

## Some interesting records of *Cladonia* species from the Nizina Wielkopolska Lowland (W Poland)

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The lichen genus *Cladonia* comprises several similar species which have hardly been recognized in Western Poland so far. We used thin layer chromatography (TLC) as a simple technique to determine diagnostic lichen substances in morphologically similar *Cladonia* species. During field studies in Sandr Nowotomyski (western Nizina Wielkopolska Lowland), ten interesting records of *Cladonia* species were made. *Cladonia novochlorophaea* is reported for the first time from this region. Our records supplement the knowledge about the distribution of *Cladonia* species both in the investigated region and in Poland. All the records are compared with existing literature data from regional floristic inventories and distribution maps from Poland.

**Key words:** *Cladonia chlorophaea*-group, TLC, Sandr Nowotomyski, Poland

### INTRODUCTION

The lichen genus *Cladonia* Hill ex P. Browne comprises several common and widely distributed epigeic species, well known as reindeer or cup lichens. Detailed chemical investigations in the 20<sup>th</sup> century revealed that secondary lichen compounds show a high diversity in cup lichens, and several new species were described on the basis of these lichen substances (e.g., Hammer 1995). Recently, the importance of secondary lichen metabolites to the taxonomy and species discrimination within the genus *Cladonia* has been confirmed in a first molecular approach by Stenroos et al. (2002). Though *Cladonia* species can be found in many lichenological reports from different regions of Poland (Fałtynowicz 2003 and literature cited therein), the information about the species recognizable only by secondary substances is rather

sparse. Microcrystallization, thin layer chromatography (TLC), or high pressure liquid chromatography (HPLC) are often the only methods to determine specific secondary metabolites (Orange et al. 2001), but in Poland only a few studies have used these laboratory techniques for the identification of *Cladonia* species so far (e.g., Kowalewska et al. 2000, 2008; Kowalewska, Kukwa 2003, 2007; Kowalewska, Szok 2004; Kukwa 2005a, b; Osyczka 2006; Oset et al. 2008; Syrek, Kukwa 2008).

Although several older papers report epigeic lichens from the Nizina Wielkopolska Lowland, this part of Western Poland is still underrepresented in the current Polish lichen inventory (Fałtynowicz, pers. comm.), and therefore every new record from this region is valuable. In this region, attention was paid only to epigeic *Cladonia* species in vegetation surveys of dry grasslands (e.g., Celiński, Balcerkiewicz 1973) and coniferous forests (e.g., Tobolewska, Wronówna 1955; Długosz 1961; Tobolewski 1962, 1963; Zarabska 2008a). Fragmentary information about epigeic *Cladonia* species can also be found in some phytosociological papers (e.g., Kaczyńska 1964; Balcerkiewicz, Brzeg 1993; Balcerkiewicz et al. 1994; Bujakiewicz, Lisiewska 2003; Rakowski 2003).

Recent lichen inventories carried out in Sandr Nowotomyski in the western part of Wielkopolska lowland in the years 2007 and 2008 revealed several stands of rare and noteworthy *Cladonia* species. Some taxa have already been known from the central part of the area in the Nowy Tomyśl region (Krawiec 1938; Dziabaszewski 1962; Nowacka-Zyber 1967; Żukiel 1967; Bujakiewicz, Lisiewska 2003; Zarabska 2008a, b). We restrict our study to rare *Cladonia* species and those which require TLC analysis for the identification. Our data supplement the information about the distribution range in Poland for the following species: *Cladonia cariosa*, *C. chlorophaea* s.str., *C. coccifera*, *C. crispata*, *C. grayi*, *C. merochlorophaea*, *C. novochlorophaea*, *C. pyxidata* s.str., *C. rei* and *C. subulata*.

