Ecology of charophytes – permanent pioneers and ecosystem engineers

Hendrik Schubert1,*, Irmgard Blindow2, Norma Catarina Bueno3, Michelle T. Casanova4, Mariusz Pełechaty5 & Andrzej Pukacz6

1 Institute for Biosciences, University Rostock, 18055 Rostock, Germany; hendrik.schubert@uni-rostock.de
2 Biological Station of Hiddensee, University of Greifswald, 18565 Kloster, Germany; blindi@uni-greifswald.de
3 Universidade Estadual do Oeste do Paraná, Cascavel, Paraná, Brazil; normacatarina@hotmail.com
4 Charophyte Services, Lake Bolac, and Federation University Australia, Mt Helen, Victoria, Australia; mt.casanova@federation.edu.au
5 Department of Hydrobiology, Faculty of Biology, Adam Mickiewicz University, 61-614 Poznań, Poland; marpel@amu.edu.pl
6 Polish-German Research Institute, Collegium Polonicum, Adam Mickiewicz University, Poznań, Poland; pukacz@europa-uni.de
* Corresponding author: hendrik.schubert@uni-rostock.de

With 3 figures

Abstract: For almost a century, charophytes have been regarded as a group that is confined to low-nutrient-clear water conditions. In light of recent research, this generalisation of the ecological niche dimensions of charophytes has changed and now includes more facets of ecological existence. In this review, the current knowledge with respect to species-specificity as well as temporal aspects – ontogenetic and successional ones – of the ecological requirements of charophytes are presented and discussed. This review identifies new directions for ecological research on charophytes as well as knowledge gaps to be filled, not just for reasons of academic curiosity, but also for applied purposes such as lake restoration, bioremediation and bioindication of water quality and water regime.

Keywords: alternative stable states, diaspores, herbivory, lake restoration, submerged vegetation, colonization

Introduction

Charophytes are morphologically complex green algae, belonging to the Streptophyta. They display differentiation into rooting structures (rhizoids) and photosynthetic structures (axes, branchlets, bract-cells), and they have multicellular reproductive organs (oosporangia and antheridia) (Fig. 1). They are among the closest relatives of the first land plants (Karol et al. 2001), and have been used as model organisms for studying the physiological aspects of terrestrial acclimation, salinity tolerance and membrane processes (Braun et al. 2007; Beilby & Casanova 2014). Charophytes are also important bioindicators of water quality and water regime (for review see Doege et al. 2016); and their capacity to absorb pollutants from freshwater makes them useful for bioremediation (Kalin et al. 2002a, 2002b; Marquardt & Schubert 2009). Concerns about the declining state of water resources have led to intensive study of both these aspects over the few last decades. The use of charophytes for bioindication has become a common tool for environmental monitoring (e.g. Gutowski et al. 1998; Kohler 1982; Krause 1981; Melzer 1994; Van Raam 1998; Burns et al. 1999; Jäger 2000; Selig et al. 2009). Most of the bioindication protocols have a focus on water quality, in particular, nutrient availability. This is based on the observation that charophytes can be a key element of aquatic ecosystems, able to create and maintain clear-water conditions by a network of biological interactions (van den Berg et al. 1998a; Blindow et al. 2002; Casanova et al. 2002; Meurer & Bueno 2012).

However, the bioindication protocols that have been developed tend to be region-specific (Doege et al. 2016). Intercalibration between “regional schemes” is possible, but complicated (Schneider 2007), not only because of the problematic taxonomy in family Characeae, but in relation to data management (Doege et al. 2016). This is highlighted by the fact that some species that are considered to be rare and threatened in their native area have successfully spread to other...