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Testing of the effect of ocean acidification on large benthic foraminifers

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Modern surface seawater is saturated with respect to calcium carbonate, including calcite, high-Mg calcite (magnesian calcite), and aragonite. However, an increase in the atmospheric CO_2partial pressure (pCO_2) causes, via air?sea CO_2exchange, the total dissolved CO_2concentration in surface seawater to increase, and seawater pH to decrease. Ocean acidification has become recognized recently to be a major threat to calcifying organisms. Previous studies have reported that calcification rates of calcareous marine organisms (e.g., corals, foraminifers, coccolithophores, pteropods, mussels, and oysters) change in response to lowering pH levels even in waters oversaturated with respect to calcium carbonate. However, the impact of ocean acidification on large benthic foraminifers, which are major contributors to organic and inorganic carbon production in coral reefs, is still unclear. In this study, we cultured asexually-produced individuals of Marginopora kudakajimensis under four different pH conditions to examine the effects of lowering pH on their growth rates. Experimental results indicate that growth rate, measured by shell diameter, shell weight, and the number of chambers added, generally decreased with lowering pH after 10 weeks of culture. Shell weight was most closely dependent upon pH, suggesting that fossil shell weight can be more useful for reconstruction of paleo-pH changes. The relationship between the shell weight and shell size also showed significant differences among the four pH conditions. Between pH 8.3 and 7.7 (NBS scale), the tendency of the growth rate of M. kudakajimensis to decrease with pH was consistent with that of most other calcifying organisms. However, the calcification/growth rates at pH 7.9 and ~8.2 (present seawater value, control) were not significantly different, and other organisms also display a nonlinear response to elevated pCO_2 at around this pH range. These results suggest that 1) they already may have experienced a reduction in growth in natural environments since preindustrial times and 2) although the seawater CO_2system of reef water shows great variation, the calcification rate of these large foraminifers should remain at the present level at pH 7.9?8.2. However, at around pH 7.7, their calcification rate would decline steeply, which would probably preclude their survival.

Keywords: larger benthic foraminifer, ocean acidification, culture experiment, calcification rate