

Species of lichenized Ascomycota new to Polish Western Carpathians and rare in whole Carpathians

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Abstract: Five species of lichen-forming fungi not reported yet or rare in the Carpathians have been found during lichenological researches by authors in the Tatra Mts and the Gorce Mts. Of these, *Terramelas chloroleucus* has not been recorded in Poland since 19th century and, similarly to *Gyalecta russula*, has been found for the first time in the Polish part of the Carpathians. *Absconditella celata* has been discovered in the Polish Western Carpathians. *Fellhanera gyrophorica* has never been listed before in the Western Carpathians and *Epigloea bactrospora* in whole Carpathians. Notes on the taxonomy, habitat and worldwide distribution of these species (including maps of their ranges in Europe) are accompanied by photo plates illustrating their morphology and anatomy.

Keywords: biodiversity, Carpathians, lichens, rare species, new records, lichen checklist

INTRODUCTION

The lichen diversity in the Carpathians has been studied for over 150 years (for detailed references see, i.a., Bielczyk et al., 2004; Ciurchea, 2007; Vondrák et al., 2010). Some regions have local, detailed studies, while others are still poorly explored. In recent years, the best preserved old-growth forests and oakwood pastures in the eastern part of this mountain range have become the spectacular object of lichenological interest, resulting in a significant enrichment of the Carpathian and regional species lists (i.a., Vondrák et al., 2009, 2015; Ardelean et al., 2013; Dymytrova et al., 2013; Czarnota et al., 2018; Malíček et al., 2014, 2018a), including lichenized fungi new to science (Malíček et al., 2018b, 2020). Also recent taxonomic revisions supported by molecular data reveal a greater species richness of lichens in the Carpathians than previously thought (i.a., Frolov et al., 2016; Guzew-Krzemińska et al., 2016; Malicek et al., 2017). In the Polish Carpathians, the most intensive field research, covering almost all ranges of these mountains, took place in the last century (see Bielczyk, 2003; Kiszka & Kościelniak, 2003). Currently, in the era of new challenges in science, reports of new discoveries or noteworthy lichen species appear less and less often (Flakus, 2014). Therefore, the records of the species previously unknown in this part of the Carpathians seem to be particularly valuable. The presentation of several of these species, with their distinctive features, as well as their

current distribution in Europe is the purpose of this work. No less important motivation is the compilation of the list of all known lichen-forming species in the Carpathians prepared as Polish part of an international project led by Dr. A. Bérešová (SAV Bratislava).

MATERIAL AND METHODS

Lichens were collected by the authors from the beginning of this century during several field explorations in Polish Western Carpathians focused on: 1) lichen-bryophyte communities inhabiting sandstone outcrops (PC), 2) diversity and ecology of wood-inhabited fungal species (PC & MT), 3) lichen diversity within the zones established to protect Western Carpathian Lobarina pulmonaria (L.) Hoffm. population (PC), and 4) forest ecology studies on permanent monitoring plots (PC). Most noteworthy species including new to Poland, the Carpathians or the Polish part of this mountain range have already been published (i.a., Czarnota, 2011, 2015, 2016; Czarnota & Hernik, 2013; Czarnota et al., 2018; Kukwa et al., 2017); five more are mentioned here.

Specimens were identified under stereomicroscope Zeiss Stemi DV4 and light-microscope Zeiss Axiostar Plus using routine lichenological methods, including morphological and anatomical characters, spot test reactions with KOH, Na-

ClO, C₆H₄(NH₂)₂ [ethanolic p-phenylenediamine solution], TLC analyses (Orange et al., 2001) and the reaction with UV light. Collections have been deposited in the herbarium of Gorce National Park (GPN). The nomenclature follows Faltynowicz and Kossowska (2018), with the support of Baloch et al. (2013) for *Gyalecta russula*, and Nordin (2004) for *Tetramelas chloroleucus*. Distribution maps (Figs 1D, 2D, 3C, 4E, 5D) are based on literature and on-line data and are updated with the authors' data listed in this article.

THE SPECIES

ABSCONDITELLA CELATA Döbbele & Poelt

Specimens examined: Poland, Carpathians: Tatra Mts, Tatra National Park, forest section 261h, Tomanowa Dolina valley, Zadni Smreczyński Grzbiet area, alt. ca. 1420 m, 49°13'13.3"N, 19°53'04.3"E, Atpol Gd59, on decaying wood of decorticated *Picea abies* trunk, leg. P. Czarnota 7016 (GPN); Western Beskidy Mts, Gorce Mts, Gorce National Park, forest section no. 97, alt. 1146 m, 49°34'07.07"N, 20°11'16.91"E, Atpol Ge21, on decaying wood of spruce log, 10.07.2018, leg. M. Tanona, F. Karpowicz & P. Czarnota 8409 (GPN); *ibid.*, valley of Forendówki stream, forest section no. 168b, alt. 1150 m, 49°32'21"N, 20°09'36"E, Atpol. Ge21, on lignum of decaying spruce log in an upper mountain spruce forest *Plagiothecio-Piceetum*, 2019, leg. M. Tanona & P. Czarnota 8453 & 8454 (GPN).

Although *A. celata* is a very inconspicuous lichen-forming fungus with a thallus resembling free-living wood-inhabited algae, its minute perithecia-like apothecia of orange colour and 3-septate fusiform ascospores (Fig. 1A–C) are very distinct diagnostic features that distinguish it from several other microlichens. The most similar species in appearance of ascocarps are representatives of *Psoroglaena* genus, i.e. *P. abscondita* (Coppins & Vězda) Hafellner & Türk and *P. dictyospora* (Orange) H. Harada. These species form pale orange perithecia, however, without an open ostiole and hamathecium composed of only periphyses (there are no interascal filaments) in contrast to hamathecium of simple, slightly widening paraphyses in *A. celata*. Ascospores of *P. abscondita* can also be 3-septate (1–3-septate), but more elongate than fusiform, and its thallus is minutely leprose. *P. dictyospora* forms even more leprose thallus and muriform ascospores. The three species can inhabit similar substrata, growing on a dead wood, decaying lichens and bryophytes in

natural as well as post-mining habitats (Czarnota, unpubl. data). *Porina leptalea* (Durieu & Mont.) A.L. Sm. can also resemble *A. celata* due to its orange, hemispherical ascocarps, thin, smooth, olive-green, crustaceous thallus, and 3-septate, fusiform ascospores. The fruit bodies of *P. leptalea* are in fact perithecia surrounded by *Porina*-yellow pigmented involucreum with paraphysioid hamathecium; its photobiont belongs to *Trentepohlia*, while in *A. celata* the photobiont is chlorococcoid. Both species prefer also different habitats since *P. leptalea* is a corticolous lichen.

Absconditella celata was not reported to date from Polish Western Carpathians being known from single localities in Slovak Carpathians (Palice, 1999) and Polish Eastern Carpathians (Bielczyk & Kiszka, 2002). Its distribution includes, moreover, mainly temperate to cold regions of Scandinavia (Holien et al., 2016; Döbbele & Poelt, 1977; Palice, 1999), Estonian Saaremaa Island on Baltic Sea (Aptroot et al., 2005), Tver Region in European Russia (Notov et al., 2011), the Czech Republic (Palice, 1999; Malíček & Palice, 2013; Malíček et al., 2019; Vondrák, unpubl. data available in <http://botanika.bf.jcu.cz>, accessed on 3.10.2019) and British Isles (Coppins, 2009; <https://species.nbnatlas.org/species/NHMSYS0001472736>, accessed on 3.10.2019) (Fig. 1D). Single reports from British Columbia in North America (Spribille et al., 2009), and Tasmania (Kantvilas & Jarman, 2012) and South Siberia in Russia are also known (Urbanavichene & Palice, 2016).

