



Myriospora himalayensis (Acarosporaceae, lichenized fungi), a new species from Western Himalayan region of India

Gaurav K. MISHRA, Sanjeeva NAYAKA*, Dalip K. UPRETI

CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001 Uttar Pradesh, India.

*Corresponding author's email: nayaka.sanjeewa@gmail.com

(Manuscript received 2 December 2020; Accepted 22 February 2021; Online published 3 March 2021)

ABSTRACT: *Myriospora himalayensis* is described as a new to science. The new species is characterized by having pruinose apothecia with small ($1.5\text{--}2.5 \times 1\text{--}1.2 \mu\text{m}$), hyaline, ellipsoid ascospores and areolate-effigurate to squamulose-lobate thalli with grey to brownish upper surface. The new species is so far known only from the Western Himalayan region of India. A key to all known species of *Myriospora* from the world is provided.

KEY WORDS: *Acarospora*, *Ascomycota*, biodiversity, key, lichenized fungi, *Myriospora myochroa*, taxonomy.

INTRODUCTION

The lichen genus *Myriospora* Nägeli was established by Hepp (1853) which is segregated from *Acarospora* A. Massal. Due to uncertainty regarding its nomenclature and validity of publication for a long time, it was treated as a synonym of *Acarospora*. Harris (2004) resurrected the genus while Harris and Knudsen (2006) reviewed the nomenclatural status of *Myriospora* and lectotyped it. Westberg *et al.* (2011) proposed a new genus, *Silobia* M. Westb. & Wedin, for the *Acarospora smaragdula* group which had characteristics similar to *Myriospora*. Arcadia and Knudsen (2012) further argued that *Myriospora* was validly published by Uloth (1861). Therefore, now *Silobia* is treated as a synonym of *Myriospora*. The genus *Myriospora* differs from *Acarospora* as the former has a broken algal layer which is disrupted at irregular intervals by bundles of medullary hyphae reaching the cortex above the algae, and tall hymenium, thin paraphyses and the presence or absence of norstictic acid (Crewe *et al.*, 2006; Wedin *et al.*, 2009). The genus *Myriospora* has been known to consist of 11 species before this study, and they were reported from different parts of Asia, Antarctica, Europe, and North and South America (Westberg *et al.*, 2011; Arcadia and Knudsen, 2012; Knudsen *et al.*, 2012, 2017; Knudsen and Bungartz, 2014; Purvis *et al.*, 2018). Among them, *M. smaragdula* (Wahlenb.) Nägeli ex Uloth and *M. hassei* (Herre) K. Knudsen & Arcadia are the most common species occurring in Asia and Europe (Knudsen, 2007, 2011; Westberg *et al.*, 2011). Knudsen and Fox (2011) published a report on *Acarospora benedarensis* M. Knowles and showed that the narrow paraphyses and high hymenium characters were similar to those of *Myriospora*, but that species was not considered under this genus due to the lack of the disruption of the algal layer by bundles of medullary hyphae. Knudsen and Fox (2011) also suggested that older areoles might be

developing algal bundles of medullary hyphae. Therefore, Roux *et al.* (2019) proposed the new combination as *M. benedarensis* (M. Knowles) Cl. Roux which was also supported by molecular data. Roux (2014) proposed another combination *M. fulvoviridula* (Harrn.) Cl. Roux for *A. fulvoviridula* Harm., but Purvis *et al.* (2018) preferred to treat this species under the genus *Acarospora*. Further, based on phylogenetic study and cluster analysis, Purvis *et al.* (2018) concluded that *M. glaucocarpa* (Ach.) Hepp. was a synonym of *A. glaucocarpa* Ach. In the present study, the authors have found an undescribed species of *Myriospora* among the preserved specimens in LWG and named it as *M. himalayensis*. Further, a world key for the *Myriospora* species is provided.

