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Two new *Bacidia* (Ramalinaceae, lichenized Ascomycota) from Antarctica

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Abstract: Formerly reported as maritime Antarctic *Bacidia* sp. A has been re-named here as *B. chrysocolla* Olech, Czarnota *et* Llop. Another new species, *B. subcoprodes* Olech *et* Czarnota, found in the continental and maritime Antarctic has also been described here. A placement of both taxa within *Bacidia* De Not. is probably tentative because they are not congeneric with the type of this genus, *B. rosella* (Pers.) De Not. Similarities to other *Bacidia* with *Laurocerasi*-brown hypothecium and mostly 3-septate ascospores are discussed.

Key words: Antarctica, lichenized fungi, lichens, Ascomycota, taxonomy, new species.

Introduction

During Antarctic expeditions carried out in the years 1987/1988, 89/90, 91/93 and 2004 by the first author a considerable collection of lichens from the maritime and continental part of Antarctica was assembled. Most of these lichens were subsequently identified and published in several papers (*e.g.* Olech 1989a, b, 1990, 1993, 1994), and also in the first annotated checklist of Antarctic lichens and lichenicolous fungi (Olech 2001). Specimens of *Bacidia* with dark brown hypothecium and 3-septate spores were classified as *B. trachona* (Ach.) Lettau, same as it was done by the majority of Antarctic lichenologists (see Olech 2001). However, recently S. Ekman suggested that these specimens probably do not represent *B. trachona* (see Øvstedal and Lewis Smith 2001). Despite of these remarks the nomenclature amendments were not introduced, and in the subsequent lists of Antarctic lichens the specimens in question were listed as *Bacidia* sp. (Øvstedal and Lewis Smith 2001; Olech 2004). Llop and Ekman (2007) preparing a taxonomic revision of *B. trachona* came to the conclusion that one of those maritime Antarctic samples [R.I.L. Smith 3836 (AAS)], represents the recently resurrected *B. coprodes* (Körb.) Lettau, which

was up to date invalidly synonimized with *B. trachona*. Others are still waiting for description.

In this work we describe two new species of *Bacidia* from Antarctica; one with the features corresponding to *Bacidia* sp. (according to Øvstedal and Lewis Smith 2001) from maritime area, and the other resembling *B. coprodes*, found also on the continental Antarctica.

Material and methods

All samples have been collected from rocky, siliceous substratum in deglaciated coastal rocks or nunataks of maritime and continental Antarctica, respectively. They are stored in the herbarium of the Jagiellonian University in Kraków (KRA).

The identification was based on the comparison with reference material from Italy and Spain [stored in the herbarium of the University of Barcelona (BCN)] checked by Llop and mentioned in the list of re-established *B. coprodes* samples in Llop and Ekman (2007). The nomenclature of other species follows Olech (2004).

The species

Bacidia subcoprodes Olech *et* Czarnota sp. nov.
(Fig. 1A–D)

Diagnosis: *Species haec Bacidiae coprodi similis sed paraphysibus ramosis, nonnumquam anastomosantibus, pycnidiis interdum suppetentibus, parvulis immersisque, conidiis brevioribus, 8–10 × 0.7 µm, filiformibus, plerumque strictis recedit.*

Holotype: Continental Antarctica, Queen Maud Land, Schirmacher Oasis, 70°45'48.1"S, 11°43'00.9"W, alt. 124 m, 4 Jan. 2004, leg. M. Olech (KRA 8581).

