The role of organic acid exudates in liberating phosphorus from seagrass-vegetated carbonate sediments

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ABSTRACT: Sediment-bound phosphorus (P) is a potential nutrient source for P-limited seagrasses inhabiting carbonate sediments. We explored the role of organic acid (OA) exudation by seagrasses in liberating mineral P from carbonate sediments. Organic acids can act to increase available P by dissolving carbonate sediment, competing with P for binding sites and complexing dissolution end products, and also by fueling microbial processes that change pore-water pH. We used dialysis tubing placed around individual roots in situ to quantify dissolved species immediately adjacent to roots (root zone) and compared these to bulk pore-water concentrations in vegetated and nonvegetated sediments. Total OA concentrations were highest in the root zone (29.8 $\pm$ 1.8 μmol L^{-1}) compared to bulk measures of 15.5 $\pm$ 1.9 and 7.5 $\pm$ 0.6 μmol L^{-1} in vegetated and nonvegetated sediments, respectively. Phosphate concentrations were also highest in the root zone and were linearly related to OA concentrations (R^2 = 0.63). Organic acid concentrations increased along a seagrass productivity gradient, and ratios of OA concentrations to productivity showed a significant response to a gradient in P-limitation of seagrasses. Organic acid concentrations found in and around roots, compared to those found in bulk sediment measures, indicate that seagrasses are a significant source of OA. Sampling at small spatial scales (mm) immediately adjacent to the roots is critical, because bulk sediment pore-water measures did not capture the observed fluctuations caused by the rapid reaction and consumption of OA in the sediment. Root-zone processes can liberate considerable quantities of P, and OA exudates likely contribute significantly to the success of *T. testudinum* in P-limited environments.

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