MATERIALS AND METHODS

This study is based primarily on collections in the herbarium of CSIR–National Botanical Research Institute (LWG) which also includes the personal herbarium of Dr. Awasthi (LWG-AWAS). The specimens were examined morphologically, anatomically, chemically and for UV fluorescence. Thin hand-cut sections of apothecia and thalli were mounted in tap water and observed under a stereozoom microscope (LEICA S8APO) and a bright-field light microscope (LEICA DM500). All anatomical measurements were recorded in tap water, while 10% KOH was used for detailed study of asci and ascospores. For spot tests, the usual reagents K, C and P were used, and lichens substance was identified by thin layer chromatography (TLC) in solvent system C following Orange *et al.* (2001). The TLC plate was observed under UV illumination at 350 nm before and after charring. The specimen was compared to the known species described in the literature (Awasthi, 2007, Westberg *et al.*, 2011, Mishra and Upreti, 2015, Purvis *et al.*, 2018, and Knudsen, 2011).

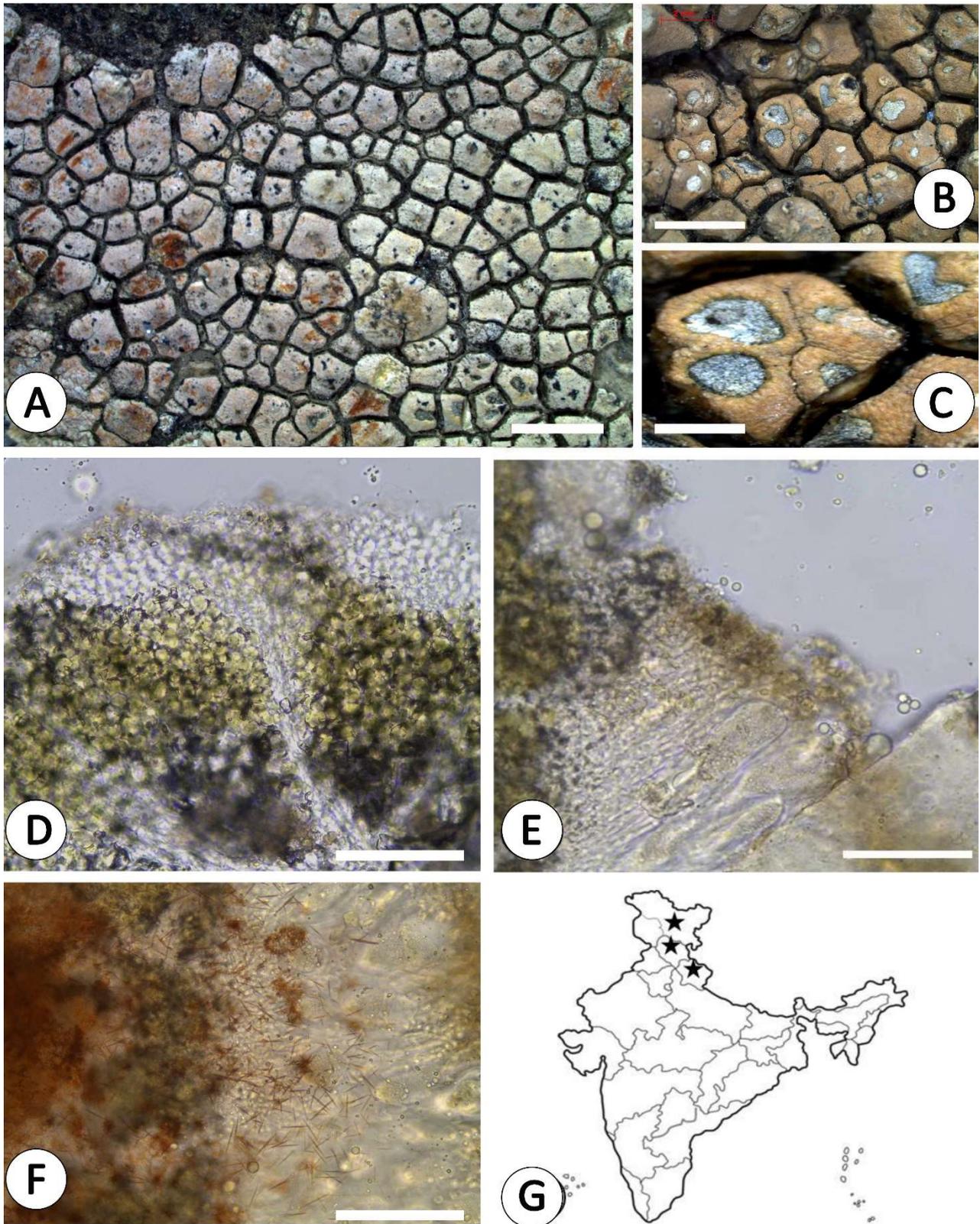


Fig. 1. *Myriospora himalayensis* (holotype, LWG). **A.** Habitat. **B.** Areoles with mostly solitary apothecia forming a contiguous indeterminate crust. **C.** Apothecia 1–4 per areole in contiguous crust. **D.** Transverse section of thallus showing algal layer in bundle. **E.** Ascospores. **F.** K⁺ red, forming needle-shaped crystals in sections. **G.** Distribution of the species in India. Scale Bars: A–C = 0.5 mm; D–E = 10 μ m.



TAXONOMIC TREATMENT

Myriospora himalayensis G.K. Mishra, Nayaka & Upreti, *sp. nov.*

Fig. 1A-G

Mycobank # MB 838705

Type: India, Jammu & Kashmir, Anantnag district, Pahalgam, north side, alt. 2240 m, on rock, 30 Jun. 2005, M. Sheikh, 05-006102 (LWG).

