Plant adaptations and microbial processes in wetlands
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Wetlands are terrestrial ecosystems characterized by high and fluctuating water tables. The spatial and temporal differences in the degree to which wetland soils are waterlogged create a very dynamic soil environment with, on average, lower oxygen concentrations than unsaturated soils. Wetland soils are characterized by gradients in redox conditions from totally oxidized to extremely reduced. These conditions require special adaptations for the plant and microbial species in the wetland. Wetland plants, particularly in wetlands with strongly fluctuating water tables, need adaptations to the shortage of oxygen in the root zone, but also to extended periods of dry conditions during low-water phases. Microbial communities are strongly coupled to redox cycles, in which alternative electron acceptors are used, for example nitrate, iron, manganese, sulphate and carbon dioxide. Plant–microbe interactions add to the complexity of the functioning of the wetland soil system.

This Highlight section of Annals of Botany addresses the adaptations of plants and microbes in wetlands with fluctuating water levels, following a broad perspective. It contains three review papers and three primary scientific papers with experiments and field comparisons. The review by Parolin et al. gives an overview of adaptations of wetland plants in Amazonian floodplains to drought. The annual water cycle in these wetlands is quite predictable but shows an amplitude of 8 m, giving rise to a long flooded period as well as a long dry period each year. Previously, most emphasis in the evaluation of plant adaptations in these environments had been on the wet phase, focusing on the difficulty of overcoming long periods of waterlogged soil and (partial) submergence of the above-ground parts of plants. This paper for the first time evaluates plant adaptations to the dry period, in the context of the total annual cycle. The review paper by Laanbroek investigates how methane emission from wetland systems is controlled by microbial processes and influenced by wetland vegetation. The complex coupling of the various microbially mediated redox cycles, the leakage of oxygen from the internal plant gas system and the ‘escape’ of methane through this gas system to the atmosphere are evaluated.

The review by Verhoeven and Setter deals with human control of water levels in wetlands to promote agricultural use. The emphasis is on the difference between sustainable and non-sustainable uses of wetlands for agriculture. Drainage of peatlands has led to severe soil subsidence and greenhouse gas emissions, whereas floodplains and rice fields are suitable for a more sustainable agricultural use. Developments in crop science, leading to increasingly waterlogging-tolerant crops are also discussed in this context.

The paper by Sorrell and Hawes evaluates the importance of convective gas flow in the lacunae of helophytes for the occupation of relatively deep-water habitats. In their study, plant species lacking convective flow occurred in very shallow water only, whereas species with high rates of convective flow were able to grow in deep water, even in eutrophic habitats where the organic soil has a high oxygen demand. Li et al. carried out an experiment with Typha domingensis to test the ability of this species to grow in nutrient-rich, strongly reduced sediments. Growth was adversely affected by low redox potentials, but high availability of phosphates moderated this negative effect. The results are discussed in the context of competitive replacement of Cladium jamaicense by Typha domingensis in parts of the Everglades affected by high agricultural run-off. Finally, Yu and Ehrenfeld have studied the way in which the plant and microbe community structure was affected by water-level fluctuations and soil characteristics in New England forested wetlands. Both median level and variability in water tables turned out to affect plant and microbe communities; however, soil genesis, a result of both water-table position and geologic history, appeared to be even more important.

LITERATURE CITED


