thallus) growing on bark of *Carpinus laxiflora*, 05.03.1997, Y. Ohmura 3049 (TNS).

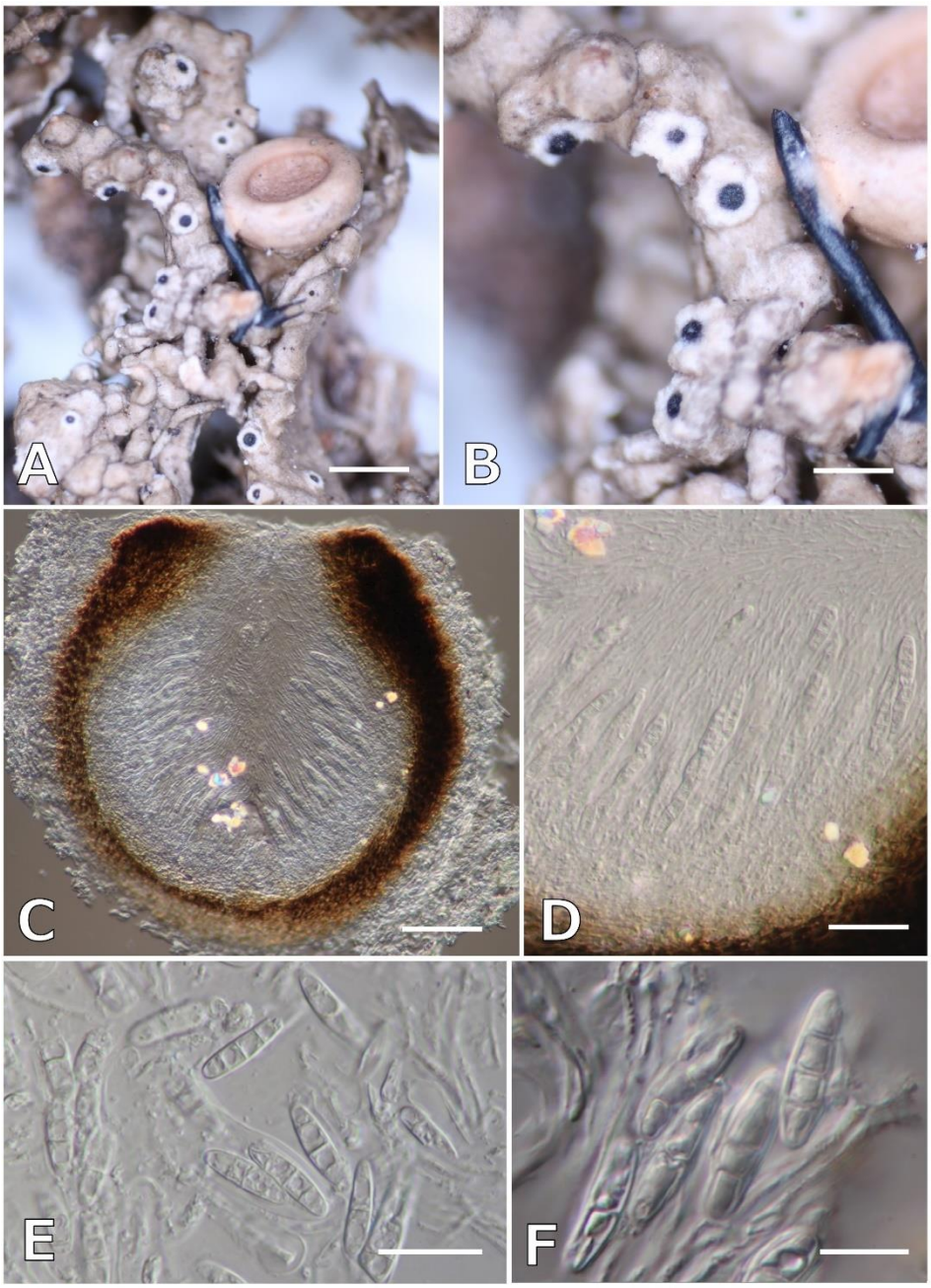

Fig. 6. *Sagediopsis campsteriana* (Linds.) D. Hawksw. & R. Sant., in Alstrup & Hawksworth, Meddr Grønland, Biosc. 31: 63 (1990). (M. Tatewaki 227, TNS). A-B. Growth habit and ascomata. C. Cross section of an ascomata. D. Hymenium. E-F. Ascospora. Scale bars: A=1.5 mm, B＝1 mm, C＝100 μm, D ＝30 μm, E＝20 μm, F＝10 μm.

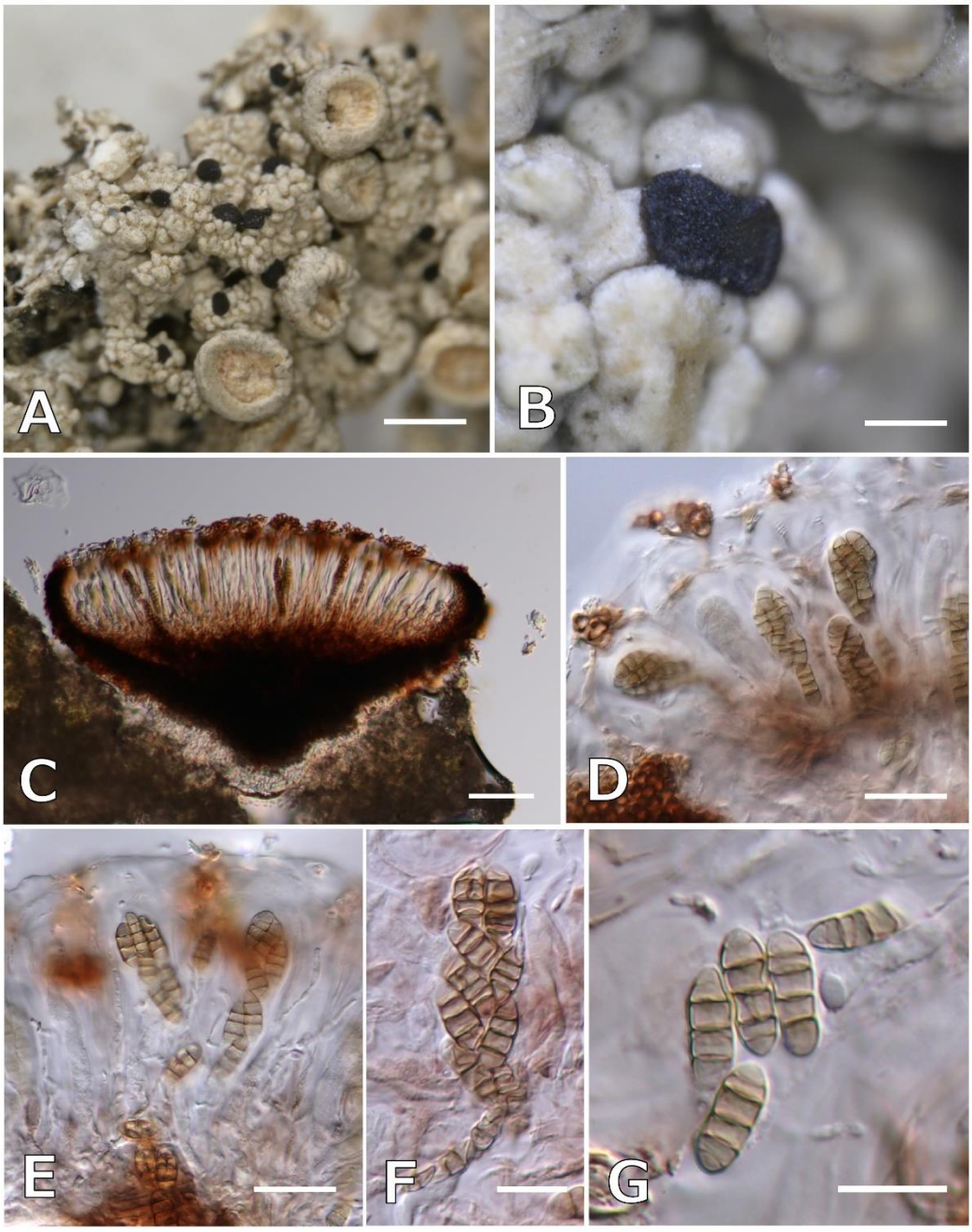

Fig. 7. *Sclerococcum glaucomarioides* (Willey ex Tuck.) Ertz & Diederich, in Diederich, Lawrey & Ertz, Bryologist 121(3): 398 (2018). (Y. Ohmura 3049, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D-E. Hymenium. F. Asci. G. Ascospore. Scale bars: A=1.5 mm, B＝0.3 mm, C＝50 μm, D＝25 μm, E＝20 μm, F-G＝10 μm.

Sclerococcum* cf. *pertusariicola (Willey ex Tuck.) Ertz & Diederich, in Diederich, Lawrey & Ertz, Bryologist 121(3): 399 (2018) =Synonymy: *Dactylospora pertusariicola*.

[Fig. 8]

Ascomata apothecia, sessile, round, black, 0.4−0.5 mm diam. **Hymenium** hyaline, 70.0−80.0 µm tall. **Hypothecium** dark brown. **Exciple** reddish brown. **Paraphyses** septate, mostly thin, 1.3−2.0 µm wide. **Asci** broadly cylindrical to subclavate, up to 64-spored, 50.0−60.0 × 12.0−15.0 µm. **Ascospores** (0−)1-septate, sometimes slightly constricted at the septa, (5.8−)6.5−7.9(−8.6) × (3.7−)4.0−5.0(−5.8) µm (n=42).

Specimens examined: Japan, Hokkaido, Prov. Kushiro, lakeside of Mashu, 43°36′N, 144°34′E, elev. ca. 500m asl, on *Ochrolechia* sp. (thallus), 28.06.1953, M. Togashi (TNS-L-32872). Honshu, Pref. Nagano, on route from Kitazawa Pass to Mt. Kosenjyogatake, Ina-city, 35°44′20″N, 138°12′40″E, elev. 2170m asl, on *Ochrolechia* sp. (thallus, occasionally apothecia) growing on bark of *Tsuga* sp., 29.06.2012, A. Frisch 12/Jp396 & Y. Ohmura (TNS).

Sphinctrina tubaeformis A. Massal. [as 'Sphinctrina tubiformis'], Memor. Lich.: 155 (1853)

[Fig. 9]

Ascomata apothecioid 0.2−0.4 mm. **Stalk** short, black to dark brown, 1.0−1.5 mm. **Capitulum** spherical, black to dark brown, shiny. **Exciple** dark brown, K−. **Asci** cylindrical, 50.0−70.0 × 6.0−8.0 µm. **Ascospore** ellipsoid, simple, reticulately interconnected ridges, brown to dark brown, (9.0−)9.9−11.9(−13.2) × (4.9−)5.5−6.5(−7.4) µm (n=34).

Specimen examined: JAPAN, Hokkaido, Prov. Kushiro: Canoe mooring place near Bekanbeushi-bridge, Akkeshi-gun. On rock; elevation about 50m. August 2, 2003.T. Shiba, 1300 (TNS).

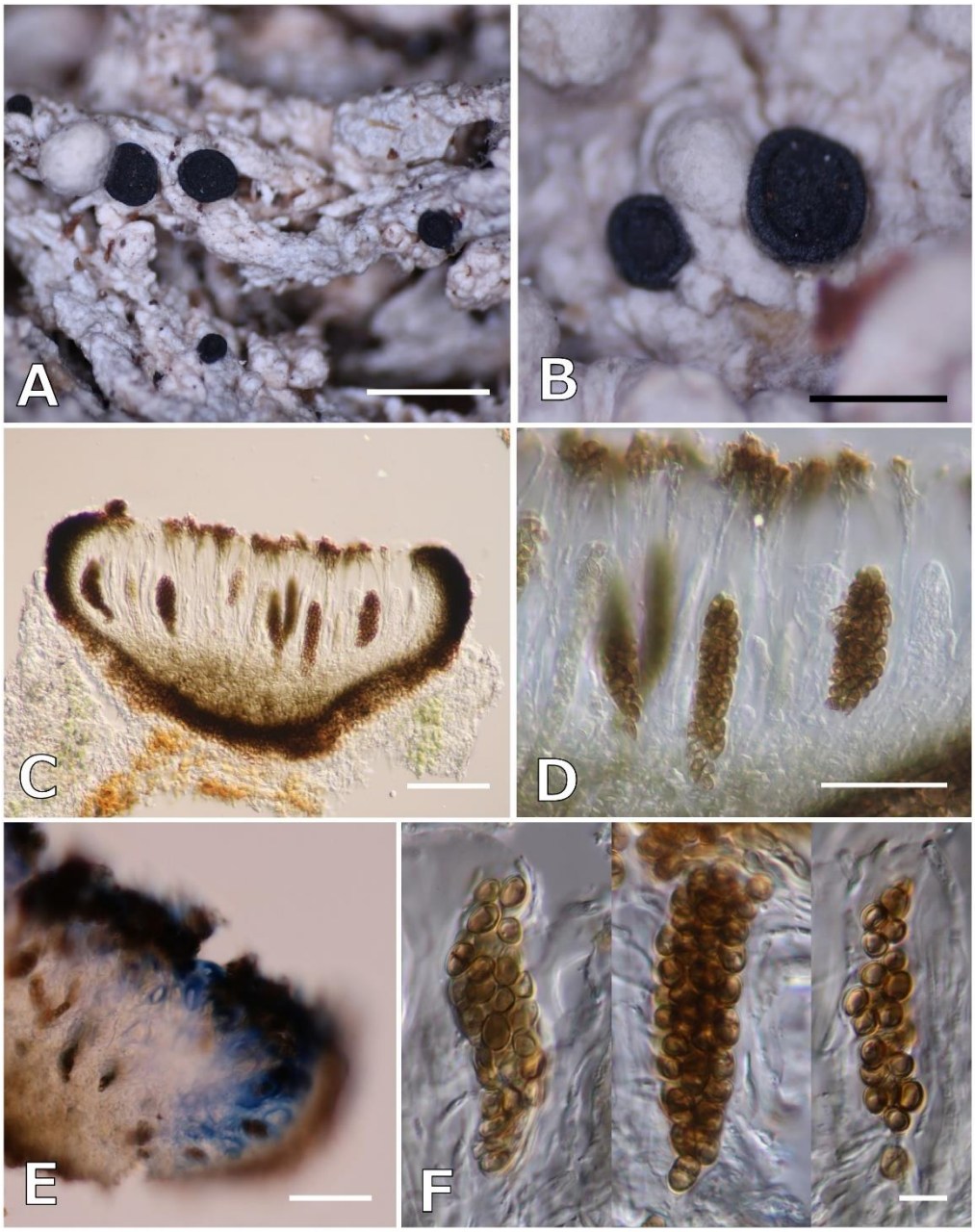

Fig. 8. *Sclerococcum cf. pertusariicola* (Willey ex Tuck.) Ertz & Diederich, in Diederich, Lawrey & Ertz, Bryologist 121(3): 399 (2018). (A. Frisch 12/Jp396 & Y. Ohmura, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E. K/I+blue reaction (Cross section of an ascomata). F. Asci and ascospore. Scale bars: A=1 mm, B＝0.5 mm, C＝50 μm, D＝30 μm, E＝40 μm, F＝10 μm.

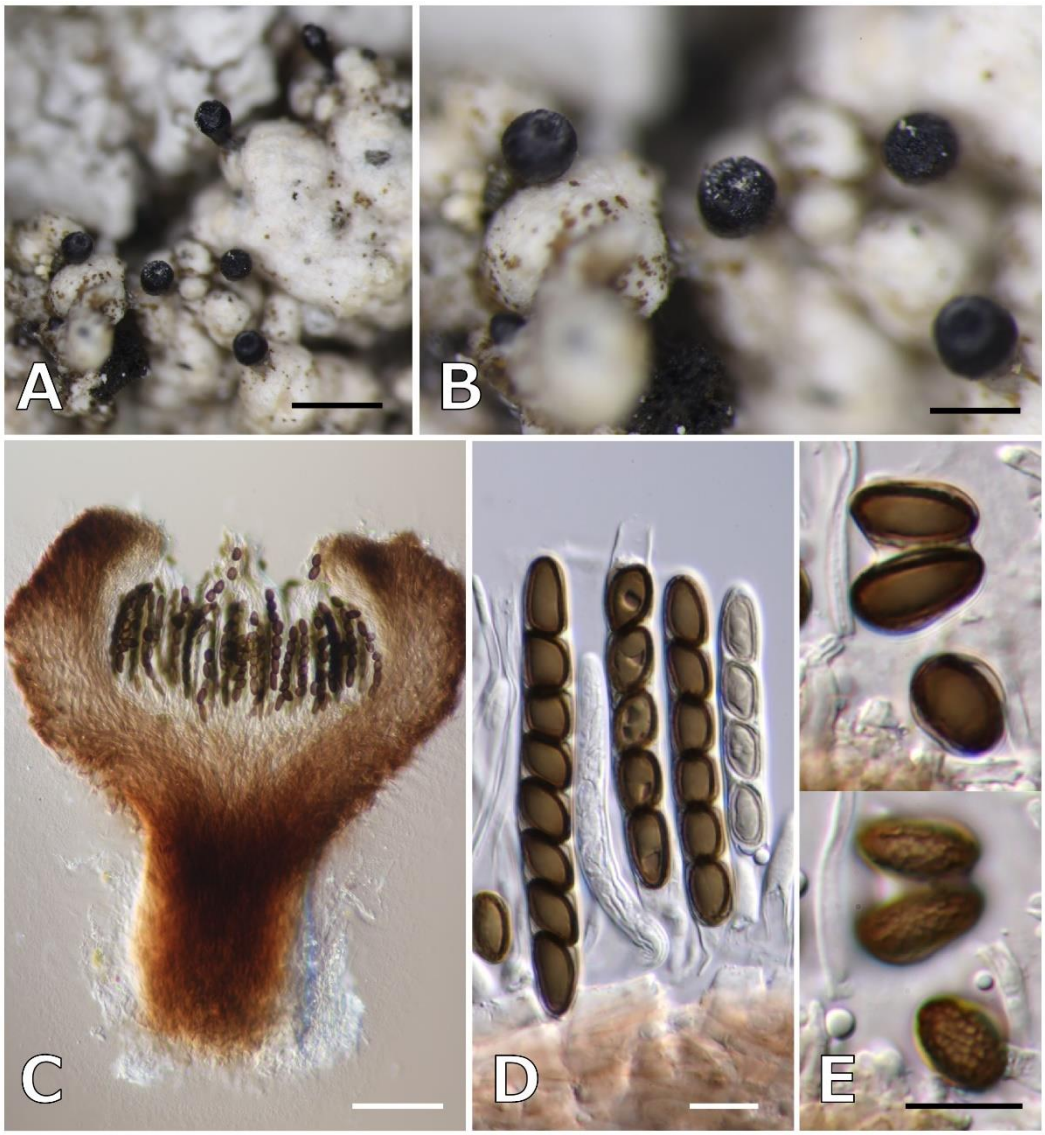

Fig. 9. *Sphinctrina tubaeformis* A. Massal. [as '*Sphinctrina tubiformis*'], Memor. Lich.: 155 (1853). (T. Shiba, 1300, TNS). A-B. Growth habit and ascomata. C. Cross section of an ascomata. D. Asci and ascospore. E. Ascospore. Scale bars: A=1 mm, B＝0.5 mm, C＝100 μm, D-E＝10 μm.

Of the 729 specimens of the genus *Ochrolechia* housed National Museum of Nature and Science, 79 specimens (11%) were parasited lichenicolous fungi. All the species confirmed this time have effects such as malformations and blackening on the host's lichen body and offspring, and no infectious type of lichenicolous fungi in the ascus layer was confirmed.

The infection rates by species are 10% for *O. akagiensis*, 0% for *O. androgyna*, 7% for *O. pallescens*, 5% for *O. parellula*, 8% for *O. submarginata*, 11% for *O. tartarea*, and *O. trochophora* was 6%, *O. upsaliensis* was 18%, *O. yasudae* was 5%, and *O. upsaliensis* tended to be slightly higher. However, considering the number of samples, this is unlikely to be a significant difference (Fig. 10).

The number of lichenicolous fungi parasitized by host type is 2 species on *O. akagiensis* (*S. glaucomarioides*, *Sphaerellothecium* sp), 0 species on *O. androgyna*, 1 species on *O. pallescens* (*S.* cf. *pertusariicola*), 3 species on *O. parellula* (*Lichenostigma* sp, *Sphaerellothecium* sp, *S. tubaeformis*), 1 species on *O. submarginata* (*L. ochrolechiae*), 4 species on *O. tartarea* (*S. campsteriana*, *S.* cf. *pertusariicola*, *S. glaucomarioides*, *Sphaerellothecium* sp), 6 species on *O. trochophora* (*L. anomala*, *L. lecanorae*, *M. lichenicola*, *S.* cf. *pertusariicola*, *Skyttea* sp, *S. tubaeformis*), 2 species on *O. upsaliensis* (*L. lecanorae*, *Sphaerellothecium* sp), and 2 species on *O. yasudae* (*S. glaucomarioides*, *Skyttea* sp). From this result, it was found that *S. glaucomarioides* parasitizes multiple species of the genus *Ocrolechia*, and *O. tartarea* and *O. trochophora* are parasitized by various lichenicolous fungi. Therefore, it is considered that at least the lichenicolous fungi parasitizing the genus *Ocrolechia* has no host specificity. It will also be necessary to clarify why *O. tartarea* and *O. trochophora* are parasitized by various lichenicolous fungi (Fig. 11).

The odds of finding lichenicolous fungi from examining domestic specimens were much lower than expected. In general, lichen specimens are collected by selecting non-

infected samples; therefore, these results are not always correct. The specimens in the museum's collection were limited to those that characterized the species. However, lichens parasitized with lichenicolous fungi tend to be deformed or discolored. Therefore, it is probable that a Japanese lichenologist did not collect these. For this reason, it was difficult to determine the number of lichenicolous fungi in Japan using this method. In the field, however, more individuals infected with lichenicolous fungi can be found.

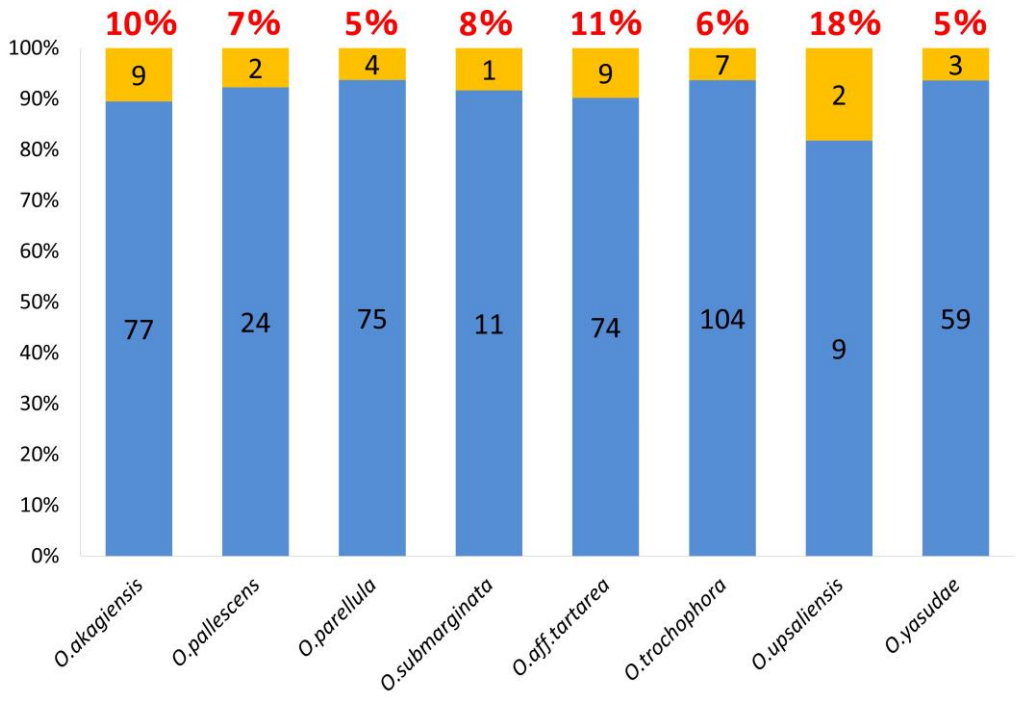

Fig. 10. Infection rate for each *Ochrolechia* specimen

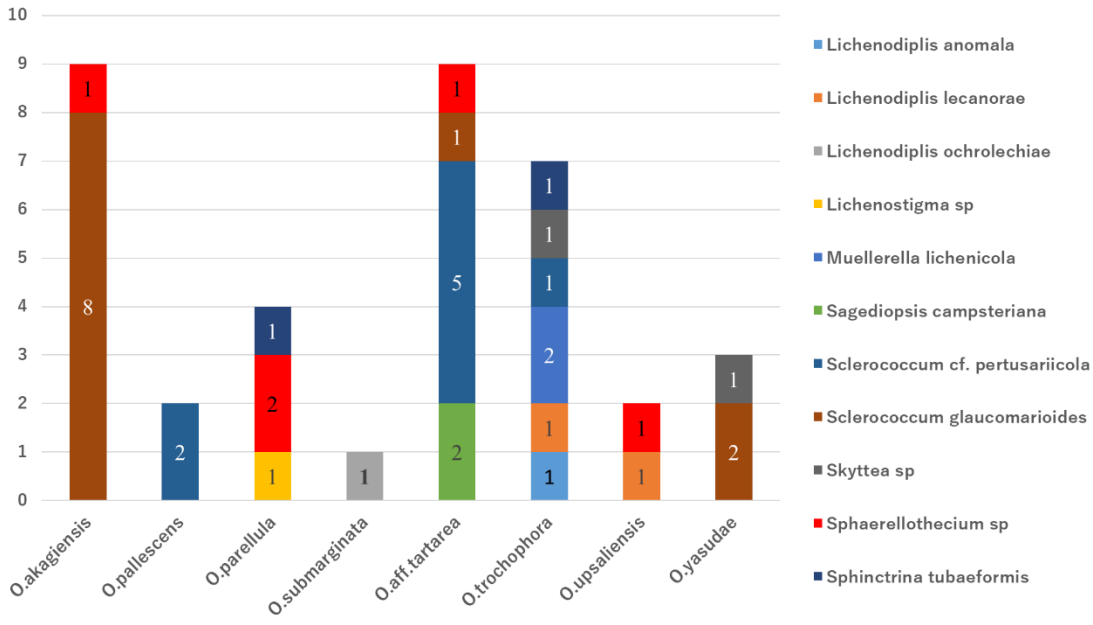

Fig. 11. Species of lichenicolous fungi parasitizing *Ochrolechia*.

Chapter 3

Field survey in Montane and Subalpine area.

3–1. Materials and methods

The host lichens were collected at Mt. Akadake and Mt. Kitayokodake in Nagano Prefecture, Mt. Myouhou in Saitama Prefecture, and Mt. Meakan in Hokkaido between December 2016 and September 2019. The presence of lichenicolous fungi was confirmed for these host lichens.

Morphological observations were made using a dissecting microscope (Olympus SZX12) and a differential interference contrast microscope (Olympus BX51). Anatomical examinations were made on hand-cut sections mounted in water

Chemical reactions were observed by the use of 10% KOH (K). The amyloidity of the hymenial gels was observed in 1.5% Lugol's iodine solution directly (I) or after a 10% KOH pretreatment (K/I). Spore measurements are given as (minimum–) average ± standard deviation (–maximum) (n = number of measurements).

As with the specimen survey, morphological and chemical features were compared with reference to the Exicata specimens (Santesson: Fungi Lichenicoli Exs) from the National Museum of Nature and Science to accurately identify the species.

3–2. Result and Discussion

Abrothallus parmeliarum (Sommerf.) Arnold, Flora, Regensburg 57: 102 (1874).

[Fig. 12]

Mycelium immersed, I–. **Ascomata** apothecioid, superficial, scattered, round, convex, constricted at the base, black, covered by a green pruina when young, 200–300 μm diam. **Epihymenium** brown to dark olivaceous brown, 10 μm tall, K+ green. **Hymenium** olivaceous greenish pigment in the upper part, hyaline in the lower part, paraphysoids branched, 50–80 μm tall, K–. **Hypothecium** brown to dark reddish brown, 50 μm tall, K–. **Asci** elongate ellipsoid to clavate, 8-spored, 43.0–53.0(–54.0) × 8.0–15.0 μm. **Ascospores** ellipsoid, 1-septate, cells unequal in width, the upper cell wider and the lower cell elongated, verrucose, dark brown, (11.9–)12.4–14.2(–15.4) × (4.5–)4.9–6.2(–7.1) μm (n=54). **Anamorph** not observed.

Morphological and anatomical features of the Japanese material mentioned above agree well with the protologue and the description provided by Suija et al. (2018) as well as with an exsiccate specimen of *Abrothallus parmeliarum* [Santesson: Fungi Lichenicoli Exs. 2 (TNS!); epihymenium K+ green, ascospores size (11.9–)12.3–14.3(–15.2) × (5.0–)5.6–6.6(–6.8) μm (n=10)].

Abrothallus parmeliarum is the fourth parasitic *Abrothallus* species known from Japan besides *A. bertianus* De Not. (Zhurbenko et al. 2015c), *A. microspermus* Tul. (Zhurbenko and Ohmura 2019), and *A. peyritschii* (Stein) Kotte (Zhurbenko et al. 2015c). *Abrothallus bertianus* is distinguished from *A. parmeliarum* by I+ blue mycelium, parasitic growth on several *Melanelixia* species (Hawksworth et al. 2010a). *Abrothallus microspermus* differs from *A. parmeliarum* by the small ascospores [(9–)11–13.5(–14) × (3–)4.5–5.5(–6.0) μm]. This species is most often found in the anamorphic state. It has been found only on *Flavoparmelia caperata*

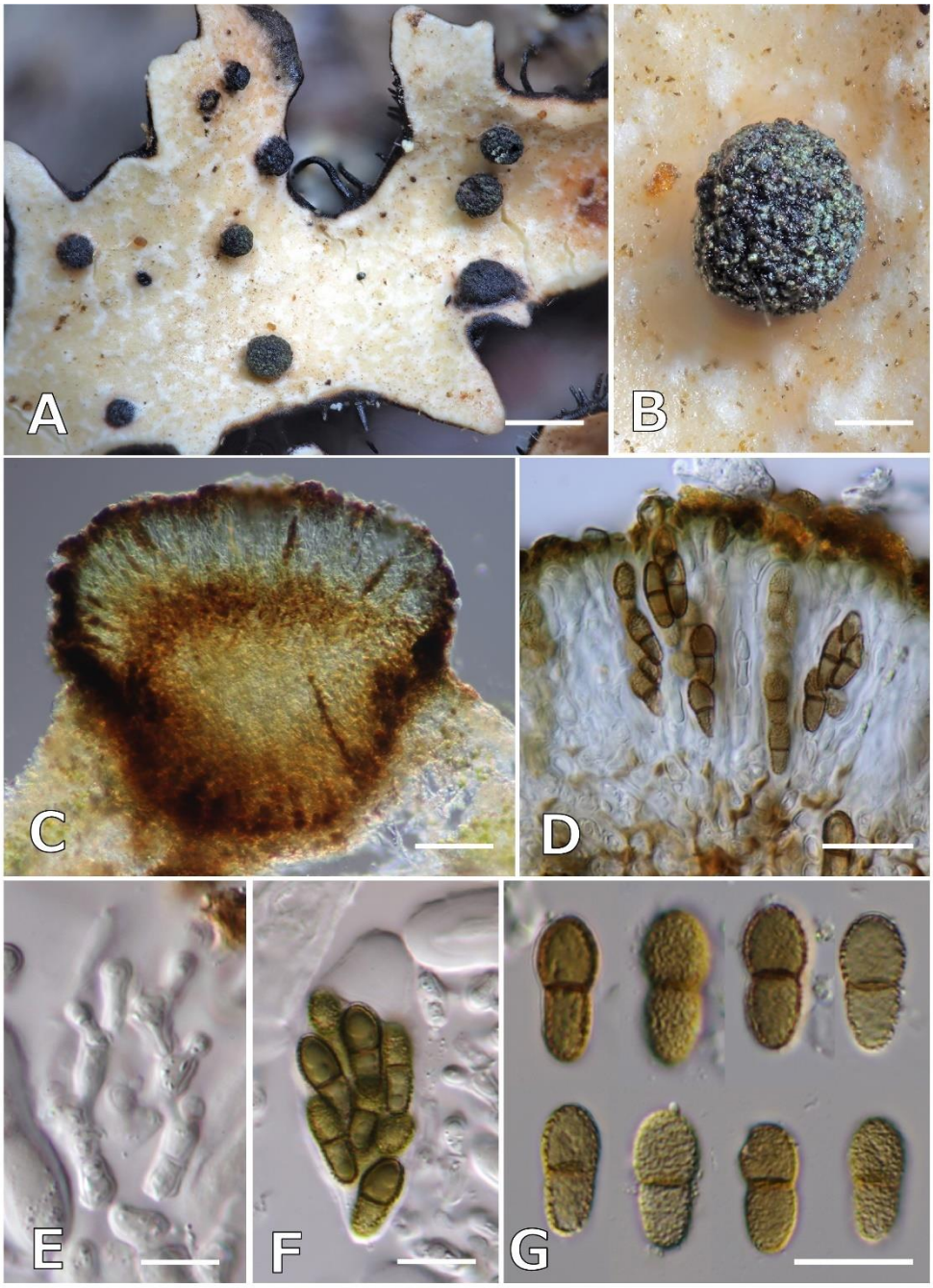

Fig. 12. *Abrothallus parmeliarum* (Sommerf.) Arnold, Flora, Regensburg 57: 102 (1874). (K. Tadome 489, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E. Paraphyses. F. Asci and ascospore. G. Ascospore. Scale bars: A=0.5 mm, B＝100 μm, C＝50 μm, D＝20 μm, E-G＝10 μm.

(L.) Hale (Hawksworth et al. 2010a). *Abrothallus peyritschii* is distinguished from *A. parmeliarum* by I+ blue mycelium, and differs morphologically by the small ascospores (10.5–13.0 × 4.5–6.0 μm). It has been found on several *Cetraria* species (Diederich et al. 2018) and *Vulpicida pinastri* (Nash et al. 2004).

Abrothallus parmeliarum was reported in Asia (India, Kazakhstan, Mongolia, and Russia) (Alstrup and Ahti 2007, Hauck et al. 2013, Joshi et al. 2016, Zhurbenko et al. 2020), Europe (Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Estonia, France, Greece, Norway, Scotland, and U.K.) (Bilovitz et al. 2010, Diederich 2011, Pérez-Ortega et al. 2014, Hafellner 2018, Suija et al. 2018), North America (Canada and U.S.A.) (Alstrup and Ahti 2007, Hafellner 2017), and South America (Argentina and Bolivia) (Flakus and Kukwa 2012, Zhurbenko et al. 2015b). The distribution is now extended to Japan (Tadome and Ohmura 2021a).

Specimen examined. JAPAN. Honshu. Shinano Prov. (Nagano Pref.): along the trail (route, mountain path) from Minotoguchi to Mt. Akadake, 1772 m elev., on *Parmelia* cf. *adaugescens*. on tree bark, 13 Sep. 2017, K. Tadome 489 (TNS).

Exsiccate examined. SWEDEN. Jämtland: Åre par., S of Stortävlan (WSW of Storlien). Alt. c. 550m. On trunks of birch in a birch forest. On *Parmelia sulcata* (thallus). August 7, 1948 (Santesson: Fungi Lichenicoli Exs. 2, TNS).

Arthonia digitatae Hafellner, Linzer Biol. Beitr. 31(1): 508 (1999).

[Fig. 13]

Ascomata apothecioid, superficial, scattered or grouped, round, convex, black, flattened at the margin, 140–150 μm diam. **Epihymenium** brown to olive brown, 7.0–10.0 μm tall, K−. **Hymenium** hyaline, without inspersion, 30–35 μm tall, I+ red, K/I+ blue;

paraphysoids branched and anastomosed, brown at the tips, slightly enlarged, extending above the asci, (1.0–)1.2–1.8(–2.0) µm wide. **Hypothecium** hyaline to pale brown. **Asci** clavate, *Arthonia*–type, (20.0–)21.0–29.0 × (11.0–)12.0–14.0(–15.0) µm, 8-spored, ascus apex with a K/I+ blue ring structure in the innermost layer. **Ascospores** oblong, 1-septate, constricted at the septum, cells unequal in width, the upper cell wider and the lower cell elongated, hyaline, (8.5–)9.8–11.4(–11.9) × 3.9–4.9(–5.5) µm (n=54).

Morphological and anatomical features of the Japanese material mentioned above agree well with the protologue and the description provided by Brackel (2015) and Hafellner (1999) as well as exsiccata of *Arthonia digitatae* [Santesson: Fungi Lichenicoli Exs. 352 (TNS!); hymenium I+ red, K/I+ blue, ascospores size (8.6–)9.0–11.0(–11.6) × (3.5–)3.6–4.2(–5.0) µm (n=15), and paraphysoids (0.8–)0.9–1.4(–1.5) µm wide].

Arthonia digitatae is the seventh parasitic *Arthonia* species known from Japan besides *A. almquistii* Vain. (Zhurbenko et al. 2015c), *A. biatoricola* Ihlen & Owe-Larss. (Frisch et al. 2014), *A. graphidicola* Coppins (Frisch et al. 2014), *A. lopingensis* Zahlbr. (Frisch et al. 2018), *A. molendoi* (Heufl. ex Arnold) R. Sant. (Tadome et al. 2018), and *A. phaeophysciae* Grube & Matzer (Frisch et al. 2020). *Arthonia almquistii* is distinguished from *A. digitatae* by larger ascospores (10.5–15.0 × 4.0–6.0 µm) and a different host spectrum including *Amygdalaria* species, *Koerberiella* species, *Porpidia* species and *Trapelia* species (Triebel 1989, Diederich et al. 2018). *Arthonia biatoricola* is distinguished from *A. digitatae* by larger ascospores [(10.0–)10.5–13.0(–15.0) × 4.0–5.0(–6.0) µm] and *Biatora efflorescens* as the host lichen (Ihlen et al. 2004). *Arthonia graphidicola* is distinguished from *A. digitatae* by larger, 2–3-septate ascospores (13.0–17.0 × 4.5–5.5 µm) and by growing on *Graphis scripta* (Coppins 1989). *Arthonia lopingensis* is distinguished from *A. digitatae* by lirellate to star-shaped ascomata that are often weakly covered with an orange and K+ purple pruina and by growing as a juvenile

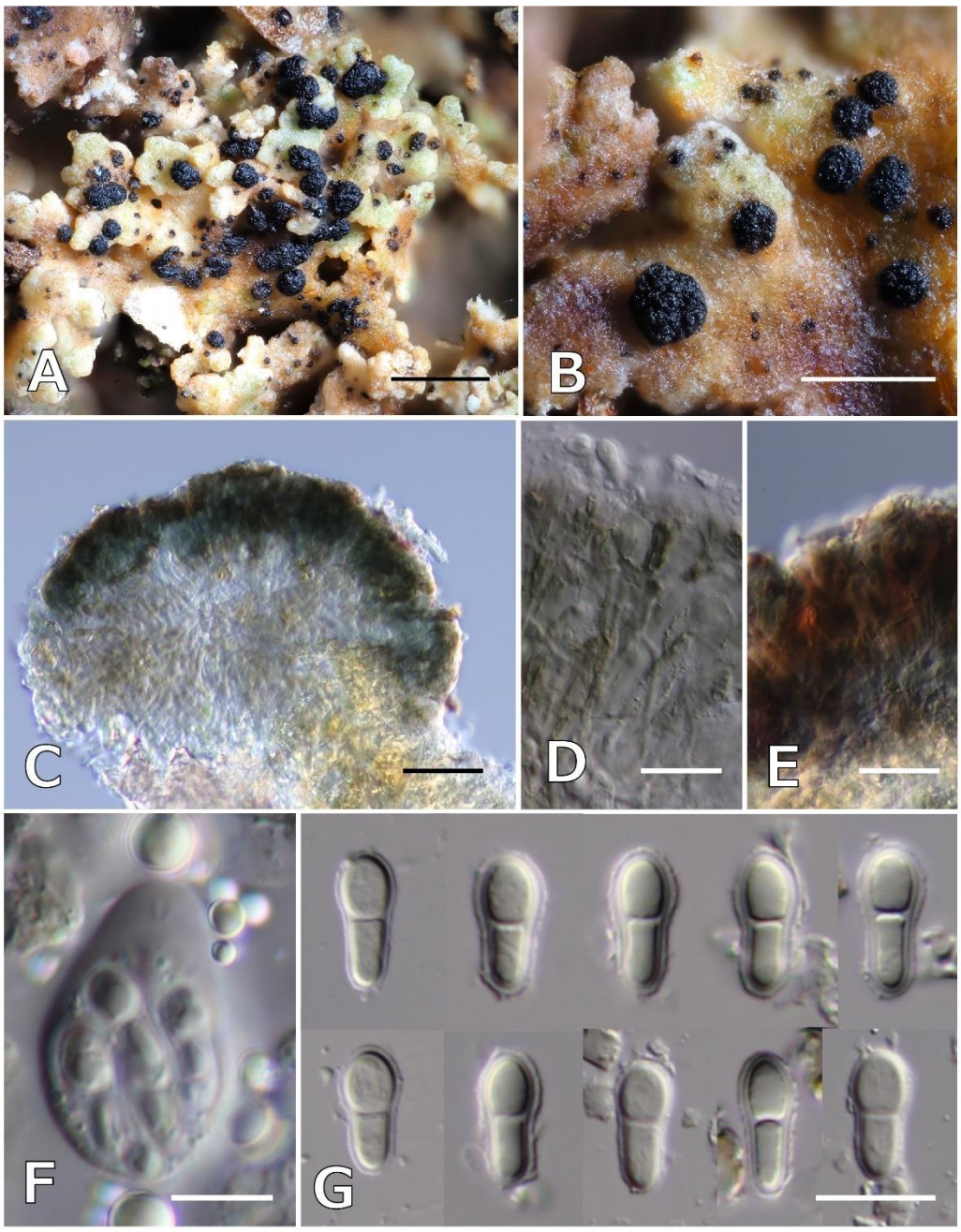

Fig. 13. *Arthonia digitatae* Hafellner, Linzer Biol. Beitr. 31(1): 508 (1999). (K. Tadome 860, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium and Paraphyses. E. I+red reaction (hymenium). F. Asci and ascospore. G. Ascospore. Scale bars: A=0.5 mm, B＝300 μm, C＝30 μm, D-G＝10 μm.

parasite on several *Graphis* species (Frisch et al. 2018). *Arthonia molendoi* is distinguished from *A. digitatae* by the color of epihymenium (blackish brown with dark olive tinge) and hypothecium (pale yellowish to medium brown) and by growing on *Calogaya* and *Rusavskia* species (Fleischhacker et al. 2016, Diederich et al. 2018). *Arthonia phaeophysciae* is distinguished from *A. digitatae* by the ascomata (developing on upper surface of thallus or breaking through the upper cortex of the host lichen) and the larger ascospores (12.0–14.0 × 4.0–6.0 μm) (Grube and Matzer 1997), and it was found on *Phaeophyscia* species and *Physciella melanchra* (Frisch et al. 2020).

Arthonia digitatae was reported from Asia (Mongolia and Russia) (Zhurbenko and Pino-Bodas 2017, Zhurbenko et al. 2016), Europe (Austria, Czech Republic, England, Estonia, Finland, France, Germany, Luxemburg, Norway, Poland, Scotland, Spain, Sweden, and Ukraine) (Aptroot et al. 2005, Czarnota et al. 2014, Darmostuk et al. 2020, Hafellner 1999, Hawksworth et al. 2010a, Ihlen and Wedin 2005, Kocourková and Van den Boom 2005, Kukwa et al. 2010, Roux 2012, Sérusiaux et al. 2003, Suija and Jüriado 2020, Zhurbenko and Pino-Bodas 2017) and North America (Canada) (Zhurbenko 2013a). The distribution is now extended to Japan (Tadome and Ohmura 2021a).

Specimen examined. JAPAN. Hokkaido Pref.: Mt. Meakan, 740 m elev., on *Cladonia squamosa*. on fallen tree, 3 Sep. 2019, K. Tadome 860 (TNS).

Exsiccate examined. AUSTRIA. Steiermark Prov., Niedere Tauern, Triebener Tauern, in the Liesing SW of the village 'Wald am Schoberpass', N exposed slope by path to Liesingkar Alm, 27:25'30"N 14:37'15"E, Alt. 1350 m, on stumps in a *Picea-Larix* forest. 24 May 2001, on *Cladonia digitata* (thallus), J. Hafellner 57084 (Santesson: Fungi Lichenicoli Exs. 352, TNS).

Illosporium carneum Fr., Syst. Mycol. (Lundae) 3(1): 259. 1829.

[Fig. 14]

Colonies formed by sporodochial conidiomata, usually discrete, sometimes confluent each other to form irregular mass in shape, erumpent through the upper cortex of the host thallus, 200–300 μm wide, 80–100 μm tall, pink to orange, K–, K/I–. **Conidiophores** micronematous, subglobose to ellipsoid or irregular in shape, densely compacted with adjacent cells. **Conidiogenous cells** ellipsoid to irregular in shape, hyaline. **Conidia** subglobose but often rather angular due to compression by adjacent conidia, connected, (4.7–)5.3–6.7(–7.7)×(4.7–)4.3–6.1(–7.0) μm (n＝40), hyaline to pale pink. This species is characterized by the pink irregular-shaped sporodochial conidiomata and subglobose conidia.

Morphological and anatomical features of the Japanese material mentioned above agree well with the protologue and the description provided by Hawksworth (1979) as well as those of exsiccatae of *Illosporium carneum* [Santesson: Fungi Lichenicoli Exs. 13, 265, 354 (TNS!); conidia size (4.5–)5.2– 6.6(–7.3) × (4.0–)4.8–6.2(–6.9) μm (n＝45)]. In Japan, the teleomorph of *I. carneum*, i.e., *Pronectria robergei*, has not been found so far. However, it will be expected to be found in further investigation as it is common lichenicolous fungus parasitized on various *Peltigera* genera around the world (Vondrák and Liška, 2013; Moisejevs, 2017; Maloles et al., 2018; Suija and Jüriado, 2020).

The genus *Illosporium* is an anamorph of the genus *Pronectria* (Bionectriaceae, Ascomycota), and characterized by the pink irregular-shaped sporodochial conidiomata and globose to subglobose conidia (Hawksworth, 1979). Most species of *Illosporium* are non-lichenicolous parasitic fungi found usually on vascular plants, but *I. carneum* is only known as lichenicolous species within the genus (Diederich et al., 2018). *Illosporium carneum* is an anamorph of *Pronectria robergei*. It was proved that *P. robergei* was developed from *I. carneum*

on infected *Peltigera* by long-term observation in the field (Killian and Erner, 1925).

This species was reported in Asia (Turkey) (Volker et al., 2020), Europe (Austria, England, Finland, Greenland, Latvia, Norway, Poland, Russia, Romania, and Spain) (Elvebakk and Prestrud, 1996; Urbanavichus et al., 2007; Hansen, 2008; Kukwa and Flakus, 2009; Hawksworth et al., 2010a; Vondrák and Liška, 2013; van den Boom and Etayo, 2014; Hafellner, 2015; Moisejevs, 2017; Suija and Jüriado, 2020), North America (Canada) (Maloles et al., 2018), and Oceania (New Zealand) (Galloway, 2007). The distribution is now extended to Japan (Tadome and Ohmura 2021b).

Specimen examined. JAPAN. Nagano Pref.: Mt. Akadake, 2300 m elev., on *Peltigera didactyla* on rock, 13 September 2017, K. Tadome 496 (TNS).

Exsiccate examined. SWEDEN. Uppland: Estuna par., 0.5 km of Kullsta, on a sandy road side, on *Peltigera spuria* (=*P. didactyla*) (thallus), 7 July 1940 (Santesson: Fungi Lichenicoli Exs. 13, TNS); Torne Lappmark Prov., the Tornetrask area, Abisko, near the Tourist Station, 68°20′N 18°51′E, alt. 385 m, on the railway bank, on *Peltigera didactyla* (thallus), 16 August 1947 (Santesson: Fungi Lichenicoli Exs. 265, TNS). AUSTRIA. Salzburg Prov., Pinzgau, Hohe Tauern, Glockner-group, Stubachtal, Enzingerboden, on the W lowermost slope of Rotenkogel, 47°10′20″N 12°37′40″E, alt. 1500 m, slope with boulders and open *Pinus mugo* grove, on *Peltigera polydactylon* (thallus), 31 August 1996 (Santesson: Fungi Lichenicoli Exs. 354, TNS).

Lichenopuccinia poeltii D. Hawksw. & Hafellner, in Hawksworth, Beih. Nova Hedwigia 79: 374 (1984).

[Fig. 15]

Conidiomata sporodochial, superficial, scattered or grouped, round, convex,

constricted at the base, black, 200–450 μm diam. **Conidiophores** cylindrical, irregularly branched, hyaline, 3.0–5.0 μm wide. **Conidiogenous cells** cylindrical, hyaline. **Conidia** occur on the sides of conidomata, elongate to clavate, thickened towards the apex, smooth, arising singly, holoblastic, (2–3 septate), hyaline, (18.1–)19.5–24.3(–29.3) × (5.4–)7.2–8.8(–9.5) μm (n=63).

Morphological and anatomical features of the Japanese material agree well with the protologue and the description provided by Hawksworth (1984). The size of the conidia was consistent with conidia from an exiccate specimen of *L. poeltii* [Santesson: Fungi Lichenicoli Exs. 169 (TNS!); conidia size (18.7–)21.0–26.9(–30.4) × (6.2–)6.8–7.8(–8.6) μm (n=21)]. *Lichenopuccinia poeltii* is characterized by the hyaline, 2–3-septate conidia on the surface or sides of the black sporodochia. Although *Minutoexcipula* species and *Sclerococcum* species also have black sporodochia, they differ from *L. poeltii* in having brown conidia (Hawksworth et al. 2010a).