Description. — *Thallus* thin, scurfy granular to almost scurfy areolate, cream to ochre, without distinct cortex, K–, C–, Pd–. *Photobiont* chlorococcoid, 8–12 µm diameter *Apothecia* sessile, 0.2–0.4 mm diameter, grey-black to brown-black, sometimes bluish tinged, older constricted at the base, at first simple but later often grouped in small clusters or ±tuberculate; immarginate when ±globose or margin concoloured with the disc. *Excipulum* distinctly developed, at least in young apothecia, *ca* (30–)50–70 µm wide, later sometimes reduced; only in upper part brown inside (concoloured with hypothecium), beyond this usually outer part at least in 1/4 length from the upper edge persistently ±blackish-grey, K ±purplish black, sometimes also paler (greyish in specimens from the continental part; it depends also on section thickness); hyphae anastomosing, not separating in KOH, lumina 2.5–3.5 µm wide. *Hypothecium* fuscous-brown, 100–120 µm wide, K– or dulling, but sometimes, around yellowish brown, K+ intensive yellow. *Hymenium* 60–70 µm tall, hyaline without distinct epihymenium, but sometimes upper part with greyish-green to greenish-blue tinge confined to gel-matrix, K–, HCl+ purplish (*Bagliettoana*-green sensu Meyer and Printzen 2000). *Paraphyses* usually slightly

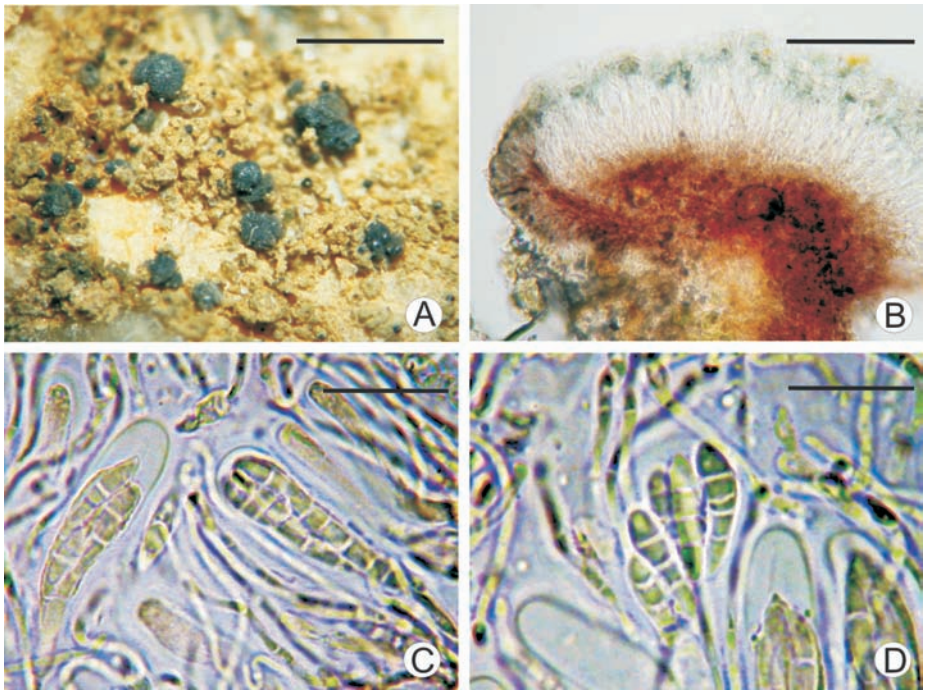

Fig. 1. *Bacidia subcoprodes* Olech *et* Czarnota (holotype): A – morphology; B – apothecial section; C – asci with ±paralelly distributed spores; D – straight and slightly curved ascospores. Scale bars: A – 1 mm; B – 100 µm; C and D – 10 µm.

curved and often branched, and especially close to excipulum anastomosed, 1.3–1.8 µm wide, multiseptate, some of them wider above, up to 2.5 µm, and usually forked in epihymenium. *Asci Bacidia*-type, 30–40 × 8–10 µm wide. *Ascospores* oblong fusiform, (1–)3(–6)-septate, (9)10–15(–22) × 3–4(4.5) µm wide. *Pycnidia* rare, immersed, inconspicuous, 25–30 µm diam., walls hyaline with greyish tinge as in excipulum; conidia filiform, 8–10 × 0.7 µm.

