

Some new records of *Rhizocarpon* from North-Eastern Poland and North-Western Belarus

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New localities of *Rhizocarpon distinctum*, *R. geographicum* and *R. reductum* are reported from NE Poland. *Rhizocarpon distinctum*, *R. grande*, *R. hochstetteri*, *R. lavatum*, *R. petraeum*, *R. polycarpum* and *R. reductum* are reported from NW Belarus for the first time. *Rhizocarpon hochstetteri*, *R. lavatum* and *R. polycarpum* are new to Belarus. A key to species occurring in the area is given.

Key words: lichenized fungi, *Rhizocarpon*, new localities, Poland, Belarus

INTRODUCTION

Rhizocarpon Ramond ex DC. is a large genus of ca 200 species belonging to the family *Rhizocarpaceae*. It is widely distributed throughout the world, especially 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.

The species of *Rhizocarpon* predominantly colonise siliceous rocks, although some species occur on basic substrates; a number of taxa are parasitic on other lichens (Poelt, Hafellner 1982; Poelt, Vězda 1984; Holtan-Hartwig, Timdal 1987; Poelt 1990).

Thomson (1967) divided the genus *Rhizocarpon* into taxa with a yellow thallus containing rhizocarpic acid (subgenus *Rhizocarpon*) and taxa with white, ashy or brown thalli lacking rhizocarpic acid (subgenus *Phaeothallus*). A comprehensive taxonomic study of yellow species of *Rhizocarpon* in Europe was conducted by Rune-mark (1956a, b), but intra-specific variation of the *R. geographicum* complex is still

unclear (Wirth 1995). A comprehensive revision of the so-called *R. obscuratum* complex with taxa containing hyaline and muriform ascospores was carried by Fryday (2000a) and of the so-called *R. hochstetteri* complex with taxa containing hyaline and one-septate ascospores was carried out by Fryday (2002). In the Nordic countries, the taxonomy of the non-yellow species of *Rhizocarpon* with hyaline and muriform ascospores is recognized by Ihlen (2004).

The knowledge of the species diversity of *Rhizocarpon* in north-eastern Poland is relatively good as reflected in literature data (e.g., Zielińska 1980; Fałtynowicz 1994; Bystrek, Kolanko 2000; Kukwa, Fałtynowicz 2002; Cieśliński 2003; Sparrus 2003; Zalewska et al. 2004a, b; Kolanko 2005; Kubiak 2005; Matwiejuk 2008), while it is insufficient in Belarus. Data mostly from Central and Eastern Belarus have been reported (Gorbach 1973; Golubkov 1987). Cieśliński (2003) reports six species from NE Poland, *R. distinctum*, *R. eupetraeum*, *R. geographicum*, *R. lecanorinum*, *R. obscuratum* and *R. polycarpum*. Zalewska et al. (2004b) confirmed the occurrence of five of the above species (except *R. eupetraeum*) and reported *R. reductum* from the Suwalski Landscape Park, where the greatest concentrations of boulders in NE Poland can be found. Gorbach (1973) lists six species for Belarus: *R. geographicum*, *R. grande*, *R. distinctum*, *R. concentricum*, *R. obscuratum* and *R. reductum*.

STUDY AREA

The study area comprises north-eastern Poland (the area acc. to Cieśliński 2003) and north-western Belarus. NE Poland consists of two administrative areas, Podlaskie and Warmińsko-Mazurskie voivodeships. NW Belarus consists of one administrative centre, Grodno.

Species of *Rhizocarpon* grow on erratics and stones in the area investigated. Those are postglacial boulders brought to the area by the Scandinavian ice-sheet in the Pleistocene. They occur individually or in larger clusters, forming boulder concentrations. Granite rocks constitute approximately 80% of erratic boulders in NE Poland and NW Belarus, the remaining ones being gneiss rocks. The greatest boulder concentrations in NE Poland can be found in the Suwalski Landscape Park with the greatest concentration of boulders in the lowlands in the „Głazowisko Bachanowo” reserve comprising ca ten thousand boulders (Kukwa, Fałtynowicz 2002). Fortifications dating from World War I in NW Belarus in the vicinity of Grodno are currently being investigated not only by historians but also by biologists.

