TEMPORAL AND SPATIAL VARIABILITY OF NITRIFYING ARCHAEA IN THE PACIFIC OCEAN

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Abstract

Crenarchaea are putative ammonia oxidizers in the marine environment. The nitrifying role that these microorganisms play is an integral component of the marine nitrogen (N) cycle. Here we present two separate, but very similar studies to assess both the temporal and spatial dynamics of ammonia oxidizing *Crenarchaea*. One study looked at the seasonal variability in the abundances and distributions of ammonia oxidizing *Crenarchaea* over a four-year time scale at the same location in the North Pacific Ocean (Station ALOHA). We found total crenarchaeal gene abundances typically increased three to four orders of magnitude between the near-surface (~5m) ocean and the epi- mesopelagic boundary (200 m), decreasing about an order of magnitude throughout the rest of the mesopelagic zone, and staying relatively constant in the bathypelagic water. Annual occurrences of 10,000 fold increases in crenarchaeal abundances in near-surface waters appeared linked to winter mixing, while during summer months, a predominately upper ocean dwelling *Crenarchaea* increased in abundance in upper mesopelagic waters coincident with periods of increased particulate nitrogen flux to the deep sea. Our other study examined meridional distributions of crenarchaeal ammonia monooxygenase (*amoA*) genes and transcripts across a vast (~5200 km) region of the central Pacific Ocean. Throughout the transect, crenarchaeal *amoA* genes showed a nearly identical depth-dependent distribution when compared to estimates at Station ALOHA. Crenarchaeal *amoA* transcripts typically increased one to two orders of magnitude between 100 m and the epi- mesopelagic boundary (200 m), before decreasing throughout the mesopelagic zone. When normalized to gene abundances, *amoA*

transcripts revealed elevated expression in the upper ocean waters (0-100m), where crenarchaeal abundances were low and transcript abundances decreased throughout the mesopelagic zone as crenarchaeal gene abundances increased. Both studies suggest that throughout the entire water column, ammonia oxidizing *Crenarchaea* are dynamic contributors to the marine nitrogen cycle in the Pacific Ocean.