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Noteworthy species of the genus *Rhizocarpon* Ramond ex DC.  
(Rhizocarpaceae, lichenized Ascomycota) in the LBL herbarium

Interesujące gatunki z rodzaju *Rhizocarpon* Ramond ex DC. (Rhizocarpaceae, zlichenizowane  
Ascomycota) w zielniku LBL

SUMMARY

*Rhizocarpon* Ramond ex DC. is a large genus of c. 200 species included in the family Rhizocarpaceae. It is widely distributed in all parts of the world but particularly in alpine and polar regions. Species of the genus grow on rock and are long-living. They have been widely used in studies on moraine-dating, in a procedure known as lichenometry. In the herbarium collection of the Botany and Mycology Department of UMCS (LBL) there are housed rare and interesting species of the genus *Rhizocarpon*. There are: *Rhizocarpon chioneum*, *R. copelandii*, *R. eupetraeoides*, *R. eupetraeum*, *R. furfurosum*, *R. hochstetteri*, *R. intermediellum*, *R. jemtlandicum*, *R. postumum*, *R. pusillum*, *R. renneri*, *R. richardii*, *R. ridescens*, *R. rittokense*, *R. sublucidum*, *R. superficiale*. The non-yellow species of the genus *Rhizocarpon* with hyaline and muriform ascospores are represented in the collection by *Rhizocarpon furfurosum*, *R. postumum*, the species with dark and muriform ascospores by *R. eupetraeum*, *R. renneri* and with 2-celled ascospores – *R. chioneum*, *R. copelandii*, *R. hochstetteri*, *R. jemtlandicum*, *R. richardii*, *R. rittokense*. The yellow species of the genus *Rhizocarpon* with 2-celled ascospores are *R. eupetraeoides*, *R. pusillum*, *R. superficiale* and the species with muriform ascospores are *R. intermediellum*, *R. ridescens* and *R. saanaense*. These taxa are known from North America and continental Europe, Asia and Africa. Their morphology, anatomy, ecology and distribution are briefly discussed in the present paper. The most important characters for separating the treated species are pruinosity of thallus, number of ascospores in asci, ascospores size and number of cells per ascospore, insoluble lichen pigments of the epihymenium and proper exciple and lichen substances.

## STRESZCZENIE

Rodzaj *Rhizocarpon* Ramod ex DC. należy do rodziny Rhizocarpaceae; liczący około 200 gatunków, występujących na całym świecie, szczególnie na terenach alpejskich i polarnych. Porosły z tego rodzaju rosną na skałach i są długowieczne. Stosowane są do datowania wieku moren, w metodzie zwanej lichenometrią. W kolekcji zielnikowej Zakładu Botaniki i Mikologii UMCS (LBL) znajduje się wiele rzadkich i interesujących gatunków tego rodzaju. Są to: *Rhizocarpon chioneum*, *R. copelandii*, *R. eupetraeoides*, *R. eupetraeum*, *R. furfurosum*, *R. hochstetteri*, *R. intermediellum*, *R. jemtlandicum*, *R. postumum*, *R. pusillum*, *R. renneri*, *R. richardii*, *R. ridescens*, *R. rittokense*, *R. sublucidum*, *R. superficiale*. Gatunki o plechach szarych i brązowych, z jasnymi i murkowatymi askosporami to *Rhizocarpon furfurosum*, *R. postumum*, z ciemnymi i murkowatymi zarodnikami – *R. eupetraeum*, *R. renneri*, z dwukomórkowymi zarodnikami – *R. chioneum*, *R. copelandii*, *R. hochstetteri*, *R. jemtlandicum*, *R. richardii*, *R. rittokense*. Żółte plechy i 2-komórkowe zarodniki posiadają *R. eupetraeoides*, *R. pusillum*, *R. superficiale*, a zarodniki murkowane – *R. intermediellum*, *R. ridescens*, *R. saanaense*. Taksony te znane są z Ameryki Północnej, kontynentalnej Europy, Azji i Afryki. W pracy omówiono ich morfologię, anatomię, ekologię i rozmieszczenie. Ważnymi cechami diagnostycznymi przy wyróżnianiu poszczególnych gatunków są: morfologia plechy, liczba zarodników w workach, ich wielkość oraz liczba komórek budujących zarodniki, zabarwienie epihymenium i excipulum oraz substancje porostowe.

Keywords: lichens, *Rhizocarpon*, rare species, new records, Carpathians, Poland, LBL herbarium.

## INTRODUCTION

Lichens have been an interesting subject for scientific research since the end of the 19<sup>th</sup> century. Collections of lichens which have been compiled for many years, may now be the only source of information about lichens from various areas. This kind of data is particularly valuable since many taxa have perished, over the years not only in regions but in the whole countries. Lichen collections are held in the herbaria, most often located in big university centers. Herbarium collection of lichens housed at the Institute of Botany and Mycology of Maria Curie-Skłodowska University in Lublin is particularly valuable, since unique and one of the richest in Poland. It includes specimens not only from Poland but from many other countries of Europe and Asia, as well as North America. An eminent Polish lichenologists – Józef Motyka (1900–1984), Jan Rydzak (1908–1971) and Jan Bystrek (*professor emeritus*) have been working at this institute.