MATERIAL AND METHODS

The material was collected during visits to respective habitats in north-eastern Poland (2002–2009) and north-western Belarus (1983–2008). Additionally, collections of *Rhizocarpon* deposited in the herbarium of the Institute of Biology, University

of Białystok and GRSU, MSK-L herbaria were verified. Data concerning species of *Rhizocarpon* and their distribution in NE Poland was supplemented with literature data.

Species were verified and named according to Thomson (1997), Fryday (2002) and Ihlen (2004). Based on descriptions and recent taxonomic innovations as well as chemical, microscopic and morphological characters, an original key to all *Rhizocarpon* species found in the study area was prepared and is presented here. Chemical analyses were performed using thin-layer chromatography (TLC) according to Orange et al. (2001) with the use of solvents A and C.

LIST OF SPECIES

Rhizocarpon distinctum Th. Fr., Lichenogr. Scand. 1: 625 (1874).

Syn. *Rhizocarpon ambiguum* (Naeg.) A. Zahlbr.; *Rh. hyalescens* Vain.

For the description of the species see Ihlen (2004). Spot test reactions: thallus K+ yellow, C–, KC–, PD–; medulla I+ blue, PD–, K–, C–. Substances detected by TLC: stictic acid in thallus and apothecia. The species was found on acid rocks. The habitats recorded were usually open and sunny.

R. distinctum is bipolar. It is known from North Europe, North America, South America and Antarctica. In Europe it has been reported from Belarus (Gorbach 1973), Germany (Wirth 1995), the Czech Republic (Vězda, Liška 1999), Lithuania (Motiejūnaitė 1999), Estonia (Randlane, Saag 1999), Austria (Hafellner, Türk 2001), Portugal (Boom, Jansen 2002), Spain (Llimona, Hladun 2001), Great Britain (Coppins 2002), Poland (Fałtynowicz 2003), Fennoscandia (Santesson et al. 2004; Ihlen 2004), Iceland (Kristinsson, Heidmarsson 2006).

The species is known from numerous localities in north-eastern Poland (Zielińska 1980; Cieśliński, Tobolewski 1989; Fałtynowicz 1994; Bystrek, Kolanko 2000; Cieśliński 2003; Zalewska et al. 2004a, b; Kolanko 2005; Kubiak 2005); however, it was reported from Central Belarus (Minsk region) only by Gorbach (1973) and Golubkov (1987).

SPECIMENS EXAMINED. NE POLAND. Wysoczyzna Białostocka high plain, Białystok, cemetery, stone gravestone, Oct. 2009, leg. A. Matwiejuk. NW BELARUS. Grodno region: Schutchinskiy district – ca 1 km SW of Orlya village, on the Niemen river, granite, 6 Sept. 1989, leg. V. Golubkov (MSK-L), vicinity of Pugachi village, geological monument of nature “Great Stone”, 17 Aug. 1999, leg. V. Golubkov (MSK-L), vicinity of Jakubovichi village, granite, 16 June 1989, leg. V. Golubkov (MSK-L), vicinity of Kostenevo village, granite, 10 July 1999, leg. V. Golubkov (MSK-L); Zelvinskiy district – vicinity of Savichy village (1 km SW), stones, 15 Aug. 1999, leg. V. Golubkov (MSK-L); Svislotchskiy district – ca 1 km SW of Khlupin village, on Ros river, granite, 11 June 1983, leg. V. Golubkov (MSK-L); Mostovskiy district – ca 0.5 km SW of Lunno village, granite, 27 Apr. 1994, leg. V. Golubkov (MSK-L); Grodno district – ca 1 km SW of Kamenka village, the sixth fort of the Grodno fortress, granite, 29 Sept. 2007, leg. V. Golubkov & E. Bludov (GRSU), vicinity of Grodno, the second fort of the Grodno fortress, granite, 11 Aug. 1990, leg. V. Golubkov (GRSU), right riverside of the Niemen, granite, 7 Sept. 2004, leg. V. Golubkov (GRSU), 1 km NW of Podlabienie village, the third fort of the Grodno fortress, on moss-covered siliceous stones, 29 July 2008, leg. V. Golubkov (GRSU), 1.5 km NW of Prigodichy village, on granite, 7 Sept. 2004, leg. V. Golubkov (GRSU).

