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ORIGINAL RESEARCH PAPER

Contribution to the knowledge of some poorly known lichens in Poland IV. *Bacidia fuscoviridis* and *Bacidina brandii*

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Abstract

Bacidia fuscoviridis and *Bacidina brandii*, two lichen-forming fungi, are reported from Poland. *Bacidia fuscoviridis*, previously known from only one locality in Poland, has been found in several ranges of Western Carpathians on natural rocks as well as on hydrotechnic constructions. The only published collection of *Bacidina brandii* from Poland was re-examined, and determined as *Bacidina sulphurella*. In addition to the author's recent collections, which are new to the Carpathians, *B. brandii* has been discovered several times in some Polish herbaria in materials labelled as *Bacidina phacodes*. Illustrated descriptions and taxonomic, ecological, and distributional notes are provided for both species.

Keywords

lichenized fungi; rare lichens, world distribution; Carpathians; Gorce range; Pieniny Mts

Introduction

The study reported here is the fourth in a series of articles that describe records of poorly known and new lichenized fungi in Poland [1–3]. This paper presents the known distribution and original illustrated descriptions of two species, *Bacidia fuscoviridis* (Anzi) Lettau and *Bacidina brandii* (Coppins & van den Boom) M. Hauck & V. Wirth. Both species were already reported from Poland. *Bacidia fuscoviridis* was found only once in the Gorce Mts [4,5] and *Bacidina brandii* was published erroneously [6], being in fact a rare morph of *Bacidina sulphurella* (Samp.) M. Hauck & V. Wirth. In the meantime, true material of *B. brandii* has been found in some Polish herbaria and new records of both species have been made in the Polish Western Carpathians.

Material and methods

Bacidina brandii was for the first time discovered in an old collection of J. Nowak deposited in the herbarium of the Polish Academy of Sciences in Cracow (KRAM) mixed with other species labeled as *Bacidina phacodes* (Körb.) Vězda. Therefore all Nowak's specimens deposited in KRAM under the name *B. phacodes* were re-examined. As a result, other specimens of *B. brandii* were found. This was an inspiration for the search of its potential habitats in Western Carpathians. At the same time, two other collections from the Gorce Mts, deposited in the herbarium of the Gorce National Park (GPN), were investigated. Since *B. brandii* had already been reported from NE Poland [6], related material from the herbarium of the University of Warmia and Mazury in Olsztyn (OTLC) was also re-examined. Material from the private herbarium of P. v.d. Boom has been used as a reference.

Bacidia fuscoviridis was mainly collected in 2008 during studies of lichens growing on hydrotechnic constructions in the Western Beskidy Mts; related specimens are stored in the herbarium of Gorce National Park (GPN).

For determination of studied species standard light microscopes and chemical reagents were used. Hand-made apothecial sections were mounted in water and K+ color reaction of pigmented tissues was checked. Internal characters of apothecia were determined in water.

Nomenclature and synonyms of the taxa follow Index Fungorum (<http://index-fungorum.org>) and Wirth et al. [7]. Localities are mapped (Fig. 1) according to the Polish ATPOL grid square system [8] modified for lichens by Cieśliński and Fałtynowicz [9].

Results

Bacidia fuscoviridis (Anzi) Lettau

Hedwigia 52: 132. 1912. ≡ *Bilimbia fuscoviridis* Anzi, Comm. Soc. Crittog. Ital. 2(1): 16. 1864. ≡ *Lecidea fuscoviridis* (Anzi) Nyl., Flora, Jena 64: 456. 1881.
= *Lecidea albidocarnea* Nyl., Flora, Jena 60: 459. 1877. = *Bilimbia albidocarnea* (Nyl.) A.L. Sm., Monogr. Brit. Lich. 2: 139. 1911. = *Bacidia albidocarnea* (Nyl.) Zahlbr., Cat. Lich. Univers. 4: 98. 1926 [1927].

Diagnostic characters. Fig. 2e,f. Thallus crustaceous, dirty greyish-green when dry and intensive green when wet, at first minutely areolate to irregularly cracked, sorediate, in patches often bordered by whitish prothallus; soralia at first punctiform, arising on surface or margins of areoles, later irregular. Apothecia 0.3–1.2 mm diam., flat and thickly marginate when young but soon convex and immarginate, beige, pale brown to grey-brown; margin darker than disk, brown. Excipulum strongly developed, composed of stout, densely compacted and branched hyphae up to 4(–5) μm in width and bound in a gel-matrix not dissolving in KOH, colorless to pale straw colored inside, ± slightly brownish in outer edge and pale brown to pinkish-brown, K± purplish in upper edge (more visible in apothecial sections of young ascocarps). Hymenium hyaline, colorless, sometimes slightly brownish (in part), K± pinkish; paraphyses simple with apices only slightly widening up to 3 μm. Hypothecium colorless to pale straw colored. Ascospores fusiform, 1–3-septate, 12–15 × (3.5)4–4.5 μm. Pycnidia not found in Polish specimens.

