Ann. Bot. Fennici 45: 448–454 ISSN 0003-3847 (print) ISSN 1797-2442 (online)
Helsinki 30 December 2008

New and interesting records of *Cladonia* and their lichenicolous fungi from the Andean cloud forest in Bolivia

Adam Flakus[1,*], Teuvo Ahti[2], Martin Kukwa[3] & Karina Wilk[1]

[1)] *Laboratory of Lichenology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland (*corresponding author's e-mail: ibflakus@ib-pan.krakow.pl)*
[2)] *Botanical Museum, P.O. Box 7, FI-00014 University of Helsinki, Finland*
[3)] *Department of Plant Taxonomy and Nature Conservation, University of Gdańsk, Al. Legionów 9, PL-80-441 Gdańsk, Poland*

Received 2 Oct. 2007, revised version received 22 Nov. 2007, accepted 27 Nov. 2007

Flakus, A., Ahti, T., Kukwa, M. & Wilk, K. 2008: New and interesting records of *Cladonia* and their lichenicolous fungi from the Andean cloud forest in Bolivia. — *Ann. Bot. Fennici* 45: 448–454.

The paper deals with 18 species of the lichen genus *Cladonia*, including eight species new to Bolivia: *C.* cf. *borbonica*, *C. coccifera*, *C. confragosa*, *C. dactylota*, *C. granulosa*, *C. kriegeri*, *C. merochlorophaea*, and *C. squamosa*. Furthermore, *C. kriegeri* is recorded here from its second and third localities in the world. Also five lichenicolous fungi are reported; among them *Arthrorhaphis aeruginosa*, *Polycoccum microcarpum* and *Sphaerellothecium cladoniae* are new to the southern hemisphere, and *Roselliniella cladoniae* and *Tremella cladoniae* are new to Bolivia. Additionally, *Polycoccum microcarpum* is reported for the first time from Slovakia and Ukraine. *Cladonia confragosa* is reported as a new host for *Sphaerellothecium cladoniae* and *Tremella cladoniae*.

Key words: Andes, biodiversity, Bolivia, Cladoniaceae, cloud forest, floristics, lichenized and lichenicolous fungi, Neotropics, new records

The genus *Cladonia* is represented by about 181 species in the Neotropics (Ahti 2000). Although some areas are very well-studied, other regions are still not well explored. Bolivia is one of the least studied countries in South America, and only about 30 *Cladonia* species have been reported so far from there (e.g. Nylander 1861, Eckfeldt 1896, Herzog 1922, Ahti 1986, 1997, 2000, Stenroos 1989b, Feuerer *et al*. 1998). This is mainly caused by the rather poor level of lichenological investigation in that region in general. In total, there are about 400 species of lichens known from Bolivia, but it has been estimated that about 80% of lichen species wait for the discovery in the future (Feuerer *et al*. 1998, Feuerer 2007, Flakus *et al*. 2006).

During the exploration of the Andean mountain cloud forest in the Santa Cruz Department in Bolivia (2004) we found a forest stand with very abundant colonies of several *Cladonia* species. As that type of vegetation is one of the very important centres of biological diversity in the world (Barthlott *et al*. 2005) and some taxa have never been reported from Bolivia so far, includ-

ing lichenicolous fungi growing on *Cladonia* species, we hereby contribute to the knowledge of the lichen flora in that habitat and of *Cladonia* in particular. We hope that our contribution will stimulate further studies in that part of the Neotropics.

As a result of our investigation, 18 *Cladonia* species were discovered, eight of them being new to Bolivia. Additionally, five lichenicolous fungi growing on *Cladonia* thalli were found, of which three are new to the southern hemisphere and two are new to Bolivia.

All the specimens were collected at a single locality in the Andes, situated at an altitude of 2582 m within montane cloud forest (Yungas), near La Palma village in the Siberia region (17°49´12´´S, 64°40´28´´W), Dept. Santa Cruz, Prov. Caballero (East Cordillera). The specimens are preserved at KRAM and LPB with duplicates donated to H and UGDA. An additional specimen of *Cladonia kriegeri* is stored in RB. Chemical analyses were performed using thin-layer chromatography (TLC) in the solvent systems A and C according to Orange *et al*. (2001).