NOTE. It is the first record of the species for North-Western Belarus.

Rhizocarpon eupetraeum (Nyl.) Arnold, Flora 53: 478 (1870).

For the description of the species see Thomson (1997). Spot test reactions: thallus K+ yellow-turning red, C–, KC+ red, PD+ orange; medulla K+ yellow turning red, PD+ yellow, C–, I+ deep blue. Substances detected by TLC: norstictic acid (Thomson 1997). The species was found on acid rocks.

The species is arctic and boreal. It is known from Northern Europe and North America. In Europe it has been reported from Germany (Wirth 1995), the Czech Republic (Vězda, Liška 1999), Lithuania (Motiejūnaitė 1999), Austria (Hafellner, Türk 2001), Spain (Llimona, Hladun 2001), Poland (Fałtynowicz 2003), Fennoscandia (Santesson et al. 2004).

R. eupetraeum is known from three localities in North-Eastern Poland (Cieśliński 2003).

Rhizocarpon geographicum (L.) DC., Lamarck & De Candolle, Fl. Franç., Edn 3 (Paris) 2: 365 (1805).

For the description of the species see Poelt (1988). Spot test reactions: medulla I+ blue, K–, C–, PD–; UV+ bright orange. Substances detected by TLC: rhizocarpic acid, psoromic acid in thallus and apothecia. The species was observed on acidic rocks, on boulders.

The species is cosmopolitan in colder areas. In Europe it has been reported from Belarus (Gorbach 1973), Germany (Wirth 1995), the Czech Republic (Vězda, Liška 1999), Lithuania (Motiejūnaitė 1999), Estonia (Randlane, Saag 1999), Austria (Hafellner, Türk 2001), Portugal (Boom, Jansen 2002), Spain (Llimona, Hladun 2001), Great Britain (Coppins 2002), Poland (Fałtynowicz 2003), Fennoscandia (Santesson et al. 2004), Iceland (Kristinsson, Heidmarsson 2006), Albania (Hafellner 2007).

R. geographicum is known from numerous localities in North-Eastern Poland (see Zielińska 1980; Cieśliński, Tobolewski 1989; Fałtynowicz 1994; Kukwa, Fałtynowicz 2002; Cieśliński 2003; Zalewska et al. 2004a, b; Kolanko 2005; Kubiak 2005; Matwiejuk 2008). It was reported from Western Belarus by Gilibert (1781) and from Central Belarus (Minsk region) by Gorbach (1973).

SPECIMENS EXAMINED. NE POLAND. Dolina Biebrzy valley, granite, Oct. 2009, leg. A. Matwiejuk. NW BELARUS. Grodno region, Grodno district – right riverside of the Niemen, 1.5 km W of Prigodichi village, granite, 7 Sept. 2004, leg. V. Golubkov (GRSU), ca 1 km SW of Kamenka village, the sixth fort of the Grodno fortress, granite, 29 Sept. 2007, leg. V. Golubkov, O. Ostrovska, D. Sviridov & A. Levchuk (GRSU).

Rhizocarpon grande (Flörke) Arnold, Flora 54: 149 (1871).

Syn. *Rhizocarpon endamyleum* Th. Fr.

For the description of the species see Thomson (1997). Spot test reactions: medulla I+ blue, C+ red, PD–, K–. Substances detected by TLC: gyrophoric acid, stictic acid and norstictic acid in thallus and apothecia. The species was found on acidic rocks.

R. grande is bipolar. It is known from Mongolia (Golubkova 1983), North America (Thomson 1997), Antarctica (Øvstedal, Lewis Smith 2001). In Europe it has been reported from Germany (Wirth 1995), the Czech Republic (Vězda, Liška 1999), Austria (Hafellner, Türk 2001), Poland (Fałtynowicz 2003), Fennoscandia (Santesson et al. 2004) and Iceland (Kristinsson, Heidmarsson 2006).

R. grande is known from one locality in north-eastern Poland (Zielińska 1980). It was reported from Central Belarus (Minsk region) by Gorbach (1973).

