



Nitrogen fixation by unicellular diazotrophic cyanobacteria in the temperate oligotrophic North Pacific Ocean

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ABSTRACT: N_2 fixation has been understudied in marine environments outside of the subtropical and tropical oceans and where water temperatures are typically below 20-25° C. We identified *nifH* phylotypes and measured N_2 fixation rates under ambient conditions (maximum of 19° C) in water collected 750 km off the coast of California in oligotrophic waters of the North Pacific Ocean (34° N, 129° W). Near-surface N_2 fixation rates averaged 0.25 ± 0.05 nmol $N\ L^{-1}\ d^{-1}$ for 24 incubation bottles. Despite low ambient concentrations of iron (<0.1 nmol L^{-1}) and phosphorus (<0.3 μ mol L^{-1}), N_2 fixation rates were unaffected by iron and phosphorus amendments. Using reverse transcription-quantitative polymerase chain reaction (RT-QPCR) methodology, we estimated transcript abundance and patterns of expression for several unicellular diazotrophs, including the group A phylotype, which showed the highest daily mRNA abundances. The N_2 -fixing assemblage extended to 60-80 m depth, well below the seasonal thermocline (40 m). The calculated areal N_2 fixation rate ($15\ \mu$ mol $N\ m^{-2}\ d^{-1}$) was small compared with estimates from other regions of the Pacific; however, the estimated fixation rate was similar to other published results, suggesting that processes other than cellular growth rate may determine the abundance of unicellular diazotrophs. Despite the low N_2 fixation rates, the new nitrogen added to the euphotic zone by N_2 fixation could account for at least 10% of new production during the study period.

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