Lichenicolous fungi from the Holarctic. Part IV: New reports and a key to species on *Dermatocarpon*

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ABSTRACT. – *Endococcus peltigericola* is reported for the first time from North America and *Epigloea urosperma* for the second time. The detection of interascal filaments in *Endococcus peltigericola* indicates that it may belong to the genus *Polycoccum*. *Adelococcus immersus* and *Trematosphaeriopsis parmeliana* are newly reported for Russia, the former is also first documented from the Arctic. The description of *A. immersus*, previously known only from a type specimen, is emended. *Halecania alpivaga* is reported new to the north-central Siberia growing on an unusual host genus (*Dermatocarpon*). A key to the species of lichenicolous fungi growing on *Dermatocarpon* is provided.

KEYWORDS. – Arctic, biodiversity discovery, biogeography, lichen-dwelling fungi, Russia, Sweden, United States of America.

INTRODUCTION

This paper continues the author’s publications on noteworthy finds of lichenicolous fungi from the Holarctic (Zhurbenko 2009a, 2009b, 2020). It is based on collections from Russia, Sweden and the United States of America, mainly from the Arctic regions. In addition to providing new reports, range extensions, taxonomic notes, and illustrations of the species studied, the first key to the lichenicolous fungi growing on species of *Dermatocarpon* Eschw. is presented.

MATERIALS AND METHODS

Microscopy and imaging were undertaken using a Stemi 2000-CS stereomicroscope and a Zeiss Axio Imager A1 compound microscope with Nomarski interference contrast, fitted with an AxioCam MRc5 digital camera. Microscopic characters were studied from hand-made sections produced using a razor blade and then mounted in water, a 10% aqueous solution of potassium hydroxide (K), Lugol’s Iodine solution, directly (I), and after KOH pre-treatment (K/I). Measurements were taken from water mounts and rounded to the nearest 0.5 μm. The length, width, and length/width ratio (l/w) of ascospores are given as (min–) (x̄−SD)–(x̄+SD) (−max), where ‘min’ and ‘max’ are the extreme values observed, ‘x̄’ the arithmetic mean, and ‘SD’ the corresponding standard deviation. Colours were determined according to the tables of Kornerup and Wanscher (1978). Voucher specimens are deposited in LE and UPS.

RESULTS

*Adelococcus immersus* Etayo & Breuss

NOTES. – The examined material generally fits the protologue (Etayo & Breuss 1998), including the ascospore size, (9.5–)12.5–16.5(–20) × (5.5–)6.5–8.5(–10) μm, l/w = (1.2–)1.6–2.4(–3.2) (n = 90)

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**Figure 1.** *Adelococcus immersus* growing on *Dermatocarpon miniatum var. complicatum* (from Zhurbenko 0777). A, habitus of ascomata. B, lateral exciple in cross-section in water. C, asci and ascospores in water. D, asci and ascospores in I. E, asci and ascospores in K/I. Scale bars: 200 µm in A, 10 µm in B–E.

versus 13–18(–20) × 7–8(–9.5) µm. However, the perithecia are often almost superficial, aggregated to occasionally concrecent, black, rather glossy, subglobose to occasionally broadly ovoid, with a brown exciple, 150–320 µm in diameter, and with ostioles 20–30 µm in diameter. In contrast, the protologue describes the perithecia as completely immersed, ovoid, up to 220 µm in diameter, and with a colourless exciple. It is likely that the discrepancy in reported excipular pigmentation relates to the degree of immersion of the perithecia wherein less immersed areas of the perithecia are exposed to sunlight, causing the exciple to become brown pigmented. Additionally, the hymenial gel is not I− as was described in the protologue, but instead is I+ pastel red, which is typical for *Adelococcus* Theiss. & H. Sydow (Hafellner 2004a). The ascospores are also not always ellipsoid as was described in the protologue, but occasionally can be subglobose, slightly curved and/or attenuated at one end, very rarely aseptate. They are also finely verruculose (described as “smooth or very weakly ornamented” in the protologue), which is best seen using the Nomarski interference contrast.

This species was previously known only from the type specimen collected in Turkey on *Dermatocarpon biennense* Zsch. (Etayo & Breuss 1998), a species close to *D. miniatum* (L.) W. Mann

(Breuss & John 2004). Here it is reported for the first time from Russia and the Arctic, and *D. miniatum* var. *complicatum* (Lightf.) Th. Fr. is a new host. As an aid in the identification of this and other lichenicolous fungi on *Dermatocarpon*, a key to the fungi known from the host is presented here (see Appendix).