Distribution and ecology. This saxicolous species is well known from natural limestone areas in Europe, being found, for example, in the fluvial mesic zone of limestone riverbeds in Great Britain [10], on shaded limestone rocks in Bohemian Karst (Czech Republic) [11,12], and several limestone ranges of the Carpathians such as Muranska planina (Slovakia) [13] and Bükk Mts (Hungary) [14]. Other records are known, for example, from Ireland [15], Sweden [16], Estonia [17], Belgium, Luxembourg, France (including the Pyrenees) [18,19], several mountainous German states [7], Southern Bohemia [20,21], Switzerland [22], Austria [23], Italy [24], Romania [25], and Bulgaria (Vondrák, personal communication, 2014). In these localities, *B. fuscoviridis* was found on calcareous substrata, as well as sandstones and concrete, similarly to those mentioned below for Polish localities.

Specimens examined. Fd-99: Beskid Makowski Mts, Myślenice city, by Średniawski street, on Bysinka

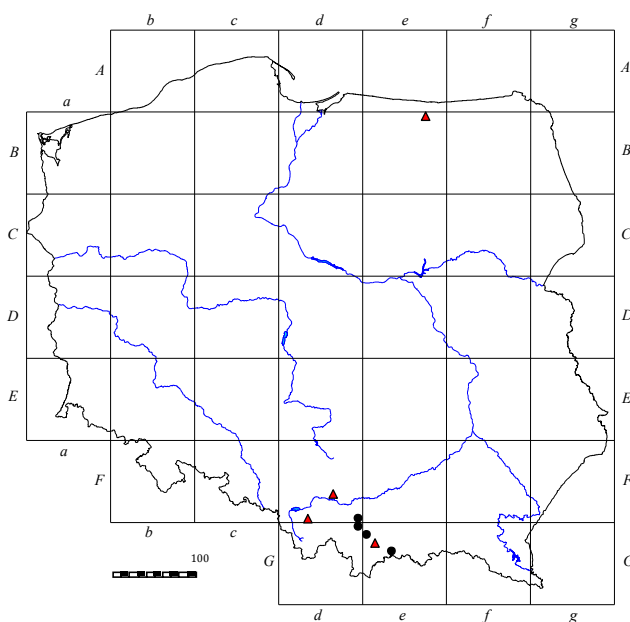


Fig. 1 Distribution of known localities of *Bacidia fuscoviridis* (black circles) and *Bacidina brandii* (red triangles) in Poland.

River, alt. 340 m, on shaded sandstone in weir, 12 October 2008, leg. B. Gawlak 143 (GPN); *ibid.*, Myślenice city, by Zdrojowa street, on Raba River, alt. 280 m, on well-lit sandstone in weir, 18 October 2008, leg. B. Gawlak 154 (GPN); *ibid.*, Stróża village, Gierczyno hamlet, on Trzebunka River, alt. 320 m, on pebble, 26 October 2008, leg. B. Gawlak 181 (GPN); *ibid.*, Bysina village, Klępówka hamlet, on Bysinka River, alt. 360 m, on sandstone in weir, 16 Nov 2008, leg. B. Gawlak 256 (GPN). Gd-09: Beskid Makowski Mts, Pcim village, Pitale hamlet, on Kaczanka stream, alt. 330 m, on well-lit sandstone in weir close to waterfall, 27 October 2008, leg. B. Gawlak 196 (GPN); *ibid.*, Skomielna Czarna Góra village, Goryl Niżny hamlet, on Bogdanówka River, alt. 430 m, on concrete in weir, 28 October 2008, leg. B. Gawlak 207 (GPN); *ibid.*, Bartosy hamlet, on Bogdanówka River, alt. 440 m, on concrete in weir, 28 October 2008, leg. B. Gawlak 220 (GPN). Ge-10: Western Beskidy Mts, Beskid Wyspowy Mts, Łostówka village on Łostówka stream, 49°39'46" N, 20°06'10" E, alt. ca. 500 m, on calcareous sandstone wall of small dam in well-lit place, 6 Apr 2008, leg. P. Czarnota 5259 (GPN); *ibid.*, Gorce Mts, Niedźwiedz village on the Porębianka River, 49°37'38" N, 20°05'15" E, alt. 500 m, on calcareous sandstone and concrete in small dam, 10 June 1999, leg. Czarnota 1957/94 (GPN) and 18 May 2008, leg. P. Czarnota 5361 (GPN). Ge-33: Pieniny Mts, Pieniński National Park, by the ruins of Pieniny Castle, 49°25'11" N, 20°25'12" E, alt. ca. 750 m, on vertical wall of limestone boulder, 27 April 2008, leg. P. Czarnota 5339 (GPN).