Chemistry. — Thallus K–, C–, Pd–; substances not detected by TLC.

Ecology and distribution. — On nunatak and oasis. Growing on metamorphic rocks in sheltered places, associated with *Buellia frigida*. Three specimens of *B. subcoprodes* have only been found to date; two of them from the continental and one from maritime part of Antarctica. It seems to be, however, more frequent there, especially in underhangs or other sheltered rocky niches.

Remarks. — The maritime specimen is well developed. Apart from the typical ±globose apothecia it has also few lecideoid ones with better developed margin, resembling those found in *B. chrysocolla* (described below). In many apothecial sections, however, we have observed only straight or slightly curved, mostly 3-septate and shorter ascospores, not characteristic for the later species. Moreover there were no coiled ascus there. Despite these morphological differences and its usually more intensive apothecial pigmentation we decided to include the speci-

men as a paratype of *B. subcoprodes*. New Antarctic explorations are needed however to show infraspecies variety of the species.

Other specimens examined. — Continental Antarctic, Queen Maud Land, nunatak near Schirmacher Oasis, alt. 405 m, 70°47'25.6"S, 11°38'02"E, 11 Jan. 2004, leg. M. Olech (KRA 8500); Maritime Antarctic, South Shetland Islands, King George Island, Admiralty Bay: Point Thomas, Wróbel Valley, alt. 150 m, 62°10'30"S, 58°30'30"W, leg. M. Olech (KRA 8180).

Discussion. — The new species in many respects resembles recently described *Bacidia gallowayi* Coppins *et* Fryday, 2007, from subantarctic Campbell Island. It differs however in convex to subglobose or sometimes tuberculate apothecia, much shorter hymenium and asci, narrower ascospores and very inconspicuous and rarely occurring pycnidia with shorter, only filiform conidia. Unfortunately, *B. gallowayi* is reported from only type locality, so no infraspecies variety has been known to date. Both taxa differ also in their chemistry; *B. gallowayi* contains zeorin, while *B. subcoprodes* has no TLC detectable substances.

The new *B. subcoprodes* closely resembles *B. coprodes* which was recently re-found in collection of Antarctic lichens (Llop and Ekman 2007). Additionally, they both have no substances detected by TLC. *B. subcoprodes* differs, however, in more branched paraphyses and lack of distinct pycnidia, with curved conidia, 15–20 µm in length, which are usually present in *B. coprodes*.

Bacidia chrysocolla Olech, Czarnota *et* Llop sp. nov.
(Fig. 2A–G)

Diagnosis: *Species haec Bacidiae curvisporae similis sed ascosporis latioribus, (2.8-)3.0-4.0 (-5.0) µm latis, 3-5(-7)-septatis, saepe strictis, pycnidiis parvulis, conidiis brevioribus, (6-)7-10 (-11) µm longis, epithecio distincto, pigmentum Bagliettoana-viridi et thallo substantiis nullis differt.*

Etymology: The epithet *chrysocolla* has been chosen in relation to distinct, intensive blue-green tinge of apothecial pigmentation referring to a unique colour of the mineral named chrysocolla.

Holotype: Maritime Antarctic, South Shetland Islands, King George Island, Admiralty Bay. Point Thomas: moraines by the northern edge of Ecology Glacier, 62°10'S, 58°25'W, alt. 30 m, 2 Mar. 1992, leg. M. Olech (KRA 8181).