## STUDY AREA

Localities of *Cladonia* species come from Sandr Nowotomyski, which is part of the Pojezierze Poznańskie Lakeland (Kondracki 2000). According to the geobotanical division of the country, this area belongs to the western part of Kraina Wielkopolsko-Kujawska range (Szafer, Zarzycki 1972). Sandy hills are covered by vegetation of the plant communities *Vaccinio myrtilli-Pinetum sylvestris* Juraszek 1927 nom. invers. (syn. *Leucobryo-Pinetum* Matuszkiewicz 1962) and in some places *Cladino-Pinetum sylvestris* Juraszek 1927 nom. invers. (Żukiel 1967; Medwecka-Kornaś 1972; Bujakiewicz, Lisiewska 2003). These habitats favor the occurrence of epigeic lichen vegetation.

## MATERIAL AND METHODS

Specimens collected during field work were identified with the help of Nowak and Tobolewski (1975), Purvis and James (1992), and Wirth (1995). For the analysis of morphologically similar *Cladonia* species, thin layer chromatography was performed in solvents A and C according to the standard method of Culberson and Ammann (1979). Nomenclature follows Fałtynowicz (2003). All samples were collected by the first author, and the specimens are kept in the Natural History Collection UAM Poznań (POZ).

In the following list of species we give precise information about location, detected secondary compounds (if TLC was carried out), about earlier notes in the literature, and about habitats.

## RESULTS

Altogether, ten species of *Cladonia* are presented here that are rare or have not been recorded in the Wielkopolska Lowland so far.

***Cladonia cariosa* (Ach.) Spreng., Syst. Veg. 4(1): 272 (1827).**

Basionym: *Lichen cariosus* Ach., Lichenogr. Suec. Prodr. 198 (1799).

This species is readily recognized by longitudinally fissured podetia, which are covered by corticated granules or squamules, and large, clustered, terminal brown apothecia (Purvis, James 1992). Tobolewski (1988) considered *Cladonia cariosa* as rare species in Poland. Until now, only a few records from the Nizina Wielkopolska Lowland have been known (Krawiec 1933, 1935, 1955; Dziabaszewski 1962; Tobolewski 1962; Nowacka-Zyber 1967; Kepel 1999). On the local scale it was counted as rare species (Dziabaszewski 1962; Nowacka-Zyber 1967), and was not confirmed during comparison inventories (Kepel 1996; Glanc 1998). In Nowy Tomyśl region, it has been reported from only one locality (Nowacka-Zyber 1967).

SPECIMEN EXAMINED. Równina Nowotomyska Plain, Miedzichowo, ca 3 km SW from village, 52°21.10'N, 15°55.55'E, alt. ca 60 m, pine forest, on soil, 24 April 2008.

***Cladonia chlorophaea* (Flörke ex Sommerf.) Sprengel, Syst. Veg. 4: 273 (1827).**

Basionym: *Cenomyce chlorophaea* Flörke ex Sommerf., Suppl. Fl. Lapp.: 130 (1826).

Cup lichen with brown apothecia on cup margin. Cups gradually tapered to the corticated to granular stalk, inner and outer cup surface usually granular-soredious, sometimes mixed with corticated granules. *Cladonia chlorophaea* s.str. belongs to a group of morphologically similar taxa, and is chemically characterized by the presence of the furmarprotocetraric chemosyndrome (Kowalewska et al. 2008). Although several localities of this taxon were reported from Nizina Wielkopolska Lowland (Krawiec 1933, 1938, 1955; Kanarek-Drela 1960; Długosz 1961; Tobolewski 1962; Kaczyńska 1964; Glanc 1965; Nowacka-Zyber 1967; Żukiel 1967; Glanc et al. 1971; Kozłowska 1975; Balcerkiewicz, Brzeg 1993; Kepel 1999; Rakowski 2003;

Bujakiewicz, Lisiewska 2003; Zarabska 2008a, b), these findings may in fact represent different species as this name was also applied to several other species of the so-called *C. chlorophaea*-group (Fałtynowicz 2003).

Substances detected by TLC: fumarprotocetraric acid (present in all specimens).