List of taxa

Cladonia arcuata Ahti

This species is essentially a Cordilleran lichen. So far only one unlocalized specimen was known from Bolivia (Ahti 2000). Substances detected by TLC: fumarprotocetraric acid chemosyndrome.

Specimen examined: on humus among bryophytes, *A. Flakus 4658*.

Cladonia cf. ***borbonica*** Nyl.

It has only recently been reported from South America, and so far has been known from Ecuador and Peru only (Ahti 2000). The species belongs to the *Cladonia ochrochlora* group and is difficult to separate from the latter. Our specimen produces tall (up to 5 cm) and usually highly corticated podetia with poorly developed soralia, which differentiate it from typical forms of the species. According to Ahti (2000) the status of *C. borbonica* in South America is not clear and needs further studies. Substances detected by TLC: fumarprotocetraric acid chemosyndrome.

Specimen examined: rotting wood, *K. Wilk 2716*.

Cladonia calycantha Delise *ex* Nyl.

This is rather a rare species in the Neotropics, known from Bolivia, Columbia, Ecuador and Peru. In Bolivia it was known only from five localities (Ahti 2000). Substances detected by TLC: fumarprotocetraric acid chemosyndrome.

Specimen examined: humus among bryophytes, *K. Wilk 2794b*.

Cladonia ceratophylla (Sw.) Spreng.

This is the most common *Cladonia* species in the Neotropics, easily identified by its large primary squamules with scattered white marginal rhizines (Ahti 2000). In Bolivia it was reported from five localities only (Ahti 2000). Substances detected by TLC: atranorin (trace) and fumarprotocetraric acid chemosyndrome.

Specimens examined: clay soil and humus among bryophytes, *A. Flakus 4554*, *4627*, *K. Wilk 2739*, *2961*.

Cladonia chlorophaea (Flörke *ex* Sommerf.) Spreng.

This is a common cosmopolitan species (Ahti & Hammer 2002). In the Neotropics it has scattered localities and grows at upper elevations of mountains (Ahti 2000). It belongs to the very difficult *Cladonia chlorophaea* group, and is mainly characterised by granular soredia, usually distinct cortex on podetial stalk, and the presence of fumarprotocetraric acid as main secondary metabolite (Ahti 1966, 2000, Ahti & Hammer 2002). Substances detected by TLC: fumarprotocetraric acid chemosyndrome.

Specimen examined: rotten bark, *A. Flakus 4643*.

Cladonia coccifera (L.) Willd.

The species is common in the northern hemisphere, but rarely reported from the southern hemisphere (Stenroos 1989a, Ahti 2000). In the

Neotropics it is rather widespread (Ahti 2000). Here it is reported as new to Bolivia. *Cladonia coccifera* belongs to the difficult group of red-fruited scyphose taxa, and is predominantly characterised by the areolate-corticated base, scyphi covered by granules, phyllidia, schizidia and/or squamules and the presence of usnic acid and zeorin (Ahti 2000). According to Ahti (2000) the tropical material is somewhat different from the European collections, and more studies are still required to clarify its identity. Substances detected by TLC: usnic, porphyrilic acids and zeorin.

SPECIMEN EXAMINED: rotten bark, *A. Flakus 4713*.

Cladonia confragosa S. Stenroos

So far this species has been known from Chile and Argentina only (Ahti 2000). *Cladonia confragosa* is characterised by long scyphose podetia, usually with strongly areolate to coarsely granulose and phyllidiate surface, the absence of central proliferations and common occurrence of atranorin (Ahti 2000). Our specimens did not contain atranorin. Substances detected by TLC: fumarprotocetraric acid chemosyndrome.

SPECIMENS EXAMINED: humus soil among bryophytes, *A. Flakus 4565*, *K. Wilk 3008*.

Cladonia confusa R. Sant.

The species is widely distributed in tropical regions. It is one of the most widespread species in the Neotropics (Ahti 2000), but not commonly reported from Bolivia. In the Neotropics it is the only species of the *Cladina* group lacking atranorin and containing perlatolic acid (Ahti 2000). Two colour forms can be distinguished within the species, f. *confusa* with usnic and perlatolic acids and f. *bicolor* (Müll. Arg.) Ahti with only perlatolic acid (Ahti 2000). In the studied material both forms have been detected. Substances detected by TLC: *C. confusa* f. *confusa* — usnic acid and perlatolic acid with satellites; *C. confusa* f. *bicolor* — perlatolic acid with satellites.