Description. — *Thallus* saxicolous, crustaceous, minutely areolate; areolae beige-grey, often with white *prothallus* which is better visible under more developed areolae. *Photobiont* chlorococcoid, algal cells globose, 10–15 µm diam. *Apothecia* sessile, at first flat and distinctly marginate (lecideoid), later sometimes convex to subglobose, and then constricted below and finally emarginate, black to dull brown-black, (0.2–)0.3–0.4 mm diam., simple or sometimes grouped in small 2–3 apothecial clusters. *Hymenium* 60–70 µm hyaline, but epihymenium dark aeruginose-green, K– or dulling, N+ violet with small, blue crystals [*Bagliettoana*-green pigment (according to Meyer and Printzen 2000)] and subhymenium sometimes also slightly greenish or brownish tinged; pigment confined to gel-matrix and caps of paraphyses. *Hypothecium* 40–60 µm tall, brown to dull fuscous-

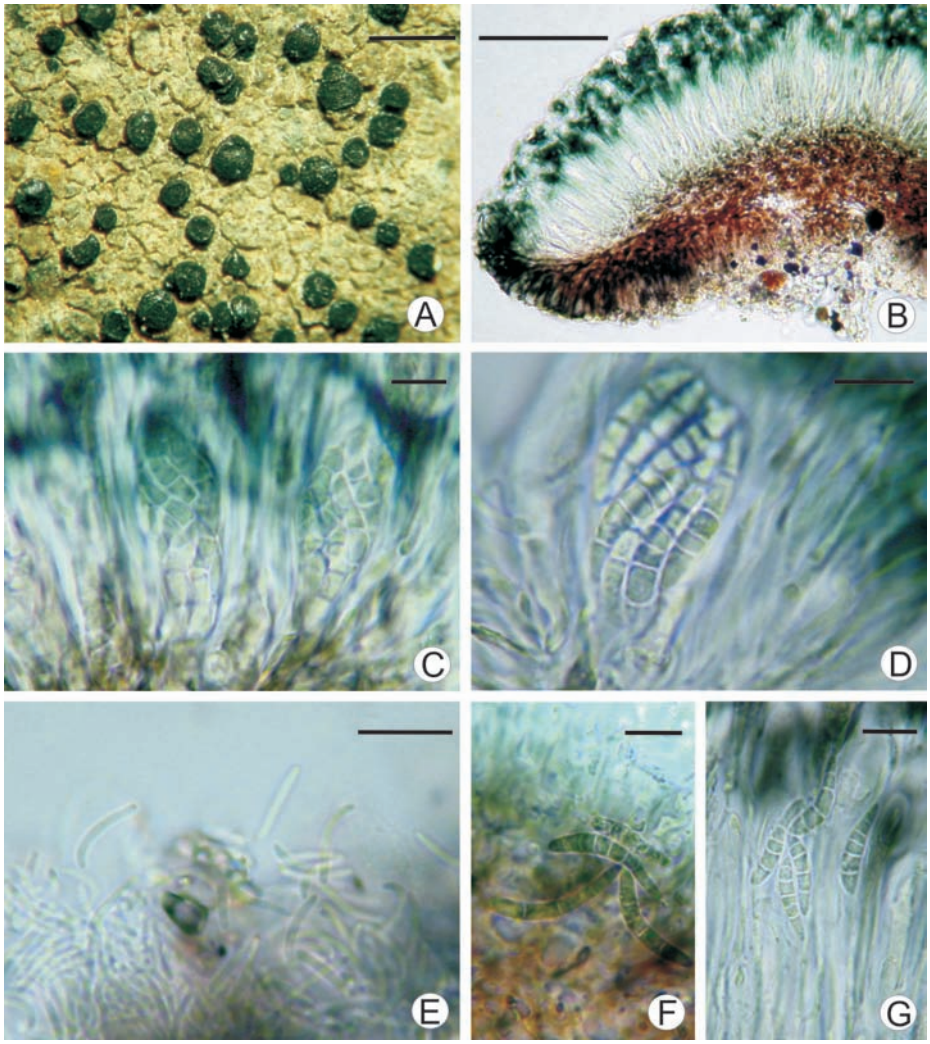

Fig. 2. *Bacidia chrysocolla* Olech, Czarnota *et* Llop: (A–E holotype) A – morphology; B – apothecial section; C – coiled asci; D – ascospores; E – filiform conidia; F – ascospores (paratype KRA 8182); G – ascospores (paratype KRA 8183). Scale bars: A – 1 mm; B – 100 µm; C–G – 10 µm.