SPECIMENS EXAMINED. NW BELARUS. Grodno region: Schutchinskiy district – vicinity of Pugachi village, the “Great Stone” geological nature monument, 17 Aug. 1999, *leg. V. Golubkov* (MSK-L); Svislotchskiy district – 1 km SW of Porozovo village, on the Ros River, granite, 11 June 1983, *leg. V. Golubkov* (MSK-L).

NOTE. It is the first record of the species from North-Western Belarus.

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.; *Rh. massalongii* sensu Malme; *Rh. crenulatum* H. Magn.

For the description of the species see Fryday (2002). Spot test reactions: thallus K–, C–, PD–; medulla K–, C–, PD–, I–. Substances detected by TLC: lichen products not detected. The species was found on acidic rocks.

R. hochstetteri is circumpolar arctic. It is known from Europe, New Zealand (Fryday 2000b), Japan (Kurokawa 2003) and North America (Thomson 1997). In Europe it has been reported from Germany (Wirth 1995), Austria (Hafellner, Türk 2001), the British Isles (Fryday 2002), Poland (Fałtynowicz 2003), Fennoscandia (Santesson et al. 2004).

SPECIMEN EXAMINED. NW BELARUS. Grodno region: Smorgonskiy district – 1.5 km SW of Balaban village, granite, 16 June 1989, *leg. V. Golubkov* (MSK-L).

NOTE. It is the first record of the species from Belarus.

Rhizocarpon lavatum (Fr.) Hazsl., Magyar. Birod. Zuzmó-Flór.: 206 (1884).

Syn. *Rhizocarpon obscuratum* f. *lavatum* (Fr.) Th. Fr.; *Rh. orphnium* (Vain.) Vain.

For the description of the species see Ihlen (2004). Spot test reactions: thallus K–; medulla I–. Substances detected by TLC: lichen products not detected. The species was found on acidic rocks.

The species is known from Germany (Wirth 1995), the Czech Republic (Vězda, Liška 1999), Austria (Hafellner, Türk 2001), Spain (Llimona, Hladun 2001), Portugal (Boom, Jansen 2002), Great Britain (Coppins 2002), Poland (Fałtynowicz 2003), Fennoscandia (Santesson et al. 2004) and Iceland (Kristinsson, Heidmarsson 2006).

SPECIMENS EXAMINED. NW BELARUS. Grodno region: Smorgonskiy district – 1.5 km W of Balaban village, granite, 16 June 1999, *leg. V. Golubkov* (MSK-L); Grodno district – vicinity of Kamenka village, granite, 27 June 1997, *V. Golubkov* (MSK-L).

NOTE. This is the first records of the species from Belarus.

Rhizocarpon lecanorinum Anders, Hedwigia 64: 261 (1923).

For the description of the species see Poelt (1988). Spot test reactions: medulla PD+ red, I+ blue, K+ yellow; epithecium K–; exciple K+ red. Substances detected by TLC: psoromic acid in thallus and apothecia. The species grows on siliceous rocks, on boulders.

The species is known from Germany (Wirth 1995), the Czech Republic (Vězda, Liška 1999), Lithuania (Motiejūnaitė 1999), Estonia (Randlane, Saag 1999), Austria (Hafellner, Türk 2001), Spain (Llimona, Hladun 2001), Portugal (Boom, Jansen 2002), Great Britain (Coppins 2002), Poland (Fałtynowicz 2003), Fennoscandia (Santesson et al. 2004).

R. lecanorinum is known from one locality in north-eastern Poland (Cieśliński, Tobolewski 1989; see also Kukwa and Fałtynowicz 2002; Cieśliński 2003; Zalewska et al. 2004b).

Rhizocarpon petraeum (Wulfen) A. Massal., Ric. Lich. Crost.: 102 (1852).

Syn. *Rhizocarpon concentricum* auct.; *Rh. excentricum* (Ach.) Arnold, Verh. Zool.-bot. Ges. Wien 29: 356 (1879); *Siegertia petraea* (Wulfen) V. Wirth.

For the description of the species see Ihlen (2004). Spot test reactions: thallus K+ yellow; medulla I–, K–, C–, PD–. Substances detected by TLC: stictic acid in thallus and apothecia. The species was found on acidic rocks.

