Sphaerellothecium reticulatum (Zopf) Etayo, a new lichenicolous fungus for Antarctica

Mehmet Gökhan Halici[1*], Miloš Barták[2]

[1]*Erciyes University, Department of Biology, Faculty of Science, Kayseri, Turkey*
[2]*Masaryk University, Department of Experimental Biology, Section of Plant Physiology and Anatomy, Kamenice 5, 625 00 Brno, Czech Republic*

Abstract
In the project aiming to determine the lichen mycota of James Ross Island, we identified a new lichenicolous fungus species which is reported from Antarctica for the first time: *Sphaerellothecium reticulatum* on *Flavoparmelia gerlachei*. Although this species was identified on other parmelioid lichens, it was never reported on *Flavoparmelia* spp.

Key words: Southern hemisphere, biodiversity, lichens, lichenicolous fungi, James Ross Island, *Mycosphaerellaceae*

DOI: 10.5817/CPR2019-1-2

Introduction

Lichenized fungi are the most dominant organisms of the terrestrial vegetation of Antarctica. Dodge (1973) reported 415 species in the White continent and in that publication he considered more than 150 species endemic to Antarctica. After two decades from this publication, Castello and Nimis (1997) examined most of the types which was described by Dodge (1973) and they concluded that only 20% of the species described by him are valid and endemism rate is not as high as reported by him.

Lichenicolous fungi are more or less inconspicuous organisms that develop on lichens. Some of them are parasitic and some of them are parasymbiotic on the host lichens (Lawrey and Diederich 2003). It is believed that they are polyphyleticaly derived from both non-lichenized or lichenized ancestors (Alstrup and Hawksworth 1990). It is assumed that biodiversity of lichenicolous fungi is richer in the mature lichen communities. According to Dodge (1973), lichen flora of Antarctica is relative-

Received April 3, 2019, *accepted* June 5, 2019.
[*]Corresponding author: M. G. Halici <mghalici@gmail.com>
Acknowledgements: The first author thanks for Erciyes University for their financial support to make the field works in James Ross Island, Antarctica and ITU Polrec for their support. This project is also supported by Tübitak 118Z587 coded Project. The authors are thankful for the infrastructure and facilities of J.G. Mendel station (project CzechPolar2, Project No. LM2015078) provided during the Czech Antarctic expedition, Jan-Feb 2017. M. Barták laboratory work was supported by the ECOPOLARIS project (CZ.02.1.01/0.0/0.0/16_013/0001708).

ly young especially in the continental parts and it is mainly originated by long-distance dispersal in the Quaternary period. But according to Hertel (1987) and Galloway (1991), especially the maritime Antarctica has an older lichen flora so that we can expect a richer lichenicolous fungal biodiversity in the maritime Antarctica. This situation is partly proved by Alstrup et al. (2018) as they reported 96 species of lichenicolous fungi from South Shetland Islands archipelago and they described many new genera and species to science. The first reports of lichenicolous fungi from Antarctica were provided by Dodge (1973) and as indicated above, also many wrong reports were in this paper and after Hawksworth and Iturriaga (2006) made revisions of the species collected by Dodge.

In 2016-2017 austral summer period, the authors made extensive field excursions to determine the lichen biodiversity of James Ross Island, specifically in the Northern deglaciated part. As a result we discovered a species of lichenicolous fungus from the study area which is new to Antarctica and provide information about this species here.

Material and Methods

The specimen of the new record is deposited in Erciyes University Herbarium, Kayseri, Turkey (EUH). The specimen was examined by standard microscopic techniques. Hand-cut sections were studied in water, potassium hydroxide (KOH) and Lugol's solution (I). Measurements of ascospores were made in water. The description summarized below is based from the Antarctic specimen.

Collection Site

Sphaerellothecium reticulatum was collected from the Solorina Valley (Fig. 1). The locality is formed by sedimentary rocks and the Solorina valley stream. The locality is rich in moss and lichen vegetation. Within last three decades, biodiversity studies have been performed in Solorina valley, focused on freshwater diatoms (Kopalová et al. 2013), terrestrial algae (Skácelová and Barták 2014), cyanobacteria, lichens (Lewis Smith and Ovstedal 1994) and mosses.