-brown, K– or K± purplish-brown (*Laurocerasi*-brown pigment). *Paraphyses* 1.5–2 µm wide (often apically wider up to 4.5 µm), mostly simple, multiseptate, usually slightly curved or sometimes branched (more in upper part and then sometimes forked) and rarely anastomosed, especially close to exciple; caps of some of them dark green coloured. *Excipulum* 30–50 µm wide, brown to purple brown; upper inner part concoloured with hypothecium, but outer part usually darker with purplish-brown tinge, due to additional green pigment like in epihymenium (and then K+ blackish to brown-black), sometimes only upper edge more pigmented with this dull green pigment; hyphae branched and anastomosed, stout, 2.5–3.0 µm

wide, with external cells lumina up to 4 µm wide. *Asci* 40–55 × 10–12(–15) µm, *Bacidia*-type. *Ascospores* oblong fusiform to wormiform 3–5(–7)-septate, 16–21 (–27) × (2.8–)3–4(–5) µm, rarely straight, usually slightly curved or often ±sigmoid; usually spirally placed within the ascus. *Pycnidia* rare, small, 30–40 µm diam., immersed within areoles, walls dark brown around ostiolae, below colourless; *conidia* filiform, (6–)7–10(–11) × 0.8 µm, usually slightly curved.

Chemistry. — Substances not detected by TLC.

Ecology and distribution. — On acid, volcanic rocks. Especially common on moraine stones and blocks, as one of the pioneer epilithic lichens; prefers sites with very long persisting snow cover or at foot of blocks. Associated with *Caloplaca johnstonii*, *C. sublobulata*, *Huea austroshetlandica*, *Candelariella aurella*, *Leptogium puberulum*, *Amandinea latemarginata* and *Arthonia molendoi* (on *A. latemarginata*). It is known to date from only several localities in maritime Antarctic. Considering other reports of that previously un-named *Bacidia* sp. A it is probably quite common lichen in this part of the Antarctic. However, materials other than those collected by M. Olech have not been revised here.

Remarks. — Large variability of ascospores in their size and shape evidently depends on their maturity. It is often clearly visible in the same apothecial section, when along with dominating 3–4-spetate spores there appear also 5–6(–7)-septate or 2-septate. Differences in their size reach up to 2 µm of thickness and up to 8 µm in length. It seems to be also probable that aging ascospores are more coiled within asci.

Laurocerasi-brown pigment within hypothecium and excipulum does not clearly react K+ purple, as it is described by Meyer and Printzen (2000), but rather K+ dulling. For this reason it could be confused with other *Superba*-brown pigment, commonly occurring in different lichens, presented for example in *Micarea lutulata* (Nyl.) Coppins. However other colour reactions N+ pinkish tinge and than K+ sordid green confirm its placement under that name. The differences are caused usually by the concentration of *Bagliettoana*-green pigment which is sometimes more abundant in outer parts of excipulum and hypothecium. Sometimes, as in the sample of Lions Rump, the thallus is bluish-grey and an apothecial pigmentation is very intensive. These cases are likely to be referred to an extremely high insolation. The lack of this pigment under the hypothecium of globose form of *B. chrysocolla* may be of some evidence to support this hypothesis. In this case, observed, *e.g.* in the sample from the shores of Bransfield Strait, only upper part of reduced excipulum is black-green coloured. The rest of outer exciple is hyaline.

