

Mniaecia jungermanniae and *Puttea margaritella* (lichenized Ascomycota) found in Poland

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Abstract

Two hepaticolous fungi, *Mniaecia jungermanniae* and *Puttea margaritella* rarely recorded in Europe have recently been found in Polish Western Carpathians. Both species are also reported here for the first time from Poland. Notes on their taxonomy, ecology and distribution are provided.

Keywords: lichens, bryosymbionts, symbiosis, endophytes, liverworts, national park, Tatra Mts, Gorce range

Introduction

Many bryosymbiotic fungi have recently been studied towards their phylogenetic relationships to other Ascomycota to explain the adoption of highly specialized life strategies during evolution of fungi [1]. Some of the specialists are endophytic being confined only to the mosses or liverwort hosts and others need additional symbioses with algal or cyanobacterial photobionts to form epibryophytic lichens. Such cases are not so rare and perhaps fungal endophytism is much more common than generally thought [2–4].

Two of the bryosymbiotic fungi, *Mniaecia jungermanniae* (Ascomycota, Leotiomyces, Helotiales) and *Puttea margaritella* (Ascomycota, Lecanoromycetes) have been collected for the first time in Poland, while they are widespread in Europe and reported already from neighboring countries. Both are known to associate with liverworts, but the first species is regarded as a non-lichenized parasite [5–7] and the second is shown as lichenized despite it develops subcuticularly and does not form clearly structured thallus [1,8].

Material and methods

Collections of *Puttea margaritella* were made in 2010 during lichenological investigations of deadwood lichens in Polish Tatra Mts by the first author, and findings of *Mniaecia* were made in

2012 by both authors during their field trip in the Gorce Mts (Polish Western Beskidy Mts; Fig. 1).

All findings were morphologically and anatomically examined under microscopes. Hand-cut preparations mounted in water and KOH were studied to measure internal apothecial characters and to check their pigmentation and epihymenial crystals. Specimens have been deposited in the Herbarium of Gorce National Park (GPN). Nomenclature and synonyms of lichen-forming taxa follows Index Fungorum (<http://indexfungorum.org>).

Polish localities are mapped according to the Atpol grid square system [9] modified by Ciesliński and Fałtynowicz [10].

Results and discussion

Mniaecia jungermanniae (Fr.) Boud.

Hist. Class. Discom. Eur. (Paris): 99. 1907. ≡ *Peziza jungermanniae* Fr., Syst. mycol. (Lundae) 2(1): 144. 1822. ≡ *Ascobolus jungermanniae* (Fr.) Berk. & Broome, Ann. Mag. nat. Hist., Ser. 3. 15: 18 (No. 1082). 1865. ≡ *Pseudopeziza jungermanniae* (Fr.) Fuckel, Jb. Nassau. Ver. Naturk. 23–24: 291. 1870. ≡ *Calloria jungermanniae* (Fr.) Quél., Enchir. fung. (Paris): 324. 1886. ≡ *Humaria jungermanniae* (Fr.) Sacc., Syll. fung. (Abellini) 8: 146. 1889.

DIAGNOSTIC CHARACTERS. This hepaticolous fungus was described and handmade illustrated in details several times [5,6,11]. Here it is photographed (Fig. 2a–d) and briefly described based on Polish findings.

External thallus absent. Apothecia blue to blue-green when moist, indistinctly marginate, 0.2–1.0 mm in diam. confined to leaves or stems of terricolous liverworts or sometimes growing directly on clayey soil between them. Hymenium up to 180 µm tall, colorless, except for the blue epihymenium, which is con-colored with distinct narrow excipulum. Hypothecium colorless. Asci 8-spored, cylindrical-clavate, numerous. Ascospores usually uniseriate, simple, elliptic with abundant lipidic

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Handling Editor: Beata Zagórska-Marek

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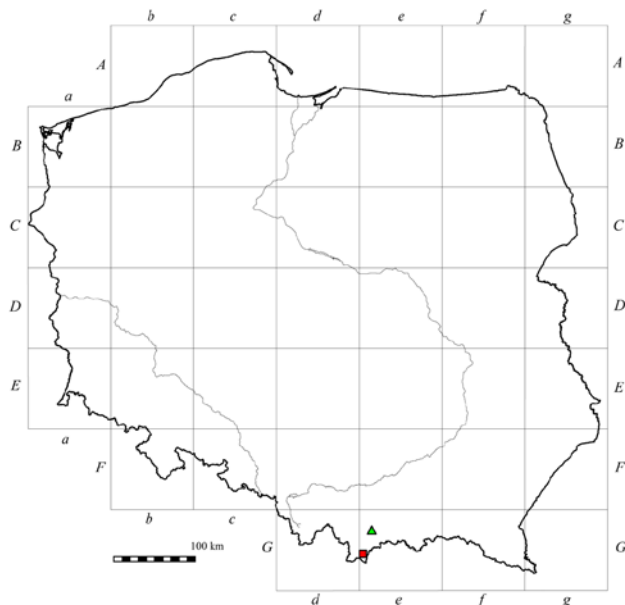


Fig. 1 Localities of *Mniaecia jungermanniae* (triangle) and *Puttea margaritella* (square) in Poland.

droplets, 8–12 × 16–22 μm. Paraphyses usually simple with apices swollen to 6 μm and bluish pigmented; some of them distinctly arise above hymenium.

