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Sources of inorganic carbon for photosynthesis in a strain of Phaeodactylum tricornutum

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ABSTRACT: Diatoms are an important functional group of marine phytoplankton because of their role in the fixation of atmospheric carbon dioxide (CO_2) and transfer of organic carbon to deep waters. Carbon-concentrating-mechanisms, such as active CO_2 and bicarbonate (HCO_3^-) uptake and carbonic anhydrase activity, are believed to be essential to marine photosynthesis, because the main carbon-fixing enzyme, ribulose-1,5-bisphosphate carboxylase-oxygenase, is less than half saturated at normal seawater $CO_2$2 concentrations. On the basis of short-term inorganic ^{14}C uptake experiments, Tortell et al. (1997; Nature 390: 243-244) recently argued that marine diatoms are capable of HCO_3^- uptake. However, as discussed herein, the extent of HCO_3^- uptake cannot be assessed on the basis of these experiments. Using short-term $^{14}CO_2$-disequilibrium experiments, we show that a clone of the marine diatom *Phaeodactylum tricornutum* takes up little or no HCO_3^- even under conditions of severe $CO_2$2 limitation. Predicting the response of the oceans to increased CO_2 concentrations will require, among other things, a careful assessment of the extent to which marine algae take up HCO_3^- or CO_2. Because the plasmalemma of microalgae is gas permeable, all phytoplankton exchange CO_2 with the growth medium. Experimental results that are merely consistent with HCO_3^- uptake are insufficient to prove that HCO_3^- uptake is occurring. Our results are in accord with predictions based on stable carbon isotopic fractionation data. Combining isotopic disequilibrium experiments with continuous growth cultures and stable isotope fractionation experiments is a powerful tool for understanding the response of oceanic primary producers to anthropogenic CO_2 emissions as well as for interpreting paleoceanographic carbon isotope data.

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