**SPECIMENS EXAMINED.** Równina Nowotomska Plain, Bolewice, ca 2.2 km SE from village, 52°21.40'N, 16°06.54'E, alt. ca 83 m, edge of pine-oak forest near dirt road, on soil, 27 Sept. 2007; Jastrzębsko Stare, ca 2.1 km, 52°17.09'N, 16°05.00'E, alt. ca 70 m, SE from village, turf, on soil, 20 Sept. 2007.

***Cladonia coccifera* (L.) Willd., Fl. Berol. Prodr. 361 (1787).**

Basionym: *Lichen cocciferus* L., Sp. Pl. 1151 (1753).

This species is characterized by yellow-green podetia with more or less coarsely corticate-granular or areolate-corticate surface and broad cups, gradually tapering to the base (Purvis, James 1992). Though Nowak and Tobolewski (1975) reported *Cladonia coccifera* as widespread in the whole country, in the Nizina Wielkopolska Lowland it has been recorded mostly in the northern part (Kozłowska 1975), and only scattered information has been published from other localities in Wielkopolska (Krawiec 1955; Długosz 1961; Tobolewski 1962; Balcerkiewicz, Brzeg 1993; Rakowski 2003). Nowacka-Zyber (1967) considered the species as not so abundant in the Nowy Tomyśl region.

The species is morphologically similar to the very rarely found *Cladonia borealis* (Osyczka 2006). The occurrence of barbatic acid in *C. borealis* is a primary feature to distinguish it from *Cladonia coccifera* (Purvis, James 1992).

Substances detected by TLC: usnic acid (present in all specimens), zeorin (present in all specimens).

**SPECIMENS EXAMINED.** Równina Nowotomska Plain, Nowa Boruja, ca 2.2 km W from village, 52°14.38'N, 16°07.38'E, alt. ca 70 m, edge of a pine forest lined by a dirt road, on soil, 26 Sept. 2007; Nowy Tomyśl, ca 2 km NW from town, 52°20.06'N, 16°06.29'E, alt. ca 95 m, pine forest, on soil, 25 Sept. 2007.

***Cladonia crispata* (Ach.) Flot., in Wendt, Thermen Warmbrunn 93 (1839).**

Basionym: *Baeomyces turbinatus* var. *crispatus* Ach., Meth. Lich. 341 (1803).

Characterized by the brownish, corticated, irregular branching, podetia terminating in a single perforation surrounded by short spines, and in being PD– (without fumarprotocetraric acid) and UV+ (squamtic acid) (Purvis, James 1992). Nowak and Tobolewski (1975) considered this species as widespread in both lowland and mountainous regions. Records in the Nizina Wielkopolska Lowland are rather old and restricted to only a few localities (Krawiec 1933; Tobolewska, Wronówna 1955; Długosz 1961; Tobolewski 1962, 1963). The species was known mainly from the *Cladino-Pinetum sylvestris* forest community (e.g., Nowacka-Zyber 1967; Żukiel 1967).

**SPECIMENS EXAMINED.** Równina Nowotomska Plain, Błońsko, ca 1.2 km S from village, 52°10.38'N, 16°08.02'E, alt. ca 71 m, mature pine forest, on soil, 07 April 2008; Sątopy, ca 1.5 km E from village, 52°19.03'N, 16°13.54'E, alt. ca 101 m, pine forest, on soil, 21 Sept. 2007.

***Cladonia grayi* Merrill ex Sandst., Clad. Exs. No. 1847 (1929).**

Cup lichen with gradually tapering, regular, trumpet- or goblet-shaped scyphus, often with proliferations from cup margin. In the upper part, the podetia are covered by granular soredia, while in the lower part, the stalk is corticated, distinctly verruculose and occasionally squamulose (Kowalewska et al. 2008). According to Kowalewska et al. (2008), *Cladonia grayi* is almost absent in Western Poland and

partially also in Eastern Poland; from the Nizina Wielkopolska Lowland it has only been reported by Kubiak (2008) so far. In the investigated area the species was found in a clearing of birch and pine forests.

Substances detected by TLC: grayanic acid (present in all specimens), furmarprotocetraric acid (present in one of two studied specimens).