NOTES. Regarding its blue apothecia spread over green small leafy liverworts, *M. jungermanniae* should be simply identified in the field, however, only in wet conditions. When it is dry, fruit-bodies are much smaller, almost black and usually unavailable to see. Raspe and De Sloover [5] provided the intraspecific hamathecium variability based on the description of *M. jungermanniae* by several researchers and their own investigations. The authors indicated two groups of examined specimens sometimes strongly differentiated in apothecial features, especially in the size of ascospores, asci and caps of paraphyses. Polish specimens correspond well with those described by Coppins and Chambers [12] and characterize by capitate long paraphyses which are distinctly higher than the hymenium (Fig. 2c).

Another representative of the genus, *Mniaecia nivea* (P. Crouan & H. Crouan) Boud., found also in Central Europe, resembles *M. jungermanniae* except for the blue apothecial and mycellial pigment. Benkert and Otte [13] suggest even that *M. nivea* is possibly only an albino form of *M. jungermanniae*, but De Sloover [6] showed several differences in their anatomy to support the separation of both taxa. A distribution of *M. nivea* is less known in the contrary to *M. jungermanniae*, possibly due to its less visible apothecia in the field, which could be simply overlooked, especially when dry.

DISTRIBUTION AND ECOLOGY. *Mniaecia jungermanniae* was reported from several European countries: Iceland [14], Great Britain [12], Norway [15], Sweden [16], Belgium [5], the Netherlands [17], Luxembourg [18], France and Hungary [6], Germany (Saxony and Brandenburg) [11,13] the Czech Republic [19], Austrian Styria [20–22], Julian Alps in Italia [23]. It has recently been found also in east North America (New Brunswick in Canada and E Pennsylvania in USA) [24]. Almost all of those collections were made in spring, when the apothecia of *M. jungermanniae* were developed. It suggests that it should be considered as a “spring fungus” available to see in the field in that time.

This endophytic fungus is known to be extremely confined to small liverworts belonging to the genera: *Calypogeia*, *Cephalozia*, *Cephaloziella*, *Diplophyllum*, *Jungermannia*, *Lepidozia*, *Lophozia*, *Lophocollea* and *Nardia scalaris* (Schrad.) Gray [6,13]. In Poland it was collected on terricolous members of *Cephalozia* and associated *Jungermannia* on the tourist path within the spruce montane forest.

SPECIMENS EXAMINED. Atpol Ge21, Poland, Carpathians, Western Beskidy Mts, Gorce Mts, Gorce National Park, by tourist track near the Borek pass, 49°33'32"N, 20°08'43"E, alt. 1000 m, on liverworts on clayey soil within spruce-fir mountain forest, 2012.05.04, leg. E. Hernik & P. Czarnota 7408 (GPN); ibid., Turbacz nature reserve, by tourist track below Czolo Mt., 49°33'23"N, 20°06'36"E, alt. 1100 m, on liverworts on clayey soil within Carpathian beech-spruce-fir forest, 2012.05.05, leg. E. Hernik & P. Czarnota 7407 (GPN).

Puttea margaritella (Hulting) S. Stenroos & Huhtinen

In Stenroos, Huhtinen, Lesonen, Palice & Printzen, Bryologist 112(3): 550. 2009. = *Lecidea margaritella* Hulting, Bot. Not. 1910: 304. 1910. = *Fellhanera margaritella* (Hulting) Hafellner, In: Hafellner & Türk, Stapfia 76: 152. 2001.

= *Lecidea symmictella* var. *albida* Vain., Acta Soc. Fauna Fl. Fenn. 57(2): 416. 1934.

DIAGNOSTIC CHARACTERS. An excellent illustrated description of *Puttea margaritella* is presented by Stenroos et al. [8]. Here are included only some most distinguishable characters based on Polish materials (Fig. 2e–g).

Thallus almost invisible, hepaticolous. Apothecia small, up to 0.4 mm in diam., white to white cream, convex, immarginate, pruinose, usually constricted at the base. Apothecial section throughout colorless. Paraphyses frequently branched and anastomosed, septate, not capitate. Excipulum composed of paraphyse-like hyphae. External part of hamathecium and excipulum covered with thin layer of hyaline, small crystals dissolving in KOH. Asci clavate, hemiamyloid in IKI (walls orange-brown). Ascospores simple, (2.5–)3 × 6.5(–7) μm.

