



Benthic primary production and nutrient cycling in sediments with benthic microalgae and transient accumulation of macroalgae

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ABSTRACT: Annual rates of sediment denitrification and sediment-water fluxes of oxygen and nutrients were quantified at two shallow locations, Virksund and Ulbjerg, in the Limfjorden, Denmark. The sediment was sandy and colonized mainly by bivalves with a wet weight of 2,508 g m⁻² at Virksund and 572 g m⁻² at Ulbjerg. A benthic microalgal community was present throughout the year, and for 1-2 months in the summer, floating macroalgae partly covered the sediment. Annual budgets for the sediment both including and excluding the activity of macroalgae were calculated. In the absence of macroalgae, the benthic primary production was highest at Ulbjerg, which was autotrophic on an annual basis, whereas Virksund was heterotrophic. When macroalgae were included, both sites were strongly autotrophic on an annual basis. From 13% to 58% of the NH₄⁺ produced by mineralization was retained in the sediment in the absence of macroalgae, primarily because of the assimilation of NH₄⁺ by the microphytobenthic community. Only 25% and 38% of the total NO₃⁻ uptake at Ulbjerg and Virksund, respectively, was denitrified in the absence of macroalgae, whereas in the presence of macroalgae, 12% and 39% of the NO₃⁻ uptake was denitrified at those sites. Nitrate uptake associated with benthic primary production limited denitrification through competition for NO₃⁻. The release of NH₄⁺ from the sediment at Virksund was reduced more than 50%, and at Ulbjerg, release of NH₄⁺ changed to uptake when the macroalgae were included in the annual budget. Nutrient uptake by macroalgae competed with all other nutrient-consuming processes, and the transient occurrence of macroalgae totally changed both the primary productivity and the nutrient budgets for the two sites.

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