In the two Polish localities this microlichen was found to be growing on dead wood in subalpine belt covered with Norway spruce stands more or less destroyed by bark-beetle outbreaks. It was accompanied there by *Micarea nowakii* Czarnota & Coppins s.l. (the sister taxon to *Micarea herbarum* M. Brand, Coppins, Sérus. & van den Boom; see Guzow-Krzemińska et al., 2019), *M. misella* (Nyl.) Hedl., *Placynthiella dasaea* (Stirt.) Tønsberg and *Thelocarpon epibolum* Nyl.

EPIGLOEA BACTROSPORA Zukal

Specimen examined: Poland, Carpathians, Western Beskidy Mts, Gorce Mts, Gorce National Park, forest section no. 128, on decaying wood of spruce log within Carpathian beech forest, 49°33'26.90"N, 20°13'55.83"E, alt. 1050 m, Atpol Ge21, 3.08.2018, leg. M. Tanona & P. Czarnota 8442 (GPN).

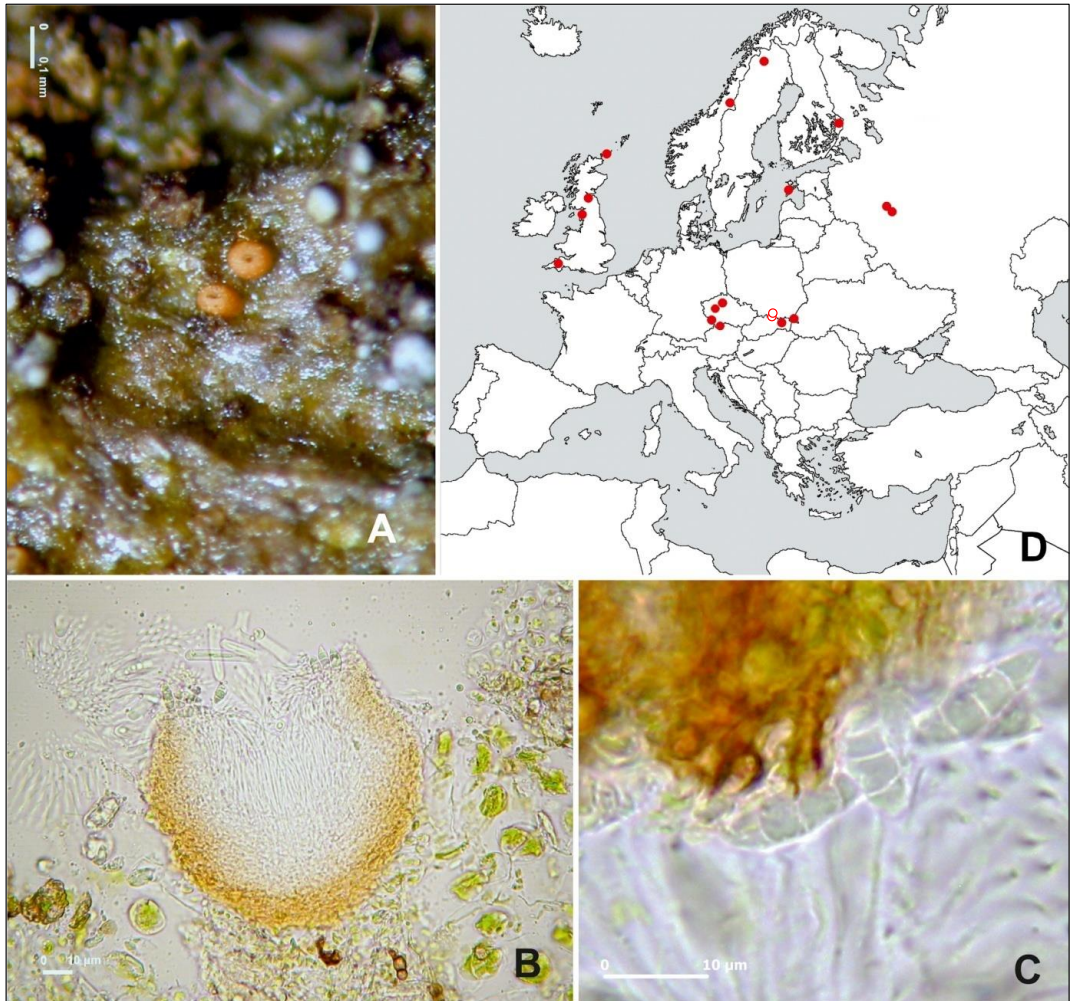


Fig. 1. *Absconditella celata* Döbbeler & Poelt: A – habit, B – ascatal cross section, C – ascospores (A–C: leg. M. Tanona, F. Karpowicz & P. Czarnota 8409; GPN), D – distribution in Europe; circles – localities known to date, rings – new localities in the Carpathians.

This minute species represents algicolous fungi associated with *Coccomyxa*. The relationship of both lichen components is probably not only symbiotic as mycobiont is sometimes parasitic depending on environmental conditions and the stage of its development (Jagg & Thomas, 1934). *Epigloea bactrospora* mostly resembles *E. pleiospora* Döbbeler in its narrowly elongate 1-septate ascospores and multispored asci, but the ascospores of *E. bactrospora* are slightly narrower ($6.0\text{--}11.0 \times 1.5\text{--}2 \mu\text{m}$ while in *E. pleiospora* reach $5.5\text{--}11.5 \times 2\text{--}3 \mu\text{m}$) and asci produce more than 32 spores contrary to the less than

32-spored asci in *E. pleiospora* (see Fig. 2A–C). For excellent descriptions of both species see Döbbeler (1984) and Ceynowa-Gieldon (2002).

Epigloea bactrospora is rarely reported from only dispersed localities throughout Europe (Fig. 2D): Norway (GBIF Norway; <https://artskart.artsdatabanken.no>, accessed on 3.10.2019), Denmark and Schleswig-Holstein (Jacobsen, 1990), the Netherlands (Aptroot et al., 1999), northern Poland (Ceynowa-Gieldon, 2002, 2005), mountainous regions of Austria, Germany, Italy (Grumann, 1968; Döbbeler, 1984; Nimis