Diagnosis: Similar to *Myriospora myochroa* (M. Westb.) K. Knudsen & Arcadia but differs in having white pruinose apothecial disc and smaller ascospores.

Thallus saxicolous, areolate-effigurate to squamulose-lobate, areoles rounded to angular, distinctly separated by cracks, contiguous to crust, becoming thinner and somewhat scattered in periphery, fertile areole (0.1–) 0.3–1.0 (–2.5) mm wide, with rounded to raised margin; upper surface whitish grey to brownish, plane to convex, with smooth to waxy appearance, epruinose; epinecral layer absent; upper cortex 20–35 µm thick, photobiont chlorococcoid (green alga), upper part colourless with dense crystals throughout the thallus; medulla white; lower surface corticated and having the same color as the upper surface or colourless.

Apothecia 1–3(–4) per areole, immersed, disc rounded to irregular 0.1–0.5 mm diam, usually sunken, sometimes at the level of the thallus, mostly black, white pruinose; proper exciple hyaline with few crystals, thick up to 136 µm; epihymenium pale yellow to brownish, hymenium colourless, 135–240 µm tall; paraphyses simple or branched, tips clavate, up to 1.3 µm thick; subhymenium colourless with many oil-drops, asci 75–112 × 15–23 µm; ascospores hyaline simple ellipsoid, 1.5–2.5 × 1–1.2 µm. Pycnidia present, immersed in the thallus, conidia ellipsoid, 1 × 0.5 µm.

Chemistry: Thallus K⁺ red, C[–], KC[–], PD⁺ yellow, UV[–]; norstictic acid present in TLC.

Etymology: The name of the taxon is based on name of locality from where the specimen was collected i.e. the Himalayas.

Ecology and distribution: The species grows on rocks in the temperate area of Western Himalaya between altitudes of 2325–4500 m in Himachal Pradesh, Jammu & Kashmir and Uttarakhand.