Lichenopuccinia poeltii was reported from Asia (Russia: Taymyr) (Zhurbenko 2009a), Europe (Norway, Portugal, Scotland and Spain) (Holien et al. 2016, Hawksworth et al. 2010a, Van den Boom and Etayo 2000), and North America (Canada and U.S.A.) (Diederich 2003, Zhurbenko and Dillman 2010). This species has a wide distribution in the Northern Hemisphere, mainly in Europe, which is now extended to Japan (Tadome and Ohmura 2021a).

Specimen examined. JAPAN. Honshu. Shinano Prov. (Nagano Pref.): Mt. Akadake, 2300 m elev., on *Parmelia fertilis*. on tree bark, 14 Sep. 2017, K. Tadome 497 (TNS).

Exsiccate examined. U.K. British Isles: Isle of Skye, SSE of Broadford, Ardnameacan, on *Parmelia saxatilis* (thallus), 27 May 1987, P. Diederich 8302 (Santesson: Fungi Lichenicoli Exs. 169, TNS).

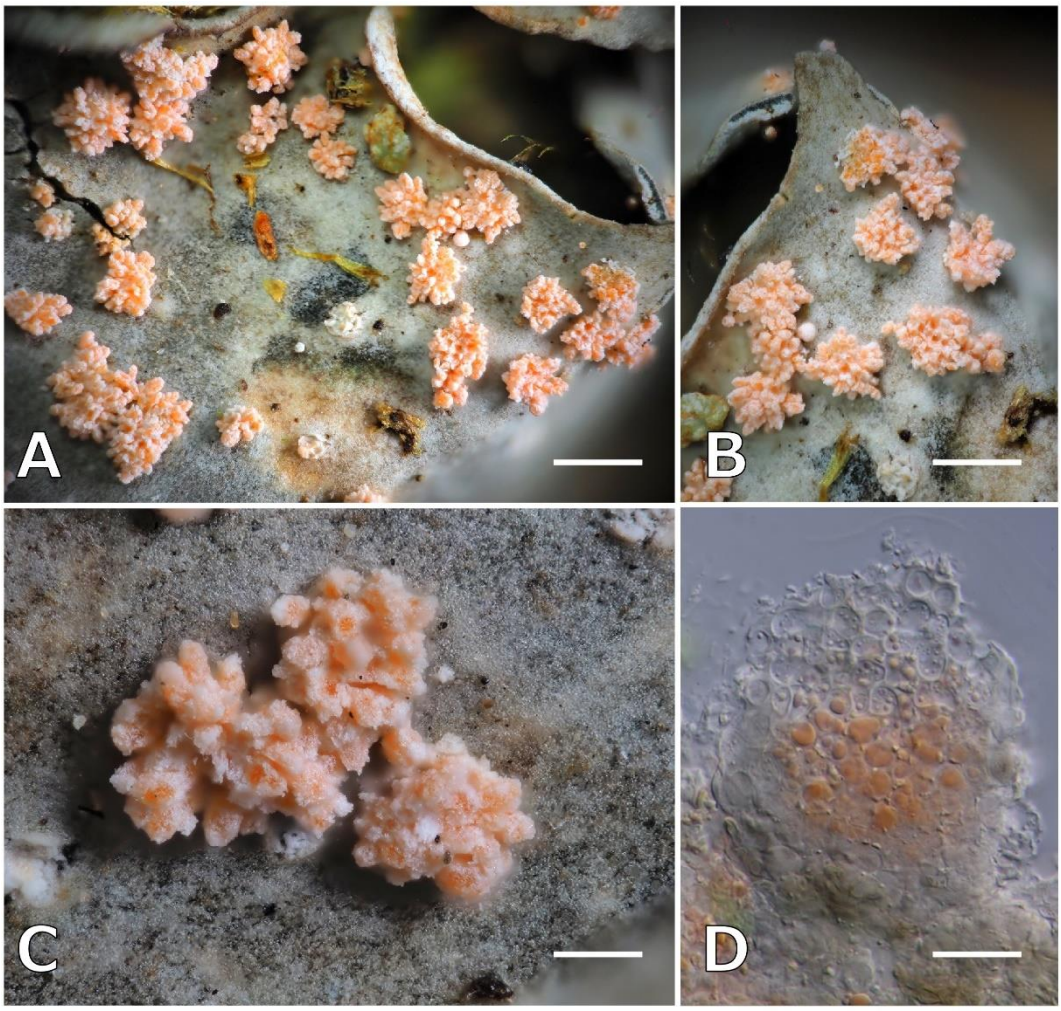

Fig. 14. *Illosporium carneum* Fr., Syst. Mycol. (Lundae) 3(1): 259. 1829. (K. Tadome 496, TNS). A. Growth habit. B-C. Colony. D. Cross section of sprodochia. Scale bars: A=0.3 mm, B＝200 mm, C＝100 μm, D＝20 μm.

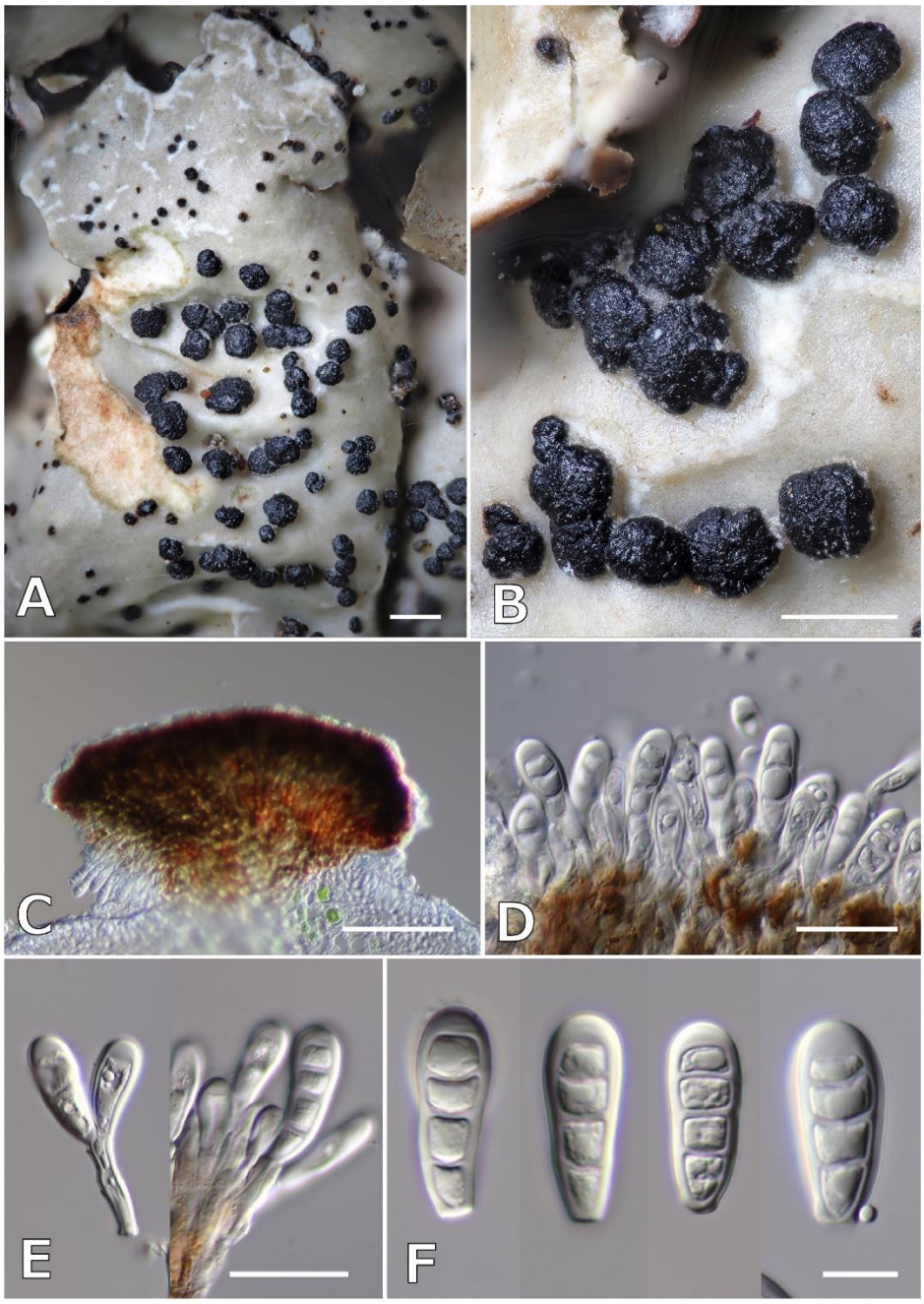

Fig. 15. *Lichenopuccinia poeltii* D. Hawksw. & Hafellner, in Hawksworth, Beih. Nova Hedwigia 79: 374 (1984). (K. Tadome 497, TNS). A. Growth habit. B. Sprodochia. C. Cross section of sprodochia. D. Acervulus. E. Conidiophore and conidia. F. Conidia. Scale bars: A-B=0.5 mm, C＝100 μm, D-E＝20 μm, F＝10 μm.

Ovicuculispora parmeliae (Berk. & M. A. Curtis) Etayo, Bull. Soc. Linn. Provence 61: 112. 2010.

[Fig. 16]

Ascomata occur on upper surface of thallus of the host lichen, scattered or grouped, globose to subglobose, with brighter colored small papilla, surface covered with long hair, pink to red, 200–250 μm diam, K–, K/I–; **ascomatal wall** hyaline to slightly orange, 30–45 μm thick; hymenium hyaline, 100–130 μm tall. **Asci** clavate, 100×30 μm, with 1 macrospore and 3–4 microspores/ascus. **Ascospores** ellipsoid to narrowly ellipsoid, rounded at the apices, costricted at the septum, hyaline; macrospore 1-septate, (30.4–)29.7–47.7(–54.4) × (11.1–)12.0– 22.1(–25.5) μm (n=22); microspore 0–1-septate, (4.9–)6.6–11.2(–12.1) × (2.3–)3.1–5.9(–6.6) μm (n = 44). **Anamorph** not observed.

This species is characterized by the hairy pink to reddish ascomata and extremely different sized ascospores (macrospore and microspore) within an ascus. Morphological and anatomical features of the Japanese material mentioned above agree well with the protologue and the description provided by Berkely (1874). In the genus *Ovicuculispora*, only two species, *O. parmeliae* and *O. macrospora* Etayo, are known. *Ovicuculispora parmeliae* is reported from worldwide, while *O. macrospora* is known only from Peru. These species were originally distinguished by the macrospore size: 31–45×13–18 μm for *O. parmeliae* vs. 67–105×32–40 μm for *O. macrospora* (Etayo, 2010). However, various range of ascospore size both for macrospores and microspores were reported in *O. parmeliae* (Table 1) and the ranges of ascospores are largely overlapped with those of *O. macropora*. Further taxonomic studies are needed for the independency of *O. macrospora* or the possibility of multiple species within *O. parmeliae*.

Ovicuculispora parmeliae was reported in Asia (South Korea) (Zhurbenko et al., 2015),

Europe (Ireland and Russia) (Etayo, 2010; Hawksworth et al., 2010a), North America (Hawksworth, 1981; Maloles et al., 2018), and South America (Bolivia and Dominica) (Flakus et al., 2006; Etayo and van den Boom, 2013). The distribution is now extended to Japan (Tadome and Ohmura 2021b).

Specimen examined. JAPAN. Saitama Pref.: Mt. Myouhou, 1330 m elev., on *Heterodermia japonica* on rock, 29 July 2018, K. Tadome 613 (TNS).

Pronectria japonica Zhurb., Tadome & Y. Ohmura, Herzogia 31(1, Teil 2): 495 (2018).

[Fig. 17]

Ascomata perithecioid, subglobose, flattened to depressed from above, immersed to-semiimmersed, erumpent, pink to orange, 150 –250 µm diam. **Ascomatal wall** pale to orange yellow, 30.0–50.0 µm thick. Interascal filaments delicate, septate, constricted at the septa, 8µm diam. **Asci** clavate, 8-spore, (44.5–)47.1–59.3(–67.1) × (10.3–)12.7–16.5(–16.8) µm (n=9). **Ascospores** narrowly fusiform, 1(–3)-septate, sometime strongly constricted septum, hyaline, (25.1–)27.0–32.8(–38.8) × (3.4–)4.2–5.4(–6.6) µm (n=61). **Conidiomata** not observed.

Specimen examined. Japan, Honshu, Pref. Saitama, Mt. Mitsumine, 35°55′N, 138°55′E, elev. 1100m asl, in Acer dominated forest, on *Ochrolechia* sp. (discs and thalline margins of apothecia), 24.12.2016, K. Tadome 16122403.

Morphologically similar to *Pronectria tenuispora*, but distinguished mainly by the larger ascospores, (25.1–)27.0–32.8(–38.8) × (3.4–)4.2–5.4(–6.6) µm vs. 22–28(– 33) × 3.5 – 4(–4.5) µm. This species is the first new species discovered in Japan, and the name comes from the country name where it was discovered (Zhurbenko et al. 2018).

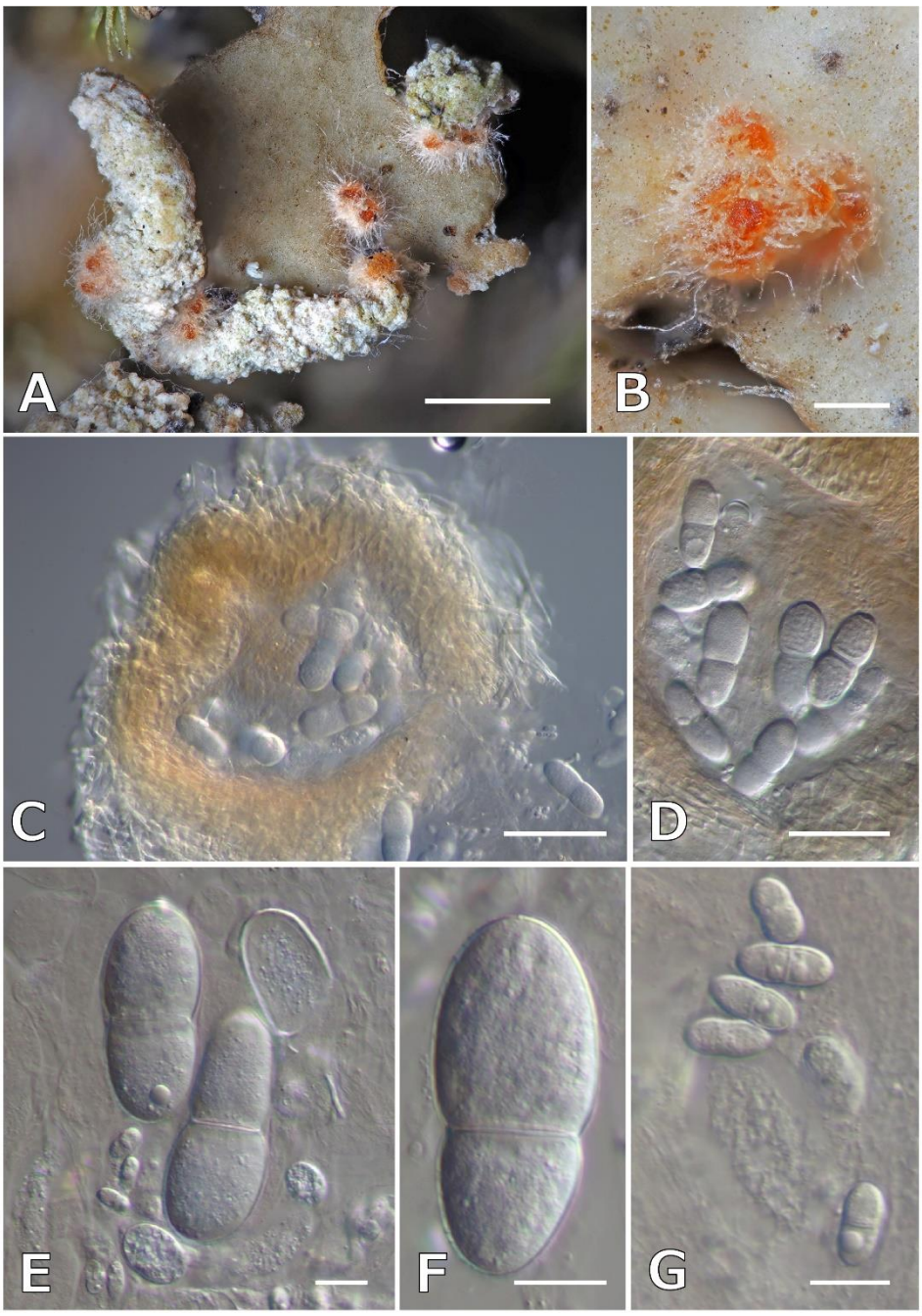

Fig. 16. *Ovicuculispora parmeliae* (Berk. & M. A. Curtis) Etayo, Bull. Soc. Linn. Provence 61: 112. 2010. (K. Tadome 613, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D-E. Ascospora. F. Macrospora. G. Microspore. Scale bars: A=1 mm, B＝200 μm, C-D＝50 μm, E-G＝10 μm.

Table 1. Comparisons of morphological features of *Ovicuculispora parmeliae* depending on country

Country	macrospore	microspore	Shape of macrospora	Host	Reference
Bolivia	34–60 × 12–23 µm	8–17 × 3–7 µm.	1–septate 	*Candelariella* sp.	Flakus *et al.* (2006)
Canada	34–50(–60) × 12–18(–20) µm	8–17 × 3.5–7 µm	1(–3)-septate 	*Hypogymnia physodes, Parmelia sulcata*	Samuel (2020)
Dominica	40–45 × 20 µm	8–10 × 5 µm	Not observing	*Pyxine* sp.	Etayo and van den Boom (2013)
Ireland	34–50(–60) × 12–18(–20) µm	8–17 × 3.5–7 µm	1–2-septate 	*Lecanora chlarotera, Xanthoria parietina*	Hawksworth *et al.* (2010)
Japan	(30.4–)29.7–47.7(–54.4) × (11.1–)12.0–22.1(–25.5) µm	(4.9–)6.6–11.2(–12.1) × (2.3–)3.1–5.9(–6.6) µm	1-septate	*Heterodermia japonica*	Tadome and Ohmura (2021)
Russia	(18.4–)42.4–73.0(–86.0) × (6.8–)18.3–33.3(–40.0) µm	(6.8–)8.7–11.7(–16.5) × (3.3–)4.5–5.5(–7.0) µm	1-septate  (very rarely 2-septate)	*Anaptychia* sp., *Cladonia* sp., *Heterodermia* cf. *microphylla*, *Heterodermia* cf. *obscurata*, *Myelochroa entotheiochroa*, *Parmelia* sp., *Pyxine sorediata*, *Rinodina xanthophaea*	Zhurbenko (2014)
U.S.A. (North Carolina)	N/A	N/A	1–septate 	*Physcia millegrana, Punctelia rudecta*	Flakus *et al.* (2006)
U.S.A. (South Carolina) (Type locality)	51 × 23 µm	9–11 × 4–6 µm	1-septate 	*Punctelia rudecta*	Hawksworth (1981)

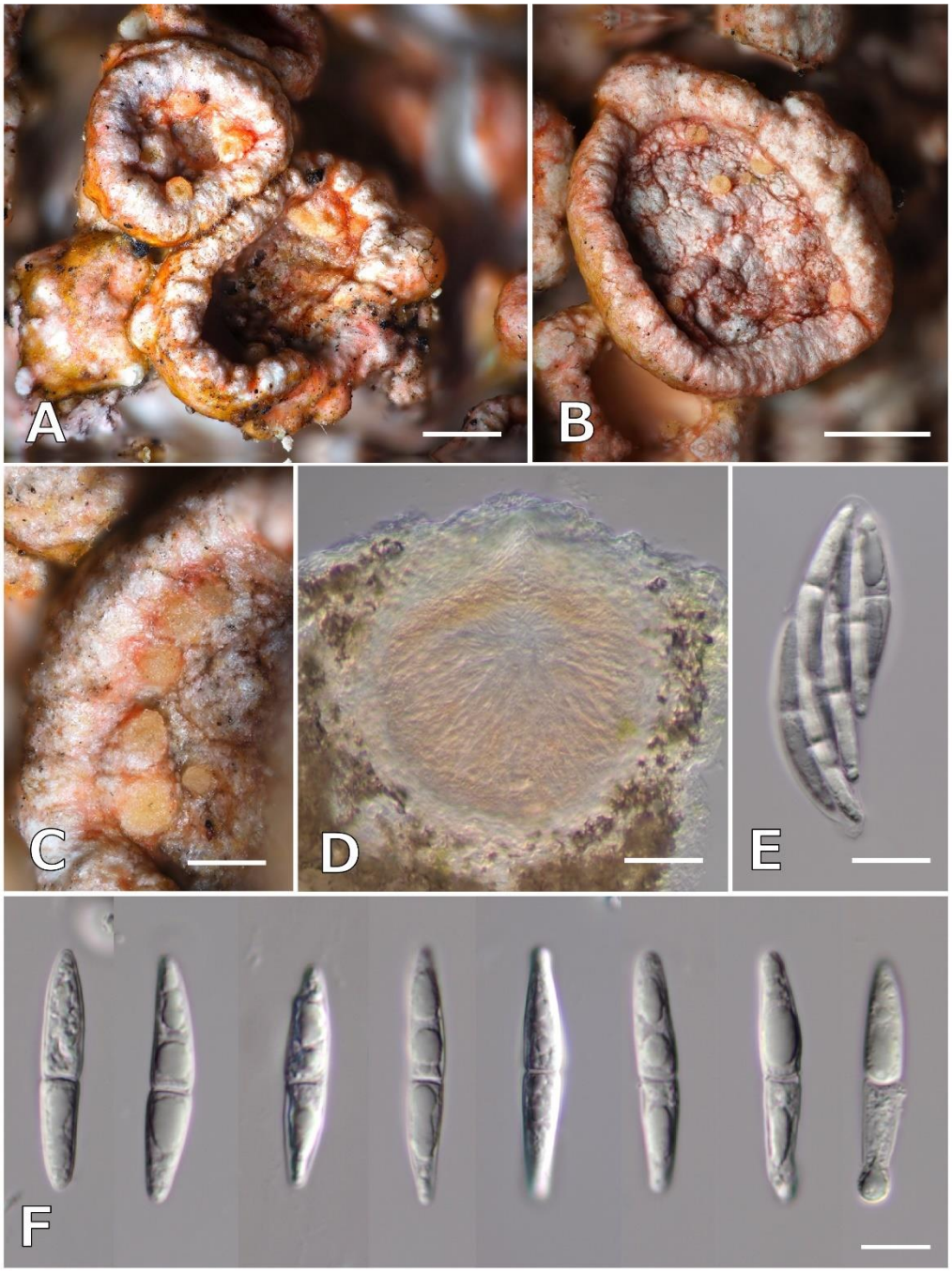

Fig. 17. *Pronectria japonica* Zhurb., Tadome & Y. Ohmura, Herzogia 31(1, Teil 2): 495 (2018). (K. Tadome, 16122403). A-B. Growth habit. C. Ascomata. D. Cross section of an ascomata. E. Asci. F. Ascospore. Scale bars: A-B=1 mm, C＝0.5 mm, D＝50 μm, E-F＝10 μm.

Pyrenidium actinellum Nyl., Flora, Regensburg 48: 210 (1865).

= See to **Chapter 4**

Reconditella physconiarum Hafellner & Matzer, in Matzer & Hafellner, Biblioth. Lichenol. 37: 47 (1990).

[Fig. 18]

Ascomata perithecioid, developed on the side and underside of the host thallus as well as often on the thallus margin of the host apothecia, scattered, pyriform, black to brownish black, shiny, 250–400 μm; ascomatal wall brown, 30–50 μm thick, K–. **Periphyses** septate, unbranched, not anastomosed, 2.5–4.0 μm wide. **Paraphyses** septate, unbranched, made up of elongated cells, 150 μm long. **Asci** cylindrical to clavate, 8-spored, (67.0–)73.0–79.0(–81.0) ×10.0–15.0(–17.0) μm. **Ascospores** ellipsoid, verrucose, simple to rarely 1-septate, not constricted at the septum, hyaline when young, brown when mature, (16.1–)16.9–19.1(–20.7) × (6.0–)6.1–7.3(–9.1) μm (n=47).

Morphological and anatomical features of the Japanese material mentioned above agree well with an exsiccate specimen of *R. physconiarum* [Santesson: Fungi Lichenicoli Exs. 173 (TNS!); ascospore size (15.0–)16.0–18.0(–20.0) × (6.0–)7.0–9.0 μm] and the size of ascospore also falls within the range shown in the protologue [Matzer and Hafellner 1990; ascospore (13.0–)15.0–21.0(–24.0) × (6.0–)8.0–10.0(–13) μm].

Reconditella physconiarum is characterized by the black perithecial ascomata developed on the side and underside of host thallus and the verrucose, simple and brownish ascospores. This species is similar to *Roselliniella*, *Roselliniomyces* and *Roselliniopsis* species. These genera are black perithecia. *Roselliniella* is distinguished from *R. physconiarum* by

immersed to semi-immersed ascomata, *Roselliniomyces* by ascomata with setae, and *Roselliniopsis* by smooth ascospores with germ pores (Hawksworth et al. 2010a, Matzer and Hafellner 1990).

This species mainly parasitizes on species of *Physconia* and rarely *Phaeophyscia* (Etayo and Pérez-Ortega 2016). In Japan, it was parasitic on *Anaptychia palmulata*.

Reconditella physconiarum was reported from Asia (Russia) (Zhurbenko 2009b), Europe (Austria, Croatia, Italy, Latvia, Portugal, Russia, Spain, and Sweden) (Brackel and Puntillo 2016, Etayo and Diederich 1998, Matzer and Hafellner 1990, Moisejevs et al. 2019, Muchnik et al. 2019), and North America (U.S.A.) (Lendemer et al. 2009). The distribution is now extended to Japan (Tadome and Ohmura 2021a).

Specimen examined. JAPAN. Honshu. Shinano Prov. (Nagano Pref.): Mt. Kitayokodake, 2400 m elev., on *Anaptychia palmulata* on tree bark, 27 Nov. 2018, K. Tadome 782 (TNS).

Exsiccate examined. AUSTRIA. Steiermark: Gesäuse area, Johnsbach, c. 0.5 km E of Gasthof Kölbl. Alt. c. 875 m. MTB 8453/4. On *Fraxinus excelsior*. On *Physconia distorta* (thallus). May 20, 1988 (Santesson: Fungi Lichenicoli Exs. 173, TNS).

Stigmidium subcladoniicola van den Boom, Acta Bot. Hung. 58(1–2): 212 (2016).

[Fig. 19]

Vegetative hyphae immersed in the host tissues, branched, smooth, pale brown, composed of elongate cells 2.0–4.3 µm, I–. **Ascomata** perithecioid, globose, immersed to semi-immersed in the host thallus, scattered, brown to black, 40–50 µm diam; ascomatal wall brown, 5–8 µm thick, K–; ostiolar and interascal filaments not observed. **Asci** obclavate or broadly cylindrical, 22.0—24.0 × (8.0–)9.0–10.0 µm, 8-spored. **Ascospores** ellipsoid, smooth, 1-septate,

wide in the upper cells and elongated in the lower cells, hyaline, (6.1–)6.6–7.8(–8.0) × (2.3–)2.5–2.9(–3.3) µm (n=33).

Morphological and anatomical features of the Japanese material mentioned above agree well with the protologue and the description provided by Van den Boom (2016) [ascospores size (6–)6.5–7 × 2–2.5 µm].

In addition to *S. subcladoniicola*, two other *Stigmidium* species parasitizing on *Cladonia* spp. are known in the world. *Stigmidium ahtii* Etayo & Palice is distinguished from *S. subcladoniicola* by the presence of a hamathecium having branched to anastomosed paraphysoids and by larger ascospores (11–13 × 3–4.5 µm) (Etayo 2017). *Stigmidium cladoniicola* has larger ascospores [(9.0–)11.5–14.3(–16.5) × (3.0–)3.4–4.2(–5.0) µm] than *S. subcladoniicola* (Zhurbenko and Diederich 2008).

Stigmidium subcladoniicola was reported from Asia (Thailand) (Zhurbenko and Ohmura 2019), Europe (Portugal) (Van den Boom 2016), and Hawaii (Zhurbenko and Ohmura 2019). The distribution is now extended to Japan (Tadome and Ohmura 2021a).

Specimen examined. JAPAN. Hokkaido Pref.: Mt. Meakan, 740 m elev., on *Cladonia straminea* on fallen tree, 3 Sep. 2019, K. Tadome 859 (TNS).

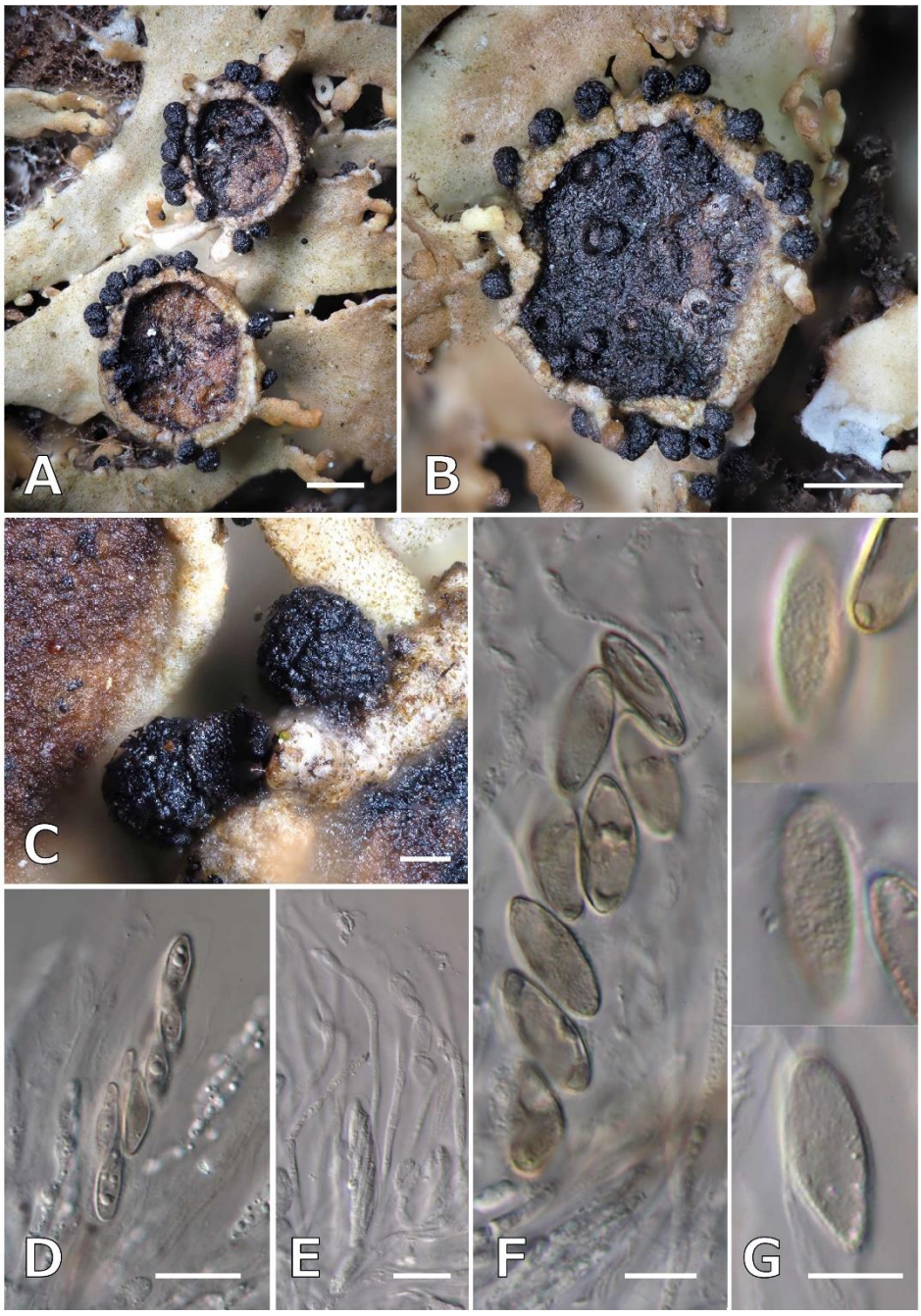

Fig. 18. *Reconditella physconiarum* Hafellner & Matzer, in Matzer & Hafellner, Biblioth. Lichenol. 37: 47 (1990). (K. Tadome 782, TNS). A-B. Growth habit. C. Ascomata. D. Asci. E. Paraphyses. F. Ascospore. G. Surface of ascospore (verrucose). Scale bars: A-B=1 mm, C＝100 μm, D-E＝20 μm, F-G＝10 μm.

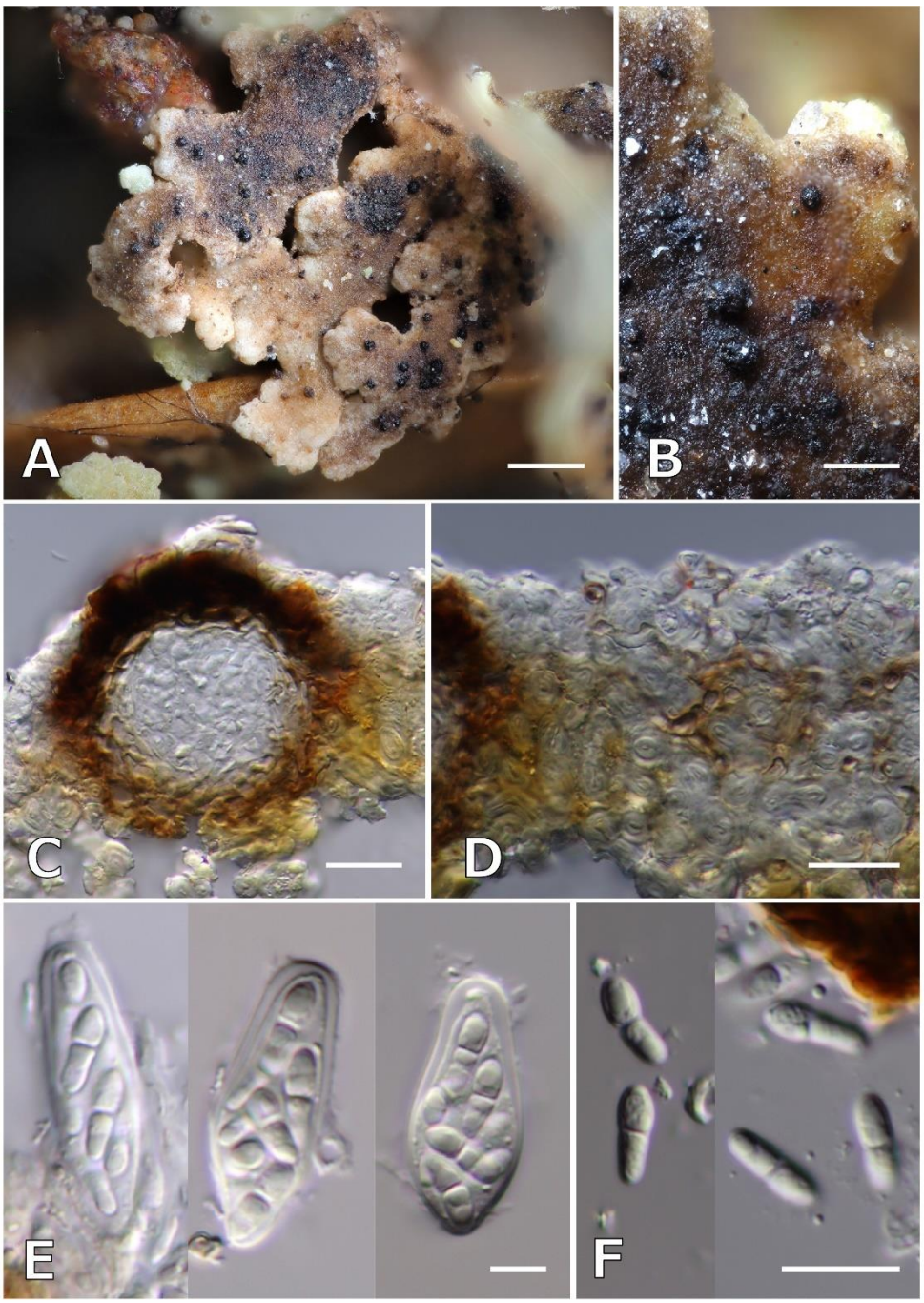

Fig. 19. *Stigmidium subcladoniicola* van den Boom, Acta Bot. Hung. 58(1–2): 212 (2016). (K. Tadome 859, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Vegetative hyphae. E. Asci and ascospora. F. Ascospora. Scale bars: A=0.5 mm, B＝200 μm, C-D＝10 μm, E＝5 μm, F＝10 μm.

Vouauxiella lichenicola (Linds.) Petr. & Syd., Feddes Repert., Beih. 42: 484 (1927).

[Fig. 20]

Conidiomata pycnidial, globose to subglobose, immersed to semi-immersed, solitary, scattered, black, 70–100 μm diam; conidiomatal wall black to dark green, 10–15 μm, K–. **Conidiophores** short, smooth, branched only at the base, pale green. **Conidiogenous cells** irregular in shape, smooth, arising directly from the inner side of the conidiomatal wall, pale green. **Conidia** olivaceous green, simple, ellipsoid with truncated ends, formed in chains of up to 8 or more adhering conidia, (4.7–)4.8–5.8(–7.1) × (2.0–)2.2–2.6(–3.0) μm (n=58).

Morphological and anatomical features of the Japanese material agree well with the description provided by Hawksworth (1981) and an exsiccate specimen of this species (Santesson: Fungi Lichenicoli Exs. 249, TNS!). The conidia size reported in Hawksworth (1981) is (5–)6–8(–9) × 3–4 μm and that of the exsiccate was measured as (5.2–)6.3–8.2(–9.7) × (2.5–)2.9–3.5(–3.8) μm (n=16). The conidia size of the present material is on the smaller end but still falls within the range of the species.

Three species of the genus *Vouauxiella* are known: *V. lichenicola*, *V. pithospora*, and *V. verrucosa* (Diederich et al. 2018). *Vouauxiella pithospora* differs from *V. lichenicola* by the smaller conidia (3–3.5 × 2.5) μm and by parasitizing on foliicolous lichens. *Vouauxiella verrucosa* is distinguished from *V. lichenicola* by verruculose conidia (Hawksworth 1981).

Vouauxiella lichenicola was reported from Asia (India and Turkey) (Etayo and Breuss 1998, Zhurbenko 2013b), Europe (Bosnia and Herzegovina, Greece, Latvia, Lithuania, Poland, Spain, and Ukraine) (Bilovitz et al. 2010, Christensen 2016, Darmostuk and Sira 2020, Lubek and Jaroszewicz 2012, Moisejevs et al. 2019, Motiejūnaitė 2007, Van den boom 1999), and North America (U.S.A.) (Etayo and Breuss 1998). The distribution is now extended to Japan (Tadome and Ohmura 2021a).

Specimen examined. JAPAN. Honshu. Musashi Prov. (Saitama Pref.): Mt. Myouhou, 1102 m elev., on Lecideoid lichen, on tree bark, 28 Dec. 2016, K. Tadome 265 (TNS).

Exsiccate examined. Canary Islands. La Palma: On the outside of Caldera de Taburiente, in the valley just SSE of La Cumbrecita, 28:41'N 17:51'W, alt. c. 1200 m, on Lecideoid lichen. on branches of *Ficus carica*, November 27, 1991 (Santesson: Fungi Lichenicoli Exs. 249, TNS).

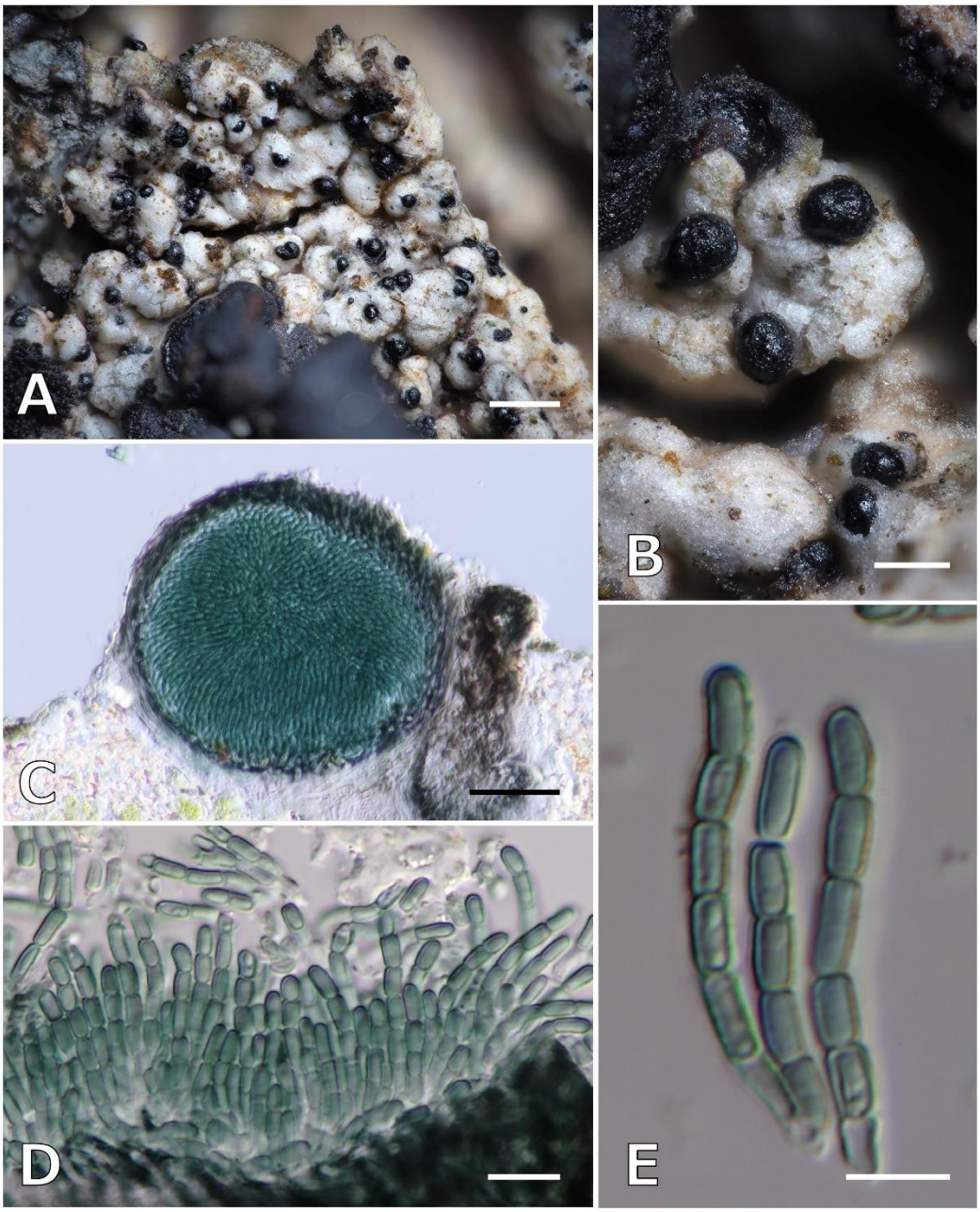

Fig. 20. *Vouauxiella lichenicola* (Linds.) Petr. & Syd., Feddes Repert., Beih. 42: 484 (1927). (K. Tadome 265, TNS)

A. Growth habit. B. Conidiomata. C. Cross section of conidiomata. D. Acervulus. E. Conidia. Scale bars: A=0.5 mm, B＝100 μm, C＝25 μm, D＝20 μm, E＝10 μm.

Chapter 4

A literature survey of Japanese lichenicolous fungi that has already been reported

4–1. Method

The lichenicolous fungi reported from Japan was made into a monograph. Since the reported papers and the literature described as new species were in languages other than English, they were translated into English and cited. Various morphological features are summarized.

4–2. Result

Abrothallus bertianus De Not., G. bot. ital. 2(1.1): 192 (1846).

[Fig. 21]

Mycelium immersed, I+ blue. **Ascomata** apothecioid, developed on surface of thallus of the host lichen, scattered, round, domed to hemispherical, becoming almost spherical, dark brown to black, covered by a green pruina when young, 100–500 μm diam, 150 μm tall. **Ascomatal wall** dark brown, composed of layers of thick-walled and pigmented cells. **Hymenium** pale green, brownish pigment in the upper part, with the apices sometimes slightly swollen, hyaline in the lower part, paraphysoids branched, 80.0 μm tall, 2.0–3.0 μm. **Hypothecium** brown to dark brown. **Asci** clavate to cylindrical, short-stalked, the apex obtuse to rounded, very thick-walled, 8-spored, 44.0–58.0 × 11.0–15.5 μm. **Ascospores** ellipsoid, 1-septate, clavate with a slightly supramedian septum, the upper cell rounded and the lower cell cylindric-ellipsoidal, rather thick-walled, verrucose, golden brown, 10.5–13.5 (–15.0) × 4.5–6.0

µm. **Conidiomata** pycnidial, conical to pyriform, developing in the surface layer of the host thallus, 60.0–90.0 µm diam. **Conidiomatal wall** 2–3 cells thick, dark brown. **Conidiogenous cells** formed in a layer lining the entire inner wall, 4.0–4.5 × 3.0–3.5 µm. **Conidia** bacilliform to cylindrical, ends rounded, aseptate, hyaline, 6.0–7.5 × 4.0–5.0 µm. **Host**: *Melanelixia* species, *Melanohalea* species and other parmelioid lichens **(**Pérez-Ortega et al. 2014, Hawksworth et al. 2010a).

This species is characterized by parasitizing *Melanelixia* spp, vegetative hyphae (mycelium) I + blue, and often occurring with *Vouauxiomyces* anamorph. It is also characterized by elliptical, 1-septate, wart-like surface, and brown spores **(**Pérez-Ortega et al. 2014, Hawksworth et al. 2010a). Ascomata is relatively large and can be fully confirmed with the naked eye. Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. SWEDEN. Västmanland: Kila par., N of the lake Stävresjön. On a fallen *Betula* in a *Populus tremula-Corylus avellana* grove. On *parmelia olivacea* (apothecia and thallus). March 28 & April 11, 1965 (Santesson: Fungi Lichenicoli Exs. 1, TNS).

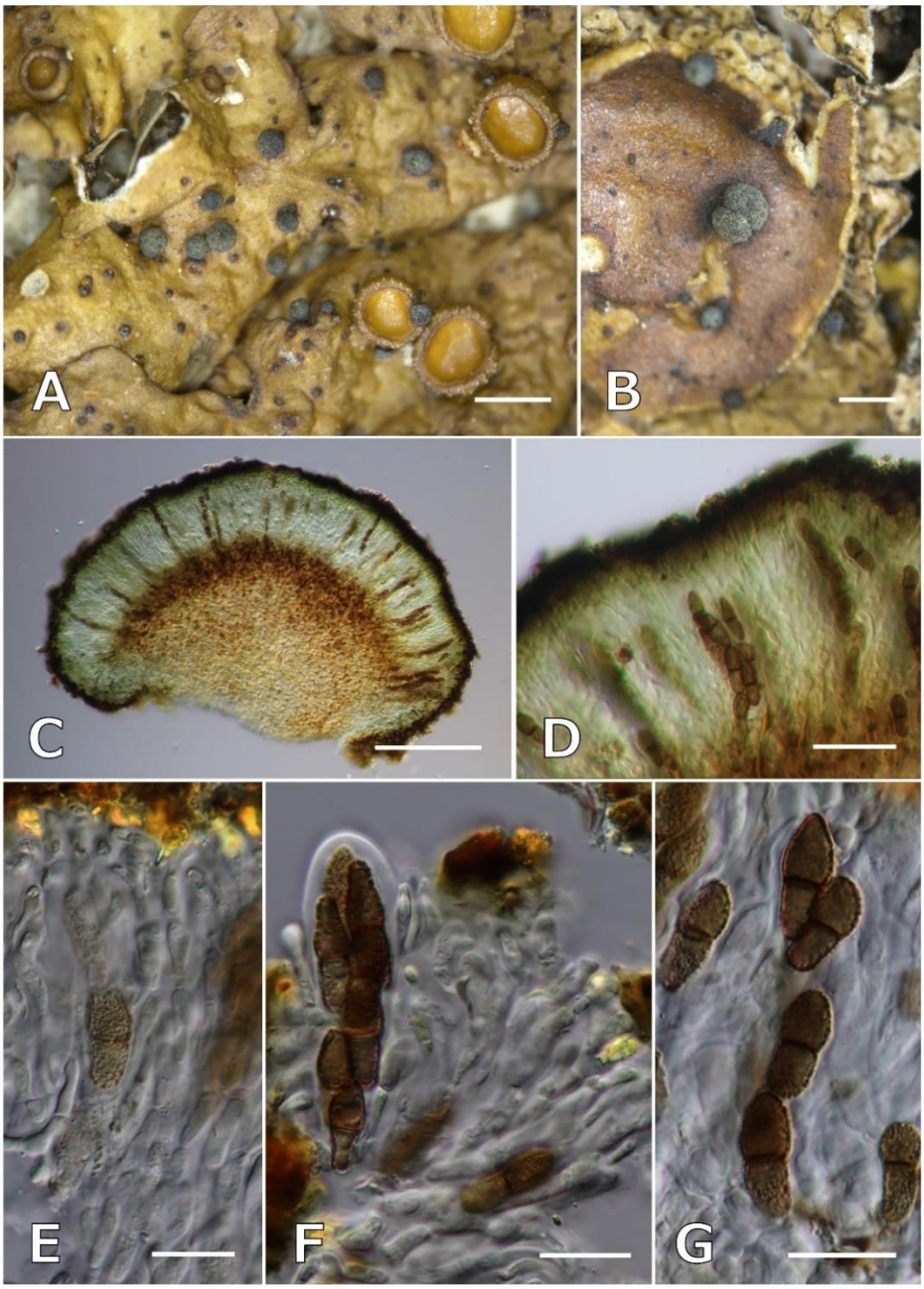

Fig. 21. *Abrothallus bertianus* De Not., G. bot. ital. 2(1.1): 192 (1846). (R. Santesson: Fungi Lichenicoli Exsiccati 1, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E. Paraphyses. F. Asci and Paraphyses. G. Asci and ascospore. Scale bars: A=1.5 mm, B=500 μm, C=100 μm, D=30 μm, E-G=10 μm.