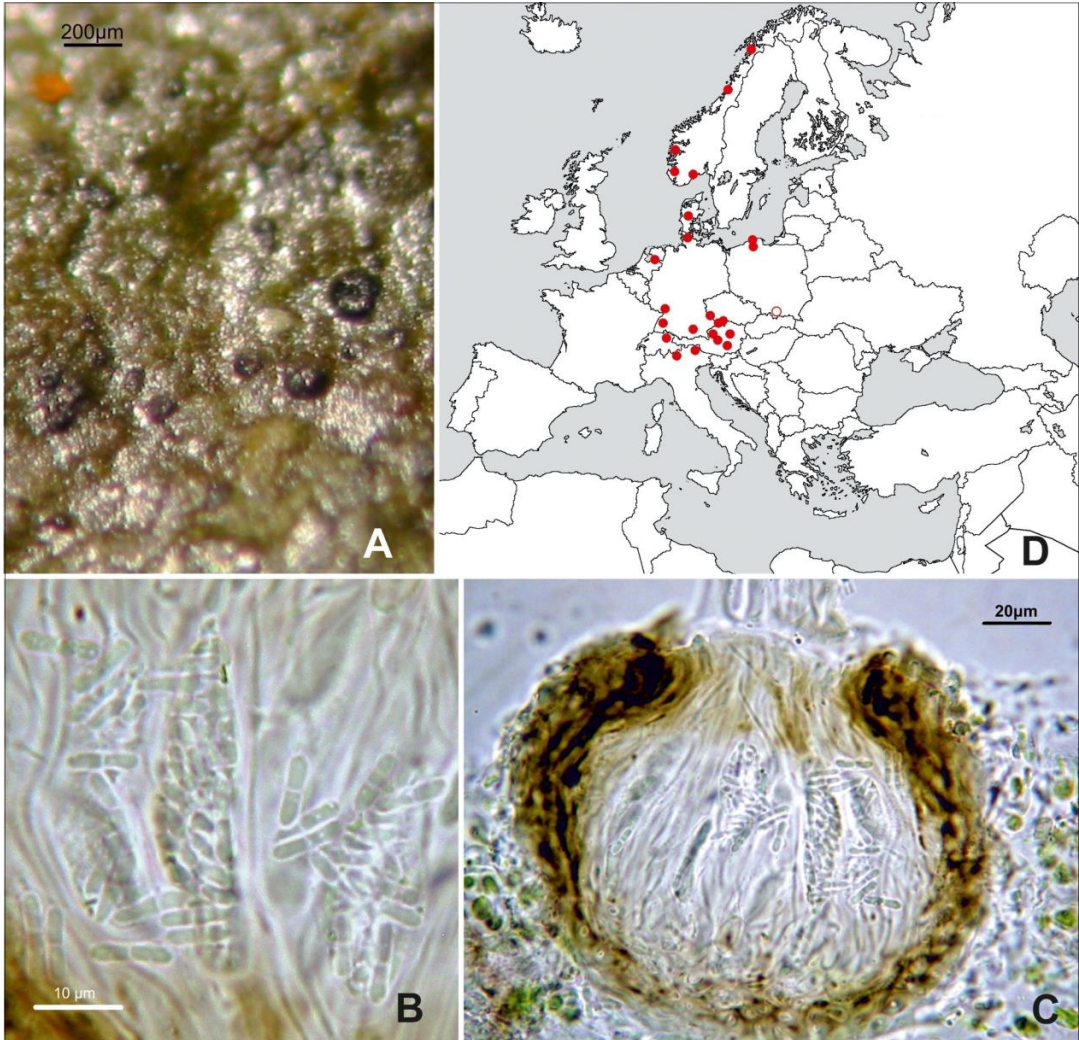


Fig. 2. *Epigloea bactrospora* Zukai: A – habit, B – hamathecium and asci filled in ascospores, C – ascomatal cross section (A–C: leg. M. Tanona & P. Czarnota 8442; GPN), D – distribution in Europe; circles – localities known to date, ring – new locality in the Carpathians.

et al., 2018), and Switzerland (Jaag & Thomas, 1934); recently it has been also found in the Czech Republic (Vondrák, unpubl. data available in <http://botanika.bf.jcu.cz>, accessed on 12.12.2019). Here *E. bactrospora* is recorded for the first time in the Carpathians.

FELLMANERA GYROPHORICA Sérus., Coppins, Diederich & Scheid.

Specimens examined: Poland, Carpathians, Western Beskidy Mts, Gorce Range, Gorce National Park, valley of Kamiénica river, 49°33'34.09"N, 20°12'17.15"E, alt.

930 m, Atpol Ge21, on bark of *Fagus sylvatica* in the Carpathian beech forest, 11.08.2015, leg. P. Czarnota 8023, L. Widak, K. Wąsik (GPN); *ibid.*, N slope of Kudłóń Mt below Stawieniec glade, forest section no. 101a, close to the Kamiénica river, 49°33'35.72"N, 20°11'48.69"E, alt. 890 m, Atpol Ge21, on bark of *Fagus sylvatica* in old-growth Carpathian beech forest, 23.11.2018, leg. P. Czarnota 8434 (GPN).

A description of the species based on only pycnidial stage had been made by Serusiaux et al. (2001) with an excellent comparison to other crustose corticolous species producing similar

± stipitate, barrel-like and widely gapping pycnidia, namely *Micarea pycnidiophora* Coppins & P. James, *Micarea doliiformis* (Coppins & P. James) Coppins & Sérus., and *Fellhanera ochracea* Sparrius & Aptroot. Systematic position of *F. gyrophorica* was proposed to be provisional that time due to pyriform conidia likely in other species of the genus. The doubt was soon clarified by Sparrius (2002) who recorded its fertile specimens. Other excellent taxonomical and ecological notes was made by Kubiak (2011) based on many collections of *F. gyrophorica* from Polish lowland. His and author's (PC) investigations of Polish herbaria materials showed that the species was formerly collected many times with apothecia (especially in the Białowieża Primeval Forest) but misidentified mostly as *Bacidina sulphurella* (Samp.) M. Hauck & V. Wirth (see Cieśliński & Tobolewski, 1988 as *Bacidia arnoldiana* (Körb.) V. Wirth & Vězda).

Fellhanera gyrophorica has most frequently been found in central-eastern European lowland including NE Poland, Belarus, Lithuania, Estonia and W Russia growing in well-preserved, humid, broad-leaved forests and old manor parks (Czyżewska et al., 2001; Sérusiaux et al., 2001; Motiejūnaitė & Prigodina-Lukošienė, 2002; Sparrius, 2002; Golubkov & Kukwa, 2006; Lubek, 2009; Kubiak, 2011; Yatsyna, 2014; Stepanchikova et al., 2018; Yatsyna et al., 2018). There it is regarded as an indicator of lowland old-growth forests (Motiejūnaitė et

al., 2004). In southern, mountainous part of Poland this crustaceous epiphyte has never been found to date, but it has been rarely recorded here and there in other mountainous regions of Central Europe including Switzerland, Austria, Luxembourg (Sérusiaux et al., 2001), Germany (Wirth et al., 2013), the Czech Republic (Malíček & Palice, 2013), and in Slovak and Ukrainian Eastern Carpathians (Sérusiaux et al., 2001; Pisút et al., 2007; Malíček et al., 2018a; Fig. 3C); recently this lichen has been also found in Caucasus (Vondrák et al., 2019). Everywhere in mountains it is mostly confined to old-growth, mainly beech forests, and therefore, also in montane environment, *F. gyrophorica* could be an indicator of most natural or primeval forest ecosystems. Here it is reported for the first time from Polish Carpathians.

GYALECTA RUSSELLA (Körb. ex Nyl.) Baloch, Lumbsch & Wedin, ≡ *Belonia russula* Körb. ex Nyl., = *Belonia fennica* Vain., = *Beloniella cinerea* Norman

Gagarina (2015) included also *Gyalecta lyngei* Baloch & Lücking, formerly *Belonia arctica* Lynge [invalid name, see Baloch et al. (2013)] as a synonym for this name, but without revision of the type specimen which is stored in O.