SPECIMENS EXAMINED: [*C. confusa* f. *confusa*]: on humus soil among bryophytes, *A. Flakus 4567*, *4568*, *4592*, *4645*, *K. Wilk 2794*, *2967*; [*C. confusa* f. *bicolor*]: on soil, *K. Wilk 2792*, *2883*.

Cladonia corniculata Ahti & Kashiw.

The species is rather widespread in the Neotropics, Australasia and southeastern Asia. In Bolivia it has been reported only twice (Ahti 2000). *Cladonia corniculata* is characterised by ascyphose and branched podetia covered with granular soredia, which are easily shed from the surface. Those characters distinguish the species from the very similar *C. subulata* (L.) F.H. Wigg. and *C. subradiata* (Vain.) Sandst. (Ahti 2000). Substances detected by TLC: fumarprotocetraric acid chemosyndrome.

SPECIMEN EXAMINED: humus and rotten bark among bryophytes, *A. Flakus 4644*.

Cladonia dactylota Tuck.

The species is widespread in the Neotropics, but is also very rarely reported from the southeastern United States and the Azores (Ahti 2000). Here it is reported from Bolivia for the first time. It is very easily recognised by the presence of psoromic acid, giving a P+ golden yellow reaction of the thallus, and the tuberculate cottony soralia (Ahti 2000). Substances detected by TLC: psoromic and conpsoromic acids.

SPECIMENS EXAMINED: clay soil and rocky soil among bryophytes, *A. Flakus 4708*, *K. Wilk 2718*, *2983*.

Cladonia didyma (Fée) Vain.

The species has a pantropical distribution and is widespread in the Neotropics (Ahti 2000, Ahti & Hammer 2002). In Bolivia it was reported in only five places so far (Ahti 2000). It is usually distinguished by the simple, microsquamulose, subulate podetia and the chemistry. However, some individuals with more sorediate or granulose surface may be difficult to separate from *Cladonia macilenta* (Ahti 2000). Substances detected by TLC: thamnolic, barbatic (±) and/or didymic (±) acids with unknown with didymic acid (±).

SPECIMENS EXAMINED: rotten wood, humus, soil among bryophytes and other lichens, *A. Flakus 4718*, *4785*, *K. Wilk 2750*, *2781*, *2832*, *2862*, *2914a*, *2972*, *3009a*, *3010*.

Cladonia granulosa (Vain.) Ahti

In South America the species is mainly known from the Andes. It has also been reported from Costa Rica and Mexico (Ahti 2000). Here it is reported as new to Bolivia. It is characterized by the 0–5 times branched podetia covered by soredia mixed with microsquamules (in the lower part of podetia macrosquamules are present) and the presence of thamnolic acid (Ahti 2000). Substance detected by TLC: thamnolic acid.

SPECIMENS EXAMINED: humus among bryophytes, *A. Flakus 4559*, *K. Wilk 2754*, *2708*, *2886*.

Cladonia kriegeri (Ahti & S. Stenroos) Ahti & DePriest

The species was only recently described from Serra do Ibitipoca, Minas Gerais, Brazil (Ahti 2000). Here it is reported as new to Bolivia and it is the second locality for this species. Additionally, it is also known from the state of Bahia, Brazil (*see* below). *Cladonia kriegeri* is very similar to *C. arbuscula* (Wallr.) Flot., but is distinguished by angular main axes and erect, divaricate apical branchlets coupled by isotomic architecture (Ahti 2000). Substances detected by TLC: usnic and fatty acids and fumarprotocetraric acid chemosyndrome.

SPECIMEN EXAMINED: on the ground, *K. Wilk 2966*. Additional specimen: **Brazil**. Bahia. Mun. Maraü: km 11 on road Porto de Campinhos–Maraü (BR-030), restinga, 1980, *P. Carvalho et al. 183* (RB).

Cladonia melanopoda Ahti

The species occurs in northwestern Argentina, Bolivia and Peru at high elevations in the Andes (Ahti 1997, 2000). It belongs to a very difficult group that is characterised by the dentate, very narrow, 0.5–1.5 mm wide and centrally proliferating scyphi and rough surface of podetia (Ahti 2000). Our material of this species is not typical, and some specimens approach *Cladonia andesita* Vain. by having robust and tall podetia. Our observations, especially based on Bolivian specimens, show that the taxonomy of the group in Bolivia and Peru is still not fully clear and needs further studies. Substances detected by TLC: fumarprotocetraric acid chemosyndrome.