Abrothallus microspermus Tul., Annls Sci. Nat., Bot., sér. 3 17: 115 (1852)

[Fig. 22]

Mycelium immersed, I–. **Ascomata** apothecioid, developed on surface of thallus of the host lichen, scattered, round, domed to hemispherical, becoming almost spherical, dark brown to black, epruinose when young, 180–280 µm in diam. **Hymenium** paraphysoids branched, hyaline or pale brown, upper part K+ green. **Hypothecium** yellowish brown, K–. **Asci** clavate to ellipsoid, 8-spored. **Ascospores** ellipsoid, 1-septate, clavate with a slightly supramedian septum, the upper cell rounded and the lower cell cylindric-ellipsoidal, rather thick-walled, verrucose, brown, (11.0–)13.5(–14.5) × 4.0–5.5 µm. **Conidiomata** pycnidial, surface of thallus of the host lichen, black, 90–200 µm diam. **Conidimatal wall** brown, 25.0–35.0 µm thick, K+ yellow in upper part. **Conidiogenous cells** 4.0–13.0 × 3.0–4.5 µm. **Conidia** ellipsoid, hyaline to pale yellow, smooth to finely verruculose, 6.5–8.5 × 3.5–5.5 µm. **Host**: *Flavoparmelia caperata* (Nash et al. 2004).

This species is characterized by vegetative hyphae (mycelium) do not respond to I and most occur with *Vouauxiomyces* anamorph. It is generally said to parasitize *Flavoparmelia caperata*, and Japanese samples also parasitized the same species. It is also characterized by elliptical, 1-septate, wart-like surface, and brown spores (Nash et al. 2004). Ascomata is relatively large and can be seen with the naked eye. Japanese records were reported by Zhurbenko and Ohmura (2019).

Specimen examined. JAPAN. Honshu. Shinano Prov. (Nagano Pref.): Sugadaira Montane Research Center, Sugadaira-Kogen, Ueda-city., on *Flavoparmelia caperata* (thallus) on tree bark, 20 Feb. 2017, K. Tadome 629.

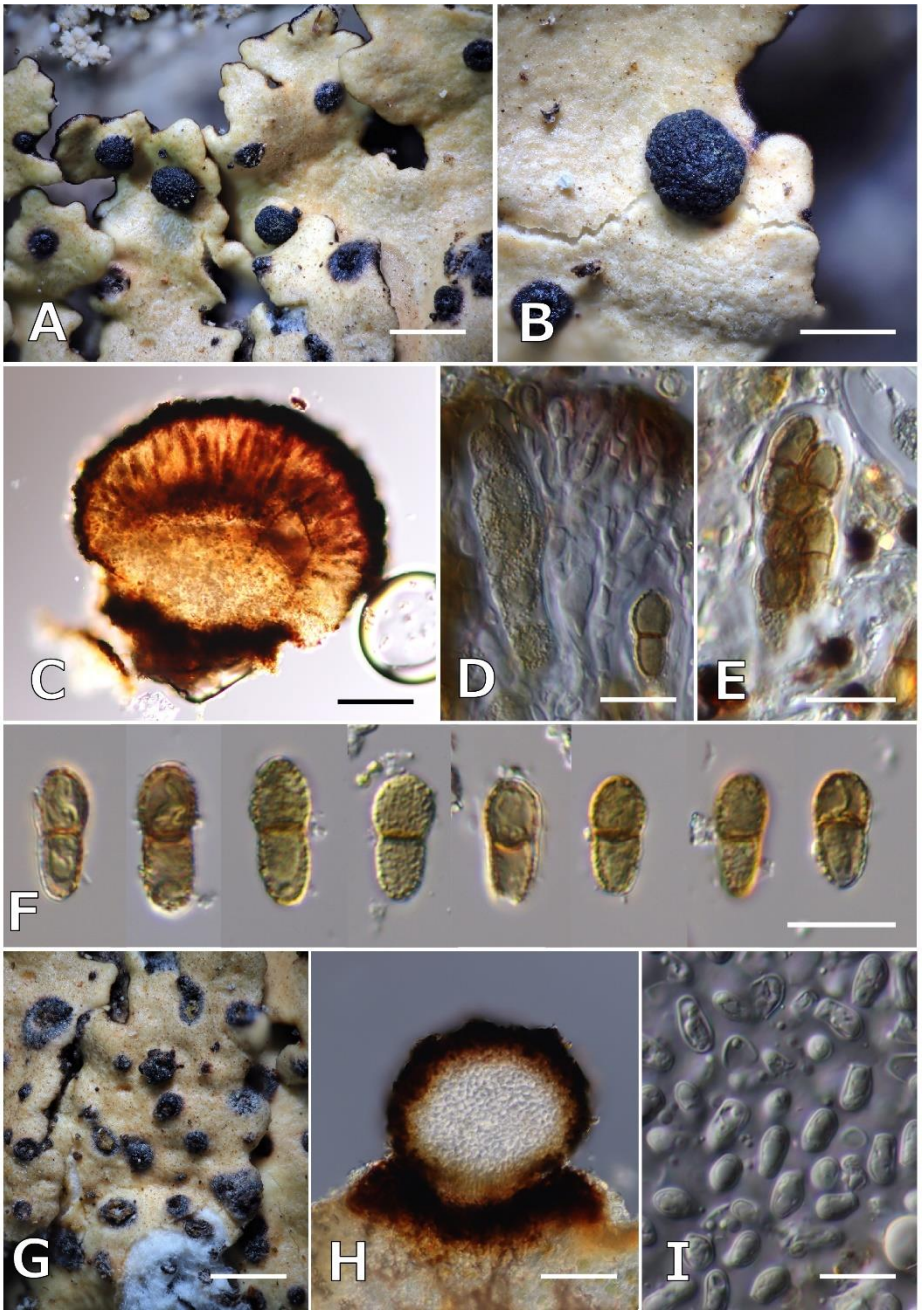

Fig. 22. *Abrothallus microspermus* Tul., Annls Sci. Nat., Bot., sér. 3 17: 115 (1852). (K. Tadome 629).

A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Paraphyses. E. Asci and Paraphyses. F. Ascospore. G. Conidiomata. H. Cross section of a conidiomata. I. Conidia. Scale bars: A=0.5 mm, B=300 μm, C=50 μm, D-F=10 μm, G=0.5 mm, H=100 μm, I=10 μm.

Abrothallus peyritschii (Stein) I. Kotte, Centbl. Bakt. ParasitKde, Abt. II 24: 76 (1909)

Mycelium I+ blue. **Ascomata** apothecioid, initially immersed, becoming surface of thallus of the host lichen, scattered, round, black, slightly pruinose,130–350 µm diam. **Epihymenium** green to brownish green, K+ intensively green. **Hymenium** paraphysoids branched, hyaline to pale brownish, upper part pale green, K+ green. **Hypothecium** brown, 150 µm tall, K–, I+ blue. **Asci** elongate to ellipsoid, clavate, 8-spored, 55.0–60.0 × 12.0–16.0 µm. **Ascospores** ellipsoid, 1-septate, cells unequal in width, upper cells are wide, and the lower cells are elongated, verrucose, pale green, then brown, 10.5–13 × 4.5–6.0 µm, K+ blue green. **Conidiomata** pycnidial, sometimes immersed, black, surface of thallus of the host lichen, scattered. **Conidiomatal wall** upper part brown to green, K+ green, lower part hyaline, I+ blue. **Conidia** ellipsoid, hyaline, (5.0–)5.5–6.5(–7.5) × (3.5–)4.0–5.0(–6.0) µm. **Host**: *Vulpicida pinastri* (Nash et al. 2004).

This species is characterized by vegetative hyphae (mycelium) occurring with I + blue, often *Vouauxiomyces* anamorph. It is generally said to parasitize *Vulpicida pinastri*, and Japanese samples also parasitized *Vulpicida* species. It is also characterized by elliptical, 1-septate, wart-like surface, brown spores, which turn bluish green with respect to K (Nash et al. 2004). Ascomata is relatively small in the same genus (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Agyrium rufum (Pers.) Fr., Syst. mycol. (Lundae) 2(1): 232 (1822)

This species has been reported as a Japanese lichenicolous fungi, but is not on the global checklist (Diederich et al. 2018, Ohmura and Kashiwadani 2018). Probably both parasitic and saprophytic.

Arthonia almquistii Vain. [as 'almqvisti'], Meddn Soc. Fauna Flora fenn. 10: 156 (1883)

Ascomata arthonioid, within hymenium of host lichen. **Ascomatal wall** K–. **Hypothecium** dark greenish brown to brown, I+ red. **Asci** broadly clavate, 8-spored, 28.0–38.0 × 17.0 µm. **Ascospore** smooth, hyaline, 10.5–15.0 × 4.0–5.5(–6.0) µm. **Host**: thallus of *Amygdalaria pelobotryon* and *Trapelia coarctata* (Hawksworth et al. 2010a).

This species is a form that is buried in the host's lichen, and is characterized by hypothecium turns dark greenish brown and turns red with respect to I. It is also characteristic that the asci are wider than the species of the same genus. The host is mainly lichens that grow on rock (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Arthonia biatoricola Ihlen & Owe-Larss., in Ihlen, Owe-Larsson & Tønsberg, Symb. bot. upsal. 34(no. 1): 107 (2004)

Ascomata arthonioid, dark brown to black, convex, round, scattered, 0.10–0.45 mm diam. **Epithecium** pale brown to brown, I+ red, 4.0–12.0 µm. **Hymenium** hyaline, I+ red, K/I+ blue, 20.0–55.0 µm tall. **Paraphysoid** branched to anastomosing, 1.0–2.0 µm thick. **Hypothecium** pale brown to brown, 25.0–40.0 µm tall. **Asci** broadly clavate to ovoid, K/I+ blue Arthonia-type, 8-spored. **Ascospore** ellipsoid, 1-septate, constricted at septum, slightly verrucose when mature, 10.0–14.0 × 4.0–6.0 µm. **Host**: *Biatora efflorescens* (Ihlen et al. 2004, Nimis and Martellos http://italic.units.it/index.php?procedure=taxonpage&num=115).

This species has convex Ascomata scattered throughout the host lichen. Ascomata is small and hard to see with the naked eye. It is characteristic that epithecium and hymenium turn

red with respect to I. Currently, it is known to parasitize *Biatora* spp. efflorescens that grow on the bark (Ihlen et al. 2004, Nimis and Martellos http://italic.units.it/index.php?procedure=taxonpage&num=115). Japanese records were reported by Frisch et al. (2014).

Arthonia graphidicola Coppins, Lichenologist 21(3): 213 (1989)

Ascomata arthonioid, fleck-like to polygonal, not pruinose, inhabiting thallus or superficially developed on disc of ascomata. **Hymenium** I+ red or blue, K/I+ blue. **Hypothecium** hyaline. **Ascospore** 2–3-septate, enlarged upper cell, verrucose, hyaline or becoming brown, (13.0–)14.0 –17.0 × 4.5–5 µm. **Host**: *Graphina anguina* and *Graphis scripta* (Hawksworth et al. 2010a).

This species is characterized by ascomata, which is scattered in the host and becomes speckled. In addition, ascomata parasitizes various parts of the host and turns red or blue for I. There are spores that turn brown when ripe in a few septa, but this feature is less common in *Arthonia* of the same genus (Hawksworth et al. 2010a). Japanese records were reported by Frisch et al. (2014).

Arthonia lopingensis Zahlbr., in Handel-Mazzetti, Symb. Sinic. 3: 36 (1930)

Ascomata lirellate, 0.5 × 0.1–0.2 mm, immersed, disc flat, brown to brownish-black, epruinose, with yellow to orange pruina, aggregated in irregular star-shaped clusters about 0.5–1.0 mm diam. **Exciple** yellow to orange, 10.0–25.0 µm wide. **Hymenium** hyaline to pale orange-brown, 50.0–70.0 µm tall. **Hypothecium** hyaline to pale orange-brown, 10.0–25.0 µm

tall. **Paraphysoid** branched and netted, 1.5–2.0 μm wide. **Asci** clavate, 8-spore, 32.0–40.0 × 13.0–17.0 μm. **Ascospore** narrow ovoid, (2–)3-septate, hyaline, become brown with fine granular ornamentation when mature, (11.0–)11.4–13.6(–15.0) × (3.5–)4.0–5.2(–5.5) μm. **Anamorph** not observed. **Host**: *Graphis species* (Frisch et al. 2018).

This species is characterized by the lilellate ascomata buried in the host. Also, the exciple is yellow to orange and the hypothecium is light orange to brown, which is also different from other types. While many species of the same genus are 1-septate, the spores of this species are also characterized by being transparent and 2–3-septate (Frisch et al. 2018). Japanese records were reported by Frisch et al. (2018).

Arthonia phaeophysciae Grube & Matzer in Biblioth. Lichenol. 68: 10 (1997).

[Fig. 23]

Ascomata developing on upper surface of thallus or breaking through the upper cortex of the host lichen, round, black, convex, 200–600 μm diam. **Epihymenium** brown with an olive tinge, 15.0 μm tall, K+ deep olive. **Hymenium** hyaline to pale brown, without inspersion, up to 35.0 μm, K+ pale grey, I+ deep red, K/I+ blue. **Paraphysoids** branched and anastomosed, the tips brown, not enlarged, extending above the asci. **Hypothecium** pale brown, K+ pale grey mottled with olive. **Asci** clavate, Arthonia-type, 25.0–30.0 × 13.0–18.0 μm, 8-spored; ascus apex with a K/I+ blue ring structure in the innermost layer of the endoascus. **Ascospores** oblong, hyaline, 1-septate, constricted at the septum, upper cell slightly larger than lower cell, (10.5–)11.4–13.6(–14.0) × (3.5–)4.0–4.6(–5.0) μm (n = 42). **Pycnidia** not observed (Frisch et al. 2020).

Arthonia phaeophysciae is distributed across Europe (Brackel 2014) and is further

reported in North America (Arizona) (Triebel et al. 1991, Hafellner et al. 2002), South America (Chile) (Etayo and Sanches 2008), and Asia (Caucasus, Korea) (Urbanavichus and Ismailov 2013, Zhurbenko 2017) (Kondratuyk et al. 2013, 2015, Brackel 2014, Lee and Hur 2016).

This species is characterized by ascomata, which grows through the surface of the host. Another feature is that epihymenium turns deep olive for K, hymenium turns pale gray for K, red for I, and blue for K/I. It is widely distributed worldwide and is said to parasitize mainly *Phaeophyscia* species, but in Japan it parasitizes *Physciella melanchra* and was recorded as a new host (Frisch et al. 2020). Japanese records were reported by Frisch et al. (2020).

Specimens examined: JAPAN. Prov. Hitachi (Ibaraki Pref.): Chuo Park, Tsukuba-city (36°05′06″N, 140°06′41″E), on concrete, 25 m elev., 9 April 2017, K. Tadome 538 (TNS). Prov. Sagami (Kanagawa Pref.): Tokyo University of Agriculture, Atsugi-city (35°25′56″N, 139°20′47″E), on *Physciella melanchra* on *Zelkova serrata*, 60 m elev., 27 July 2003, K. Tadome 535 (TNS).

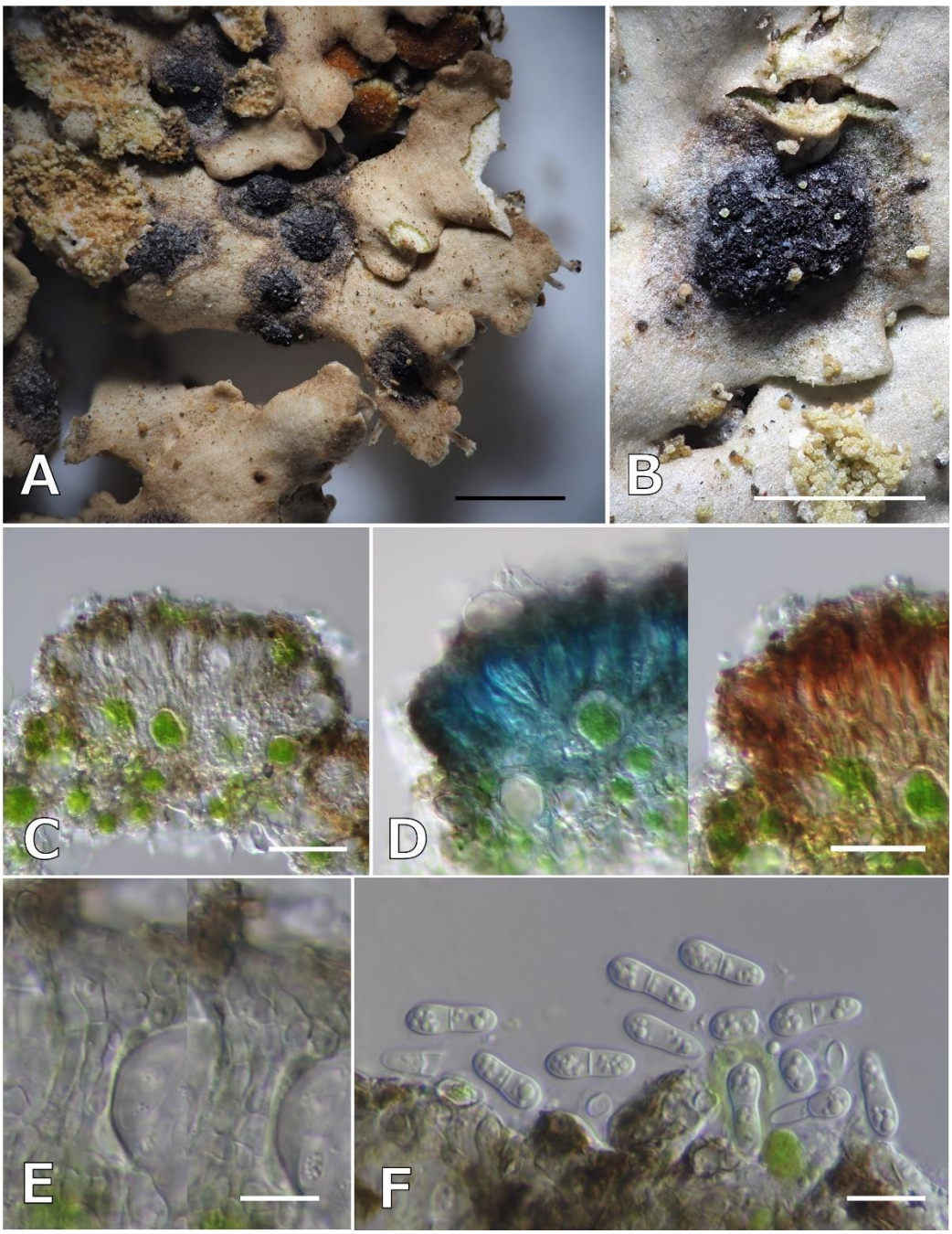

Fig. 23. *Arthonia phaeophysciae* Grube & Matzer in Biblioth. Lichenol. 68: 10 (1997). (K. Tadome 535, TNS).

A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Chemical reaction of hymenium (left: K/I + blue, right: I + red). E. Paraphyses. F. Ascospore. Scale bars: A=1 mm, B＝0.5 mm, C＝100 μm, D＝50 μm, E-F＝10 μm.

Arthrorhaphis aeruginosa R. Sant. & Tønsberg, Lichenologist 26(3): 295 (1994)

Ascomata rounded, lecideioid to perithecioid, sessile to sub-stipitate, ca 0.4 mm diam; host tissue with aeruginose discoloration. **Paraphyses** branched to anastomosed. **Asci** fissitunicate, K/I–. **Ascospore** acicular, sigmoid or filiform, 80.0–110(–120) × (2.5–)3.0–4.0(–5.0) µm. **Host**: *Cladonia* species (squamules or rarely podetia) (Hawksworth et al. 2010a, Ohmura and Kashiwadani 2018).

The characteristics of this species are that ascomata is black and lecideioid to perithecioid, and the spores are very elongated and have many setates. In addition, when parasitized by this species, the host often turns dark green (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Bachmanniomyces punctum (A. Massal.) Diederich & Pino-Bodas, in Diederich, Lawrey & Ertz, Bryologist 121(3): 393 (2018)

= Basionym: *Phaeopyxis punctum* (A. Massal.) Rambold, Triebel & Coppins, in Rambold & Triebel, Notes R. bot. Gdn Edinb. 46(3): 384 (1990)

[Fig. 24]

Ascomata apothecioid, black to dark brown, shiny, concave when young, superficial, constricted at the base, with margin, 50.0–250 µm diam. **Epihymenium** reddish brown, dark brown, purplish brown to black, 3.0–8.0 µm tall. **Hymenium** hyaline to slightly violet, becoming reddish brown when old, I–, K/I–, 30.0–50.0 µm tall. **Paraphyses** septate, sometimes branched, 2.0–2.5 µm. **Subhymenium** hyaline to light reddish brown, ca 30.0 µm tall. **Exciple** dark reddish to orangish brown, blackish gray, bluish olive or olive brown, 10–20 µm thick. **Asci** clavate to subcylindrical, I+ very pale blue, K/I+ pale blue, 8-spored, (35.0–)42.0–52.5(–

55.0) × (8.0–)8.5–10.5(–11.5) µm. **Ascospores** narrowly ellipsoid, simple, smooth, hyaline to sometimes light reddish brown, (7.2–)8.6–10.2(–11.0) × (2.7–)3.1–3.5(–3.8) µm. **Conidiomata** pycnidial, subglobose, immersed 40.0–110 µm diam. **Conidia** oblong, rounded at the apex and truncated at the base, hyaline, (2.9–)3.4–4.6(–6.4) × (1.3–)1.4–1.6(–1.8) µm. **Host**: *Cladonia* species (Zhurbenko and Pino-bodas 2017).

The characteristic of this species is that ascomata is dark brown and disc-shaped, and when young, it is buried in the host. In addition, ascomata occurs in large numbers in the host, and the host becomes mottled in appearance. When epihymenium is observed under a microscope, it looks reddish brown or purple brown. The spores are narrowly ellipsoid, simple, and hyaline, which is also a characteristic of this species (Zhurbenko and Pino-bodas 2017). This species is a typical species of lichenicolous fungi that parasitizes *Cladonia* species. Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. AUSTRIA. Kärnten Prov., Gailtaler. Alpen, Lake Weissensee, Laka, NW of ridge. 46°42′N 13°21′16E. Grid: MTB 9446. Alt. 1000 m. On *Cladonia digitata* (thallus). July 31, 2001 (Santesson: Fungi Lichenicoli Exs. 362, TNS).

Biatoropsis usnearum Räsänen, Ann. bot. Soc. Zool.-Bot. fenn. Vanamo 5(no. 9): 8 (1934)

[Fig. 25]

Basidiomata pale pinkish to reddish brown, dark brown or black, convex, gall, (0.2–)0.5–2.0(–2.5) mm. **Basidiospore** subglobose to ellipsoid, with apiculus, 4.5–8.0 × 4.0–7.5 µm. **Basidia** claviform to cylindrical, 1–3-septate, not constricted at the septate, hyaline, 20.0–44.0 × 3.0–6.5 µm (Hawksworth et al. 2010a).

The characteristic of this species is that it forms pink to brown bumps and basidia

shaped like a club. Basidia is 1–3-septate (Hawksworth et al. 2010a). The classification of this species has been reviewed in recent years, and it is thought that Japanese products can also be divided into multiple species (Ohmura and Kashiwadani 2018). This species is a typical species of lichenicolous fungi that parasitizes *Usnea* species. Japanese records were reported by Diederich and Christiansen (1994).

Exsiccata examined. FRANCE. Finistère: just W of Menez-Hom (=c. 12 km WNW of Chateaulin). On the trunk of a solitary tree of *Pinus pinaster*. On *Usnea* sp. (thallus). July 20, 1954 (Santesson: Fungi Lichenicoli Exs. 156, TNS).

Buelliella inops (Triebel & Rambold) Hafellner, in Hafellner, Triebel, Ryan & Nash, Mycotaxon 84: 298 (2002).

Mycelium immersed, brown. **Pseudothecia** black, opening apically ascoma wall crumbling off and exposing hymenium, become to apothecioid, 0.15–0.25 mm diam. **Ascomatal wall** paraplectenchymatic, composed of cells, outside dark brown, inside pale brown. **Hymenium** hyaline, 45.0–55.0 µm tall. **Paraphysoids** branched, anastomoses, 2.5–3.0 µm thick. **Asci** broadly clavate to cylindrical, 34.0–50.0 × 14.0–17.0 µm, 8-spored. **Ascospores** 1-septate, rarely 2-septate, smooth, constricted at the septum, hyaline when young, pale brown when mature, (13.0–)16.0–17.0(–18.0) × 6.0–8.0(–8.5) µm. **Anamorph** not observed. **Host**: Thallus and apothecia of *Caloplaca* species (Nash et al. 2004).

This species is characterized by a black, round ascomata with transparent ascospores (slightly brown when mature). It is also characterized by asci of this genus does not respond to K/I and that it is bitunicate (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

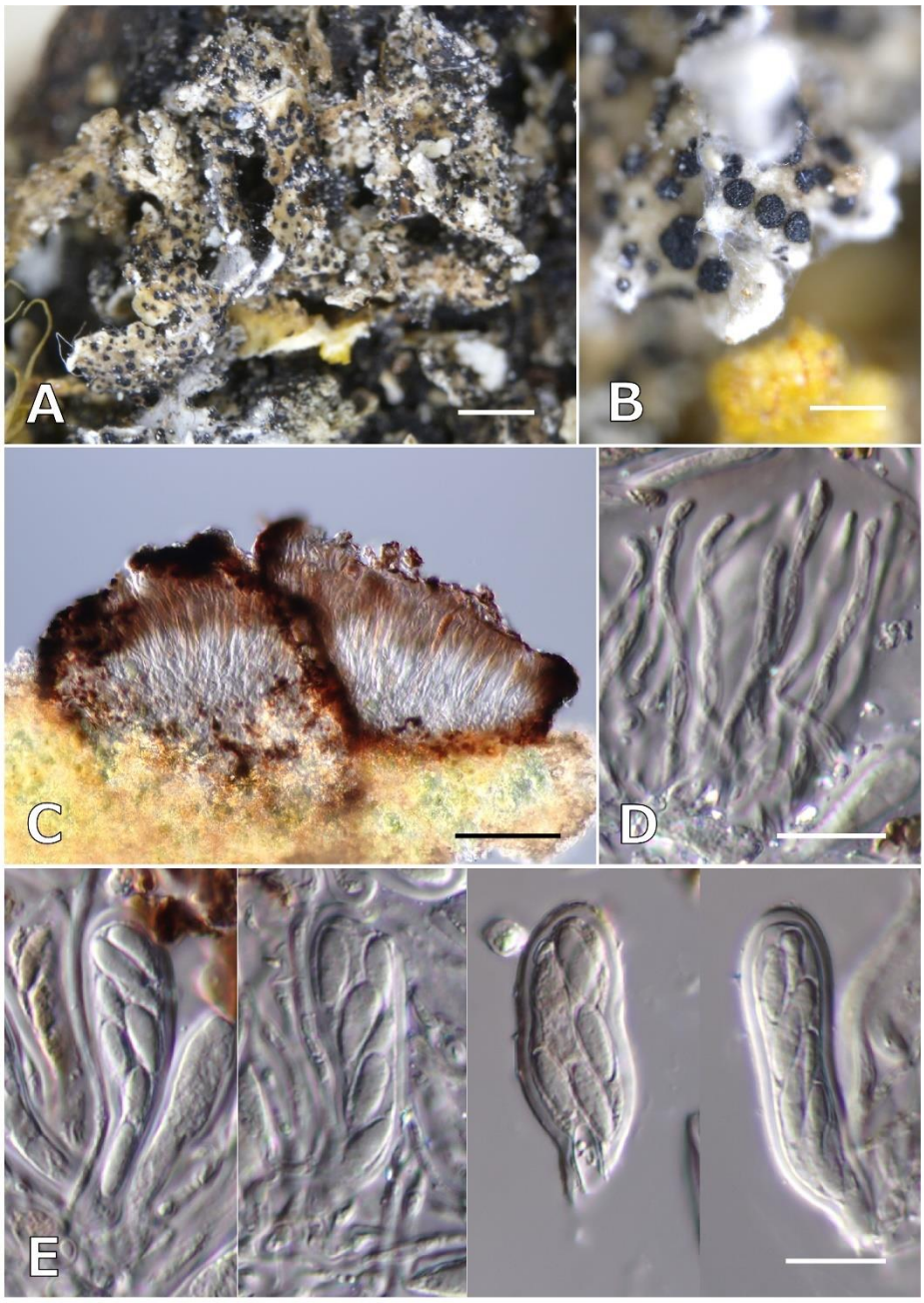

Fig. 24. *Bachmanniomyces punctum* (A. Massal.) Diederich & Pino-Bodas, in Diederich, Lawrey & Ertz, Bryologist 121(3): 393 (2018). (R. Santesson: Fungi Lichenicoli Exsiccati 362, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Paraphyses. E. Asci and ascospore. Scale bars: A=2 mm, B=500 μm, C=50 μm, D-E=10 μm.

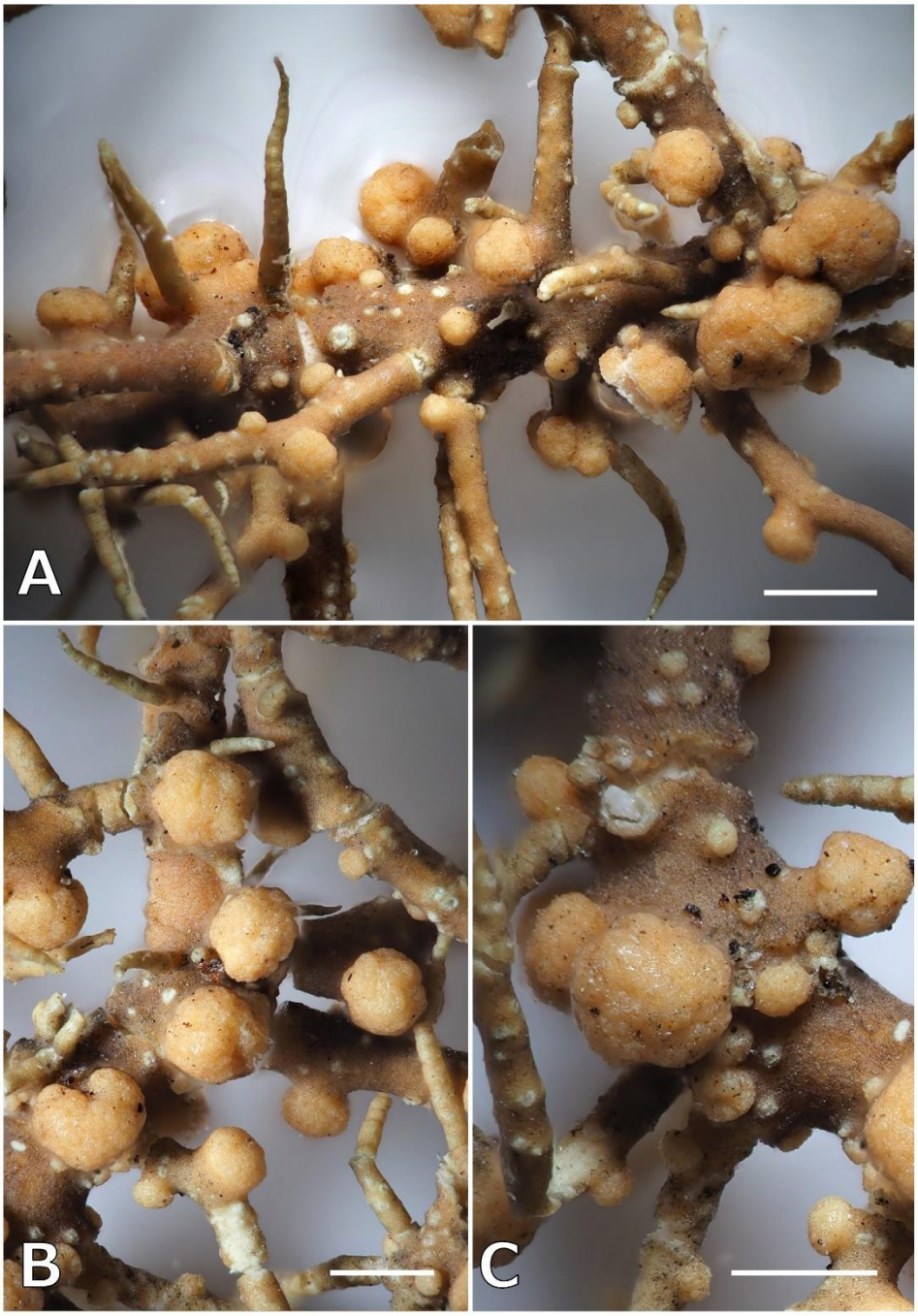

Fig. 25. *Biatoropsis usnearum* Räsänen, Ann. bot. Soc. Zool.-Bot. fenn. Vanamo 5(no. 9): 8 (1934). (R. Santesson: Fungi Lichenicoli Exsiccati 156, TNS). A. Growth habit. B-C. Basidiomata. Scale bars: A-C=1 mm.

Buelliella ohmurae Zhurb. & Diederich, in Zhurbenko & Ohmura, Lichenologist 52(6): 438 (2020).

Ascomata Lecideoid, partly immersed, with an irregularly rounded opening surrounded by radial splits, exposing hymenium, black, 80–160 μm diam. **Exciple** brown, 15.0–30.0 μm thick, composed elongate cells, up to 7 μm with walls 1–2 μm thick. **Paraphyses** septate, slightly enlarged and pale brown at the apex, branched, occasionally anastomosed, 1.0–1.5 μm diam. **Epihymenium** pale brown. **Hymenium** hyaline, 50–60 μm tall, I−, K/I−. **Asci** bitunicate, elongate-clavate, distinct foot, 45.0–55.0 × 13.0–17.0 μm, wall laterally rather thick, I−, K/I−, 8-spored. **Ascospores** obovoid, 1-septate, constricted at the septum, smooth, hyaline to medium brown (12.5–)13.5–15.5(–17.5) × 5.0–6.0(–6.5) μm. **Anamorph** not observed. **Host**: apothecia of *Icmadophila ericetorum* **(**Zhurbenko and Ohmura 2020).

This species is a black lecideoid ascomata, characterized by a black round ascus with hyaline spore (medium brown when mature). In addition, the ascus does not respond to K/I and has the characteristic of bitunicate. It is slightly smaller than previously known species and has recently become a new species due to its host being the *Icmadophila ericetorum* **(**Zhurbenko and Ohmura 2020). Japanese records were reported by Zhurbenko and Ohmura (2020).

Buelliella physciicola Poelt & Hafellner, Beih. Nova Hedwigia 62: 155 (1979).

[Fig. 26]

Ascomata apothecioid, sessile, black, 100–200 μm diam. **Hymenium** hyaline, pale brown in the upper part, 30.0–80.0 μm tall, I–. **Paraphyses** branched to anastomose, slightly enlarged end cells, embedded in a pale brown, 2.0–3.0 μm thick. **Asci** broadly cylindrical, 50.0–60.0 × 12.0–17.0 μm, 8-spored. **Ascospores** 1-septate, hyaline, finally pale brown, (12.0–)13.0–

17.0 × 6.0–8.5 µm. **Host**: *Phaeophyscia* species (Nash et al. 2004).

This species is characterized by black, round ascomata, clear hymenium, 1-septate, hyaline spores (slightly brown when mature). Spores are slightly smaller than other species and parasitize *Phaeophyscia* species (Nash et al. 2004). Japanese records were reported by Hafellner (1979).

Exsiccata examined. PERU. Dept. Junin: Prov. Tarma, c. 10 km (road distance) NNE of Palca. 11°18′S, 75°32′W. Alt. c. 2600 m. On a steep, rocky slope with a rich *Bromeliaceous* vegetation. On *Phaeophyscia endococcinodes* (thallus and apothecia). February 7, 1981 (Santesson: Fungi Lichenicoli Exs. 103, TNS).

Capronia triseptata (Diederich) Etayo, Bull. Soc. linn. Provence 47: 113 (1996)

Ascomata setae, brown, 70.0–150 µm diam. **Asci** 64-spored. **Ascospore** (0–)3(–5)-septate, brown, 9.0–10.5(–13.0) × 3.0–3.5 µm (Hawksworth et al. 2010a).

This species is black to brown ascomata and is characterized by its surface covered with setae. The characteristic of this species is that the ascus contains a large number of spores (64-spores), and the spores are brown and simple to 3–5-septate (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

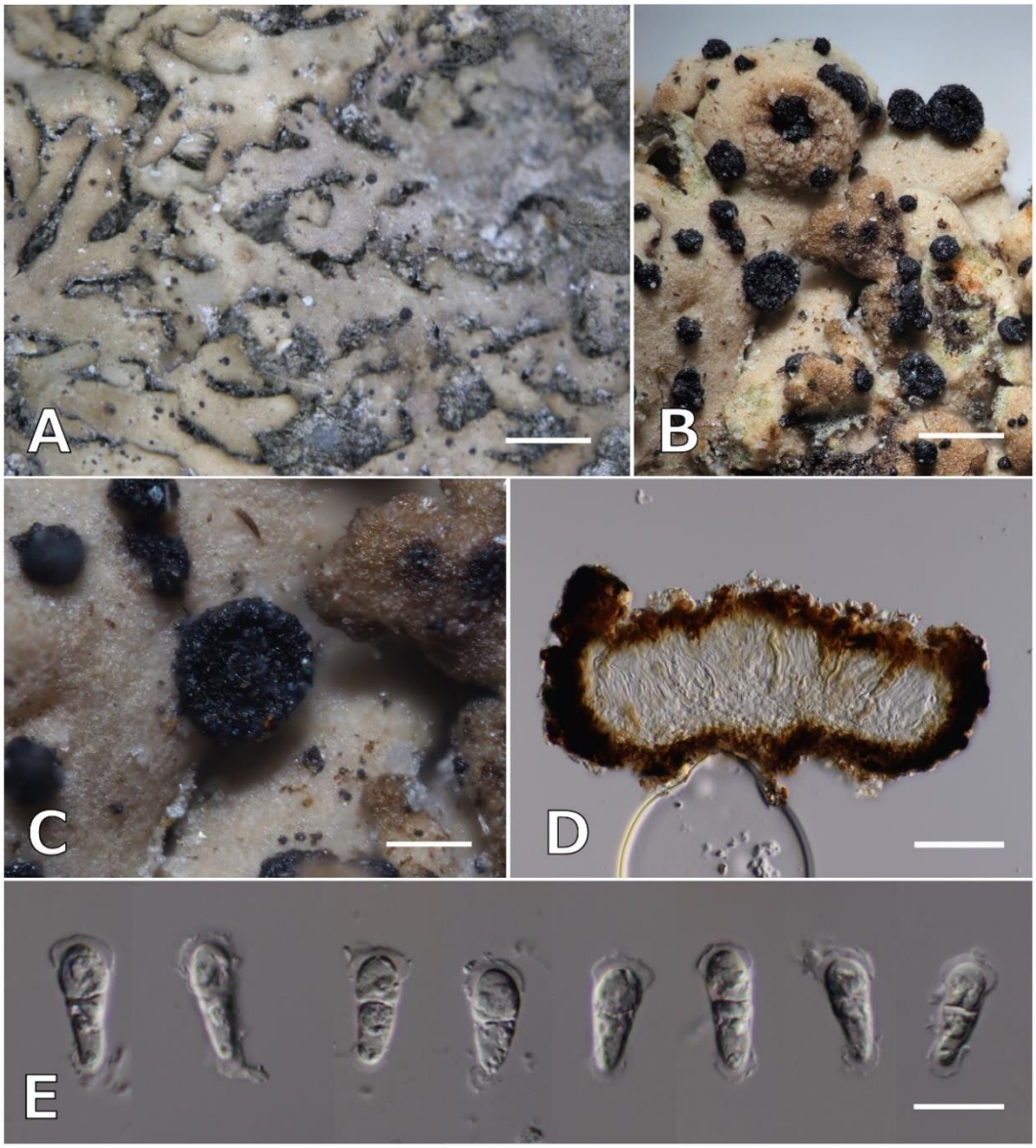

Fig. 26. *Buelliella physciicola* Poelt & Hafellner, Beih. Nova Hedwigia 62: 155 (1979). (R. Santesson: Fungi Lichenicoli Exsiccati 103, TNS). A-B. Growth habit. C. Ascomata. D. Cross section of an ascomata. E. Ascospore. Scale bars: A=1 mm, B=0.5 mm, C=100 µm, D=30 µm, E=10 µm.

Carbonea vitellinaria (Nyl.) Hertel, Mitt. bot. St Samml., Münch. 19: 442 (1983)

[Fig. 27]

Ascomata apothecioid, immersed or sessile, 100–500 µm diam. **Disc** plane to convex, black. **Exciple** black, gray, green, brown. **Epihymenium** dark green to brack. **Hypothecium** hyaline, brown to brownish yellow. **Hymenium** hyaline, rarely black, emerald–green or turquoise above, 40.0–45.0 µm tall. **Paraphyses** branched, hyaline. **Asci** clavate, 8-spored. **Ascospores** ellipsoid to obovoid, hyaline, simple, with obtuse ends, 6.0–12.0(–13.0) × 4.0–7.0 µm. **Host**: *Candelariella* species, *Lecanora* species, *Lecidea* species, and *Rhizocarpon* species (Nash et al. 2004, Ohmura et al. 2014).

This species is characterized by its black and circular ascomata and exciple-epihymenuim, which are dark brown to green. The spores are also characterized by being ellipsoid to obovoid, hyaline and simple. It is known to parasitize various crustose lichens (Nash et al. 2004). Japanese records were reported by Ohmura et al. (2014).

Exsiccata examined. SWEDEN. Uppland: Torstuna par., SE of Myrsjöberget. On the top of a large boulder in a field. On *Candelariella coralliza* (thallus). June 11, 1961 (Santesson: Fungi Lichenicoli Exs. 8, TNS).

Catillaria japonica Zhurb. & Hafellner, in Zhurbenko & Ohmura, Lichenologist 52(6): 440 (2020).

Ascomata apothecioid, superficial, slightly concave to slightly convex disc, constricted at the base, arising singly or in small groups, occasionally contiguous, 150–450(–600) µm diam. **Exciple** medium to dark reddish brown, sometimes forms a stipe immersed in the host thallus, 30.0–50.0 µm laterally, 50.0–250 µm base. **Hypothecium** medium reddish

brown, K+ slightly fading, 30.0–70.0 μm tall. **Epihymenium** medium to dark reddish brown, 10.0 μm tall. **Hymenium** hyaline to dull red, 55.0–70.0 μm tall, I+ blue, K/I+ blue with greyish red patches. **Paraphyses** 1.0–2.0 μm diam, straight to sinuous, extending beyond the asci, branched to anastomose. **Asci** subclavate, Catillaria type, 50.0–65.0 × 10.0–12.0 μm, tholus thickened, K/I+ blue and partly reddish outer gelatinous coat, 8-spored. **Ascospores** ellipsoid to narrowly obovoid, 0–1(2–3)-septate, not or only slightly constricted at the median septum, slightly wider upper cell, hyaline to occasionally pale brownish orange or dull red, (9.5–)10.5–13.0(–15.5) × (4.0–)4.5–6.0(–6.5) μm. **Host**: *Dibaeis* species and *Pseudobaeomyces* species (Zhurbenko and Ohmura 2020).

This species is black ascomata, exciple and hypothecium to epihymenium is characterized by a reddish-brown color. Also, hymenium turns blue with respect to I and K/I. The spores are ellipsoid to narrowly obovoid, simple to 1-septate, sometimes 2-3 septate, colorless, but some are light brown (Zhurbenko and Ohmura 2020). Japanese records were reported by Zhurbenko and Ohmura (2020).

Catillaria stereocaulorum (Th. Fr.) H. Olivier, Bull. Acad. Intern. Géogr. Bot. 15: 274 (1905)

Ascomata apothecioid, sessile, discoid to subglobose, constricted at the base, brown to black, 0.1–0.8 mm diam, surface K+ red orange. **Exciple** brown, I+, K/I+ violet. **Epithecium** reddish brown, 5.0–10.0 μm tall. **Paraphyses** 4.0–8.0 μm diam, dark reddish brown. **Hymenium** 50.0–80.0 μm tall, hyaline to pale yellowish brown. **Hypothecium** 100–250 μm tall, hyaline to pale yellowish brown, K+ red orange, I+, K/I+ violet, with geenish yellow. **Asci** I+, K/I+ blue green. **Ascospores** elliptic to narrowly ellipsoid to oblong, smooth, hyaline, (0–)1-septate, not constricted at the septum, (10.5–)13.5–17.5(–19) × (3.5–)4.0–5.5(–6.5) μm.

Conidiomata pycnidial, immersed, brown, 50.0–130 μm diam. **Conidia** simple, hyaline, falcate to bacilliform, (8.0–)10.0–12.5(–13.5) × 1.0–1.5 μm. **Host**: *Stereocaulon* species (Zhurbenko 2010).

This species is characterized by the round, brown to black ascomata, exciple and hypothecium are brown and turn purple with respect to I and K/I. The ascus also turns blue green with respect to I and K/I. The spores are narrowly ellipsoid to oblong, simple to 1-septate and colorless. In addition, there are some species of this genus that grow as lichens (Zhurbenko 2010). Japanese records were reported by Zhurbenko and Ohmura (2019).

Cecidonia umbonella (Nyl.) Triebel & Rambold, Nova Hedwigia 47(3-4): 284 (1988)

Ascomata apothecioid, subimmersed, with central umbo, black, 0.2–0.5 mm diam. **Epithecium** dark brown. **Hymenium** 70.0–90.0 μm high. **Subhymenium** hyaline, ca 50.0 μm tall. **Paraphyses** anastomosed, 2.0–2.5 μm thick. **Asci** clavate, 60.0–75.0 × 15.0–25.0 μm. **Ascospore** ellipsoid, 11.0–13.0 × 7.0–9.0 μm. **Host**: *Lecidea* species (Inoue 1997).

This species is characterized by the round, brown to black ascomata is half buried in the host lichen (Inoue 1997). However, there are few records of collection, and it is considered necessary to conduct a follow-up survey on detailed morphological characteristics. Japanese records were reported by Inoue (1997).

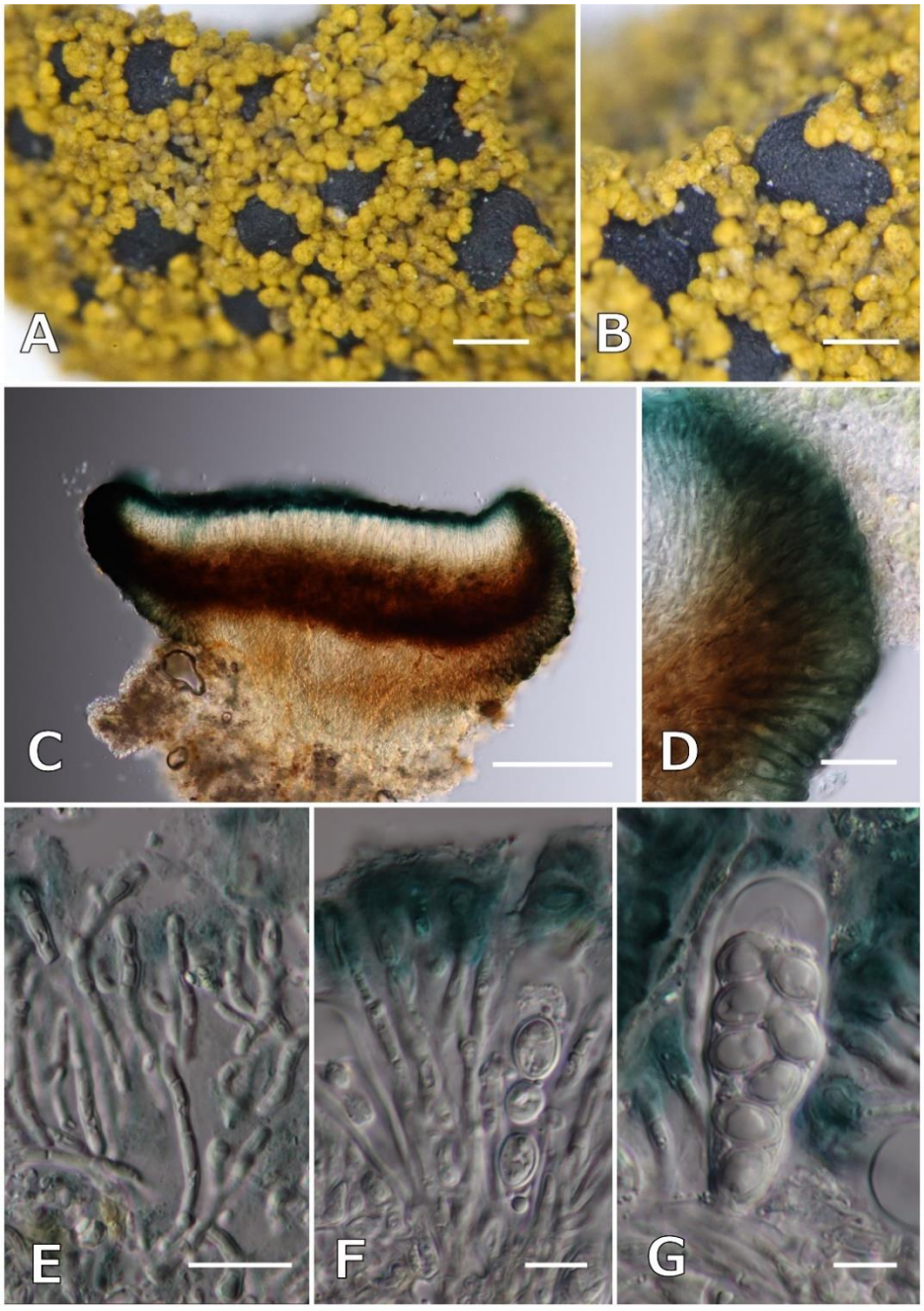

Fig. 27. *Carbonea vitellinaria* (Nyl.) Hertel, Mitt. bot. St Samml., Münch. 19: 442 (1983). (R. Santesson: Fungi Lichenicoli Exsiccati 8, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Exciple. E. Paraphyses. F. Asci and paraphyses. G. Asci and ascospore. Scale bars: A=0.5 mm, B=200 μm, C=100 μm, D=20 μm, E-G=10 μm.