SPECIMENS EXAMINED. Równina Nowotomska Plain, Chrośnica, ca 2.6 km NE from village, 52°17.08'N, 16°00.40'E, alt. ca 71 m, edge of birch grove, on soil, 27 Sept. 2007; Jastrzębsko Stare, ca 1.8 km NW from village, 52°18.35'N, 16°03.51'E, alt. ca 75 m, pine forest, on soil, 21 Sept. 2007.

***Cladonia merochlorophaea*** Asahina, J. Jap. Bot. 16: 713 (1940).

Characterized by tall, brownish, greenish-grey podetia with gradually flaring scyphi and areolate-corticate, verruculose, or obscurely sorediate to coarsely granular surface (Kowalewska et al. 2008), morphologically indistinguishable from *C. novochlorophaea*. Several localities of *C. merochlorophaea* were discovered in the western Poland by Kowalewska et al. (2008). In Wielkopolska it was previously noted only by Rakowski (2003) and Zarabska (2008a, b), but seems to be the most common member of the *Cladonia chlorophaea*-group in this region. In accordance with results of Kowalewska et al. (2008), *C. merochlorophaea* was mainly recorded on humus-rich soil.

Substances detected by TLC: merochlorophaeic and 4-O-methylcryptochlorophaeic acid (present in all specimens), furmarprotocetraric acid (present in four of seven studied specimens).

SPECIMENS EXAMINED. Równina Nowotomska Plain, Nowa Boruja, ca 2.2 km W from village, 52°14.38'N, 16°07.38'E, alt. ca 70 m, edge of pine forest lined by a dirt road, on soil, 26 Sept. 2007; Chrośnica, ca 1.0 km SE from village, 52°15.47'N, 16°00.51'E, alt. ca 80 m, on sunny clearing in pine forest, on soil, 27 Sept. 2007; Chrośnica, ca 2.6 km NE from village, 52°17.08'N, 16°00.40'E, 27 Sept. 2007, alt. ca 71 m, edge of birch grove, on soil; Jastrzębsko Stare, ca 2.1 km SE from village, 52°17.09'N, 16°05.00'E, alt. ca 70 m, turf, on soil, 20 Sept. 2007; Jastrzębsko Stare, ca 1.8 km NW from village, 52°18.37'N, 16°02.49'E, alt. ca 75 m, pine forest, on humus, 19 Sept. 2007; Miedzichowo, ca 3 km SW from village, 52°21.10'N, 15°55.55'E, alt. ca 60 m, pine forest, on soil, 24 April 2008; Bolewice, ca 2.7 km SE from village, 52°22.48'N, 16°06.54'E, alt. ca 80 m, pine forest, on soil, 2 Oct. 2007.

***Cladonia novochlorophaea*** (Sipman) Brodo Ahti, Canad. J. Bot. 74: 1167 (1996).

Basionym: *Cladonia merochlorophaea* Asahina var. *novochlorophaea* Sipman, Acta Bot. Neerl. 22: 496 (1973).

According to Kowalewska et al. (2008), this cup lichen is morphologically indistinguishable from *C. merochlorophaea* and was only recently discovered in Poland (Kowalewska, Kukwa 2001). Until now, it was rarely noted in the country and was recorded mainly from the northern part (Kowalewska et al. 2008). It can be distinguished from *C. merochlorophaea* by the presence of homosekikaic and sekikaic acids. Here, the species is reported for the first time for the Nizina Wielkopolska Lowland.

Substances detected by TLC: homosekikaic acid and sekikaic acid (present in all specimens), furmarprotocetraric acid (present in one of two studied specimens).

SPECIMENS EXAMINED. Równina Nowotomska Plain, Jastrzębsko Stare, ca 2.1 km SE from village, 52°17.09'N, 16°05.00'E, alt. ca 70 m, turf, on soil, 20 Sept. 2007; Bolewice, ca 2.2 km SE from village, 52°21.40'N, 16°06.54'E, alt. 90 m, pine-oak forest, on soil, 27 Sept. 2007.