SPECIMENS EXAMINED: humus soil among bryophytes, *A. Flakus 4555*, *K. Wilk 2755*, *2793*, *2814*.

Cladonia merochlorophaea Asahina

This is a very widespread member of the *Cladonia chlorophaea* group. In South America the species is known only from Brazil, Peru and Venezuela. It seems to be rare, but must be much overlooked (Ahti 2000). The species is characterised by scyphose podetia with rough surface (granules, schizidia, phyllidia, microsquamules) and the presence of merochlorophaeic and 4-*O*-methylcryptochlorophaeic acids (Ahti 1966, 2000). Substances detected by TLC: merochlorophaeic and 4-*O*-methylcryptochlorophaeic acids and fumarprotocetraric acid chemosyndrome.

SPECIMEN EXAMINED: humus, *K. Wilk 3009c*.

Cladonia rappii A. Evans

Cladonia rappii is rather widespread in South America (total range unclear), but in Bolivia earlier reported only from three localities (Ahti 2000). It is a difficult species, which can possibly include more taxa. It is characterized by a smooth cortex, 3–7 mm wide, and not lacerate scyphi in 6–18 tiers (Ahti 2000). Substances detected by TLC: fumarprotocetraric acid chemosyndrome.

SPECIMEN EXAMINED: humus among bryophytes, *A. Flakus 4722*.

Cladonia squamosa Hoffm.

The species is widespread in the colder regions of the northern and southern hemispheres. In South America it is known mainly from the Andes (Ahti 2000). Here it is reported as new to Bolivia. The species is characterised by the mostly decorticate surface of podetia, covered with squamules and granules, ascyphose to narrowly scyphose tips of podetia, frequently open axils, and the presence of squamatic (chemotype I) or thamnolic (chemotype II) acids (Ahti 2000, Osyczka *et al.* 2007). Substance detected by TLC: squamatic acid.

Specimens examined: humus among bryophytes, *A. Flakus 4721*, *4730*, *K. Wilk 2745*, *2882*.

Cladonia subsquamosa Kremp.

The species has a pantropical distribution pattern (Ahti 2000, Ahti & Hammer 2002). It is widespread in South America, but only two Bolivian localities have been reported so far (Ahti 2000). The species belongs to the *Cladonia chlorophaea* group, but is also very similar to *C. fimbriata* (L.) Fr. *Cladonia subsquamosa* primarily differs by having granular, sometimes isidioid, not farinose soredia, and glassy rather than white stereome (Ahti 2000). Also *C. chlorophaea* can be very similar, but *C. subsquamosa* has completely sorediate podetia lacking a distinct cortical sheath on its podetial stalks (Ahti & Hammer 2002). Substances detected by TLC: fumarprotocetraric acid chemosyndrome.

Specimen examined: humus and plant debris, *A. Flakus 4727*.

Lichenicolous fungi

****Arthrorhaphis aeruginosa*** R. Sant. & Tønsberg

The species is new to the southern hemisphere. It is rather widely distributed in Europe (Santesson & Tønsberg 1994, Etayo & Diederich 1998, Kocourková 2000, Hafellner 2002, Santesson *et al*. 2004, Kukwa & Czarnota 2006) and is known also from North America (Esslinger 2007).

Specimen examined: on squamules of *Cladonia* sp. growing on rotting wood, *K. Wilk 2907*.

****Polycoccum microcarpum*** Diederich & Etayo

The species is new to the southern hemisphere. So far, it has been reported only from Great Britain and the Pyrenees (Etayo & Diederich 1998). The material studied included three specimens of *P. microcarpum* from Ukraine and Slovakia. It is new for these countries as well. Our specimens differ slightly from the original description. The spores are mostly smooth (as reported by Etayo & Diederich 1998 and Zhurbenko & Alstrup 2004), but some are minutely verruculose, and a few are longer, up to 17 μm (up to 14.5 μm according to Etayo & Diederich 1998). Also the size of asci (up to 50 × 12 μm) and perithecia [up to 100(–120) μm] is larger than observed by Etayo and Diederich (1998) [asci 30–35 × 15 μm, pertithecia 30–60(–100) μm]. Additional specimens studied from Ukraine and Slovakia also differ, but only in the size of asci (35–55 × 10–15 μm). We presume, that the variability of *P. microcarpum* was not well known in the past due to rather sparse material, and at the time being, we prefer to treat our specimen under that name. However, more studies of richer material will enable to clarify the position of our specimens and also the affinities to the very similar *P. cladoniae* Diederich & D. Hawksw.

