CLADONIA DIVERSA (CLADONIACEAE, LICHENIZED ASCOMYCOTA) – OVERLOOKED LICHEN IN POLAND

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ABSTRACT

This is the first report on *Cladonia diversa* Asperges in Poland. Till the present this species was overlooked and usually included under the name *C. coccifera*. The study is based on revision of over a thousand of specimens of the genus *Cladonia* section *Cocciferae* deposited in Polish herbaria. The morphology, chemistry, habitat requirements and known distribution of the lichen in Poland are discussed. A taxonomical remarks concerning the species are also provided.

KEY WORDS: lichens, *Cladonia*, section *Cocciferae*, taxonomy, distribution.

INTRODUCTION

Cladonia diversa Asperges is a representative of the section *Cocciferae* (Delise) A. Evans. The section is well-known for its numerous red-fruited *Cladonia* species. Most of them contain rhodocladonic acid in the hymenium which gives characteristic tint of the discs of apothecia. The group comprises about 65 species throughout the world (Huovinen et al. 1989) from which 17 were reported from Poland till now (Fałtynowicz 2003; see also Kowalewska and Kukwa 2004; Kukwa 2005; Osyczka 2006; Osyczka et al. 2006). Members of this section develop various types of secondary thallus – the podetia can be scyphose or blunt, covered with farinose to granular soredia, microsquamules, coricated granules and/or more or less areolate cortex. The determination of particular taxa is relatively simple when they additionally have diverse chemistry. Morphologically similar species which contain the same lichen substances are often most difficult to distinguish. Great morphological variability within the section still provides problems with delimitation of some taxa.

Cladonia diversa was distinguished from *C. coccifera* (L.) Willd. and *C. pleurota* (Flörke) Schaer. by Asperges (1983, 1985). All three taxa contain usnic acid and zeorin as main secondary lichen substances and therefore a chemical distinction is not possible. In general, *Cladonia diversa* differs from the latter two species by usually more narrow scyphi, slender podetia and densely microsquamulose-granulose surface of podetia. It is often fairly distinct, however, great morphological variability of the species may induce difficulties in its delimitation (especially from *C. coccifera*). For this reason the taxon was often discussed together with *C. coccifera* or included as its synonym (e.g. Ahti and Stenroos 1986; Huovinen et al. 1989; Wirth 1995). However, the most recent papers consider *C. diversa* as a separate species (e.g. Coppins 2002; Söchting and Alstrup 2002; Santesson et al. 2004).

During revision of a cup-shaped *Cladonia* from the section *Cocciferae* in Poland some specimens were found to refer to *C. diversa*. The paper recognizes its distribution in Poland as well as provides discussion on its morphology, chemistry and ecology.

MATERIAL AND METHODS

The object of this revision were three scyphose *Cladonia* species from the section *Cocciferae* containing usnic acid and zeorin as major secondary lichen compounds: *C. coccifera*, *C. pleurota* and *C. deformis* (L.) Hoffm. Altogether 1121 specimens were examined. The material studied originated from the following Polish herbaria: BDPA, GPN, KRA, KRAM, KRAP, KTC, LBL, POZ, UGDA, WA, WRSL, Hb. Kolanko. As reference material the type collections of *C. diversa* were examined (BR – holotype, BM – isotype).

The morphology was examined using standard microscopic techniques. Chemical analyses were performed by TLC (in solvents A and C) according to the standardized methods (White and James 1985; Orange et al. 2001).

Metter-Toledo SevenEasy pH meter was employed for substratum pH determination. The study was made by su-

spending substrate matter in pure water. The pH analysis was done for lichen specimens with sufficient amount of substrate material (min. ~1.1 g).

All ascertained localities of the species are listed and mapped according to the ATPOL gird square system (Zając 1978; modified by Cieśliński and Fałtynowicz 1993). The physiographical division of Poland used in the paper are based on Kondracki (2001). The following abbreviations in localities citation are used: NP – National Park; NR – nature reserve; LP – landscape park; fs – forest section; fd – forest division; vill. – village.

