Linares, F. 2004. Microphytobenthos and nitrogen fluxes, with special emphasis on dissolved organic nitrogen (DON). Department of Marine Ecology, Marine Botany, Göteborg University, P.O. Box 461, SE-405 30 Göteborg, Sweden

Abstract. The ecology of shallow-water coastal sediments, the role that microphytobenthos (MPB) play in the cycling of nitrogen within these areas, as well as the role of dissolved organic nitrogen (DON) as a potential nutrient source for MPB were studied in the field and in the laboratory. Previous studies from cool microtidal temperate areas suggest that MPB incorporation of nitrogen (N) exceeds N-removal by denitrification in illuminated shallow-sediments. To assess this, sediment-water nitrogen fluxes, and the balance between microphytobenthic assimilation and bacterial denitrification were studied by measuring oxygen and nutrient fluxes, as well as denitrification, in intact sediment at *in situ* conditions. Two field studies were carried out, one in the Kalmar Sound, located between the Öland Island and the mainland on the Southeast coast of Sweden, in the Baltic Sea, and one along a depth gradient at a microtidal site in the Gullmar Fjord, in the Eastern Skagerrak. Two laboratory studies were carried out to assess the quantitative importance of DON for natural MPB communities. The response in biomass and productivity to a mixture of dissolved free amino acids (DFAA), as well as the uptake of ^{3}H-labeled DFAA by MPB communities (natural and isolated), were studied under different conditions of light and dissolved inorganic nitrogen (DIN) availability. Furthermore, prokaryotic and eukaryotic DFAA uptake was differentiated using the prokaryotic inhibitor chloramphenicol.

All sediment systems investigated in the Baltic Sea were autotrophic during daytime both in the autumn and spring, and on a 24-h time scale, they were autotrophic in the spring, but heterotrophic in early autumn. The sediment system in the Gullmar Fjord was found to be net autotrophic only at depths less than 5 m. Sediments in the Baltic Sea functioned as sources of DIN and DON during the autumn, and sinks during the spring, with DON fluxes dominating or being as important as DIN flux. In the Gullmar Fjord, the general pattern was to exhibit an uptake of nutrients at shallow depths (1-5m), and an efflux deeper down (10-15m). MPB activity controlled fluxes of both DIN and DON during both studies. Estimated nitrogen assimilation by MPB in the Baltic Sea study, based on both net primary production (0.7-6.5 mmol N m^{-2} day^{-1}) and on 80% of gross production (1.9-9.4 mmol N m^{-2} day^{-1}) far exceeded measured rates of denitrification (0.01-0.16 mmol N m^{-2} day^{-1}). In the Gullmar Fjord study, denitrification increased with depth, but rates remained low (< 0.4 mmol N m^{-2} d^{-1}), and calculated MPB assimilation (0.2-4 mmol N m^{-2} d^{-1}) equaled or exceeded denitrification. A theoretical calculation showed that MPB incorporated on an average 35 to 60% of the remineralised N, while denitrification removed between 20 to < 10%, in the Gullmar Fjord and the Baltic Sea studies respectively.

The stimulus from DFAA on MPB growth and productivity was similar, and at times even higher than that of NO_3^- that was added as a separated treatment. The isolated community responded faster than the semi-natural community to the added DFAA. When light was a limiting factor, both communities were still able to use amino acids to the same degree, or even better than NO_3^-. Uptake of labelled DFAA by MPB communities occurred in all experiments. Sediment communities took up between 2-18% of the added label. Of the total adsorption-corrected uptake, prokaryotic uptake ranged between 45 and 85% (0.3-2.2 μmol N m^{-2} h^{-1}), and eukaryotic uptake ranged from 15 to 55% (0.3 to 0.7 μmol N m^{-2} h^{-1}). Although prokaryotic uptake rates generally exceeded eukaryotic uptake rates, they were similar in some cases. Short-term changes in light levels had no effect on the uptake of the communities and the availability of ammonium lowered DFAA uptake only marginally.

The general importance of MPB in illuminated shallow-water sediments was underlined by the studies presented in this thesis. MPB assimilation of N appears to be a far more important N-consuming process than denitrification in these non-tidal, shallow-water sediments. Furthermore, the results from our DFAA studies support the previous suggestion that an efficient recycling of N allows generally N-poor sandy sediments to sustain high MPB productivity by using DON, and thereby retain N within the system.

Keywords: microphytobenthos, N-cycle, DON, DFAA, assimilation, denitrification, Skagerrak, Baltic Sea.

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