Cercidospora stenotropae Nav.-Ros. & Hafellner, ad int., nom. inval.

Ascomata perithecioid, globose, (95.0–)110(–150) µm diam. **Exciple** hyaline lower part, green-blue or with some brown tinges around the ostiole, 10.0–15.0 µm. **Paraphyses** 1.0–1.5 µm thick. **Asci** cylindrical to clavate, (40.0–)55.0(–65.0) × (8.0–)10.0(–12.0) µm, 2–4-spores. **Ascospores** narrowly ellipsoid to slightly fusiform, 1-septate, lower cell slightly narrower than the upper cell, (13.0–)15.0–21.0(–22.0) × (4.5–)5.0–5.3(–6.0) µm. **Conidiomata** pycnidia, globose, 50.0–70.0 µm diam. **Conidia** colorless, simple, bacilliform, 3.0–5.0 × 0.5–1.0 µm. **Host**: *Lecanora polytropa* (Calatayud et al. 2013).

This species is characterized by the ascomata is a spherical perithecioid and the inside of the exciple is turquoise. It is also characterized by the pointed shape of both tips of the spores. Due to the relatively large size of the spores, only 2–4-spores are contained in the spores (Calatayud et al. 2013). Japanese records were reported by Zhurbenko et al. (2015).

Cercidospora stereocaulorum (Arnold) Hafellner, Herzogia 7(3-4): 362 (1987).

Ascomata perithecioid, flask-shaped, 75.0–125 µm diam. **Ascomatal wall** dark brown to black. **Hamathecium** present. **Asci** 4(–6)-spore. **Ascospores** fusiform, smooth, 3-septate, hyaline, sometimes slightly yellowish to brown when over mature, 22.0–25.0 × (5.0–)5.5–6.5 µm. **Host**: *Stereocaulon* species (Hawksworth et al. 2010a).

This species is characterized by ascomata having a flask-like shape and exciple being brown to black. It is also characterized by the pointed shape of both tips of the spores. Due to the relatively large size of the spores, only 4 (–6)-spores are contained in the spores. The spores are colorless but may turn slightly yellow to brown when over mature (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko and Ohmura (2019).

Cercidospora trypetheliza (Nyl.) Hafellner & Obermayer, Cryptog. Bryol. - Lichénol. 16(3): 180 (1995).

[Fig. 28]

Ascomata perithecioid, immersed host thallus, greenish black, 150–200 µm diam. **Ascomatal wall** pale brown to brown. **Interascal filament** branched to anastomose, hyaline. **Asci** cylindrical, 8-spores, 65.0–80.0 × 11.0–12.0 µm. **Ascospore** narrowly ellipsoid to slightly fusiform, lower cell slightly narrower than the upper cell, 1-septate, hyaline, (13.0–) 15.0–17.0 (–19.0) × 4.5–5.5 µm. **Conidiomata** 80.0–100 µm. **Host**: *Arthrorhaphis alpine* (Hafellner and Obermayer 1995).

In this species, ascomata is shaped like a flask, and the ascomatal wall is black to green. It is characterized by the pointed shape of both tips of the spores. The spores are slightly smaller than the species of the same genus, with up to 8-spores in the ascus (Hafellner and Obermayer 1995). Japanese records were reported by Zhurbenko and Ohmura (2019).

Exsiccata examined. AUSTRIA. Salzburg Prov. (close to the border to Kärnten), Pinzgau, Hohe Tauern, Glockner group, W of the Grossglocker - Hochalpen road, between Hochtor and Brennkogel, N slope of Grossen Margrözenkogel. 47°05'05''N 12°50'15''E. Alt. 2600 m. On *Arthrorhaphis alpina* (thallus). August 30, 1996 (Santesson: Fungi Lichenicoli Exs. 310, TNS).

Chaenothecopsis brevipes Tibell, Symb. bot. upsal. 27(no. 1): 119 (1987)

Ascomata apothecioid, K–, shorter than 0.5 mm. **Stalk** present or absent. **Ascospore** 1-septate. **Host**: *Arthonia* species (Selva 2013).

This species grows on the host lichen like a pin. In addition, this species is characterized in that ascomata does not discolor with respect to K (Selva 2013). Japanese records were

reported by Tibell and Thor (2003).

Chaenothecopsis consociata (Nádv.) A.F.W. Schmidt, Mitt. Staatsinst. Allg. Bot. Hamburg 13: 148 (1970)

Ascomata apothecioid, K+ green. **Ascospore** 1-septate. **Host**: thallus of *Chaenotheca chrysocephala* (Selva 2013).

This species grows on the host lichen like a pin. In addition, this species is characterized by ascomata turns green with respect to K (Selva 2013). Japanese records were reported by Tibell and Thor (2003).

Chaenothecopsis nigra Tibell, Symb. bot. upsal. 27(no. 1): 132 (1987)

Ascomata apothecioid, K–, taller than 0.5 mm. **Stalk** present or absent. **Ascospore** pale brown, with darkly pigmented septum, 1-septate (Selva 2013).

This species is characterized by ascomata does not discolor with respect to K. The spores of this species are brown and the septum appears darker brown (Selva 2013). Japanese records were reported by Tibell and Thor (2003).

Chaenothecopsis pusilla (Ach.) A.F.W. Schmidt, Mitt. Staatsinst. Allg. Bot. Hamburg 13: 148 (1970)

Ascomata apothecioid, K–, taller than 0.5 mm. **Stalk** present or absent. **Ascospore** medium brown, with poorly pigmented septum, 1-septate (Selva 2013). Japanese records were

reported by Asahina (1931).

Chaenothecopsis pusiola (Ach.) Vain., Acta Soc. Fauna Flora fenn. 57(no. 1): 70 (1927)

Ascomata apothecioid, K+ red, the color disappearing quickly. **Ascospore** 1-septate (Selva 2013).

This species is characterized by the fact that ascomatata turns red or darker than K (Selva 2013). Japanese records were reported by Tibell and Thor (2003).

Chaenothecopsis sanguinea Tibell, Symb. bot. upsal. 27(no. 1): 151 (1987)

Although this species is on the Japanese checklist (Ohmura and Kashiwadani 2018), it is not a Lichenicolous fungi because it was collected from *Nothofagus* in New Zealand (Indexfungorum:http://www.indexfungorum.org/names/NamesRecord.asp?RecordID=131061). Japanese records were reported by Tibell and Thor (2003).

Chaenothecopsis viridireagens (Nádv.) A.F.W. Schmidt, Mitt. Staatsinst. Allg. Bot. Hamburg 13: 153 (1970)

Ascomata apothecioid, K+ green. **Ascospore** 1-septate. **Host**: lichen or colonies of algae (Selva 2013).

This species is characterized by the fact that ascomatata turns green with respect to K (Selva 2013). However, it may not be a strict lichenicolous fungi because it parasitizes not only lichens but also algae. Japanese records were reported by Tibell and Thor (2003).

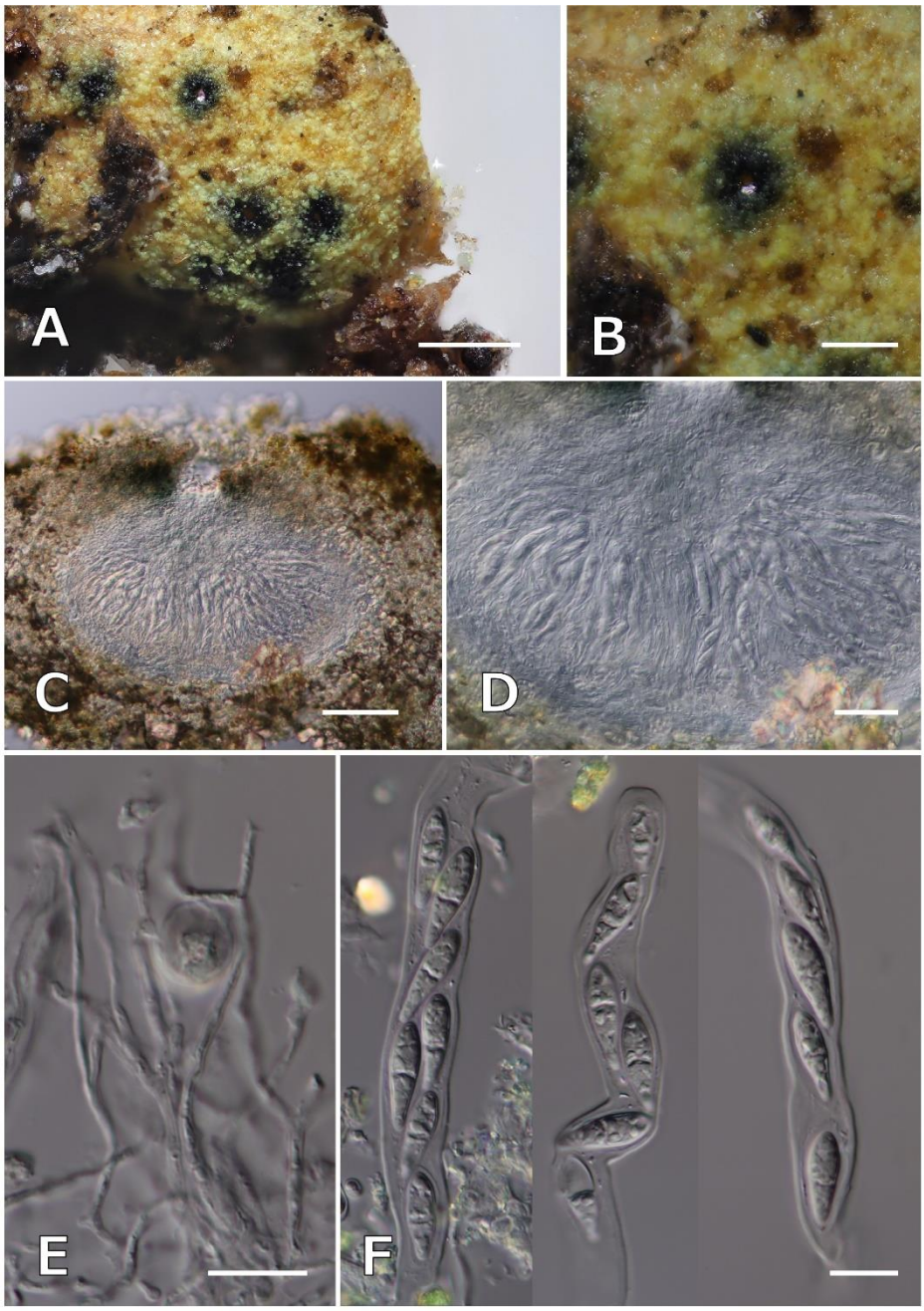

Fig. 28. *Cercidospora trypetheliza* (Nyl.) Hafellner & Obermayer, Cryptog. Bryol. - Lichénol. 16(3): 180 (1995). (R. Santesson: Fungi Lichenicoli Exsiccati 310, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E. Paraphyses. F. Asci and ascospore. Scale bars: A=0.5 mm, B=100 µm, C=50 µm, D=30 µm, E-F=10 µm.

Cladophialophora parmeliae (Etayo & Diederich) Diederich & Unter., in Diederich, Ertz, Lawrey, Sikaroodi & Untereiner, Fungal Diversity 58: 70 (2012) [2013]

= Basionym: *Sclerococcum parmeliae* Etayo & Diederich 1996

Sporodochia greyish brown, 50.0–120 µm diam. **Conidiophore** from compact sporodochia. **Conidia** irregularly ellipsoid, (0–)1(–2)-septate, 7.0–9.0 × 3.5–5.0 µm. **Host**: *Parmelia* species (Hawksworth et al. 2010a).

This species develops like black spots on the surface of the host lichen. Using a microscope, sporodochia with entangled hyphae and brown 2-septate conidia can be observed (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Clathroporina japonica Zahlbr., Bot. Mag., Tokyo 41: 313 (1927)

This species is no longer a Lichenicolous fungi because it is not on the global checklist (Ohmura and Kashiwadani 2018).

Thallus smooth, greenish white 0.3–0.5 mm diam. **Ascomata** perithecioid. **Paraphyses** anastomosed. **Asci** fissitunicate, thickened apex. **Ascospore** of 30.0–40.0 × 12.0–16.0 µm (McCarthy 1995).

Clypeococcum cetrariae Hafellner, Herzogia 10: 4 (1994)

Mycelium immersed, brown, frequently branching. **Ascomata** perithecioid, pseudothecia, immersed, globose, ostiolate, arising in groups, dark brown to black, 65.0–75.0 × 85.0–90.0 µm. **Perithecial wall** 6.0–15.0 µm thick. **Hymenium** hyaline, 50–60 µm tall. **Subhymenium** hyaline, 10.0–15.0 µm thick. **Paraphyses** filiform, branched to anastomosing,

septate, 1.0–2.0 µm thick. **Periphyses** not clearly differentiated. **Asci** cylindrical, 43.0–46.0 × 10.0–13.0 µm, 4-spored. **Ascospores** ellipsoid to soleiform, rounded at the apices, 1-septate, slightly constricted at the septum, the lower cell often somewhat narrower, weakly verruculose, olivaceous brown, (14.0–)16.0(–17.1) × (4.9–)5–6(–6.2) µm. **Anamorph** not obserbed. **Host**: *Cetraria islandica* (Pirogov 2015).

The characteristic of this species is that the host's lichen has spots like black spots, and multiple black ascomatas are formed there. The spores are dark olive to brown, 1-septate, and the lower cells are elongated compared to the upper cells (Pirogov 2015). Japanese records were reported by Zhurbenko and Ohmura (2019).

Clypeococcum hypocenomycis D. Hawksw., Notes R. bot. Gdn Edinb. 38(1): 167 (1980)

[Fig. 29]

Mycelium immersed, spreading host thallus, brown, branched, 2.0–3.5 µm wide. **Ascomata** perithecioid, pseudothecia, immersed, globose, ostiolate, 50–100 µm diam, arising singly but becoming aggregated by clypeus, dark brown to black, mainly 20.0–30.0 µm thick. **Perithecial wall** 8.0–15.0 µm thick, K+ olive. **Hymenium** hyaline, 50.0–60.0 µm tall, I–, K/I–. **Subhymenium** hyaline, 4.0–6.0 µm thick. **Paraphyses** persistent, filiform, branched to anastomosing, septate, 1.0–2.0 µm thick. **Asci** elongate-clavate, 45.0–55.0 × 12.0–15.0 µm, 8-spored. **Ascospores** ellipsoid to soleiform, rounded at the apices, 1-septate, slightly constricted at the septum, the lower cell often somewhat narrower, weakly verruculose, olivaceous brown, (9.0–)10.0(–13.5) × (4.0–)5.0(–6.5) µm. **Conidiomata** immersed, black, 45.0–60.0 µm in diam. **Conidiomatal wall** dark brown, K+ olive. Conidia bacilliform, hyaline, simple, 5.5–6.0 × 1.0 µm. **Host**: *Hypocenomyce* species (Nash et al. 2004).

The characteristic of this species is that the host's lichen has spots like black spots, and multiple black ascomatas are formed there. In some cases, the stains may stick together and the host may turn black. The ascomatal wall is also characterized by the fact that it turns olive-colored with respect to K, and the spores are 1-septate, from olivaceous brown (Nash et al. 2004). Japanese records were reported by Zhurbenko and Ohmura (2015).

Exsiccata examined. SWEDEN. Västergötland: Undenäs par., Tiveden National Park, Vitsand. 58°43'N 14°34'E. Alt. c. 160 m. On the trunk of a *Pinus sylvestris* in an open *Pinus*-forest. On *Hypocenomyce scalaris* (thallus). June 9, 1988 (Santesson: Fungi Lichenicoli Exs. 160, TNS).

Corynespora laevistipitata (M.S. Cole & D. Hawksw.) Heuchert & U. Braun, Herzogia 19: 13 (2006)

Colonies developed host thallus, caespitose, dark brown to black. **Mycelium** immersed, hyphae branched, septate, smooth, with a few superficial hyphae, yellowish to pale brown, 1.5–3.0 µm wide. **Conidiophores** arising from internal hyphae, erumpent, unbranched or sometimes branched, cylindrical, 60.0–220 × 5.0–10.0 µm, (1–)4(–10)-septate. **Conidiogenous cells** smooth to somewhat rough-walled or granulate, medium to dark brown, 13.0–40.0 µm long, 1.0–2.0 µm wide. **Conidia** singly or short chains, broadly ellipsoid to ovoid, 1–4-septate, not constricted at the septa, pale brown, 20.0–70.0 × 8.0–15.0 µm. **Host**: *Graphis* species, *Lecanora* species, *Lepra* species, *Pertusaria* species, *Phaeophyscia* species and *Xanthoria* species (Heuchert and Braun 2006).

The characteristic of this species is that brown to black hyphae grow in colonies on the host lichen. It looks like hair is growing on the lichen body. The conidia are very elongated

oval and look like 1–4-septate. The color is light brown. It parasitizes a wide range of crustose lichens and foliose lichens (Heuchert and Braun 2006). Japanese records were reported by Zhurbenko et al. (2015).

Corynespora thorii U. Braun, Zhurb. & Frisch, in Zhurbenko, Braun, Heuchert & Kobzeva, Herzogia 28(2): 585 (2015).

Conidiophores medium to dark brown, 2 µm thick. **Conidia** (0–)1(–3)-septate, shorter, (14.0 –)20.0 –30.0 × 5.0 –7.0(– 8.0) µm. **Host**: *Lecanora* species (Zhurbenko et al. 2015).

The characteristic of this species is that brown to black hyphae grow in colonies on the host lichen. It looks like hair is growing on the lichen body. Conidia are very elongated ellipses, predominantly 1-septate, but may also look like simple or 4-septate. The color is medium brown. It parasitizes mainly the genus *Lecanora* (Zhurbenko et al. 2015a).

Cryptodiscus ihlenii Zhurb., in Zhurbenko & Ohmura, Lichenologist 52(6): 440 (2020).

Ascomata apothecioid, aggregated, subglobose, concave, immersed, pale orange to orange-white, 80.0–250 µm diam. **Exciple** hyaline, K−, 10.0–20.0 µm thick. **Periphysoid** absent. **Epihymenium** indistinct. **Hymenium** hyaline, 70.0–100 µm tall. **Subhymenium** hyaline, 10.0 µm thick. **Paraphyses** filiform, septate, branched, hyaline, 1.0–2.0 µm thick. **Asci** narrowly ellipsoid to elongate clavate, 8-spore, 55.0–80.0 × 13.0–17.0 µm. **Ascospore** narrowly obovate, 1-septate, smooth, with many guttules, hyaline, (14.0–)15.5–19.0(–20.5) × (5.0–)5.5–7.0(–7.5) µm. **Anamorph** not observed (Zhurbenko and Ohmura 2020).

This species is a circular ascomata and is characterized by a pale orange to white color.

This ascomata is immersed in the host's lichen. Exciple, hymenium, and subhymenium are all colorless, and the spores are also colorless, narrowly obovate, and 1-septate (Zhurbenko and Ohmura 2020). Japanese records were reported by Zhurbenko and Ohmura (2020).

Diplolaeviopsis japonica Zhurb. & Diederich, in Zhurbenko, Frisch, Ohmura & Thor, Herzogia 28(2): 768 (2015)

Ascomata apothecioid, subglobose, erumpent, sessile, scattered and adjacent, initially closed, later on cupulate, with white hairs around the pore, black, 80.0–190 µm diam. **Exciple** medium to dark olive with grayish reddish brown, 20.0–30.0 µm thick. **Excipular hairs** abundant around the ascomatal opening, simple, smooth, 10.0–33.0 µm long. **Hymenium** not inspersed, hyaline to pale olive, 30.0–50.0 µm tall. **Epihymenium** indistinct. **Hypothecium** pale olive, ca 20.0 µm tall. **Paraphyses** filiform, not or rarely branched, hyaline, 1.5 –2.2 µm diam. **Asci** clavate to subcylindrical, 8-spored, (31.0–)35.0 –41.5(– 43.5) × 7.0–8.5(–9.5) µm. **Ascospore** narrowly fusiform to bacilliform, slightly curved, simple, smooth, hyaline, (14.4 –)20.0–27.0(–38.0) × (1.8 –)2.0 –2.4(–3.0) µm. **Anamorph** not observed. **Host**: *Gyalolechia flavorubescens* (Zhurbenko et al. 2015).

This species is characterized by its round, black ascomata and its surface covered with a large number of hairs. Ascomata grows like breaking through the host's lichen. Ascomata is initially closed, but opens as it grows. The spores are transparent, elongated fusiform to bacilliform, and simple (Zhurbenko et al. 2015). Japanese records were reported by Zhurbenko et al. (2015).

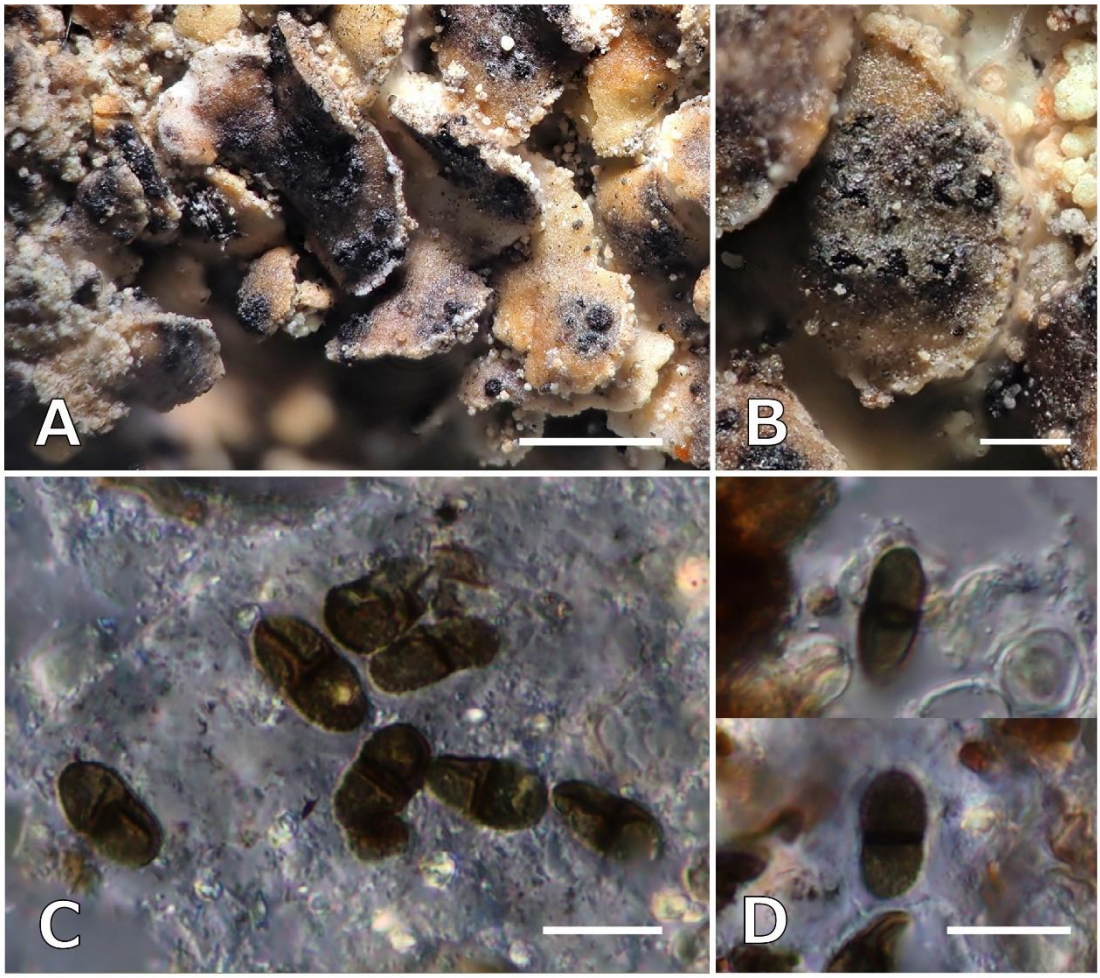

Fig. 29. *Clypeococcum hypocenomycis* D. Hawksw., Notes R. bot. Gdn Edinb. 38(1): 167 (1980). (R. Santesson: Fungi Lichenicoli Exsiccati 160, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D-E. Ascospore. Scale bars: A=1 mm, B=0.5 mm, C-D=10 μm.

Distopyrenis japonica H. Harada, Mycoscience 41(5): 491 (2000).

Ascomata Perithecioid, grayish to brown. **Ascomatal wall** brown, 1.0–1.5 µm. **Exciple** dark brown. **Periphyses** unbranched or sometimes branched at base, 5.0–15.0 µm long. **Hymenium** paraphyses unbranched, 1.0–1.5 µm wide. **Asci** cylindrical to clavate, 8-spores, apical dome prominent, I–. **Ascospores** ellipsoid, smooth, brown,12.0–15.0 × 5.0–6.0 µm. **Host**: *Graphis proserpens* (Harada 2000).

This species was first announced in Japan as the only lichenicolous fungi of the genus *Distopyrenis*. In general, the genus *Distopyrenis* is a lichen that grows on tree trunks. It has been announced that this species was parasitic on the genus *Graphis*, but it is considered that re-examination is necessary for details (Harada 2000). Japanese records were reported by Harada (2000).

Endococcus brachysporus (Zopf) M. Brand & Diederich, in Sérusiaux, Diederich, Brand & van den Boom, Lejeunia, n.s. 162: 24 (1999).

Ascomata perithecioid, erumpent, scattered to clusters on host thallus, subglobose to pyriform, with a shortly papillate, black, 150–250 µm diam. **Ascomatal wall** comprising 3–6 layers of radially compressed cells, dark brown. **Hamathecium** absent, ostiole internally with periphyses. **Asci** clavate to cylindric-clavate, with a markedly thickened apex when young, 40.0–45.0 × 20.0–28.0 µm, 8-spored, I–. **Ascospores** broadly ellipsoid, end of rounded, 1-septate, not constricted at the median septum, smooth, thick-walled, dark brown, (8.0–)9.5(–10.5) × 5.0–6.5 µm. **Host**: *Porpidia* species (Sérusiaux et al. 1999, Hawksworth et al. 2010a).

The characteristic of this species is that the black pyriform ascomata is buried in the host's lichen, and the ascus does not discolor with respect to I. It is also broadly ellipsoid, 1-

septate (not constricted in the middle), and features dark brown spores (Sérusiaux et al. 1999, Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Endococcus nanellus Ohlert, Schr. Königl. Phys.-Ökon. Ges. Königsberg 11: 44 (1870).

Ascomata perithecioid, subglobose, sessile, immersed, dispersed, black, (50.0–)100(–150) μm diam. **Ascomatal wall** dark brown, K+ dark olive. **Hamathecium** absent, hymenial gel I– or I+ pale red to purple. **Asci** subcylindrical, rounded apices, ocular chamber distinct, (30.0–)33.0–46.0(–52.0) × (5.0–)7.0–9.0(–11.0) μm, wall I–, K/I+ pale blue with darker blue apical spot, 8-spored. **Ascospores** oblong ellipsoid to broadly ellipsoid, narrowly soleiform to fusiform, tapering towards apices, (0–)1-septate (reraly 2-septate), not or slightly constricted at the septum, upper cell usually slightly broader than the lower one, often with oil droplets, hyaline when young, pale grey-olive to olive when mature, (6.0–)9.0–12.0(–16.0) × (2.0–)3.0–4.0(–5.0) μm. **Host**: *Stereocaulon* species (Zhurbenko 2010).

This species is characterized by the black pyriform ascomata buried in the host lichen and the ascomatal wall turning dark olive to K. In addition, the tissue of hymenium may turn reddish purple or may not respond to I. The spores are oval, 1-septate (not constricted in the middle), colorless when young, and change from gray to olive when mature (Zhurbenko 2010). Japanese records were reported by Zhurbenko and Ohmura (2019).

Endococcus propinquus (Körb.) Trevis., Conspect. Verruc.: 17 (1860)

[Fig. 30]

Ascomata perithecioid, black, immersed, 160–260 μm diam. **Ascomatal wall**

medium brown, (15.0–)20.0–30.0(–50.0) µm thick. **Paraphyses** absent. **Periphyses** septate, partly embedded in gelatin, (15.0–)20.0–30.0(–40.0) × (1.0–)1.5(–2.0) µm. **Asci** clavate to subcylindrical, sessile or shortly stalked, 35.0–50.0 × 13.0–15.0 µm, 8-spored. **Ascospores** broadly ellipsoid, 1-septate, not or slightly constricted at the septum, end of scarcely attenuated, medium to dark brown, 10.0–12.0 × 6.5–7.0 µm. **Anamorph** not observation. **Host**: *Porpidia* species (Nash et al. 2004).

This species has a black pyriform ascomata buried in the host lichen, the spores are elliptical, 1-septate (sometimes slightly constricted or not constricted in the middle), and the color is medium to dark brown (Nash et al. 2004). Japanese records were reported by Triebel (1989).

Exsiccata examined. SWEDEN. Härjedalen: Tännäs par., Ramundberget, Sörgruvorna (c. 3 km S-SSE of Hotel Ramundberget. 62°40'N 12°24'E. Alt. c. 900 m. In an old copper mine. On *Porpidia flavicunda* (thallus). August 4, 1987 (Santesson: Fungi Lichenicoli Exs. 209, TNS).

Endococcus rugulosus Nyl., Mém. Soc. Imp. Sci. Nat. Cherbourg 3: 193 (1855).

[Fig. 31]

Ascomata perithecioid, globose to subglobose, immersed, scattered, ca165–250 µm diam. **Ascomatal wall** dark brown to black, 30.0–45.0 µm diam. **Hamathecium** absent. **Asci** clavate to sub-cylindrical, short furcate, broad pedicel, thickened and rounded at apex, with an ocular chamber, 67.0–75.0 × 14.0–18.0 µm, 8-spored. **Ascospores** ellipsoid, (0–)1-septate, not constricted at the septum, brown, 14.0–16.0 × 7.0–9.0 µm. **Host**: *Verrucaria* species, also reported from other saxicolous lichens (Subashini et al. 2016).

This species is characterized by black pear-shaped ascomata buried in the host lichen,

spores elliptical, 1-septate (not constricted in the middle), brown in color, and parasitizing a wide range of crustose lichens (Subashini et al. 2016). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. SWEDEN. Torne Lappmark: the Torneträsk area, Abiskojakka, Marmorbrottet. Alt. c. 400 m. On mica schist by a stream, sometimes inundated. On *Rhizocarpon amphibium* (thallus). August 7, 1971 (Santesson: Fungi Lichenicoli Exs. 57, TNS).

Endococcus verrucosus Hafellner, Herzogia 10: 8 (1994).

Ascomata perithecioid, 150–200 µm diam, immersed. **Ascomatal wall** dark brown, K+ light olive. **Hamathecium** absent, hymenial gel K/I+ blue with reddish. **Ascospores** ellipsoid to subglobose, ends acute or rounded, (0–)1-septate, both cells usually equal in size, occasionally slightly constricted at the septum, hyaline when young, medium greyish brown when mature, K−, (7.5–)10.3–14.9(–21.3) × (5.1–)6.1–7.7(–9.6) µm. **Host**: *Aspicilia* species (Zhurbenko and Notov 2015).

This species is characterized by the black pear-shaped ascomata buried in the host lichen and the ascomatal wall becoming olive-colored relative to K. In this species, the hymenium tissue turns blue or red with respect to K/I. The spores are oval and 1-septate (slightly constricted in the middle), colorless when young and grayish brown when mature (Zhurbenko and Notov 2015). Japanese records were reported by Zhurbenko et al. (2015).

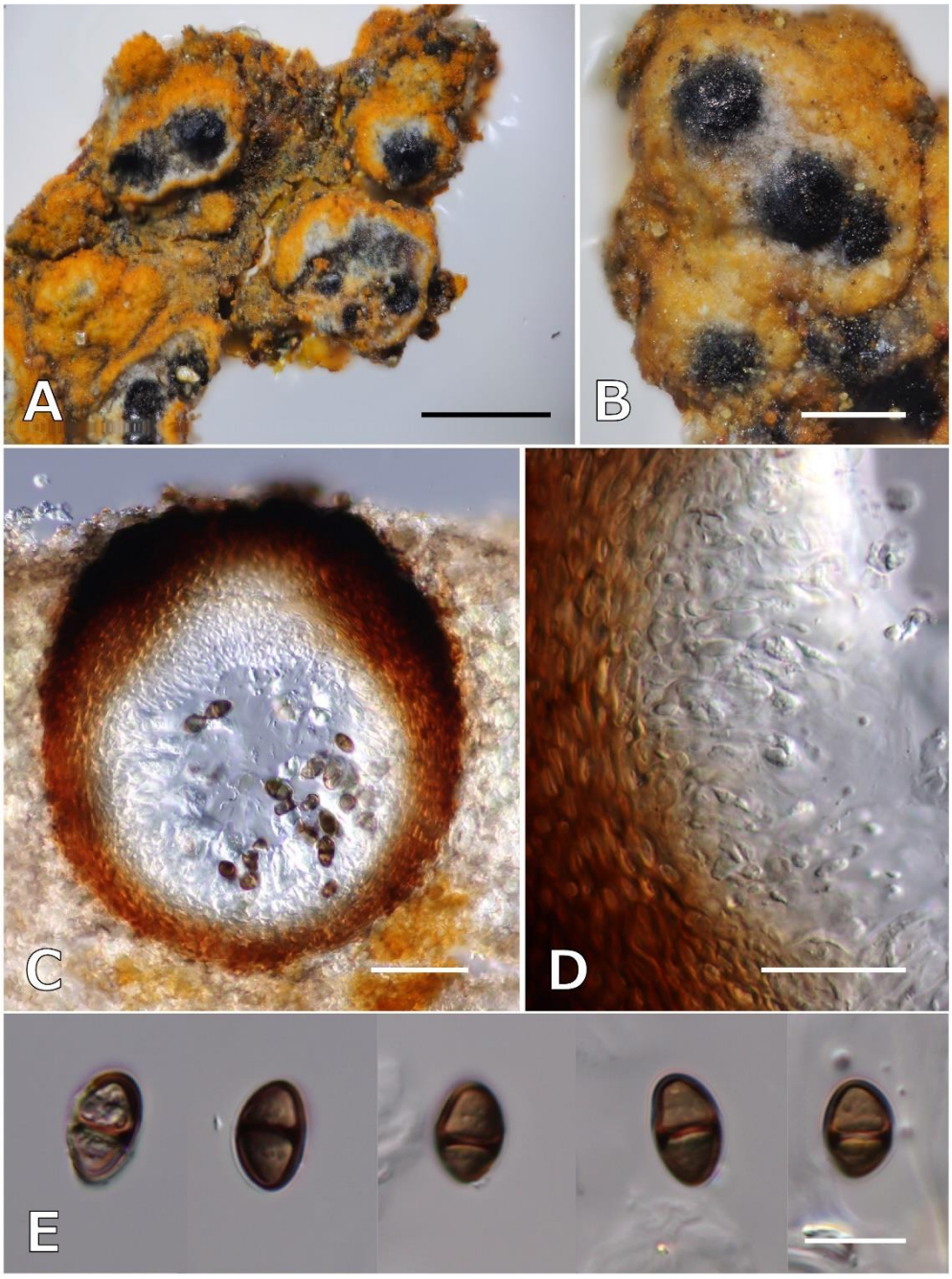

Fig. 30. *Endococcus propinquus* (Körb.) Trevis., Conspect. Verruc.: 17 (1860). (R. Santesson: Fungi Lichenicoli Exsiccati 209, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E. Ascospore. Scale bars: A=0.5 mm, B=250 µm, C=50 µm, D=30 µm, E=10 µm.

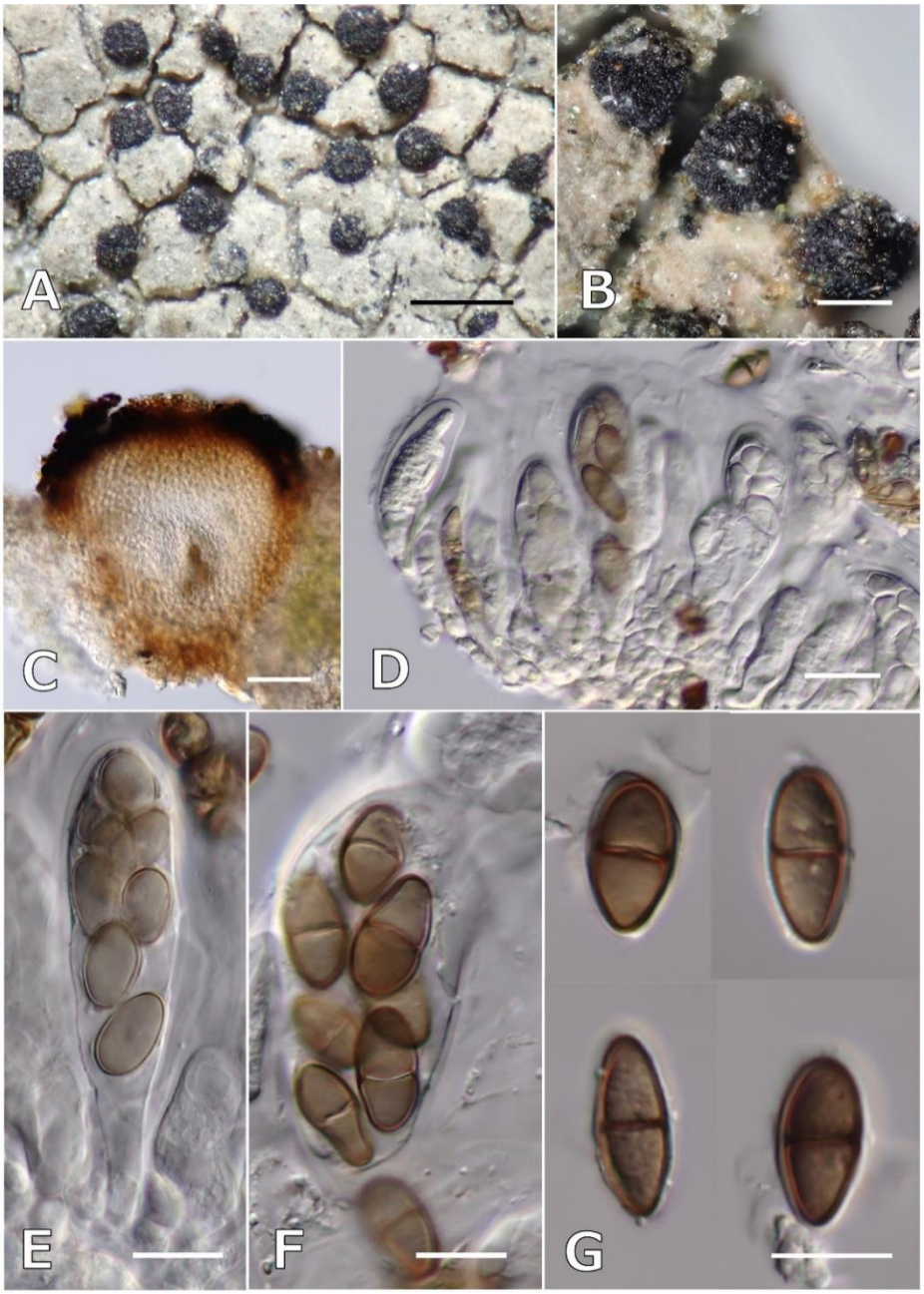

Fig. 31. *Endococcus rugulosus* Nyl., Mém. Soc. Imp. Sci. Nat. Cherbourg 3: 193 (1855). (R. Santesson: Fungi Lichenicoli Exsiccati 57, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E-F. Asci and ascospore. G Ascospore. Scale bars: A=0.5 mm, B=200 µm, C=50 µm, D=20µm, E-G=10 µm.

Enterographa mazosiae R. Sant. ex Matzer & R. Sant., in Matzer, Mycol. Pap. 171: 54 (1996)

Ascomata elongate, straight, curved, simple or branched, immersed, dark reddish to blackish, 100–450 µm long. **Epihymenium** hyaline, 5.0–15.0 µm tall. **Hymenium** hyaline, I+ orange to red, K/I+ blue, 40.0–60.0 µm tall. **Hypothecium** light brown to dark red-brown, I+ orange to red, K/I+ blue, 8.0–30.0 µm. **Interascal filaments** septate, branched and anastomosed, ca 1.0 µm wide. **Asci** fissitunicate, cylindrical or clavate, 8-spored, 30.0–44.0 × 12.0–16.0 µm. **Ascospore** hyaline, ellipsoid, 3– (6)-septate, not constricted at the septa, smooth, 13.0–19.0(–20.0) × 2.0–3.0 µm. **Host**: *Mazosia* species (Matzer 1996).

This species is elongated and characterized by a reddish brown ascomata. hymenium and hypothecium turn orange to red for I and blue for K/I. The spores are elongated ellipsoid, 3– (6)-septate and colorless. In addition, this species is known to parasitize lichens (*Mazosia* species) that grow on leaves (Matzer 1996). Japanese records were reported by Thor et al. (2000).

Epicladonia sandstedei (Zopf) D. Hawksw., Bull. Br. Mus. nat. Hist., Bot. 9(1): 16 (1981)

Conidiomata pycnidial, galls, convex, verruciform, ca 1.0 mm diam; pycnidia subglobose, arising singly, scattered, immersed, ostiole and upper part of the picnidium slightly erumpent, translucent brown to black when mature, (50.0–)80.0(–125) µm diam; pycnidial walls subhyaline of the ostiole, olivaceous brown to dark brown, 8.0–15.0 µm thick. **Conidiophores** short-cylindrical, simple, hyaline. **Conidiogenous cells** subcylindrical, holoblastic, arising directly from the pycnidial wall, hyaline, 10.0–20.0 µm tall, 3.0–4.0 µm. **Conidia** singly, subcylindrical to narrowly ellipsoid, truncated at the base, (0–)1-septate, hyaline, (7.5–)9.0–12.0(–14.0) × (2.5–)3.0(–4.0) µm. **Host**: *Cladonia* species, squamules and

podetial (Hawksworth 1981).

This species is a conidiomata buried in the host and is characterized by an elongated cylindrical shape of conidia. Conidia are colorless and slightly larger than those of the same genus. It is a typical type of lichenicolous fungi that parasitizes the genus *Cladonia* (Hawksworth 1981). Japanese records were reported by Zhurbenko et al. (2015).

Epicladonia stenospora (Harm.) D. Hawksw., Bull. Br. Mus. nat. Hist., Bot. 9(1): 20 (1981)

Conidiomata pycnidial, immersed in squamules, without galls, singly, scattered, the ostiole slightly erumpent or depressed, brown, subglobose, 75.0–120 µm diam; pycnidial wall hyaline to olivaceous brown or dark brown, 7.0–15.0 µm thick. **Conidiogenous cells** holoblastic, arising from the pycnidial wall, ampulliform, hyaline, 7.0–12.0 × 3.0–5.0 µm. **Conidia** singly, subcylindrical, slightly truncated, simple or exceptionally 1-septate, sometimes 2 or more guttulate, smooth, 7.5–11.0 × 3.0–3.5 µm. **Host**: *Cladonia* species, occurring on the primary squamules.

This species is a conidiomata buried in the host and is characterized by an elongated cylindrical shape of conidia. Conidia are colorless and slightly smaller than those of the same genus. It is a typical type of lichenicolous fungi that parasitizes the genus *Cladonia* (Hawksworth 1981). Japanese records were reported by Zhurbenko and Ohmura (2019).

Epigloea soleiformis Döbbeler, Beih. Nova Hedwigia 79: 229 (1984).

This species was identified as lichenicolous fungi. but has been excluded from the global checklist (Diederich et al. 2018) as it has been confirmed to parasitize plants (Index

Fungorum: (http://www.indexfungorum.org/names/NamesRecord.asp?RecordID=107495. 29.10.2021). Japanese records were reported by Zhurbenko and Ohmura (2019).

Mycelium immeresed, growing on the algae on the surface of the host. **Ascomata** Perithecioid, immersed to semiimmersed host thallus, globose, dull blackish green, 0.1–0.15 mm diam. **Hamathecium** thin paraphyses, simple. **Asci** cylindrical, 40.0–50.0 × 9.0–11.0µm, 8-spored. **Ascospores** ellipsoid to ovoid, 1-septate, slightly constricted at the septum, (4.0–)5.5(–6.0) × (9.0–)10.0–13.0(–14.0) µm. **Anamorph** not observed (Czarnota and Hernik 2013).

Epithamnolia xanthoriae (Brackel) Diederich & Suija, comb. nov.

= Synonym: *Hainesia aeruginascens* Brackel, Biblthca Lichenol. 109: 131 (2014)

Conidiomata 100–250 µm diam. **Conidiophores** simple to branched, septate, 1–3 elongate filiform cells, 7.0–11.0 × 2.0–2.2 µm. **Conidiogenous cells** 5.0–11.0 × 1.5–2.5 µm. **Conidia** filiform, basally slightly truncate, apically rounded, distinctly attenuated towards both ends, 0–5(–8)-septate, (25.0–)40.0(–84.0) × (1.8–)2.0–3.0(–4.0) µm. **Host**: *Candelaria* species, *Hypogymnia* species, *Lecanora* species, *Melanohalea* species, *Parmelia* species, *Phaeophyscia* species, *Physcia* species, *Platismatia* species, *Polycauliona* species, *Protoparmeliopsis* species, *Pseudevernia* species, *Punctelia* species, *Rusavskia* species and *Xanthoria* species (Suija et al. 2017).

The characteristic of this species is very elongated conidia. Conidia may or may not have septa. It is known to parasitize various types of lichens (Suija et al. 2017). Japanese records were reported by Zhurbenko et al. (2015).

Homostegia piggotii (Berk. & Broome) P. Karst., Bidr. Känn. Finl. Nat. Folk 23: 222 (1873)

[Fig. 32]

Stromata superficial, developing on host thallus, (1.2–)2.0 (–2.5) mm diam, round, convex, black. **Ascomata** perithecioid, with 5–12 locules immersed in each stroma, 150–200 µm diam. **Hymenium** paraphyses, branched, 1.5–2.0 µm. **Asci** 80.0–100 × 18.0–22.0 µm, clavate, rounded apex, I–, 8-spored. **Ascospores** ellipsoid to fusiform, 3-septate, slightly constricted at the median septum, smooth, dark brown, 18.0–22.5 × 5.5–8.0 µm. **Conidiomata** pycnidia, globose, immersed in the stroma with ascomata, 120–180 µm diam. **Conidiophores** absent. **Conidiogenous cells** cylindrical, 5.0–7.0 × 2.0–2.5 µm. **Conidia** obovoid, simple, hyaline, 3.0–4.0 × 1.0 µm. **Host**: *Parmelia* species (Hawksworth et al. 2004, 2010).

This species is characterized by the formation of many black spots on the surface of the host's lichen. Ascomata is gathered and formed in the spots. Also, hymenium is formed. It is also characterized by an ellipsoid to fusiform, 3-septate, brown spore (Hawksworth et al. 2004, 2010). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. SWEDEN. Smäland: Päskallavik, at the mouth of the stream Emän just N of Em. On a large boulder in a very sparse deciduous forest. On *Parmelia saxatilis* (thallus). July 16, 1957 (Santesson: Fungi Lichenicoli Exs. 12, TNS).