RESULTS AND DISCUSSION

Cladonia diversa was an overlooked lichen in Poland in the past, however, as a result of this study it was recognized as relatively frequent in the area. Below, the species is characterized and discussed in details.

Cladonia diversa Asperges (Fig. 1A-D)

De Cladonia's uit de sectie *Cocciferae* in België (morfologie, chemie, ecologie, sociologie, erspreiding en systematick) 2. Ph.D. Thesis (Wilrijk): 358 (1983).

Belgium, Kempisch district, Kalmthout, Van Ganzenven, 1974, M. Asperges 2498 (BR! – holotype, Figure 1A, see also Figure 1 in Asperges 1985; BM!, H, U – isotypes).

Morphology. The primary squamules are persistent and middle size, up to 0.5 cm long, protruding from the ground, sparsely divided into roundish lobes. The podetia are up to c. 3 cm tall, slender, unbranched or frequently with marginally proliferating scyphi. The scyphi are rather narrow, up to 0.5-0.7 cm wide, sometimes only a little wider than podetial stalk, usually gradually expanded. The surface of the podetia is esorediate and densely covered by corticated granules or/and microsquamules and scaly plates. Basal parts of podetia are often abundantly squamulose. More detailed description of the species is provided by Asperges (1985) and Stenroos (1989a, b).

Chemistry. The thallus of the species always contains usnic acid and zeorin as a major secondary substances. Apothecia (hymenia) contain rhodocladonic acid. Porphyrilic acid and bellidiflorin were reported by Asperges (1983, 1985) as the accessory substances sometimes produced by the species. Only in one specimen from Poland (UGDA-L–13159) porphyrilic acid was detected. This indicates that chemosyndrome of the species without this dibenzofurane is considerably frequent.

Ecology. *Cladonia diversa* is predominantly an epigeic lichen in Poland. Most of the specimens were collected from soil (~78%). The species inhabits also peat and decaying plant and mosses debris (~13%). On mosses and decaying wood *C. diversa* was found more rarely. It prefers primarily open habitats, like: pine forests, grasslands, dune areas, heathlands. Based on the pH analysis of substrate matter of selected specimens (n=28), it seems that *C. diversa* is a strictly acidophilous lichen. The pH range of 3.67-