The object of this research is *Rhizocarpon* Ramond ex DC. It is a large genus of about two hundred species of which many are widespread, occurring in temperate, often alpine and/or polar habitats. It is included in the family Rhizocarpaceae M. Choisy ex Hafellner, together with the genera *Catolechia* Flot., *Epilichen* Clem. and *Poeltinula* Hafellner (Hafellner 1984; Kirk et al. 2001; Eriksson et al. 2004; Feuerer & Timdal 2004; Ihlen 2004; Pennycook & Galloway 2004; Eriksson 2005). The family is characterised by a lecidine exciple, asci with a distinct amyloid cap in the distal part of the thallus, and branched and anastomosing hamathecial filaments (Hafellner 1984; Ihlen & Ekman 2002). A perispore distinguished the genera *Rhizocarpon* and *Poeltinula*, but it is lacking in *Catolechia* and *Epilichen* (e.g. Hafellner 1984). *Poeltinula* is separated from *Rhizocarpon* by having ascospores reacting red with nitric acid, and shortly lirelliform to angular apothecia (Ihlen 2004).

The species of *Rhizocarpon* colonise predominantly siliceous rocks, although some species occur on basic substrata; a number of taxa are parasitic on other lichens (Poelt & Hafellner 1982;

Poelt & Vězda 1984; Holtan-Hartwig & Timdal 1987; Poelt 1990). The literature on *Rhizocarpon* is extensive, covering mainly northern hemisphere and especially arctic taxa, with to date very few recent works done or attempted to southern hemisphere (Vainio 1922, 1944, 1949; Lynge 1932, 1936; Lamb 1940; Runemark 1956a, b; Thomson 1968; 1979, 1997; Honegger 1978; Geyer et al. 1984; Poelt 1988; Timdal & Holtan-Hartwig 1988; Feuerer 1991; Asta & Letrouit-Galinou 1995; Fryday 1996, 2000a, b, 2004; Clayden 1997a, b, 1998; Elvebakk & Hertel 1997; Ihlen 2004; Feuerer & Timdal 2004). Antarctic taxa are discussed by Dodge (1948, 1973), Øvstedal & Lewis Smith (2001), Fryday (2002) and Olech (2004).

A recent molecular study of 13 species of *Rhizocarpon* (nine of which occur in New Zealand) suggested that the genus as presently circumscribed is polyphyletic (Ihlen & Ekman 2002). Several morphological characters (i.e. ascospore septation, ascospore pigmentation, amyloid reaction of the medulla, presence of rhizocarpic and stictic acids), formerly used to subdivide *Rhizocarpon* into subgeneric groupings (e.g. Thomson 1968; Feuerer 1991), showed to have changed several times over the time and that consequently their utility in predicting relationships within the genus is artificial and of limited value.

The objective of the study has been a review of collections of rare, non-yellow and yellow species of *Rhizocarpon*. The following structure were measured for analyses: diameter of apothecia and areoles (in mm), hymenium height (in  $\mu\text{m}$ ), ascospore length, width (in  $\mu\text{m}$ ), number of cells per ascospore.

#### MATERIAL AND METHODS

The material has been verified according to taxonomic and nomenclature standards. Descriptions have been made. Synonyms have been assigned to each species.

Spot tests colour reactions of the thallus and medulla from K, C, I and Pd were observed under the microscope. The chemistry is given according to Runemark (1956a), Culberson (1969), Poelt (1988), Øvstedal & Gremmen (1995), Wirth (1995), Thomson (1997) and Ihlen (2004).

The species have been named and synonyms assigned to particular taxa according to Santesson et al. (2004). Descriptions have been made for each species. Habitat and distribution have been analyzed.

#### RESULTS

The herbarium collection of lichens of Botany and Mycology Department of Maria Curie-Skłodowska University in Lublin include rare and noteworthy species of the genus *Rhizocarpon* with non-yellow thallus and hyaline and muriform ascospores – *Rhizocarpon furfurosum*, *R. postumum*, with non-yellow thallus and dark and muriform ascospores – *R. eupetraeum*, *R. renneri* and with non-yellow thallus and 2-celled ascospores – *R. chioneum*, *R. copelandii*, *R. hochstetteri*, *R. jemtlandicum*, *R. richardii*, *R. rittokense*, with yellow thallus and 2-celled ascospores – *R. eupetraeoides*, *R. pusillum*, *R. superficiale* and with yellow thallus and muriform ascospores – *R. intermediellum*, *R. ridescens* and *R. saanaense*.