Recently, ecophysiological studies on some lichen species collected in the Solorina valley have been performed, such as *e.g.* evaluation of heavy metals in thalli of *Usnea antarctica* (Zvěřina et al. 2017). Sediments from the Solorina valley has been sampled and analyzed for POP contents (Klánová et al. 2008). The POP concentrations found in the samples supported the hypothesis of the long-range atmospheric transport of POPs to the James Ross Island (Fuoco et al. 2009). The Solorina Valley is located on Eastern coast of the James Ross Islands, therefore, it is shielded by the Lachman Crags mesa from the strong W and NW winds (Hrbáček et al. 2015, Ambrožová et al. 2019). This results in less precipitation in the Eastern compared to Western part of James Ross Island (Davies et al. 2013). Thus, the soils of the Solorina valley and neighbouring the Santa Martha Cove have characteristics of rather inland site soils with less influence of sea spray than the soils from coastal sites. The substrate of the Solorina valley and the Santa Martha Cove is basically composed of coarse-grained cretaceous sandstones and siltstones of the Alpha Member of the Santa Martha Formation (Hrbáček et al. 2016).

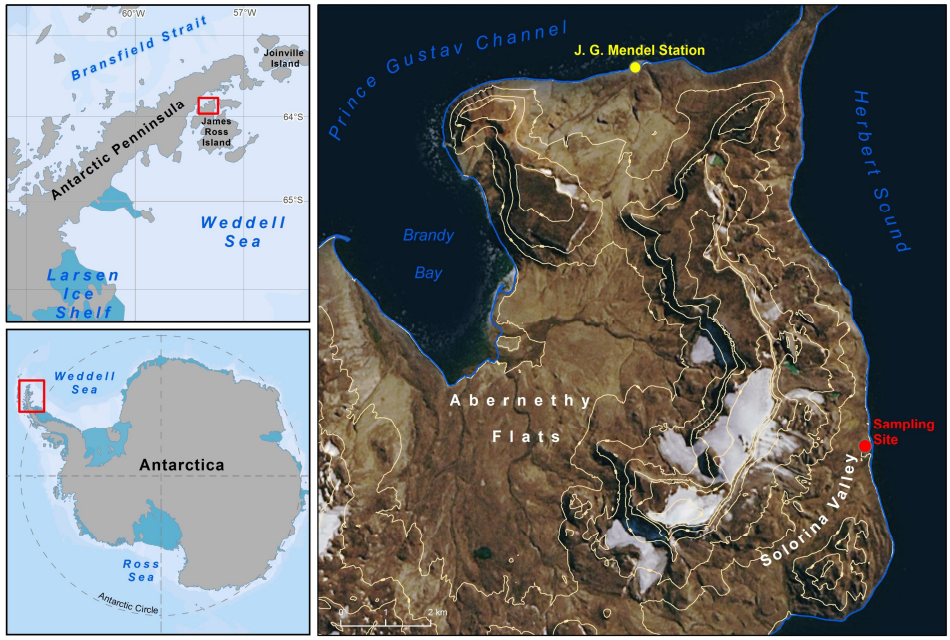

Fig. 1. Collection site, Solorina Valley, James Ross Island. *Source*: [1].

