

## Contribution to the bryophyte flora of Antarctica: the James Ross Island moss inventory and the new records

Michal Goga<sup>1,2\*</sup>, Marko S. Sabovljević<sup>3</sup>, Ingeborg Lang<sup>2</sup>, Martin Bačkor<sup>1</sup>

<sup>1</sup>Department of Botany, Institute of Biology and Ecology, Faculty of Science, Pavol Jozef Šafárik University, Mánesova 23, 041 67, Košice, Slovakia

<sup>2</sup>Core Facility Cell Imaging and Ultrastructure Research, University of Vienna, Althanstrasse 14, 1090 Vienna, Austria

<sup>3</sup>Institute of Botany and Botanical Garden, Faculty of Biology, University of Belgrade, Takovska 43, 11000 Belgrade, Serbia

### Abstract

The interest in distribution of bryophytes in Antarctica has increased in view of global climate warming and its effects in Antarctica. The moss flora of Antarctica is relatively rich, since only a small area (up to 1%) of this continent is not covered by ice. An immense space remains completely bryologically under-recorded. In this paper, we present a comprehensive moss list of James Ross Island (37 moss species). Two newly-recorded species are reported in our study: *Bryum dichotomum* and *B. pallescens*.

**Key words:** mosses, James Ross Island, Antarctica

**DOI:** 10.5817/CPR2018-1-3

### Introduction

Antarctica is the Earth's southernmost continent. It is coldest, driest, and windiest continent, with a polar desert climate. Small parts of the total surface of the continent are not covered by ice permanently, *i.e.* around 0.3% of area is ice-free in summer (Fox et Cooper 1994). Kurbatova et Ochyra (2012) reported 1% of Antarctica surface to be free of ice cover, inferring that

the ice cover decrease. Extremely cold temperature, limited sunlight and moisture, underdeveloped soils, disturbed nutrient uptake, and a short growing period have deterred most plant species from successfully growing in this barren ecosystem. Despite the odds, there are still plants that have evolved specifically to live in these conditions. Vascular plants known up to date from maritime Ant-

Received December 3, 2017, accepted March 27, 2018.

\*Corresponding author: M. Goga <michal.goga@univie.ac.at>

**Acknowledgements:** The authors thank J. G. Mendel station at James Ross Island (Czech Polar Research Infrastructure, project CzechPolar2, LM2015078), Antarctica for logistic support. This work was financially supported by Slovak Grant Agency (VEGA 1/0792/16). We would like to also thank to Mgr. Margaréta Marcínčinová for helping with map. We acknowledge the valuable comments of anonymous reviewers which significantly improved the manuscript.

arctica, count two species, but non-vascular plants include many species (Convey 2010).

Cryptogams such as mosses, liverworts, lichens, and algae are not nutrient-dependent on root systems and can thrive on nutrient-limited substrates since they receive the nutrients via the whole body surface. Unlike the northern Polar biome, the Antarctica has very cold summers which is a major factor determining the survival of terrestrial biota in the south Polar regions. Lichens and mosses are poikilohydric/poikilothermic organisms with a remarkable capacity to tolerate extreme conditions, notably low and rapidly fluctuating temperature and tissue water contents (Ochyra *et al.* 2008a). They are also reported to withstand high sun radiation doses (Schroeter *et al.* 2012). Therefore, Antarctica hosts a unique biome of the World, dominated by lower autotrophic organisms namely lichens and bryophytes. Up to date, it is known to harbour 113 moss taxa (according to Ochyra *et al.* (2008a) and Li *et al.* (2009)). These belong to 17 families and 56 genera. The lack of bryological investigation as well as very dynamic changes in Antarctica biome infer that more taxa can be present there.

Almost 190 years after the first records of mosses in Antarctica, more than 300 taxa

have been reported (*e.g.* Green 1986). However, a revised approach to such a high number of species reported was needed. Thus, we used the critical treatment by Ochyra *et al.* (2008a, b) of Antarctic bryophyte taxa and the total count is reduced significantly to less than a half. Kurbatova *et Ochyra* (2012) stated only 23 species to be native to continental Antarctica.

Apart from some recent reports on the presence of mosses in various parts of Antarctica, mosses from this part of the world paid attention of scientific community owing their peculiar biological feature to survive in such a harsh environment. Thus, not only that researchers are interested in bryophyte diversity, but also in the way how they cope with inhospitable conditions.