## The species

***Rhizocarpon chioneum*** (Norman) Th. Fr.

Lichenogr. Scand. 2: 620, 1874.

Syn.: *Catillaria chionea* Norman, Kongel. Norske Videnskabersselsk. Skr. 19 de Aarhundr. 5: 355, 1868.

Thallus continuous or areolate, thick, farinose, chinky-areolate, white, often bordered with a bluish black hypothallus.

Apothecia black with a white thalline margin around the proper exciple; sessile to raised. True margin black, thin, pruinose, disappearing. Exciple black or purplish black; disc black, flat to slightly convex, smooth, sometimes pruinose. Epithecium purplish black. Hymenium 100–125 µm, hyaline below, violet-red above. Hypothecium red-purple. Paraphyses coherent, thin 1–1.5 µm, tips capitate up to 4–5 µm. Asci clavate. Ascospores 8 in ascus, 2-celled, hyaline but darkening, often aborted, halonate, 12–23 x 8–12 µm.

Reactions: medulla K–, C–, I–; the violet color of hymenium and hypothecium intensified by KOH.

The species grows on calcareous rocks. It is apparently circumpolar arctic-alpine (Thomson 1997). It is known from: Arctic, Great Britain, Fennoscandia and North American (Esslinger & Egan 1995; Thomson 1997, Coppins 2002; Santesson et al. 2004).

Specimen examined: CANADA. Canadian Arctic Archipelag, Cornwallis Island, August, 1959, leg. J. W. Thomson (LBL).

***Rhizocarpon copelandii*** (Körb.) Th. Fr.

Lichenogr. Scand. 2: 615, 1874.

Syn.: *Buellia copelandii* Körber, Zweite Deutsch. Polar Exped. 2: 79, 1874; *Rhizocarpon hyperboreum* (Vain.) Vain.; *Rhizocarpon elevatum* H. Magn.; *Rhizocarpon cyclodes* Hellb. ex Th. Fr.

Thallus areolate, thick or thin, the areolate up to 0.8 mm broad, rounded or angular, flat or convex, commonly slightly shining, ashy gray, surrounded by black hypothallus.

Apothecia 1 to 1.8 mm, flat to convex, black, dull or shining, matt or glossy, thalline margin thick or thin, concolorous with disc, usually persistent; true exciple red-brown. Disc slightly roughened. Epithecium green-black to red-black, K- or K+ faint reddish. Hymenium 100–140 µm, pale to brownish, greenish above. Hypothecium red-brown to dark-brown. Paraphyses capitate, coherent, tips dark. Asci clavate. Ascospores 8 in ascus, 1-septate, soon dark bluish black, with halo, 20–30 x 9–12 µm.

Reactions: thallus and medulla K+ yellow turning red, C–, KC+ red, Pd+ yellowish, I–; exciple K+ red with red needle-like crystals produced; epithecium K–; hypothecium K+ red.

Contents: norstictic acid (Thomson 1997), stictic and norstictic acids (Řvstedal & Gremmen 1995).

The species grows on calcareous rocks. It is apparently circumpolar arctic-alpine lichen (Thomson 1997), known from: Antarctica, Austria, Czech Republic, Great Britain, Greenland, Italy, North America, Scandinavia, Siberia, Spain and Spitzbergen (Lynge 1932, 1936; Thomson 1968, 1979, 1997; Nimis 1993; Santesson 1993; Esslinger & Egan 1995; Øvstedal & Gremmen 1995; Elvebakk & Hertel 1997; Vězda & Liška 1999; Hafellner & Türk 2001; Llimona & Hladun 2001; Øvstedal & Lewis Smith 2001; Coppins 2002; Nimis & Martellos 2003; Olech 2004; Santesson et al. 2004).

Specimen examined: NORWAY. Norwegia centralis, pr. Finse, 19.07.1927, leg. J. Motyka (LBL).

***Rhizocarpon eupetraeoides*** (Nyl.) Blomb. & Forssel

Enum. Pl. Scand. 93, 1880.

Syn.: *Lecidea eupetraeoides* Nyl., Flora 58: 12, 1875; *Rhizocarpon atroalbescens* (Nyl.) Zahlbr.; *Rhizocarpon chionophiloides* (Vain.) Vain.

Thallus of scattered or grouped areolae, the areolae to 1.5 mm, angular or rounded, slightly to strongly convex, whitish yellow to yellow or orange yellow; the surface farinose to smooth. Hypothallus present, well-developed, black.

Apothecia 0.4–1.2 mm broad, rounded, flat to slightly convex. Thalline margin black, smooth. True exciple dark reddish black. Disc black, smooth to slightly roughened. Epithecium dark. Hymenium 100–140 µm, upper part green to greenish blue, lower part hyaline. Hypothecium dark brown. Paraphyses branched, coherent, tips clavate. Asci clavate. Ascospores 8 in ascus, 1-septate, soon dark, halonate, 18–32 x 10–15 µm.