Specimens examined: India, Himachal Pradesh, Kullu district, Great Himalayan National Park, Shilt to Gumtora, alt. 3000 m, on rock, 06 Sep. 1999, *D.K. Upreti*, 99-53620, 99-53624 (LWG); Jammu & Kashmir, Udhampur district, Patni Top, 16 km away from Sanasar area, alt. 2500 m, on rock, 10 Dec. 2005, *M. Sheikh*, 05-006660 (LWG); Uttarakhand, Chamoli district, near Tapovan 26 km before Malari, alt. 2325 m, on rock, 19 Aug. 2007, *D.K. Upreti* & *S. Nayaka*, 07-010226 (LWG); Badrinath, behind Garhwal Jal Sansthan Guest House, alt. 3500 m, on rock, 20 Jun. 2005, *V. Shukla* & *Y. Joshi*, 05-005373/B (LWG); Mana village, alt. 3300 m, on rock, 21 Jun. 2005, *V. Shukla* & *Y. Joshi*, 05-005359 (LWG); way to Vasundhara from Mana, alt. 3333 m, on rock, 21 Aug. 2007, *D.K. Upreti* & *S. Nayaka*, 07-010160 (LWG); between Vasundhara and Bhagirathi Glacier, alt. 3900–4500 m, on rock, 09 Sep. 1991, *D.K. Upreti*, 202390 (LWG);

Auli, below Ghursu top, alt. 3300 m, on rock, 06 Sep. 1991, *D.K. Upreti* 202347 (LWG); Uttarkashi district, on way to Gangotri Sukki, alt. 3500 m, on rock, 21 Apr. 1962, *A. Singh* 97242 (LWG); 24 Apr. 1962, *A. Singh*, 97501 (LWG).

DISCUSSION

The new species is characterized by rounded to irregular, white pruinose apothecial discs, small ascospores, as well as the K⁺ red and PD⁺ yellow thallus. *M. rhagadiza* (Nyl.) K. Knudsen & Arcadia, reported from Denmark, Iceland, Norway, Sweden, Italy and Great Britain closely resembles the new taxon in having fertile areoles up to 2 mm wide, 15–35 µm thick upper cortex and 1–6 apothecia per areole, but differs in having a taller hymenium up to 240 µm and lacking lichen substance. The new species closely resembles *M. myochroa* (M. Westb.) K. Knudsen & Arcadia and *M. smaragdula* in having norstictic acid, a tall hymenium, 120–240 µm thick (cf. 120–230 µm for *M. myochroa* and 140–240 µm for *M. smaragdula*; see Westberg, *et al.* 2011) and crystals in the upper cortex, but differs from them in having white pruinose apothecial discs and smaller ascospores (cf. 3–5 × 1–1.5 µm for *M. myochroa* and 2.5–4.5 × 1–1.5 µm for *M. smaragdula*; see Westberg, *et al.* 2011). *Myriospora hassei* is also similar to the new species in having ellipsoid ascospores and black apothecial discs but differs in lichen substances, pruinose discs and upper cortex having crystals. *Myriospora rufescence* (Ach.) Hepp ex Uloth is also morphologically similar in having coloured thalli and 1–4 apothecia per areole and dark brown to black discs, but the new species differs in having norstictic acid, pruinose discs and ellipsoid ascospores. It is closely related to *M. scabrada* (Hedl. ex H. Magn.) K. Knudsen & Arcadia, which also has a similar colour of the thallus, epihymenium with oil drops and pycnidia, but the new taxon differs by the absence of white pruina on the thallus, which is K⁺ red and PD⁺ yellow, and by pruinose apothecial discs. Compared to *M. westbergii* K. Knudsen & Bungartz, the new species has ellipsoid ascospores and black apothecial discs with pruina. The new species closely resembles *M. dilatata* (M. Westb. & Wedin) K. Knudsen & Arcadia and *M. signyensis* Purvis, Fern.-Brime, M. Westb. & Wedin in having 1–4 apothecia per areole and pruinose disc, but it differs in chemistry and in colour of the thallus.