Specimens examined: on squamules of *Cladonia* sp. growing on humus, *A. Flakus 4586/1*.

Additional specimens (all on *Cladonia digitata*): **Slovakia**. Vysoké Tatry Mts., Tatra National Park, Bielovodská Dolina valley, S of Lysá Poľana, on stone, 17.08.1999, *M. Kukwa s.n.* (UGDA-L 10343). **Ukraine**. Chivchino-Grinyavskie Mts., Albin Mt. by Popadia stream, alt. 1340 m, on wood, 21.07.1935, *T. Sulma s.n.* (UGDA-L 10345); Lozdun Mt., alt. 1280 m, on spruce, 30.07.1935, *T. Sulma s.n.* (UGDA-L 10346).

****Roselliniella cladoniae*** (Anzi) Matzer & Hafellner

The species is widespread, being reported from various *Cladonia* species (Zhurbenko & Alstrup 2004, Etayo 2002). In South America it was only known from Colombia (Etayo 2002).

Specimens examined: on thallus of *Cladonia chlorophaea* and *C.* cf. *polyscypha* growing on wood, *A. Flakus 4586*, *4654*.

****Sphaerellothecium cladoniae*** (Alstrup & Zhurb.) Hafellner

The species is new to the southern hemisphere. It is a common and widely distributed fungus in the northern hemisphere (Zhurbenko & Alstrup 2004). *Cladonia confragosa* is a new host for the fungus. In our specimen the asci are slightly narrower (8.5–9 μm) than reported by Zhurbenko

and Alstrup (2004) (11.5–15 μm), but only few asci were found as many perithecia were not well developed or empty. The mycelium was very sparse, and only few hyphae were observed, but such specimens were also found by Zhurbenko and Alstrup (2004) and were included in the variability range of the species.

SPECIMEN EXAMINED: on thallus of *Cladonia confragosa*, *A. Flakus 4678/1*.

****Tremella cladoniae*** Diederich & M.S. Christ.

The species is widespread in the northern hemisphere (Diederich 1996, Hafellner 1999, Czyżewska 2003, Esslinger 2007). In South America it was only reported from Colombia (Etayo 2002), and hence the species is new to Bolivia. *Cladonia confragosa* is a new host for the fungus.

SPECIMENS EXAMINED: thallus of *Cladonia confragosa* and *C.* sp., *A. Flakus 4678*, *K. Wilk 3003*.

Acknowledgements

We wish cordially to thank Professor Zbigniew Mirek (Krakow) for supporting this study, Dr. Stephan G. Beck and M.Sc. Rosa Isela Moneses Q. (La Paz) for their assistance, Andrzej Szwagrzak (La Paz) for his help during the field work and the Herbario Nacional de Bolivia, Instituto de Ecología, Universidad Mayor de San Andrés for generous cooperation. We would like also to thank anonymous reviewers for commenting on the manuscript.

References

Ahti, T. 1966: Correlation of the chemical and morphological characters in *Cladonia chlorophaea* and allied lichens. — *Ann. Bot. Fennici* 3: 380–389.

Ahti, T. 1986: New species and nomenclatural combinations in the lichen genus *Cladonia*. — *Ann. Bot. Fennici* 23: 205–220.

Ahti, T. 1997: *Cladonia melanopoda*, an overlooked Andean lichen. — *Symb. Bot. Upsal.* 32: 7–10.

Ahti, T. 2000: *Cladoniaceae*. — *Flora Neotropica Monogr.* 78: 1–363. New York Bot. Garden, New York.

Ahti, T. & Hammer, S. 2002: *Cladonia*. — In: Nash, T. H. III, Ryan, B. D., Gries, C. & Bungartz, F. (eds.), *Lichen flora of the Greater Sonoran Desert region* I: 131–158. Lichens Unlimited, Arizona State Univ., Tempe.