Reactions: medulla K– or K+ red, P+ yellow or P–, C–; exciple K+ red (Thomson 1997).

Contents: rhizocarpic acid and norstictic or psoromic acid (Runemark 1956a).

The species grows on acid rocks. It is a circumpolar arctic-alpine species. Known from: Fennoscandia, Great Britain, Japan, North America and Poland (Esslinger & Egan 1995; Thomson 1997; Coppins 2002; Fałtynowicz 2003; Kurokawa 2003; Santesson et al. 2004).

Specimen examined: POLAND. Tatry Mountains, Mały Kościelec, 19.08.1925, leg. J. Motyka (LBL).

***Rhizocarpon eupetraeum*** (Nyl.) Arnold

Flora 53: 478, 1870.

Syn.: *Lecidea eupetraea* Nyl., ibid. 53: 36, 1870; *Rhizocarpon grande* f. *eupetraeum* (Nyl.) Th. Fr.

Thallus verruculose or areolate, the verrucules regularly rounded, constricted at base, ashy, smooth, epruinose. Black hypothallus usually present.

Apothecia 0.5–1.4 mm in diameter, black, between the verrucules, round, flat or becoming convex. Thalline margin black, persistent or disappearing. True exciple reddish brown, radiate. Disc smooth. Epithecium reddish brown. Hymenium 120–160 µm, brownish, upper part reddish or hyaline. Hypothecium reddish brown. Paraphyses coherent, clavate. Asci clavate, 100–120 x 30–40 µm. Ascospores 8 in ascus, 3- or 4-septate transversely, 1 or 2 longitudinally, dark brown, with halo, muriform, 20–34 x 9–15 µm.

Reactions: thallus K+ yellow → turning red, C–, KC+ red, Pd+ orange; medulla K+ yellow turning red, Pd+ yellow, C–, I+ deep blue; exciple and hypothecium K+ red with acicular crystals; epithecium K–.

Contents: norstictic acid (Thomson 1997).

The species grows on acid rocks. It is arctic and boreal lichen, known from: Austria, Bolivia, Czech Republic, Germany, Greenland, Italy, Japan, North America, Poland, Scandinavia, Spain and Svalbard (Lyngé 1932, 1936; Thomson 1968, 1979; Feuerer 1978, 1991; Nimis 1993; Santesson 1993; Esslinger & Egan 1995; Elvebakk & Hertel 1997; Vězda & Liška 1999; Scholz 2000; Hafellner & Türk 2001; Llimona & Hladun 2001; Fałtynowicz 2003; Kurokawa 2003; Nimis & Martellos 2003; Feuerer & Tindal 2004; Santesson et al. 2004).

Specimen examined: POLAND. Zelejowa Mountain, near Chęcin town, 29.07.1951, leg. J. Rydzak (LBL).

***Rhizocarpon furfurosum*** H. Magn. & Poelt

In Poelt, Verh. Zool.-Bot. Ges. Wien 95: 110, 1955.

Syn.: *Rhizocarpon obscuratum* (Ach.) Massal. f. *granulosum* Schade in Sitz. Ber. U. Abh. Naturwiss. Ges. Isis Dvesden 1932, 158, 1933.

Thallus spreading to 1–3 cm diameter, cracked, areolate, continuously, dark brown, brown-grey, grey, consisting of isidia. Isidia minute, ca 0.02–0.04 mm long, often slightly constricted at base, fragile, and sparsely branched. Areoles flat or slightly convex. Hypothallus black.

Apothecia not observed. According to Poelt (1955) and Purvis et al. (1992), to 0.8 mm diam., disc flat to weakly convex, black, margin distinct. Exciple in section dark brown in outer part, pale brown in inner part. Epithemium brown to black brown, K-. Hymenium hyaline or pale brown, 80–100 µm high. Asci clavate. Ascospores 8 in ascus, ellipsoid to narrowly ellipsoid, (sub-) muriform, with 4–6 cells, 14–27 × 7–12 µm (Ihlen 2004).

Reactions: thallus K+ yellow, C-; medulla K+/Pd+ yellow.

Contents: stictic acid or norstictic acid (Wirth 1995), stictic acid (Ihlen 2004).

The species grows on metal-rich rocks. It is known from: British Isles, Fennoscandia, Germany and Nordic countries (Wirth 1995; Coppins 2002; Ihlen 2004; Santesson et al. 2004).

Specimen examined: GERMANY. The Alps, Harz, Nordharz, Niedersachsen, elev. ca 425 m, November 1963, leg. H. Ullrich (LBL).

***Rhizocarpon hochstetteri* (Körb.) Vain.**

Acta Soc. Fauna Fl. Fenn. 53: 280, 1922.

Syn.: *Catillaria hochstetteri* Körber, Parerga Lichenol. 195, 1861; *Rhizocarpon applanatum* (Fr.) Th. Fr.; *Rhizocarpon massalongii* sensu Malme; *Rhizocarpon crenulatum* H. Magn.