A world key to the species of *Myriospora*

- 1a. Thallus terricolous 2
- 1b. Thallus saxicolous 3
- 2a. Thallus pale brown to dark brown, hymenium 180–200 µm tall, ascospores subglobose to broadly ellipsoid, 3–4 × 1.5 µm *M. benedarensis*
- 2b. Thallus pale grey to brownish and white pruinose, hymenium 100–170 µm tall, ascospores narrowly ellipsoid to ellipsoid, 3–5 × 1.5–2 µm *M. scabrada*
- 3a. Thallus K⁺ red, containing norstictic acid 4
- 3b. Thallus K[–], lacking lichen substances 6



- 4a. Apothecia up to 4 per areole, disc black and white pruinose and ascospores ellipsoid, $1.5-2.5 \times 1-1.2 \mu\text{m}$ *M. himalayensis*
 4b. Apothecia up to 8(–14) per areole, disc brown to dark brown, epruinose and ascospores narrowly ellipsoid to bacilliform, $2.5-4.5 \times 1-1.5 \mu\text{m}$ 5
 5a. Subhymenium with oil drops, pycnidia present, conidia ellipsoid, $2 \times 1 \mu\text{m}$ *M. myochroa*
 5b. Subhymenium without oil drops, pycnidia absent .. *M. smaragdula*
 6a. Thallus growing in the spray-zone, on sea shore, apothecial disc reddish brown to brown *M. rhagadiza*
 6b. Thallus not growing on sea-shore rocks, apothecial disc otherwise 7
 7a. Thallus ochraceous or orange to rusty red 8
 7b. Thallus whitish, grayish to brownish black or pale greenish to yellowish 10
 8a. Hymenium $180-250 \mu\text{m}$ tall, apothecia disc epruinose, epinecral layer either present or absent *M. tangerina*
 8b. Hymenium $130-175 \mu\text{m}$ tall, apothecia disc pruinose, epinecral layer absent 9
 9a. Upper cortex with crystals, apothecial disc brown to black and orange red pruinose, subhymenium oil drops absent, ascospores oblong, $2-4 \times 1-1.2 \mu\text{m}$, pycnidia present *M. signyensis*
 9b. Upper cortex without crystals, apothecial disc black sometimes rusty red pruinose, subhymenium with many oil drops, ascospores narrowly ellipsoid, $3-4 \times 1.5 \mu\text{m}$, pycnidia absent *M. dilatata*
 10a. Upper cortex with dense crystals, apothecia 1–2 per areole, prominent thalline margin present, ascospores oblong *M. westbergii*
 10b. Upper cortex lacking crystals, apothecia 1–12 per areole, without prominent thalline margin, ascospores otherwise 11
 11a. Hymenium $110-200 \mu\text{m}$ tall *M. hassei*
 11b. Hymenium $100-170 \mu\text{m}$ tall 12
 12a. Thallus white pruinose, epinecral layer present, subhymenium with large number oil drops, ascospores narrowly ellipsoid to ellipsoid, pycnidia present *M. scabrida*
 12b. Thallus lacking pruina, epinecral layer absent, subhymenium lacking oil drops, ascospores narrowly ellipsoid to bacilliform *M. rufescens*

ACKNOWLEDGMENTS

The authors are thankful to the Director, CSIR-National Botanical Research Institute, Lucknow for providing facilities under OLP101. One of the authors, GKM would like to thank the Department of Science & Technology, New Delhi for award of N-PDF (PDF/2017/000356). (CSIR-NBRI Manuscript number CSIR-NBRI_MS/2020/06/16).

