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Active phosphorus and iron solubilisation by seagrass roots in tropical sediments

Jakob Santner (1), Kasper Elgetti Brodersen (2,3), Klaus Koren (2), Maria Mosshammer (2), Peter J. Ralph (3), Michael Kühl (2,3)

(1) Division of Agronomy, Department of Crop Sciences, University of Natural Resources and Life Sciences, Vienna, 3430 Tulln an der Donau, Austria, (2) Marine Biological Section, Department of Biology, University of Copenhagen, DK-3000 Helsingør, Denmark, (3) Climate Change Cluster, Faculty of Science, University of Technology Sydney (UTS), Sydney 2007, New South Wales, Australia

Seagrasses are globally important ecosystem engineers, providing numerous ecosystem services including high-biodiversity habitats, shelter for fish reproduction, enhanced carbon sequestration, and coastal zone protection against erosion. In tropical, carbonaceous sediments, phosphorus is rapidly precipitated as Ca-phosphates and strongly bound to Fe(III) oxy-hydroxides, leading to severe P limitation for plants inhabiting these environments. Yet, seagrasses are highly successful in tropical sediments, suggesting that they actively solubilize P, and potentially also other nutrients.

Using chemical imaging techniques, we studied the small-scale distribution and day-night dynamics of pH, radial oxygen leakage, and labile P and Fe in the seagrass rhizosphere. We show that seagrass roots acidify their rhizosphere, leading to the dissolution of Ca-phosphates, and that root-mediated microbial sulphide production leads to the reduction of Fe(III) to dissolved Fe(II), rendering Fe as well as phosphate plant-available. This work provides the first experimental evidence for the rhizosphere mechanisms involved in satisfying the nutrient demand of seagrasses in tropical, nutrient-limited conditions, and contributes to understanding how seagrasses thrive in these harsh environments.