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Extended Abstract

Metabolomics of Freshwater Macrophytes: Main Achievements and Prospects.

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Abstract

The study of low-molecular-weight organic compounds (LMWOCs), which are metabolites of aquatic plants, lags far behind terrestrial habitats. Our research has shown that the number of components of the low-molecular-weight metabolome (LMWM) of specific aquatic macrophytes can be more than 200, and there are more than 1500 such compounds in total. We have shown that there are patterns of formation and change of LMWM of macrophytes both depending on the geographical growth of plants and depending on the impact of various biotic and abiotic factors. Among the various functions of LMWOCs of aquatic macrophytes, particular attention is paid to the study of the phenomenon of allelopathy. Aquatic macrophytes play an important role in structuring communities in aquatic environments. These plants provide physical structure, increase habitat complexity and heterogeneity and affect various organisms like invertebrates, fishes and waterbirds. The complexity provided by macrophytes has been exhaustively studied in aquatic environments. However, macrophyte complexity has rarely been measured in a standardized fashion, making comparisons among different studies and the establishment of general conclusions difficult. To address this issue, this review is focused on questions related to the habitat structural complexity provided by these plants, exploring: i) how complexity has been viewed by ecologists, with an emphasis on macrophyte studies; ii) the pros and cons of several methods used to quantify plant complexity; iii) the consequences of habitat structuring by macrophytes on invertebrates and fish and possible causes, mediated by habitat complexity, that lead to changes in these animal assemblages; iv) potential impacts of non-native macrophyte species on habitat complexity and v) the importance of complexity provided by macrophytes to management strategies for maintaining aquatic biodiversity. We examined literature produced in both temperate and tropical regions, but prioritized the latter. We found a great variety of habitat complexity measurements that are applied to aquatic macrophytes to understand their influence on attached animal assemblages. A lack of standardization (considering the wide range of techniques and scales of resolution used) limits comparisons between different studies exploring this subject, in which biological samples and physical substrates were used to explore these relationships. Macrophytes affect animal assemblages and promote biodiversity through a chain of mechanisms, related to habitat complexity, that involve the availability of shelter and feeding sites. Invasive macrophyte species may modify habitat structure and thus influence associated organisms. In this sense, they are suitable as the main focus of management strategies aimed at biodiversity restoration and conservation. It was revealed that representatives of the genera Myriophyllum, Ceratophyllum, Nuphar, Potamogeton, Elodea, and family Characeae are the most active macrophytes in respect of the allelopathy. Detection and identification of compounds were performed using the gas chromatography-mass spectrometry method. Computer program PASS (Prediction of Activity Spectra for Substances) has been applied for the prediction of biological activity spectra of the major components with the aim to discover their ecological potential against cyanobacteria. PASS predictions were successfully experimentally confirmed. We have created and patented an algicide of the new generation to suppress the development of cyanobacteria based on metabolites-allelochemicals of aquatic plants. The use of such algicides can be a promising alternative to other methods of controlling "blooming" and can take place without harm to other components of the aquatic ecosystem, in contrast to other known methods of suppressing the development of cyanobacteria.

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