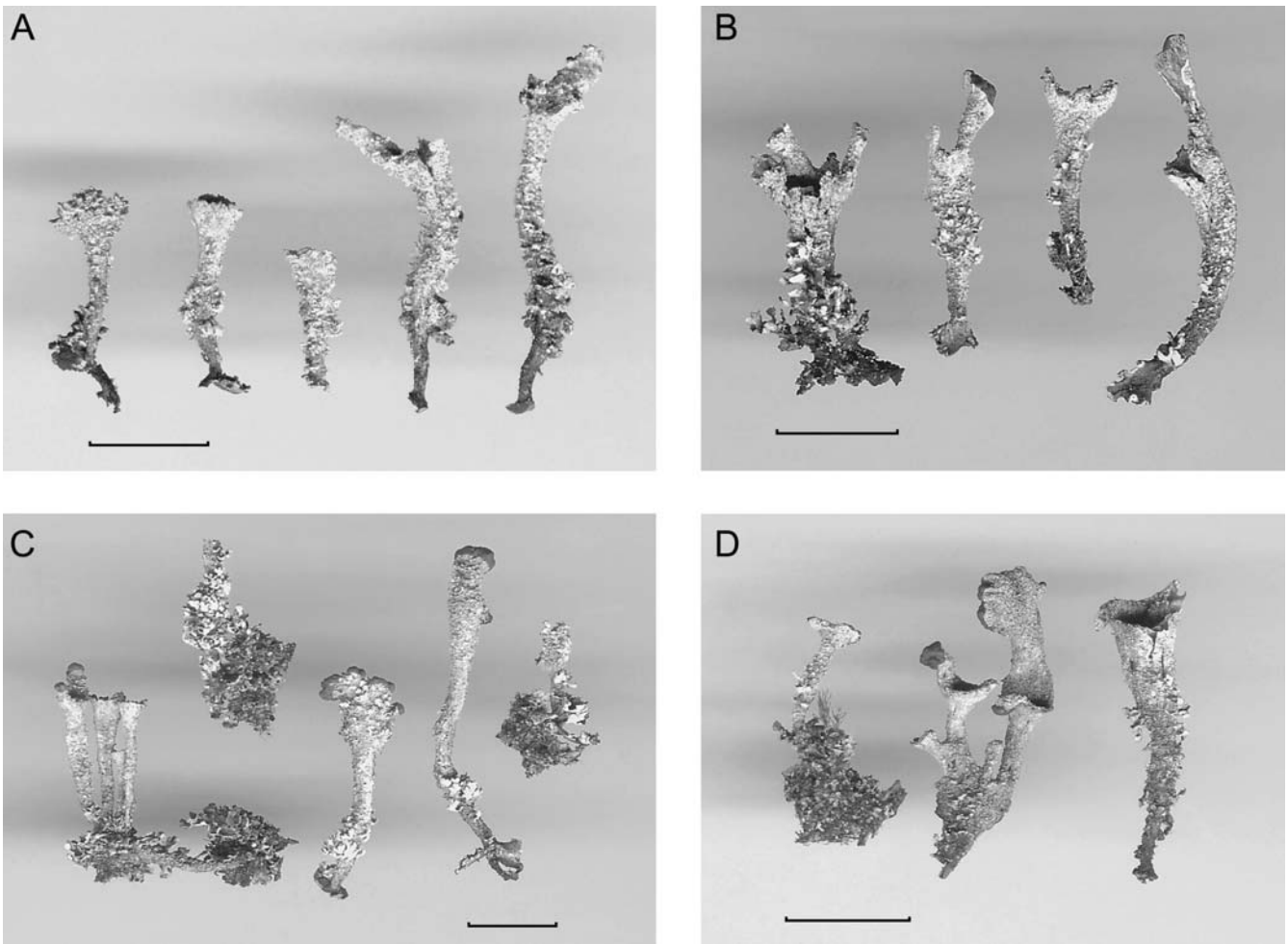

Fig. 1. *Cladonia diversa* Asperges: **A** – Asperges 2498, holotype (BR); **B** – W. Fałtynowicz, 29.07.1984 (UGDA-L–2553); **C** – M. Herbichowa and J. Herbich, 15.09.2004 (UGDA-L–11165); **D** – M. Kukwa, 24.06.1996 (UGDA-L–9730). Scale bars = 1 cm.