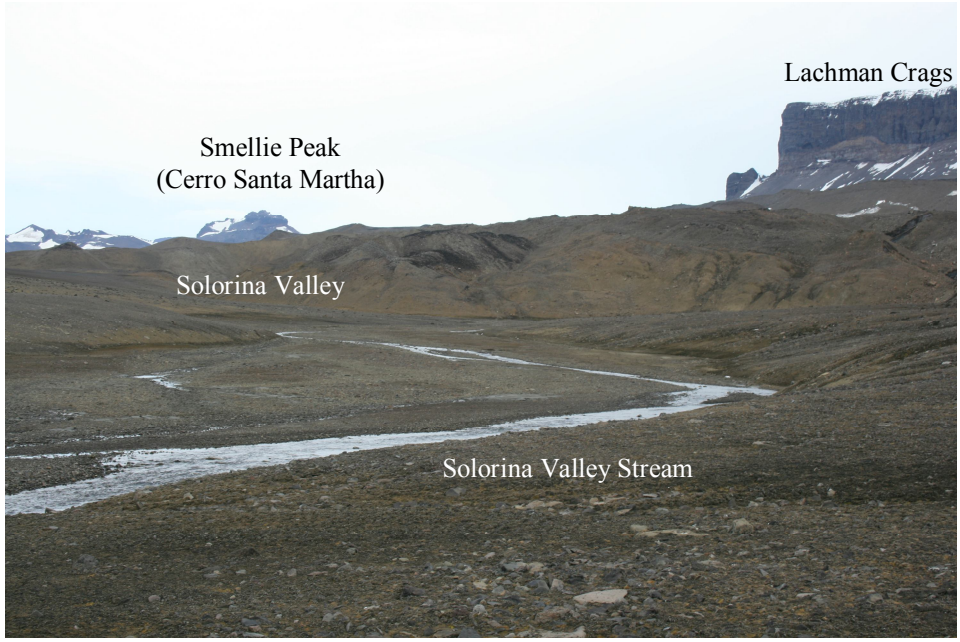

Fig. 2. General view on the Solorina Valley taken in austral summer season (February 15th, 2017). Patchy distribution of vegetation is seen on the stream banks. Photo: © M. Barták.

Fig. 3. Collection and documentation of lichen species close to the stream mouth (150 m from the sea shore line). Photo: © M. Barták.

The land surface is generally covered by a debris layer of gravelsand large clasts that are mixed with loose sandy regolith, mostly derived from James Ross Volcanic Group basalts, which were deposited as debris flows. Soil microbiota is dominated by bacterial taxa such as Actinobacteria, Proteobacteria, Acidobacteria (Meier et al. 2018). The Solorina valley is rich in seepages formed by patterned mosaic of microbiological mats, lichen- and moss dominated patches (*see* Fig. 2, 3).

Daily air temperatures reach a maximum of 9.0°C, and -33.0°C (Elster et al. 2016). In austral summer, monthly mean air temperature ranges between -18.7°C (August) and 0.7°C (February).

Results and Discussion

Sphaerellothecium reticulatum (Zopf) Etayo

A detailed description of this species was provided by Zopf (1898).

Heavily pathogenic for the host lichen as the infected parts of the host thallus is bleached (Fig. 4). Ascomata perithecioid. Outer part of perithecium wall is covered by dark brownish septae. The superficial and dark brownish to almost black hyphae form a reticulate pattern on the host thallus, especially in the older parts of the areolles. Perithecium wall dark brown. Interascal filaments absent. Asci and hymenium K/I$^-$ Asci 8-spored. Ascospores hyaline and 1-septate, 7-11 x 3.5-4.5 µm.

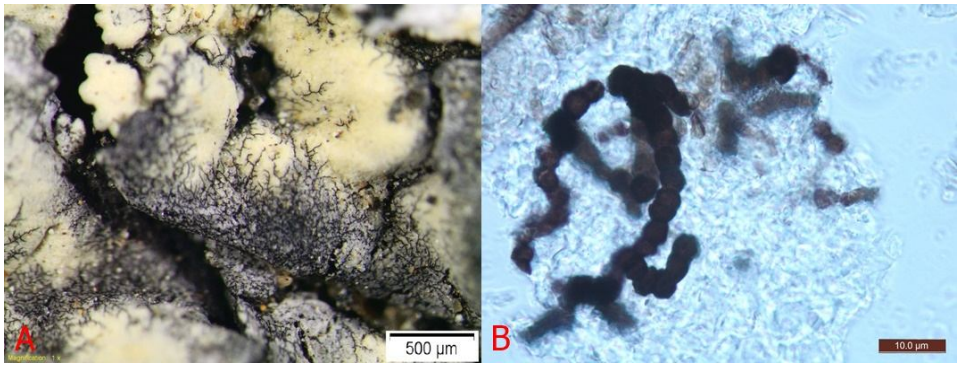

Fig. 4. *Sphaerellothecium reticulatum*. A - The superficial hyphae of the fungus on the host lichen. B - Microscopic view of the vegetative hyphae.