***Cladonia pyxidata* (L.) Hoffm. s.str.,** *Deutschl. Fl.* 2: 121 (1796).

Basionym: *Lichen pyxidatus* L., *Spec. Pl.* 2: 1151 (1753).

Syn. *C. callosa* Delise, *C. neglecta* (Flörke) Spreng.

Gradually flaring from the base to the top, greenish grey to brownish podetia are covered with an irregular areolate cortex (Kowalewska et al. 2008). *Cladonia pyxidata* s.str. is mainly found in the south of Poland. From the western part of the country only scattered localities are known (Kowalewska et al. 2008). This species was often recorded in floristic studies of the Nizina Wielkopolska Lowland (Krawiec 1933; Dziabaszewski 1962; Tobolewski 1963; Glanc 1965, 1969, 1998; Nowacka-Zyber 1967; Żukiel 1967; Kozłowska 1975; Brzeg 1981; Balcerkiewicz, Brzeg 1993; Balcerkiewicz et al. 1994; Rusińska 1999; Rakowski 2003), but numerous records may have been mistaken for morphologically similar species, e.g. *Cladonia merochlorophaea*, *C. chlorophaea*, *C. grayi*, or *C. monomorpha*. *Cladonia pyxidata* s.str. is mentioned only in an article of Bujakiewicz, Lisiewska (2003), who recorded this lichen also in the Nowy Tomyśl region.

Substances detected by TLC: furmarprotocetraric acid (present in all specimens).

**SPECIMENS EXAMINED.** Równina Nowotomyska Plain, Jastrzębsko Stare, ca 2.1 km SE from village, 52°17.09'N, 16°05.00'E, alt. ca 70 m, turf, on soil, 20 Sept. 2007; Nowy Tomyśl, ca 2 km NW from town, pine forest, on soil, alt. ca 95 m, 52°20.06'N, 16°06.29'E, 25 Sept. 2007.

***Cladonia rei* Schaer.,** *Lich. Helv. Spicil.:* 34 (1823).

Syn. *C. nemoxya* (Ach.) Arnold.

Characterized by long, granular-sorediate to farinose podetia with or without narrow cups with short proliferations, by often prominent apothecia, or by stout podetia with short anisodiametric branching patterns. This species can be confused with the morphologically similar *C. glauca* and *C. subulata* (Kukwa 2005a). In Poland, *Cladonia rei* is common in the eastern part of the country and has been recorded from the Wielkopolska Lowland only once (Syrek, Kukwa 2008).

Lately, the taxonomical status of *C. rei* has been under discussion (Spier, Aptroot 2007; Syrek, Kukwa 2008); however, most recent molecular studies by us (Dolnik, Beck and Zarabska *subm.*) proved the distinctness of *C. rei* as a separate species, which is not closely related to *C. subulata*.

Substances detected by TLC: homosekikaic acid (present in all specimens), furmarprotocetraric acid (present in two of four studied specimens).

**SPECIMENS EXAMINED.** Równina Nowotomyska Plain: Jabłonna, ca 2.2 km N from village, 52°13.32'N, 16°12.19'E, alt. ca 85 m, pine forest, on soil, 17 Sept. 2008; Szarki, ca 2.5 km S from village, 52°15.30'N, 16°04.21'E, on the edge of a pine forest, on soil, alt. ca 70 m, 25 Sept. 2008; Chrośnica, ca 2.6 km NE from village, 52°17.08'N, 16°00.40'E, alt. ca 71 m, edge of birch grove, on soil, 27 Sept. 2007; Jastrzębsko Stare, ca 2.1 km SE from village, 52°18.35'N, 16°03.51'E, alt. ca 70 m, turf, on soil, 20 Sept. 2007.

***Cladonia subulata* (L.) Weber in F. H. Wigg.,** *Prim. Fl. Holsat.* 90 (1780).

Basionym: *Lichen subulatus* L. *Sp. Pl.* 1153 (1753).

