Acta Societatis Botanicorum Poloniae

DOI: 10.5586/asbp.3610

Publication history
Received: 2018-12-21
Accepted: 2018-12-21
Published: 2018-12-31

Handling editor
Beata Zagórska-Marek, Faculty of Biological Sciences, University of Wrocław, Poland

Authors' contributions
Both authors equally contributed to the writing of the manuscript.

Funding
MR was supported by the National Science Center, Poland, grant number NCN 2015/17/B/NZ8/02475.

Competing interests
No competing interests have been declared.

Citation
Wojtuń B, Ronikier M. Polar terrestrial ecosystems: ecology, diversity, and biogeography. Acta Soc Bot Pol. 2018;87(4):3610. https://doi.org/10.5586/asbp.3610

EDITORIAL

Polar terrestrial ecosystems: ecology, diversity, and biogeography

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The Arctic and the Antarctic, surrounding the two poles of the globe, share several features and at the same time have contrasting biogeographical constitutions, which influences fundamental aspects of their terrestrial ecosystems. The polar regions and their extreme environment have deeply fascinated naturalists for centuries. Polish polar research has a long tradition dating back to the nineteenth century with the prominent participation of two Polish scientists, Henryk Arctowski (1871–1958) and Antoni Bolesław Dobrowolski (1872–1954), in the famous international expedition to the Antarctic on the ship Belgica in 1897–1899, as the most symbolic opening event [1]. Within the framework of the polar exploration for over more than a century, but especially during the last decades, Polish botanists have contributed considerably to the general knowledge on biodiversity, taxonomy, biogeography, and ecology of the Arctic and Antarctic flora, especially key groups for these biomes such as lichens (lichenized fungi) and mosses (see [2,3] for some overviews). These long-term studies have resulted in a wealth of data including comprehensive regional accounts (e.g., [4–7]) and key syntheses, becoming benchmark references for global research, as best exemplified by the seminal *The illustrated moss flora of Antarctica* by R. Ochyra et al., published by Cambridge University Press in 2008 [8]. In 2017, Polish polar research celebrated the following two important anniversaries: the sixtieth anniversary of the Polish Polar Station in Hornsund, Svalbard (Arctic) and the fortieth anniversary of the H. Arctowski Polish Antarctic Station in the King George Island, South Shetland Islands (Antarctica). These two remote outposts are arguably the most significant icons of Polish scientific exploration globally [9]. Hence, as meaningful landmarks in Arctic and Antarctic studies, these anniversaries inspired the present special issue of *Acta Societatis Botanicorum Poloniae* (ASBP) focused on botanical exploration of harsh, polar terrestrial ecosystems.

The current issue is the fourth themed edition of ASBP, which is preceded by the special issues of the journal published in 2012 (vol. 81, issue 4), 2014 (83/4), and 2016 (85/4). It contains 14 articles, which provide a fair overview of botanical research carried out in the polar regions, aiming at better describing and understanding the biodiversity, ecology, and biogeography of these exceptional and fragile terrestrial environments. They also reflect the main aspects of recent Polish research activities in polar plant biology, concentrating on all the major groups of organisms traditionally treated as plants, including vascular plants, mosses, lichens, lichenicolous fungi, and algae. Studies on biodiversity in the polar regions become especially necessary in the context of ongoing dramatic environmental changes induced by the global warming climatic trends, including emergence of new terrestrial habitats due to massive deglaciation.

The articles gathered in this special issue cover a wide range of topics on polar plant biology. As a formal classification, they can be assigned mainly into the following two categories: (***i***) ecology and (***ii***) taxonomy and phytogeography. However, they are often placed at the interface of biodiversity and related ecological and biogeographical factors, and in some cases also including anthropogenic influence. Seven articles deal with central themes of plant ecology such as succession, the universal process of

vegetation dynamics. Wietrzyk-Pełka et al. [10] provide insights into the colonization process that occurs during the primary succession in the forelands of retreating Arctic glaciers. Analyses of species composition and abundance in the chronosequence of habitats furthered our understanding of the establishment of terrestrial communities. In addition, a comparison of the terricolous lichen communities in these habitats with those in the mature tundra of the surrounding revealed that the most dominant group was chlorolichens in both the habitats. Various kinds of organisms interact with their environments at different levels. Richter et al. [11] describe how the structure of cyanobacterial and algal assemblages depends on correlative physicochemical factors in the high Arctic tundra habitats.