Specimen examined: Poland, Carpathians, Gorce Mts, Gorce National Park, N slope of Kudłoń Mt, forest section no. 12c, 49°34'36.2"N, 20°10'16.2"E, alt. 1120 m, Atpol Ge11, on calcareous sandstone wall of

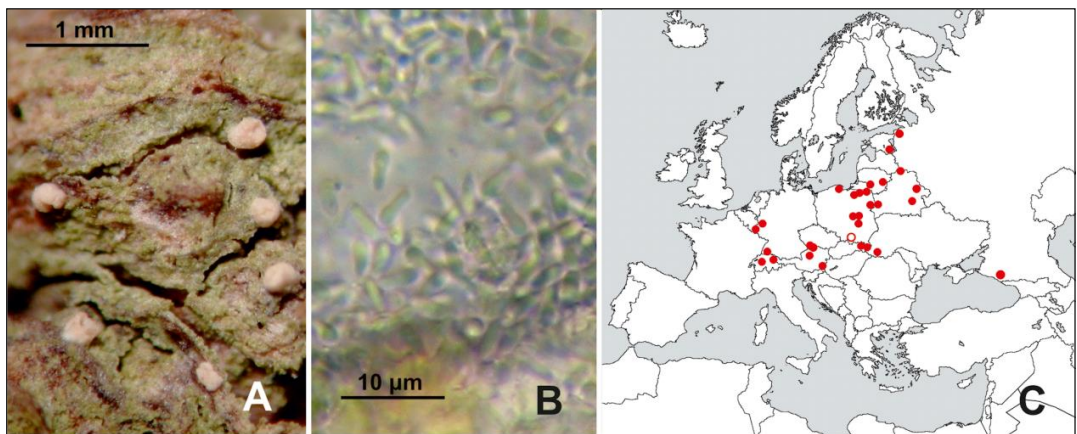


Fig. 3. *Fellhanera gyrophorica* Sérus., Coppins, Diederich & Scheid: A – habit of pycnidial stage, B – pycnosporangia (A–B: leg. P. Czarnota 8434; GPN), C – distribution in Europe; circles – localities known to date, ring – new locality in the Carpathians.

Kudłoński Baca outcrop, 20.06.2014, leg. P. Czarnota 8437 (GPN).

This epilithic lichen inhabiting more or less basic rocks was described few times by different lichenologists as to belong to different genera, but recent phylogenetic studies by Baloch et al. (2010) nested it again within *Gyalecta*.

The thallus of this lichen contains *Trentepohlia* algae, which is usually reflected in a reddish tinge of its thallus (see e.g. Purvis & Orange, 2009). In the case of the Polish finding, its inconspicuous perithecia-like fruiting bodies are

immersed in pale yellowish green thallus warts (Fig. 4C & D) without any reddish tinge, its less than 20-septate worm-like ascospores reached 60–80(–85) μm in length (Fig. 4B), and some part of asci seem to be 4-spored (Fig. 4A). These characteristics could refer to *Gyalecta calcicola* (Walt. Watson) Baloch & Lücking (see Purvis & Orange, 2009; Gagarina, 2015). Taxonomic position of this species, known only from Great Britain is, however, controversial; Purvis and Orange (2009) suggested that it could be conspecific with *G. russula*. We decided to keep our finding as *G. russula*, since its thallus is distinctly su-

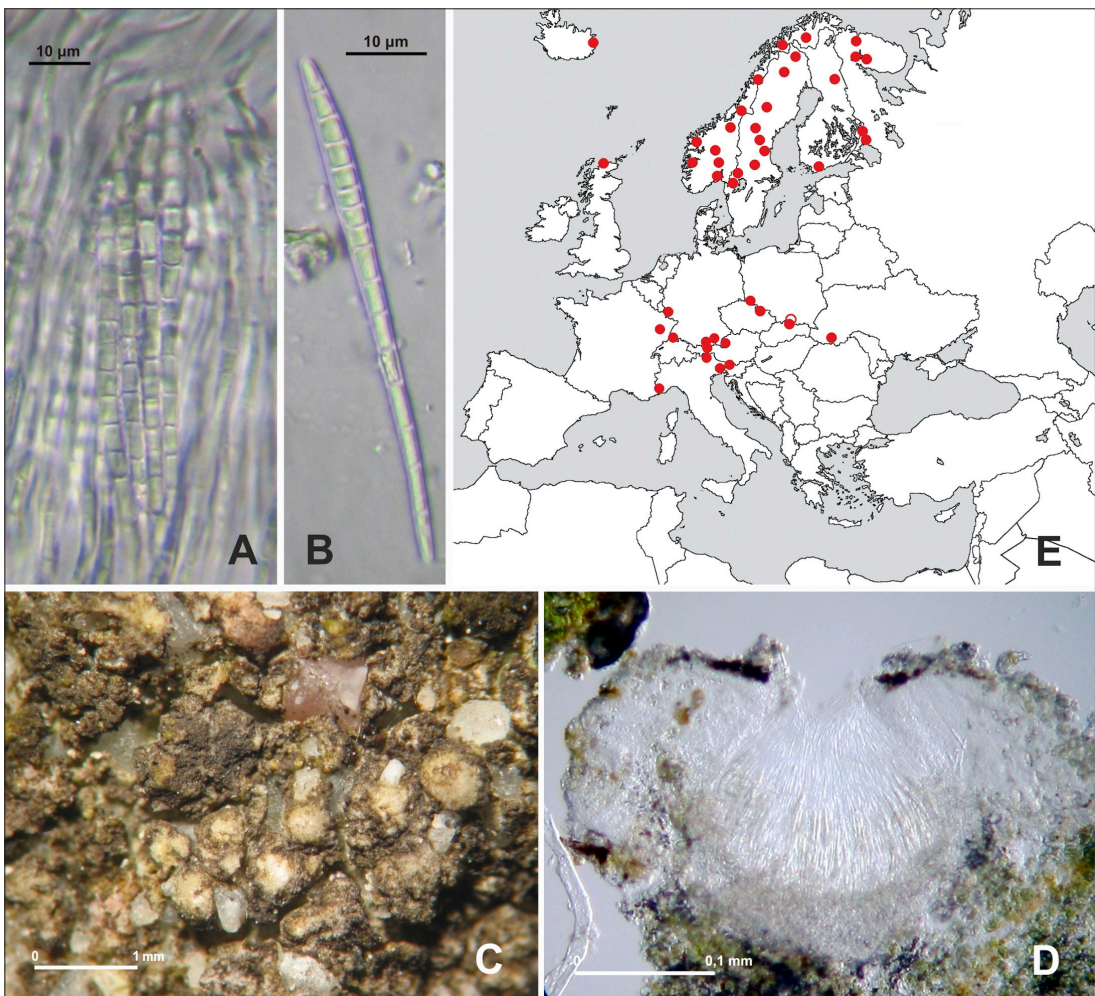


Fig. 4. *Gyalecta russula* (Körb. ex Nyl.) Baloch, Lumbsch & Wedin: A – hamathecium and ascus filled in ascospores, B – ascospore, C – habit, D – ascomal cross section (A–D: leg. P. Czarnota 8437; GPN), E – distribution in Europe; circles – localities known to date, ring – new locality in the Carpathians.

perforated, minutely areolate and inhabits slightly calcareous substrata contrary to semi-immersed thallus of *G. calcicola* which was found to date on limestones. The pale coloured thallus warts are probably due to usually dead additional algal cells reaching up to 25 µm in diam. and surrounded by gelatinous, thick walls of 3 µm in width. Moreover, Nimis and Martellos (2017) noted also, that *G. russula* found in Italian Alps can form pale yellowish grey verrucules, what seems to refer to our Polish finding.