Bacidina brandii (Coppins & van den Boom) M. Hauck & V. Wirth

Herzogia 23: 16. 2010. ≡ *Bacidia brandii* Coppins & van den Boom, Lichenologist 34(4): 328. 2002.

Diagnostic characters. Fig. 2a–d. Thallus thin, composed of small, flat warts, grey-green or continuous. Apothecia pale-brown to ± brown with paler, beige colored margin (they often resemble apothecia of lecanorine-type), at the beginning plane and distinctly marginate, later convex, sometimes adnate with reduced to completely excluded proper margin, 0.1–0.4 mm in diam. Apothecial section colorless except for the brown hypothecium (at least in upper part) and sometimes inner part of excipulum; pigment Arnoldiana-brown [26], K+ dulling, olive-brown. Excipulum usually ± paraplectenchymatous, lumina of cells 3–5 μm in the middle part, widening towards apical edge to 7(–10) μm; sometimes excipular hyphae thinner, 1.5–2.0 μm wide, but at least most outer row cells swollen up to 7(–10) μm. Paraphyses simple, apices often swollen to 5 μm, colorless. Ascospores acicular, 0–3-septate, 25–30 × 0.8–1 μm. Pycnidia not found in Polish material.

Distribution and ecology. The known distribution of *B. brandii* might suggest that this species has some Atlantic preference, since it was found in the western part of Europe, namely Great Britain [27], Belgium [18], France and the Netherlands [28], in German states: Upper Lusatia [29] and Schleswig-Holstein [30]; however, the latter finding is uncertain, since a description of that specimen significantly differs from that mentioned in the protologue [28]. Additionally, *B. brandii* was also found in Iberian Peninsula [31], and to the east, in Lithuania [28,32].

Specimens examined. Belgium, Limburg, NNW of Neerpelt, NW of Grote Heide, Hageven, nature reserve, 51°16.16' N, 5°25.70' E, alt. 35 m, on stump of *Quercus* sp., 14 May 2010, leg. P. v.d. Boom 44815 (herb. P. v.d. Boom; reference material). Poland, Be-07: Równina Sępopolska lowland, Parys village near Korsze town, on bark of roadside *Fraxinus excelsior*, 4 May 1989, leg. J. Nowak (KRAM-L-26290, together with *Bacidina* “*phacodes*”, *B. saxenii* and *Psoroglaena dictyospora*). Fd-66: Dolina Górnej Wisły basin, forest between Olszynki and Rozkochów villages near Chrzanów town, on decaying stump of *Alnus* sp. close to a stream, 6 April 1974, leg. J. Nowak (KRAM-L-19601 p.p. & 19727). Fd-93: Western Beskidy Mts, Beskid Mały Mts, Kozy settlement (Wróblowice), alt. 570 m, on horizontal surface of stump, 21 October 1966, leg. J. Nowak (KRAM-L-547, together with *Bacidina* “*phacodes*”). Ge-21: Western Beskidy Mts, Gorce Mts, 1 km N of Turbacz Mt, by a tourist trail, 49°32'57" N, 20°05'56" E, alt.

1200 m, on horizontal surface of spruce stump in subalpine spruce forest, 28 October 2011, leg. P. Czarnota 7560 (GPN); *ibid.*, 0.5 km N of Rozdziele glade by a tourist trail, 49°33'13" N, 20°05'38" E, alt. 1150 m, on horizontal surface of spruce stump in subalpine spruce forest, 28 October 2011, leg. P. Czarnota 7599 (GPN).

