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ORIGINAL RESEARCH PAPER

Additions to the lichen biota of the Sudety Mountains. I. Records from the Karkonosze Mountains

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Abstract
Records of 10 rare and noteworthy lichen species in Poland have been presented. Four species, *Japewia subaurea*, *Myriolecis persimilis*, *Palicella filamentosa*, and *Scoliciosporum sarothamni* are new to the Polish part of the Sudetes. *Anisomeridium polypori* and *Pyrenula coryli* are new species to the Karkonosze Mountains.

Keywords
lichenized fungi; lichen diversity; epiphytic lichens; Lower Silesia

Introduction

The Sudety Mountains are one of regions with the richest and the best-known lichen biota in Poland, with more than 1,000 species recorded to date (Kossowska, unpublished). Nevertheless, detailed studies still provide new data about the occurrence and distribution of lichen species (e.g., [1–3]). In addition, there are still some Sudetian mountain ranges where this group of organisms is poorly recognized. The aim of this new series of publications is to expand our knowledge and to provide the most up-to-date information about interesting and rare lichen taxa in Poland.

In this paper, 10 noteworthy lichen species have been presented. All these species were found in the highest Sudetian range, the Karkonosze Mountains. Four of them, *Japewia subaurea*, *Myriolecis persimilis*, *Palicella filamentosa*, and *Scolicosporum sarothamni* have been reported for the first time from the Polish part of the Sudetes. Two others, *Anisomeridium polypori* and *Pyrenula coryli*, are new to the Karkonosze Mountains.

Material and methods

The species were recorded mainly during the third edition of the monitoring of epiphytic lichens on permanent sample plots in the Karkonoski National Park, carried out in 2016. The methodology of the monitoring used has been described in detail in [4].

Collected specimens were identified using standard techniques, with an aid of a Nikon SMZ-U stereoscope and a Nikon Eclipse E600 light microscope. Anatomical

characters were measured from hand-cut sections. Brief descriptions of the species are based on own observations and measurements. Chemical properties of the thalli were examined using standard reagents: 10% potassium dioxide (K), sodium hypochlorite (C), *p*-phenylenediamine in ethanol (Pd), and Lugol's iodine (I). A content of secondary metabolites was determined by thin layer chromatography (TLC) in solvent A [5].

Localities of each species are arranged according to ATPOL grid square system [6]. Collected material has been deposited in the lichen herbarium of the first author. Names of the taxa are given according to [7].

Results

Anisomeridium polypori (M. B. Ellis & Everh.) M. E. Barr.

Thallus very thin and inconspicuous, greenish. Ascomata perithecia, not seen in collected material. Specimen identified on the basis of characteristic, conical pycnidia containing macroconidia. Pycnidia numerous, black, 0.1–0.15 mm diam., sessile, with gelatinous, white tendril containing elipsoid conidia ejected from the ostiole.

Anisomeridium polypori is one of the species with rapidly increasing number of records in Poland. In the twentieth century, it was reported only from a northern part of the country [8]; now this species has been identified at many sites, including central and southern Poland [9–13]. It is difficult to confirm if this species is actually spreading or the increasing number of localities is the result of a more thorough examination of the lichen biota. The reported site of *Anisomeridium polypori* is the first one in the Polish part of the Karkonosze Mountains.

Specimen examined. Eb 80 – Eastern Karkonosze Mts, NE slope of the Kopa Mt, between Łomniczka and Wilczy Potok streams, 50°45′29.3″ N / 15°44′53.7″ E, on the bark of *Betula pendula*, July 6, 2016, leg. A. Piegdoń & H. Fałtynowicz.

Cladonia caespiticia (Pers.) Flörke

Thallus composed of irregularly incised, erect squamules forming cushions. Podetia very short, without algal layer, translucent when wet. Apothecia pale brown to brown, either on podetia or sessile directly on squamules. Brown pycnidia also present on the upper surface and the edges of squamules. Thallus turns red with Pd because of the presence of fumaroprotocetraric acid.

Although this species is widespread in Poland, it is rather rare and considered endangered (category EN in Polish red list of lichens [14]). Contemporarily, it was recorded in several mountain ranges belonging to the Sudetes, namely in the Masyw Śnieżnika (Śnieżnik Massif) and Bialskie Mountains [15], Pogórze Kaczawskie (Kaczawskie Foothills) [16], Kotlina Jeleniogórska (Jelenia Góra Basin) [17], and Stołowe Mountains [13]. The new findings presented here are the first ones in the Karkonosze Mountains since the beginning of the twentieth century [18,19].