Barthlott, W., Mutke, J., Rafiqpoor, D., Kier, G. & Kreft, H. 2005: Global centers of vascular plant diversity. — *Nova Acta Leopoldina* 92(342): 61–83.

Czyżewska, K. 2003: Distribution of some lichenicolous fungi in Poland. — *Acta Mycol.* 38: 111–122.

Diederich, P. 1996: The lichenicolous heterobasidiomycetes. — *Biblioth. Lichenol.* 61: 1–198.

Eckfeldt, J. W. 1896: Lichenes. — *Mem. Torrey Bot. Club* 6: 129–130.

Esslinger, T. L. 2007: *A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada*. — North Dakota State Univ., Fargo, available at http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm.

Etayo, J. 2002: Aportación al conocimiento de los hongos liquenicolas de Colombia. — *Biblioth. Lichenol.* 84: 1–154.

Etayo, J. & Diederich, P. 1998: Lichenicolous fungi from the Western Pyrenees, France and Spain. IV. — *Lichenologist* 30: 103–120

Feuerer, T. (ed.) 2007: *Checklists of lichens and lichenicolous fungi*. — Hamburg University, Hamburg, available at http://www.checklists.de.

Feuerer, T., Ahti, T. & Vitikainen, O. 1998: Lichenological investigations in Bolivia. — In: Marcelli, M. P. & Seaward, M. R. D. (eds.), *Lichenology in Latin America: history, current knowledge and applications*: 71–86. CETESB — Companhia de Tecnologia de Saneamento Ambiental, Estado de São Paulo, São Paulo, Brazil.

Flakus, A., Kukwa, M. & Czarnota, P. 2006: Some interesting records of lichenized and lichenicolous Ascomycota from South America. — *Polish Bot. J.* 51: 209–215.

Hafellner, J. 1999: Additions and corrections to the checklist and bibliography of lichens and lichenicolous fungi of Insular Laurimacaronesia. II. — *Fritschiana* 17: 1–26

Hafellner, J. 2002: Eine Beitrag zur Diversität von lichenisierten und lichenicolen Pilzen im Gebiet der Gleinalpe (Steiermark, Österreich). — *Fritschiana* 33: 33–51.

Herzog, T. 1922: Beitrag zur Flechtenflora von Bolivien. — *Hedwigia* 63: 263–268.

Kocourková, J. 2000: Lichenicolous fungi of the Czech Republic (The first commented checklist). — *Sbornik Národniho Muzea v Praze* 55: 59–169.

Kukwa, M. & Czarnota, P. 2006: New or interesting records of lichenicolous fungi from Poland IV. — *Herzogia* 19: 11–123.

Nylander, W. 1861: Additamentum ad lichenographiam Andium Boliviensium. — *Annales des Sciences Naturelles, Botanique* 15: 365–382.

Orange, A., James, P. W. & White, F. J. 2001: *Microchemical methods for the identification of lichens*. — British Lichen Soc., London.

Osyczka, P., Flakus, A., Węgrzyn, M. & Cykowska, B. 2007: *Cladonia crispata* var. *cetrariiformis* (Cladoniaceae, lichenized Ascomycota) in the Tatra Mts. — *Biologia* (Bratislava) 62: 144–147.

Santesson, R. & Tønsberg, T. 1994: *Arthrorhaphis aeruginosa* and *A. olivaceae*, two new lichenicolous fungi. — *Lichenologist* 26: 295–299.

Santesson, R., Moberg, R., Nordin, A., Tønsberg, T. &

Vitikainen, O. 2004: *Lichen-forming and lichenicolous fungi of Fennoscandia*. — Mus. Evol., Uppsala Univ., Uppsala.

Stenroos, S. 1989a: Taxonomy of the *Cladonia coccifera* group. 1. — *Ann. Bot. Fennici* 26: 157–168.

Stenroos, S. 1989b: Taxonomic revision of the *Cladonia miniata* group. — *Ann. Bot. Fennici* 26: 237–261.

Zhurbenko, M. P. & Alstrup, V. 2004: Lichenicolous fungi on *Cladonia* mainly from the Arctic. — *Symb. Bot. Upsal.* 34(1): 477–499.