Thallus grey-brown to red-brown, areolate, very thin, 0.1–0.35 mm thick. Areolae flat to subconvex, 0.2–1 mm diam. Sometimes with slight black hypothallus present or hypothallus lacking.

Apothecia frequent, black, lecideine, flat to subconvex, 0.6–1 (–1.2) mm diam., sessile when well-developed, or innate among areolae. Proper exciple persistent, often poorly formed. Epithemium usually with blue-black pigmentation (*macrocarpa*-green; K-, N+ red), rarely only brown pigmentation present. Hymenium colourless, I+ blue, 95–150 µm high. Hypothecium dark-brown. Asci clavate, 85–100 × 30–35 µm. Ascospores 8 in ascus, 1-septate, hyaline becoming brown when over-mature, halonate, 21–25(–28) × (8.5–)10–12 µm.

Reactions: thallus K- or K+ yellow, C-, Pd- or Pd+ orange.

Contents: stictic acid or no lichen substances present (Fryday 2002).

This species may grow on either acid or calcareous rocks. It is circumpolar arctic lichen, known from: Austria, British Isles, Fennoscandia, Germany, Japan, New Zealand, North America, Poland and Spain (Wirth 1995; Thomson 1997; Fryday 2000a, 2002; Hafellner & Türk 2001; Llimona & Hladun 2001; Kurokawa 2002; Fałtynowicz 2003; Santesson et al. 2004).

Specimen examined: POLAND. Śnieżnik Mts., 24.08.1955, leg. J. Rydzak (LBL); Babia Góra Mts., Djablak, elev. ca 1680 m, 7.06.1927, leg. J. Motyka (LBL).

***Rhizocarpon intermediellum* Räsänen**

Feddes Repet. Spec. Nov. Regni Veg. 52: 141, 1943.

Syn.: *Rhizocarpon wulfianum* Räsänen

Thallus of contiguous or dispersed areolate up to 0.7 mm broad, irregularly angular, more or less convex, yellow to greenish yellow or whitish yellow, dull or glossy. Black hypothallus present or absent.

Apothecia to 0.5 mm, black, roundish to round, concave or flat, rarely convex. Margin black, distinct. Exciple brownish. Epithemium indistinct, brownish. Hymenium 59–90 µm, hyaline or faintly greenish, upper part brownish red. Hypothecium brownish. Paraphyses clavate. Asci clavate. Ascospores 8 in ascus, with few septate, 1–4 transversely, and sometimes 1 longitudinally, dark, with halo, 12–21 × 6–10 µm.

Reactions: medulla K-, Pd-, C-, I+ deep blue; exciple K+ reddish; hypothecium K-.  
Contents: rhizocarpic acid (Thomson 1997).

The species grows on calcareous rocks. It is circumpolar arctic-alpine lichen, known from: Austria, Fennoscandia, Germany, Great Britain, Greenland and North America, (Poelt 1990; Esslinger & Egan 1995; Thomson 1997; Hafellner & Türk 2001; Coppins 2002; Santesson et al. 2004).

Specimen examined: AUSTRIA. The Alps, Nordtirol, elev. ca 2150-2200 m, August 1961, leg. M. Steiner (LBL).

***Rhizocarpon jemtlandicum*** (Malme) Malme

Svensk Bot. Tidskr. 8.3: 283, 1914.

Syn.: *Catillaria jemtlandica* Th. Fr. & Almg., Lichenogr. Scandin. 1: 550, 1874; *Rhizocarpon vainioëense* Lyngé

Thallus verruculose or areolate, the areolae flat or more often convex, ashy or brownish-ashy, smooth, esorediate. Black hypothallus present.

Apothecia to 1 mm, round or angular, between the verrucules or areolae, elevated above them, flat or becoming convex. Margin fairly thick, persistent, rarely thin to disappearing. Exciple red-brown to black. Disc black, not papillate, dull or shiny. Epithecium greenish black to olivaceous. Hymenium 140 µm, hyaline, upper part dirty greenish, partly reddish. Hypothecium red-brown to black. Paraphyses coherent, capitate. Asci clavate. Ascospores 8 in ascus, 1-septate, soon black-brown, sometimes greenish dark, constricted, with halo, 18-34 x 9-14 µm.

Reactions: medulla K+ yellow, Pd+ orange, I-; exciple and hypothecium K+ reddish violet; epithecium K- or K+ greenish.

Contents: stictic acid (Thomson 1997).

This species grows on acid rocks in sunny situations. It is circumpolar arctic lichen (Thomson 1997). It is known from: Fennoscandia, Germany, Great Britain, North America and Spain (Wirth 1995; Thomson 1997; Scholz 2000; Llimona & Hladun 2001; Coppins 2002; Santesson et al. 2004).

