

## ***CLADONIA ASAHINAE*, A LICHEN SPECIES OVERLOOKED IN POLAND**

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Lichens belonging to the so-called *Cladonia chlorophaea* group are characterized by brown fruit bodies, and scyphose podetia covered with corticate granules or farinose to granular soredia (e.g., Orange 1992). As many taxa are superficially similar, their diverse secondary chemistry plays a key role in taxonomy and identification (Holien & Tønsberg 1985; Brodo & Ahti 1996). Discriminating them has always been a matter of discussion, especially when their identification was based on the set of lichen substances, and various taxonomic ranks have been accepted. Some taxonomists prefer to treat them at the level of species (e.g., Brodo & Ahti 1996) or subspecies (e.g., Wirth 1995), but sometimes only as formally unnamed chemotypes (e.g., Motyka 1964; Purvis & James 1992; Aptroot *et al.* 2001). Recent molecular studies have proven helpful. It was shown that taxa of the *C. chlorophaea* group are not necessarily very closely related to each other and do not form a separate clade (Stenroos *et al.* 2002). Morphological similarity in that group can be interpreted as the result of convergent evolution rather than from having a common ancestor (Stenroos *et al.* 2002). Thus the taxonomy of the group is more complex than previously thought, and needs further studies. Since the taxa seem to be genetically distant, they deserve to be distinguished at species level.

Some species of the *Cladonia chlorophaea* group are widely distributed in Poland (Fałtynowicz 2003), but up to recent times their identification has been based on differences in morphology and spot test reactions, which give rather weak information on their very important chemistry. On

account of that, usually two taxa besides the very similar *C. fimbriata* (L.) Fr. and *C. pyxidata* (L.) Hoffm. have been distinguished in most papers: *C. chlorophaea* (Flörke *ex* Sommerf.) Spreng. s.str. and *C. grayi* G. Merr. *ex* Sandst. Other taxa were largely ignored, even if some data necessary for their determination existed in Polish sources (Motyka 1964; Nowak & Tobolewski 1975). As the group has been much neglected here, we have undertaken studies to determine the distribution and habitat requirements of all members of the group. Some results have already been published (Kowalewska & Kukwa 2003a, b, 2004).

Among the rich collection of *ca* 1500 Polish specimens, we found one specimen with unique chemistry. Closer examination showed it to contain fumarprotocetraric, rangiformic and norrangiformic acids, matching the chemistry of *Cladonia asahinae* J. W. Thomson (Holien & Tønsberg 1985; Brodo & Ahti 1996). The species has not been reported from Poland previously. This paper presents its first locality in the country, provides a description based on Polish material, discusses similar taxa and their chemistry, and adds remarks on its habitat requirements.

The chemical analyses employed thin-layer chromatography (TLC) in solvent systems A and C (methods according to Orange *et al.* 2001). An acetone extract of *Lepraria jackii* Tønsberg was used as the control for Rf values of rangiformic and norrangiformic acids. Several specimens of *C. asahinae* deposited in Helsinki (H) were studied for comparison. Abbreviations of the authors of lichen names follow Brummitt and Powell (1992). The locality of the specimen is

given in the ATPOL grid square system (Cieśliński & Fałtynowicz 1993).

***Cladonia asahinae* J. W. Thomson**

J. Jap. Bot. **51**: 361. 1977.

Podetia up to *ca* 2 cm high; podetial stalk corticate at lower part or up to cups, without or with squamules; cortex cracked to areolate, areoles convex to  $\pm$  flat, cortex sometimes extending to the lower part of the scyphi; scyphi with short dentate proliferations bearing pycnidia or, very rarely, with proliferations resembling podetia; margin of scyphi with or without divided squamules; outer part of scyphi covered with farinose to granular soredia or with corticated granules, very rarely with few squamules; very rarely the lower part of scyphi covered with cortex, or soredia/granules are shed, revealing white medulla; inside part of scyphi with farinose to granular soredia or with corticate granules; apothecia not found in Polish material.

**CHEMISTRY.** Rangiformic and norrangiformic acids and the fumarprotocetraric acid chemosyndrome were detected in the Polish specimen; therefore it belongs to the common chemotype I. There are two additional chemotypes recognized: II, with protolichesterinic acid; and III, with the fumarprotocetraric acid chemosyndrome only (Hammer 1995; Brodo & Ahti 1996). However, they have not been reported from Europe so far (Holien & Tønsberg 1985; Huovinen *et al.* 1990).

