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Nitrification and growth of autotrophic nitrifying bacteria and Thaumarchaeota in the coastal North Sea

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A dual stable isotope (15N and 13C) tracer approach in combination with compound-specific stable isotope analysis of bacterial and Thaumarchaeotal lipid biomarkers was used to investigate nitrification and the associated growth of autotrophic nitrifiers in the Dutch coastal North Sea. This study focusses on the stoichiometry between nitrification and DIC fixation by autotrophic nitrifiers as well as on the contributions of bacteria versus Thaumarchaeota to total autotrophic DIC-fixation by nitrifiers. Water from the dutch coastal North Sea was collected at weekly to biweekly intervals during the winter of 2007-2008. Watersamples were incubated with 15N-labeled ammonium and 15N was traced into nitrate and suspended material to quantify rates of nitrification and ammonium assimilation respectively. Growth of autotrophic nitrifiers was measured by incubating water samples with 13C-DIC in the presence and absence of nitrification inhibitors (nitrapyrin and chlorate) and subsequent analysis of 13C in bacterial phospholipid-derived fatty acids (PLFAs) and the Thaumarchaeotal biomarker crenarchaeol. Results revealed high nitrification rates with nitrification being the primary sink for ammonium. 13C-DIC fixation into bacterial and Thaumarchaeotal lipids was strongly reduced by the nitrification inhibitors (27-95%). The ratio between rates of nitrification versus DIC fixation by nitrifiers was higher or even much higher than typical values for autotrophic nitrifiers, indicating that little DIC was fixed relative to the amount of energy that was generated by nitrification, and hence that other other processes for C acquisition may have been relevant as well. The inhibitor-sensitive 13C-PLFA pool was dominated by the common PLFAs 16:0, 16:1ω7c and 18:1ω7c throughout the whole sampling period and occasionally also included the polyunsaturated fatty acids 18:2ω6c and 18:3ω3. Cell-specific 13C-DIC fixation activity of the nitrifying bacteria was much higher than that of the nitrifying Thaumarchaeota throughout the whole sampling period, even during the peak in Thaumarchaeotal abundance and activity. This suggests that the contribution of autotrophic Thaumarchaeota to nitrification during winter in the coastal North Sea may have been smaller than expected from their gene abundance.