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Activity and growth efficiency of heterotrophic bacteria in a salt marsh (Ria de Aveiro, Portugal)

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Summary

Bacterial utilization of monomers is recognized as an important step in the biogeochemical cycling of organic matter. In this study we have compared the heterotrophic activity of bacterial communities from different micro-habitats within a salt marsh environment (Ria de Aveiro, Portugal) in order to establish spatial patterns of bacterial abundance, monomer turnover rates (Tr) and bacterial growth efficiency (BGE).

Differences in bacterial abundance and activity could be found between distinct plant rhizospheres. BGE tended to be lower at *Halimione portulacoides* banks, when compared to *Sarcocornia perennis* subsp. *perennis* banks which, on the contrary, showed the highest bacterial densities.

Experiments of amendment of natural samples with organic and inorganic supplements indicated that salt marsh bacteria are not strongly regulated by salinity but the increased availability of labile organic matter causes a significant metabolic shift towards mineralization.

Introduction

Salt marshes are wetlands with brackish water vegetation that extend up estuaries to the limit of tidal influence and act as traps for particulate nutrients and sources of solutes (Vernberg, 1993). In salt marsh ecosystems, below-ground biomass of macrophytes can reach values up to 10-fold higher than above-ground biomass, making the bacterial communities of the sediments important consumers of autochthonous primary production (Valiela et al., 1976). Exudates from the roots of salt marsh vegetation provide bacteria with high-quality sources of carbon and energy-enhancing diazotrophy in the rhizosphere (Bagwell et al., 1998). Bacterial populations from the rhizosphere of salt marsh vegetation show host specificities in terms of composition (Burke et al., 2002) as well as in terms

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of abundance and heterotrophic activity (Christopher et al., 2001; Burke et al., 2002), thus reflecting the adaptation to distinct environmental pressures. The balance between bacterial and root activity will greatly influence sediment environment in terms of redox and availability of oxidized and reduced forms of organic and inorganic nutrients (Howes et al., 1985).

Data on the concentration and quality of salt marsh dissolved organic matter (DOM) are scarce but there are indications that concentrations range from less than 1 to greater than 40 mg L^{-1} and that the lability of this material is similar to the lability of DOM from lakes and oceans and even higher than the lability of DOM originating in rivers and estuaries (revision by del Giorgio and Davies, 2003). Low-molecular-weight DOM, in particular monomers, are available in low concentrations but their turnover can be fast enough, so that it accounts for a large fraction of labile DOM flux (Kirchman, 2003). Although participating in processes of production, transformation and decomposition of organic matter, in aquatic ecosystems, bacteria are especially associated with processes of degradation (del Giorgio and Davies, 2003). At the cellular level, the balance between processes of production of new biomass and mineralization will determine the ecological role of salt marsh bacteria and also the processes of cycling and transfer of organic matter within the salt marsh and between the salt marsh and the estuary.

In this study, we have compared bacterial communities from different micro-habitats within the salt marsh environment with respect to their capacity for monomer cycling and growth efficiency. In order to understand some of the nutritional factors involved in the regulation of the intracellular partitioning of the monomers taken up by natural bacterial communities, experiments involving amendment with organic and inorganic supplements were performed in the laboratory.

Materials and methods

Study area and sample collection

Ria de Aveiro (Fig. 1) is a bar-built estuary (Pritchard, 1989), also described as a coastal lagoon, on the Northwest coast of Portugal. It is a complex system characterized by narrow channels and extensive intertidal zones. During spring tides, the maximal wet area is 83 km^2 at high tide, reduced to 66 km^2 at low tide (Dias et al., 2000).

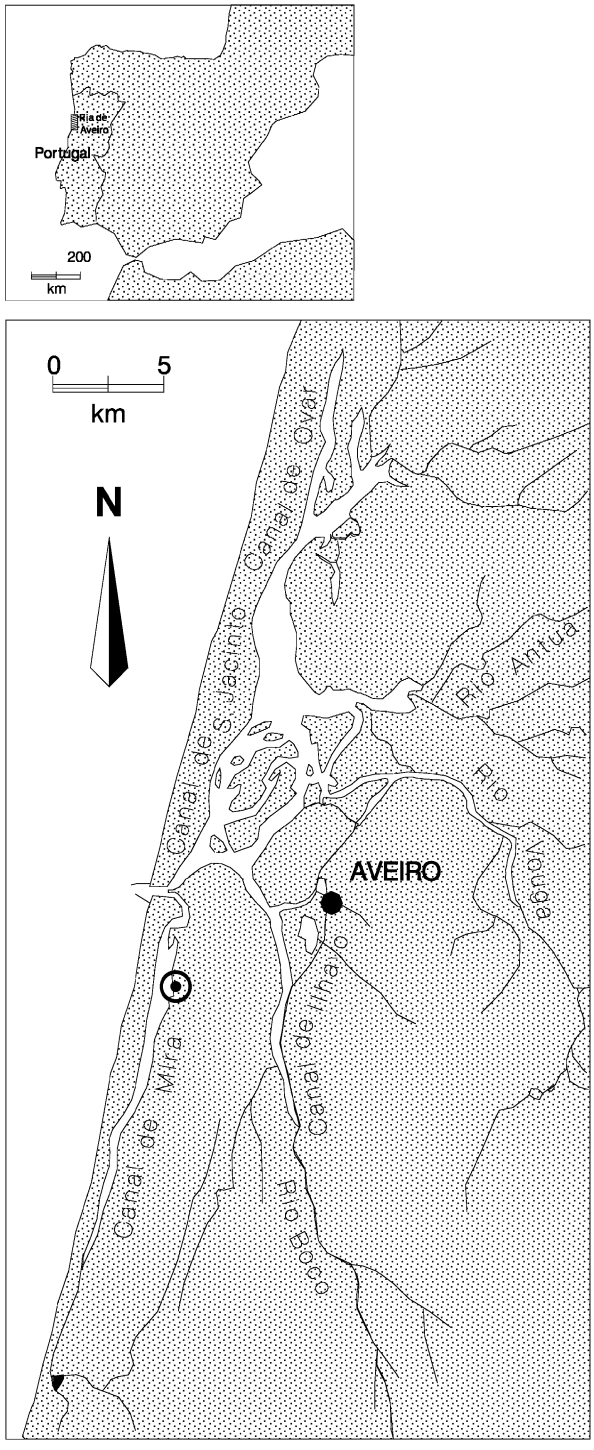

Figure 1. Iberian Peninsula and Ria de Aveiro lagoon (Portugal) with sampling site at the east margin of Canal de Mira indicated by ⊙.

The tidal range varies between 0.6 m at neap tides and 3.2 m at spring tides, with an average of about 2 m (Dias et al., 2000). Salt marshes account for important areas of intertidal zones, especially in the central and north zones of the estuarine system (Borrego et al., 1993).