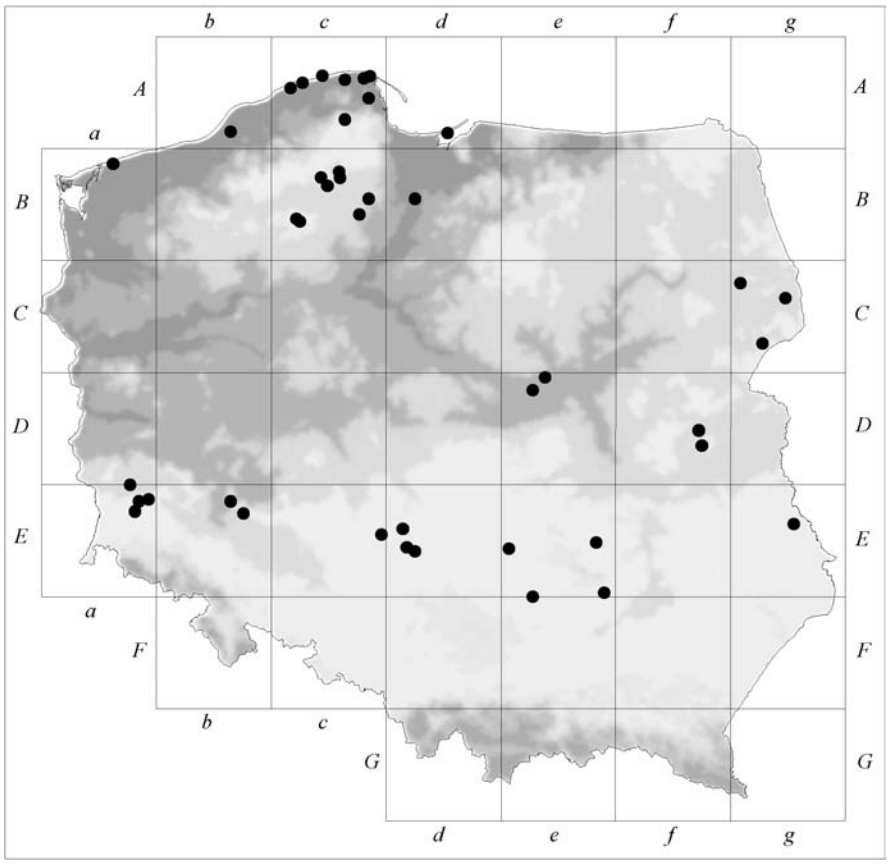

Fig. 2. Known distribution of *Cladonia diversa* Asperges in Poland given in ATPOL grid square system.

-4.46 was determined for substrates occupied by the species and such substrates can be qualified as strongly acid. For the one soil sample pH amounted 3.06 and it is defined as extremely acid kind of soil. The taxa from the section *Cocciferae* frequently demonstrate a tendency to occur on acid substrates (e.g. Wirth 1995).

Distribution in Poland. Currently known distribution of *C. diversa* in Poland is presented in Figure 2. Most of the species localities are situated in the northern part of Poland (the Pobrzeża Południowobałtyckie coastlands, the Pojezierza Południowobałtyckie lakelands, the Wysoczyzny Podlasko-Białoruskie plateau). The lichen seems to be particularly frequent near the Baltic coast. Several collecting sites are located across the central (the Niziny Sasko-Łużyckie lowlands, the Niziny Środkowopolskie lowlands, the Polesie region) and in the south-central part of Poland (the Wyżyna Śląsko-Krakowska upland, the Wyżyna Małopolska upland). The species was not recorded in the mountain areas of the country.

World distribution. The general distribution of *C. diversa* is not well recognized yet. In Europe the species has been reported inter alia from: Fennoscandia (Santesson 1993; Santesson et al. 2004), Iceland (Kristinsson 1999), Lithuanian (Motiejunaite 2002), United Kingdom (Coppins 2002), Denmark (Søchting and Alstrup 2002), Netherlands (Hasse and Daniëls 2006), Belgium (Asperges 1983, 1985), Germany (Scholz 2000), France (Asperges 1985; Stenroos 1989a), Iberian Paninsula (Burgaz and Ahti 1994; Llimona and Hladun 2001), and Italy (Tretiach 1992). Apart from Europe the species is known from China (Guo 1999), the U.S.A. (Lendemer 2006), and Macaronesia (Hafellner 1995; Etayo and Burgaz 1997).

Taxonomical remarks. *Cladonia diversa* belongs to the group of taxa from the section *Cocciferae* containing usnic acid and zeorin as a major lichen substances. It is morphologically often very similar to *C. coccifera* and also *C. pleurota*. There are, however, some distinguishing characters helpful for *C. diversa* determination: slender podetia, densely microsquamulose and/or granulose podetial surface, giving somewhat rugged appearance; usually narrow scyphi, and rather frequent lateral or marginal proliferations. *Cladonia coccifera* is squat, frequently forms wide scyphi (up to 1.5 diam.), has areolate and scaly cortical plates which are rather distracted. A distinction of *Cladonia diversa* from *C. pleurota* is easier because the latter has at least partly granulose sorediate surface of the podetia. Diagnostic characters separating these three species are also juxtaposed in the papers by Asperges (1985) and Stenroos (1989b).

Nomenclatural notes. The nomenclature of *C. diversa* Asperges is not clear. The species name is regarded to be effectively published under the Art. 29.1 of the Code (see Index Fungorum). However, according to the other recent sources (Diederich et al. 2009) the name requires validation based on the Art. 30 of Vienna Code. This important issue needs further consideration.