The most distinctive character of the genus *Sphaerellothecium* is their distinct reticulum of dark brownish vegetative thick-walled hyphae. *Sphaerellothecium reticulatum* was classified previously under the genus *Echinothecium* and it is mostly confined to the lichen host *Parmelia* s. str (Nash et al. 2004). However, this pathogenic species was also reported on many other parmelioid lichens and different macrolichens such as *Arctoparmelia centrifuga* (Zhurbenko 2009), *Evernia prunastri* (Kondratyuk et al. 2014), *Hypogymnia tubulosa* (Halici et al. 2007). Triebel et al. (1991) reported this species on *Flavoparmelia caperata*, but according to Nash et al. (2004), the populations on *Flavoparmelia* spp. requires further studies and these populations were not treated in Sonoran Flora by the authors. The Antarctic specimen on *Flavoparmelia gerlachei* is similar in morphology to the illustrations in Zopf (1898), because of this we did not hesitate to report this specimen as *Sphaerellothecium reticulatum*. Although this species has a wide distribution especially in the boreal zone of Europe, Greenland, N and S America (Triebel et al. 1991), it was never reported from Antarctica.

We believe that more careful studies considering the lichenicolous fungi as a part of biodiversity in the terrestrial vegetation of Antarctica, the number of these organisms will increase in the White continent.

References

ALSTRUP, V., HAWKSWORTH, D. L. (1990): The lichenicolous fungi of Greenland. Commission for Scientific Research in Greenland. [Meddelelser om Grønland, Bioscience No. 31] Copenhagen: Kommissionen for videnskabelige Undersøgelser i Grønland. 9 February 1990. 90 p., 45 figs. ISBN 978-87-635-1202-2.

ALSTRUP V., OLECH, M., WIETRYZK-PELKA, P. and WEGRZYN, M. H. (2018): The lichenicolous fungi of the South Shetland Islands, Antarctica: species diversity and identification guide. *Acta Societatis Botanicorum Poloniae*, 87(4): 1-32.

AMBROŽOVÁ, K., LÁSKA, K., HRBÁČEK, F., KAVAN, J. and ONDRUCH, J. (2019): Air temperature and lapse rate variation in the ice‐free and glaciated areas of northern James Ross Island, Antarctic Peninsula, during 2013–2016. *International Journal of Climatology*, 39: 643-657.

CASTELLO, M., NIMIS, P. L. (1997): Diversity of lichens in Antarctica. *In*: B. Battaglia, J. Valencia, D.W.H. Walton (eds.): Antarctic Communities: Species, Structure and Survival. Cambridge University Press, pp. 15-21.

DAVIES, B. J., GLASSER, N. F., CARRIVICK, J. L., HAMBREY, M. J., SMELLIE, J. L. and NÝVLT, D. (2013): Landscape Evolution and Ice-Sheet Behaviour in a Semi-Arid Polar Environment: James Ross Island, Ne Antarctic Peninsula. *Geological Society, London, Special Publications*, 381, pp. 353-395. doi: 10.1144/SP381.1.

DODGE, C. W. (1973): Lichen flora of the Antarctic continent and Adjacent Islands. Canaan, New Hampshire: Phoenix Publishing. 399 p.

ELSTER, J., NEDBALOVÁ, L., VODRÁŽKA, R., LÁSKA, K., HALODA, J. and KOMÁREK, J. (2016): Unusual biogenic calcite structures in two shallow lakes, James Ross Island, Antarctica. *Biogeosciences*, 13(2): 535-549.

FUOCO, R., CAPODAGLIO, G., MUSCATELLO, B., RADAELLI, M. (2009): Persistent Organic Pollutants (POPs) in the Antarctic environment. SCAR Publication, Scott Polar Research Institute, Cambridge, United Kingdom, 98 p.

GALLOWAY, D. (1991): Phylogeography of Southern Hemisphere Lichens. *In*: P. L. Nimis, T. J. Crovello (eds.): Quantitative Approaches to Phytogeogaphy, Dordrecht: Kluwer Academic Publishers, pp. 233-262.

HALICI, M. G., HAWKSWORTH, D. L. and AKSOY, A. (2007): New and interesting lichenicolous fungi records from Turkey. *Nova Hedwigia*, 85(3-4): 393-401.