Specimen examined: NORWAY. *Norwegia occidentalis*, insula Břmlo, pr. Bergen, 20.06.1927, leg. J. Motyka (LBL).

***Rhizocarpon postumum*** (Nyl.) Arnold

Flora 53: 478, 1870

Syn.: *Lecidea postuma* Nyl., Flora 51: 345, 1868

Thallus crustose, very thin, finely verrucose or areolate, diffused or concentrated, dirtily white or brown, frequently vaece or dying out, epruinose. Areoles 0.2-0.5 mm in diam., 15-20 mm<sup>2</sup>, frequently in small group, angular, flat or convex, smooth or slightly verrucose, weakly dispersed, whitish, with indistinct hypothallus.

Apothecia numerous, 0.3-0.4(-0.5) mm in diam., widely adjacent to thallus, ±roused, scattered, angular to rounded, plane, black, matt, epruinose. Disc black, nude, flat, without warts or slightly verrucose. Margin thin, 0.03-0.05 mm thick, permanent. Excipulum brown, K-. Epithecium yellow-brown to blue-black. Hymenium hyaline, 100-140 µm high. Hypothecium dark brown. Paraphyses in abundant jelly, with rare septa, 1.5 µm wide, up to 3 µm on tips. Asci clavate. Ascospores 8 in ascus, mostly 3-septate, narrowly ellipsoid to ellipsoid, hyaline or dark if very old, 22-28 x 9-13 µm, with (6-)7-8 cells.

Reactions: thallus K-, C-, Pd-; medulla I-, excipulum K-.

Contents: stictic acid (Ihlen 2004).

The species grows on basalts. It is known from: Austria, Czech Republic, Germany, Great Britain, Japan, Nordic countries, North America and Poland (Feuerer 1978; Santesson 1993; Esslinger & Egan 1995; Vězda & Liška 1999; Scholz 2000; Hafellner & Türk 2001; Coppins 2002; Faltynowicz 2003; Kurokawa 2003; Ihlen 2004; Santesson et al. 2004).

Specimen examined: POLAND. Tatry Mountains, Kościeliska Valley, Kiry, August 1927, leg. J. Motyka (LBL, with *Rhizocarpon petraeum*)

Note: This is the first record of the species for the Polish Carpathians. Previously it was reported exclusively from the Sudety Mts. (see Faltynowicz 2003).

***Rhizocarpon pusillum*** Runemark

Opera Bot. 2: 63, 1956a.

Thallus very small, less than 1 cm in diam., rounded, of areolate less than 0.6 mm broad, the areolate angular to rounded, flat to convex, whitish yellow to yellow, smooth or slightly farinose above, dull. Indistinct hypothallus present. Lichenicolous, growing over *Sporastatia testudinea* (Ach.) A. Massal.

Apothecia to 0.7 mm broad, angular to rounded-angular, flat to convex. Margin indistinct. Disc plane to convex. True exciple reddish brown. Epithecium dark brownish or purplish, K+ reddish or K-, granular, 8–13(–15)  $\mu\text{m}$  thick. Hymenium 70–100  $\mu\text{m}$ , hyaline to brownish, upper part dark. Hypothecium brown. Paraphyses capitate. Asci clavate, 69–80 x 15–20  $\mu\text{m}$ . Ascospores 8 in ascus, 1-septate, dark, with halo, 9–14 x 4–6  $\mu\text{m}$ , slightly constricted at septum.

Reactions: thallus K-, C-, KC-, Pd+ yellow; medulla K-, Pd+ yellow, I-; exciple K+ reddish violet; epithecium K- or K+ reddish.

Contents: rhizocarpic and psoromic acids (Thomson 1997).

The species grows on rocks on other lichens, such as *Sporastatia* and *Lecidea*. It is known from: Scandinavia and the Alps in Europe, as well Czech Republic, Spain and also from North America (Esslinger & Egan 1995; Thomson 1997; Vězda & Liška 1999; Llimona & Hladun 2001; Santesson et al. 2004).

Specimen examined: AUSTRIA. The Alps, elev. ca 2500 m, September 1960, leg. A. Schröppel, M. Steiner, J. Poelt (LBL).

***Rhizocarpon renneri*** Poelt

Planta (Berlin) 51: 306, 1958.

Thallus up to 5–8 mm broad, areolate, greyish. Areolae round to angular, 0.5 to 1 mm diam. Lichenicolous, on thallus areoles of *Dimelaena oreina*.

Apothecia very dispersed, convex, black, to 0.8 mm broad. Epithecium violet-brownish. Hymenium 90–100  $\mu\text{m}$  high, hyaline with upper part violet to grey black. Hypothecium brown-black. Paraphyses thin 1–1.5  $\mu\text{m}$ . Ascospores 8 in ascus, soon very dark, submuriform, with 5 to 7 cells, 16–22 x 9–12  $\mu\text{m}$ .

