Scientific Paper:

Aquatic Microbial Ecology 49, 165-180, 2007

Effect of nutrient availability on carbon and nitrogen incorporation and flows through benthic algae and bacteria in near-shore sandy sediment

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Abstract:

Carbon and nitrogen uptake in a microbial community comprising bacteria and microalgae in a sandy marine sediment under nutrient-limited and -replete conditions was studied using a mesocosm approach. After 2 wk of incubation, a pulse of $H^{13}CO_3^-$ and $^{15}NH_4^+$ was added to the mesocosms, and subsequent uptake of ^{13}C and ^{15}N by bacteria and microphytobenthos (MPB) was traced by analysis of ^{13}C and ^{15}N incorporation into hydrolysable amino acids, including the bacterial biomarker D-alanine. The results confirm that MPB communities are capable of sustained high rates of photosynthesis despite nutrient limitation. Under these conditions cellular growth stops (as defined by the synthesis of chlorophyll a and amino acids) and the carbon fixed under such conditions consists predominantly of carbohydrates produced through 'overflow metabolism'. In the treatment with nutrient addition, algal growth was stimulated and label incorporation was more balanced, with carbohydrates accounting for a much smaller fraction of newly fixed organic carbon. There was close agreement between net C fixation based on O_2 fluxes and the increase of particulate organic carbon in the sediment under both nutrient-limited and -replete conditions. This finding suggests that very little fixed C was lost to the water column as dissolved organic carbon (DOC), consistent with direct measurements of DOC release using ^{14}C. There was a significant and rapid transfer of ^{13}C from the MPB to bacterial biomass in both treatments within 24 h of label addition, revealing that fixed carbon excreted by MPB was rapidly utilised by bacteria. In both treatments, bacteria incorporated a significant fraction of ^{15}N from $^{15}NH_4^+$, with the greatest incorporation being observed under nutrient-limited conditions

Key-words: Amino acid, isotope label, nitrogen, carbon, algae, bacteria, sediment, excretion