New reports on moss distribution occur and highlight the fact that we are still far from sufficient knowledge on the bryophyte distribution and biology in Antarctica, especially if we consider recent facts on global warming effects and the likely changes in vegetation cover structure. Here, we present the list of mosses known from the James Ross Island up to date, as well as the moss list recorded in 2017 including two species newly reported for James Ross Island.

## Material and Methods

During the research visit to the Antarctica in 2017, senior author (M. Bačkor) made small collection of mosses among the other cryptogams. These were recorded at James Ross Island (Fig. 1), namely at:

1. 63°48.0000' S, 57°52.9330' W, leg. Bačkor M., 18.02.2017
2. 63°49.0100' S, 57°50.7394' W, leg. Bačkor M., 01.02.2017
3. 63°48.4476' S, 57°50.7135' W, leg. Bačkor M., 31.01.2017
4. 63°47.2670' S, 57°47.7330' W, leg. Bačkor M., 11.02.2017

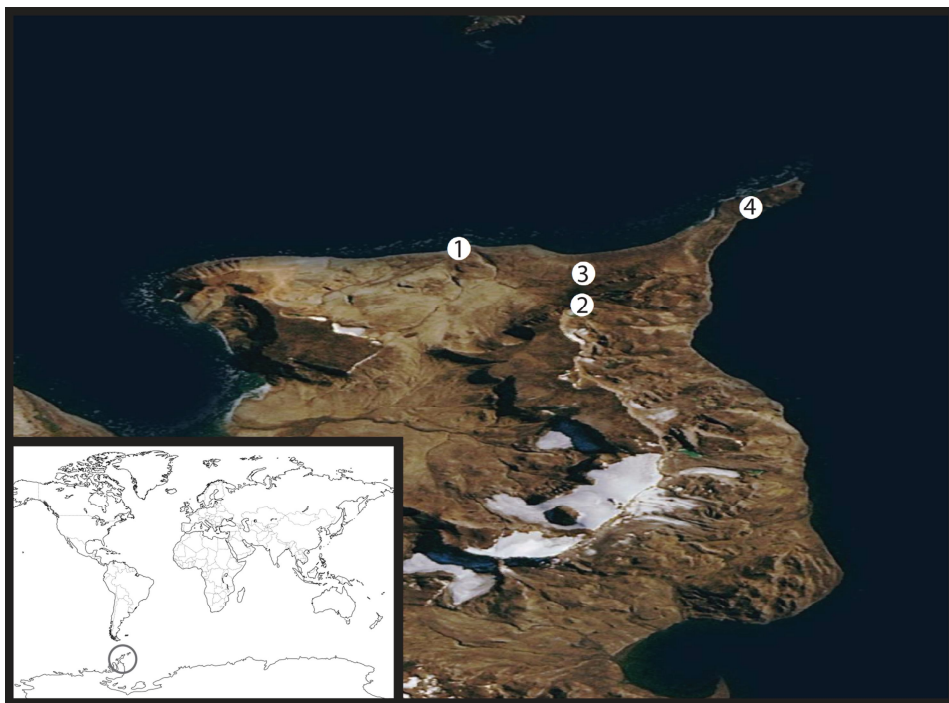


Fig. 1. The moss collecting sites (white dots) in James Ross Island (Antarctica).

## Results and Discussion

James Ross Island is situated in the western part of Antarctica and was previously bryologically investigated by only one investigator R. I. Lewis Smith (Ochyra et al. 2008a). Based on these records, and a contemporary nomenclature approach the list of species known from the James Ross Island is given. It includes 37 species and additional two intraspecific taxa of *B. argenteum*. Barták et al. (2015) were mapping the moss-dominated vegetation oases at northern part of James Ross Island. The authors compiled

available literature sources and British Antarctic Survey database (BAS) and stated 49 moss species to be present there but without a list given. Thus, the list presented here is the first one related to James Ross Island based on published records.

The discrepancy in species numbers presented here and that of Barták et al. (2015), can be due to different approach to taxonomical levels of bryophyte entities as well as nomenclatural inconsonance and often changes.

### Compiled list of moss species known from James Ross Island (Antarctica)

1. *Aloina brevirostris* (Hook. & Grev.) Kindb.
2. *Andreaea gainii* Cardot
3. *Andreaea regularis* Mull. Hal.
4. *Bartramia patens* Brid.
5. *Brachythecium austrosalebrosum* (Müll. Hall.) Kindb.

