Ocean Acidification Disrupts Prey Responses to Predator Cues but Not Net Prey Shell Growth in *Concholepas concholepas* (loco)

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Abstract

Background: Most research on Ocean Acidification (OA) has largely focused on the process of calcification and the physiological trade-offs employed by calcifying organisms to support the building of calcium carbonate structures. However, there is growing evidence that OA can also impact upon other key biological processes such as survival, growth and behaviour. On wave-swept rocky shores the ability of gastropods to self-right after dislodgement, and rapidly return to normal orientation, reduces the risk of predation.

Methodology/Principal Findings: The impacts of OA on this self-righting behaviour and other important parameters such as growth, survival, shell dissolution and shell deposition in *Concholepas concholepas* (loco) were investigated under contrasting pCO_2 levels. Although no impacts of OA on either growth or net shell calcification were found, the results did show that OA can significantly affect self-righting behaviour during the early ontogeny of this species with significantly faster righting times recorded for individuals of *C. concholepas* reared under increased average pCO_2 concentrations ($\pm$ SE) (716 ± 12 and 1036 ± 14 µatm CO_2) compared to those reared at concentrations equivalent to those presently found in the surface ocean (388 ± 8 µatm CO_2). When loco were also exposed to the predatory crab *Acanthocyclus hassleri*, righting times were again increased by exposure to elevated CO_2, although self-righting times were generally twice as fast as those observed in the absence of the crab.

Conclusions and Significance: These results suggest that self-righting in the early ontogeny of *C. concholepas* will be positively affected by pCO_2 levels expected by the end of the 21st century and beginning of the next one. However, as the rate of self-righting is an adaptive trait evolved to reduce lethal predatory attacks, our result also suggest that OA may disrupt prey responses to predators in nature.

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Introduction

A wide range of marine organisms, including phytoplankton, invertebrates and fish, synthesize some form of calcium carbonate structure. The most conspicuous of these structures are the skeletons of corals, molluscs, coccolithophores, and crustaceans. Ocean acidification (OA), caused by the rapid uptake of anthropogenic CO_2 into the surface ocean, is a term, which describes the currently observed reduction in seawater pH and carbonate ion concentration (CO_3^{2-}) [1]. In turn, these changes in seawater chemistry are widely predicted to not only decrease calcium carbonate ($CaCO_3^{2-}$) formation in many marine organisms, but also possibly accelerate its dissolution and/or erosion [2]. This idea is supported by studies in which the carbonate structures in a number of marine invertebrates have been shown to decrease in size in response to OA [3,4]. However, recent evidence has also shown that carbonate structures of fish [5,6] and some invertebrates [7,8] can actually increase in size as a homeostatic response to changing internal levels of CO_2.