Gyalecta russula is regarded as an alpine-arctic, probably circumpolar species (Nimis et al., 2018) since it is known in the whole Scandinavia, especially mountainous regions of Norway and Sweden, European NW Russia, Ural, Siberia and alpine as well as subalpine belts in mountains of Central Europe (Eitner, 1910; Vězda, 1959; Urbanavichus & Andreev, 2010; Wirth et al., 2013; Gagarina, 2015, and literature cited therein; <https://artskart.artsdatabanken.no/app>, accessed on 7.08.2019; Nimis et al., 2018), also in Scotland (Purvis & Orange, 2009), Alaska (Thomson & Sowl, 1989; Amchitka Island), Iceland (Kristinsson, 1999) and Greenland (Alstrup et al., 2009). This species has recently been also reported from Polish part of Sudetes being rediscovered after c. 150 years in the *locus classicus* of Giant Mountains (Kossowska, 2011). Several Carpathian records of *G. russula* are known in the Slovak part of Tatra Mts (see Lisická, 2005) and in the Ukrainian part of Eastern Carpathians, namely Czornohora Mts (Black Mountain) (Vondrák et al., 2010, and literature cited therein). In Polish Carpathians this saxicolous species has never been recorded before thus here it is the only locality in this part of the Carpathians.

TETRAMELAS CHLOROLEUCUS (Körb.) A. Nordin, ≡ *Buellia chloroleuca* Körb.; = *B. poeltii* T. Schauer; = *Tetramelas poeltii* (T. Schauer) Kalb

Specimen examined: Poland, Western Carpathians, High Tatra Mts, Tatra National Park, forest sec. no 47c, NW slope of Zabia Grań Mt near the border of Slovakia, 49°12'40"N, 20°05'24"E, alt. 1500 m, on bark of *Sorbus aucuparia* at the base of trunk close to the timber-line in upper mountain spruce forest, Atpol Ge60, 09.07.2002, leg. P. Czarnota 7561 (GPN); det. M. Giralt.

This species, under the name *Buellia chloroleuca*, was described by Körber (1865) based on the material collected in the currently Polish part of

Sudetes. Only recently Giralt et al. (2000) clearly re-defined *B. chloroleuca* showing characters of this species referring to *Tetramelas* Norman. The genus name was resurrected by Marbach (2000) for the group of *Buellia* s.l., which is generally characterized by the presence of xanthones (at least 6-O-methylarthothelin; see Elix, 2019), and two-layered spore wall with cracked, dark coloured perispore (Nordin, 2004). Based on the re-examined type materials, Giralt et al. (2000) synonymized also *Buellia poeltii* with *B. chloroleuca*. Finally, Nordin (2004) transferred this taxon to the genus *Tetramelas* including *T. poeltii*, the name earlier combined by Kalb (2004). The taxonomic distinction of *Tetramelas* from the other groups of polyphyletic *Buellia* s.l. was supported soon by the ITS phylogeny analysis (Nordin & Tibell 2005).

Diagnostic features of the Polish specimen (Fig. 5A–C) correspond well with the description of *T. chloroleucus* by Giralt et al. (2000), including thallus UV+ orange, K+ and C+ yellowish, KC+ orange reactions (due to the presence of xanthone), brown thick-walled ascospores with perispore, bacilliform, straight, 4.5–5.5(–6) × 1 µm conidia and its ecological requirements. Fałtynowicz (2003) included this species within the list of lichens in Poland using the former Körber's record and additional report by Kiszka and Kościelniak (1998). These authors excluded it, however, from their own Polish Eastern Carpathian list of lichens published in the same year (Kiszka & Kościelniak, 2003) as probably doubtful. Considering this, *T. chloroleucus* is reported here from Polish Carpathians for the first time, and rediscovered in Poland after 150 years.

This boreal-montane, epiphytic or wood inhabiting species is known to be widely distributed in high mountains of Europe, especially in Pyrenees, Alps (Giralt et al., 2000; Nimis et al., 2018) and Scandinavian mountains (Nordin, 2000). It has only recently been found in Carpathians, i.e. in Ukrainian (Dymytrowa et al., 2013) and Slovak (Vondrák et al., 2015) parts of Eastern Carpathians (Fig. 5D). Additional European records of *T. chloroleucus* are known in arctic regions of Russia (Zhdanov & Dudoreva, 2008), Norway and Island; in boreal forests in Finland (Nordin, 2000; Bjerke et al., 2011) and Lenin-grad Region of Russia (Himmelbrant et al., 2017). It is also reported from a distant area of Asian part of Russia (Urbanavichus & Andreev, 2010).

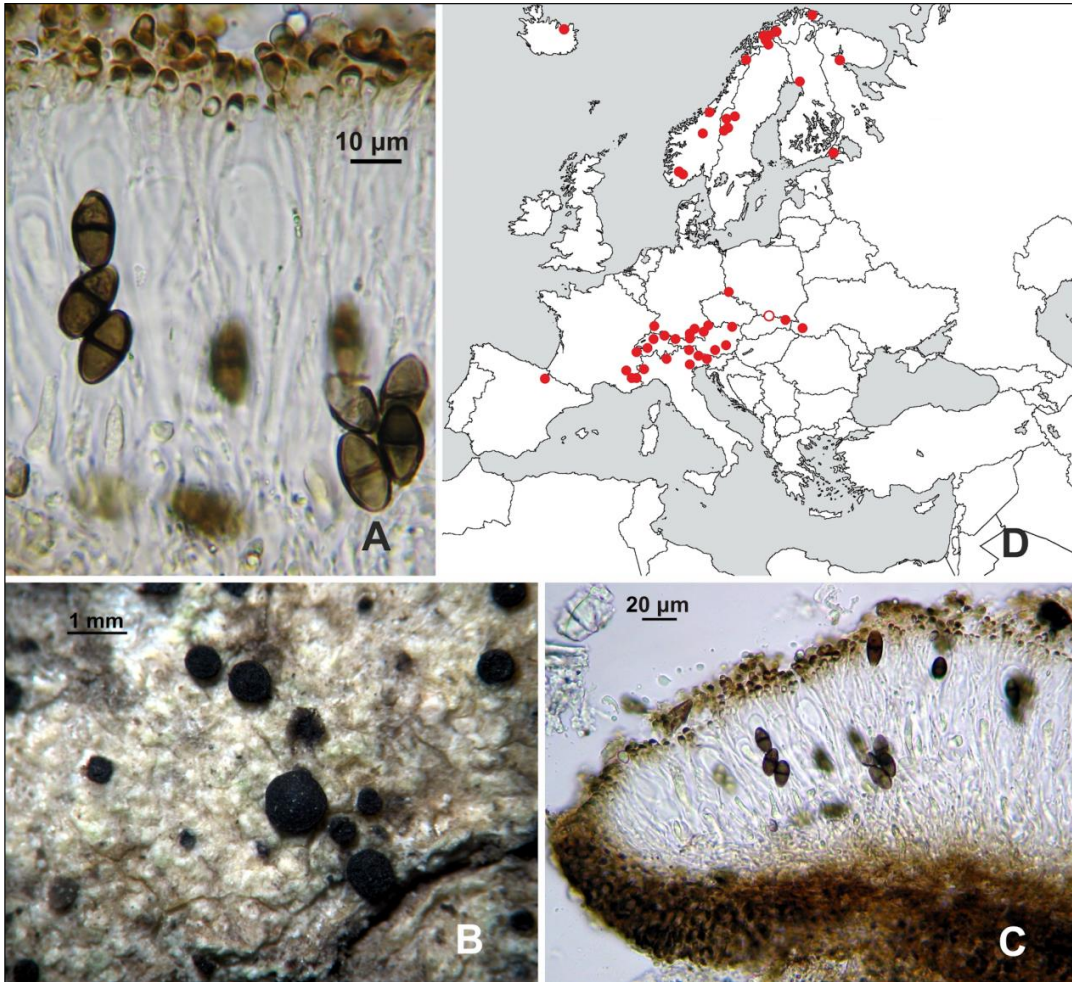


Fig. 5. *Tetramelas chloroleucus* (Körb.) A. Nordin: A – hamathecium with ascospores, B – habit, C – apothecial cross section (A–C: leg. P. Czarnota 7561; GPN), D – distribution in Europe; circles – localities known to date, ring – new locality in the Carpathians.