6. *Bryoerythrophyllum antarcticum* (L.I. Savicz & Smirnova) P. Sollman
7. *Bryoerythrophyllum recurvirostrum* (Hedw.) P.C. Chen
8. *Bryum argenteum* Hedw. (with typical var. *argenteum* and var. *muticum* Brid.)
9. *Bryum pseudotriquetrum* (Hedw.) P. Gaertn.
10. *Ceratodon purpureus* (Hedw.) Brid.
11. *Didymodon brachyphyllus* (Sull.) R.H. Zander
12. *Distichium capillaceum* (Hedw.) Bruch & Schimp.
13. *Distichium indinatum* (Hedw.) Bruch & Schimp.
14. *Drepanocladus longifolius* (Wilson ex Mitt.) Broth. ex Paris
15. *Encalypta procera* Bruch
16. *Encalypta rhaptocarpa* Schwägr.
17. *Grimmia plagiopodia* Hedw.
18. *Henediella heimii* (Hedw.) R.H. Zander
19. *Hymenoloma antarcticum* (Müll. Hall.) Ochyra
20. *Hypnum revolutum* (Mitt.) Lindb.
21. *Meesia uliginosa* Hedw.
22. *Platydictya jungermannioides* (Brid.) H.A. Crum
23. *Pohlia cruda* (Hedw.) Lindb
24. *Pohlia nutans* (Hedw.) Lindb
25. *Polytrichastrum alpinum* (Hedw.) G.L. Sm.
26. *Polytrichastrum longisetum* (Brid.) G.L. Sm.
27. *Pterygonemrum ovatum* (Hedw.) Dixon
28. *Sanionia georgicouncinata* (Müll. Hall.) Ochyra & Hedenäs
29. *Sanionia uncinata* (Hedw.) Loeske
30. *Schistidium andinum* (Mitt.) Herzog
31. *Schistidium antarctici* (Cardot) L.I. Savicz & Smirnova
32. *Schistidium halinae* Ochyra
33. *Syntrichia magellanica* (Mont.) R.H. Zander
34. *Syntrichia sarconeurum* Ochyra & R.H. Zander
35. *Syntrichia saxicola* (Cardot) R.H. Zander
36. *Tortella fragilis* (Drumm.) Limpr.
37. *Warnstorfia sarmentosa* (Wahlenb.) Hedenäs

After determination of the collections made by the senior author in 2017, six species have been reconfirmed for James Ross Island. Additionally, two more species were recorded as new for the James Ross Island (marked by an asterisk). Various *Schisti-*

*dium* species were collected, but due to the absence of sporophytes in some specimens the identification to species level was not possible. The list of species recorded in 2017 is given below:

1. *Brachythecium austrosalebrosus*, loc. 1, 3
2. \**Bryum dichotomum* Hedw., loc. 2, 4
3. \**Bryum pallescens* Schleich. ex Schwägr, loc. 3.
4. *Encalypta rhaptocarpa*, loc. 4.
5. *Henediella heimii*, loc. 4.
6. *Hypnum revolutum*, loc. 3.
7. *Schistidium andinum*, loc. 3.
8. *Schistidium antarctici*, loc. 3.
9. *Schistidium* sp. var., loc. 2, 3

The richest moss flora in Antarctica is known from the South Shetland Islands where 87 species and one variety have been recorded (Li et al. 2009). This is a large archipelago of 15 islands located in maritime Antarctica (west of the Antarctic peninsula). The greatest diversity of mosses in this archipelago is reported for the King George Island, the largest island in the group. It is worthy to mention that the King George Island comprise about 10% of ice free surface area, and in total 64 moss species were recorded there. Other areas in the neighbouring Antarctic region with a large moss flora include the Signy Island in the South Orkney Islands (59 species), as well as the Livingston Island (56) and the Deception Island (54), both in the South Shetland Islands Group. The James Ross Islands remained bryologically under-recorded. New reports on bryophytes are greatly important not only for general interest in the flora and its distribution, but in a view of global warming-related spread of biota in Antarctica (e.g. Carvalho-Victoria et al. 2009, Camara et al. 2017). Lewis Smith (2005a, b, c) documented the bryophyte flora diversity to be in relation to thermal sources or geological types in Antarctica.

Additionally, moss carpets facilitate growth and establishment of vascular plants by providing a seed bed, typically on the islands west of the Antarctic peninsula as shown for the grass *Deschampsia antarctica* (Casanova-Katny et Caviers 2012).

