Transgenerational exposure of the Manila clam *Ruditapes philippinarum* to ocean acidification: Preferential uptake of metabolic carbon facilitates shell formation

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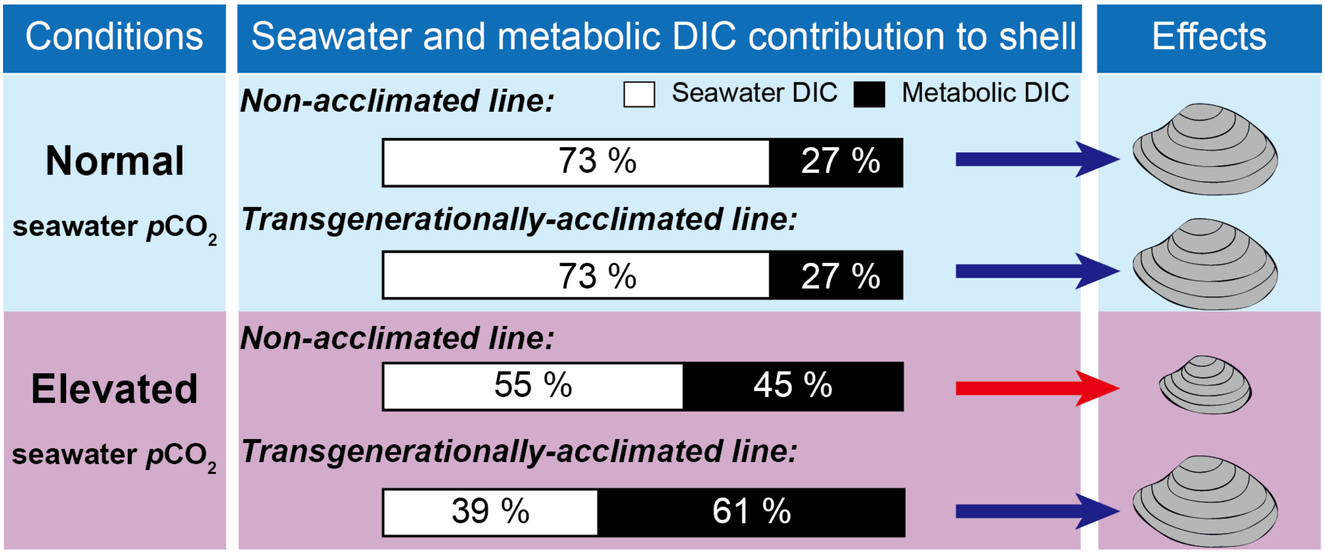
Ocean acidification profoundly affects marine bivalves, and consequently, understanding their capacity for acclimation and adaption to lower pH over multiple generations is crucial to make predictions about the fate of this economically and ecologically important fauna in an acidifying ocean. Transgenerational exposure to an acidification scenario projected by the end of the century (i.e., pH 7.7) has been shown to confer resilience to juvenile offspring of the Manila clam (*Ruditapes philippinarum*). However, whether and to what extent this resilience can persist into adulthood are largely unknown and the mechanisms driving transgenerational acclimation remain poorly understood. Here, we take observations of aforementioned juvenile clams further into adulthood and observe similar transgenerational responses. Under acidified conditions, clams originating from parents reproductively exposed to the same level of low pH show a significantly faster shell growth rate, a higher condition index and a lower standard metabolic rate compared to those without prior history of transgenerational acclimation. Further analyses of stable carbon isotopic signatures in dissolved inorganic carbon of seawater, individual soft tissues and shells reveal that up to 61 % of shell carbonate comes from metabolically generated carbon, suggesting that transgenerationally acclimated clams can preferentially extract internal metabolic carbon rather than actively transport external seawater inorganic carbon to construct their shells, the latter known to be energetically expensive. Noteworthily, while a large metabolic carbon contribution (45 %) is seen in non-acclimated clams, a significant reduction in the rate of shell growth indicates it might occur at the expense of other calcification-relevant processes. It therefore seems plausible that *R. philippinarum* implements a less costly and more efficient energy-utilizing strategy to mitigate the impact of acidified seawater following transgenerational acclimation. Collectively, our findings indicate that marine bivalves are likely more resilient to ocean acidification projected for the end of the century than previously thought.

Keywords: Ocean acidification, Acclimation and adaption, Marine bivalves


Conditions
Seawater and metabolic DIC contribution to shell
Effects
Seawater DIC
Metabolic DIC
Normal
seawater pCO_2
Non-acclimated line:
73 %
27 %
Transgenerationally-acclimated line:
73 %
27 %
Elevated
seawater pCO_2
Non-acclimated line:
55 %
45 %
Transgenerationally-acclimated line:
39 %
61 %