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The rates and pathways of carbon oxidation in bioturbated saltmarsh sediments

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ABSTRACT: This study was carried out to quantify the effects of higher organisms, invertebrate macrofauna, and macrophyte plants on the rates and pathways of microbial respiration coupled to organic matter oxidation in saltmarsh sediments. Sediment geochemistry, rates of microbial metabolism, and the abundance of anaerobic respiratory bacteria were determined at sites differing in the abundance of fiddler crab (*Uca pugnax*) burrows and vegetation (*Spartina alterniflora*) coverage. Solid-phase Fe(III) concentrations were 50 to 100 times higher, and solid sulfide concentrations were eight times lower in bioturbated, vegetated sediments (BVL) as compared to nonbioturbated, unvegetated (NUC) sediments. Integrated sulfate reduction rates were 10 times lower in BVL (2 mmol m^{-2} d^{-2}) as compared to NUC sediments (20 mmol m^{-2} d^{-1}). Directly measured Fe(III) reduction rates were high at the BVL site, whereas no Fe(III) reduction was detected at NUC or in killed sediment treatments. Molybdate, a specific inhibitor of sulfate reduction, inhibited 70% of carbon oxidation when added to NUC sediment but showed no effect on Fe(III) reduction or C oxidation in BVL sediments. Counts of Fe(III)-reducing bacteria (FeRB) were two orders of magnitude higher in BVL sediments (10^7 cells g^{-1}) in comparison to NUC sediments (10^5 cells g^{-1}). Fe(III) respiration comprised up to 100% of carbon oxidation in BVL sediments, whereas sulfate reduction was the dominant respiration process ($\geqslant$70% of C oxidation) at NUC. We provide strong evidence to show that macroorganisms stimulate FeRB to outcompete sulfate-reducing bacteria in saltmarsh sediments by supplying an abundance of reactive Fe(III) through reoxidation processes.

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