According to the list of bryophytes of James Ross Island presented above, two species are new for the moss flora of this area (*Bryum dichotomum* and *B. pallescens*). The species are already known from elsewhere in Antarctica (according to Ochryra et al. 2008a).

*B. dichotomum* is reported to be widely distributed but scattered in the maritime Antarctica (Ochryra et al. 2008a), but it was not previously reported from James Ross Island.

*B. pallescens* has a wide range throughout the maritime Antarctica. However, it is generally an infrequent species. It ranges in Antarctica from the southern South Sandwich Islands, through the South Orkney and the South Shetland Islands along the western coast of the Antarctic Peninsula to the Marguerite Bay, reaching its southernmost occurrence in the Terra Firma Islands. Here, it is reported for the first time from James Ross Island.

## References

- BARTÁK, M., VÁCZI, P., STACHOŇ, Z. and KUBEŠOVÁ, S. (2015): Vegetation mapping of moss-dominated areas of northern part of James Ross Island (Antarctica) and a suggestion of protective measures. *Czech Polar Reports*, 5: 75-87.
- CAMARA, P. E. A. S., COSTA SILVA, B. G., CARVALHO-SILVA, M. and KNOP HENRIQUES, D. (2017): The moss flora of Ostrov Geologov (Geologist Island) Maxwell Bay, King George Island, Antarctica. *Boletín de Sociedad Argentina de Botánica*, 52: 251-255.
- CARVALHO-VITORIA, F., BATISTA PEREIRA, A. and PINHEIRO DA COSTA, D. (2009): Composition and distribution of moss formations in the ice-free areas adjoining the Arctowski region, Admiralty Bay, King George Island, Antarctica. *Iheringia*, 64: 81-91.
- CASANOVA-KATNY, M. A., CAVIERS, L. A. (2012): Antarctic moss carpets facilitate growth of *Deschampsia antarctica* but not its survival. *Polar Biology*, 35: 1869-1878.
- CONVEY, P. (2010): Terrestrial biodiversity in Antarctica – Recent advances and future challenges. *Polar Science*, 4: 135-147.
- FOX, A. J., COOPER, A. P. R. (1994): Measured properties of the Antarctic ice sheet derived from the SCAR Antarctic digital database. *Polar Record*, 30: 201-206.
- GREENE, D. M. (1986): A conspectus of the mosses of Antarctica, South Georgia, the Falkland Islands and southern South America. British Antarctic Survey, National Environment Research Council, Cambridge, 314 p.

- KURBATOVA, L. E., OCHYRA, R. (2012): Two noteworthy additions to the moss flora of the Schirmacher Oasis in continental Antarctica. *Cryptogamie Bryologie*, 33: 159-167.
- LEWIS SMITH, R. I. (2005a): The bryophyte flora of geothermal habitats on Deception Island, Antarctica. *Journal of Hattori Botanical Laboratory*, 97: 233-284.
- LEWIS SMITH, R. I. (2005b): The thermophilic bryoflora of Deception Island: unique plant communities as a criterion for designation Antarctic Specially Protected Area. *Antarctic Science*, 17: 17-27.
- LEWIS SMITH, R. I. (2005c): Bryophyte diversity and ecology of two geologically contrasting Antarctic Islands. *Journal of Bryology*, 27: 195-206.
- LI, S. P., OCHYRA, R., WU, P. C., SEPPELT, R. D., CAI, M. H., WANG, H. Y. and LI, C. S. (2009): *Drepanocladus longifolius* (Amblystegiaceae), an addition to the moss flora of King George Island, South Shetland Islands, with a review of Antarctic benthic mosses. *Polar Biology*, 32: 1415-1425.
- OCHYRA, R., LEWIS SMITH, R. I. and BEDNAREK-OCHYRA, H. (2008a): The Illustrated moss flora of Antarctica. Cambridge University Press, Cambridge. 685 p.
- OCHYRA, R., BEDNAREK-OCHYRA, H. and LEWIS SMITH, R. I. (2008b): New and rare moss species from the Antarctic. *Nova Hedwigia*, 87: 457-477.
- SCHROETER, B., GREEN, T. G. A., KULLE, D., PANNWITZ, S., SCHLENSOG, M. and SANCHO, L. G. (2012): The moss *Bryum argeteum* var. *muticum* Brid. is well adapted to cope with high light in continental Antarctica. *Antarctic Science*, 24: 281-291.