Specimens examined. Ea 79 – Pogórze Karkonoskie (Karkonosze Foothills), Dolina Choińca (Choiniec Valley), 50°49′51.7″ N / 15°39′ 11.1″ E, on the base of *Picea abies*, July 31, 2016, leg. A. Piedgoń & H. Fałtynowicz; E slope of Żar Mt, 50°49′45.1″ N / 15°38′55.9″ E, on the base of *Fagus sylvatica*, July 31, 2016, leg. A. Piedgoń & H. Fałtynowicz.

Japewia subaurifera Muhr & Tønsberg

Thallus almost entirely sorediate, yellowish brown. Soralia initially discrete, but soon coalescing to form thick, leprose crust. Soredia granular, externally brown, internally yellow (visible in abraded soralia), with characteristic oil droplets. Brown pigment of soredia became K+ fuscous. Apothecia are not present in the collected specimen.

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Japewia subaurifera was reported in Poland for the first time from an upper montane belt in the Tatra Mountains [20]. Until now, it was known in the country to be present only in montane spruce forests in the Carpathians [21]; however, in the Czech Republic, this species was recorded also in the Sudety Mountains [22]. Although in Scandinavian boreal forests this species grows on various deciduous trees, like *Betula* spp., *Sorbus aucuparia* and *Alnus incana* [23], in Poland and the Czech Republic it was collected only from conifers. The new finding extends the range of *Japewia subaurifera* on the Polish part of the Sudetes; it is also the first Polish record of this species on a deciduous phorophyte.

Specimen examined. Ea 79 – Western Karkonosze Mts, slope above Jagniątków, 50°48′32.6″ N / 15°36′36.9″ E, on the bark of *Betula pendula*, July 22, 2016, leg. K. Patejuk & P. Jarema.

Mycoblastus sanguinarius (L.) Norman

Thallus crustose, very thick, with irregular, verrucose surface, pale grey. Apothecia numerous, big (up to 1 mm diam.), black and shining, at first plane but soon becoming convex. Easily distinguished by characteristic carmine-red pitts visible when thallus or apothecia are damaged. The same red pigment is also present in the hypothecium. Hymenium aeruginose throughout in examined specimen. Spores large, 90–95 µm, with thick walls. Thallus reacts K+ and Pd+ faintly yellow.

Mycoblastus sanguinarius is a rather rare boreal lichen, occurring in the northern and southern, mountainous regions of Poland [8]. Contemporarily, in the Sudetes, it was found only in the Karkonosze Mountains [24] and the Masyw Śnieżnika [25,26].

Specimen examined. Ea 78 – Western Karkonosze Mts, upper part of the Dolina Kamieńczyka (Kamieńczyk Valley), 50°47′50.1″ N / 15°30′02.4″ E, on the bark of *Picea abies*, July 28, 2016, leg. M. Dimos-Zych & M. Buksakowska.

Myriolecis persimilis (Th. Fr.) Śliwa, Zhao Xin & Lumbsch

Thallus almost inapparent, membranaceous, grey. Apothecia partly single, partly clustered in groups of two–three, widely attached to the substratum. Thalline margin olive-brown, slightly pruinose at the edge. Discs pale brown to chocolate, glossy. Hymenium ca. 50 µm, with olive brown epithecium. Spores elipsoid, 10–12 × 5–6 µm.

Myriolecis persimilis is very often reported in recent lichenological literature and seems to be common in Poland. Probably it has been overlooked earlier because of growing predominantly on twigs and small branches [27]. However, all Polish records to date were from northern and central part of the country [28–34]. The new finding is the first from the mountainous areas in the south of Poland and the species is new in the Polish Sudetes.

Specimen examined. Ea 78 – Western Karkonosze Mts, slope Gawry below the Mały Śnieżny Kocioł (Mały Śnieżny Cirque), 50°47′13.2″ N / 15°33′37.7″ E, on the bark of *Sorbus aucuparia*, July 30, 2016, leg. M. Dimos-Zych & M. Buksakowska.

Palicella filamentosa (Stirt.) Rodr. Flakus & Printzen

Thallus continuous or cracked-areolate, white to pale greenish-grey. Apothecia numerous, usually crowded, variable in color, from pale brown to almost black. Thalline exciple present in early stages, but soon excluded and only true exciple visible. Hymenium ca. 50 µm, with brown epithecium. Hypothecium and exciple colorless. Spores single, ellipsoid, 12–14 × 4–5 µm. Thallus reacts K+ and Pd+ yellow because of the presence of atranorin.

This is a member of newly described genus *Palicella* [35], in former Polish literature known mainly as *Lecidea ramulicola* (H. Magn.) Hillman or *Lecanora ramulicola* (H.