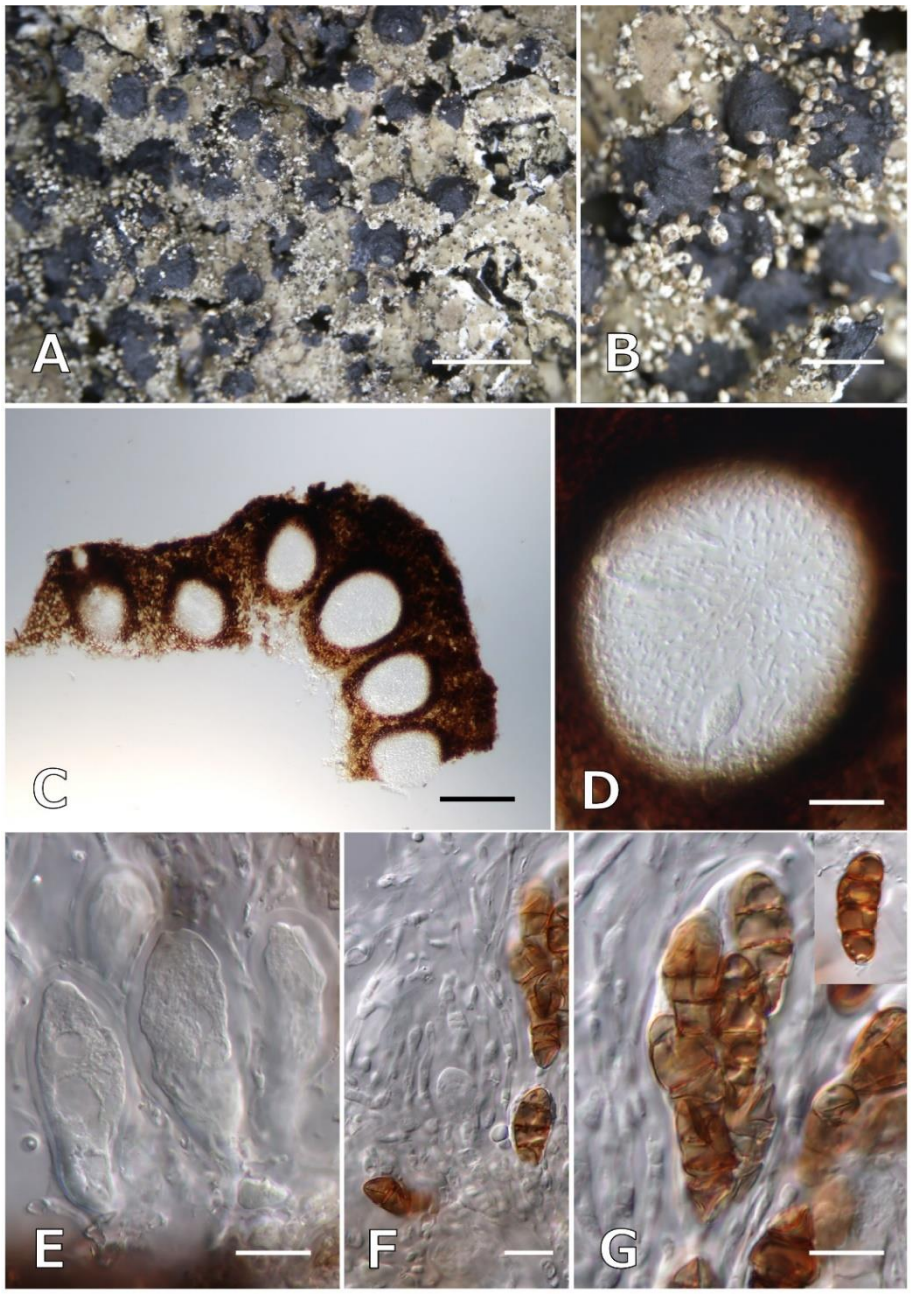

Fig. 32. *Homostegia piggotii* (Berk. & Broome) P. Karst., Bidr. Känn. Finl. Nat. Folk 23: 222 (1873). (R. Santesson: Fungi Lichenicoli Exsiccati 12, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E. Asci. F. Paraphyses. G. Ascospore. Scale bars: A=3 mm, B=1 mm, C=200 µm, D=50 µm, E-G=10 µm.

Intralichen christiansenii (D. Hawksw.) D. Hawksw. & M.S. Cole, Fungal Diversity 11: 90 (2002)

Mycelium immersed, hyaline to pale brown. **Conidiophores** branched, straight to flexuose, septate, sometimes constricted at the septa, pale brown, 15.0–35.0 × 2.5–4.0 µm. **Conidiogenous cells** not clearly, pale brown. **Conidia** ellipsoid, smooth, catenate, 1-septate, pale brown, 5.0–8.0 × 4.0–6.0 µm. **Host**: Apothecia of *Candelariella vitellina* (Hawksworth 1979, Nash et al. 2004).

This species has a very interesting ecology that it burrows inside the ascomata of *Candelariella vitellina* and grows. It is characterized by brown hyphae and brown 1-septate conidia (Hawksworth 1979, Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Intralichen lichenum (Diederich) D. Hawksw. & M.S. Cole, Fungal Diversity 11: 93 (2002).

Mycelium immersed, brown, smooth, septate, not constricted at the septa. **Conidiophores** branched, smooth, septate, distinctly constricted at the septa, pale brown, 25.0–50.0 µm long, 1.7–3.0 µm wide. **Conidiogenous cells** monoblastic, subcylindrical to ellipsoidal, pale brown. **Conidia** subglobose to ellipsoid, 0–1-septate, catenate, composed of 1–20 conidia, with chains often branched, brown, 3.0–4.5 × 2.5–4.0 µm. **Teleomorph** not observed. **Host**: *Candelariella* and other lichens (Diederich 1990, Hawksworth 1979, Hawksworth and Cole 2002).

This species grows in the host lichen ascomata. Very similar to *Intralichen christiansenii*, except that the conidia are simple or 1-septate. Japanese records were reported by Zhurbenko et al. (2015).

Lasiosphaeriopsis stereocaulicola (Th. Fr. ex Linds.) O.E. Erikss. & R. Sant., Mycotaxon 25(2): 570 (1986).

[Fig. 33]

Ascomata perithecioid, subglobose, superficial, singly but usually aggregated into blackberry like clusters, erumpent, sessile, 300–400 µm diam. **Ascomatal wall** composed of angular cells with Munk pores, dark brown, 50.0–70.0 µm thick. **Interascal tissue** absent. **Asci** cylindrical, short-stalked, 4-spored, I–, 90.0–100 × 12.0–14.0 µm. **Ascospores** broadly fusiform, hyaline when young, becoming brown, (2–) 4–5 (–9)-septate, eventually three-layered. (30.0–)35.0(–53.0) × (10.0–)11.0(–13.0) µm. **Host**: *Stereocaulon* species (Eriksson and Santesson 1986, Hawksworth et al. 2010a).

The characteristic of this species is that black ascomata is densely packed and becomes like blackberries. The spores are brown and (2–) 4–5 (–9) -septate. Due to the large size of the spores, the ascus contains up to four spores (Eriksson and Santesson 1986, Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko and Ohmura (2019).

Exsiccata examined. SWEDEN. Härjedalen: Tännäs par., Mt. Grönvålen (SE of Mt. Havtorstöten), near the summit. Alt. 1050 m. In an open alpine tundra. On *Stereocaulon glareosum* (thallus). July 25, 1974 (Santesson: Fungi Lichenicoli Exs. 58, TNS).

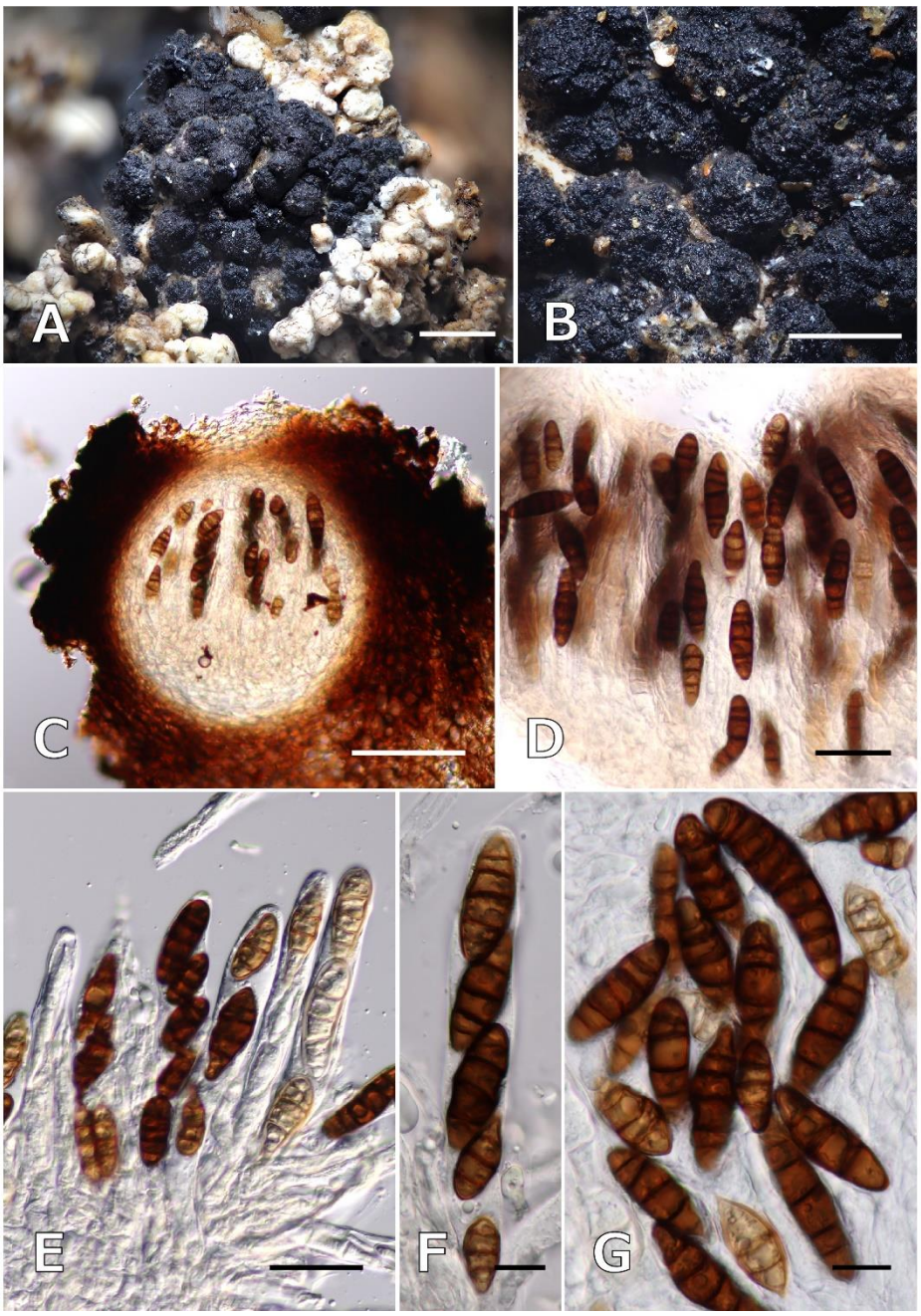

Fig. 33. *Lasiosphaeriopsis stereocaulicola* (Th. Fr. ex Linds.) O.E. Erikss. & R. Sant., Mycotaxon 25(2): 570 (1986). (R. Santesson: Fungi Lichenicoli Exsiccati 58, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D一E. Hymenium. F. Asci and ascospore. G. Ascospore. Scale bars: A=1 mm, B=0.5 mm, C=100 μm, D=50 μm, E=30 μm, F-G=10 μm.

Leptosphaeria akagiensis Vain., Bot. Mag., Tokyo 35: 79 (1921)

This species has few records collected and its morphological characteristics are largely unknown. Also, since the host is unknown, it is not known whether it is parasitic or saprophytic (Crane and Shearer 1991). Japanese records were reported by Vainio (1921).

Lichenochora obscuroides (Linds.) Triebel & Rambold, Biblthca Lichenol. 48: 168 (1992)

[Fig. 34]

Mycelium immersed, hyaline, inducing the formation of galls on the host lichen. **Gall** convex, concolorous or slighty darker. **Ascomata** perithecioid pyriform, 180–240 µm diam. **Ascomatal wall** brown, 20.0–30.0 µm. **Hymenium** present of lower half of the ascomata. **Hamathecium** present of periphyses and paraphyses. **Periphyses** numerous, unbranched, 2.0–4.0 µm thick. **Paraphyses** branched to unbranched, hyaline, 3.0–5.0 µm thick. **Asci** cylindrical to slightly clavate, 50.0−70.0 × 9.0–14.0 µm, 8spored. **Ascospores** ellipsoid to oblong, 1-septate, hyaline, 15.0–18.0 × 5.0–7.0 µm. **Anamorph** not observed. **Host**: *Phaeophyscia hispidul* (Hafellner 1989, Hafellner and Zimmermann 2012, Nash et al. 2004).

This species is characterized by the dense formation of small ascomatas that form gall-like lichens on the host's lichen. Each ascomata is pyriform and is black to brown. The spores are colorless, ellipsoid to oblong and 1-septate (Hafellner 1989, Hafellner and Zimmermann 2012, Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. LUXEMBOURG. NE of Bergem, Schèierboesch. On *Phaeophyscia orbicularis* (thallus). August 26, 1987 (Santesson: Fungi Lichenicoli Exs. 180, TNS).

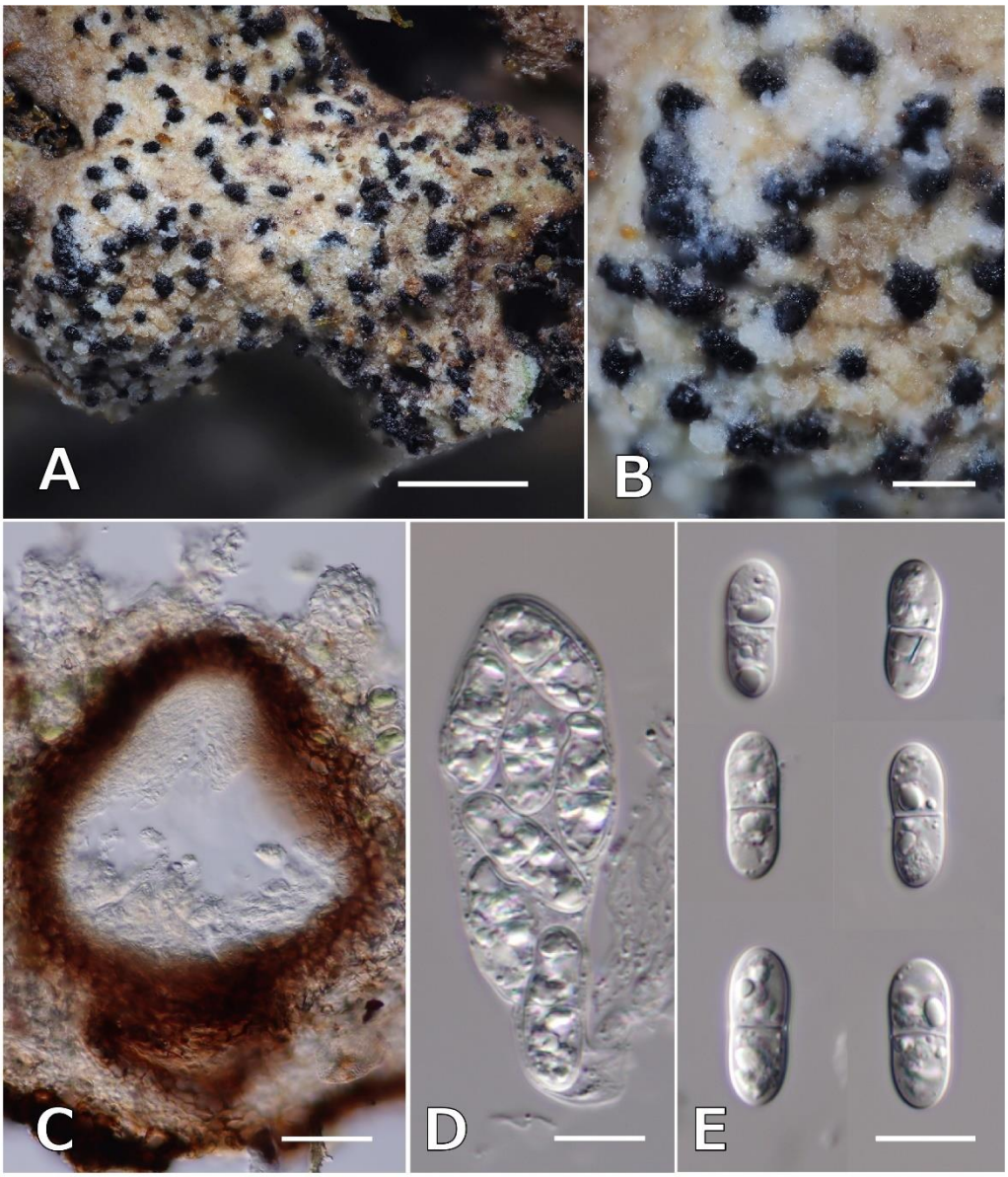

Fig. 34. *Lichenochora obscuroides* (Linds.) Triebel & Rambold, Biblthca Lichenol. 48: 168 (1992). (R. Santesson: Fungi Lichenicoli Exsiccati 180, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Asci. E. Ascospore (in K). Scale bars: A=1 mm, B=0.5 mm, C=50 µm, D-E=10 µm.

Lichenoconium species.

The genus *Lichenoconium* is characterized by black to brown conidiomata and subglobose brown conidia (Nash et al. 2004). The size and shape of conidiogenous cells can be used to distinguish between species, but the difference is very vague. Currently, five types of *Lichenoconium* are known in Japan, but taxonomic review will be required in the future.

Lichenoconium erodens M.S. Christ. & D. Hawksw., in Hawksworth, Persoonia 9(2): 174 (1977)

[Fig. 35]

Conidiomata pycnidial, immersed to erumpent, subglobose, black, (20.0–)30.0–50.0(–60.0) µm in diam. **Conidiomatal wall** dark brown, 3.0–5.0 µm diam. **Conidiogenous cells** (3.5–)4.0–5.0(–6.0) × (2.0–)3.0–3.5(–4.0) µm. **Conidia** subglobose, simple, verruculose, brown to dark brown, (2.0–)3.5(–4.0) µm. **Host**: *Lecanora* species, *Parmelia* species, *Cladonia* species, *Evernia* species, *Hypogymnia* species, *Pertusaria* species (Nash et al. 2004). Japanese records were reported by Zhurbenko and Ohmura (2019).

Exsiccata examined. U. K. British Isles Wales: Marioneth (V.C.48), Bala Lake (Llyn Tegid), Glanllyn (SE of the lake). On *Quercus* in an open forest. On *Evernia prunastri* (thallus). July 26, 1964 (Santesson: Fungi Lichenicoli Exs. 181, TNS).

Lichenoconium lecanorae (Jaap) D. Hawksw., Bull. Br. Mus. nat. Hist., Bot. 6(3): 270 (1979)

[Fig. 36]

Conidiomata pycnidial, immersed to erumpent, subglobose to ovoid, black,

(30.0–)40.0–80.0(–100) µm. **Conidiomatal wall** dark brown, 5.0–7.0 µm. **Conidiogenous cells** (4.0–)5.0–7.0(–8.0) × (2.0–)3.0–3.5(–4.0) µm. **Conidia** subglobose, simple, base of truncate, verruculose, brown to dark brown, (2.5–)3.0–4.5(–5.5) µm. **Host**: *Lecanora* species, *Parmelia* species (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015). **Exsiccata examined.** SWEDEN. Uppland: Jumkil par., 0.4 km S of Kättslinge (=1 km E of the parish church). 59°56'N 17°27'E. On the trunk of a *Populus tremula*. On *Lecanora* sp. (apothecia). September 5, 1971 (Santesson: Fungi Lichenicoli Exs. 182, TNS).

Lichenoconium lichenicola (P. Karst.) Petr. & Syd. [as 'lichenicolum'], Beih. Reprium nov. Spec. Regni veg. 42(1): 432 (1927) [1926]

Conidiomata pycnidial, subglobose, opening with a large porescattered, erumpent, black, 100–200 µm diam. **Conidiomatal wall** 7.0–12.0 µm thick. **Conidiogenous cells** cylindrical, sometimes becoming faintly to pigmented and verrucose, (6.0–)8.0–13.0(–14.0) × 2.0–3.5 µm. **Conidia** subglobose to ellipsoid or clavate, tapered towards the base, often truncate at the base, singly, simple, verrucose, brown to dark brown, (4.0–)6.0–8.0(–9.0) × 3.0–4.0(–6.0) µm. **Teleomorph** not observed. **Host**: *Physcia* species (Hawksworth 1977, Hawksworth et al. 2010a, Lawrey et al. 2011). Japanese records were reported by Zhurbenko et al. (2015).

Lichenoconium usneae (Anzi) D. Hawksw., Persoonia 9(2): 185 (1977)

[Fig. 37]

Conidiomata Pycnidial, immersed, subglobose, (40.0–)50.0–80.0(–110) µm diam. **Conidiomatal wall** dark brown, 4.0–7.0 µm thick. **Conidiogenous cells** (5.0–)7.0–9.0(–11.0)

× (2.0–)2.5–3.5(–4.0) µm. **Conidia** subglobose, simple, verruculose, brown to dark brown, (2.5–)3.0–4.0(–5.0) µm. **Hosts**: *Cladonia* species, *Parmelia* species, *Physcia* species, *Ramalina* species, *Usnea* species (Hawksworth et al. 2010a, Nash et al 2004). Japanese records were reported by Zhurbenko and Ohmura (2019).

Exsiccata examined. Sweden. Skäne: Rörum par., between Nygärd and Mossaryd. 55°30'N 14°15'E. On a siliceous boulder in a *Corylus grove*. On *Xanthoparmelia conspersa*, *Neofuscelia pulla* and *N. loxodes* (apothecia). July 9, 1947. (Santesson: Fungi Lichenicoli Exs. 183, TNS).

Lichenoconium xanthoriae M.S. Christ., Friesia 5(3−5): 212 (1956)

[Fig. 38]

Conidiomata pycnidial, subglobose, immersed, black, (80.0–)100–175(–200) µm in diam. **Conidiomatal wall** dark brown, 5.0–10.0 × 3.0–7.0 µm diam. **Conidiogenous cells** (5.0–)6.0–8.0(–11.0) × (2.0–)2.5–4.0 µm. **Conidia** subglobose, simple, truncated of base, smooth to verruculose, brown to dark brown, (2.5–)3.0–4.5(–6.0) µm. **Hosts**: *Caloplaca* species, *Cetrelia* species, *Heterodermia* species, *Melanelia* species, *Physcia* species, *Tuckermannopsis* species, *Xanthoria* species (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. SWEDEN. Bohuslän: T järnö par., the Koster Islands, Sydkoster, W. of Valfjäll. On twigs of *Malus sylvestris*. On *Xanthoria polycarpa* (apothecia). June 29, 1971 (Santesson: Fungi Lichenicoli Exs. 84, TNS).

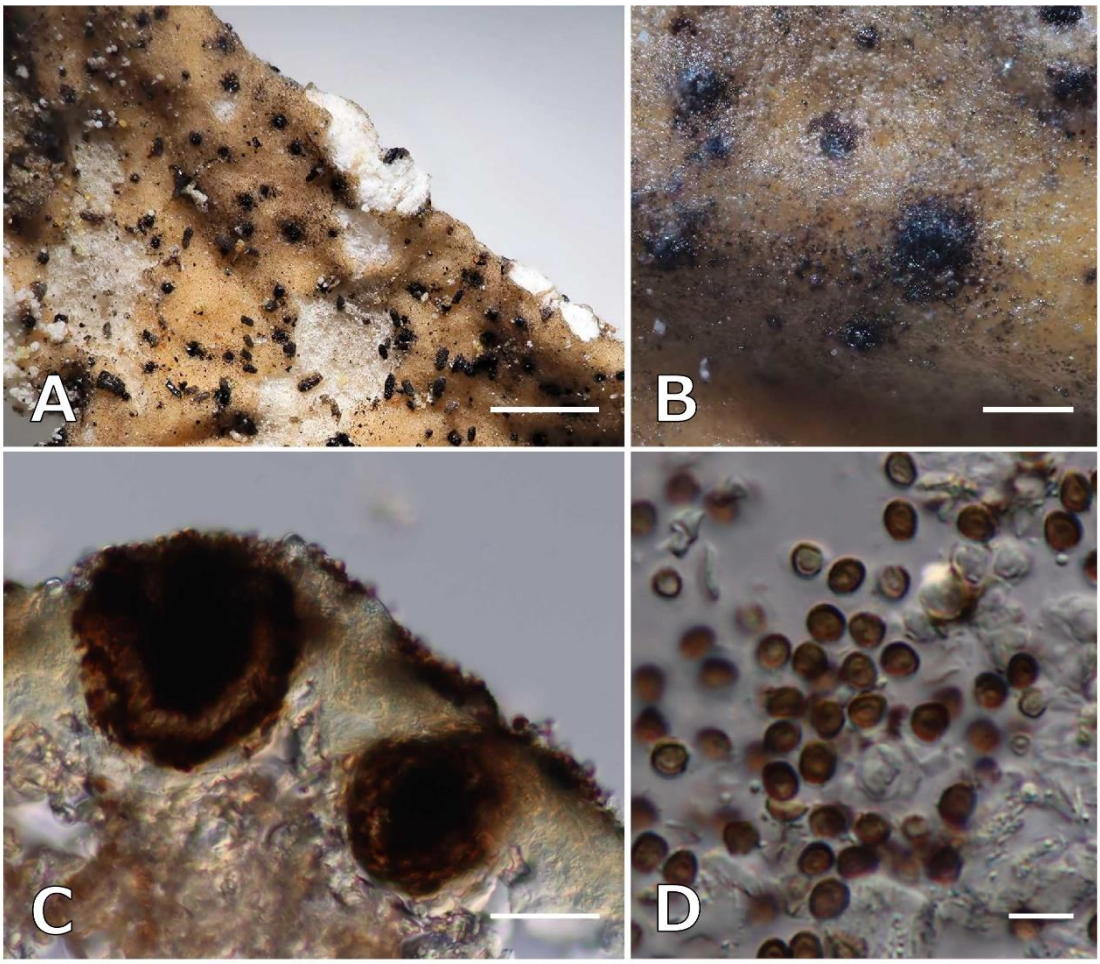

Fig. 35. *Lichenoconium erodens* M.S. Christ. & D. Hawksw., in Hawksworth, Persoonia 9(2): 174 (1977). (R. Santesson: Fungi Lichenicoli Exsiccati 181, TNS). A. Growth habit. B. Conidiomata. C. Cross section of conidiomata. D. Conidia. Scale bars: A=1 mm, B=100 µm, C=25 µm, D=5 µm.

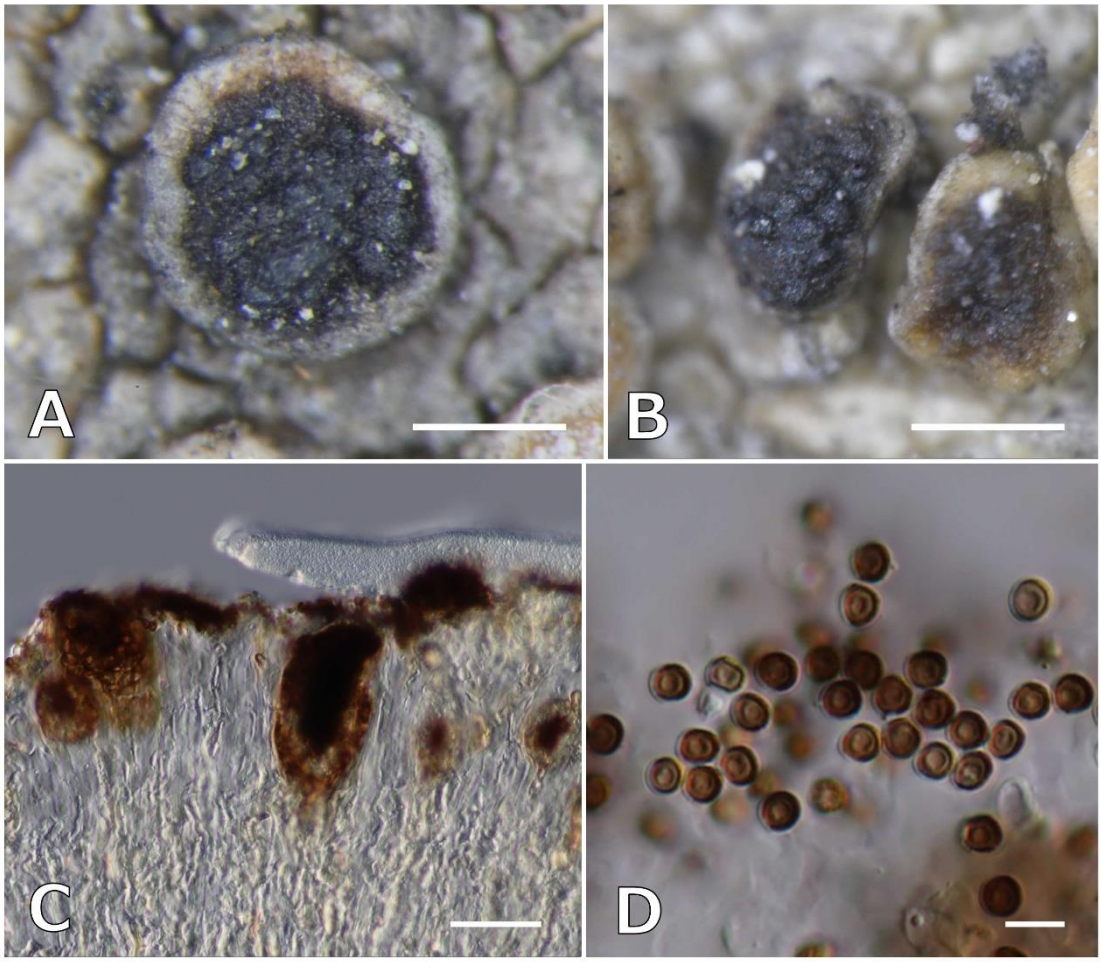

Fig. 36. *Lichenoconium lecanorae* (Jaap) D. Hawksw., Bull. Br. Mus. nat. Hist., Bot. 6(3): 270 (1979). (R. Santesson: Fungi Lichenicoli Exsiccati 182, TNS). A. Growth habit. B. Conidiomata. C. Cross section of conidiomata. D. Conidia. Scale bars: A-B=0.5 mm, C=20 µm, D=5 µm.

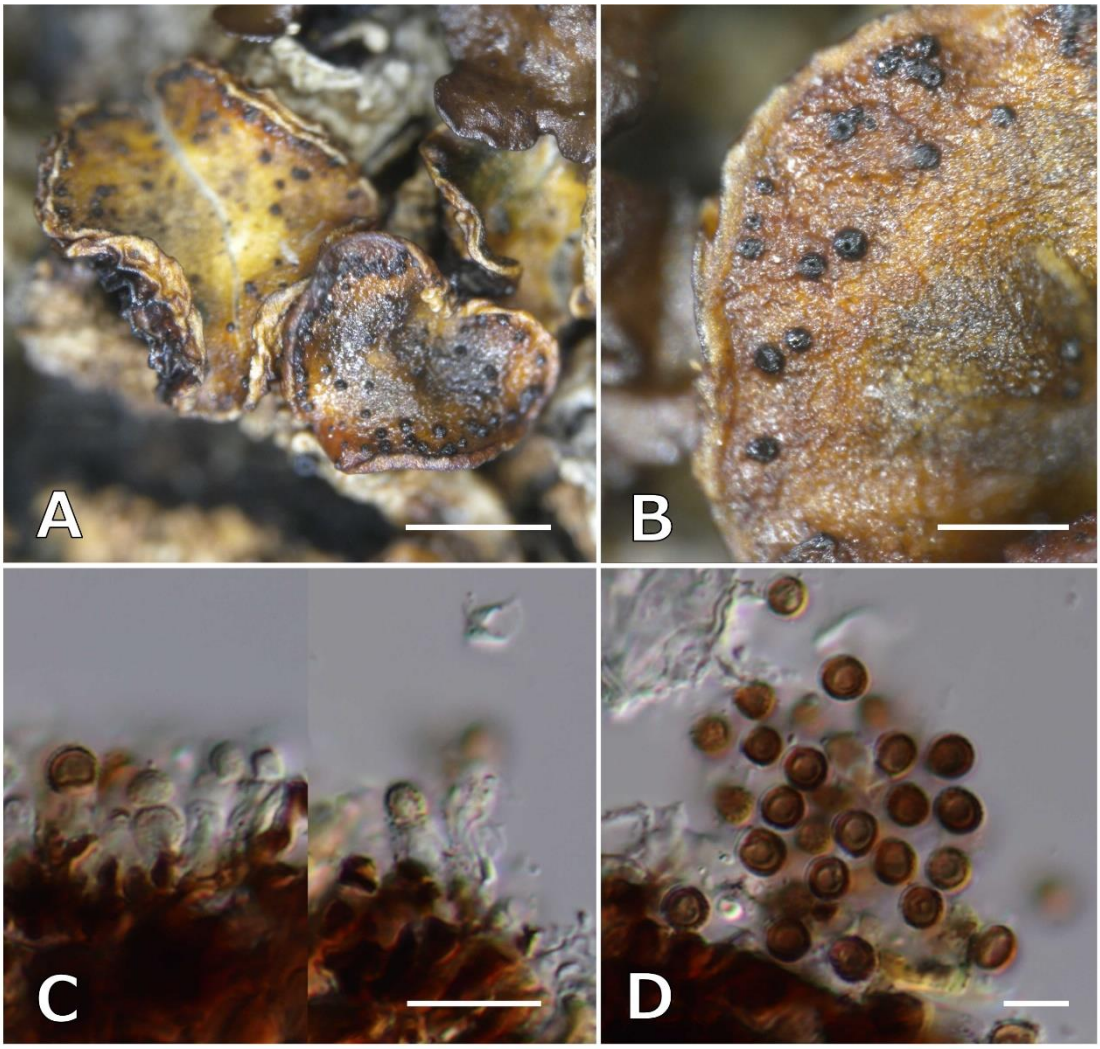

Fig. 37. *Lichenoconium usneae* (Anzi) D. Hawksw., Persoonia 9(2): 185 (1977). (R. Santesson: Fungi Lichenicoli Exsiccati 183, TNS). A. Growth habit. B. Conidiomata. C. Conidiophore and conidia. D. Conidia. Scale bars: A=0.5 mm, B=400 µm, C=10 µm, D=5 µm.

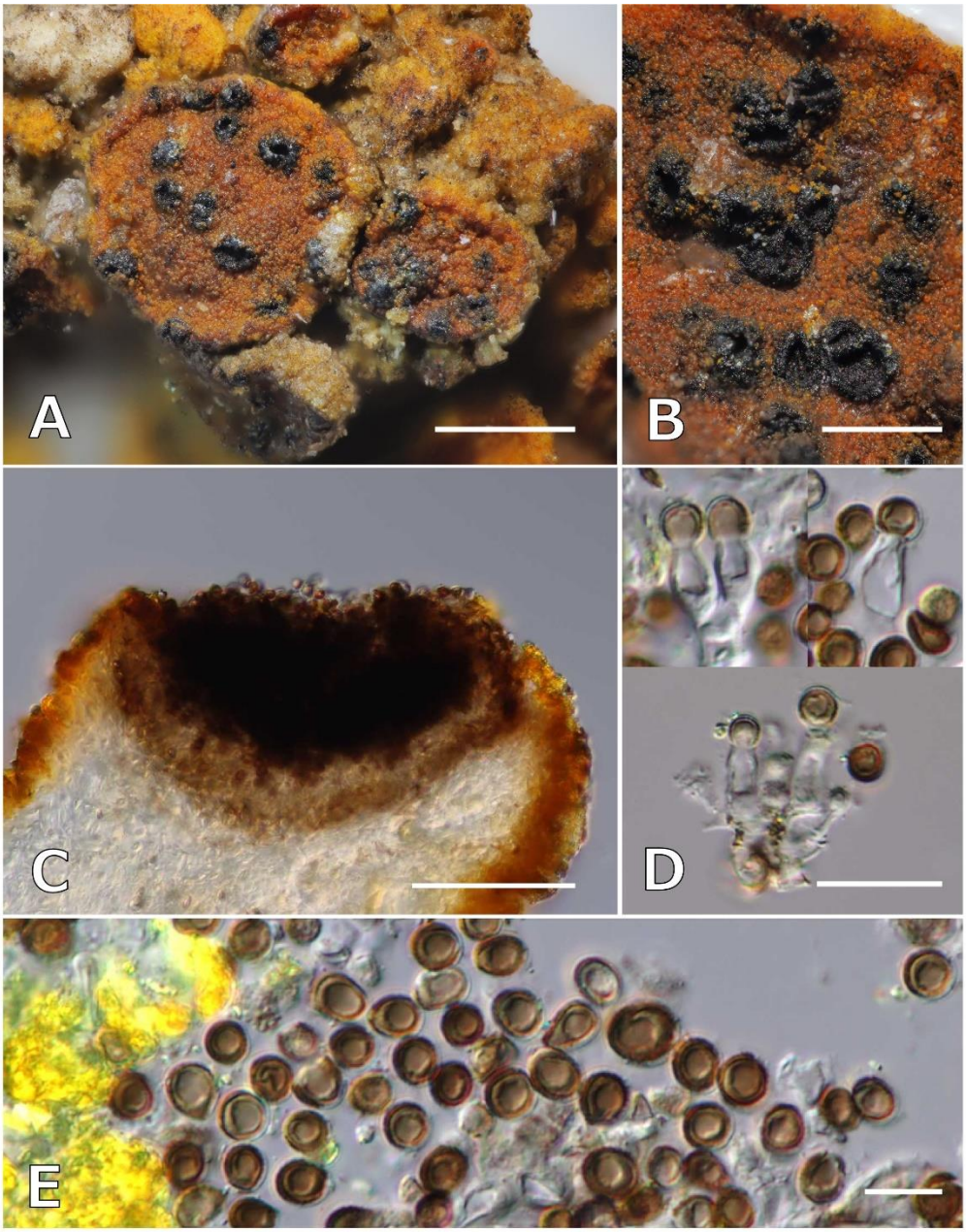

Fig. 38. *Lichenoconium xanthoriae* M.S. Christ., Friesia 5(3−5): 212 (1956). (R. Santesson: Fungi Lichenicoli Exsiccati 84, TNS). A. Growth habit. B. Conidiomata. C. Cross section of conidiomata. D. Conidiophore and conidia. E. Conidia. Scale bars: A=1 mm, B=200 µm, C=50 µm, D=10 µm, E=5 µm.

Lichenopeltella cetrariae (Bres.) Höhn., Sber. Akad. Wiss. Wien, Math. naturw. Kl., Abt. 1 128(7–8): 553 (1919)

Ascomata catathecioid, ostiole almost triangular, without setae, 62.0–100.0 µm diam. **Asci** 22.0–31.0 × 10.0 µm, 4-spored. **Ascospores** ellipsoid, 1-septate, with 3 pairs of setulae, hyaline, (12.0–)12.5–14.3(–15.0) × (3.0–)3.2–3.9 (–4.0) µm. **Host**: *Cetraria* species (Brackel 2011).

This species is characterized by catathecioid ascomata and colorless 1-septate spores with setulae. The spores are slightly smaller in size than the species of the same genus (Brackel 2011). Japanese records were reported by Zhurbenko and Ohmura (2019).

Lichenopeltella cladoniarum E.S. Hansen & Alstrup, Graphis Scripta 7(1): 33 (1995)

Ascomata 50.0–90.0 µm diam. **Asci** (31.0–)34.0–42.0(–50.0) × (11.5–)12.0–13.0(–15.0) µm. **Ascospore** (12.3–)15.5–18.9(–22.8) × (4.4–)4.8–5.8(–6.5) µm. **Host**: *Cladonia* species (Zhurbenko and Pino-Bodas 2017).

This species has catathecioid ascomata and relatively large 1-septate colorless spores and is characterized by parasitizing the genus *Cladonia* (Zhurbenko and Pino-Bodas 2017). Japanese records were reported by Zhurbenko and Ohmura (2019).

Lichenosticta lecanorae (Vouaux) Brackel & Zhurb., in Zhurbenko, Frisch, Ohmura & Thor, Herzogia 28: 773 (2015)

Conidiomata pycnidial, subglobose, immersed or sessile, scattered or groups, black, 50.0–120.0 µm diam. **Conidiomatal wall** composed of short cells, brown, K−. **Conidiophore**

flexuous, ramifying, septate, hyaline, 6.0–25.0 × 2.0–3.5 µm. **Conidiogenous cells** phialidic, subcylindrical, lageniform, ampulliform to doliiform, integrated chains, hyaline, 3.8–4.6 × 1.6–2.4 µm. **Conidia** acro-pleurogenous, ellipsoid to oblong, slightly truncated at the base, smooth, simple, hyaline, (2.7–)3.1–4.3(–5.5) × (1.5 –)1.6–2.0(–2.2) µm. **Host**: *Lecanora* species (Zhurbenko et al. 2015).

This species is characterized by black conidiomata and chained conidiogenous cells. Conidiophore, conidiogenous cells, and conidia are colorless. Conidia is an ellipse and simple (Zhurbenko et al. 2015). Japanese records were reported by Zhurbenko et al. (2015).

Lichenostigma cosmopolites Hafellner & Calat., Mycotaxon 72: 108 (1999)

Hyphal strands superficial, spreading over the host thallus and apothecial discs, septate, slightly constricted at the septa, ramified to net-like, connected also the ascomata, dark brown. **Hyphal cells** ornamented with punctiform, 6.0–10.0 × 4.0–7.0 µm long, less than 1 µm wide. **Ascomata** superficial, subglobose or ellipsoid, scattered, opening apically with irregular, brown to black, 60.0–100 µm diam. **Ascomatal wall** dark brown, hyaline in the internal cells. **Internal structure** pseudoparenchymatic, I+ orange-red, K/I+ blue. **Asci** broadly clavate to subglobose, 8-spored, K/I+ bluish around the apex when young, 15.0–20.0 × 12.0–15.0 µm. **Ascospores** narrowly obovate, halonate, 1-septate, hyaline, brown when mature, 8.0–11.0 × 3.0–5.0 µm. **Host**: *Xanthoparmelia* species (Nash et al. 2004).

This species is characterized by hyphal strands that spread in a mesh pattern on the host surface, pseudoparenchymatic internal structure, and brown spores that are 1-septate. It is also characterized by turning orange with respect to I (Nash et al. 2004). Japanese records were reported by Hafellner and Calatayud (1999).

Lichenostigma maureri Hafellner, Kew Bull., Addit. Ser. 9: 301 (1983)

Hyphal strands absent. **Ascomata** superficial, cushion-like, round, slightly constricted base, scattered or aggregated, convex to flat, black, 70.0–120 µm diam. **Ascomatal wall** dark brown, hyaline in the internal cells. **Internal structure** pseudoparenchymatic, I–. **Asci** broadly ovate to subglobose, 4–8-spore, 20.0–25.0 × 13.0–18.0 µm. **Ascospores** obovate, halonate, 1-septate, slightly constricted at the septum, granular, hyaline when young, brown when mature, 9.0–12.0 × 4.0–6.0 µm. **Host**: *Alectoria* species, *Evernia* species, *Letharia* species, *Pseudevernia* species, *Ramalina* species, *Usnea* species (Nash et al. 2004).

This species is characterized by pseudoparenchymatic internal structure, and brown spores that are 1-septate. Another feature is that it does not discolor with respect to I (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Lichenothelia rugosa (G. Thor) Ertz & Diederich, Fungal Diversity 66: 135 (2014)

= Basionym: *Lichenostigma rugosum.*

Hyphal strands absent. **Ascomata** superficial, cushion-like, round, slightly constricted base, aggregated, convex to flat, 50.0–200 µm diam. **Ascomatal wall** brown, hyaline in the internal cells. **Internal structure** I–. **Asci** subglobose, 8-spored, 22.0–26.0 × 15.0–20.0 µm. **Ascospores** ellipsoid to obovate, halonate, 1-septate, reraly 2–4-septate, slightly constricted at the septum, areolate, hyaline when young, brown when mature, 10.0–13.0 × 5.0–7.0 µm. **Host**: *Diploschistes* species (Nash et al. 2004).

This species is characterized by pseudoparenchymatic internal structure, and brown spores that are 1-septate. Particularly characteristic is that the spores sometimes become 2–4-septate (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Marchandiomyces corallinus (Roberge) Diederich & D. Hawksw., in Diederich, Mycotaxon 37: 312 (1990)

[Fig. 39]

Colonies superficial, sometimes erumpent through the upper cortex of the host, pink, convex and translucent, sporodochia, 100–500 µm diam. **Conidiophore** ellipsoid, clavate to cylindrical, 15.0–35.0 × 3.0–9.0 µm. **Conidiogenous cells** proliferation irregular (sometimes absent), 9.0–11.0 × 4.0–9.0 µm. **Conidia** ellipsoid to clavate, hyaline, smooth, 11.0–15.0 × 7.0–10.0 µm. **Teleomorph** not observed. **Host**: Various lichens (Diederich 1990, Diederich and Lawrey 2007, Hawksworth et al. 2010a).

This species is known to parasitize various lichens. The feature is that pink spherical colonies are scattered on the host (Diederich 1990, Diederich and Lawrey 2007, Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Merismatium decolorans (Rehm) Triebel, Biblthca Lichenol. 35: 182 (1989)

Ascomata subglobose, sessile, glossy, brown to black, (75.0–)125(–250) µm diam. **Ascospores** ellipsoid, narrowly ellipsoid or clavate, sometimes irrgerlar shape, smooth, brown, (0–)1–3(–4) transsepta and rarely 1(–2) longitudinal or oblique septa in central segments, sometimes slightly constricted at the septa, (9.3–)11.4–14.4(–16.7) × (3.6–)4.1–5.5(–7.0) µm. **Host**: *Bilimbia* species, *Lopadium* species, *Placynthiella* species, *Trapeliopsis* species, etc (Zhurbenko and Pino-bodas 2017).

This species is spherical and black ascomata and is known to parasitize various lichens. Characteristic is brown, with muriform spores (Zhurbenko and Pino-bodas 2017). Japanese records were reported by Zhurbenko et al. (2015).

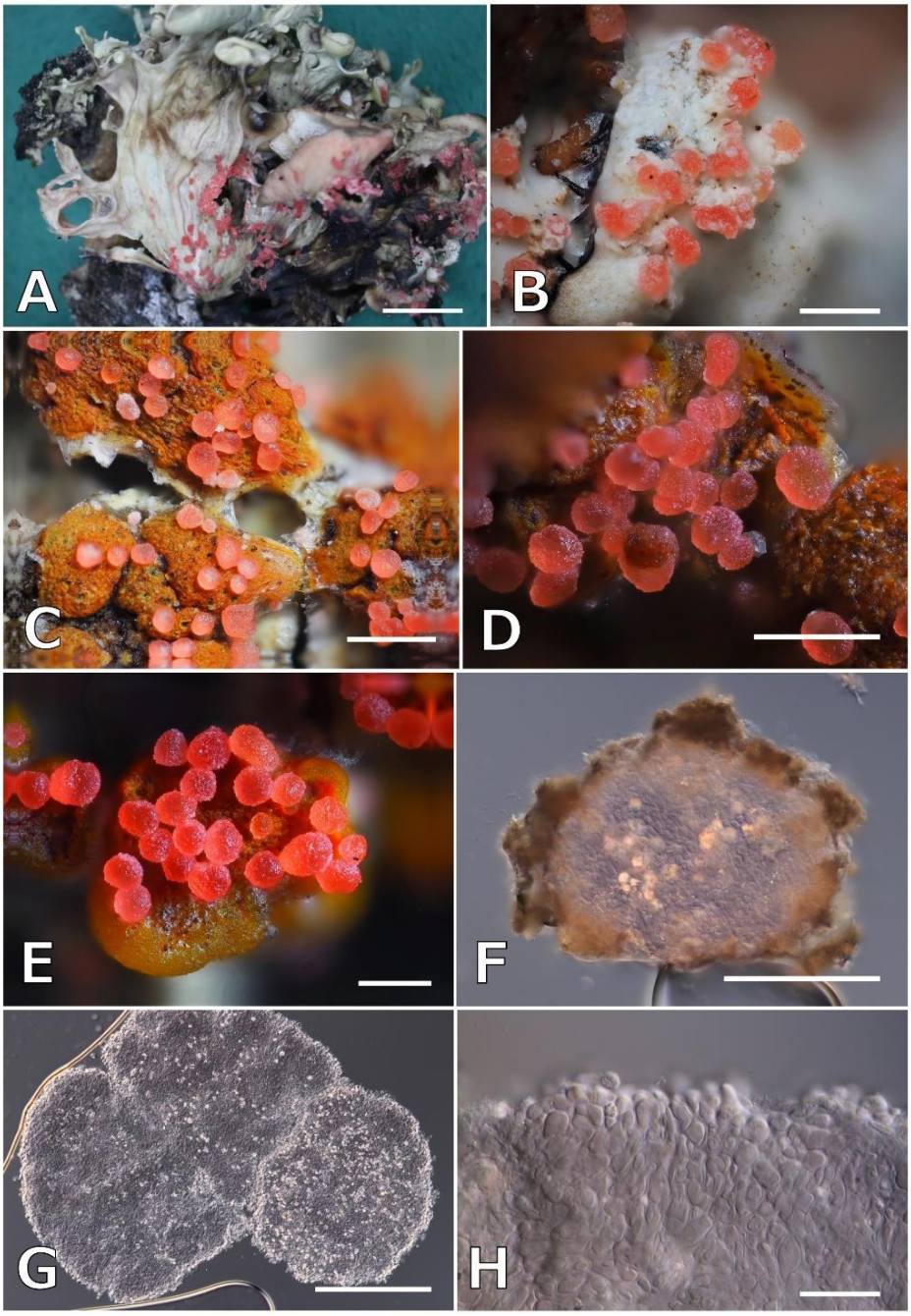

Fig. 39. *Marchandiomyces corallinus* (Roberge) Diederich & D. Hawksw., in Diederich, Mycotaxon 37: 312 (1990). A-E. Growth habit. F-H. Cross section of Sporodochia. Scale bars: A=5 mm, B=0.5 mm, C=1 mm, D-E＝500 μm, F=100 μm, G=200 μm, H=30 μm.

Micarea inquinans (Tul.) Coppins, Biblthca Lichenol. 48: 169 (1992)

Ascomata apothecioid, strongly convex, aggregated, red brown to dark brown, 0.2–0.5 mm. **Epithecium** reddish brown, olive or green. **Hymenium** paraphyses, hyaline to green, K/I+blue. **Asci** Micarea-type, K/I+ dark blue axial. **Ascospores** ellipsoid to subglobose, simple, hyaline, 8.0–13.0 × 4.0–7.0 μm. **Host**: *Dibaeis baeomyce* (Fryday 2017, Hawksworth et al. 2010a, Zhurbenko 2020).