R. petraeum is circumpolar arctic and boreal. In Europe the species is known from Germany (Wirth 1995), the Czech Republic (Vězda, Liška 1999), Lithuania (Motiejūnaitė 1999), Austria (Hafellner, Türk 2001), Spain (Llimona, Hladun 2001), Great Britain (Coppins 2002), Iceland (Kristinsson, Heidmarsson 2006), Poland (Fałtynowicz 2003), Fennoscandia (Santesson et al. 2004). *R. petraeum* was reported from Central Belarus (Minsk region) by Gorbach (1973).

SPECIMENS EXAMINED. NW BELARUS. Grodno region: Grodno district – ca 1 km SW of Kamenka village, the sixth fort of Grodno fortress, on moss-covered siliceous stones, 29 Sept. 2007, leg. V. Golubkov, O. Ostrowska, D. Sviridov & A. Levchuk (MSK-L); Schutichinskiy district – vicinity of Jakubowice village, granite, 16 June 1989, leg. V. Golubkov (MSK-L).

NOTE. This is the first record of the species from North-Western Belarus.

Rhizocarpon polycarpum (Hepp) Th. Fr., Lichenogr. Scand. 1: 617 (1874).

Syn. *Rhizocarpon confervoides* sensu Rabenh., Kremp.; *Rh. cyanescens* (Hellb.) Zahlbr.

For the description of the species see Thomson (1997). Spot test reactions: thallus K+ yellow, C–; medula I+ blue, K–, C–, PD–. Substances detected by TLC: stictic acid in thallus and apothecia. This species was found on acidic rocks, on boulders.

The species is bipolar. It is known from North Europe, North America (Thomson 1997), Australia (Fryday 2000b), Antarctica (Øvstedal, Lewis Smith 2001). In Europe it has been reported from Germany (Wirth 1995), the Czech Republic (Vězda, Liška 1999), Estonia (Randlane, Saag 1999), Austria (Hafellner, Türk 2001), Portugal (Boom, Jansen 2002), Spain (Llimona, Hladun 2001), Iceland (Kristinsson, Heidmarsson 2006), Great Britain (Coppins 2002), Poland (Fałtynowicz 2003) and Fennoscandia (Santesson et al. 2004).

It is known from several localities in north-eastern Poland (Bystrek and Kolanko 2000; Kukwa and Fałtynowicz 2002; Cieśliński 2003; Zalewska et al. 2004b; Kubiak 2005).

SPECIMEN EXAMINED. NW BELARUS. Grodno region: Svislotchskiy district – Porozovo (1 km SW), on the Ros River, granite, 11 June 1983, leg. V. Golubkov (MSK-L).

NOTE. It is the first record of the species from Belarus.

Rhizocarpon reductum Th. Fr., Lichenogr. Scand. 1: 633 (1874).

Syn. *Rhizocarpon obscuratum* auct. not. (Ach.) A. Massal.

For the description of the species see Fryday (2000b). Spot test reactions: thallus K+ yellow, C–; medulla I–, C–, K+ red, PD+ orange. Substances detected by TLC: stictic acid in thallus and apothecia. The species was found on acidic rocks, on boulders.

The species is circumpolar. In Europe it has been reported from Germany (Wirth 1995), Poland (Fałtynowicz 2003) and Fennoscandia (Santesson et al. 2004; Ihlen 2004).

It is known from several localities in North-Eastern Poland (Cieśliński, Tobolewski 1989, as *R. obscuratum*; Kukwa, Fałtynowicz 2002; Sparrius 2003; Zalewska et al. 2004b; Matwiejuk 2007). It was reported from Central Belarus (Minsk region) by Gorbach (1973).

SPECIMENS EXAMINED. NE POLAND. Wysoczyzna Białostocka high plain, Białystok city, cemetery, stone gravestone, Aug. 2005, leg. A. Matwiejuk. NW BELARUS. Grodno region: Novogrudokskiy district, 1 km SW of Zhdanovitchy village, on the Roc River, granite, 6 June 1989, leg. V. Golubkov (MSK-L).