Reactions: thallus K-, C-; medulla I+ light blue; epithecium K- or K+ violet; hymenium I+ blue (Poelt 1958).

The species grows on rocks on other lichens, such as *Dimelaena oreina*. It is known from Austria, Germany, Scandinavia, Spain and also from North America (Esslinger & Egan 1995; Wirth 1995; Llimona & Hladun 2001; Hafellner & Türk 2001; Santesson et al. 2004).

Specimen examined: AUSTRIA. The Alps, Tirol, Samnaungruppe, steep surface of the big Block near the Kolner Haus on Comperdell, elev. ca 2000 m, July 1958, leg. J. Poelt (LBL – isotype).

***Rhizocarpon richardii*** (Lamy ex Nyl.) Zahlbr.

Cat. Lich. Univ. 4: 341: 1926–1927.

Syn.: *Lecidea richardii* Lamy, Flora 58: 446, 1875; *Rhizocarpon constrictum* Malme; *Rhizocarpon atlanticum* I. M. Lamb

Thallus cracked-areolate, brownish. Areoles flat to convex, 0.5 to 1 mm diam. Apothecia frequent, black, flat to slightly convex. Epihymenium olivaceous green to greyish black, K-. Hymenium 80–100 µm tall, hyaline. Hypothecium brown. Ascospores 8 in ascus, 1-septate, hyaline, 22–32 x 12–14 µm.

Reactions: thallus usually C+ red; medulla I+ blue; epihymenium K-.

Contents: gyrophoric acid (Fryday 2002)

The species grows on seashore rocks, on overhangs. It is known from: British Isles, Fennoscandia, Germany and Spain (Scholz 2000; Llimona & Hladun 2001; Fryday 2002; Coppins 2002; Santesson et al. 2004).

Specimen examined: SWEDEN, Göteborg, June 1929, leg. J. Motyka (LBL).

***Rhizocarpon ridescens*** (Nyl.) Zahlbr.

Cat. Lich. Univ. 4: 391, 1926–1927.

Syn.: *Lecidea ridescens* Nyl., Flora 64: 533, 1881.

Thallus sorediate, brilliant yellow to greenish yellow, often large. Areoles to 1 mm diam., roundish, strongly convex, always dispersed on a dark hypothallus. Areole with a flat to spherical, more or less stalked soralium that is eruptive at the apex.

Apothecia rare, to 1 mm diam., flat, with persistent margins. Epihymenium K+ red-violet. Hymenium hyaline. Hypothecium brown. Ascospores 8 in ascus, submuriform, 20–30 x 12–16 µm.

Reactions: thallus K-; medulla K-, Pd+ yellow, I+ violet; epihymenium K+ red-violet.

Contents: psoromic acid (Poelt 1988, Wirth 1995).

The species grows on siliceous rocks rich in iron minerals. The species prefers more or less south-facing, protected, dry, steep sides of boulders with high iron content. It is known from: Austria, Czech Republic, Fennoscandia and Germany (Poelt 1988; Wirth 1995; Vězda & Liška 1999; Hafellner & Türk 2001; Santesson et al. 2004).

Specimen examined: AUSTRIA. The Alps, elev. ca 2500 m, August 1962, leg. M. Steiner (LBL).

***Rhizocarpon rittokense*** (Hellb.) Th. Fr.

Lichenogr. Scand. 2: 615, 1874.

Syn.: *Buellia rittokense* Hellbom, Öfvers Förh. Kongl. Svenska Vetensk.-Akad. 22: 463, 1865; *Rhizocarpon melaneimum* (Vain.) Zahlbr.

Thallus with umbilicate areolae resembling apothecia. Areoles 0.5–1.5 mm broad, concave to flattish, or convex, round, brown, shining, often with pruinose margins. Margins of thallus thick, pulverulent, lower side dark. Black hypothallus present.

Apothecia to 1.6 mm, black, epruinose. Margin thin, subpersistent. Exciple black to exterior, paler inward. Disc becoming rough and convex. Epithecium brown. Hymenium 100–140 µm, hyaline. Hypothecium brown. Paraphyses coherent, branched, septate, 2 µm wide, tips 3–4 µm. Asci clavate. Ascospores 8 in ascus, 1-septate, with halo, becoming brown to black, 20–24 x 10–15 µm.

Reactions: thallus K-; medulla K-, C-, KC-, Pd-, I-; exciple K- or K+ violet; hypothecium K-, I-; epithecium K- or K+ violet; hymenium I+ blue.

Contents: rhizocarpic acid (Culberson 1969).

This species grows on acid rocks in dry areas. It is circumpolar arctic lichen, known from: Greenland, Iceland, North America, Novaya Zemlya, Poland, Scandinavia, Siberia and Spitzbergen (Esslinger & Egan 1995; Thomson 1997; Fałtynowicz 2003; Santesson et al. 2004).