Specimens examined: **[Ab-86]** – c. 2 km S of Porzecze vill., on humous rock, 04.08.2004, leg. M. Kukwa 3421 (UGDA-L–10984); **[Ac-34]** – E part of Mierzeja Sarbska sand-bar, fs no. 14, on soil, 18.10.1985, leg. J. Miądlikowska (UGDA-L–3695); **[Ac-36]** – Powiat Morski district, Białogóra vill., on soil, 19.08.1953, leg. Z. Tobolewski (POZG); Mierzeja Łebska sand-bar, Białogóra fd, fs no.

27m, c. 1 km NW of Białogóra vill., near Babnica NR, on soil, 31.07.2003, leg. R. Markowski (UGDA-L–9124); Białogóra fd, fs no. 10i, 15.09.2004, on soil, leg. M. Herbichowa and J. Herbich (UGDA-L–11165); **[Ac-37]** – Bielawskie Błoto, c. 2,5 km E of Sławoszynko vill., 08.10.1981, on decaying plant debris and mosses, leg. W. Fałtynowicz (UGDA-L–1180); **[Ac-38]** – Bielawskie Błoto, c. 2.5 km W of Mieroszyn vill., heathland, on decaying plant debris and mosses, 20.07.1981, leg. W. Fałtynowicz (UGDA-L–1188); Bielawskie Błoto, heathland, on soil, 24.07.1981, leg. W. Fałtynowicz (UGDA-L–1397); Bielawa NR, S of Moroszka Bielawskiego Błota NR, heathland with young pines and birches, on decaying peat, 17.06.2006, leg. M. Kukwa 5214 (UGDA-L–13004); **[Ac-42]** – Słowiński Park Narodowy NP, c. 2 km W of Wydma Łącka dune, on sandy soil, 15.08.1996, leg. M. Kukwa (UGDA-L–9790); Słowiński Park Narodowy NP, fs no. 60g, on decaying peat, no date, leg. J. Duriasz (UGDA-L–13159); **[Ac-44]** – Mierzeja Sarbska sand-bar near Łeba town, on sandy soil, 19.10.1985, leg. J. Miądlikowska (UGDA-L–3609); **[Ac-51]** – Słowiński Park Narodowy NP, c. 2 km N of Smołdziński Las vill., on soil, 24.06.1996, leg. M. Kukwa (UGDA-L–9730); **[Ac-58]** – Wejherewo district, Biała Góra vill., on sandy soil, 29.09.1953, leg. Z. Tobolewski (LBL-61); Wejherowo district, Biała Góra vill., on soil, 29.08.1957, leg. K. Glanc (KRAM-L–39576); **[Ad-85]** – Przebrno vill., fs no. 75, on soil, 08.08.1982, leg. E. Budzbon (UGDA-L–1989); **[Ba-16]** – Pobierowo vill., on humous soil, 28.07.1996, leg. E. Kozioł (WRSL-98352); **[Bc-24]** – Bory Tucholskie forests, Popówka fd, fs no. 318n, on soil, 02.03.1975, leg. W. Fałtynowicz (UGDA-L–695); **[Bc-25]** – Wdzydzki Park Krajobrazowy LP, c. 0.5 km W of Schodno vill., on soil, 16.06.2003, leg. M. Kukwa 1840 (UGDA-L–10644); Wąglikowice vill., 500 m E of Kramsko Duże lake, on decaying wood, 14.11.1976, leg. W. Fałtynowicz (UGDA-L–916); **[Bc-34]** – Przymuszewo fd, between Lubnia and Wiele villages, fs no. 327/328, Bór Chrobotkowy im. Prof. Z. Tobolewskiego NR, on soil, 19.05.1999, leg. U. Bielczyk (KRAM-L–44758); Przymuszewo fd, fs no. 324iS, on soil, 05.04.1978, leg. W. Fałtynowicz (UGDA-L–407); **[Bc-40]** – NW of Człuchów vill., c. 2 km E of PKP Bielsko railway-station, heathland, on soil, 12.07.1987, leg. W. Fałtynowicz (UGDA-L–3126); **[Bc-48]** – Pojezierze Starogardzkie lakeland, between Ocypel vill. and Ocyplek lake, on soil, 29.07.1984, leg. W. Fałtynowicz (UGDA-L–2553); **[Bc-57]** – Rosochatka vill., 