NOTE. It is the first record of the species from North-Western Belarus.

KEY TO THE SPECIES OF *RHIZOCARPON* OCCURRING IN NORTH-EASTERN POLAND AND NORTH-WESTERN BELARUS

1. Thallus yellow; containing rhizocarpic acid (UV+ bright orange) 2
- 1.* Thallus brown or ashy; lacking rhizocarpic acid (UV-) 3
2. Epithecium reddish, K+ purple-violet *R. geographicum*
- 2.* Epithecium brownish, K-; areoles mostly-shaped, each segment partly to entirely surrounding an apothecium *R. lecanorinum*
3. Ascospores 1- septate 4
- 3.* Ascospores muriform 5
4. Medulla I+ blue, K-, C-; epithecium brown, K+ violet-red *R. polycarpum*
- 4.* Medulla I-, K-, C-; epithecium green-brown, K- *R. hochstetteri*
5. Ascospores hyaline or only slightly darkened with age 6
- 5.* Ascospores very soon dark 9
6. Medulla I+ blue; epithecium red-brown, K+ purple *R. distinctum*
- 6.* Medulla I- 7
7. Thallus pruinous; ascospores muriform, with 10-20 cells *R. petraeum*
- 7.* Thallus epruinous 8
8. Stictic acid present, thallus K+ yellow *R. reductum*
- 8.* Substances not detected by TLC, thallus K- *R. lavatum*
9. Medulla K- *R. grande*
- 9.* Medulla K+ red *R. eupatrum*

DISCUSSION

The lichen biota in East-Central Europe has been studied reasonably well. Some groups of species, however, particularly *Rhizocarpon* species, are still poorly known in many regions (e.g., Belarus). As a result, many species frequent or even common in other areas of Europe have not been reported from a number of countries in central-east part of the continent. Twenty nine species of the genus have been reported in Poland so far (Fałtynowicz 2003); six species were recorded in NE

Poland (Cieśliński 2003) and six species in Belarus (Gorbach 1973). Of the eight taxa presented here, seven species of *Rhizocarpon* are reported for the first time for north-western Belarus, including three for Belarus. The occurrence of three species reported from NE Poland in literature data was confirmed in this study, with new localities recorded for them.

Rhizocarpon distinctum is the only common species in the study area while others are rare or very rare and were found at single localities.

Rocks and boulders, occurring singly or in small groups, are mostly suitable for their development in the lowland. In NE Poland, the area of the Suwalski Landscape Park covers lowland regions with a particularly large accumulation of mostly granite and gneiss boulders (Kukwa, Fałtynowicz 2002; Zalewska et al. 2004b). Boulders, stones and pebbles are in different habitat types: in the fields, balks, pastures, roads, on the slopes, in forests and their edges. Among the *Rhizocarpon* species characterized in the paper, *R. geographicum* and *R. lecanorinum* are rare in the lowlands. In NW Belarus, rare species of *Rhizocarpon* were recorded on the fortifications from World War I in Grodno.

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Nowe notowania gatunków *Rhizocarpon*
z Polski Północno-Wschodniej i Północno-Zachodniej Białorusi

Streszczenie

Celem niniejszej pracy jest uzupełnienie danych o porostach z rodzaju *Rhizocarpon* na terenie Polski Północno-Wschodniej i Północno-Zachodniej Białorusi. Na terenie NE Polski odnotowano trzy nowe stanowiska *Rhizocarpon* – *R. distinctum*, *R. geographicum* i *R. reductum*, a na terenie NW Białorusi osiem gatunków – *R. distinctum*, *R. geographicum*, *R. grande*, *R. hochstetteri*, *R. lavatum*, *R. petraeum*, *R. polycarpum*, *R. reductum*. Siedem gatunków (*R. distinctum*, *R. grande*, *R. hochstetteri*, *R. lavatum*, *R. petraeum*, *R. polycarpum*, *R. reductum*) jest podanych po raz pierwszy dla zachodniej Białorusi, a trzy gatunki (*R. hochstetteri*, *R. lavatum*, *R. polycarpum*) są nowe dla Białorusi. Opracowano autorski klucz do gatunków występujących na badanym obszarze.