HAWKSWORTH, D. L., ITURRIAGA, T. (2006): Lichenicolous fungi described from Antarctica and the sub-Antarctic islands by Carroll W. Dodge (1895–1988). *Antarctic Science*, 18(3): 291-301.

Hertel, H. (1987): Progress and problems in taxonomy of Antarctic saxicolous lecideoid lichens. *In*: E. Peveling (ed): Progress and Problems in Lichenology in the Eighties. *Bibliotheca Lichenologica* 25, pp. 219-242.

HRBÁČEK, F., LÁSKA, K., NÝVLT, D., ENGEL, Z. and OLIVA, M. (2015): Effect of Snow Cover on the Active-Layer Thermal Regime – A Case Study from James Ross Island, Antarctic Peninsula. *Permafrost and Periglacial Processes*, 27: 307-315.

HRBÁČEK, F., LÁSKA, K., NÝVLT, D., ENGEL, Z., and OLIVA, M. (2016): Active Layer Thickness Variability on James Ross Island, Eastern Antarctic Peninsula, International Conference on Permafrost, Potsdam, Germany, 2016.

KLÁNOVÁ, J., MATYKIEWICZOVA, N., MÁČKA, Z. PROŠEK, P., LÁSKA, K., and KLÁN, P. (2008): Persistent organic pollutants in soils and sediments from James Ross Island, Antarctica. *Environmental Pollution*, 52: 416-423.

KOPALOVÁ, K., NEDBALOVÁ, L., NYVLT, D., ELSTER, J. and VAN DE VIJYER, B. (2013): Diversity, ecology and biogeography of the freshwater diatom communities from Ulu Peninsula (James Ross Island, NE Antarctic Peninsula). *Polar Biology*, 36(7): 933-948.

KONDRATYUK, S., LOKOS, L., HUR, J. S. (2014): New lichen-forming and lichenicolous fungi from Ukraine. *Acta Botanica Hungarica*, 56(3-4): 361-368.

LAWREY, J. D., DIEDERICH, P. (2003): Lichenicolous fungi: interactions, evolution, and biodiversity. *The Bryologist,* 106(1): 80-121.

LEWIS-SMITH, R. I., ØVSTEDAL, D. O. (1994): *Solorina spongiosa* in Antarctica: An extemely disjunct bipolar lichen. *Lichenologist,* 26: 209-213.

MEIER, L. A., KRAUZE, P., PRATER, I., HORN, F., SCHAEFER, C. E. G. R., SCHOLTEN, T., WAGNER, D., MUELLER, C. W. and KÜHN, P. (2018): From substrate to soil in a pristine environment – pedochemical, micromorphological and microbiological properties from soils on James Ross Island, Antarctica. *Biogeosciences Discussion*, doi: 10.5194/bg-2018-488.

NASH, III T. H., RYAN, B. D., DIEDERICH, P., GRIES, C. and BUNGARTZ, F. (2004): Lichen flora of the Greater Sonoran desert region. Vol. 2. Lichens Unlimited, Tempe, Arizona: Arizona State University. 742 p.

SKÁCELOVÁ, K., BARTÁK, M. (2014): Gradient of algal and cyanobacterial assemblages in a temporary lake with melting water at Solorina Valley, James Ross Island, Antarctica. *Czech Polar Reports*, 4: 185-192.

TRIEBEL, D., RAMBOLD, G. and NASH, III T. H. (1991): On lichenicolous fungi from continental North America. *Mycotaxon*, 52: 263-296.

ZHURBENKO, M. P. (2009): Lichenicolous fungi and some lichens from the Holarctic. *Opuscula Philolichenum*, 6: 87-120.

ZOPF, W. (1898): Untersuchungen über die durch parasitische Pilze hervorgerufenen Krankheiten der Flechten. *Nova Acta Academiae Caesareae Leopoldino-Carolinae Germanicae Naturae Curiosorum,* 70: 243-288. (In German).

ZVĚŘINA, O., COUFALÍK, P., BARTÁK M., PETROV, M. and KOMÁREK, J. (2017): The contents and distributions of cadmium, mercury, and lead in *Usnea antarctica* lichens from Solorina Valley, James Ross Island (Antarctica). *Environmental Monitoring and Assessment*, 190: 13.

Web sources / Other sources

[1] Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community.