Specimens examined (both on thalli of *Dermatocarpon miniatum* var. *complicatum*) – RUSSIA.

**KRASNOYARSK TERRITORY:** Taimyr Peninsula, Byrranga Mountains, N of Levinson-Lessing Lake, 74°31′N, 98°36′E, elev. 300 m, rocks in tundra, 24.vii.1995, M.P. Zhurbenko 95605 (LE 310199); Taimyr Peninsula, Byrranga Mountains, W of Levinson-Lessing Lake, 74°30′N, 98°30′E, elev. 120 m, rocks in tundra, 27.viii.1995, M.P. Zhurbenko 95604 (LE 310200).

*Endococcus peltigericola* Zhurb. & Stepanchikova

**Figure 2.**

*Notes.* This fungus is characterized by superficial perithecioid, brown to blackish ascomata, sometimes with indistinct interascal filaments, the presence of conidia, and its confinement to species of *Peltigera* Willd. The examined material fits the protologue (Zhurbenko et al. 2012), including its brown to blackish superficial ascomata (45–)50–80–(90) µm in diameter (n = 21), asci that are 33–45 × 9.5–10 µm (n = 8), ascospores that are (9.5–)10–12(–12.5) × (3.5–)4–4.5(–5) µm, l/w = (2.0–)2.3–2.9(–3.2) (n = 27),
Figure 3. *Epigloea urosperma* growing on *Placynthiella icmalea* (from Magnusson 12934). A, habitus of ascomata. B, asci and ascospores in K/I. Scale bars: 200 µm in A, 10 µm in B.

and conidia that are aseptate, pale brown, ellipsoid, oblong or broadly clavate, often somewhat truncated at the base, 5–6.5 × 2.5–3.5 µm in size. The presence of branched interascal filaments reported in this species by Zhurbenko and Vershinina (2014) is also confirmed here, which suggests it belongs to the genus *Polycoccum* Körb. Compared with the other species of *Polycoccum* that grow on *Peltigera*, *E. peltigericola* is quite similar to *P. superficiale* D. Hawksw. & Miądl. also characterized by superficial ascomata, which are unusual for the genus, and is known from Finland, Germany, Poland, Asian and European parts of Russia, and Sweden (Czyżewska 2003, Hawksworth & Miądlikowska 1997, Puolasmaa et al. 2012, Zhurbenko & Vershinina 2014). However, according to the protologue (Hawksworth & Miądlikowska 1997) and the description in Zhurbenko and Vershinina (2014), the latter species differs in having larger asci, (43–)50–64(–73) × (12–)14–17(–20) µm, and ascospores (10.5–)13.5–17(–19) × (5–)5.5–7(–8.5) µm. Further studies are needed to determine whether these taxa are conspecific. Until this issue is resolved, I prefer not to change the generic position of *E. peltigericola*.

This species was previously known only from the type specimen collected in the Kamchatka Territory of Russia growing on *Peltigera membranacea* (Ach.) Nyl. (Zhurbenko et al. 2012) and is newly reported here for North America. *Peltigera aphthosa* (L.) Willd. is a new host species.

**Specimen examined.** – **U.S.A. ALASKA. INTERIOR:** ca. 50 km ENE of Fairbanks, Caribou-Poker Creeks Watershed, *Alnus crispa-Betula papyrifera-Populus tremuloides* forest, 65°10.133′ N, 147°30.241′ W, elev. 305 m, on *Peltigera aphthosa* (cephalodia, mainly fringing their margins; thallus), 26.viii.2000, **M.P. Zhurbenko 0091** (LE 310184).

**Epigloea urosperma** Döbbeler

**Notes.** – According to Döbbeler (1994), this fungus is characterized by immersed to superficial perithecia that are minute, inconspicuous, blackish, glabrous, glossy, subglobose, usually with a well-developed depression around the ostiole, 60–150 µm in diameter, and with a thin, light brown, gelatinous exicle consisting of periclinaly-oriented hyphae. The paraphyses are filiform, simple or rarely branched, not capitated at the apex, and surrounded by gelatinous sheaths. The asci are elongate-clavate, short-stalked, rounded at the apex, without any distinct apical apparatus, discharging by longitudinal splits, mostly 32-spored, with I+ and K/I+ evenly blue wall. The ascospores are hyaline, narrowly ellipsoid, 5–9 × 2–2.5 µm, 1-septate, smooth-walled, non-halonate, irregularly arranged in the ascus, and with thread-like appendages at both ends that are up to 6 µm long. The specimens cited here match these characters.

