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Adaptive evolution in the coccolithophore Gephyrocapsa oceanica following 1,000 generations of selection under elevated CO_2.

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Abstract

Coccolithophores are important oceanic primary producers not only in terms of photosynthesis but also because they produce calcite plates called coccoliths. Ongoing ocean acidification associated with changing seawater carbonate chemistry may impair calcification and other metabolic functions in coccolithophores. While short-term ocean acidification effects on calcification and other properties have been examined in a variety of coccolithophore species, long-term adaptive responses have scarcely been documented, other than for the single species Emiliania huxleyi. Here, we investigated the effects of ocean acidification on another ecologically important coccolithophore species, Gephyrocapsa oceanica, following 1,000 generations of growth under elevated CO_2 conditions (1,000 μatm). High CO_2 -selected populations exhibited reduced growth rates and enhanced particulate organic carbon (POC) and nitrogen (PON) production, relative to populations selected under ambient CO_2 (400 μatm). Particulate inorganic carbon (PIC) and PIC/POC ratios decreased progressively throughout the selection period in high CO_2 -selected cell lines. All of these trait changes persisted when high CO_2 -grown populations were moved back to ambient CO_2conditions for about 10 generations. The results suggest that the calcification of some coccolithophores may be more heavily impaired by ocean acidification than previously predicted based on short-term studies, with potentially large implications for the ocean's carbon cycle under accelerating anthropogenic influences.

KEYWORDS: Gephyrocapsa oceanica ; calcification; coccolithophore; evolution; ocean acidification; plasticity

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