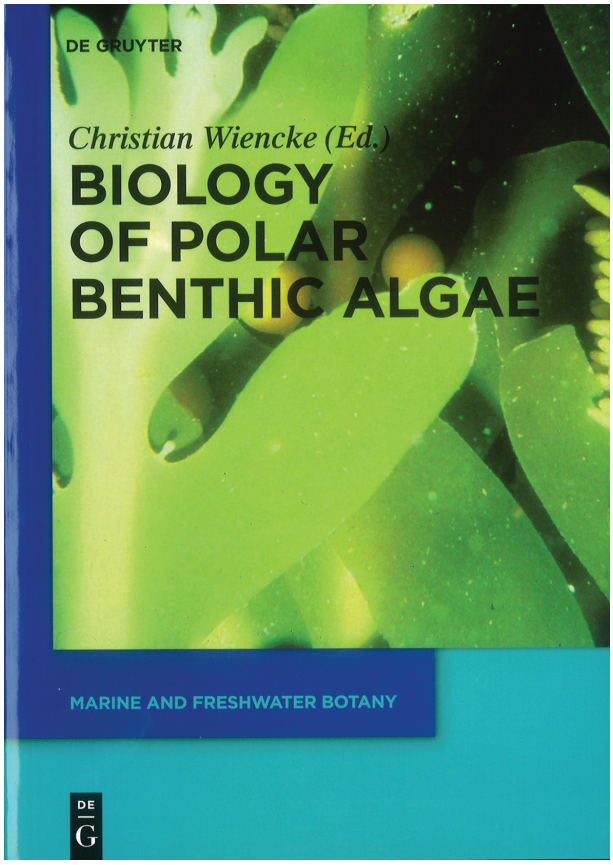
Polar Research

BOOK REVIEW

Review of *Biology of polar benthic algae*, edited by Christian Wiencke (2011). Berlin: Walter de Gryuter GmbH & Co. KG. 337 pp. ISBN 978-3-11-022970-7.



This impressive book summarizes international research on Arctic and Antarctic benthic algae spanning more than three decades. Fifteen chapters and 38 contributors are a clear indication for a broad range of topics discussed in this book. The editor is a leading luminary in this area and has capably orchestrated the authors' intelligent contributions to form a comprehensive view of this important topic.

The book is based on a special issue of *Botanica Marina* (volume 52, 2009), which documented the considerable progress that has been made on the biology of polar benthic algae. While there is much information about the benthic seaweeds in the polar regions, only limited information is available concerning the benthic microalgae from these regions. Earlier reviews have summarized basic research, but so far no attempt has been made to include the impacts of global climate change on these organisms. In the present book, the initial contributions to *Botanica Marina* have been substantially changed and updated by including recent results.

The first section is devoted to the environment, biodiversity and biogeography of polar benthic algae. This section contains two reviews and one chapter presenting original research. The reviews summarize our knowledge of the abiotic environment, the biodiversity, biogeography and zonation. A strong seasonality of light conditions and low temperatures are important factors for polar benthic algae. It has been shown that nutrient levels are generally higher in Antarctic regions, while a depletion of nutrients is found in Arctic waters during summer. The systematics and biodiversity of benthic microalgae are poorly known, whereas Arctic macroalgae have been studied more intensely due to their conspicuousness and accessibility. The original research reported in this section describes several new taxa of Antarctic and sub-Antarctic red algae. Phylogenetic analysis of *rbc*L sequences is employed to explain the biogeographic relationships of these organisms.

The next section of the book is on chemical ecology and comprises two chapters dealing with biotic interaction. Interactions of macroalgae with herbivores and biofouling organisms are described. The importance of brown algal-typical phlorotannins is pointed out. These compounds are shown as effective defence mechanisms against herbivores, diatoms and bacteria.

The third section—on the primary production and ecophysiology of benthic micro- and macroalgae—comprises three reviews and two chapters presenting original research. As this section explains, our knowledge of microalgal production is limited despite the importance of this group in terms of its substantial contribution to the productivity of coastal areas and down to 30 m depth. It is estimated that benthic microalgae contribute a total of $1.1–1.6 \times 10^7$ tonnes of carbon per year. Data on the microphytobenthic biomass in Kongsfjorden, in Spitsbergen, are presented, indicating that chlorophyll-a varied and was highest close to the glaciers. Biomass doubled or tripled in shallow waters during summer but was stable in greater depths. The physiology and phenology of polar seaweeds is drastically influenced by seasonal changes in

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day length. Growth and reproduction take place mainly in winter and early spring. The formation and remobilization of storage carbohydrates are important for this life strategy. Photosynthetic rates are highest in spring, when the light conditions are optimal. Photosynthesis products are stored in summer as reserve compounds, and in winter and early spring they are translocated to the growing parts. It is generally found that the light requirements of polar macro- as well as microalgae are very low, allowing these organisms to grow at considerable depths. Microscopic stages of seaweeds and benthic diatoms are low-light adapted and tolerate even long periods of darkness. Moreover, Antarctic seaweeds and benthic microalgae are adapted to lower temperatures compared to the algae from the Arctic, based on their metabolic properties. Intrinsic freezing tolerance and photosynthetic performance under low temperatures are key adaptations under these conditions. This is exemplified by a brown alga that has been shown to be remarkably active down to the freezing point. In contrast, a red alga was shown to be limited by low water temperatures in combination with high light intensities, which demonstrates the need for further investigation.

The last section of the book is devoted to polar benthic algae in a changing world. The effects of global warming and enhanced UV radiation on the geographic distribution of cold-water seaweeds are discussed. North Atlantic cold-temperate seaweeds will extend their distribution to the High Arctic, while polar-adapted species will retreat further north, resulting in substantial changes in the biodiversity of seaweed-dominated ecosystems. The effects of enhanced UV radiation on the physiology and metabolism of polar benthic micro- and macro algae are also illustrated. While UV affects DNA and proteins directly, there are also indirect effects from the UV-induced formation of reactive oxygen species. To cope with UV radiation, algae have evolved potent defence systems, such as UV absorbing mycosporine-like amino acids and phlorotannins of brown algae. Nevertheless, UV irradiation has a drastic influence on polar seaweed communities. The resistance of benthic microalgal communities to UV is exceptionally high, which has positive effects for the development of seaweed communities by reducing the UV that reaches deeper regions. Another topic covered is how glacier retreat opens up spaces for new colonization but also changes the nutrient supply and salinity of coastal waters. The increased sedimentation that comes with glacier melt decreases light availability in the water. For all these reasons, algal succession and the structure of polar benthic communities are expected to change in a changing environment.

As a plant cell biologist who has been working in Arctic regions with micro- and macroalgae on a physiological and cellular level, I was brought up to date on many promising avenues of investigation for this group of plants by the *Biology of polar benthic algae*. I highly recommend this book to colleagues, as well as students interested in polar ecosystems.

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