Other specimens examined. — Maritime Antarctic, King George Island, shores of Admiralty Bay and Bransfield Strait: Demay Point, 62°13'S, 58°25'W, alt. 60 m, 3 Febr. 1987, leg. M. Olech (KRA 8182); Ezcurra Inlet: Belweder, 62°11'S, 58°38'30"W, alt. 80 m, 27 Dec. 1987, leg. M. Olech (KRA 8190); Keller Peninsula, Moraine Point, alt. 10 m, 62°04'20"S, 58°24'W, 5 Mar. 1987, leg. M. Olech (KRA 8183); King George Bay, Lions Rump: "104 Hill" 62°08'20"S, 58°08'W, alt. 60 m, 18 Jan. 1988, leg. M. Olech (KRA 8195).

Discussion. — Despite some morphological and anatomical differences, we decided to treat all above mentioned specimens as representatives of the same species.

Phenotype diversity of the representatives of many genera of lichenized fungi is well known. In many cases species variability is reflected by a huge number of synonyms. For example, a thallus can vary in colour according to the rock mineralogy which appears to be the most spectacular in *Acarospora smaragdula* (Wahlenb.) Massal. (Purvis and James 1992). In *Micarea*, for example, various morphotypes are easily found in *M. denigrata* (Fr.) Hedl. and *M. peliocarpa* (Anzi) Coppins *et* R. Sant. (*e.g.* Czarnota 2007). Also within the genus *Bacidia*, pale form of *B. hemipolia* (Nyl.) Malme – *B. hemipolia* f. *pallida* Czarnota *et* Coppins has recently been established (Czarnota and Coppins 2007). Anatomical differences (*e.g.* in length and septation of ascospores) between American and European *Bacidia subincompta* (Nyl.) Arnold, resulting in various descriptions, are known for a long time, although both are treated as members of the same species (see Coppins 1992; Ekman 1996). A huge variety of internal apothecial pigmentation in *B. subincompta* is also observed (see description of *e.g.* Ekman 1996). A septation of ascospores seems to be sometimes not constant character for several species, at least for *Micarea lignaria* (Ach.) Hedl. and *Bilimbia sabuletorum* (Schreb.) Arnold. Often they are found to be mostly (or even only) 3-septate, instead of 3–7-sepate as in their descriptions (see, *e.g.* Coppins 1992; Wirth 1995). We suppose that the same situation is found in the case of the Antarctic *B. chrysocolla* and that in some Antarctic specimens ±straight, shorter, 3-sepate spores can dominate, while in others they are usually longer, curved to ±sigmoid and coiled.

Sigmoid spores have recently been discovered in coastal *Bacidia curvispora* Coppins *et* Fryday (Coppins and Fryday 2007) from subantarctic island. The new *B. chrysocolla* resembles this species by a thallus and apothecial morphology, curved and coiled spores, as well as in internal pigmentation, but differs, however, in the chemistry (because of zeorin found in *B. curvispora*), in wider and usually more septate spores (but see comments above), inconspicuous, rare pycnidia and shorter conidia. Perhaps both are sister, "young" taxa with not finished process of speciation. This may be confirmed by molecular analyses, but unfortunately, first attempts of DNA isolation from *B. chrysocolla* were unsuccessful, probably due to the age of the material.

Morphologically *B. chrysocolla* can also resemble more pigmented *B. coprodes*. It differs, however, above all in more septate, usually curved or ±sigmoid, wider and longer ascospores, in small, rare pycnidia and shorter conidia. Apothecia of *B. chrysocolla* are also usually more intensively *Bagliettoana*-green pigmented in upper part of hymenium and excipulum. The size, shape and pigmentation of apothecia of Antarctic *B. chrysocolla* are, however, various as it was mentioned above.

Reference material of *Bacidia coprodes* examined: Italy. Quarto (Genova), *infra Montem Jasce and immam maceriem, herbis tectam*, Mar. 1937, leg. C. Sbarbaro (BCN-lich 4168; det. E. Llop). Spain, Girona, Ripollés, Vall de Núria, Fontalba, 18 July 1986, leg. P. Navarro-Rosinés (BCN-lich 910; det. E. Llop).

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