Sources of inorganic carbon for phytoplankton in the eastern Subtropical and Equatorial Pacific Ocean

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ABSTRACT: We present the results of a field study examining inorganic carbon utilization by phytoplankton assemblages in the eastern Subtropical and Equatorial Pacific Ocean. Data from isotope disequilibrium experiments demonstrate that HCO_3^- was the principal form of inorganic carbon taken up by all of the in situ phytoplankton populations we sampled. In a cyanobacteria-dominated assemblage, HCO_3^- uptake occurred chiefly through a direct transmembrane transport mechanism. Diatom-dominated assemblages expressed extracellular carbonic anhydrase and transported CO_2 derived from the catalyzed dehydration of HCO_3^-. Direct HCO_3^- transport by the diatoms may have also occurred. In a 3-d incubation experiment, we observed the CO_2-dependent regulation of inorganic C uptake in diatom-dominated phytoplankton assemblages. Phytoplankton assemblages grown at 150 ppm CO_2 possessed external carbonic anhydrase activity and took up HCO_3^- following its dehydration to CO_2. In contrast, the assemblages cultured with 750 ppm CO_2 appeared to lack external carbonic anhydrase activity and rely solely on CO_2 as an exogenous source of carbon for photosynthesis. The CO_2 effect on inorganic C utilization occurred in the absence of a detectable difference in phytoplankton growth rates between the 150 and 750 ppm CO_2 treatments. Our field data provide compelling evidence that HCO_3^- utilization is prevalent in natural marine phytoplankton communities and is regulated by ambient CO_2 concentrations. We discuss the ecological and biogeochemical implications of these results.