The species was previously known from Africa (Republic of Seychelles; Diederich et al., 2017), Asia (Russia; Urbanavichus et al. 2020), Europe (Austria, Czech Republic, England, Estonia, Finland, Germany, Luxembourg, Poland, Slovakia, Spain, Sweden, Switzerland; Brackel 2014, Diederich et al. 2012, Döbbeler 1994, Kukwa & Flakus 2009, Maliček et al. 2018, Myllys & Launis 2018, Pérez-Ortega & Barreno 2006, Suija et al. 2007, Vondrák et al. 2015), North America (U.S.A.; Spribille et al. 2020) and South America (Bolivia; Flakus & Kukwa 2012) where it grows on *Placynthiella dasaea* (Stirt.) Tönsberg.

Notes. – Information on the biology of this species is somewhat contradictory. According to Fletcher and Coppins (2009) it is a lichen, that grows on calcareous rocks in arctic-alpine environments of

and *P. uliginosa* (Schrad.) Coppins & P. James (the latter is the host of the type specimen). Here it is reported for the second time from North America based on a second collection from Alaska. As the species is only known from a small number of occurrences in Sweden, an additional specimen located while studying material at UPS is included here.


*Halecania alpivaga* (Th. Fr.) M. Mayrhofer

**Figure 4.**
the Holarctic. However, Poelt and Mayrhofer (1988) cited it as an example of a cyanotrophic lichen growing on saxicolous cyanolichens of the genus Placynthium (Ach.) Gray or on free-living cyanobacteria of the genera Stigonema Bornet & Flahault and Gloeocapsa Kützing. It was also reported growing on species of Physcia (Schreb.) Michx. (Mayrhofer 1987, Poelt 1958, Santesson et al. 2004), Collema Weber ex F.H. Wigg. agg., Dermatocarpon and Toninia A. Massal. (Rambold & Triebel 1992). As the specimen reported here was found on an unusual host, namely on D. miniatum var. complicatum, which is lichenized with green algae, a brief description is given below. This is the first report of the species from north-central Siberia (Kotlov 2003, Zhurbenko 2009a).

DESCRIPTION. – Lichenized thallus indistinct. Apothecia sessile, constricted at the base, 370–620 µm in diameter, disc dark brown, ± flat, thalline margin medium brownish orange to pale orange, mostly prominent, 50–100 µm wide, 100–180 µm thick, in cross-section with brown outer edge 20–30 µm wide; aggregated, occasionally contiguous. Hypothecium colourless, 100–150 µm tall, composed of isodiametric or slightly elongated, thick-walled cells. Hymenium 60–100 µm tall, including epihymenium 15–20 µm tall, not inspersed, colourless except for the brown, K− epihymenium, I+ and K/I+ blue. Paraphyses filiform, 1.5–2 µm in diameter, often with swollen brown apices, 3.5–6.5 µm in diameter, occasionally branched. Ascii of Catillaria-type, with amyloid tholus without axial structures, with amyloid outer coat, elongate clavate, (49–)53–60–(61) × (9.5–)10.5–12.5–(14) µm (n = 11), 8-spored. Ascospores colourless, very narrowly obovate (wider above), 1-septate, not constricted at the septum, (13–)13.5–16.5–(18) × (4–)4.5–(6–6.5) µm, l/w = (2.2–)2.5–3.5–(4.6) (n = 24), guttulate, with perispore clearly visible in K, ca. 2 µm thick (in K), irregularly biseriate in the ascus.

Specimen examined. – RUSSIA. KRAСNOYАRSK TERRITORY: Severnaya Zemlya Archipelago, Bol’shevik Island, near western coast of Akhmatov Bay, 10 km S of the Bazovaya River mouth, 79°03’N, 102°42’E, elev. 60 m, polar desert, semi-dried bed of a stream, on thallus of Dermatocarpon miniatum var. complicatum growing on rock, 16.vii.1996, M.P. Zhurbenko 961034 (LE 310198).

Trematosphaeriopsis parmeliana (Jacz.) Elenkin

FIGURE 5.