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REFERENCES

Alstrup, V., Kocourková, J., Kukwa M., Motiejūnaitė, J., von Brackel, W. & Suija, A. 2009. The lichens and lichenicolous fungi of South Greenland. *Folia Cryptogamica Estonica* 46: 1–24.
 Aptroot, A., van Herk, C. M., Sparrius, L. B. & van den Boom, P. P. G. 1999. Checklist van de Nederlandse lichenen en lichenicole fungi. *Buxbaumiella* 50(1): 1–64.

Aptroot, A., Czarnota, P., Jüriado, I., Kocourkvá, J., Kukwa, M., Lõhmus, P., Palice, Z., Randlane, T., Saag, L., Sérusiaux, E., Sipman, H., Sparrius, L.B., Suija, A. & Thüs, H. 2005. New or interesting lichens and lichenicolous fungi found during the 5th Symposium in Estonia. *Folia Cryptogamica Estonica* 41: 13–22.
 Ardelean, I. V., Keller, C. & Scheidegger, C. 2013. Lichen flora of Rodnei Mountains National Park (Eastern Carpathians, Romania) including new records for the Romanian mycoflora. *Folia Cryptogamica Estonica* 50: 101–115. <https://doi.org/10.12697/fce.2013.50.13>
 Baloch, E., Lücking, R., Lumbsch, H. T. & Wedin, M. 2010. Major clades and phylogenetic relationships

- between lichenized and non-lichenized lineages in Ostropales (Ascomycota: Lecanoromycetes). *Taxon* 59: 1483–1494. <https://doi.org/10.1002/tax.595013>
- Baloch, E., Lumbsch, H. T., Lücking, R. & Wedin, M. 2013. New combinations and names in *Gyalecta* for former *Belonia* and *Pachyphiale* (Ascomycota, Ostropales) species. *Lichenologist* 45(6): 723–727. <https://doi.org/10.1017/S0024282913000492>
- Bielczyk, U. 2003. The lichens and allied fungi of the Polish Western Carpathians. In: Bielczyk, U. (ed.) *The lichens and allied fungi of the Polish Carpathians – an annotated checklist*. Pp. 24–232. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- Bielczyk, U., Lackovičová, A., Farkas, E. E., Lőkös, L., Liška, J., Breuss, O. & Kondratyuk, S. Ya. 2004. *Checklist of lichens of the Western Carpathians*. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków. 181 pp.
- Bielczyk, U. & Kiszka, J. 2002. *Absconditella celata* (Stictidaceae) – a lichen species new to Poland. *Polish Botanical Journal* 47(1): 70–71.
- Bjerke, J. W., Mathiassen, G., Granmo, A. & Tibell, L. 2011. *Phaeocalicium compressulum* new to North Norway. *Graphis Scripta* 23: 33–35.
- Ceynowa-Gieldon, M. 2002. The genus *Epigloea* in Poland. *Acta Mycologica* 37(1/2): 3–11. <https://doi.org/10.5586/am.2002.001>
- Ceynowa-Gieldon, M. 2005. New localities of *Epigloea bactrospora* and *E. pleiospora* in Poland. *Graphis Scripta* 17: 52–55.
- Cieśliński, S. & Tobolewski, Z. 1988. Porosty (Lichenes) Puszczy Białowieskiej i jej zachodniego przedpola. *Phytocoenosis* 1 (N.S.), Suppl., *Cartographiae Geobotanicae* 1: 3–216.
- Ciurchea, M. 2007. Checklist of lichens and lichenicolous fungi of Romania. <http://www.academic.ro/lichens/Checklist.htm> (accessed on 12.12.2019)
- Coppins, B. J. 2009. *Absconditella Vězda* (1965). In: Smith, C. W., Aptroot, A., Coppins, B. J., Fletcher, A., Gilbert, O. L., James, P. W. & Wolseley, P. A. (eds). *The lichens of Great Britain and Ireland*. 123–124. British Lichen Society, London.
- Czarnota, P. 2011. *Micarea contexta* and *M. lynceola* (lichenized Ascomycota), new for Poland. *Polish Botanical Journal* 56(2): 307–313.
- Czarnota, P. 2015. *Lecania cuprea* and *Micarea pycnidophora* (lichenized Ascomycota) new to Poland. *Acta Societatis Botanicorum Poloniae* 84(2): 303–307. <https://doi.org/10.5586/asbp.2015.014>
- Czarnota, P. 2016. Contribution to the knowledge of some poorly known lichens in Poland IV. *Bacidia fuscoviridis* and *Bacidina brandii*. *Acta Mycologica* 51(1): 1074. <https://doi.org/10.5586/am.1074>
- Czarnota, P. & Hernik, E. 2013. Notes on two *Epigloea* species from Central Europe. *Acta Societatis Botanicorum Poloniae* 82(4): 321–324. <https://doi.org/10.5586/asbp.2013.030>
- Czarnota, P., Mayrhofer, H. & Bobiec, A. 2018. Noteworthy lichenized and lichenicolous fungi of open-canopy oak stands in east-central Europe. *Herzogia* 31: 172–189. <https://doi.org/10.13158/099.031.0111>
- Czyżewska, K., Motiejūnaitė, J. & Cieśliński, S. 2001. Species of lichenized and allied fungi new to Białowieża Large Forest (NE Poland). *Acta Mycologica* 36(1): 13–19. <https://doi.org/10.5586/am.2001.003>
- Döbblers, P. & Poelt, J. 1977. *Absconditella celata* spec. nov., eine Flechtenart aus Lappland. *Herzogia* 4: 363–366.
- Döbblers, P. 1984. Symbiosen zwischen Gallertalgen und Gallertpilzen der Gattung *Epigloea* (Ascomycetes). *Nova Hedwigia* 79: 203–239.
- Dymytrova, L., Nadyeina, O., Naumovych, A., Keller, C. & Scheidegger, C. 2013. Primeval beech forests of Ukrainian Carpathians are sanctuaries for rare and endangered epiphytic lichens. *Herzogia* 26: 73–89. <https://doi.org/10.13158/heia.26.1.2013.73>
- Eitner, E. 1910. Dritten Nachtrag zur Schesischen Flechten flora. *Schlesische Gesellschaft für vaterländische Kultur* 88(2b Abth.): 20–60.
- Elix, J. 2019. Notes on the genus *Tetramelas* (Cali-ciaceae, Ascomycota) in South America: Two new species from Peru, and a new combination. *Opuscula Philolichenum* 18: 390–395. <http://sweetgum.nybg.org/philolichenum/> (accessed on 12.12.2019)
- Fałtynowicz, W. 2003. *The lichens, lichenicolous and allied fungi of Poland*. W. Szafer Institute of Botany Polish Academy of Sciences, Kraków. 435 pp.
- Fałtynowicz, W. & Kossowska, M. 2018. The lichens of Poland. A fourth checklist. *Acta Botanica Silesiaca Monographiae* 8: 3–122.
- Flakus, A. 2014. *Lichens of the subnival belt of the Polish Tatra Mountains* (in Polish, English abstract). W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków. 280 pp.
- Frolov, I., Vondrák, J., Fernández-Mendoza, F., Wilk, K., Khodosovtsev, A. & Halici, M. G. 2016. Three new, seemingly-cryptic species in the lichen genus *Caloplaca* (Teloschistaceae) distinguished in two-phase phenotype evaluation. *Annales Botanici Fennici* 53(3–4): 243–262. <https://doi.org/10.5735/085.053.0413>
- Gagarina, L.W. 2015. *Gyalectoid lichens (families Gyalectaceae Stizenb. and Coenogoniaceae (Fr.) Stizenb. in extratropical Eurasia* (in Russian). Nestor-Istoria, Sankt Petersburg. 240 pp.
- Giralt, M., Barbero, M. & Elix, J. 2000. Notes on some corticolous and lignicolous *Buellia* species from the Iberian Peninsula. *Lichenologist* 32(2): 105–128. <https://doi.org/10.1006/lich.1999.0251>
- Golubkov, V.V. & Kukwa, M. 2006. A contribution to the lichen biota of Belarus. *Acta Mycologica* 41(1): 155–164. <https://doi.org/10.5586/am.2006.019>