This species is characterized by epithecium being eddish brown or olive green. Especially characteristic is that hymenium is hyaline to green (Fryday 2017, Hawksworth et al. 2010a, Zhurbenko 2020). The spores are also colorless and simple. Japanese records were reported by Zhurbenko et al. (2015).

Microcalicium arenarium (Hampe ex A. Massal.) Tibell for a morphological description, see Tibell (1999).

Ascomata apothecioid, (0.6−)1.8(−2.5) mm tall. **Stalk** granular surface, black, 0.08−0.12 mm diam. **Capitulum** 0.14−0.28 mm diam. **Exciple** reddish brown, K+ yellowish brown. **Asci** broadly ellipsoid 9.0−11.0 × 5.0−6.0 μm. **Ascospores** 1-septate, ornamented with spiral ridges, dark brown or greenish black, K+ yellowish brown, 6.7−8.2 × 2.3−2.9 μm. **Host**: *Psilolencia* species and green algae (Nash et al. 2004).

However, it is also found on moist rocks and roots, so it is thought to be both parasitic and symbiotic. Japanese records were reported by Tibell et al. (2014).

Milospium graphideorum (Nyl.) D. Hawksw., Trans. Br. mycol. Soc. 65(2): 228 (1975)

[Fig. 40]

Conidia (6.0–)17.0(–20.0) × 5.0–10.0 µm. **Host**: *Lecanactis amylacea*, *Lecanographa lyncea*, *Dirina massiliensis*, *Opegrapha atra*, *Schismatomma decolorans* (Hawksworth et al. 2010a).

This species looks like a mass of black powder on the host lichen. Conidia are semi-colorless, semi-black spheres, and have a special shape as if they were gathered together. Various species of lichens that serve as hosts are known (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. SWEDEN. Oland: Köping par., 1.5 km W of the parish church. On vertical or slightly overhanging calcareous cliffs. On *Dirina massiliensis* (thallus). July 11, 1957 (Santesson: Fungi Lichenicoli Exs. 60, TNS).

Milospium planorbis Aptroot & Sipman, J. Hattori bot. Lab. 91: 331 (2001)

This species may not be a lichenicolous fungi as it has been excluded from the global checklist (Diederich et al. 2018, Ohmura and Kashiwadani 2018). Japanese records were reported by Degawa (2011).

Minutoexcipula mariana V. Atienza, Biblthca Lichenol. 82: 142 (2001)

[Fig. 41]

Conidiomata pycnidia, immersed, large apical opening, brown to black, 100–300 µm diam. **Conidiomatal wall** hyaline to brown, irregular in thickness, with cells 2.5–5.0 µm

diam. **Conidiophore** branched, subcylindrical, pale brown, up to 13.0 µm long, 2.0–3.0 µm wide. **Conidiogenous cells** subcylindrical, annellation, hyaline to pale brown, 3.5–6.2 × 1.5–2.5 µm. **Conidia** ellipsoid to obpyriform, truncate at base, 1-septate, smooth, pale brown to brown, 6.2–7.5 × 2.5–3.7 µm. **Host**: *Pertusaria* species (Nash et al. 2004).

The characteristics of this species are brown to black conidiomata, brown conidiophore, conidiogenous cells, and brown 1-septate conidia. Another feature is that conidiomata is concave (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. PORTUGAL. Faro Prov. S of Lagoa, Carvoeiro, gardens in village. 37°06'N 08°28'W. On *Prunus amygdalus*. On *Pertusaria* sp. (thallus). March 31, 2005 (Santesson: Fungi Lichenicoli Exs. 358, TNS).

Muellerella erratica (A. Massal.) Hafellner & Volk. John, Herzogia 19: 165 (2006)

Ascomata perithecioid, subglobose, immersed to almost completely superficial, black, 150–220 µm diam. **Interascal tissue** absent. **Periphyses** hyaline, 40.0 µm length. **Asci** cylindric-ellipsoidal, sessile, the apex rounded, 64-spores, 70.0–90.0 × 18.0–25.0 µm. **Ascospores** ellipsoid, 1-septate, not constricted septum, smooth, dark brown, (5.5–) 6.0–7.0 × 3.0–3.5 µm. **Host**: various lichens (Hafellner and John 2006).

This species is characterized by a black ascomata buried in the host and an ascus containing a large number of spores (about 64-spores). The spores are small, brown, 1-septate, ellipsoid (Hafellner and John 2006). Japanese records were reported by Zhurbenko et al. (2015).

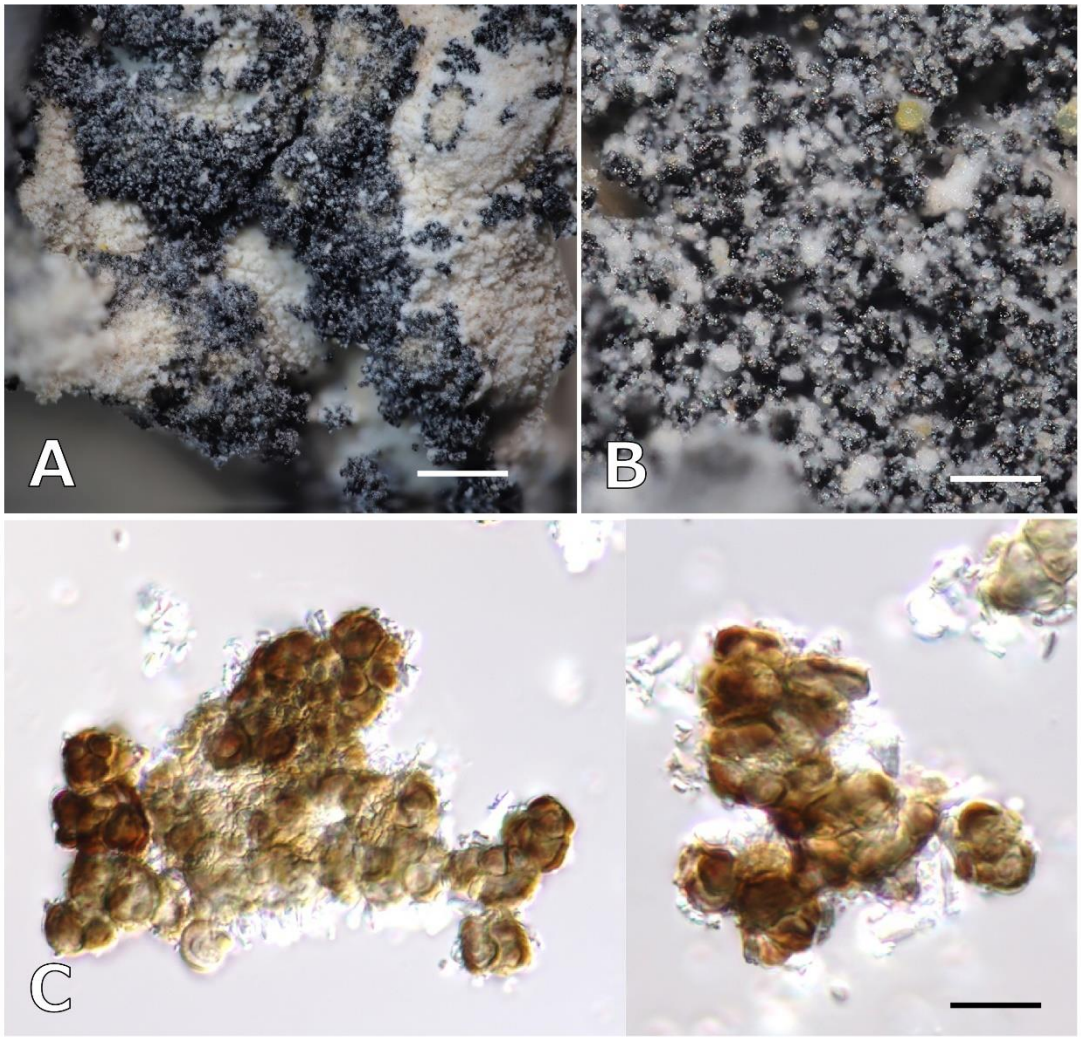

Fig.40. *Milospium graphideorum* (Nyl.) D. Hawksw., Trans. Br. mycol. Soc. 65(2): 228 (1975). (R. Santesson: Fungi Lichenicoli Exsiccati 60, TNS). A. Growth habit. B. Sprodochia. C. Conidia. Scale bars: A=0.2 mm, B=100 μm, C=10 μm.

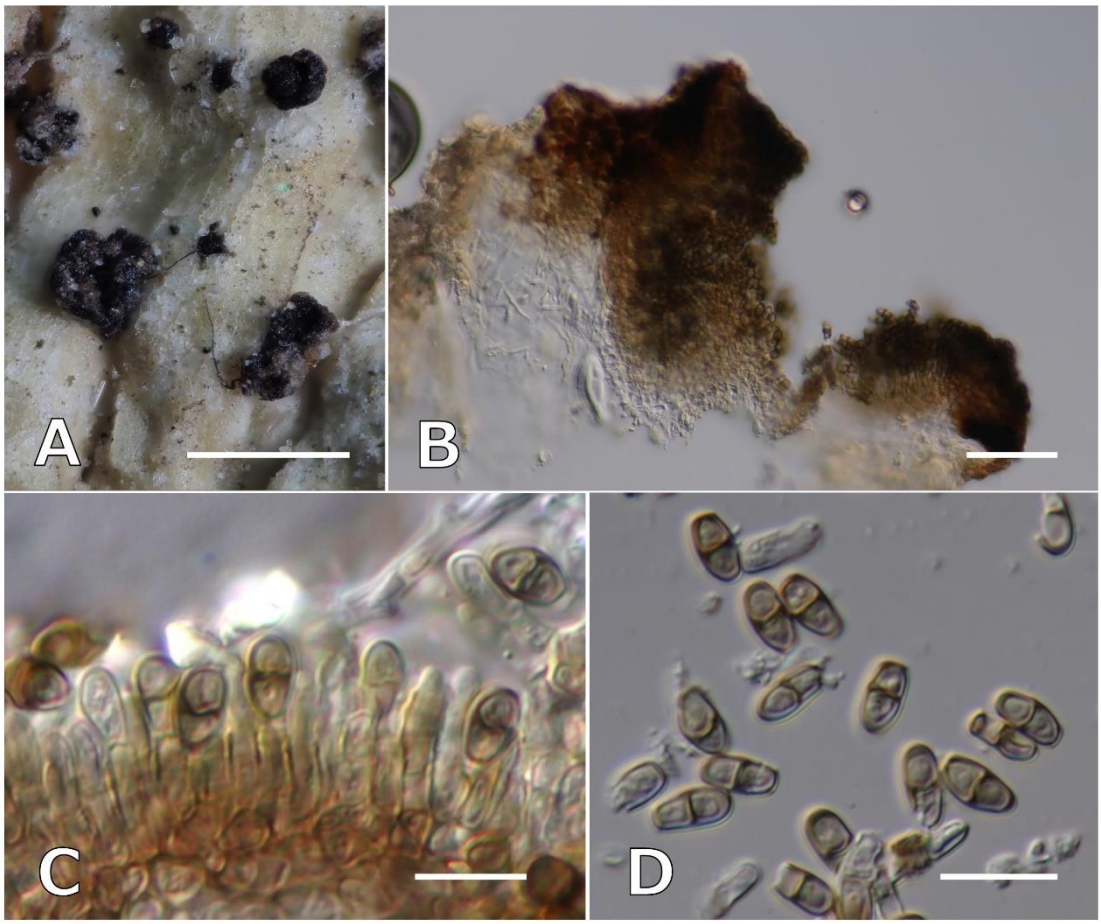

Fig. 41. *Minutoexcipula mariana* V. Atienza, Biblthca Lichenol. 82: 142 (2001). (R. Santesson: Fungi Lichenicoli Exsiccati 358, TNS). A. Growth habit. B. Cross section of sprodochia. C. Conidiophore and conidia. D. Conidia. Scale bars: A=0.5 mm, B=50 μm, C-D=10 μm.

Nesolechia cetrariicola (Linds.) Arnold, (1874).

Ascomata apothecial, aggregated, erumpent, dark brown to black, glossy, 0.6 mm diam; developing on both sides of host lobes, which become enlarged and spoonshaped under heavy infections but not discolored. **Epihymenium** obscurely granular, brownish orange, 5.0 µm thick. **Hymenium** upper part pale brownish orange, lower part pale brownish orange to colorless, I–, 70.0–80.0 µm tall. **Paraphyses** septate, often with dark brown apical. **Hypothecium** brown, I–, 40.0–100 µm. **Asci** clavate to broadly clavate, thickened apical wall, 50.0–65.0 × 16.0–22.0 µm. **Ascospores** ellipsoid to narrowly ellipsoid, almost fusiform, with rather acute, occasionally forming apiculi to 2.0 µm long at one or both ends, simple, smooth, hyaline, (10.8–)13.6–16.6(–18.6) × (4.3–)5.5–7.1(–8.0) µm. **Host**: *Cetraria* species (Zhurbenko et al. 2019).

This species is characterized by the aggregation of black ascomata and the gall-like host. Characteristic is the color of hymenium, which has an orange-brown color. The spores are colorless and oval, but both tips are slightly pointed (Zhurbenko et al. 2019). Japanese records were reported by Zhurbenko and Ohmura (2019).

Nesolechia oxyspora (Tul.) A. Massal., Miscell. Lichenol.: 13 (1856)

[Fig. 42]

Ascomata apothecial, aggregated, erumpent, brown to dark brown, matt to glossy, 200–450 µm diam. **Exciple** hyaline to pale brown, (10.0–)30.0 (–40.0) µm thick. **Epithecium** pale brown to brown, 15.0–20.0 µm thick. **Hymenium** hyaline to pale brown, 55.0–65.0 µm tall. **Hypothecium** hyaline to pale brown. **Paraphyses** branched to anastomosed, 2.0–3.0 µm diam; the apical cells with brownish, 3.0–5.0 µm diam. **Asci** obovoid, 8-spored, 43.0–55.0 ×

14.0–19.0 µm. **Ascospores** fusiform to ellipsoid, the apices acute, smooth, (13.0–) 16.0–18.0 (–21.0) × (5.0–) 5.5(–7.0) µm. **Conidiomata** pycnidial, globose, immersed, 90.0–100 µm diam. **Conidiomatal wall** hyaline to pale brown below, upper part with darker brown. **Conidiogenous cells** 9.0–11.0 × 3.0–4.0 µm. **Conidia** bacilliform, 5.5–6.0 × 0.5–1.0 µm. **Host**: *Parmeliaceae* species (Doré et al. 2006, Hawksworth et al. 2010a, Triebel et al. 1995).

This species is characterized by the aggregation of brown to black ascomata on the host lichen. In addition, the spores are colorless and spindle-shaped, and are characterized by sharp ends (Doré et al. 2006, Hawksworth et al. 2010a, Triebel et al. 1995). Japanese records were reported by Zhurbenko and Ohmura (2019).

Exsiccata examined. PERU. Junin: Tarma, c. 10 km (road distance) NNE of Palca. 11°18'S 75°41'W. Alt. c. 2600 m. On cliffs on a steep rocky slope. On *Punctelia lorentzii* (thallus). February 7, 1981 (Santesson: Fungi Lichenicoli Exs. 189, TNS).

Nesolechia oxyspora var. ***oxyspora*** (Tul.) A. Massal., Miscell. Lichenol.: 43 (1856)

= Synonym: *Phacopsis oxyspora* (Tul.) Triebel & Rambold, Nova Hedwigia 47(3-4): 300 (1988)

[Fig. 43]

Ascomata apothecioid, immersed, 150−500 µm diam; disc black or dark brown, convex to plane; exciple indistinct, colorless to brown. **Epihymenium** hyaline to brown. **Hymenium** hyaline to pale brown, 20.0−65.0 µm. **Paraphyses** slightly branched to anastomosed, apical cells thickened, with brown to dark brown caps, 1.5−3.0 µm wide. **Hypothecium** hyaline to dark brown, I− or I+violet. **Asci** broadly clavate, 8-spored, 35.0−55.0 × 14.0−20.0 µm. **Ascospores** fusiform to ellipsoid, with aciculate ends, simple, hyaline,

(11.0−)14.0−18.5(−24.5) × (5.0−)5.5−6.5(−7.0) µm. **Conidiomata** pycnidial, globular, immersed, ca 100 µm in diam. **Conidia** bacilliform, 5.5−6.0 × 0.5−1.0 µm. **Host**: *Cavernularia* species, *Everniastrum* species, *Hypogymnia* species, *Hypotrachyna* species, *Melanelia* species, *Menegazzia* species, *Neofuscelia* species, *Parmelia* species, *Parmelinopsis* species, *Parmotrema* species, *Platismatia* species, *Pseudevernia* species, *Punctelia* species, *Xanthoparmelia* species (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. AUSTRALIA. New South Wales Prov., Weddin Mountains Nat. Park, 16 km SW of Grenfell. 34°01'S 148°03'E. Alt. 420 m. Dry sclerophyll forest along rocky seasonal stream. On shaded boulder. On *Punctelia subrudecta* (thallus). March 10, 1992 (Santesson: Fungi Lichenicoli Exs. 276, TNS).

Opegrapha anomea Nyl., Act. Soc. linn. Bordeaux 21(4): 399 (1857) [1856]

Ascomata round to spherical when young, upper layer breaking along irregular slits, 400–900 µm diam; aggregated when mature, 3.0–4.0 mm diam. **Exciple** 30.0–40.0 µm, K–. **Hymenium** hyaline or pale brown to dark purplish brown, upper and lower part I+ blue, middle part sometimes I+red, 110–120 µm. **Subhymenium** pale brown, 20.0–30.0 µm. **Paraphysoids** apically indistinctly swollen, 2.0–2.5 µm. **Asci** clavate, (4–)6(–8)-spored, 70.0–90.0 × 20.0–24.0 µm. **Ascospores** ellipsoid to oblong-ovoid, with ends rounded, 3-septate, constricted at septa, with brownish granular warts, (21.0–)27.0(–29.0) × (7.0–)8.0(–10.0) µm. **Conidiomata** pycnidia, immersed to subimmersed. **Conidia** (5.0–)6.0–7.0 × 1.5(–2.0) µm. **Host**: *Pertusaria* species, *Ochrolechia* species (Nash et al. 2004).

This species is round when young and features ascomata with irregular slits when ripe.

By the time it ripens, it breaks through the surface of the host. Exciple does not discolor with respect to K. The upper and lower parts of hymenium turn blue with respect to I, but the middle part sometimes turns red. The ascus often contains 6-spores. The spores are ellipsoid to oblong-ovoid and 3-septate (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Opegrapha foreaui (C. Moreau & M. Moreau) Hafellner & R. Sant., in Hafellner, Fritschiana 36: 14 (2002)

= Basionym: *Telimena foreaui* C. Moreau & M. Moreau 1951, Synonym: *Opegrapha trassii*.

Ascomata apothecioid, lirellate. **Exciple** 18.0–27.0 µm thick. **Ascospore** 3-septate, hyaline, 4.5–5.0 µm wide. **Conidia** 3.8–5.0 × 0.5–0.7 µm. **Host**: *Heterodermia* species (Ertz and Diederich 2003, Joshi 2019).

This species is characterized by lilellate ascomata. The spores are also colorless and 3-septate. It is known to parasitize mainly lichens of the genus *Heterodermia* (Ertz and Diederich 2003, Joshi 2019). Japanese records were reported by Zhurbenko et al. (2015).

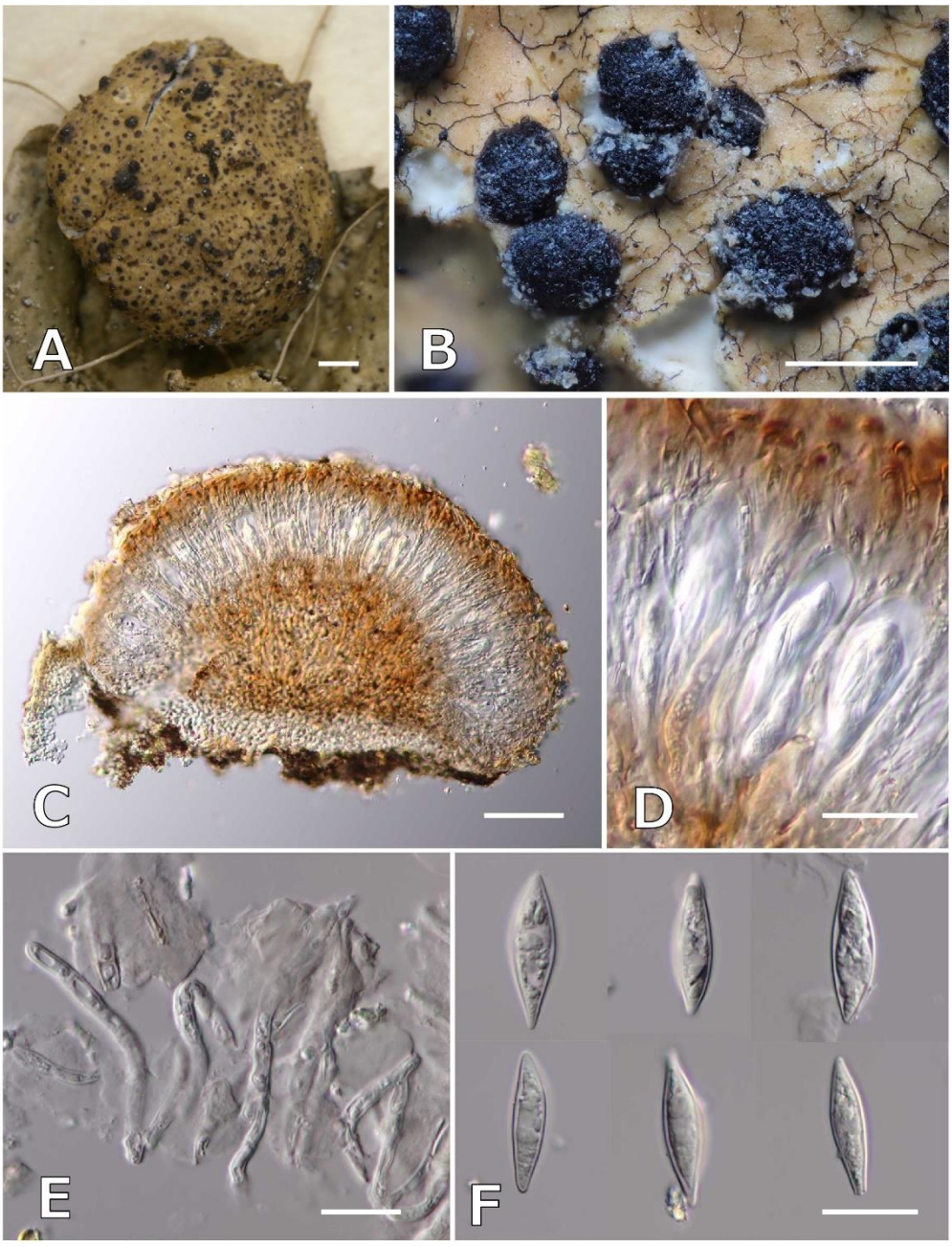

Fig. 42. *Nesolechia oxyspora* (Tul.) A. Massal., Miscell. Lichenol.: 13 (1856). (R. Santesson: Fungi Lichenicoli Exsiccati 189, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E. Paraphyses. F. Ascospore. Scale bars: A=1 mm, B=300 µm, C=50 µm, D=20 µm, E-F=10 µm.

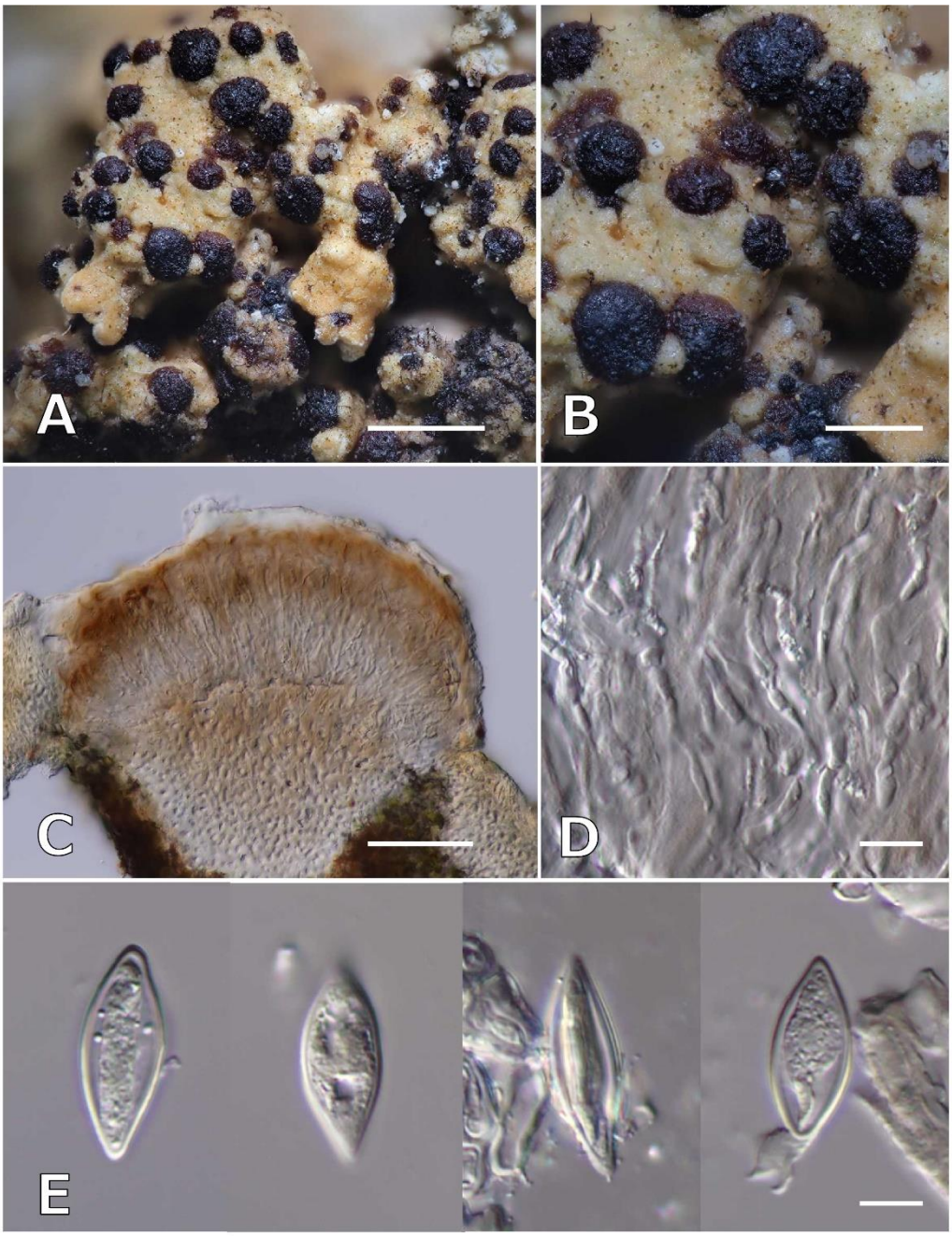

Fig. 43. *Nesolechia oxyspora var. oxyspora* (Tul.) A. Massal., Miscell. Lichenol.: 43 (1856). (R. Santesson: Fungi Lichenicoli Exsiccati 276, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Paraphyses. E. Ascospore. Scale bars: A=0.3 mm, B=200 μm, C=50 μm, D=10 μm, E=5 μm.

Opegrapha lichenicola G. Thor, Lücking & Tat. Matsumoto, Symb. bot. upsal. 32(no. 3): 49 (2000).

Ascomata aggregated, round to lirelliform, black, 0.1 × 0.05 mm. **Epithecium** pale brownish. **Hymenium** I+ red, K/I+ blue, 25.0–30.0 µm tall. **Hypothecium** dark brown, ca 10.0 µm tall. **Paraphysoid** branched, hyaline to pale brown, 1.0–2.0 µm thick. **Asci** 4–6-spored, K/I+ blue, 20.0–25.0 × 8.0–10.0 µm. **Ascospore** clavatc, hyaline, 1–2(–3)-septate, 9.0–12.0 × 3.0 µm. **Conidiomata** black, 0.05 mm diam. **Conidia** bacilliform, 3.0–4.0 × 1.0 µm. Host: *Porina* species (Thor et al. 2000).

This species is characterized by the aggregation of lilellate ascomata. Also, hymenium turns red for I and blue for K/I. In addition, spores are colorless, mostly 1-2-septate, and rarely 3-septate. It is known to parasitize the *Polina* species that grow on the leaves (Thor et al. 2000). Japanese records were reported by Thor et al. (2000).

Opegrapha phaeophysciae R. Sant., Diederich, Ertz & Christnach, in Ertz, Christnach, Wedin & Diederich, Biblthca Lichenol. 91: 132 (2005)

[Fig. 44]

Ascomata scattered to crowded, rounded, slightly convex to flattened, black, 100–400 µm diam; upper stromatic layer irregularly reticulate fissured, sometimes expose the hymenium. **Epihymenium** brown, I+blue, K/I+blue, 15.0–20.0 µm. **Hymenium** hyaline, I+ red, K/I+ blue, 70.0–120.0 µm tall. **Paraphysoids** branched to anastomosing, 2.0–2.5 µm thick. **Subhymenium** hyaline, I+pale blue or pale red, K/I+blue, 10.0–15.0 µm. **Asci** clavate, with an apical K/I+blue ring (Opegrapha type), 4-spored, 40.0–70.0 × 12.0–16.0 µm. **Ascospores** elongate to ellipsoid, hyaline, (3–)6-septate, slightly constricted at the septa, hyaline when

young, brown and granular in mature, (21.0–)28.0(–32.0) × 4.0–6.0 µm. **Host**: *Phaeophyscia hispidula* (Joshi et al. 2015).

This species is characterized by a round, convex to flat ascomata. Hymenium is colorless and turns red for I and blue for K/I. The subhymenium is colorless and turns pale blue or pale red for I. Epihymenium turns blue with respect to I and K/I. There are four spores in the ascus. The spores are brown when ripe and 6-septate (Joshi et al. 2015). Japanese records were reported by Frisch and Ohmura (2013).

Exsiccata examined. RUSSIA. Primorskii Region, Lazovskii District, Lazovskii Reserve, small hill along the seashore, c. 5 km S of Glazovska village. 41º01'N 134º10'E. Alt. 30 m. On *Quercus mandchurica* in the southern slope towards the sea. On *Phaeophyscia hispidula* (thallus) (Santesson: Fungi Lichenicoli Exs. 360, TNS).

Opegrapha stereocaulicola Alstrup & D. Hawksw., Meddr Grønland, Biosc. 31: 49 (1990).

Ascomata apothecioid, round, elliptic or lirelliform, convex, constricted at the base, glossy, brown to black, 0.5–4.0 × 0.5–1.0(–2.0) mm. **Exciple** I+ blue green. **Hymenium** I+ reddish orange. **Hypothecium** I+ blue green. **Ascospore** ellipsoid, narrowly ellipsoid to narrowly oblong, slightly curved, medium brown when mature, (0–)3–5(–6)-septate, constricted at the septum, verruculose when mature, (13.5–)19.5–26.0(–33.0) × (4.0–)5.0–7.0(–8.5) µm. **Conidia** bacilliform, hyaline, 5.0–8.0 × 1.0–2.0 µm, produced in *Opegrapha* ascomata. **Host**: stems and phyllocladia of *Stereocaulon* species (Zhurbenko 2010).

This species is round to lilelliform and is characterized by a convex ascomata. Exciple and hypothecium turn blue-green for I, and Hymenium turns red to orange for I. The spores turn brown when mature and are ellipsoid, 3–5-septate (Zhurbenko 2010). Japanese records were

reported by Zhurbenko and Ohmura (2019).

Paranectria oropensis (Ces.) D. Hawksw. & Piroz., Can. J. Bot. 55(19): 2555 (1977)

[Fig. 45]

Ascomata perithecioid, scattered, single or grouped, white to orange, 150–230 µm diam. **Paraphyses** not observed. **Periphyses** simple, 25.0–30.0 × 2.0–2.5 µm. **Asci** elongate-clavate, 8-spored, 65.0–80.0 × 15.0–21.0 µm. **Ascospores** ellipsoid to narrowly ellipsoid, muriform, with 5–8-transverse and 1–2-longitudinal septate, appendages up to 12.0 µm long, hyaline, (22.0–)25.0–32.0(–36.0) × (9.0–)11.0–14.0(–15.0) µm. **Host**: *Buellia* species, *Cladonia* species, *Lecidea* species, *Lepraria* species, *Parmeliella* species, *Parmelina* species, *Xanthoria* species (Nash et al. 2004).

This species is characterized by white to orange ascomata. The surface of ascomata is often covered with white hyphae. Particularly characteristic are colorless, muriform spores. Both ends of the spore are sharply pointed. It is known to parasitize various lichens (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. AUSTRIA. Steiermark Prov., Steirisches Randgebirge, Gleinalpe, Gamsgraben, c. 4.5 km NW of Rothleiten, close behind the mouth of Lehmbachgraben. 47° 18’05"N 15°15’05"E. Alt. 650 m. Near a small stream. On *Fagus*. On *Biatora pontica* (thallus). December 3, 20 (Santesson: Fungi Lichenicoli Exs. 361, TNS).

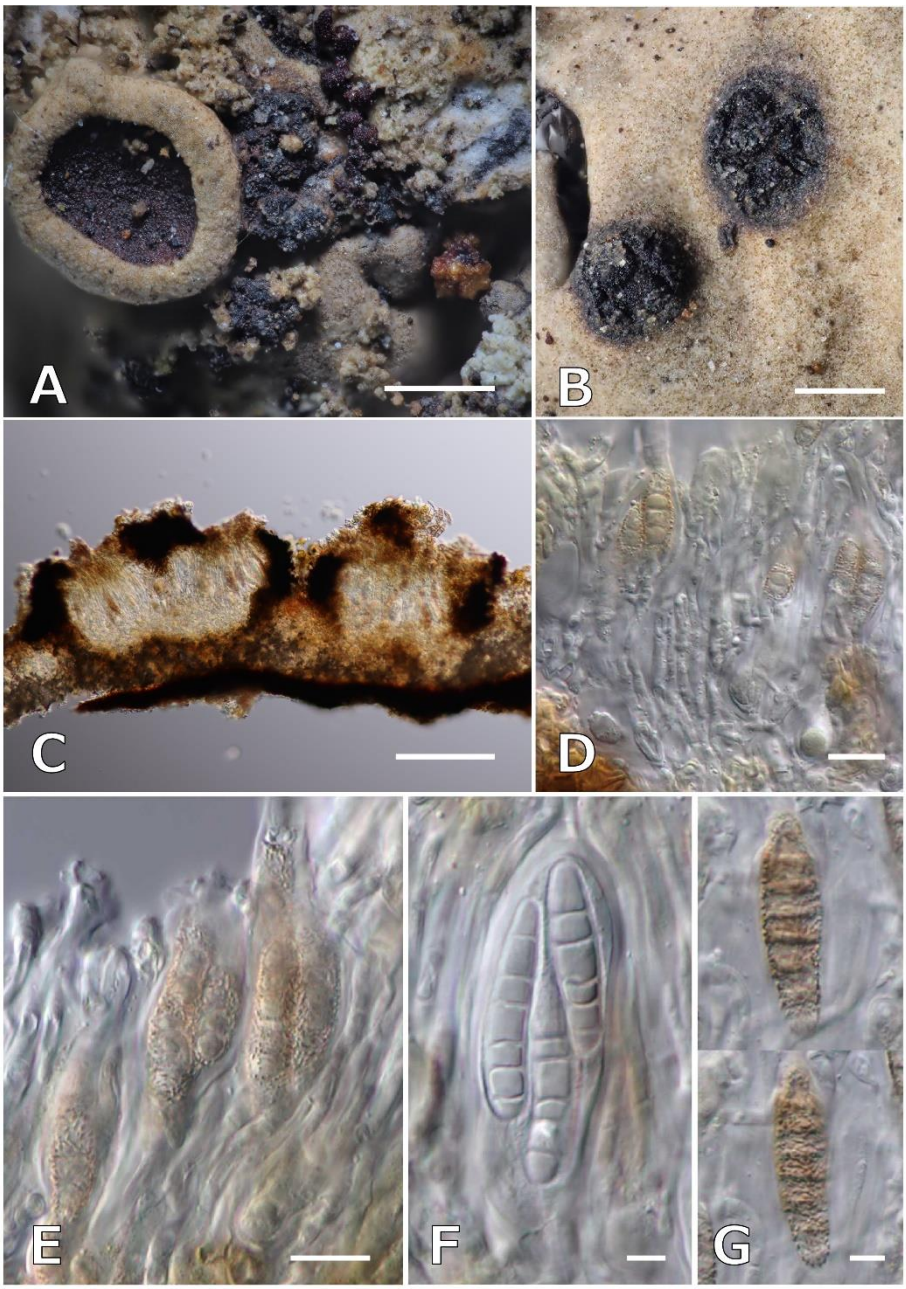

Fig. 44. *Opegrapha phaeophysciae* R. Sant., Diederich, Ertz & Christnach, in Ertz, Christnach, Wedin & Diederich, Biblthca Lichenol. 91: 132 (2005). (R. Santesson: Fungi Lichenicoli Exsiccati 360, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D-E. Hymenium. F. Asci and young ascospore. G. Mature ascospore. Scale bars: A=0.5 mm, B=200 µm, C=100 µm, D-E=10 µm, F-G=5 µm.

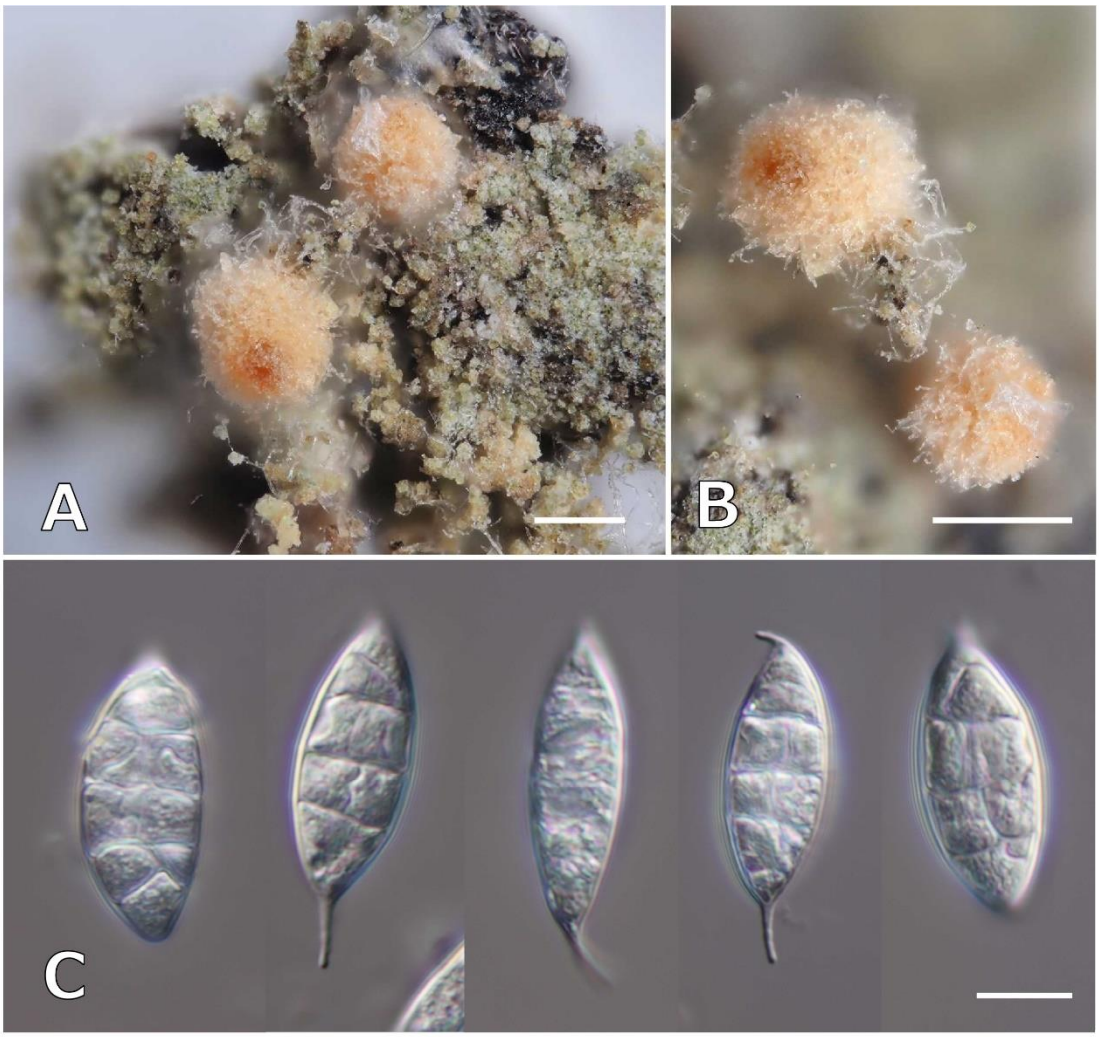

Fig. 45. *Paranectria oropensis* (Ces.) D. Hawksw. & Piroz., Can. J. Bot. 55(19): 2555 (1977). (R. Santesson: Fungi Lichenicoli Exsiccati 361, TNS). A. Growth habit. B. Ascomata. C. Ascospore. Scale bars: A-B=0.1 mm, C=10 µm.

Perigrapha cetrariae Zhurb., Folia cryptog. Estonica 55: 17 (2018)

Ascomata stromatic, superficial, dispersed, convex, rough, elongated, black, ca 2.5 mm long, 150–350 µm thick. **Stroma** multilocular, subspherical, dark reddish brown, K+ brown to grayish brown, (40.0–)60.0–85.0(–100) µm diam. **Hymenium** hyaline to pale orange yellow above, 60.0–80.0 µm tall; hymenial gel I+ orange red to partly blue above, K/I+ blue. **Epihymenium** indistinct. **Subhymenium** hyaline to pale orange yellow, ca. 10 µm. **Paraphyses** branched to anastomosing, septate, apically not obviously enlarged, 1.0–2.3 µm thick. **Asci** clavate to subcylindrical, endoascus somewhat thickened above, apical K/I+ blue ring, 8-spored, (42.0–)45.0–53.0(–55.0) × (7.0–)7.5–9.0(–10.0) µm. **Ascospores** fusiform, with rather acute apices, without appendages, (1–)3(–4)-septate, smooth, hyaline, occasionally becoming pale orange yellow and verruculose when mature, (13.5–)14.7–17.9(–19.4) × (2.7–)3.0–3.8(–4.0) µm. **Anamorph** not observed. **Host**: *Cetraria laevigata* (Zhurbenko and Ohmura 2018).

This species is characterized by black and convex stromatic ascomata (multiple hymeniums are formed in stromatic). Stroma turns grayish brown with respect to K. Hymenium turns orange to red for I and blue for K/I. In addition, the characteristic of this species is that the spores are fusiform and both ends are sharply pointed, which is 3-septate. It is transparent when young, but turns orange to yellow when mature (Zhurbenko and Ohmura 2018). Japanese records were reported by Zhurbenko et al. (2018).

Perigrapha lobariae Zhurb., in Zhurbenko, Frisch, Ohmura & Thor, Herzogia 28(2): 776 (2015)

Ascomata superficial, subglobose, stromatic, convex, elongated, erumpent,

100−200μm diam. **Stroma** dark brownred or orange, shiny, K+ darker or grayish olive, 0.5−1.0(−1.5) mm wide, up to 250 μm wide. **Hymenium** which contains granules, K+ olive brown, I+ blue, K/I+ blue, 60.0−75.0 μm tall. **Paraphyses** flexuous, branched to anastomose, apices slightly enlarged, 2.0−2.5μm diam. **Asci** clavate, 4−8-spored, K/I+ blue apical ring, (60.0−)63.0−73.0(−77.0) × 15.0−19.5(−21.5) μm. **Ascospores** very narrowly ellipsoid to oblong, ends generally rather acute, (2−)3(−4)-septate, constricted at the septa, smooth, hyaline or very rarely pale yellowish brown, (19.0−)23.7−27.9(−30.0) × (4.5−)5.1−6.0(−6.5) μm. **Conidiomata** pycnidial, subglobose, immersed, erumpent, 50.0−60.0 μm diam. **Conidiomatal wall** medium orangish brown. Conidia narrowly ellipsoid to oblong, hyaline, (3.0−)3.7−5.3(−6.3) × (1.0−)1.1−1.3(−1.4) μm. **Host**: *Lobaria japonica* (Zhurbenko et al. 2015).

This species is characterized by black and convex stromatic ascomata (multiple hymeniums are formed in stromatic). Stroma grows by destroying the surface of the host's lichen. Stroma changes color from dark green to olive with respect to K. Hymenium turns olive to brown for K, blue for I, and blue for K/I. The characteristic of this species is that the spores are very thin ellipsoid to oblong, both ends are very sharp, and they are colorless but rarely pale yellow to pale brown. The spores are 3-septate (Zhurbenko et al. 2015). Japanese records were reported by Zhurbenko et al. (2015).

Perigrapha superveniens (Nyl.) Hafellner, Nova Hedwigia 63(1-2): 174 (1996)

[Fig. 46]

Ascomata superficial, with 5−10 small groups, into stroma, black, up to 1.5 mm diam. **Hamathecium** paraphysoids, hyaline, ca 2.0 μm thick. **Asci** slightly cylindrical, 4−8- spores,

80.0 × 12.0−15.0 µm. **Ascospore** spindle-shaped, 3-septate, with tail-like ornament, 30.0−35.0 × 4.5−6.0 µm (without ornament), the ornament up to 50.0 µm long. **Anamorph** not observed. **Host**: *Parmelia* species (Hafellner 1996).

This species is characterized by black and convex stromatic ascomata (multiple hymeniums are formed in stromatic). Also, the characteristic of this species is that the spores are very thin ellipsoid to oblong, both ends are very sharp, colorless, and 3-septate (Hafellner 1996). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. MADEIRA. By the road from Camacha to Poiso, slightly sloping, towards SW open part of a valley close under Carreiras. 32°40’30"N 16°52’W. Alt. 890 m. On branches of fallen *Quercus* in a thin *Quercus-Castanea* forest. On *Parmelia sulcata* (thallus). February 12, 1990 (Santesson: Fungi Lichenicoli Exs. 274, TNS).

Phacopsis prolificans (Müll. Arg.) Triebel & Rambold, Biblthca Lichenol. 48: 169 (1992)

Ascomata apothecioid, sessile, convex, round, aggregated, brown, 0.5−1.5(−2.0) mm diam. **Hypothecium** hyaline, 150−250 µm tall. **Subhymenium** hyaline. **Hymenium** hyaline, ca 40.0–50.0 µm. **Paraphyses** septate, scarcely branched and anastomosed, apical cells with brown caps, ca. 2.0−2.5 µm thick. **Epihymenium** brown, ca 10 µm tall. **Asci** 44.0−52.0 × 11.0−12.0 µm. **Ascospores** fusiform, partly curved, aciculate at ends, smooth, (15.0−)16.0−17.0(−20.0) × 3.0−4.0 µm. **Host**: *Platismatia interrupta* (Triebel et al. 1995).

This species is characterized by a dense collection of black, irregularly shaped ascomata that grow on the surface of the host's lichen. The spores are also colorless, spindle-shaped, slightly curved, and pointed at both ends (Triebel et al. 1995). Japanese records were reported by Triebel et al. (1995).

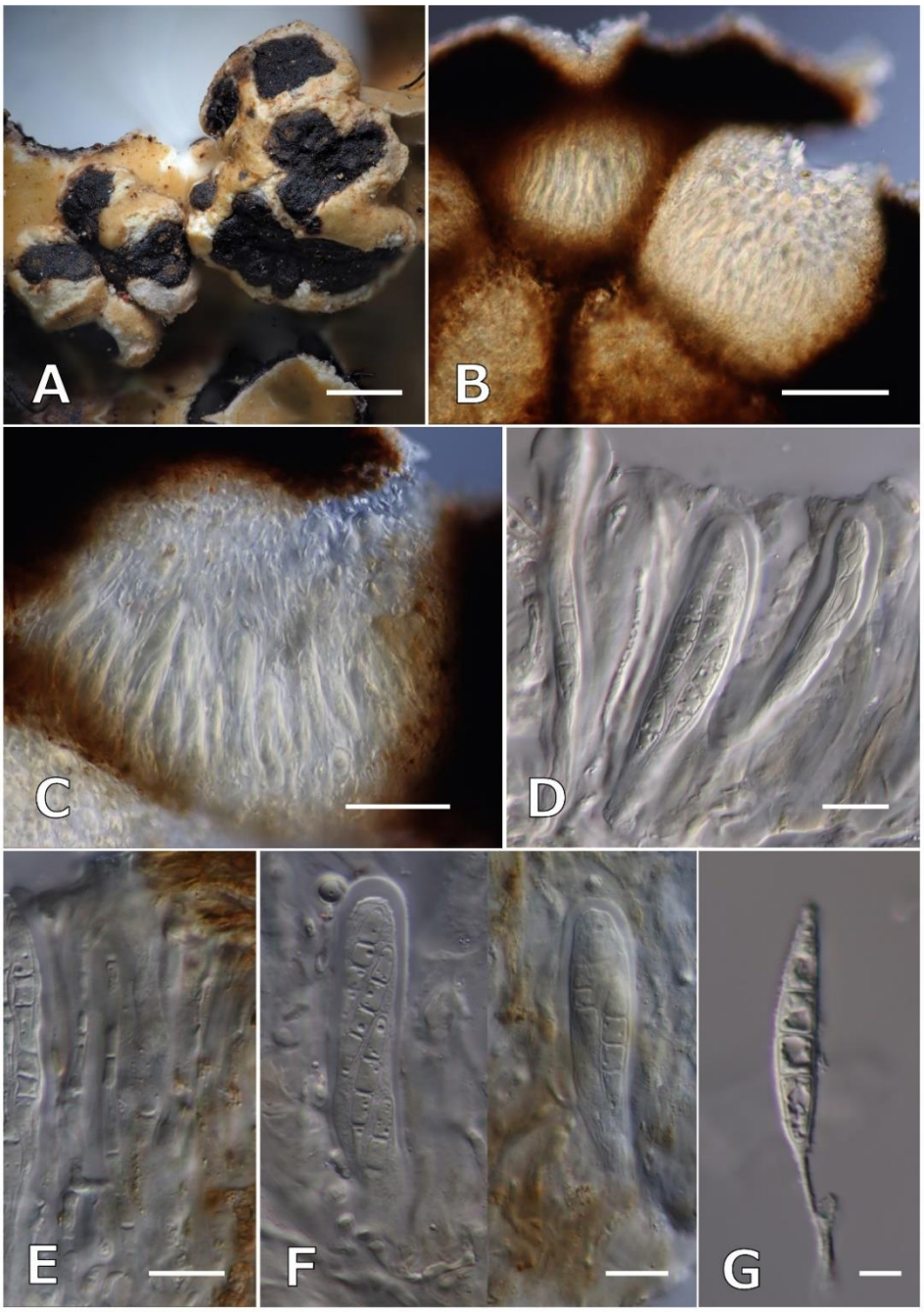

Fig.46. *Perigrapha superveniens* (Nyl.) Hafellner, Nova Hedwigia 63(1-2): 174 (1996). (R. Santesson: Fungi Lichenicoli Exsiccati 274, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E. Paraphyses. F. Asci and ascospore. G. Ascospore. Scale bars: A=0.5 mm, B=100 μm, C=50 μm, D-F=10 μm, G=5 μm.