Syn. *C. cornutoradiata* (Coem.) Zopf, *C. fimbriata* var. *cornutoradiata* Coem.

Characterized by long subulate podetia with a granular to farinose sorediate surface, often with an antler-like branching pattern, and by prominent long-stalked cups with long and unequal proliferations narrowing to an acute tip. In contrast to *Cladonia rei*, this species was often recorded in the Wielkopolska area (Krawiec 1930, 1933, 1938, 1955; Tobolewska, Wronówna 1955; Dziabaszewski 1962; Tobolewski

1963; Glanc 1969, 1998; Glanc et al. 1971; Kozłowska 1975; Tobolewski, Kupczyk 1977; Balcerkiewicz, Brzeg 1993; Brzeg, Pawlak 1998; Kepel 1996, 1999; Rakowski 2003), but misidentifications through confusion with furmarprotocetraric acid containing morphs of *C. rei* cannot be ruled out completely. *Cladonia subulata* was recorded in six new localities in the western part of Wielkopolska. These were also the first recordings of this species for Sandr Nowotomyski.

Substances detected by TLC: furmarprotocetraric acid (present in all specimens).

SPECIMENS EXAMINED. Równina Nowotomyska Plain, Komorówko, ca 1.6 km SW from village, 52°10.42'N, 16°10.19'E, pine forest, on soil, alt. ca 78 m, 07 April 2008; Jabłonna, ca 2.2 km N from village, 52°13.32'N, 16°12.19'E, alt. ca 85 m, on soil, 17 Sept. 2008; Chrośnica, ca 2.6 km NE from village, birch forest, 52°17.08'N, 16°00.40'E, on soil, alt. ca 71 m; Jastrzębsko Stare, ca 2.1 km SE from village, 52°18.35'N, 16°03.51'E, alt. ca 70 m, turf, on soil, 20 Sept. 2007; Sękowo, ca 0.9 km NW from village, 52°18.40'N, 16°04.57'E, alt. ca 71 m, pine forest, on soil, 20 Sept. 2007; Sątopy, ca 1.5 km E from village, 52°19.03'N, 16°13.54'E, alt. ca 101 m, pine forest, on soil, 21 Sept. 2007.

## CONCLUSION

Western Poland, especially sandy areas with inland dunes, comprises an interesting epigeic lichen flora with several *Cladonia* species. The use of TLC for the identification of lichens collected in the Wielkopolska region revealed several records of rare species, which have been absent in older sources of Poland. The previously poorly recognized species *Cladonia merochlorophaea* turned out to be the most common member of the *Cladonia chlorophaea*-group in the region.

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Interesujące notowania *Cladonia* spp. z Niziny Wielkopolskiej (Polska Zachodnia)

## Streszczenie

Rodzaj *Cladonia* zawiera kilka podobnych taksonomicznie gatunków, które były dość rzadko podawane z obszaru Polski Zachodniej. W trakcie identyfikacji gatunków wykorzystaliśmy metodę chromatografii cienkowarstwowej (TLC) pozwalającą na określenie substancji porostowych mających charakter diagnostyczny u podobnych pod względem morfologicznym gatunków rodzaju *Cladonia*. Podczas badań terenowych na Sandrze Nowotomyskim (zachodnia Wielkopolska) odnotowano interesujące gatunki rodzaju *Cladonia* (*C. cariosa*, *C. chlorophaea*, *C. coccifera*, *C. crispata*, *C. grayi*, *C. merochlorophaea*, *C. novochlorophaea*, *C. pyxidata* s.str., *C. rei* i *C. subulata*). *Cladonia novochlorophaea* została stwierdzona po raz pierwszy w Wielkopolsce.

Podane informacje pozwolą uzupełnić wiedzę na temat rozmieszczenia chrobotków zarówno w objętym inwentaryzacją regionie, jak i w Polsce. Przy analizach występowania wyszczególnionych taksonów wykorzystano informacje zawarte w danych literaturowych i na mapach rozmieszczenia tych gatunków w Polsce.