The seedling stage is often the most threatened stage of a plant's life cycle [12]. The stressors that can affect seedlings are not only related to harsh, abiotic terrestrial conditions, but also to chemical factors originating from marine activities. From this perspective, Rudak et al. [13], by comparing populations from different climatic zones, studied the cosmopolitan species *Poa annua* with respect to its seed germination and invasion success in Antarctica. Koc et al. [14] compared the effects of methanesulfonic acid, derived from marine ecosystems, on seed germination and morphophysiological changes in the seedlings of two *Colobanthus* species.

One of the most promising recent developments in ecology is the identification of spectral properties of plant species from airborne and satellite remote sensing data. Using this method, Zagajewski et al. [15] demonstrate how to verify in situ-acquired hyperspectral properties in high Arctic plants, i.e., remote-acquired indices for chlorophyll, by simultaneously measuring the chlorophyll concentration. As a result, the best informative remote sensing indices, which reflect the vital state of plants, were identified.

Polar terrestrial ecosystems, like other parts of the world, face the increasing effects of pollutants. Polar environments are commonly considered to be relatively pristine because of the absence of significant local atmospheric contamination sources. However, these areas receive long-distance air pollutants from lower latitude regions [16]. In this context, Węgrzyn et al. [17] emphasize the importance of trace metal monitoring in the Svalbard archipelago using lichen bioindicators. Then, the study of Kvíderová [18], at the interface of ecology and physiology, describes the unique physiological adaptations of internal structure and photosynthesis of cyanobacteria colonies (*Nostoc* sp.) to extreme environments, such as those of high Arctic.

Surveys on biodiversity, which contribute to the knowledge of species richness and distribution at various spatial scales, provide basic information of utmost importance for further biological studies and monitoring. Stebel et al. [19] and Maciejowski et al. [20] focus on recently deglaciated areas in their studies on moss and lichen diversity. Their study results increase our knowledge on biodiversity of a weakly known part of Spitsbergen and illustrate the need for basic data on biodiversity in polar studies. Accordingly, a short report by Wierzgoń et al. [21] on two newly discovered rare moss species in the South Shetland Islands archipelago in the austral polar region further contributes to the basic knowledge of biodiversity and phytogeography. Their findings are discussed in relation to rapid deglaciation processes and the possible population history. Bednarek-Ochyra et al. [22] report a new moss genus recorded in the Subantarctic. Biogeographical implications of this finding invoke the moss's possible ancient origin dating back to Gondwana. Furthermore, the authors also provide a historical overview and an up-to-date account of moss diversity in the Subantarctic region. In turn, Alstrup et al. [23] present an overview of diversity and taxonomy of a peculiar group of lichenicolous fungi in the South Shetland Islands, one of the biologically richest regions of the Antarctic.

The assessment of biodiversity in the extreme habitats of the polar regions is challenged by taxonomic difficulties related to isolated position of several taxa and scarcity of data. This problem is well illustrated by several Antarctic moss species, whose only gametophytic phase is known, limiting the availability of taxonomically relevant characters. Ronikier et al. [24], by applying DNA sequence analysis, provide evidence for distinctness of *Didymodon gelidus*, an endemic moss of the austral polar region and highlight the importance of molecular tools in polar taxonomy and biogeography.

Finally, Wąsowicz [25] approaches flora diversity of a relatively long inhabited subarctic/arctic territory (Iceland) from a different angle, making the first attempt

to identify vascular plant species that became a part of the regional flora but were introduced by humans in ancient times (archaeophytes). This aspect, well studied and discussed in the mainland Europe, has only recently been addressed in the north, due, among others, to more limited historical sources available.

We would like to thank the authors who responded to our call and sent in their interesting contributions. All manuscripts submitted were processed through the peer-reviewed system of the ASBP. We gratefully acknowledge the excellent input of the peer reviewers, who provided invaluable help in refining the quality of submitted articles. We would also like to thank members of the ASBP editorial team for their excellent assistance. We particularly thank the Editor-in-Chief, Prof. dr hab. Beata Zagórska-Marek, Deputy Editor, Dr hab. Edyta Gola, and Managing Editor, MSc Piotr Otręba, for getting us started and monitoring our work.

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