NOTES. Morphologically it characterizes by very small, white, immarginate apothecia appearing almost exclusively on the widespread liverwort *Ptilidium pulcherrimum* (Weber) Vain. Considering the apothecia, *Puttea margaritella* may resemble some morph of *Micarea micrococca* (Körb.) Gams ex Coppins distinguished by Czarnota and Guzow-Krzemińska [25] (Fig. 2a) as *M. micrococca* s.str. This species has also colorless apothecium, sometimes simple spores, branched, anastomosed paraphyses and moreover can grow as an epibryophyte. It differs, however, in the thallus structure; thallus superficial and composed of gonocysts while the thallus of *P. margaritella* is almost endophytic. Similar pale apothecia form also some species of *Bacidina* Vězda [for example some morphs of *B. chlorotricula* (Nyl.) Vězda & Poelt, *B. delicata* (Larbal. ex Leight.) V. Wirth & Vězda] as well as *Fellhanera subtilis* (Vězda) Diederich & Sérus. and several members of the genus *Veizdaea* Tscherm.-Woess & Poelt. Each of them is hyaline and almost colorless in the apothecial section, but among other differences their exciple are paraplectenchymatic or in the case of *Veizdaea* the excipulum is not developed. Ascospores in *Bacidina* spp. are acicular and multiseptate, in *Fellhanera* fusiform and also transversely septate, and in the case of *Veizdaea* if they are simple, are much larger. Despite the mentioned species can occasionally occupy bryophytes, all of them produce external, well developed thalli. Similar pale cream and whitish pruinose apothecia producing simple, small ascospores develops *Biatora veteranorum* Coppins & Sérus., but