Magn.) Printzen & P. F. May. The species has been considered rare in Poland. However, recent detailed studies [36] showed that it was quite frequent in the country and only had been misidentified or generally misunderstood. To date, the known distribution of *Palicella filamentosa* in Poland included areas from the Baltic coast to the Western Carpathians; the species was recorded also in the Czech part of the Sudety Mountains near the Polish border [37]. Here, it is reported as new to the Polish Sudetes. The specimens of *P. filamentosa* were collected on 19 dispersed sites in the Karkonosze Mountains; the species seems to be widespread and frequent on spruce in upper montane belt of this mountain range. Probably it had been collected earlier but not properly identified because of nomenclatural and taxonomical confusion concerning this taxon in the Polish literature [36].

Selected specimens examined. Ea 78 – Western Karkonosze Mts, "Zielony Klin" – N slope of Mumlawski Wierch Mt, 50°48′02.1″ N / 15°28′12.9″ E, on the bark of *Picea abies*, July 30, 2016, leg. A. Piegdoń & H. Fałtynowicz; N slope of Czeskie Kamienie Mt, 50°46′54.9″ N / 15°35′25.4″ E, on the bark of *Picea abies*, July 19, 2016, leg. A. Piegdoń & H. Fałtynowicz.; **Ea 89** – Western Karkonosze Mts, N slope of Ptasi Kamień Mt, 50°46′04.5″ N / 15°37′44.4″ E, on the bark of *Picea abies*, July 20, 2016 leg. M. Dimos-Zych, A. Piegdoń & H. Fałtynowicz; Eastern Karkonosze Mts, valley of Pląsawa Stream above Polana, 50°45′46.8″ N / 15°42′04.8″ E, on the bark of *Picea abies*, July 15, 2016, leg. K. Patejuk & H. Fałtynowicz; **Eb 80** – Eastern Karkonosze Mts, Sowia Przełęcz (Sowia Pass), 50°44′51.3″ N / 15°47′12.3″ E, on the bark of *Picea abies*, July 8, 2016, leg. A. Piegdoń & H. Fałtynowicz; Kowarski Grzbiet (Kowary Ridge), 50°45′17.9″ N / 15°48′27.8″ E, on the bark of *Picea abies*, July 7, 2016, leg. K. Patejuk & P. Jarema.

Porina leptalea (Durieu & Mont.) A. L. Sm.

Thallus very thin, smooth, dark olive green. Ascomata perithecia, one half immersed in the substrate, reddish brown and glossy, 0.2–0.3 mm in diam. Involucrellum orange in section, containing algal cells (*Trentepohlia* sp.). Excipulum colorless, ca. 200 µm wide. Spores one–three-septate, fusiform, 20 × 4–5 µm. Easily distinguished from the other corticolous species of the genus, *P. aenea*, by the color of perithecia.

Porina leptalea is considered rare and endangered in Poland (category EN on the Polish red list of lichens [11]). All the known localities of this species are concentrated in mountainous parts of the country [38–42]. In the Sudety Mountains, it is known from several contemporary localities in Masyw Śnieżnika [43], Pogórze Kaczawskie [16], and Karkonosze Mountains [44]. New record suggests that this species is probably widely distributed, at least in a southern part of Poland, but may have been overlooked.

Specimen examined. Ea 89 – Eastern Karkonosze Mts, Kocioł Łomniczki (Łomniczka Cirque), 50°44′30.6″ N / 15°44′08.8″ E, on the base of *Picea abies*, intermixed with *Micarea botryoides*, July 11, 2016, leg. M. Dimos-Zych & M. Buksakowska.

Pyrenula coryli A. Massal.

"Thallus" inconspicuous, greyish, apparently not lichenized. Perithecia numerous, ca. 0.2 mm diam, with colorless excipulum and laterally extended involucrellum. Spores 15–17 × 5 µm, three-septate, with strongly thickened walls and lenticular cells. No pycnidia visible in the collected material.

This species is often considered nonlichenized and named *Mycopyrenula coryli* (A. Massal.) Vain. However, scattered cells of the photobiont are sometimes present in the "thallus" [45,46]. *Pyrenula coryli* is rarely reported in the lichenological literature; in Poland, only historical data from the nineteenth and early half of twentieth centuries are available [8]. The new record is the first one from the Karkonosze Mountains.

Specimen examined. Ea 78 – Western Karkonosze Mts, slope Gawry below Mały Śnieżny Kocioł, 50°47′13.2″ N / 15°33′37.7″ E, on the bark of *Sorbus aucuparia*, July 30, 2016, leg. M. Dimos-Zych & M. Buksakowska.

Pyrenula nitida (Weigel) Ach.

Thallus continuous or cracked, partly immersed in the substrate, olive, with dot-like pseudocyphellae. Perithecia big, up to 0.8 mm diam., black and shiny. Outer part of hymenium with orange-brown mass of anthraquinones, K+ purple-red. Spores three-septate, with strongly thickened walls and lenticular cells, pale brown, 20–24 × 6–7 µm. Pycnidia numerous, with simple, curved conidia. Thallus K+ orange.