- Grumann, V. J. 1968. Alte und neue Halbflechten. Ein neuer Flechten parasit. *Placynthium asperulum* neu für Mitteleuropa. *Sydowia* 22: 216–224.
- Guzow-Krzemińska, B., Czarnota, P., Lubek, A. & Kukwa, M. 2016. *Micarea soralifera* sp. nov., a new sorediate species in the *M. prasina* group. *Lichenologist* 48(3): 161–169. <https://doi.org/10.1017/S0024282916000050>
- Guzow-Krzemińska, B., Sérusiaux, E., van den Boom, P. P. G., Brand, A. M., Launis, A., Lubek, A. & Kukwa, M. 2019. Understanding the evolution of phenotypical characters in the *Micarea prasina* group (Pilocarpaceae) and descriptions of six new species within the group. *MycKeys* 57: 1–30. <https://doi.org/10.3897/mycokeys.57.33267>
- Himelbrant, D. E., Stepanchikova, I. S., Motiejūnaitė, J., Gerasimova J. V., Kuznetsova, E. S., Dyomina, A. V. & Tsurukau, A. G. 2017. New records of lichens and allied fungi from the Leningrad Region, Russia. VIII. *Folia Cryptogamica Estonica* 54: 63–70. <https://doi.org/10.12697/fce.2017.54.11>
- Holien, H., Frisch, A., Jonsson, F., Klepsland, J. T., Millanes, A. M., Motiejunaite, J., Prieto, M., Pykäää, J., Suija, A., Tsurukau, A., Westberg, M. & Bendiksby, M. 2016. Interesting lichenized and lichenicolous fungi found during the Nordic Lichen Society excursion in Nord-Trøndelag, Norway 2015. *Graphis Scripta* 28: 40–49.
- Jaag, O. & Thomas, E. 1934. Neue Untersuchungen über die flechte *Epigloea bactrospora* Zukai. *Berichte der Schweizerischen Botanischen Gesellschaft = Bulletin de la Société botanique Suisse* 43(1): 77–89.
- Jacobsen, P. 1990. *Epigloea bactrospora* fund in Denmark and Schleswig-Holstein. *Graphis Scripta* 3: 19.
- Kalb, K. 2004. New or otherwise interesting lichens II. *Bibliotheca Lichenologica* 88: 301–329.
- Kantvilas, G. & Jarman, S. J. 2012. Lichens and bryophytes in Tasmanian wet eucalypt forest: Floristics, conservation and ecology. *Phytotaxa* 59: 1–31. <https://doi.org/10.11646/phytotaxa.59.1.1>
- Kiszka, J. & Kościelniak, R. 1998. The flora of lichens in the Polish Eastern Carpathians. In: Kondratyuk, S. & Coppins, B. J. (eds). *Lobarion lichens as indicators of primeval forests of the Eastern Carpathians (Darwin International Workshop: honoured to the 100-years anniversary of a famous Ukrainian lichenologist Professor Alfred M. Oxner (1898–1973), 25–30 May 1998, Kostrino, Ukraine*. Pp. 82–101. M. H. Kholodny Institute of Botany, Phytosociocentre, Kiev.
- Kiszka, J. & Kościelniak, R. 2003. The lichens and allied fungi of the Polish Eastern Carpathians. In: Bielczyk, U. (ed.). *The lichens and allied fungi of the Polish Carpathians – an annotated checklist*. Pp. 233–294. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- Kossowska, M. 2011. New, rare and noteworthy lichens in the Giant Mountains. *Biologia* 66(5): 755–761. <https://doi.org/10.2478/s11756-011-0084-4>
- Körber, G. W. 1865. *Parerga lichenologica. Ergänzungen zum Systema Lichenum Germaniae*. Verlag von Eduard Trewendt, Breslau. 501 pp. <https://doi.org/10.5962/bhl.title.87905>
- Kristinsson, H. 1999. The 12th meeting of the Nordic Lichen Society in Eidar, Iceland 1997. *Graphis Scripta* 11(1): 13–21.
- Kubiak, D. 2011. Distribution and ecology of the lichen *Fellhanera gyrophorica* in the Pojezierze Olsztyńskie Lakeland and its status in Poland. *Acta Societatis Botanicorum Poloniae* 80(4): 293–300. <https://doi.org/10.5586/asbp.2011.035>
- Kukwa, M., Czarnota, P. & Lubek, A. 2017. Three lichen species in *Buellia*, *Catillaria*, and *Cheiromycina*, new to Poland. *Mycotaxon* 132: 177–182. <https://doi.org/10.5248/132.177>
- Lisická, E. 2005. *The lichens of the Tatry Mountains*. Veda, Bratislava. 439 pp.
- Lubek, A. 2009. New records of lichens from the Polish uplands. *Acta Mycologica* 44(2): 275–282. <https://doi.org/10.5586/am.2009.026>
- Maliček, J. & Palice, Z. 2013. Lichens of the virgin forest reserve Žofinský prales (Czech Republic) and surrounding woodlands. *Herzogia* 26: 253–292. <https://doi.org/10.13158/heia.26.2.2013.253>
- Maliček, J., Palice, Z. & Vondrák, J. 2014. New lichen records and rediscoveries from the Czech Republic and Slovakia. *Herzogia* 27: 257–284. <https://doi.org/10.13158/heia.27.2.2014.257>
- Maliček, J., Berger, F., Palice, Z. & Vondrák, J. 2017. Corticolous sorediate *Lecanora* species (Lecanoraceae, Ascomycota) containing atranorin in Europe. *Lichenologist* 49(5): 431–455. <https://doi.org/10.1017/S002428291700038X>
- Maliček, J., Palice, Z., Acton, A., Berger, F., Bouda, F., Sanderson, N. & Vondrák, J. 2018a. Uholka primeval forest in the Ukrainian Carpathians – a keynote area for diversity of forest lichens in Europe. *Herzogia* 31: 140–171. <https://doi.org/10.13158/099.031.0110>
- Maliček, J., Palice, Z., Vondrák, J., Lubek, A. & Kukwa, M. 2018b. *Bacidia albogranulosa* (Ramalinaceae, lichenized Ascomycota), a new sorediate lichen from European old-growth forests. *MycKeys* 44: 51–62. <https://doi.org/10.3897/mycokeys.44.30199>
- Maliček, J., Palice, Z., Vondrák, J., Kostovčík, M., Lenžová, V. & Hofmeister J. 2019. Lichens in old-growth and managed mountain spruce forests in the Czech Republic: assessment of biodiversity, functional traits and bioindicators. *Biodiversity and Conservation* 28(13): 3497–3528. <https://doi.org/10.1007/s10531-019-01834-4>
- Maliček, J., Palice, Z., Vondrák & Tønsberg, T. 2020. *Japewia aliphatica* (Lecanoraceae, lichenized

