Phytoplankton community response to carbon dioxide enrichment in winter incubation experiments

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Coastal waters are experiencing changes in carbonate chemistry, including pH, in response to increasing atmospheric CO_2 concentration and the microbial degradation of organic matter associated with nutrient enrichment. The effects of this change on plankton communities have important implications for food webs and carbon fixation in surface waters. However, conflicting results have emerged regarding responses of phytoplankton species and communities to experimental CO_2 enrichment. To explain these differences, experiments are needed that capitalize on the benefits of controlled experiments but conserve potentially confounding or ameliorating features of intact ecosystems. We performed winter "ecostat" incubations of natural plankton communities from lower Narragansett Bay at ambient bay temperatures (5-13 C), light, and nutrients under three levels of CO_2 enrichment. These levels simulated past, present and future CO_2 conditions (mean pCO_2 levels were 224, 361, and 724 uatm). Growth rates for <5, 5-20, and >20 um size fractions and plankton species composition were estimated at the end of the 7-day incubation period. Samples for carbonate analysis, chlorophyll *a*, and plankton size-abundance were collected daily. Diatom abundance increased during the incubation in all treatments, but no treatment effects on community composition were detected. pCO_2 treatments caused significant differences in growth rates for the 5-20 um size fraction and in the power law relationship between cell size and cell abundance. In the past and future treatments, there was a shift in cell size abundance toward smaller cells and a higher growth rate in the 5-20 um fraction. These non-monotonic effects of increasing pCO_2 may be related to opposing physiological effects of high CO_2 vs low pH both within and among species. Interaction of these effects with other factors (e.g., nutrients, light, temperature, grazing, initial species composition) may explain variability among published studies.