1 km N of Czersk town, heathland, on sandy soil, 30.09.1988, leg. W. Fałtynowicz (UGDA-L–4028); **[Bc-62]** – c. 20 km N of Człuchów town, near Nowa Wieś vill., 1 km of S bank of Krasne lake, on soil, leg. W. Fałtynowicz (UGDA-L–4300); **[Bd-42]** – Biały Dwór fd, fs no. 235, Ryjewo commune, on soil among mosses, 24.09.1996, leg. M. Kukwa (UGDA-L–9857); **[Cg-34]** – 0.5 km NW of Tanica Górna vill., on soil, 15.08.1992, leg. S. Cieśliński (KTC-1172); **[Cg-10]** – c. 2 km E of Skroblanka vill., on soil, 13.05.1987, leg. S. Cieśliński and Z. Tobolewski (KTC-180); **[Cg-72]** – SW of Puszcza Białowieska forest, near Jelonka vill., on sandy soil, 1980, leg. S. Cieśliński (KTC); 2 km SW of Jelonka vill., on soil, 1980, leg. S. Cieśliński and Z. Tobolewski (KTC); **[De-03]** – Kampinoski Park Narodowy NP, Rybitwa vill., on soil, 18.09.1962, leg. J. Zielińska (WA); **[De-12]** – Kampinoski Park Narodowy NP, near Bieliny vill., on sandy soil, 12.07.1961, leg. J. Zielińska (WA); **[Df-47]** – Strzakły vill., on sandy soil, 1974, leg. A. Hawryluk (LBL); **[Df-67]** – Biała vill. near Radzyń town, on soil among mosses, 1974, leg. A. Hawryluk (LBL); **[Ea-07]** – near Świętoszów vill., on soil, 19.08.1997, leg. E. Kozioł (WRSL-98348); **[Ea-18]** – Ławszów vill., Osiecznica commune, on soil among mosses, 16.08.1997, leg. E. Kozioł (WRSL-98346); Kliczków vill., heathland, on soil, 18.08.1997, leg. E. Kozioł (WRSL-98343); SE of Ławszów vill., heathland, on soil, 28.08.1998, leg. E. Kozioł (WRSL-98929); **[Ea-19]** – Trzebień vill., on dead mosses, 28.07.1992, leg. E. Kozioł (WRSL-98341); **[Ea-28]** – Tomisław vill., on humous soil, 04.09.1992, leg. E. Kozioł (WRSL-98342); **[Eb-16]** – Stary Wołów vill., on humous soil, 29.06.1996, leg. E. Kozioł (WRSL-98345); **[Eb-27]** – Jodłowice vill. near Brzeg Dolny town, on humous soil, 17.07.1989, leg. E. Kozioł (WRSL-98340); **[Ec-49]** – Motyl vill. near Ożarów town, on soil, 21.06.1964, leg. J. Nowak (KRAM-L–12750); **[Ed-41]** – between Kamion and Krzeczów villages, on bank of Warta river, on soil, 23.06.1964, leg. J. Nowak (KRAM-L–12710); **[Ed-51]** – Wapiennik vill. near Parzymiechy vill., on sandy soil, 18.06.1964, leg. J. Nowak (KRAM-L–42633); **[Ed-52]** – Zawady vill. near Rogów vill., on sandy soil, 03.06.1964, leg. J. Nowak (KRAM-L–12478); Zawady vill., on soil, 03.06.1964, leg. J. Nowak (KRAM-L–13404); **[Ee-50]** – between Pilczyca and Czamiętniki villages, dune area, 21.08.1975, leg. S. Cieśliński (KTC-290); **[Ee-58]** – Lubienia vill., on soil, 13.07.1973, leg. S. Cieśliński (KTC-7); **[Ee-92]** – Pogórze Szydłowskie foothills, S of Raków town, on soil, 1982, leg. S. Cieśliński (KTC); **[Ee-99]** – 5 km W of Bogoria vill., Malkowice fd, fs no. 34, on sandy soil, 13.07.1986, leg. M. Chyb (KTC); **[Eg-35]** – Wólka vill. near bank of Bug river, on sandy soil, 31.08.1991, leg. S. Cieśliński (KTC-1129).

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