- Ascomycota), a new acidophilous sorediate-blasioid lichen from Europe. *Phytotaxa* (in review).
- Marbach, B. 2000. Corticole and lignicole Arten der Flechtengattung *Buellia* sensu lato in den Subtropen und Tropen. *Bibliotheca Lichenologica* 74: 1–384.
- Motiejūnaitė, J. & Prigodina-Lukošienė, I. 2002. *Chaenothecopsis rubescens* new to Lithuania and *Fellhanera gyrophorica* new to Estonia. *Graphis Scripta* 13: 43–44.
- Motiejūnaitė, J., Czyżewska, K. & Cieśliński, S. 2004. Lichens – indicators of old-growth forests in biocentres of Lithuania and North-East Poland. *Botanica Lithuanica* 10(1): 59–74.
- Nimis, P. L., Hafellner, J., Roux, C., Clerc, P., Mayrhofer, H., Martellos, S. & Bilovitz, P. O. 2018. The lichens of the Alps – an annotated checklist. *MycoKeys* 31: 1–634. <https://doi.org/10.3897/mycokeys.31.23568>
- Nimis, P. L. & Martellos, S. 2017. ITALIC – The Information System on Italian Lichens. Version 5.0. University of Trieste, Dept. of Biology. <http://dryades.units.it/italic> (accessed on 11.12.2019)
- Nordin, A. 2000. *Buellia chloroleuca* in the Nordic Countries. *Graphis Scripta* 11: 35–39.
- Nordin, A. 2004. New species in *Tetramelas*. *Lichenologist* 36(6): 355–359. <https://doi.org/10.1017/S0024282904014562>
- Nordin, A. & Tibell, L. 2005. Additional species in *Tetramelas*. *Lichenologist* 37(6): 491–498. <https://doi.org/10.1017/S0024282905015434>
- Notov, A. A., Himelbrant, D. E. & Urbanavichus, G. P. 2011. *The list of lichens and allied fungi of Tver Region* (in Russian, English abstract). Tver State University, Tver. 124 pp.
- Orange, A., James, P. W. White, F. J. 2001. *Microchemical methods for the identification of lichens*. British Lichen Society, London. 101 pp.
- Palice, Z. 1999. New and noteworthy records of lichens in the Czech Republic. *Preslia* 71: 289–336.
- Pisút, I., Lackovičová, A., Guttová, A. & Palice, Z. 2007. New lichen records from Bukovské Vrchy Mts (NE Slovakia). *Acta Mycologica* 42(2): 267–280. <https://doi.org/10.5586/am.2007.030>
- Purvis, O. W. & Orange, A. 2009. *Belonia* Körb. ex Nyl. (1857). In.: Smith, C. W., Aptroot, A., Coppins, B. J., Fletcher, A., Gilbert, O. L., James, P. W. & Wolseley, P. A. (eds). *The lichens of Great Britain and Ireland*. Pp. 211–212. British Lichen Society, London.
- Sérusiaux, E., Coppins, B. J., Diederich, P. & Scheidegger, C. 2001. *Fellhanera gyrophorica*, a new European species with conspicuous pycnidia. *Lichenologist* 33(4): 285–289. <https://doi.org/10.1006/lich.2001.0328>
- Sparrius, L. B. 2002. Discovery of apothecia confirms generic position of *Fellhanera gyrophorica*. *Lichenologist* 34(1): 86. <https://doi.org/10.1006/lich.2002.0370>
- Spribile, T., Björk, C. R., Ekman, S., Elix, J. A., Goward, T., Printzen, C., Tønsberg, T. & Wheeler, T. 2009. Contributions to an epiphytic lichen flora of northwest North America: I. Eight new species from British Columbia inland rain forests. *Bryologist* 112(1): 109–137. <https://doi.org/10.1639/0007-2745-112.1.109>
- Stepanchikova, I. S., Himelbrant, D. E., Motiejūnaitė, J., Ahti, T., Suija, A., Kuznetsova, E. S. & Dyomin, A. V. 2018. New records of lichens and allied fungi from the Leningrad Region, Russia. IX. *Folia Cryptogamica Estonica* 55: 117–124. <https://doi.org/10.12697/fce.2018.55.12>
- Thomson, J. W. & Sowl, L. W. 1989. Additional records of lichens from Amchitka Island, Alaska. *Evansia* 6(1): 7–11.
- Urbanavichene, I. N. & Palice, Z. 2016. Rarely recorded lichens and lichen-allied fungi from the territory of the Baikal Reserve – additions for lichen flora of Russia. *Turczaninowia* 19(1): 42–46. <https://doi.org/10.14258/turczaninowia.19.1.5>
- Urbanavichus, G. P. & Andreev, M. P. 2010. *A checklist of the lichen flora of Russia*. Nauka, Sankt Petersburg. 194 pp.
- Vězda, A. 1959. K taxonomii rozsireni a ekologii lisejniku *Belonia russula* Krb. v Estredni Evrope [On the distribution and ecology of the lichen *Belonia russula* in Central Europe]. *Prirodovedny Casopis Slezsky, Opava* 20: 241–253 (in Czech).
- Vondrák, J., Šoun, J., Lőkös, L. & Khodosovtsev, A. 2009. Noteworthy lichen-forming and lichenicolous fungi from the Bükk Mts, Hungary. *Acta Botanica Hungarica* 51(1–2): 217–230. <https://doi.org/10.1556/ABot.51.2009.1-2.20>
- Vondrák, J., Palice, Z., Khodosovtsev, A. & Postoyalkin, S. 2010. Additions to the diversity of rare or overlooked lichens and lichenicolous fungi in Ukrainian Carpathians. *Chornomors'kyi Botanichnyi Zhurnal* 6(1): 6–34. <https://doi.org/10.14255/2308-9628/10.61/1>
- Vondrák, J., Maliček, J., Šoun, J. & Pouska, V. 2015. Epiphytic lichens of Stuzica (E Slovakia) in the context of Central European old-growth forests. *Herzogia* 28: 104–126. <https://doi.org/10.13158/heia.28.1.2015.104>
- Vondrák, J., Urbanavichus, G., Palice, Z., Maliček, J., Urbanavichene, I., Kubásek, J. & Ellis, C. 2019. The epiphytic lichen biota of Caucasian virgin forests: a comparator for European conservation. *Biodiversity and Conservation* 28: 3257–3276. <https://doi.org/10.1007/s10531-019-01818-4>
- Wirth, V., Hauck, M. & Schultz, M. 2013. *Die Flechten Deutschlands*. 2 Bände. E. Ulmer, Stuttgart. 1244 pp.
- Yatsyna, A. 2014. Lichens from manor parks in Minsk region (Belarus). *Botanica Lithuanica* 20(2): 159–168. <https://doi.org/10.2478/botlit-2014-0016>
- Yatsyna, A. P., Gagarina, L. V., Konoreva, L. A. & Chesnokov, S. V. 2018. Lichens and closely re-

lated fungi of manor parks of the Mogilev region (Republic of Belarus). *Bulletin of Bryansk dpt. of RBS* 14(2): 26–42 (in Russian, English abstract).

Zahlbruckner, A. 1923. *Catalogus Lichenum Universalis* 2. Bornträger, Leipzig. 815 pp.

Zhdanov, I. S. & Dudoreva, T. A. 2008. Lichen flora of Kandalakshsky State Reserve (Murmansk Re-

gion): history of investigations and first results. In: *Fundamental and applied problems in botany at the beginning of XXI century. Proceedings of XII congress of Russian Botanical Society, part 2* (in Russian). Petrozavodsk. Pp. 189–192.