Phaeospora arctica Horáková & Alstrup, Graphis Scripta 6(2): 61 (1994).

Ascomata subglobose, semi-immersed, black, ca 120 µm diam. **Hymenial ge**l I+ pale red. **Hamathecium** not observed. **Asci** clavate to subcylindrical, 6–8-spored, 55.0–60.0 × 11.0–14.0 µm. **Ascospores** narrowly elliptic to elliptic, (1–)3-septate, not constricted at the septa, smooth, hyaline to pale cinnamon-brown, (10.0–)15.5–20.5(–22.0) × (4.5–)5.0–6.0(–8.0) µm. **Host**: *Arctoparmelia* species, *Cetraria* species and *Nephromopsis* species (Zhurbanko 2012).

This species is black, subglobose, a little ascomata buried in the host. Hymenium turns pale red with respect to I. This species is particularly characterized by spores, which are colorless to cinnamon to brown and 3-septate (Zhurbanko 2012). Japanese records were reported by Zhurbenko and Ohmura (2019).

Phaeospora catolechiae Zopf, Nova Acta Acad. Caes. Leop. Carol. German. Nat. Cur. 70(4): 281 (1898)

Vegetative hyphae brown, 1.5–2.5 µm diam. **Ascomata** perithecioid, subglobose, aggregated, sessile, black, glossy, 125–250(–300) µm diam. **Ascomatal wall** brown to slightly orange, K+ olivaceous-brown, (2.5–)4.0–6.0(–10.0) µm. **Periphyses** 1.0–1.5 µm diam. **Periphysoids** septate, sometimes branched, 15.0–25.0 × 1.0–2.5 µm. **Hymenial gel** I+ red, K/I+ blue. **Asci** elongate to ellipsoid, clavate to subcylindrical, bitunicate, 8-spored, (55.0–)60.0–68.0(–70.0) × (14.0–)15.0–17.0(–20.0) µm. **Ascospores** narrowly ellipsoid to obovate, sometimes apiculus, (1–)3(–4)-septate, smooth, hyaline when young, brown when mature, K+ olivaceous-brown, (10.0–)13.6–19.0(–24.5) × (4.8–)5.6–7.6(–10.0) µm. **Host**: *Catolechia wahlenbergii* (Zhurbenko 2014b).

This species is aggregated by black ascomata. Ascomata changes color from olive to brown with respect to K. Hymenium turns red for I and blue for K/I. The characteristic of this species is that the spores are thin ellipsoid to obovate, colorless, 3-septate, and change color from olive to brown with respect to K (Zhurbenko 2014). Japanese records were reported by Zhurbenko and Ohmura (2019).

Polycoccum aksoyi Halıcı & V. Atienza, in Halıcı, Atienza & Hawksworth, Mycotaxon 101: 158 (2007)

Ascomata perithecioid, pyriform, globose, semi–immersed to immersed, black, singly. **Ascomatal wall** pale brown to dark brown, 25.0 µm. **Hamathecium** branched and anastomosing, septate, 1.3–2.0 µm wide. **Asci** subcylindrical, bitunicate, (31.5–)33.0–42.0(–44.0) × (12.0–)14.0–17.5(–18.0) µm. **Ascospores** ellipsoid, 1–septate, constricted at the septum, smooth, brown to dark brown, (9.8 –)11.2–14.2(– 15.3) × (5.3 –)6.0–7.4(– 8.5) µm. **Host**: *Aspicilia* species (Darmostuk and Golovenko 2016).

In this species, the black perithecioid ascomata is buried in the host lichen. This species is brown to dark brown in spores, 1-septate, ellipsoid, slightly larger than other species of the same genus, and is characterized by parasitizing *Aspicilia* species (Darmostuk and Golovenko 2016). Japanese records were reported by Zhurbenko et al. (2015).

Polycoccum hymeniicola (Berk. & Broome) Zhurb., Bryologist 113(2): 263 (2010).

Ascomata perithecioid, subglobose to broadly ellipsoid, immersed, sessile, black, glossy, (60–)100–220 (–280) mm diam. sometimes as irregularly split opening, usually

numerous and tightly packed. **Ascomatal wall** orange brown or reddish-brown, 10.0–35.0 µm. **Hamathecium** septate, branched to anastomosed, 1.5–3.5 mm diam; Interascal gel I−, K/I−. **Asci** bitunicate, subcylindrical to elongate clavate, (6–)8-spored, I and K/I +yellowish brown to brownish orange, (66.0–)75.0–91.0(–101) × (10.0–)12.0–14.0(–15.0) µm. **Ascospores** ellipsoid, with rounded ends, (0–)1-septate, often with a bigger upper cell, sometimes constricted at the septum, hyaline to pale yellowish brown, smooth, with a few drops, (11–)14.5–19(–24.5) 3 (4.5–)5.5–7(–9) µm. **Conidiomata** 80.0– 170 mm diam. **Conidiogenous cell** ellipsoid to ampulliform, 6.5–12.0 × 4.0–7.5 µm. **Conidia** broadly obovate or ellipsoid to subglobose, usually truncated at the base, smooth, simple, hyaline to pale yellowish brown, (6.3–)8.9–11.4(–13.0) × (4.4–)6.3–8.3(–9.9) µm. **Host**: *Lobaria* species (Zhurbenko and Dillman 2010).

In this species, the black perithecioid ascomata is buried in the host lichen. Ascomata opens with irregular splits. This species is characterized by the ascus being yellow to brown or orange to brown with respect to K/I. The characteristics of this species are ellipsoidal spores, rounded ends, pale yellow to pale brown, 1-septate, and the upper cells are larger than the lower cells (Zhurbenko and Dillman 2010). Japanese records were reported by Zhurbenko et al. (2015).

Polycoccum microcarpum Diederich & Etayo, in Etayo & Diederich, Lichenologist 30(2): 111 (1998)

Ascomata perithecioid, immersed in convex gall, ostiolate, dark brown to black, 30.0–60.0(–100) µm diam. **Hamathecium** anastomose, 1.5–2.0 µm thick. **Asci** elongate clavate, bitunicate, 8-spore, 30.0–35.0 × 15.0 µm. **Ascospore** 1-septate, slightly constricted at the

septum, brown, 12.0–14.5 × 4.5–7.0 µm. **Host**: *Cladonia* species (Etayo and Diederich 1998, Zhurbenko and Pino-bodas 2017).

In this species, the black perithecioid ascomata is buried in the host lichen. The characteristic of this species is that small ascomata aggregate to form galls. The spores are brown and 1-septate. The characteristic of this species is that it parasitizes *Cladonia* species (Etayo and Diederich 1998, Zhurbenko and Pino-bodas 2017). Japanese records were reported by Zhurbenko and Ohmura (2019).

Polycoccum trypethelioides (Th. Fr.) R. Sant., Svensk bot. Tidskr. 54(4): 505 (1960).

[Fig. 47]

Ascomata perithecioid, subglobose to broadly ovate, immersed, black, glossy, 150–200 µm diam. **Ascomatal wall** dark brown. **Paraphyses** septate, scarcely branched and anastomosed **Asci** (4–)8 spore. **Ascospores** obpyriform to obovate, (0–)1-septate, constricted at the septum, usually lower cells smaller, hyaline to olive to brown, (12.0–)15.0–19.0(–22.5) × (7.0–)8.5–10.5(–12.5) µm. **Conidiomata** pycnidial, subglobose, immersed to erumpent, black, 50.0–100 µm diam; crowded and intermixed with the ascomata. **Conidiogenous cells** holoblastic, subcylindrical to elongate-ampulliform, ca 14.0–15.0 × 2.5–3.5 µm. **Conidia** oblong to ellipsoid, rounded apex, truncated base, hyaline, simple, smooth, (3.5–)4.0–5.0(–7.0) × 1.5–2.0 µm. **Host**: *Stereocaulon* species (Zhurbenko 2010, Hawksworth et al. 2010a).

In this species, the black perithecioid ascomata is buried in the host lichen. The characteristic of this species is that it becomes a gall-like shape by aggregating small ascomata. The spores are colorless to olive or brown, 1-septate, smaller in the lower cells than in the upper cells. The characteristic of this species is that it parasitizes *Stereocaulon* species (Zhurbenko

2010, Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko and Ohmura (2019).

Exsiccata examined. SWEDEN. Torne Lappmark: the Torneträsk area, Vassitjäkko, the NE slope. Alt. 1000 m. On a wind-swept heath on calcareous ground. On *Stereocaulon alpinum* (thallus). July 16, 1948 (Santesson: Fungi Lichenicoli Exs. 34, TNS).

Protounguicularia nephromatis (Zhurb. & Zavarzin) Huhtinen, D. Hawksw. & Ihlen, Lichenologist 40(6): 550 (2008).

Ascomata apothecioid, gregarious, erumpent, discoid, with marginal hairs, disc faint yellowish to faint brownish, margin whitish, ca 330 µm diam. **Paraphyses** cylindrical or slightly clavate, simple to branched, 3.0 µm wide. **Asci** cylindrical-clavate, (37.0–)58.9(–74.0) × 8.0–9.0 µm, 8-spore. **Ascospores** fusoid to subfusoid, simple, smooth, hyaline, (8.5–)11.5–16.0 (–17.5) × (2.5–)2.9(–3.2) µm. **Host**: *Nephroma* species (Huhtinen et al. 2008).

The characteristic of this species is round, yellow to white to light brown apothecia. Particularly characteristic are colorless, slightly spindle-shaped spores (fusoids). This species is known to parasitize *Nephroma* species (Huhtinen et al. 2008). Japanese records were reported by Zhurbenko et al. (2015).

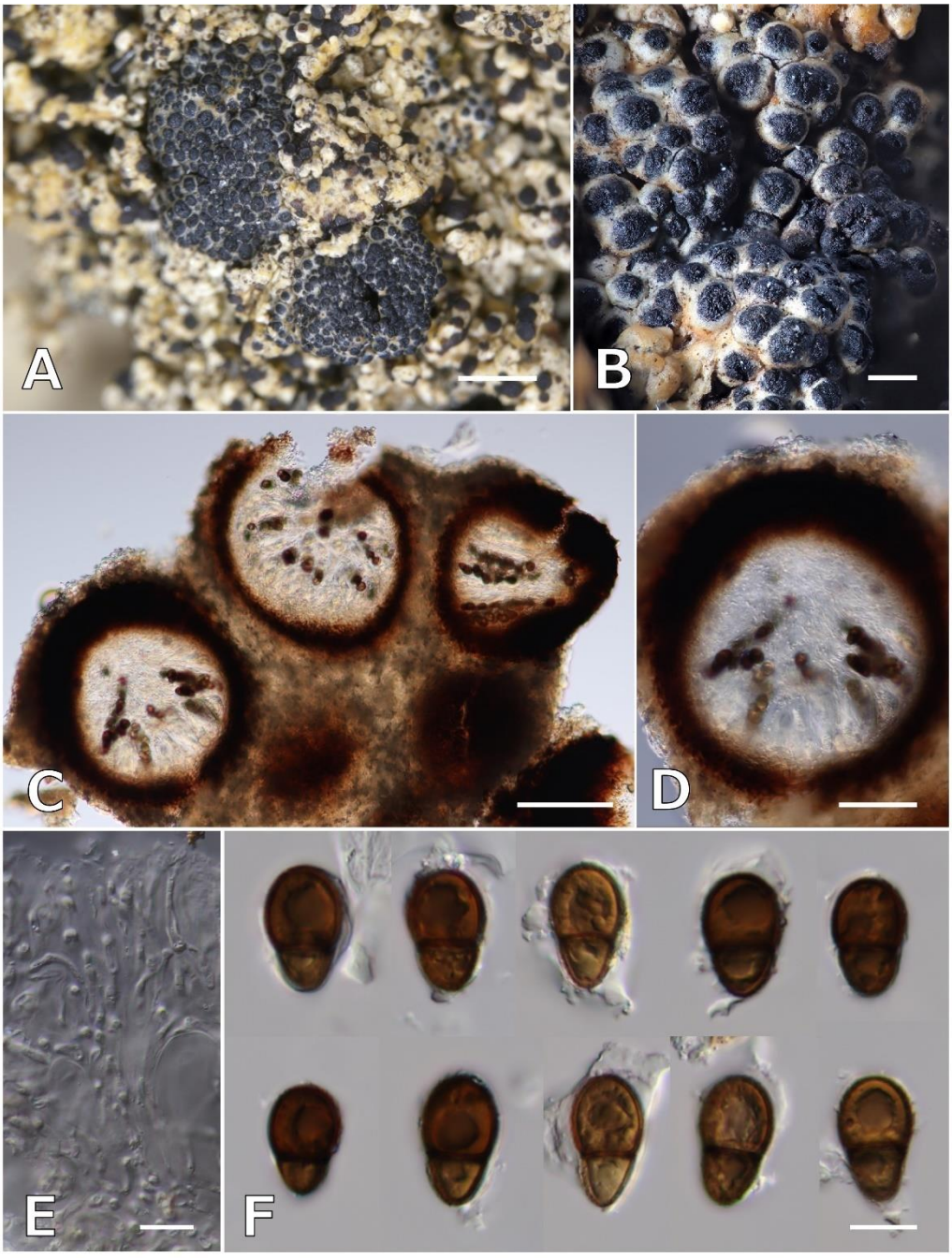

Fig. 47. *Polycoccum trypethelioides* (Th. Fr.) R. Sant., Svensk bot. Tidskr. 54(4): 505 (1960). (R. Santesson: Fungi Lichenicoli Exsiccati 34, TNS). A. Growth habit. B. Ascomata. C-D. Cross section of an ascomata. E. Paraphyses. F. Ascospore. Scale bars: A=1 mm, B＝200 μm, C=100 μm, D=50 μm, E-F=10 μm.

Pyrenidium actinellum Nyl., Flora, Regensburg 48: 210 (1865).

[Fig. 48]

Ascomata perithecioid, subglobose, immersed to semi-immersed, scattered or small groups, dark brown to black, 100−150 μm diam. **Ascomatal wall** brown to dark brown, 20.0−30.0 μm thick. **Paraphysoid** filiform, septate, branched and anastomosed, hyaline, 1.0−3.0 μm diam. **Periphyses** branched, hyaline, green pigmented at the top. **Asci** clavate to subcylindrical, 4-spored, 40.0−85.0 × 12.0−15.0 μm. **Ascospores** ellipsoid to broadly fusiform, (2-)3-septate, slightly constricted at septa, brown to dark brown, (17.0−)19.5−22.1(−22.7) × (7.3−)8.1−9.3(−9.8) μm (n=31).

The characteristic of this species is that ascomata buried in black form a group and are buried in the host lichen. Paraphysoids are clearly present, composed of colorless hyphae, filiform, septate, administered and anastomosed. In addition, as a characteristic of this species, since the spores are rather large, there are about 4 spores in the ascus. The spores are brown, ellipsoid to broadly fusiform, rarely slightly curved and 2−3-septate (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Specimen examined: JAPAN, Honshu, Pref. Saitama, Mt. Mitsumine, 35°55′N, 138°55′E, elev. 1100m asl, on *Ochrolechia* sp. (thallus), 30.10.2016, K. Tadome 20161030007 (TNS).

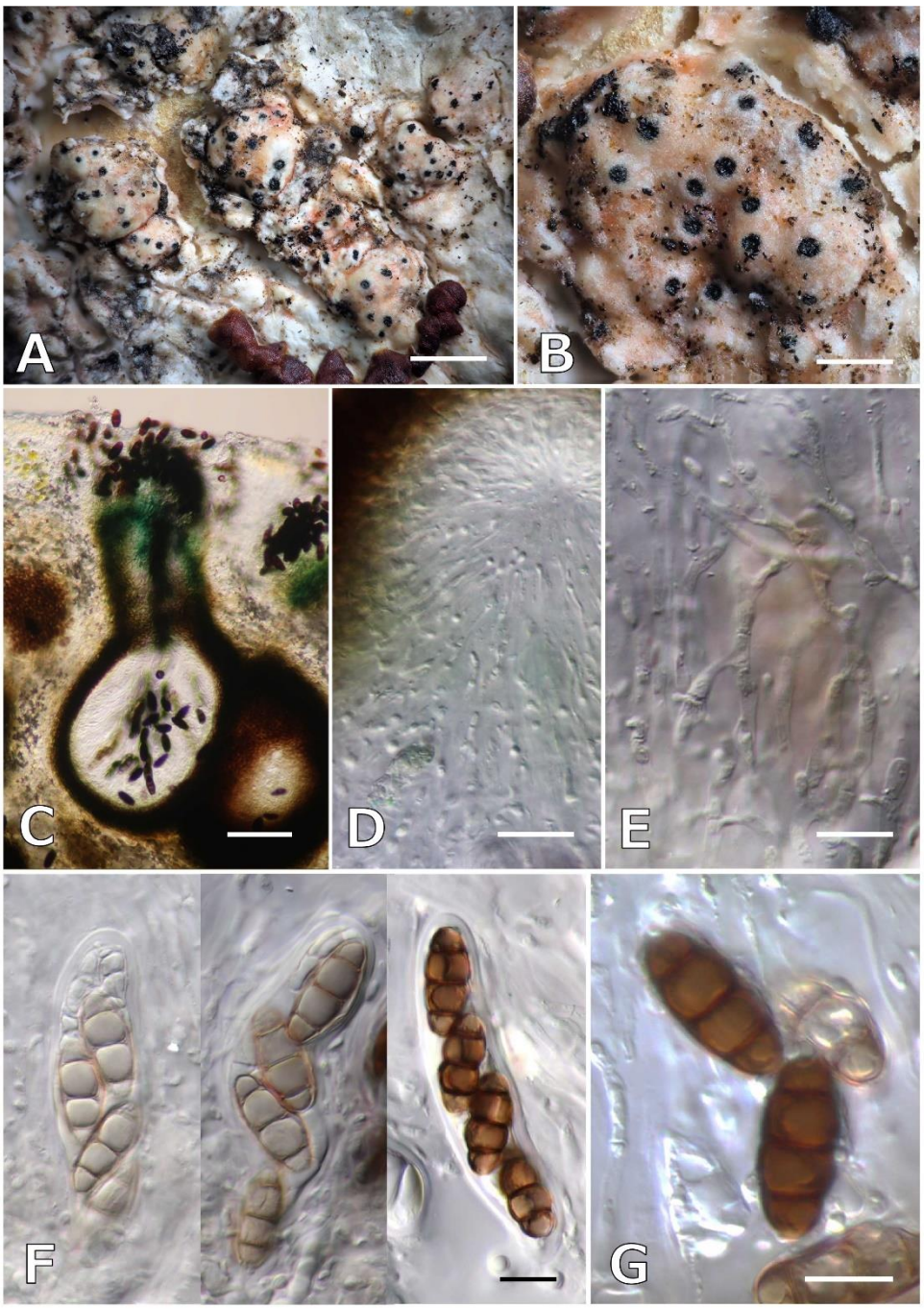

Fig. 48. *Pyrenidium actinellum* Nyl., Flora, Regensburg 48: 210 (1865). (K. Tadome 20161030007 TNS).

A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Periphyses. E. Paraphysoid. F. Asci. F. Ascospore. Scale bars: A=1 mm, B＝0.5 mm, C＝50 μm, D＝10 μm, E＝5 μm, F-G＝10 μm.

Raesaenenia huuskonenii (Räsänen) D. Hawksw., Boluda & H. Lindgr., in Divakar et al., New Phytol. 208: 1221 (2015)

= Basionym: *Phacopsis huuskonenii* Räsänen 1948.

Ascomata elongate, convex, sometimes gall forming, shiny black, ca 2.0–2.5 × 0.5–1.1 mm. **Ascospore** with 1.0–3.0 µm thickened caps, 13.0–17.0(–19.0) × 3.0–4.0 µm. **Host**: *Bryoria capillaris*, *B. fuscescens* and *B. subcana* (Hawksworth et al. 2010a).

The characteristic of this species is that a black gall can be the host. The spores form thick cups at both ends. Formerly the genus *Phacopsis*, it is now the genus *Raesaenenia*. It parasitizes only *Bryoria* species (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko and Ohmura (2019).

Rhabdospora haematommatum Kalb & Hafellner, in Kalb, Hafellner & Staiger, Biblthca Lichenol. 59: 211 (1995)

Conidiomata black to dark brown, with hairs. **Conidia** filiform, incurvata, simple, hyaline, 25.0–32.0 × 1.2–1.7 µm. **Host**: *Haematomma fauriei* (Kalb et al. 1995).

The characteristic of this species is black conidiomata with hyphae on the surface. Conidia are colorless, filiform, and very elongated (Kalb et al. 1995). Japanese records were reported by Kalb et al. (1995).

Roselliniella cladoniae (Anzi) Matzer & Hafellner, Biblthca Lichenol. 37: 59 (1990).

[Fig. 49]

Ascomata pyriform, superficial, with long hyphae, protruding or descending to the

host thallus surface, brown, 250–500 µm diam. **Asci** 4–8-spore. **Ascospores** ellipsoid to narrowly ellipsoid, oblong, ovoid, apices rather acute to occasionally rounded, simple (reraly 1–4-septate, not constricted at the septa) hyaline to brown, (11.8–)18.2–29.0(–38.0) × (7.3–)9.8–13.2(–16.5) µm. **Host**: *Cladonia* species (Zhurbenko and Pino-bodas 2017).

This species of ascomata is shaped like a pear from a sphere. Also, as a feature of this species, the surface of ascomata is covered with black hyphae. The spores are colorless to brown, ellipsoid, simple, but rarely 1–4-septate. As a characteristic of this species, it parasitizes the lichen of the genus *Cladonia* (Zhurbenko and Pino-bodas 2017). Japanese records were reported by Zhurbenko and Ohmura (2019).

Exsiccata examined. SWEDEN. Uppland: Läby par., Läbyvad, 0.5 km SE of the bridge. 59°50'N 17°33'E. On rocks in a *Picea abius* forest. On *Cladonia arbuscula* (thallus). April 4, 1948 (Santesson: Fungi Lichenicoli Exs. 218, TNS).

Roselliniella euparmeliicola Millanes & D. Hawksw., in Hawksworth, Millanes & Wedin, Persoonia 24: 13 (2010).

Ascomata perithecia, erumpent, black, broadly pyriform, ostiole developed, (145–)170–410(–430) µm diam. **Hamathecium** periphyses and interascal filaments, filamentous, septate, 1.5–2.0 µm wide. **Asci** clavate to subcylindrical, 8-spored, (52.0–)77.0–85.0(–95.0) × (12.5–)14.0–17.0 µm. **Ascospores** ellipsoid, rounded at the apices, smooth, hyaline when young, pale to dark brown when mature, 17.0–20.0(–22.0) × 8.0–9.5(–12.0) µm. **Host**: *Parmelia* species (Hawksworth et al. 2010b).

This species of ascomata is shaped like a pear from a sphere. In addition, as a characteristic of this species, the surface of ascomata is covered with black hyphae, and it grows

by destroying the surface of the host. Hamathecium has clear hyphae. Spores are ellipsoids, colorless when young and light brown when mature (Hawksworth et al. 2010b). Japanese records were reported by Zhurbenko et al. (2015).

Roselliniopsis tartaricola (Nyl. ex Leight.) Matzer, Cryptog. Mycol. 14(1): 16 (1993).

Vegetative hyphae forming a subiculum, branched, dark brown, septate, 4.0–8.0 µm wide. **Ascomata** perithecioid, subglobose to ovoid, superficial or slightly immersed, arising from the subiculum, black, 300–500µm diam. **Hamathecium** filiform, septate, ca 2.5 µm wide. **Asci** cylindrical, apex rounded, 8-spores, 60.0–90.0 × 10.0–11.0 µm. **Ascospores** ellipsoid, smooth, brown, 0(–1)-septate with an asymmetric septum, rarely 2–3-septate, (10.5 –)11.6 – 14.7(–17.0) × (7.0–)7.1– 8.4(–10.0) µm. **Host**: *Lepra* species, *Ochrolechia* species, *Pertusaria pupillaris* and *Varicellaria hemisphaerica* (Brackel and Puntillo 2016).

The characteristic of this species is black, spherical to oval ascomata, which is buried in the host. Ascomata has vegetative hyphae and invades the tissues in the host. The spores are brown, ellipsoidal and simple, but rarely 2-3-septate. It is also characterized by being parasitic on various crustose lichens (Brackel and Puntillo 2016). Japanese records were reported by Zhurbenko and Ohmura (2019).

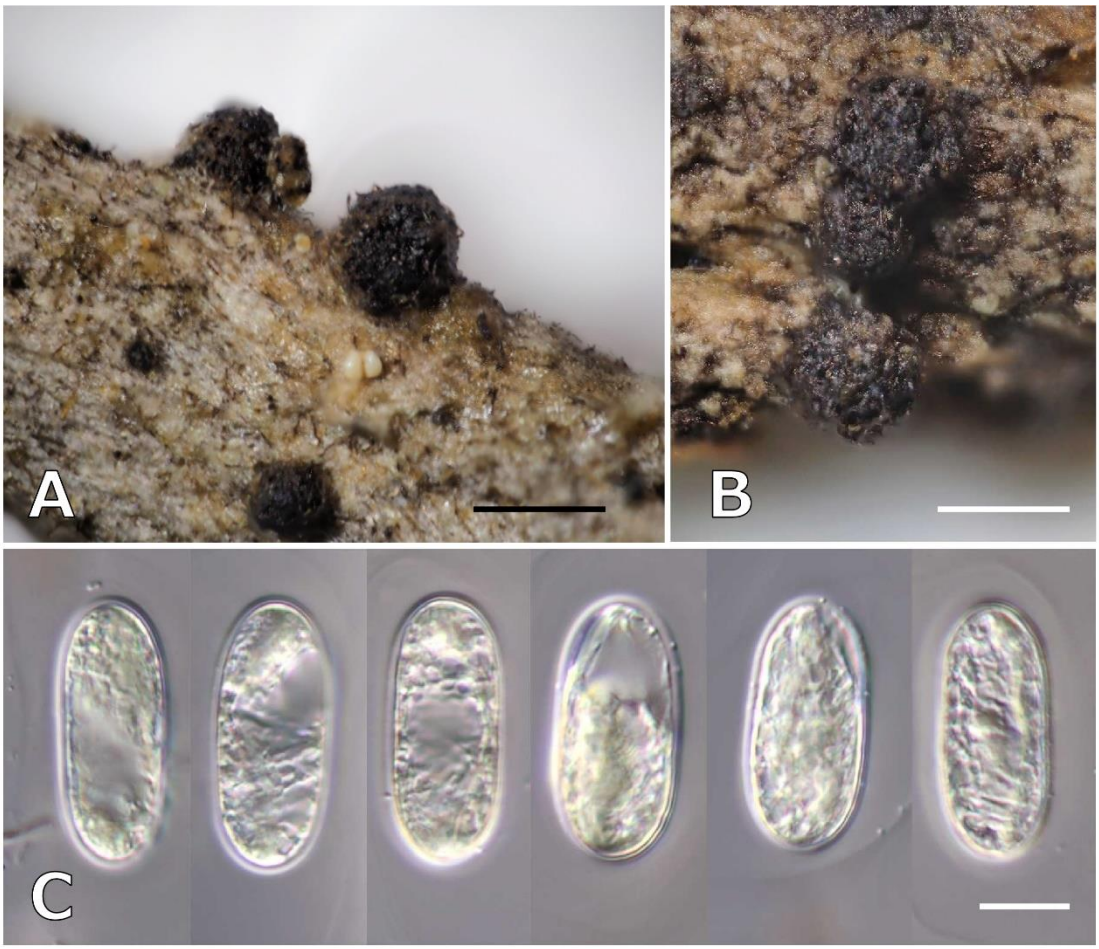

Fig. 49. *Roselliniella cladoniae* (Anzi) Matzer & Hafellner, Biblthca Lichenol. 37: 59 (1990). (R. Santesson: Fungi Lichenicoli Exsiccati 218, TNS). A. Growth habit. B. Ascomata. C. Ascospore. Scale bars: A-B=0.3 mm, C＝10μm.

Sagediopsis vasilyevae Zhurb., Folia cryptog. Estonica 51: 125 (2014).

Ascomata perithecioid, black, subglobose to obovate, opening by an irregular broad pore, (60.0–)100–200 µm diam. **Ascomatal wall** brown, K+ lighter yellow to orange-brown, 30–50 µm thick. **Periphysoids** hyaline, 1–4-septate, ca 10.0–20.0 × 1.0–1.5 µm. **Interascal filaments** cylindrical, (1.0–)1.5(–2.0) µm diam. **Hymenial gel** I and K/I+ blue. **Asci** narrowly ellipsoid to clavate, 8-spored, I and K/I+ blue, (50.5–)52.0–64.0(–69.0) × (9.5–)10.5–14.5(–17.0) µm. **Ascospores** elongate-bacilliform to acicular, acuminate at both ends, 3(–4)-septate, not constricted at the septa, guttulate, smooth, hyaline, (37.5–)41.7–50.3(–53.0) × (2.5–)2.9–3.5(–3.8) µm. **Conidiomata** ca 50.0 × 70.0 µm. **Conidiomatal wall** pale brown ca 10.0 µm. **Conidiogenous cells** ca 7.0–10.0 × 2.0–3.0 µm. **Conidia** bacilliform, simple, hyaline, (3.7–)3.9–4.5(–4.9) × (1.2–)1.4(–1.5) µm. **Host**: *Rhizocarpon* species (Zhurbenko and Yakovchenko 2014).

The characteristic of this species is black, spherical to oval ascomata, which is buried in the host. Ascomata opens irregularly, ranging from bright yellow to orange to brown with respect to K. Hymenium and asci turn blue with respect to I and K/I. The characteristic of this species is colorless spores, elongate-bacilliform to acicular, pointed at both ends, and 3-septate (Zhurbenko and Yakovchenko 2014). Japanese records were reported by Zhurbenko et al. (2015).

Sarcogyne lapponica (Ach. ex Schaer.) K. Knudsen & Kocourk., Mycotaxon 105: 160 (2008)

It is on the Japanese checklist (Ohmura and Kashiwadani 2018), but not on the global checklist (Diederich et al. 2018). In the future, it will also be removed from the Japanese checklist. Japanese records were reported by Knudsen and Kocourková (2008).

Sclerococcum ahtii (Zhurb. & Pino-Bodas) Ertz & Diederich, in Diederich, Lawrey & Ertz, Bryologist 121(3): 395 (2018).

= Basionym : *Dactylospora ahtii* Zhurb. & Pino-Bodas.

Ascomata apothecia, scattered, disc shiny, dark brown to black, round, plane to concave, (80.0–)130–250(–600) µm diam. **Exciple** medium red-brown or orange-brown, upper part of the exciple contains deep purple to dark violet, K+ dark green to blue-green blotches, (15.0–)30.0(–70.0) µm thick. **Epihymenium** reddish brown to orange-brown, 5.0(–10.0) µm tall. **Hymenium** hyaline to pale red or brownish orange, I+ blue above, red below or I+ blue, K/I+ blue with red patches, 40–60 µm tall. **Paraphyses** septate, 1.5–2.0 µm diam, apical cells red or orange-brown, capitate, (3.0–)4.0(–5.5) µm diam. **Asci** elongate clavate, 8-spored, I+ blue, K/I+ blue, ca 40.0–55.0 × 9.0–12.0 µm. **Ascospores** ellipsoid to slightly obovate, (0–)1-septate, guttulate, smooth, hyaline to light brown, (7.6–)10.4–13.0(–16.3) × (3.0–)3.5–4.3(–5.5) µm. **Host**: *Cladonia* species (Pino-Bodas et al. 2017).

This species is black, circular apothecia and slightly concave. Exciple is a reddish-brown color that changes from dark green to bluish green with respect to K. Hymenium is colorless and turns blue for I and red for the bottom (sometimes all turn blue), and for K/I it turns blue but may have red spots. Asci turns blue with respect to I and K/I. The characteristic of this species is that the spores are ellipsoid, 1-septate, colorless to light brown. It is also characterized by being parasitic on the genus *Cladonia* (Pino-Bodas et al. 2017). Japanese records were reported by Zhurbenko and Ohmura (2019).

Sclerococcum anziae (Zhurb., Ezhkin, Skirina & Y. Ohmura) Ertz & Diederich, in Diederich, Lawrey & Ertz 2018

= Basionym : *Dactylospora anziae* Zhurb., Ezhkin, Skirina & Y. Ohmura, Folia cryptog. Estonica 54: 13 (2017)

Ascomata apothecia, plane disc, sessile, constricted at the base, dispersed to aggregated, black, (100–)150–400(–600) µm diam. **Exciple** reddish brown, K+ brown to greyish brown, 30.0–50.0 µm thick. **Epihymenium** medium reddish brown, K+ brown to greyish brown, 5.0–8.0 µm tall. **Hymenium** hyaline to pale reddish brown, I and K/I+ blue or partly red, (50.0–)60.0(–70.0) µm tall. **Paraphyses** branched, septate, constricted at the septa, apex enlarged, (1.0–)2.5(–3.5) µm diam. **Asci** clavate to broadly cylindrical, 8-spored, I and K/I+ blue or partly red, (42.0–)44.0–56.0(–60.0) × (10.0–)11.0–15.0(–17.0) µm. **Ascospores** oblong, ellipsoid or obovoid, with rounded ends, (0–)1-septate, constricted at the septum, hyaline to light olive grey and brown, with finely verruculose, (6.3–)8.9–10.4(–12.3) × (3.8–)4.8– 6.2(–7.9) µm. **Anamorph** not observed. **Host**: *Anzia colpodes*, *A. colpota*, *A. opuntiella* and *A. stenophylla* (Zhurbenko et al. 2017).

This species is aggregated in black, circular apothecia. The characteristic of this species is that Exciple and epihymenium are reddish brown, and the color changes from brown to taupe with respect to K. Hymenium is colorless to light reddish brown and turns blue with respect to I and K/I, but may have red spots. Asci turns blue with respect to I and K/I. The spores of this species are oblong to ellipsoid, 1-septate, colorless to light olive gray or brown. It is also characterized by being parasitic on the genus *Anzia* (Zhurbenko et al. 2017). Japanese records were reported by Zhurbenko et al. (2017).

Sclerococcum attendendum (Nyl.) Ertz & Diederich, in Diederich, Lawrey & Ertz 2018.

Ascomata dark-brown, K–. **Hypothecium** pale reddish brown. **Asci** clavate, 8-spore, 35.0–52.0 × 11.0 µm. **Ascospores** 3-septate, light brown to brownish grey, 12.0–14.0 × 3.5–4.5 µm. **Host**: *Amygdalaria* species, *Icmadophila* species, *Pilophorus* species and *Porpidia* species (Brackel and Berger 2019).

This species is dark brown and circular apothecia, and is characterized by not discoloring with respect to K. The spores are 3-septate and light brown or taupe. It is known to parasitize various crustose lichens (Brackel and Berger 2019). Japanese records were reported by Triebel and Rambold (1989).

Sclerococcum lobariellum (Nyl.) Ertz & Diederich, in Diederich, Lawrey & Ertz 2018.

= Basionym : *Dactylospora lobariella* (Nyl.) Hafellner, Beih. Nova Hedwigia 62: 118 (1979).

Ascomata apothecia, superficial, scattered, discoid, plane to slightly concave when young, slightly convex when mature, black, 0.3–0.5 mm diam. **Exciple** reddish-brown. **Epithecium** pale brown, ca 10 µm thick. **Hymenium** hyaline, I + blue to red, 40.0–55.0 µm thick. **Hypothecium** brown, 10.0–20.0 µm thick. **Interascal tissue** paraphyses, branched, septate, 1.5–2.0 µm diam. **Asci** elongate-clavate, thick-walled, 8-spore, thick K/I+ blue outer gelatinized layer, (35.0–) 40.0–48.0 × (9.0–) 12.0–15.0 µm. **Ascospores** ellipsoid to clavate, rounded ends, 1-septate, not constricted at septum, strongly verrucose, brown to olivaceous, 11.0–14.0 (–17.0) × 4.5–6.0 µm. **Host**: *Lobaria* species, *Ricasolia* species, *Pseudocyphellaria* species (Hawksworth 1975, Hawksworth et al. 2010a).

This species is black, circular apothecia, scattered on the surface of the host. The characteristic of this species is that colorless hymenium changes color from blue to red with

respect to I. The spores are ellipsoid to clavate and are characterized by being brown to olive, 1-septate, and strongly verrucose (Hawksworth 1975, Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Sclerococcum parasiticum (Flörke) Ertz & Diederich, in Diederich, Lawrey & Ertz 2018.

= *Dactylospora parasitica* (Florke) Zopf, Hedwigia 35: 159 (1896).

Ascomata apothecia, discoid, dark reddish brown to black, (200–)300–550 µm diam. **Ascomatal wall** dark brown. **Hymenium** 50.0–70.0 µm tall. **Interascal tissue** paraphyses 2.0–2.5 µm diam, branched, slightly swollen apex. **Asci** cylindric-clavate, short-stalked, thick-walled, 8-spored, 44.0–54.0 × 8.5–12.0 µm. **Ascospores** cylindrical, rounded ends, smooth, 3–5-septate, dark brown, (9.0–) 11.5–12.5 (–16.0) × 3.5–4.5 µm. **Host**: *Lepra* species, *Ochrolechia* species, *Pertusaria* species (Diederich et al. 2013, Nash et al. 2004).

This species is reddish brown to black and round apothecia. The characteristic of this species is that the spores are dark brown, 3–5-septate, and cylindrical. In addition, this species is characterized by being parasitic on crustose lichen (Diederich et al. 2013, Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Sclerococcum porphyreum (Hafellner & Kalb) Ertz & Diederich, in Diederich, Lawrey & Ertz, Bryologist 121(3): 399 (2018)

= Basionym : *Dactylospora porphyrea*

Epihymenium and exciple reddish brown. **Hymenium** 40.0−50.0 µm. **Ascospore** (1−)3-septate, slightly ornamented. **Host**: *Bacidia* species, *Brigantiaea* species and *Phyllopsora*

species (Etayo and Breuss 1998).

This species is characterized by a reddish-brown epihymenium and exciple. This species is known to parasitize various lichens, mainly crustose lichen (Etayo and Breuss 1998). Japanese records were reported by Zhurbenko and Ohmura (2019).

Sclerococcum simplex D. Hawksw., Bull. Br. Mus. nat. Hist., Bot. 6(3): 249 (1979)

Conidiomata sporodochia, dark brown to black, 100−300 µm diam. **Conidia** 0(–1)-septate, rounded, (3.5–)4.0–7.0(–8.0) µm. **Host**: *Pertusaria* species (Hawksworth et al. 2010a).

This species forms a black sporodochia. The characteristic of this species is dark brown, simple or 1-septate circular conidia, and it is known that it mainly parasitizes the genus *Pertusaria* (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Scutula epiblastematica (Wallr.) Rehm, Rabenh. Krypt. - Fl., Edn 2 (Leipzig) 1.3(lief. 32): 322 (1890) [1896]

Ascomata developed surface of the host thallus, scattered, pale brown to black, 0.1–0.3(−0.45) mm diam. **Ascospores** narrowly ellipsoid to ellipsoid, 1−3-septate, (8.0–)8.6–12.6(–17.0) × (2.5–)2.9–4.2(–4.5) µm. **Pycnidia** of two types 45.0–95.0 µm diam. **Microconidia** bacilliform to shortly filiform, ca 5.0–8.0 × 1.0–1.4 µm. **Mesoconidia** bacilliform to falcate, ca 6.2−8.0 × 1.7–2.3 µm. **Host**: *Peltigera* species (Hawksworth et al. 2010a).

This species has black, circular ascomata scattered on the surface of the host lichen. The characteristic of this species is that the spores are ellipsoid and 1−3-septate. Also, as a feature, it

parasitizes the genus *Peltigera* (Hawksworth et al. 2010a). Japanese records were reported by Zhurbenko et al. (2015).

Skyttea fusispora Sherwood, D. Hawksw. & Coppins, Trans. Br. mycol. Soc. 75(3): 484 (1981) [1980]

Ascomata apothecioid, opening rounded, pore, immersed, black, 110–190 µm diam. **Exciple** greenish brown, K+ olive; excipular hairs greenish to brownish, 10.0–15.0 × 2.0–5.3 µm. **Epihymenium**, hymenium and subhymenium hyaline. **Paraphyses** filiform, simple or rarely branched, septate, 1.5–2.0 µm. **Asci** cylindrical to clavate, with thick apex, 8-spored, 60.0–70.0 × 6.0–8.0 µm. **Ascospores** hyaline, narrowly ellipsoid, simple, 20.0–28.0 × 2.5–3.5 µm. **Host**: *Ochrolechia rosella* (Diederich and Etayo 2000).

The characteristic of this species is ascomata, which is black and buried in the host, and has a circular opening. Especially characteristic is the opening, which is covered with bristles. Exciple turns greenish brown with respect to K. The spores are colorless and ellipsoid. Also, as a characteristic of this species, it parasitizes *Ochrolechia rosella* (Diederich and Etayo 2000). Japanese records were reported by Zhurbenko et al. (2015).

Skyttea lecanorae Diederich & Etayo, Lichenologist 32(5): 439 (2000)

Ascomata erumpent, margin in opened ascomata, pore, black, (75.0–)90.0–125(–150) µm diam. **Exciple** greenish brown, K+ olive, 10.0–25.0 µm thick; excipular hairs hyaline to greenish, straight, 8.0–13.0(–20.0) × 1.5−2.5 µm. **Subhymenium** hyaline, 6.0–10.0 µm thick. **Hymenium** 45.0–55.0 µm thick. **Epihymenium** hyaline to pale greenish. **Paraphyses** filiform,

simple or rarely branched, 1.5–2.0 µm thick. **Asci** subcylindrical, with thick apex, 8-spored, 35.0–50.0 × 3.0–4.0 µm. **Ascospores** ellipsoid, simple, hyaline, 7.0–9.0(–13.0) × (2.0–)3.0–3.5(–4.5) µm. **Host**: *Lecanora* species (Diederich and Etayo 2000).

The characteristic of this species is ascomata, which is black and buried in the host, and has a circular opening. ascomata destroys and opens the surface of the host's lichen. Especially characteristic is the opening, which is covered with bristles. Exciple is green to brown, but turns olive to K. The spores are colorless and ellipsoid. Also, as a characteristic of this species, it parasitizes the genus *Lecanora* (Diederich and Etayo 2000). Japanese records were reported by Zhurbenko et al. (2015).

Skyttea ochrolechiae Zhurb., in Zhurbenko, Frisch, Ohmura & Thor, Herzogia 28(2): 780 (2015)

Ascomata apothecioid, immersed when young, subglobose, erumpent, opening rounded (20–60µm wide), greynish brown, 100–200 µm diam. **Exciple** brownish orange, with gray depositions up to 20 µm thick above the outer edge, K+ pale to medium purple, excipular hairs abundant, pore, hyaline, acuminate, (9.9–)12.4–19.4(–24.0) µm, (2.8–)3.6–5.0(–6.2) µm wide. **Subhymenium** hyaline, 10.0–20.0 µm tall. **Hymenium** hyaline, 60.0 µm tall. **Paraphyses** filiform, hyaline, septate, sometimes branched, 2.0–2.5(–3.5) µm diam. apex slightly enlarged. **Asci** subcylindrical, narrowly ellipsoid or elongate obclavate, 8-spored, (50.0–)56.0–70.0(–77.0) × (8.0–)8.5–11.0(–13.0) µm. **Ascospores** fusiform to occasionally bacilliform, simple, smooth, hyaline, (9.7–)14.7–18.9(–21.8) × (2.5–)3.1–3.9(–5.0) µm. **Host**: *Ochrolechia trochophore* (Zhurbenko et al. 2015).

The characteristic of this species is ascomata, which is taupe-brown and buried in the

host, and has a circular opening. ascomata destroys and opens the surface of the host's lichen. Especially characteristic is the opening, which is covered with bristles. Exciple is brown to orange, but turns purple with respect to K. The spores are colorless, fusiform to occasionally bacilliform. Also, as a characteristic of this species, it parasitizes *Ochrolechia trochophore* (Zhurbenko et al. 2015). Japanese records were reported by Zhurbenko et al. (2015).

Sphaerellothecium conioides (Nyl.) Cl. Roux & Diederich, in Roux & Triebel, Bull. Soc. linn. Provence 45: 527 (1994)

Ascospore (11.0–)12.0–14.5(–16.5) × (3.5–)4.5–5.5(–6.0) µm. **Host**: *Baeomyces* species (Zhurbenko and Ohmura 2020). Japanese records were reported by Zhurbenko and Ohmura (2020).

Sphaerellothecium minutum Hafellner, Herzogia 9(3–4): 760 (1993).

[Fig. 50]

Superficial hyphae developed irregular network, branched and anastomosed, dark brown to black, 4.0–6.0 µm diam. **Ascomata** perithecial, superficial, globose with a slightly conical apex, black, 60.0–80.0 µm diam. **Peridium** dark brown. **Interascal tissue** absent. **Asci** saccate to pyriform, thick-walled, (6–)8-spored, 20.0–25.0 × 12.0–16.0 µm. **Ascospores** ellipsoid to clavate-ellipsoid, 1-sptate, slightly constricted at the septum, upper cell wider than lower cell, hyaline, 9.0–13.0 × 3.0–5.0 µm. **Anamorph** not observed. **Host**: *Sphaerophorus* species (Hafellner 1993, Hawksworth et al. 2010a, Wedin and Gilbert 2009).

The characteristic of this species is that it forms network-like hyphae on the surface

of the host lichen. ascomata is black and spherical, with no clear tissue inside. The spores are colorless, ellipsoid, 1-septate, and the upper cells are often larger than the lower cells. (Hafellner 1993, Hawksworth et al. 2010a, Wedin and Gilbert 2009)

Exsiccata examined. AUSTRIA. Steiermark: Niedere Tauern, Rottenmanner Tauern, Grosser Bösenstein, by E-Grat N above Grünen Lacke. MTB 8552/3. Alt. c. 2300 m. September 16, 1992 (Santesson: Fungi Lichenicoli Exs. 221, TNS).

Sphinctrina intermedia Tibell, in Tibell, Frisch & Thor, Ann. bot. fenn. 51(3): 192 (2014)

Ascomata apothecia, stalk, scattered, black, K+ red, 0.2–0.3 mm tall. **Capitulum** spherical, regular, smooth, shining black, 0.11–0.15 mm diam. **Excipulum** brown, 3.0–4.0 µm diam. Stalk black, 3.0–4.0 µm diam. **Asci** 37.0–43.0 × 3.0–4.5 µm. **Ascospores** globose to cuboid, simple, slightly irregular folds or cracks, dark brown, 5.0–5.5 × 5.0–7.5 µm. **Host**: *Pertusaria* species (Tibell and Thor 2003, Tibell et al. 2014).

The characteristic of this species is that it looks like a pin. Particularly characteristic are that ascomata turns red with respect to K, and the spores are brown, simple and globose. Also, this genus often parasitizes *Pertusaria* species (Tibell and Thor 2003, Tibell et al. 2014). Japanese records were reported by Tibell et al. (2014).