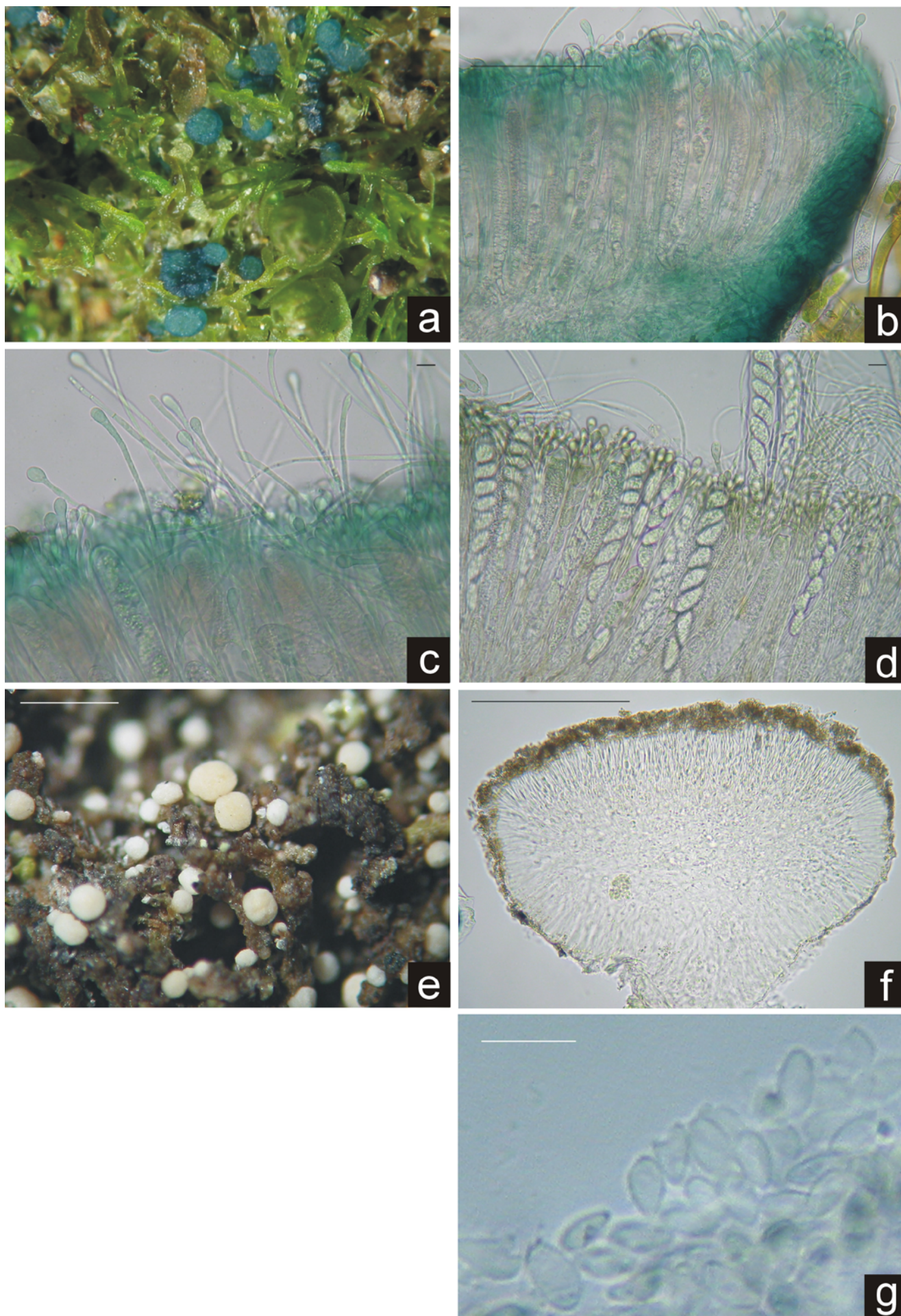


Fig. 2 Characters of Polish findings of *Mniaecia jungermanniae* (a–d) and *Puttea margaritella* (e–g). *M. jungermanniae*: habit (a); apothecial section (b); paraphyses (c); asci and ascospores (d); *P. margaritella*: habit (e); apothecial section (f); ascospores (g). Scale bars: b,f 100 μ m; c,d,g 10 μ m; e 1 mm.

the species is exclusively lignicolous and its thallus despite is usually not superficial, is reach in stipitate, pruinose pycnidia [26], which have never been observed in *Puttea margaritella*. Several next species showing closer phylogenetic affinities to *P. margaritella* have been also discussed by Sérusiaux et al. [26].

DISTRIBUTION AND ECOLOGY. So far *Puttea margaritella* is known mainly from Europe, from the whole Fennoscandia and Leningrad Region of Russia to the north (there the species seems to be not so rare) across the Czech Republic and Slovakia up to alpine regions of Austria and Switzerland to the south of the continent [8]. Recently it has also been recorded in Alaska [27]. Its closest localities to Poland are in Slovak Western Carpathians [8]. Here it is reported as new for the Tatra Mts and Poland.

In Poland *P. margaritella* was found only in the upper mountain spruce forests, in wet niches, surely because of the habitat requirements of its liverwort “host”. Considering its inconspicuous habit, this lichenized fungus could be overlooked elsewhere, but on the other hand, its creamy white apothecia are strongly contrasting to their neighborhood, thus are quite simple to see. Its worldwide distribution suggests that *P. margaritella* is a mountain species in Central Europe and there should concentrate its next localities. At least in Polish mountains it seems to be however a rare lichen-forming fungus since intensive recent author’s explorations of several Western Carpathian ranges resulted only in the two collections presented in this paper. Stenroos et al. [8] defined *P. margaritella* as a probably nectrotrophic parasite or a colonizer of already moribund, decaying parts of the liverwort host. Indeed, the Polish gatherings can confirm that opinion, but in this case except for the almost exclusively infected *Ptillidium pulcherrimum* [8], probably also dead *Lophocolea heterophylla* (Schrad.) Dum. is noted as its facultative host. Associated lichen-forming fungi in the Polish collections include: *Cladonia* sp., *Hypogymnia physodes*, *Micarea botryoides* and *Veizdaea* cf. *retigera*.

SPECIMENS EXAMINED. Atpol Ge-50, Poland, Carpathians, Tatra Mts, Tatra National Park: Dolina Rybiego Potoku valley, below Opalone Mt., forest section no. 53f, 49°13'10.5"N, 20°05'05.6"E, on dead liverwort *Ptillidium pulcherrimum* on bark of dead *Picea abies* within upper montane spruce forest *Plagiothecio-Piceetum*, alt. 1330 m, 2010.07.02, leg. Czarnota 6710 (GPN); *ibid.*, Dolina Waksmundzka valley, forest section 66a, 49°15'03.4"N, 20°04'58.8"E, on dead liverworts *Ptillidium pulcherrimum* and *Lophocolea heterophylla* on log of wind-thrown *Picea abies* in upper montane spruce forest, alt. 1280 m, 2010.10.04, leg. P. Czarnota 7125 (GPN).

Acknowledgements

Special thank to Prof. Adam Stebel (Sosnowiec, Medical University of Silesia) for determination of liverworts infected by both presented fungi. This research was supported by the Polish Ministry of Science and Higher Education, grant No. N N305 306835 (P. Czarnota). A part of this study was financially supported by the University of Rzeszów task grant No. WBR/KAiAK/DS/5/ 2012.

Authors' contributions

The following declarations about authors' contributions to the research have been made: field studies, determination,

laboratory works, photographs, writing the manuscript: PC; field studies, bibliography studies: EH.

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