NOTES. – This fungus is characterized by its occurrence on Xanthoparmelia (Vain.) Hale, pseudothecia that are completely immersed in bullate galls, a hyaline to pale brown upper exciple, simple to occasionally septate, apically not swollen interascal filaments, I− and K/I− hymenial gel, fissitunicate, subcylindrical, 8-spored, I− and K/I− asci, and ascospores that are very narrowly ellipsoid to fusiform, initially smooth and hyaline, finally becoming verruculose and occasionally pale yellow, sometimes halonate, (0–)3-septate, sometimes slightly constricted at the septa (Hafellner 2004b; specimen cited below). It is known from scattered localities in Africa (Canary Islands; Hafellner 2001), Asia (Mongolia; Elenkin 1901, Hafellner 2001), Europe (Austria, Germany, Italy; Brackel 2010; Hafellner 2001, 2004b), North America (Mexico, U.S.A.; Hafellner 2001, 2004b) and South America (Venezuela; Hafellner 2001) and is here newly reported for the Asian part of Russia from the Mongolian border region.

Specimen examined. – RUSSIA. REPUBLIC OF BURYATIA: Dzhida District, Borgoi steppe, 4 km W of Beloozersk, 50°39’N, 105°40’E, elev. 650 m, steppe, on Xanthoparmelia camtschadalis (Ach.) Hale (thallus) growing on soil, 21.vi.2005, M.P. Zhurbenko 0538a (LE 310189a).

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Figure 5. *Trematosphaeriopsis parmeliana* growing on *Xanthoparmelia camtschadalis* (from Zhurbenko 0538a). A, galls with immersed pseudothecia. B, gall with immersed pseudothecia in cross-section in water. C, interascal filaments in K. D, ascospores in water. Scale bars: 1 mm in A, 50 µm in B, 10 µm in C & D.

**LITERATURE CITED**


APPENDIX – KEY TO THE LICHENICOLOUS FUNGI GROWING ON Dermatocarpon

This key was compiled from the literature cited under each species below under ‘Lit.’. References to taxonomic descriptions of the species are given in bold font, those that exclusively related to the occurrence of the species on Dermatocarpon are given in regular font. The names of species that are exclusively or mainly confined to species of Dermatocarpon are given in bold. Lichenized species are denoted by 1. Homostegia dermatocarponis Alstrup & M. Cole and Phaeospora dermatocarponis (R.G. Werner) S.Y. Kondr., reported from species of Dermatocarpon by Alstrup and Cole (1998) and Werner (1963) respectively, are considered to be synonyms of Opegrapha pulvinata Rehm var. pulvinata (Diederich et al. 2018). Non-lichenicolous lichens occasionally found on species of Dermatocarpon (e.g., Agonimia tristica (Nyl.) Zah. fide Hafellner et al. 2005; Myriecles semipallida (H. Magn.) Sliwa, Zhao Xin & Lumbsch fide Poelt et al. 1995, Valadbeigi & Sipman 2010) are not included.

1. Ascomata apothecia .........................................................................................................................................................2

2. Apothecia lirellate, shortly elongate, aggregated in dense clusters; hymenium opening with a slit; ascospores soon becoming light brown, 3-septate, (18–)20–24–(26) × 6–7–(8) µm. Lit.: Ertz & Egea (2007) ................................................................................................................................. Opegrapha pulvinata Rehm var. pulvinata

3. Ascospores mostly or exclusively 3-septate ..........................................................................................................................4

4. Apothecial disc with a bluish-grey pruina, up to 0.5 mm in diameter; hypothecium colourless; ascospores 3-septate, 18.5–23 × 4–4.5 µm. Note. This is a poorly known species described from a find on thallus of Dermatocarpon sp. growing on a calcareous rock in the Kyrgyz Republic. It was characterized as a parasite that does not develop its own thallus, except for the apothecial thalline margin. Lit.: Makarevich (1971)1 Lecania ferganae Oksner

5. Ascospores 0–1-septate, non-halonate ...........................................................................................................................6

6. Apothecia up to 1 mm in diameter, disc brownish or olive-brown, ascospores 9–14 × 5.5–6 µm. Lit.: Poelt (1974), Zhurbenko (2009a) ................................................................................................................................. Lecanora dispersa (Pers.) Sommerf. f. parasita (Wedd.) Harm.

7. Ascospores hyaline, 1-septate, 16–18 × 4.5–5.5 µm. Lit.: Keissler (1930), Santesson et al. (2004)..... 
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Stigmidium stygnospilum (Minks) R. Sant.
7. Ascospores brown, (0–)1 or 3-septate ................................................................................8
8. Ascospores (0–)1-septate, 9.5–20 × 5.5–10 µm. Lit.: Etayo & Breuss (1998), present paper..... 
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Adelococcus immersus Etayo & Breuss
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Pyrenidium hetairizans (Leight.) D. Hawksw.