Benthic metabolism and nitrogen cycling in a subtropical east Australian estuary (Brunswick): Temporal variability and controlling factors

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Limnol. Oceanogr., 50(1), 2005, 81-96 | DOI: 10.4319/lo.2005.50.1.0081

ABSTRACT: We examined temporal variability in benthic metabolism and nitrogen (N) cycling in the subtropical Brunswick Estuary, Australia from December 2000 to December 2002. Benthic metabolism was tightly coupled to the production of labile carbon (C) in the water column (phytodetritus) and temperature, both of which increased in summer, resulting in increased rates of benthic metabolism and a shift to sulfate reduction. C:N ratios of remineralized material showed a consistently low return of N relative to □□Redfield□□-type material over the 2-yr study period (up to 84 : 1 and averaging 31 : 1). The highest remineralized C:N ratios occurred at a sediment CO_2 productivity/ respiration of ~0.4, which corresponds to maximum respiration and maximum productivity, and also when watercolumn dissolved inorganic nitrogen concentrations were lowest, reflecting potential N limitation. The □missing N□ was most likely assimilated by heterotrophic bacteria and autotrophic benthic microalgae (BMA). Extracellular organic carbon extruded by the BMA and subsequently decomposed may also account for some of the high remineralized C:N ratios. Net N_2 effluxes were controlled by a complex interaction between the supply of NO_3^- from the water column and nitrification, the supply and decomposition of labile C, benthic productivity, and macrofauna abundance. A N mass balance for the sediment over the 2-yr study period showed that a significant proportion of the mineralized nitrogen may have been removed from the microbial loop and passed up to the metazoan levels of the food chain. About 22% of the remineralized N was permanently removed via denitrification. This active competition for limited N resources between heterotrophs, autotrophs, and chemoautotrophs appears to be a mechanism by which N-limited oligotrophic subtropical estuaries tightly recycle and conserve N.