LITERATURE CITED

- Arcadia, L. and K. Knudsen.** 2012. The name *Myriospora* is available for the *Acarospora smaragdula* group. *Opusc. Philolichenum* **11**: 19–25.
- Awasthi, D.D.** 2007. *A compendium of the Macrolichens from the India, Nepal and Sri Lanka*. Bishen Singh and Mahendra Pal Singh, Publishers Dehradun, India.
- Crewe, A.T., O.W. Purvis and M. Wedin.** 2006. Molecular phylogeny of *Acarosporaceae* (Ascomycota) with focus on the proposed genus *Polysporinopsis*. *Mycol. Res.* **110(5)**: 521–526.
- Harris, R.C.** 2004. A preliminary list of the lichens of New York. *Opusc. Philolichenum* **1**: 55–73.
- Harris, R.C. and K. Knudsen.** 2006. The genus *Myriospora*. *Opusc. Philolichenum* **3**: 1–4.
- Hepp, P.** 1853. *Abbildungen und Beschreibungen der Sporen zum i. ii. Iii. iv. Zürich.*
- Knudsen, K. and H. Fox.** 2011. *Acarospora benedarensis*: a rare terricolous maritime lichen from Ireland, Scotland and Wales. *Opusc. Philolichenum* **9**: 31–34.
- Knudsen, K. and F. Bungartz.** 2014. *Myriospora westbergii* (*Acarosporaceae*), a new discovery from the Galapagos Islands, Ecuador. *Opusc. Philolichenum* **13**: 177–183.
- Knudsen, K., A. Flakus and M. Kukwa** 2012. A contribution to the study of *Acarosporaceae* in South America. *The Lichenologist* **44(2)**: 253–262.
- Knudsen, K.** 2007. *Acarospora smaragdula* in North America. *Evansia* **24(4)**: 94–96.
- Knudsen, K.** 2011. A new member of the genus *Silobia* (*Acarosporaceae*) from North America. *Opusc. Philolichenum* **9**: 27–30.
- Knudsen, K., J. Kocourkova and U. Schiefelbein.** 2017. New reports of *Myriospora* (*Acarosporaceae*) from Europe. *Mycotaxon* **132(4)**: 857–865.
- Mishra, G.K. and D.K. Upreti.** 2015. *Lichens flora of Kumaun Himalaya*. LAP LAMBERT Academic Publishing, OmniScriptum GmbH & Co. KG, Heinrich-Böcking-str. 6–8, 66121, Saarbrücken, Germany.
- Orange, A., P.W. James and F.J. White.** 2001. *Microchemical methods for the identification of lichens*. British Lichen Society.
- Purvis, O.W., S. Fernández-Brime, M. Westberg and M. Wedin.** 2018. *Myriospora*, a genus newly reported for Antarctica with a worldwide key to the species. *The Lichenologist* **50(1)**: 101–112.
- Roux, C.** 2014. *Catalogue des Lichens et Champignons Lichénicoles de France Métropolitaine*. Fougères: Henry des Abbayes.
- Roux, V.C., S. Poumarat, C. Gueidan, P.N. Rosines, J.Y. Monnat and K.J.M. Houmeau.** 2019. La *Acarosporaceae* de Okcidenta Eŭropo. *Bull. Soc. Linn. Provence* **70**: 219.
- Uloth, W.** 1861. Beiträge zur Flora der Laubmoose und Flechten von Kurhessen. *Flora* **44**: 161–175, 177–187, 565–576, 585–592, 598–607, 617–622, 649–656, 713–716, 735–736, 745–752, 761–763.
- Wedin, M., M. Westberg, A.T. Crewe, A. Tehler and O.W. Purvis.** 2009. Species delimitation and evolution of metal bioaccumulation in the lichenized *Acarospora smaragdula* (Ascomycota, Fungi) complex. *Cladistics* **25(2)**: 161–172.
- Westberg, M., A.T. Crewe, O.W. Purvis and M. Wedin.** 2011. *Silobia*, a new genus for the *Acarospora smaragdula* complex (Ascomycota, *Acarosporales*) and a revision of the group in Sweden. *The Lichenologist* **43(1)**: 7–25.