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Bacterial Respiration, Growth Efficiency and Protist Grazing Rates in Mangrove Waters in Cape Rachado, Malaysia

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Abstract: This study was carried out at an inter-tidal site at Cape Rachado (02º24′48N, 101º51′31E, Fig. 1) from April 2003 until April 2004. A small mangrove forest populated with *Sonneratia* and *Rhizophora* trees was located nearby. Bacterial respiration ranged 0.818–3.208 µM O_2 h^{-1}, and the amount of carbon respired was 9.80–38.44 µg C L^{-1} h^{-1}. Concurrent bacterial production during the incubation was 1.23–3.28 µg C L^{-1} h^{-1}. Using both these respiration and production values, we calculated the bacterial growth efficiency, and it ranged 4.0–11.1%. The low growth efficiency indicated the lower substrate quality here. However adding nutrients did not significantly increase bacterial growth rates (Student's t-test for matched pairs: $t = 1.883$, $df = 2$, $p > 0.10$). In this study, protists consumed $0.49 – 5.72 \times 10^4$ bacterial cells mL^{-1} h^{-1} or 22 ± 15% of bacterial production. In carbon equivalents, grazing ranged 0.15 – 1.81 µg C L^{-1} h^{-1}. Annual bacterial production at this site is 42.7 g C m^{-3} yr^{-1}, and carbon consumed by the bacteria was estimated at 585 g C m^{-3} yr^{-1}. Of this, only 8 g C m^{-3} yr^{-1} was channeled onto protists. These calculations showed that effectively only 1% of the carbon consumed by bacteria was passed onto protists. The role of bacteria here was essentially that of a remineralizer, and as a sink for carbon.

Key words: Bacterial carbon flux, bacterial carbon transfer, bacterial carbon demand, carbon sink, Straits of Malacca.

Introduction

Mangroves are ecosystems at the land-sea margin. In the tropics and subtropics, mangroves cover 100,000–230,000 km^2, and is the major ecosystem fringing the continental margins (Snedaker, 1984). Mangroves support a large portion of the coastal fisheries, and about two-thirds of the important coastal fish and shellfish species in Malaysia are dependent on mangrove habitats (Khoo, 1989).

The term 'microbial loop' was introduced more than two decades ago (Azam et al., 1983) to describe the importance of the microbial food web on the recycling and mineralization of organic matter in aquatic habitats. As bacteria are the most abundant component responsible for the transformation of organic matter (Cole et al., 1988), bacterial production (BP) becomes a key process in the dissolved organic matter (DOM) flux. However whether the bacteria act as a link (recyclers) or a sink (mineralizers) depends on the bacterial growth efficiency (BGE) (del Giorgio and Cole, 2000). BGE is essentially the ratio of net production over gross production, where gross production has been measured as production plus respiration (Lee et al., 2002) or DOM utilization (Amon and Benner, 1996) or both (Cherrier et al., 1996).

Knowledge of BGE is therefore a prerequisite to understand the function of an aquatic system. BGE is an important parameter to evaluate the fate of organic carbon inputs especially for mangrove waters that receive a considerable amount of mangrove plant litter. However

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