**AFFINITIES.** Morphologically *Cladonia asahinae* resembles *C. chlorophaea* and *C. fimbriata*. It shares the presence of mostly granular soredia with *C. chlorophaea*, and the shape of podetia with a relatively long stalk and abruptly expanded scyphi with *C. fimbriata*. All three taxa produce the fumarprotocetraric acid chemosyndrome, but only *C. asahinae* produces fatty acids as major secondary compounds (in European specimens only rangiformic and norrangiformic acids) (Brodo & Ahti 1996).

Only *Cladonia humilis* (With.) J. R. Laundon var. *bourgeanica* A. W. Archer, placed in the *C. chlorophaea* group, produces fatty acids together with fumarprotocetraric acid, but it

produces bourgeanic acid instead of rangiformic and norrangiformic acids. It also differs morphologically in having mostly farinose soredia on the podetia (Holien & Tønsberg 1985; Kowalewska & Kukwa 2003a).

**DISTRIBUTION AND ECOLOGY.** So far *Cladonia asahinae* has been found at only a single locality in Poland. It seems to be very rare in the country and most probably endangered, as only one specimen was located in a very rich collection of the *C. chlorophaea* group. In Poland the species was found on soil by a path. It was growing together with *C. merochlorophaea* Asahina and some epigeic mosses.

**GENERAL DISTRIBUTION.** Europe: Andorra (Azuaga *et al.* 2001), Czech Republic (Holien & Tønsberg 1985), Finland (Huovinen *et al.* 1990; Santesson *et al.* 2004), Great Britain (Coppins 2002), Lithuania (Motiejūnaitė 2002), Iceland (Brodo & Ahti 1996; Feuerer 2006), Norway, Sweden (Holien & Tønsberg 1985, Santesson *et al.* 2004). Asia: Russia (Brodo & Ahti 1996; Ahti & Hammer 2002; Kristinsson *et al.* 2006). North America: Canada (Brodo & Ahti 1996), U.S.A. (Thomson 1976; Hammer 1995; Brodo & Ahti 1996 and literature cited therein; Ahti & Hammer 2002). South America: Argentina (Tierra del Fuego) (Brodo & Ahti 1996 and literature cited therein; see also additional specimens examined). Antarctica (Brodo & Ahti 1996 and literature cited therein; Osyczka & Olech 2005).

**SPECIMEN EXAMINED.** [Grid square Ge-34] – POLAND. BESKIDY ZACHODNIE MTS. Beskid Sądecki Mts: between Prehyba and Radziejowa Mts, alt. 1126 m, 49°26'N/20°36'E, by path, on soil, 19 Aug. 1960, *leg. J. Kiszka & J. Nowak* (KRAM-L 7308, sub *Cladonia chlorophaea*).

**ADDITIONAL SPECIMENS EXAMINED.** FINLAND. Varsinais-Suomi, Pohja, Mörby, N end of Bokärr, alt. 25 m, granite outcrop in woods, on rock, 14 Apr. 1985, *leg. T. Ahti 43906* (H); CANADA. British Columbia, Parke Mt. top, Mayne I., S. Str. of Georgia, on soil, 04 June 1962, *leg. W. B. Schofield 17539 & F. M. Boas* (H, paratype); ARGENTINA. Tierra del Fuego, Isla Grande, Dept. Ushuaia, Parque Nacional Tierra del Fuego, above Cascada Rio Pipo, alt. 50 m, 54°49'S/68°29'W, old *No-*

*thofagus betuloides* forest, on humus soil, 11 Jan. 1989, leg. T. Ahti 47662 (H).

ACKNOWLEDGEMENTS. We are grateful to Professor Teuvo Ahti (Helsinki) for confirming the Polish specimen of *Cladonia asahinae* and to Dr. Jan J. Wójcicki (Kraków) and the reviewer for helpful comments on the manuscript. The study was financed by the Ministry of Science and Higher Education (Grant no. 2 P04C 055 27).