Specimen examined: POLAND. Tatry Mountains, Czarny Staw lake, above Morskie Oko, 2.08.1929, leg. J. Motyka (LBL); Suchy Kondracki, 28.07.1924, leg. J. Motyka (LBL); Suchy Kondracki, 21.07.1924, leg. J. Motyka (LBL).

***Rhizocarpon saanaënsæ*** Räsänen

Ann. Bot. Soc. Zool.-Bot. Fenn. Vanamo, XVI, Notul, Botan. 12: 61, 1942.

Syn.: *Rhizocarpon subclucidum* Räsänen

Thallus crustose, areolate, bright yellow. Areoles to 2 mm diam., flat to very convex.

Apothecia to 1.5 mm diam., flat to concave, roundish, with indistinct margins. Epithemium red brown. Hymenium hyaline, 150–160 µm. Hypothecium dark brown. Ascus 100–140 x 25–40 µm. Ascospores 8 in ascus, usually more than twenty cells visible, 32–70 x 16–25 µm.

Reactions: thallus K–; medulla K–, Pd+ yellow, rarely Pd–.

Contents: psoromic acid (Poelt 1988).

The species occurs on unshaded rocks above tree limit in the European mountains (Poelt 1988). It is known from: Austria, Germany, North America, Poland and Scandinavia (Esslinger & Egan 1995; Scholz 2000; Hafellner & Türk 2001; Fałtynowicz 2003; Santesson et al. 2004).

Specimen examined: POLAND. Tatry Mountains: Twardy Uplaz, 10.06.1923, leg. J. Motyka (LBL); Rysy, elev. ca 1650 m, 09.08.1927, leg. J. Motyka (LBL).

Note: This is the first record of the species for the Polish Carpathians. Previously it was reported exclusively from the Sudety Mts. (see Fałtynowicz 2003).

***Rhizocarpon superficiale*** (Schaer.) Vain.

Acta Soc. Fauna Fl. Fenn. 53: 319, 1922.

Syn.: *Lecidea superficiale* Schaerer, Lich. Helv. Spic. 125. 1828.

Thallus areolate, of dispersed or contiguous areoles; areolate angular and concave to flat or convex, or rounded and convex, yellowish white to yellow or greenish yellow, smooth, dull or glossy to scabrous. Black hypothallus present.

Apothecia to 2 mm broad, round or angular, usually higher than the areolae, flat to slightly convex with a very characteristically minutely papillate “sooty” surface, black. Margin persistent, black. Exciple reddish brown, radiate. Epithecium reddish or greenish and with dark granules. Hymenium 70–100 µm, hyaline to brownish, upper part reddish or greenish. Hypothecium brown, separated from hypothallus by white medullary tissue. Paraphyses coherent, slightly branched, tips dark, capitate. Ascospores 8 in ascus, 1-septate, brown with thin halo, 11–18 x 6–8 µm.

Reaction: thallus K+ yellow, Pd+ orange; medulla K+ yellow, Pd+ brick-red, I–, C–; exciple K+ redish violet; hymenium I+ blue.

Contents: rhizocarpic acid plus atictic acid, rarely also psoromic acid (Thomson 1997).

The species grows on exposed acid rocks and outcrops. It is circumpolar arctic and alpine (Thomson 1997). It is reported from: Antarctica, the Arctic, Asia (the Himalaya), Australia, Austria, East Africa, Great Britain, Italy, Germany, North America, Scandinavia, South America (Venezuela and Chile) and Spain (Runemark 1956a, b; Thomson 1968, 1979; Hertel 1971; Purvis et al 1992; Nimis 1993; Santesson 1993; Esslinger & Egan 1995; Hansen 1995; Wirth 1995; Elvebakk & Hertel 1997; Galloway & Quilhot 1999; Scholz 2000; Hafellner & Türk 2001; Llimona & Hladun 2001; Øvstedal & Lewis Smith 2001; Coppins 2002; McCarthy 2003, 2006; Nimis & Martellos 2003; Feuerer & Timdal 2004; Olech 2004; Santesson et al. 2004; Søchting et al. 2004).

Specimen examined: AUSTRIA. The Alps, Nordtirol, elev. ca 2150–2200 m, August 1961, leg. M. Steiner (LBL).

## CONCLUSIONS

The LBL herbarium housed large and interesting collection of lichens. Among others, a rare species of the genus *Rhizocarpon* are available in the herbarium. The most noteworthy are presented in the paper. In total, 16 species are discussed. They represent various taxonomic groups. The most numerous and valuable specimens were collected by Józef Motyka in the Polish mountains such as the Tatras, Pieniny, Beskid Niski and Zachodni, Świetokrzyskie as well as in Norway. Specimens from the Alps were collected by Poelt, Steiner and Ullrich. Materials of Thomson from Canada and Arctic were also studied.

It is especially worth mentioning are two species, *Rhizocarpon postumum* and *R. saanaënse*, for the first time reported from the Polish Carpathians based on the investigated collection.

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