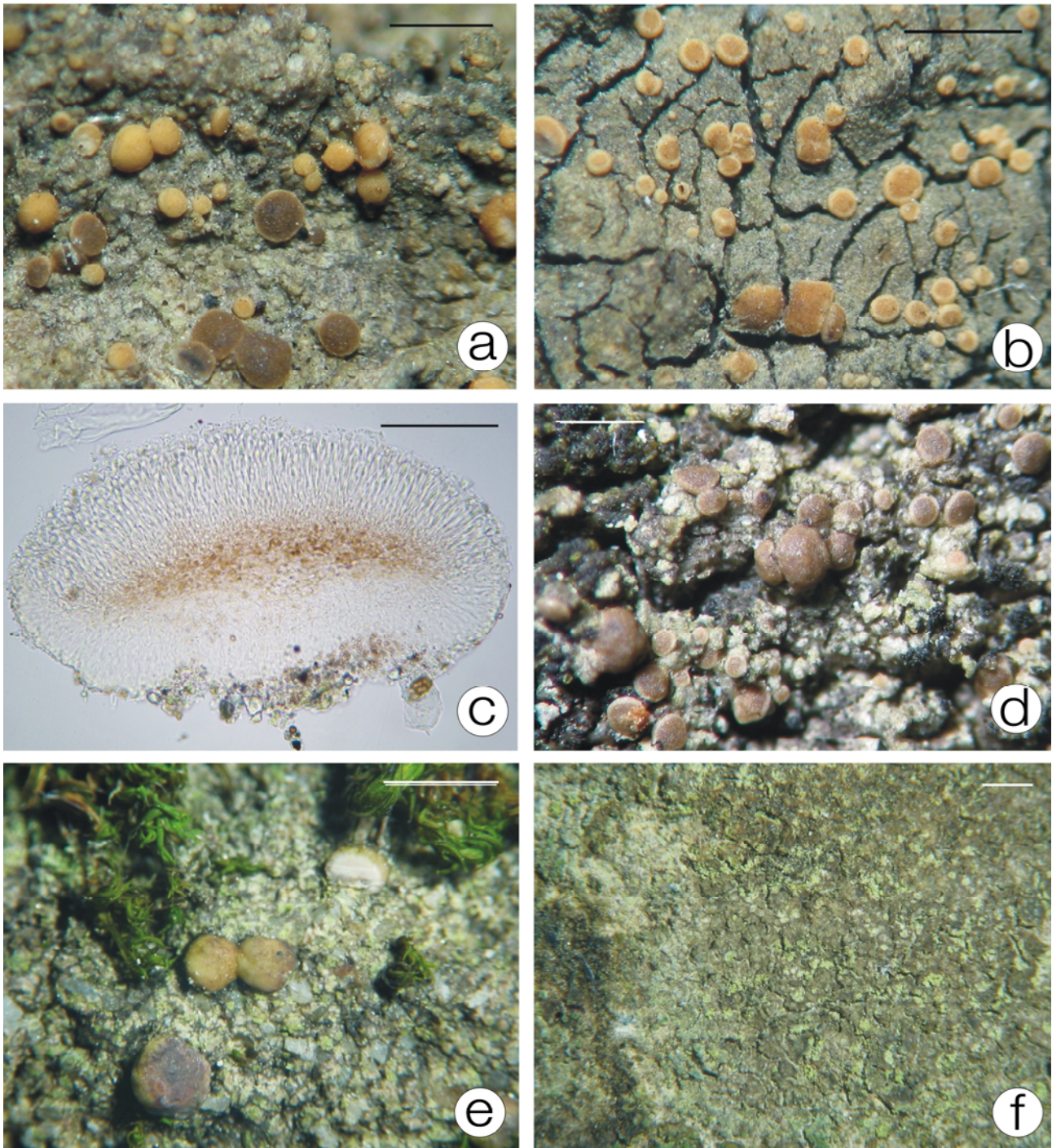


Fig. 2 Selected examined specimens of *Bacidina brandii* (a–d) and *Bacidia fuscoviridis* (e,f). **a** *B. brandii* (darker apothecia) mixed with *B. "phacodes"* on bark of *Fraxinus excelsior*; J. Nowak (KRAM-L-26290). **b** Pale form of *B. brandii* on horizontal cut surface of spruce stump in Western Carpathians; J. Nowak (KRAM-L-547). **c** Apothecial section of *B. brandii* in water with the Arnoldiana-brown pigmented hypothecium; J. Nowak (KRAM-L-547). **d** Reference material of *B. brandii* from Belgium; v.d. Boom 44815 (hb. P. v.d. Boom). **e** Ascocarps of *B. fuscoviridis*; B. Gawlak 196 (GPN). **f** Sterile, sorediate thallus of *B. fuscoviridis*; B. Gawlak 181 (GPN). Scale bars: **a,b,d–f** 1 mm; **c** 100 μ m.