## REFERENCES

- AHTI T. & HAMMER S. 2002. *Cladonia*. In: T. H. NASH III, B. D. RYAN, C. GRIES & F. Bungartz (eds), *Lichen Flora of the Greater Sonoran Desert Region*. 1: 131–158. Lichens Unlimited, Arizona State University, Tempe, Arizona.
- APTROOT A., SIPMAN H. J. M. & VAN HERK C. M. 2001. *Cladonia monomorpha*, a neglected cup lichen from Europe. *Lichenologist* **33**(4): 271–283.
- AZUAGA T., BARBERO M. & GÓMEZ-BOLEA A. 2001. Additions to the knowledge of the genus *Cladonia* (Cladoniaceae, lichenized Ascomycotina) in the alpine belt of the Pyrenees in Andorra. *Mycotaxon* **79**: 433–446.
- BRODO I. M. & AHTI T. 1996. Lichens and lichenicolous fungi of the Queen Charlotte Islands, British Columbia, Canada. *Canad. J. Bot.* **74**: 1147–1180.
- BRUMMITT R. K. & POWELL C. E. 1992. Authors of plant names. Royal Botanic Garden, Kew.
- CIEŚLIŃSKI S. & FAŁTYNOWICZ W. (eds) 1993. Atlas of the geographical distribution of lichens in Poland. Part 1. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- COPPINS B. J. 2002. Checklist of lichens of Great Britain and Ireland. British Lichen Society, London. <http://www.thebls.org.uk/checklist.html>.
- FAŁTYNOWICZ W. 2003. The lichens, lichenicolous and allied fungi of Poland – an annotated checklist. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.
- FEUERER T. (ed.) 2006. Checklists of lichens and lichenicolous fungi. Hamburg University, Hamburg. [Version 1 June 2006]. <http://www.checklists.de>.
- HAMMER S. 1995. A synopsis of the genus *Cladonia* in the Northwestern United States. *Bryologist* **98**(1): 1–28.
- HOLIEŃ H. & TØNSBERG T. 1985. Notes on *Cladonia asahinae*, *C. conista* and the *C. grayi*-group in Norway. *Gunneria* **51**: 1–26.
- HUOVINEN K., AHTI T. & STENROOS S. 1990. The composition and contents of aromatic lichen substances in *Cladonia* section *Cladonia* and group *Furcatae*. *Biblioth. Lichenol.* **38**: 209–241.
- KOWALEWSKA A. & KUKWA M. 2003a. Additions to the Polish lichen flora. *Graphis Scripta* **14**: 11–17.
- KOWALEWSKA A. & KUKWA M. 2003b. Preliminary studies of the *Cladonia chlorophaea* group (Cladoniaceae, Ascomycota lichenisati) in northern Poland. *Botanica Lithuanica* **9**(2): 135–143.
- KOWALEWSKA A. & KUKWA M. 2004. New records of *Cladonia monomorpha* (Cladoniaceae, lichenised Ascomycota) from Europe. *Herzogia* **17**: 103–105.
- KRISTINSSON H., HANSEN E. S. & ZHURBENKO M. 2006. Panarctic lichen checklist. [http://archive.arcticportal.org/276/01/Panarctic\\_lichen\\_checklist.pdf](http://archive.arcticportal.org/276/01/Panarctic_lichen_checklist.pdf).
- MOTIEJŪNAITĖ J. 2002. Additions to the Lithuanian flora of foliose and fruticose lichens. *Botanica Lithuanica* **8**(1): 69–76.
- MOTYKA J. 1964. Porosty (Lichenes). *Flora Polska. Rośliny Zarodnikowe Polski i Ziemi Ościennych* **3**(2). Państwowe Wydawnictwo Naukowe, Warszawa.
- NOWAK J. & TOBOLEWSKI Z. 1975. Porosty polskie. Państwowe Wydawnictwo Naukowe, Warszawa – Kraków.
- ORANGE A. 1992. A key to the *Cladonia chlorophaea* group in Europe, using microcrystal tests. *British Lichen Society Bulletin* **70**: 36–42.
- ORANGE A., JAMES P. W. & WHITE F. J. 2001. Microchemical methods for the identification of lichens. British Lichen Society, London.
- OSYČZKA P. & OLECH M. 2005. The lichen genus *Cladonia* of King George Island, South Shetland Islands, Antarctica. *Polish Polar Res.* **26**(2): 107–123.
- PURVIS O. W. & JAMES P. W. 1992. *Cladonia* Hill ex Browne (1756). In: O. W. PURVIS, B. J. COPPINS, D. L. HAWKSWORTH, P. W. JAMES & D. M. MOORE (eds), *The lichen flora of Great Britain and Ireland*, pp. 188–210. Natural History Museum Publications, London.
- SANTESSON R., MOBERG R., NORDIN A., TØNSBERG T. & VITIKAINEN O. 2004. Lichen-forming and lichenicolous fungi of Fennoscandia. Museum of Evolution, Uppsala University.
- STENROOS S., HYVÖNEN J., MYLLYS L., THELL A. & AHTI T. 2002. Phylogeny of the genus *Cladonia* s. lat. (Cladoniaceae, Ascomycetes), inferred from molecular, morphological and chemical data. *Cladistics* **18**: 237–278.
- THOMSON J. W. 1977. *Cladonia asahinae* sp. nov. from western North America. *J. Jap. Bot.* **51**(1976): 360–364.
- WIRTH V. 1995. Die Flechten Baden-Württemberg. 1–2. Ed. 2. Verlag Eugen Ulmer, Stuttgart.