Pyrenula nitida is widespread in Poland [8] but has not been found frequently. Cieśliński et al. [14] considered it endangered in the country (cat. VU). In the Sudety Mountains, this species used to be common [18], but in the twenty-first century, it was reported only from several sites in the Masyw Śnieżnika [15] and Stołowe Mountains [13]. The localities reported here are the first from the Polish part of the Karkonosze Mountains.

Specimens examined. Ea 79 Western Karkonosze Mts, Dolina Czerwienia (Czerwień Valley), on bark of *Fagus sylvatica*, July 2011, leg. K. Kobylnik; **Eb 80** – Eastern Karkonosze Mts, valley of Łomniczka Stream above Karpacz-Wilcza Poręba, 50°45′42.7″ N / 15°45′39.3″ E, on the bark of *Betula pendula*, July 7, 2016, leg. M. Dimos-Zych, M. Buksakowska, K. Patejuk, P. Jarema, A. Piegdoń & H. Fałtynowicz.

Scoliciosporum sarothamni (Vain.) Vězda

Thallus thin and warted, olive brown, sorediate. Soralia initially discrete, punctiform, 0.1 mm wide, later coalescing and becoming contiguous. Soredia minutely granular, yellowish green, C+ faintly red. Apothecia numerous in examined material, pale brown to almost black, 0.2–0.3 mm diam. Hymenium 50–60 µm, brown in the upper part. Hypothecium colorless. Spores curved to S-shaped, spirally arranged in the ascus, mostly three-septate, 20–35 × 2–3 µm. Distinguished from the common *S. chlorococcum* by the presence of soralia reacting with C, and twisted spores [47].

This species was reported from Poland for the first time by Kowalewska and Kukwa [48], who recorded it on several sites in the northern part of the country. Since then *S. sarothamni* has been found in many regions of Poland [32,49–52]. It seems to be common but was probably overlooked because of its inapparent habitus. Here, it is reported as new to the Polish part of the Sudetes.

Specimen examined. Eb 80 – Eastern Karkonosze Mts, Kowarski Grzbiet, N slope of the Czoło Mt, 50°45′37.5″ N / 15°48′58.6″ E, on twigs of *Betula pendula*, together with *Lecanora conizaeoides*, July 7, 2016, leg. A. Piegdoń & H. Fałtynowicz.

Discussion

Presented results of the lichenological investigations raised the number of lichen species known from the Polish part of the Karkonosze Mts to 631 [53,54]. The lichen biota of this mountain range is one of the richest and the best known in the mountainous part of Poland; in number of recorded species, it yields only to the Tatras [55–57]. However, in the latter half of the twentieth century, the Karkonosze Mts were affected by an ecological disaster. Most of the epiphytic lichens disappeared due to the catastrophic level of air pollution. Only recently, a slow regeneration of the lichen biota has been observed. This process has been manifested by the increasing number of localities of species sensitive to air pollution, as well as appearance of new taxa and reappearance of regionally extinct ones [58]. Presented results seem to confirm this optimistic tendency.

Almost all new and interesting lichens reported here produce inconspicuous, crustose thalli, easy to overlook during the routine lichenological research. Therefore, detailed field investigations, conducted throughout the Karkonosze Mts as a part of the monitoring program, provided a better opportunity to record them. It is worth emphasizing that almost all reported taxa were recorded on single localities. The only widely distributed new species was *Palicella filamentosa*.

Four of six species reported here as new to the Karkonosze Mountains, *Anisomeridium polypori*, *Japewia subaurifera*, *Pyrenula nitida*, and *Scoliciosporum sarothamni*, were collected on birches, i.e., trees that are only admixed in mountain forests dominated by spruce. Birch is a very interesting phorophyte, offering various microhabitats suitable for different lichen species (young bark is thin and smooth, then starts to peel, finally it is thick and cracked, with various chemical properties [59]). In the Karkonosze Mts, birch is one of the phorophytes with the most rapidly increasing number of recorded lichen species [60]. In the future, special attention should be paid to trees of this species as potential sources of lichen propagules and centers of recolonization.

Although relatively well recognized, the lichen biota of the Karkonosze Mountains, as well as the Sudetes as a whole, still requires careful and thorough studies. Further detailed researches, especially in the areas and habitats investigated in a lesser extent, may result in more discoveries. Because of the general improvement of aerosanitary conditions and the great return of lichens to their former localities, which is observed in various parts of Europe [61–63], in the future we can also expect to find species of large, foliose and fruticose macrolichens, known now only from the historical records [60].

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