Discussion

Based on apothecial characters of *Bacidia fuscoviridis*, especially strongly developed plectenchymatous excipulum composed of stout, radiating hyphae bound in a gel-matrix, the ontogeny of apothecia which are finally strongly convex and immarginate and the fusiform ascospores, this species is phenotypically more closely related to representatives of the genus *Bilimbia* de Not. [e.g., *B. sabuletorum* (Schreb.) Arnold]. Indeed, a recent phylogenetic study of the genus *Lecania* A. Massal., which included also some members of *Bilimbia* and *Bacidia*, showed the close affinity of *B. fuscoviridis* to *Bilimbia* s. str. [33]. Despite this, it is still kept within the genus *Bacidia* and regarded as a “hard-placed” taxon (e.g., [15,33]).

Bacidia fuscoviridis is usually found in a sterile stage as more or less separated grey-green sorediate patches and probably for this reason is poorly recognized in the field or under-collected. In early stages of development, when young soralia are often punctiform, it can be confused with the thallus of *Porpidia soredizodes* (Lamy ex Nyl.) J.R. Laundon. The species, however, colonizes rather siliceous, acid rocks and differs by its chemistry, i.e., the presence of stictic acid, reacting P+ ginger [34]; *Bacidia fuscoviridis* has no secondary metabolites and grows on more or less calcareous rocks. Larger, more sorediate sterile patches of *B. fuscoviridis* superficially resemble *Lecidella scabra* (Taylor) Hertel & Leuckert, also found on calcareous substrata (including concrete), but the latter species differs chemically since it produces atranorin and several xanthenes, reacting C+ orange [15].

Bacidia fuscoviridis is probably more frequent throughout Europe, but overlooked when sterile. Many records of this species relate to at least periodically wet and shaded localities within the forests or to surroundings of riverbeds, or to old, calcareous man-made walls. Occurrence of *B. fuscoviridis* on weirs, dams and other hydrotechnic constructions has not been emphasized to date.

Bacidina brandii was already reported from Poland by Kubiak and Sparrius [6], but erroneously, based on specimen OLTC-L-2109 which actually represents a morphotype of *B. sulphurella* (Samp.) M. Hauck & V. Wirth with a dull grey margin, which is also known from other sites (Czarnota, unpublished data). A similar collection from Prague (Czarnota 5967, GPN) was recently sequenced by Czarnota and Guzow-Krzemińska [35] showing it is really placed within lineage of *B. sulphurella*.

At first glance flesh-colored apothecia of *B. brandii* resemble larger apothecia of *B. chloroticula* (Nyl.) Vězda & Poelt, *B. delicata* (Larbal. ex Leight.) V. Wirth & Vězda or *B. phacodes* (Körb.) Vězda having only slightly darker disc with a pale brownish tinge. Young ascocarps of *B. brandii* are flat and distinctly sessile with a paler, well-developed rim; later they are usually slightly convex with the margin more or less excluded. In water the apothecia become almost completely translucent (as for example in *Dimerella pineti* or *B. phacodes*) but inside, unlike the three above-mentioned members of *Bacidina*, they are more or less brown due to the Arnoldiana-brown pigmented (K+dulling) hypothecium (distinctly visible also in apothecial sections). The excipulum, composed of radiating, stout hyphae with large lumina of outer cells up to 5–8(–10) µm diam., is another diagnostic character for this species.

Recently one specimen resembling a pale form of *B. brandii* in almost all characters was collected in the Beskid Niski Mts (Polish Carpathians) [Magurski National Park, W slope of Suchania hill, 49°30'29.6" N, 21°32'40.2" E, alt. ca. 430 m, on decaying wood of beech in the Carpathian beech forest, September 2009, leg. L. Betleja & R. Kościelniak (KRAP)]. Considering its minutely granular thallus composed of gonioscysts and different excipular hyphae, perhaps it represents some undescribed taxon but this assumption requires further investigation.

Discovering *B. brandii* at higher elevations of Western Carpathians in southern Poland came as a surprise since previously it was regarded as an Atlantic species (see distribution and related literature above). In the Carpathians, this species inhabits hard wood of horizontal cut surfaces of tree stumps. Such a substrate was already mentioned by Diederich et al. [18], but elsewhere *B. brandii* was usually known to be terricolous on soil or plant debris [18,28], lignicolous on rotting stumps [28], and sometimes corticolous on roots and tree bases [15]. Recently, it has also been found on stems of *Vaccinium myrtillus* [32]. All these reports show that *B. brandii* has a larger ecological plasticity and is probably more widespread in Central Europe than we thought.

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