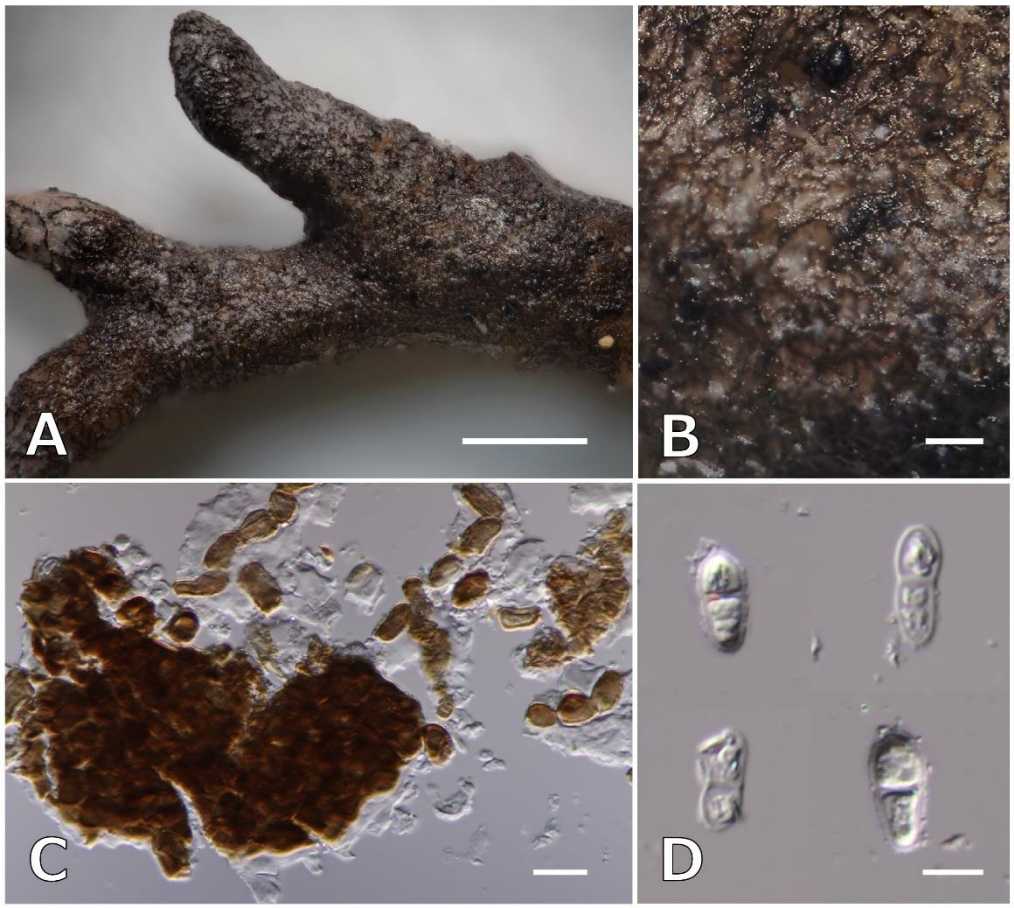

Fig. 50. *Sphaerellothecium minutum* Hafellner, Herzogia 9(3–4): 760 (1993). (R. Santesson: Fungi Lichenicoli Exsiccati 221, TNS). A. Growth habit. B. Ascomata. C. Ascomata and hyphae D. Ascospore. Scale bars: A=0.5 mm, B=50 µm, C=10 µm, D=5 µm.

Sphinctrina leucopoda Nyl., Flora, Regensburg 42: 44 (1859)

Ascomata apothecia, stalk, scattered, black, K–, 0.2−0.3 mm tall. **Excipulum** dark brown, K–. **Stalk** 3.0–4.0 µm diam. **Asci** cylindrical, 32.0–45.0 × 4.5–6.0 µm. **Ascospores** subglobose, simple, with irregular folds or cracks, dark brown, 4.5–6.0 × 4.0–6.0 µm. **Host**: *Pertusaria* species (Tibell and Thor 2003, Tibell et al. 2014).

The characteristic of this species is that it looks like a pin. Particularly characteristic is that ascomata does not discolor with respect to K, and the spores are brown, simple and subglobose. Also, this genus often parasitizes *Pertusaria* species (Tibell and Thor 2003, Tibell et al. 2014). Japanese records were reported by Tibell and Thor (2003).

Sphinctrina turbinata Fr., Syst. orb. veg. (Lundae) 1: 121 (1825)

Ascomata apothecia, sessile to short-stalked, K+violet-red, 0.2–0.3 mm tall. **Capitulum** round, shining black to dark brown, 0.2–0.4 mm diam. **Excipulum** dark wine-red, K + red, 50.0–85.0 µm thick. **Asci** cylindrical, 40.0–51.0 × 5.0–7.0 µm. **Ascospores** subglobose, simple, verrucose, with some irregular cracks when old, dark brown, 5.0–7.0 × 4.5–7.0 µm. **Host**: *Pertusaria* species (Tibell and Thor 2003).

The characteristic of this species is that it is very short with or without stems. Especially characteristic is that ascomata turns reddish purple with respect to K, the spores are brown and simple, subglobose, and the old spores have irregular cracks on the surface. Also, this genus often parasitizes *Pertusaria* species (Tibell and Thor 2003). Japanese records were reported by Tibell and Thor (2003).

Spirographa ciliata (Kalb) Flakus, Etayo & Miadlikowska, comb. Nov.

= Basionym: *Cornutispora ciliata* Kalb, in Gierl & Kalb, Herzogia 9(3-4): 632 (1993)

Conidiomata immersed, black. **Conidia** Y-shaped, hyaline, 10.0 × 7.0 µm, composed of strongly swollen and apically cilate arms, with non-evident main axis, 6.5–9.0 × 2.0–2.5 µm. **Host**: *Dibaeis cretacea* and reported from a number of other hosts (Flakus et al. 2019, Diederich et al. 2018).

The characteristic of this species is conidia like the shape of Y. The main axis of the conidia is not clear and has a ciliated arm at the tip. It is known to parasitize various lichens (Flakus et al. 2019, Diederich et al. 2018). Japanese records were reported by Zhurbenko et al. (2015).

Spirographa fusisporella (Nyl.) Zahlbr., in Engler & Prantl, Nat. Pflanzenfam., Teil. I (Leipzig) 1: 96 (1903)

Ascomata subspherical to flattened, superficial, opening by a pore, become brown disc margin, dark brown, 80.0–200 µm diam. **Hymenium** hyaline, 50.0–65.0 µm tall. **Periphysoids** indistinct. **Paraphyses** filiform, simple or rarely branched, septate, hyaline, 1.0–2.5 µm diam. **Hypothecium** absent. **Asci** elongate clavate to subcylindrical, K/I–, 16–32-spores, 47.0–55.0 × 5.5–12.0 µm. **Ascospores** acicular, helicoid, 1-septate, not constricted at septum, both cells equal in length, smooth, hyaline, 22.0–31.0 × 1.0–2.5 µm. **Host**: *Fuscidea* species, *Graphis* species, *Haematomma* species, *Lecanora* species, *Lobaria* species, *Melanelia* species, *Ochrolechia* species, *Parmelina* species, *Peltigera* species, *Pertusaria* species, *Phlyctis* species, *Platismatia* species, *Porpidia* species, *Pseudocyphellaria* species, *Rinodina* species and *Xylographa* species (Diederich et al. 2018, Nash et al. 2004).

This species produces a flat, dark brown ascomata on the surface of the host. The characteristic of this species is that there are many spores (16–32-spores) in the ascus. It is also characteristic that the spores are acicular, 1-septate, and colorless. It is known to parasitize a wide range of crustose lichens and foliose lichens (Diederich et al. 2018, Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Spirographa herteliana (Knoph.) Flakus, Etayo & Miadlikowska, comb. nov. Notes. *Lecidella cf. elaeochroma* (Knoph 2004).

= Basionym: *Cornutispora herteliana* Knoph, Biblthca Lichenol. 88: 346 (2004)

Conidiomata immersed, black. **Conidia** Y-shaped, hyaline, 10.5–15.5 × 7.0 µm, composed of the main axis, 10.0–11.0 × 2.0–3.0 µm, and 3.0–5.0 µm long conidial arms. **Host**: *Lecidella* species (Flakus et al. 2019).

The characteristic of this species is conida shaped like Y. The conidia have a clear main axis and two short arms are extended. Also, as a characteristic of this species, it parasitizes lichens of the genus *Lecidella* (Flakus et al. 2019, Diederich et al. 2018).

Spirographa lichenicola (D. Hawksw. & Sutton) Flakus, Etayo & Miadlikowska, comb. nov.

= Basionym: *Cornutispora lichenicola* D. Hawksw. & B. Sutton, in Hawksworth, Trans. Br. mycol. Soc. 67(1): 51 (1976)

[Fig. 51]

Conidiomata immersed, black, 100–200 µm diam. **Conidia** Y-shaped, hyaline, 10.0–14.0 × 7.0–9.0 µm. composed of a larger main axis, 6.0–11.5 × 1.5–2.0 µm, and two

smaller arms 2.5–6.0 × 0.5 µm. **Host**: *Parmelia sulcate*, various lichens (Flakus et al. 2019, Diederich et al. 2018).

The characteristic of this species is conidia shaped like Y. The conia has a clear main axis and is large, with two short arms extending. In addition, it is known that this species parasitizes various lichens, mainly the genus *Parmelia* (Flakus et al. 2019, Diederich et al. 2018). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. SWEDEN. Västmanland: Arboga par., near the cemetery of Skogskyrkogården (c. 2.5 km SSE of the centre of the city). 59°22'N 15°51'E. On twigs of birch in a thin, mixed forest. On *Cetraria sepincola* (apothecia). July 17, 1990 (Santesson: Fungi Lichenicoli Exs. 161, TNS).

Stenocybe pullatula (Ach.) Stein, in Cohn, Krypt. - Fl. Schlesien (Breslau) 2(2): 298 (1879)

Either saprobic or parasitic (Tibell and Thor 2003). Although it is on the Japanese lichen and lichenicolous fungi checklist (Ohmura and Kashiwadani 2018), it is not on the global checklist (Nash et al. 2004), so it is not a lichenicolous fungi. Japanese records were reported by Tibell and Thor (2003).

Ascomata apothecia, developed narrowly obconical to cup-shaped, dark brown to black, shiny, 0.19–0.70 mm tall. **Stalk** forked to multi-branched, black, 0.07–0.08 mm diam. **Exciple** brown, 8.0–11.0 µm thick. **Capitulum** lenticular to elongated, cup-shaped, 0.08–0.15 mm wide. **Epithecium** dark, 4.0–6.0 µm thick. **Hypothecium** hyaline, hyphae 1.5–2.0 µm diam. **Asci** narrowly cylindrical, 8-spored, 84.0–89.0 × 4.5–6.0 µm. **Ascospores** narrowly ellipsoid, straight or slightly curved, 1−3 septate, pale gray to brown, (11.0–)17.0(–19.0) × 3.0–5.0 µm (Diederich et al. 2018, Nash et al. 2004).

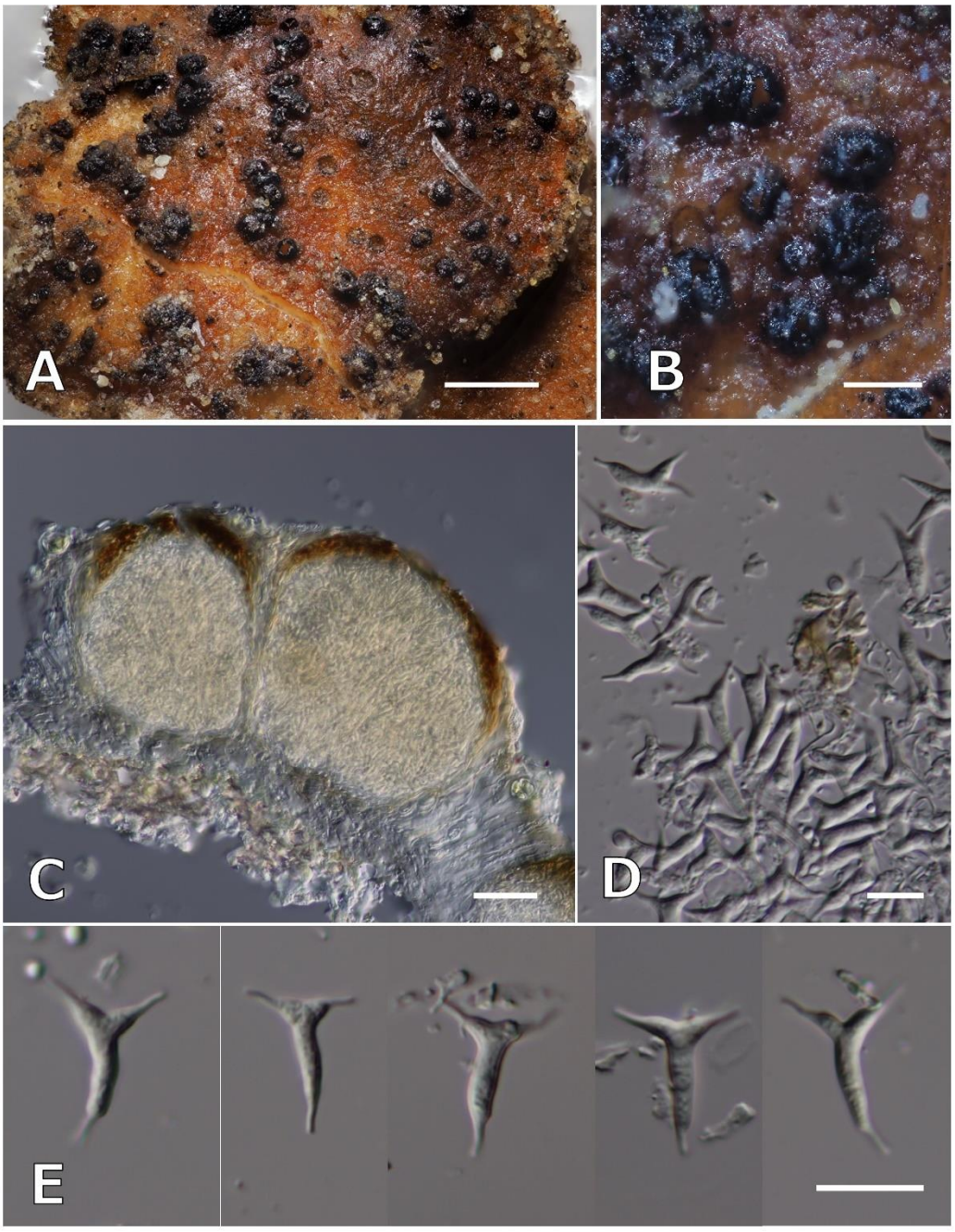

Fig. 51. *Spirographa lichenicola* (D. Hawksw. & Sutton) Flakus, Etayo & Miadlikowska, comb. nov. (R. Santesson: Fungi Lichenicoli Exsiccati 161, TNS). A. Growth habit. B. Conidiomata. C. Cross section of conidiomata. D-E. Conidia. Scale bars: A=0.5 mm, B＝200 µm, C＝50 µm, D-E＝10 µm.

Stenocybe septata (Leight.) A. Massal., Atti Inst. Veneto Sci. lett., ed Arti, Sér. 3 5: 267 (1860) [1859-1860]

Either saprobic or parasitic (Tibell and Thor 2003). Although it is on the Japanese lichen and lichenicolous fungi checklist (Ohmura and Kashiwadani 2018), it is not on the global checklist (Diederich et al. 2018). Japanese records were reported by Tibell and Thor (2003).

Ascomata apothecia, black, shiny, 1.0–1.7 mm tall. **Stalk** branched once to twice, dark brown, 0.08–0.12 mm diam. **Capitulum** obconical, 0.2–0.3 mm diam. **Epithecium** poorly developed. **Hypothecium** narrowly obconical, dark brown, 140 µm tall. **Excipulum** dark brown. **Asci** narrowly cylindrical, 285–330 × 22.0–27.0 µm. **Ascospores** broadly ellipsoid, smooth, 3-septate, dark to brown, 45.0–60.0 × 20.0–25.0 µm (Tibell and Thor 2003).

Stigmidium species

Ascomata perithecioid, immersed to sessile, stiolate, black. **Ascomatal wall** black or brown. **Hamathecium** periphyses, not branched, present or absent, interascal elements present or absent. **Paraphysoids** with rarely. **Asci** clavate to subcylindrical, ascus wall apically thickened, bitunicate, 4–8-spore. **Ascospores** ovoid, ellipsoid, oblong or fusiform-elongate, 1−3-septate, smooth or slightly warted, hyaline or rarely pale brown to brown when mature, 7.0−23.0 × 2.0−7.5 µm. **Conidomata** pycnidial, immersed. **Conidiomatal wall** dark brown. **Conidiogenous cells** hyaline. **Conidia** hyaline, short bacilliform (Nash et al. 2004).

That circumscriptions are often unclear and require elucidation, because overlapping morphological characteristics regarding to ascomata size, ascospore size and septation. Japanese records were reported by Zhurbenko et al. (2015), Zhurbenko and Ohmura (2019).

Stigmidium alectoriae Linds. ex Etayo, in Etayo & Sancho, Biblthca Lichenol. 98: 236 (2008).

Ascomata round, immersed, black, 55.0−70.0 mm diam. **Ascomatal wall** black to brown, K + greenish brown, 8.0−10.0 µm. thick. **Hymenium** hyaline, KI + violet. Paraphysoid present. **Asci** broadly clavate, upper part slightly widened, K and KI + orange, 27.0−35.0 × 12.0−14.0 µm. **Ascospore** 1-septate, slightly constricted at the septum, hyaline, 11.0−12.5 × 4.0−5.0 µm. **Host**: *Usnea* species (Etayo and Sancho 2008).

Stigmidium arthrorhaphidis Hafellner & Obermayer, Cryptog. Bryol. - Lichénol. 16(3): 186 (1995).

Ascomata spherical, immersed, black, 70.0–85.0 µm. **Ascomatal wall** brown to dark brown, 10.0–25.0 µm thick. **Paraphysoid** absent. **Asci** bulbous to sack shaped, 35.0–40.0 × 10.0–12.0 µm. **Ascospores** obovate, 1-septate, lower cell longer and narrower, hyaline, (10.0–) 11.0–12.0 (–13.0) × 4.0–4.5 (–5.0) µm. **Anamorph** not observed. **Host**: *Arthrorhaphis citronella* (Hafellner and Obermayer 1995).

Stigmidium beringicum Zhurb. & Triebel, Mycol. Progr. 7(3): 142 (2008).

Ascomata perithecioid, immersed, black, glossy, subglobose to pyriform, indistinctly ostiolate, 75.0–100(–150) µm diam. **Peridium** pale brown to dark brown, K–. **Hymenial gel** I–, K/I–. **Ostiolar filaments** poorly developed, branched, usually of 3–5 elongated cells, 10.0–20.0(–30.0) µm tall, thickened apices, 1.0–2.0 µm diam. **Asci** subcylindrical, clavate to obclavate, bitunicate, thickened apex, 8-spored, (40.0–)47.0–60.0(–70.0) × (9.0–)10.0–13.0(–15.0) µm. **Ascospores** hyaline, fusiform, 1-septate, constricted at the septum, upper cell slightly

thicker than the lower cell, smooth, (14.0–)16.0–19.0(–20.0) × (3.5–)4.0–4.5(–5.0) μm. **Anamorph** not observed. **Host**: *Stereocaulon* species (Zhurbenko and Triebel 2008).

Stigmidium congestum (Körb.) Triebel, Mycotaxon 42: 290 (1991)

[Fig. 52]

Ascomata subglobose, 40.0–85.0 × 30.0–77.0 μm diam. **Ascomatal wall** brown to dark brown. **Ascospores** 1–3-septate, finely verruculose, hyaline, (11.0–)12.0–14.0(–16.0) × (2.5–)3.0(–4.0) μm. **Host**: *Lecanora chlarotera* (Hawksworth et al. 2010a).

Exsiccata examined. AUSTRIA. Steiermark, Gleinalpe, 29 km NW of Graz, the valley of Übelbach, Neuhofgraben, c 0.5 km E of Wirthaus Hoyer. 47°14'N 15°08'E. Alt. 840 m. On *Fraxinus excelsior*. On *Lecanora chlarothera* (apothecia). March 28, 1991 (Santesson: Fungi Lichenicoli Exs. 291, TNS).

Stigmidium cupulare (Pat.) D. Hawksw., in Hawksworth & Cole, Mycosystema 22(3): 362 (2003)

= Basionym: *Pharcidia cupularis* Pat., Bull. Soc. mycol. Fr. 18(4): 303 (1902).

Ascomata perithecia, sparse or clustered, superficial, without hairs, flattened, minute papillate-ostiolate, black, bright, 200–400 μm diam, 200 μm tall. **Asci** subclavate, 50.0 × 8.0 μm. **Ascospores** oblong, tapering on both sides, simple, not constricted, hyaline, 13.0–15.0 × 3.0–4.0 μm. **Host**: *Sticta* species (Patouillard 1902).

(https://www.biodiversitylibrary.org/page/34217858#page/333/mode/1up. 2021.10.9)

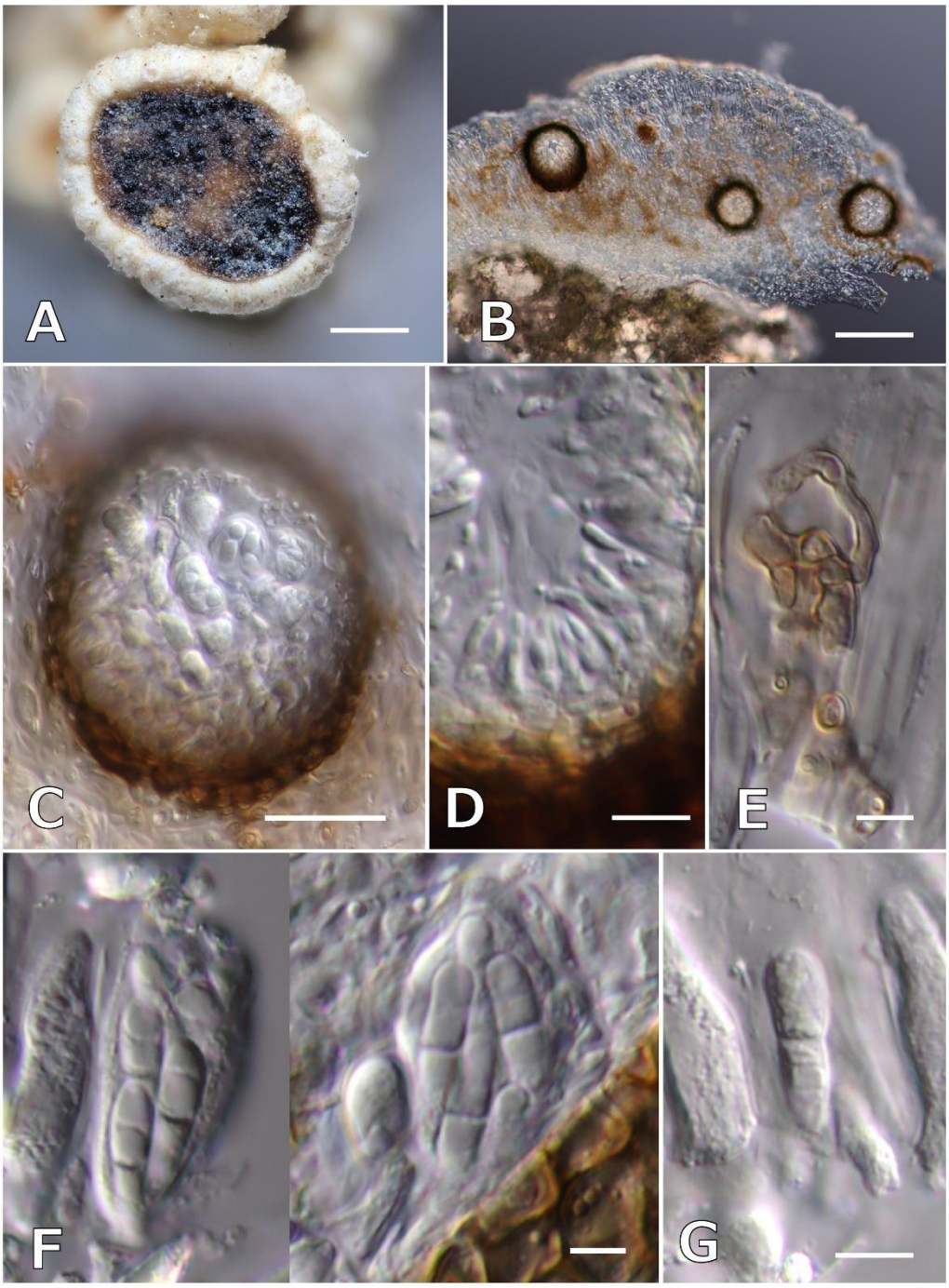

Fig. 52. *Stigmidium congestum* (Körb.) Triebel, Mycotaxon 42: 290 (1991). (R. Santesson: Fungi Lichenicoli Exsiccati 52, TNS). A-B. Growth habit. C. Cross section of an ascomata. D. Hymenium. E. Hyhae. F. Asci and ascospore. G. Ascospore. Scale bars: A=0.3 mm, B=100 μm, C=50 μm, D=10 μm, E-G=5 μm.

Stigmidium ephebes (Henssen) D. Hawksw., Kew Bull. 30(1): 201 (1975).

Ascomata globose to subglobose, 70.0–125 × 60.0–120 µm. diam. **Ascospores** 1-septate, 16.0–20.0 × 4.0–5.0 µm. **Host**: *Ephebe* species (Hawksworth et al. 2010a).

Stigmidium hafellneri Zhurb., Opuscula Philolichenum 6: 110 (2009).

Ascomata perithecioid, subglobose, surface, aggregated, ostiolate, black, shiny, 30.0–50.0 µm diam. **Peridium** brown, K+ grey olive, ca 10 µm thick. **Interascal and ostiolar filaments** absent. **Interascal gel** I–, K/I–. **Asci** bitunicate, lanceolate to narrowly elliptic, 8-spored, (23.0–)26.0–36.0(–40.0) × (6.0–)7.0–9.0(–12.0) µm. **Ascospores** broadly soleiform, (0−)1-septate, constricted at the septum, smooth, hyaline when young, olive brown when mature, (7.0–)7.5–8.5(–11.0) × (2.5–)3.0–3.5(–4.5) µm. **Anamorph** not observed. **Host**: *Nephromopsis cucullata* (Zhurbenko 2009a).

Stigmidium joergensenii R. Sant., Nordic Jl Bot. 9(1): 99 (1989).

Vegetative hyphae very pale brown or hyaline, 1.5–2.0 µm diam. **Ascomata** globose, immersed, numerous, light brown, 30.0–45.0 µm. **Ascomatal wall** light brown above, hyaline below, 5.0–7.0 µm thick. **Asci** broadly clavate, 19.0–27.0 × 11.0–13.0 µm. **Ascospore** subclavate or ellipsoid, the lower narrowed at the tip, hyaline, (8.0–) 9.0–11.5 × 3.5–4.0 µm. **Anamorph** not observation. **Host**: *Agonimia foliacea* (Roux and Triebel 1994).

Stigmidium microcarpum Alstrup & J.C. David, Graphis Scripta 5(2): 100 (1993).

Ascomata embedded in stromatic tissue, composed of brown hyphae, black necrotic patches ca 2 mm. **Asci** (25.0–)32.0(–37.0) × (5.5–)7.0–9.0(–9.5) µm. **Ascospores** hyaline to pale brown, smooth and 0−1-septate, verruculose and 2-septate, (6.5–)6.9–8.3(–9.3) × (2.3–)2.4–3.0(–3.2) µm. **Host**: *Cetraria* species and *Nephromopsis cucullata* (Zhurbenko and Yakovchenko 2014).

Stigmidium microspilum (Körb.) D. Hawksw., Kew Bull. 30(1): 201 (1975)

[Fig. 53]

Ascomata 80–120 µm diam. **Ascomatal wall** brown to dark brown. **Asci** 8-spored. **Ascospores** 1-septate, 14.0–19.0 × 3.0–5.0 µm. **Host**: *Graphis scripta* (Hawksworth et al. 2010a).

Exsiccata examined. AUSTRIA. Burgenland: neigbourhood of Güssing, Natzwald, just SW of Hasendorf. MTB 8963/2. Alt. c. 230 m. On *Carpinus* in a *Quercus-Carpinus* forest. On *Graphis scripta* (thallus). April 18, 1990 (Santesson: Fungi Lichenicoli Exs. 197, TNS).

Stigmidium stereocaulorum Zhurb. & Triebel, Mycol. Progr. 7(3): 143 (2008).

Vegetative hyphae immersed, sparse, pale olive-brown, flexuous, 2.0–5.0 µm diam. **Ascomata** perithecioid, subglobose, dispersed, ostiolate, sessile, glossy, black, (50.0–)75.0(–100) µm diam. **Peridium** olive-brown, K–, 8.0–10.0 µm thick. **Hymenial gel** I–, K/I–. **Periphyses** 4.0–5.0 µm. **Interascal filaments** absent. **Asci** ellipsoid to clavate or subcylindrical, bitunicate, 8-spored, I–, K/I–, (25.0–)32.0–43.0(–50.0) × (9.0–) 10.0–15.0 µm. **Ascospores**

soleiform, 1-septate, slightly constricted at the septum, with upper cell thicker than the lower cell, smooth, hyaline, pale olive when old, (10.0–)12.0–15.0(–17.0) × (3.0–)4.0–4.5(–5.5) μm. **Anamorph** not observed. **Host**: *Stereocaulon* species (Zhurbenko and Triebel 2008).

Stigmidium tabacinae (Arnold) Triebel, Biblthca Lichenol. 35: 236 (1989)

Ascomata 65.0 × 75.0 μm diam. Ascospores 1-septate, hyaline, (10.0–)11.5–12.5(–14.0) × (3.0–)3.5(–4.0) μm. **Host**: *Toninia* species and *Lecania olivacea* (Hawksworth at al. 2010).

Taeniolella diederichiana Etayo & Calat., Lichenologist 37(4): 303 (2005).

Sporodochia densely grouped host lichen, immersed mycelium, black, (30.0–)50.0(–70.0) μm diam. **Conidiophores** mononematous, semi-macronematous, caespitose, erect, branched in the lower part, septate, verruculose wall, brown, 7.0–30.0 × 5.5–7.0 μm. **Conidiogenous cells** monoblastic, 6.5–8.0 × 5.5–6.5 μm. **Conidia** ellipsoid to doliiform, catenate, 0–1(–2)-septate, truncated at the base or at both extremities, thick-walled, verruculose, dark brown, 6.0–14.0 × 5.0–6.0 μm. **Host**: *Placopsis* species (Etayo and Calatayud 2005).

This species is characterized by dense black hyphae forming sporodochia. The conidia are ellipsoid, dark brown, 0–1 (–2) –septate (Etayo and Calatayud 2005). Japanese records were reported by Zhurbenko et al. (2015).

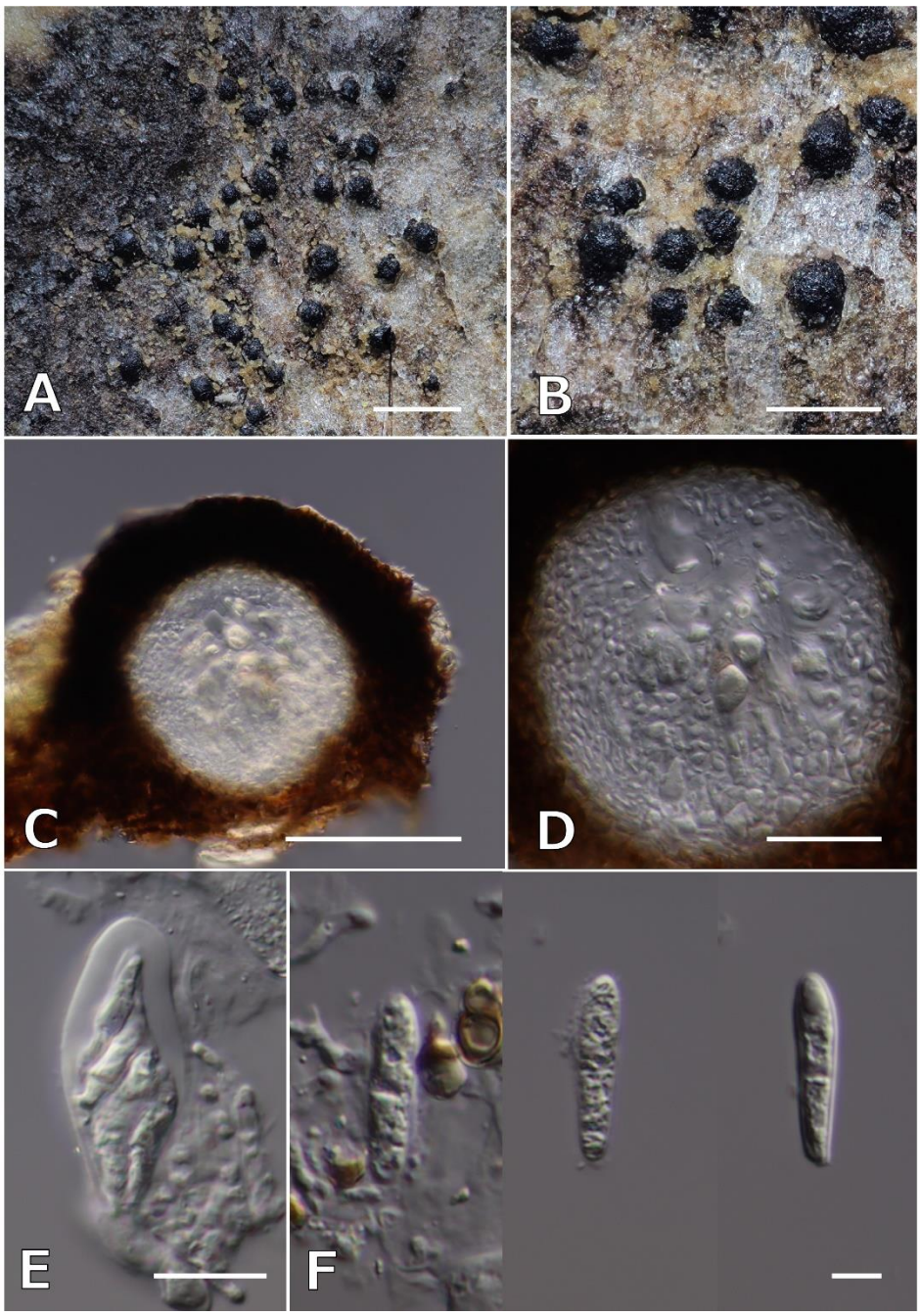

Fig. 53. *Stigmidium microspilum* (Körb.) D. Hawksw., Kew Bull. 30(1): 201 (1975). (R. Santesson: Fungi Lichenicoli Exsiccati 197, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Hymenium. E. Ascospore. Scale bars: A=0.3 mm, B=200 μm, C=50 μm, D=20 μm, E=10 μm, F=5 μm.

Talpapellis beschiana (Diederich) Zhurb., U. Braun, Diederich & Heuchert, in Heuchert, Braun, Diederich & Ertz, Fungal Systematics and Evolution 2: 231 (2018).

Colonies effuse, caespitose, dark brown to black. **Conidiophores** cylindrical, erect, straight to slightly flexuous, unbranched, aggregations, simple to 1–8-septate, smooth to irregularly verruculose, brown to dark brown, 11.0–70.0 × 3.0–6.0 µm. **Conidiogenous cells** annellations. **Conidia** ellipsoid to subcylindrical or lemon-shaped, chains, simple or 1-septate, smooth to irregularly verruculose, truncated at base, pale brown, (4.0–)13.0 (–15.0) × (2.0–)5.0 (–5.5) µm. **Host**: *Cladonia* species (Heuchert et al. 2014, 2018).

In this species, black hyphae grow from the host lichen and become colonies. Characteristically, conidiophores are simple to 1–8-septate. Conidia are ellipsoid, light brown, simple or 1-septate, linked in chains. This species parasitizes the genus *Cladonia* (Heuchert et al. 2014, 2018). Japanese records were reported by Zhurbenko and Ohmura (2019).

Tremella phaeophysciae Diederich & M.S. Christ., in Diederich, Biblthca Lichenol. 61: 142 (1996).

Basidiomata olive to brown, sometimes reddish brown, flat to slightly convex gall, 0.4–2.0 mm diam. **Mother cell** ellipsoid to subspherical, 3.0–4.0 × 2.5–3.0 µm. **Basidia** 2-celled, 1-septate, 15.0–27.0 × 4.5–8.0 µm. **Basidiospores** subspherical to ellipsoid, 6–8 × 5.5–7.5 µm. **Host**: *Phaeophyscia* species (Nash et al. 2004).

When parasitized by this species, a large number of light brownish to dark brown galls are formed on the lichen body. Galls vary in size. Also, as a characteristic of this species, it parasitizes lichens of the genus *Phaeophyscia* (Nash et al. 2004). Japanese records were reported by Zhurbenko et al. (2015).

Zwackhiomyces berengerianus (Arnold) Grube & Triebel, in Grube & Hafellner, Nova Hedwigia 51(3−4): 308 (1990).

Ascomata perithecioid, pyriform, superficial, 125−180(200) µm diam. **Hamathecium** present. **Asci** 6(−8)-spore. **Ascospores** 1-septate, hyaline, pale brown at mature, verruculose, 17.0−24.0(−27.0) × 5.0−8.0(−10.0) µm. **Host**: *Lecidea berengeriana, Mycobilimbia berengeriana* (Grube and Hafellner 1990).

This species has a pear-shaped ascomata on the surface of the host's lichen. This species is characterized by 1-septate, colorless to light brown, verruculose spores. In addition, this species is characterized by parasitizing crustose lichen such as the genus *Lecidea* and the genus *Mycobilimbia* (Grube and Hafellner 1990). Japanese records were reported by Zhurbenko and Ohmura (2019).

Zwackhiomyces cf. kantvilasii S.Y. Kondr., Muelleria 9: 98 (1996)

Japanese material: **Asci** 4−8-spore. **Ascospore** (10.4−)11.6−14.2(−15.3) × (4.3−)4.8−5.8(−6.2) µm. Protologue: **Asci** 4-spore. **Ascospore** 14.5−18.0 × 3.5−4.0(−5.5) µm. **Host**: *Parmotrema* species (Zhurbenko et al. 2015). Japanese records were reported by Zhurbenko et al. (2015).

Zwackhiomyces martinatianus (Arnold) Triebel & Grube, in Grube & Hafellner, Nova Hedwigia 51(3–4): 322 (1990)

[Fig. 54]

Ascomata globose, immersed in clusters in small galls, black, (75.0−)100(−125) µm

diam. **Peridium** dark brown, 10.0−20.0 (−25.0) µm thick. **Interascal tissue** pseudoparaphyses, branched to anastomosed, 1.0−2.0 µm diam. **Asci** cylindrical to clavate, fissitunicate, short-stalked, (6−) 8-spored, (45.0−) 50.0(−70.0) × 8.0−12.0 µm. **Ascospores** ellipsoid to clavate, 1-sptate, with upper cell thicker than the lower cell, smooth, hyaline to pale brown, (11.0−)14.5 (−16.0) × 3.5−5.5 µm. **Conidiomata** pycnidia, globose, ca 70 µm diam. **Conidiomatal wall** brown, 10.0−15.0 µm thick. **Conidiogenous cells** flask-shaped, ca 7.5 × 3.0 µm. **Conidia** cylindrical, hyaline, 3.0−5.0 × 1.0 µm. **Host**: *Porpidia* species (Ertz et al. 2008, Grube and Hafellner 1990, Triebel 1989).

This species is characterized by the dense ascomata of globose, which forms a gall. Ascomata is dark brown with a clear hyphal tissue inside. The spores are ellipsoid, 1-septate, and the upper cells are larger than the lower cells and are characterized by being colorless to light brown (Ertz et al. 2008, Grube and Hafellner 1990, Triebel 1989). Japanese records were reported by Zhurbenko et al. (2015).

Exsiccata examined. AUSTRIA. Steiermark: Grazer Bergland, the road from Semriach, S. Rechbergdorf. Alt. c. 930 m. On a W-exposed slope. On small stones. On *Porpidia crustulata* (thallus). January 21, 1990 (Santesson: Fungi Lichenicoli Exs. 250, TNS).

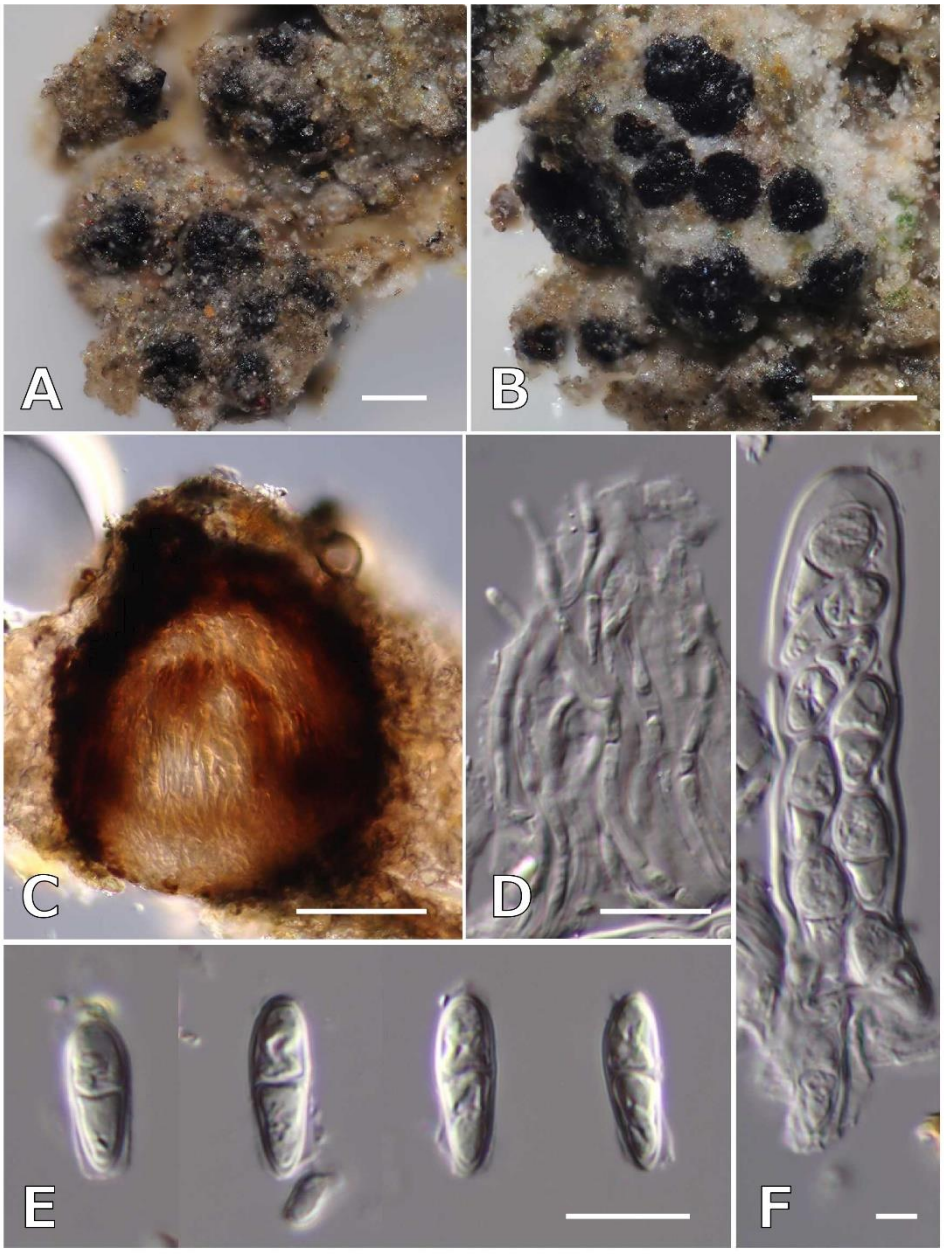

Fig.54. *Zwackhiomyces martinatianus* (Arnold) Triebel & Grube, in Grube & Hafellner, Nova Hedwigia 51(3–4): 322 (1990). (R. Santesson: Fungi Lichenicoli Exsiccati 250, TNS). A. Growth habit. B. Ascomata. C. Cross section of an ascomata. D. Paraphyses. E. Ascospore F. Asci and ascospore. Scale bars: A-B=100 µm, C=50 µm, D-E=10 µm, F=5 µm.

4–3. Discussion

In this chapter, 141 species of Japanese lichenicolous fungi were investigated through literature research. The Japanese lichen checklist used in this study also includes fungi related to lichens (Ohmura and Kashiwadani 2018) that can be mistaken for lichenicolous fungi. This checklist was checked against the global lichenicolous fungi checklist (Diederich et al. 2018). As a result, some of the checklist types from Japan deviated from the concept of lichenicolous fungi (lichenicolous fungi are defined as organisms other than lichens that are "parasitic and endogenous to lichens"). Notably, some of them grow on lichens, some fungi that parasitize lichens are excluded from this definition, and some are not included in the global lichenicolous fungi checklist.

The species listed as Japanese, but were not exactly lichenicolous fungi, are listed below. *Agyrium rufum* is said to have a saprophytic feature, and *Chaenothecopsis sanguinea* was confirmed on the tree *Nothofagus*. *Clathroporina japonica* is said to be a Japanese lichenicolous fungus; however, it is not on the global checklist. *Epigloea soleiformis* is considered a lichenicolous fungus, but it has also been found on bryophytes and is no longer considered a strict lichenicolous fungus. *Leptosphaeria akagiensis* has very few collection records, and its actual condition is unclear, but it is not a strict lichenicolous fungus because it is both parasitic and saprophytic, according to the description. *Milospium planorbis* has been removed from the lichenicolous fungi category because it has also been found on trees. *Sarcogyne lapponica* is considered a lichen and has been removed from the global checklist. *Stenocybe pullatula* and *S. septata* are not strict lichenicolous fungi because they have both parasitic and saprophytic characteristics.

In light of this, it may be excluded from the category of lichenicolous fungi due to the

discovery of new epiphytes and the review of life history. Thus, further investigation and reexamination are necessary even for known species. In addition, some species of lichenicolous fungi from Japan are distributed in areas of high latitude, some species are distributed in subtropical regions, and a wide variety of species are expanding their range. Consequently, there is a high possibility that further investigation and reexamination will lead to the discovery of new biological resources.

Chapter 5

Comprehensive consideration

In previous studies, 14 species were new recorded in Japan, and one new species was described. The morphological and anatomical characteristics of 159 species of Japanese lichenicolous fungi were organized in this study. There were some species with slight morphological differences between the Japanese and foreign species, but these were considered regional variations. However, because collecting samples facilitates the recognition of clear differences between species, and may lead to the discovery of new species, continuous research is required.

Abrothallus parmeliarum is a species that is widely distributed worldwide, with records in the Eurasian continent of East Asia and Western Europe, as well as in North and South America. *Arthonia digitatae*, *Reconditella physconiarum*, *Stigmidium subcladoniicola*, and *Vouauxiella lichenicola* were recorded in the Northern Hemisphere. Moreover, *Illosporium carneum* was not only recorded in the Northern Hemisphere, such as the western part of the Eurasian continent (including West Asia, Europe, and the North American continent), but it was also recorded in New Zealand in the Southern Hemisphere. *Lichenopuccinia poeltii* is distributed in the high latitudes of Europe and North America, and the only record from Asia thus far is from Taymyr in Russia, which is close to the Arctic region. Therefore, this was the first confirmation from East Asia, and it was found that lichens in the high latitudes of the Northern Hemisphere also grow in high-altitude areas in Japan. *Ovicuculispora parmeliae* also has a wide area of distribution as it has been recorded to occur from the Eurasian continent to the Americas with differences in the size and morphology of ascospores in each region, suggesting the existence of inclusion species.

As mentioned above, species distributed in the high latitudes of the Northern Hemisphere and those distributed in the Southern Hemisphere also grow in Japan. This is because Japan is a long and narrow archipelago extending 3,000 km from north to south and has a variety of environments such as mountainous areas, alpine areas, subtropical areas, cold temperate zones, deciduous forests, and evergreen forests. Therefore, there are still new species, including those new to Japan, and they may have useful new biological resources.

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摘要

地衣類は菌類と藻類の共生生物であり，世界で約 30000 種，日本で約 1800 種確認されている．地衣生菌は，地衣類をおもな宿主とし，内生または寄生する菌群である．寄生性のあるものは世界で約 2000 種の確認されており，日本からは約 150 種が報告されているが，地衣生菌が重点的に研究されている海外諸国と比較すると，日本での地衣生菌相はまだ 40%程度しか分かっていないとされている．本研究では，日本産地衣生菌相の解明を目的とした各調査と，日本産既知種を体系的にまとめることを目的とした.

国立科学博物館に収蔵されているアカサビゴケ属 *Xanthoria* とオオロウソクゴケモドキ属 *Rusavskia* の標本 42 点，ニクイボゴケ属 *Ochrolechia* 標本 729 点を対象に標本調査を行なった．その結果，北海道で採集されたオオロウソクゴケモドキ（*Rusavskia elegans*）の標本から，日本新産である *Arthonia molendoi* を確認した．ニクイボゴケ属標本から見つかった，*Lichenodiplis lecanorae*, *Muellerella lichenicola*, *Sphinctrina tubaeformis* の 3 種は日本からの報告がすでにあり，日本新産種である *L. anomala*, *L. ochrolechiae*, *Sagediopsis campsteriana*, *Sclerococcum* cf. *pertusariicola*, *S. glaucomarioides* を確認した.

次に，東日本の山地帯～亜高山帯で調査を実施した．調査対象地は雌阿寒岳（北海道 1499m），赤岳（長野県 2899m），北横岳（長野県 2480m），妙法ヶ岳（埼玉県 1329m）である．その結果，日本新産 8 種 *Abrothallus parmeliarum*, *Arthonia digitatae*, *Illosporium carneum*, *Lichenopuccinia poeltii*, *Ovicuculispora parmeliae*, *Reconditella physconiarum*, *Stigmidium subcladoniicola*, *Vouauxiella lichenicola*, 既知種 1 種 *Pyrenidium actinellum* を確認し，新種 1 種 *Pronectria japonica* を記載した.

文献調査によって 141 種類の日本産地衣生菌の形態，解剖学的特徴について体系

的に整理した．その結果，厳密な地衣生菌の定義から外れる（地衣生菌の定義は「地衣類に特化して寄生・内生する」であり，地衣類以外にも着生するものや，地衣類へ腐生的にはたらく菌類はこの定義から除外される）ものもあり，日本産地衣生菌として認識されてきた種の中には，世界的な地衣生菌のチェックリストから除外された種もあった．このように，新しい着生基物の発見や生活史の見直しにより，地衣生菌のカテゴリーから外されることがおきるため，既知種であっても追調査や再検討が必要であると考えられる．