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INSIDE JEB

COPING WITH OCEAN ACIDIFICATION

Nicola Stead

Our appetite for fossil fuels and our increasing carbon footprint is having a dramatic impact on our environment, not least in our oceans, where excess carbon dioxide is absorbed and reacts with water to form carbonic acid. 'At first scientists thought this was a good thing because the ocean would take that carbon and sequester it away from the atmosphere, but it turns out that in the process of doing that, carbonic acid is changing the pH of the ocean', says Jonathon Stillman, a researcher at San Francisco State University, USA. With our oceans gradually acidifying, how will marine organisms cope? Stillman realised that the intertidal porcelain crab would be the perfect organism with which to study the affects of acidification; he explains why: 'embryonic crabs are brooded in the intertidal

zone, where the habitat is very dynamic with lots of [natural] variability in pH. Then the embryos hatch into larvae and swim offshore into an environment that is more stable, before they settle back into the variable intertidal zone as juveniles.' With embryos and juveniles growing in variable pH environments, do they cope better with low pH than larvae, which are used to stable environments? If so, what physiological changes are associated with this pre-adaptation to lower pHs? Stillman recruited two eager Master's students, Lina Ceballos-Osuna and Hayley Carter, to find out (p. 1405 and p. 1412).

As the lab had never worked with early life stages before, the two students first had to establish how to maintain the embryos, larvae and juveniles. Stillman recalls that this was no small feat as the embryos are the size of a poppy seed and while the larvae are relatively long at 1 cm, they have long spines covered in tiny little hooks. These barbed spines meant that the larvae tended to get stuck in pipettes or the mesh used in their storage chambers. However, with guidance from both Stillman and Nathan Miller, a post-doc in the lab, the pair quickly overcame these hurdles, and began investigating how various physiological aspects changed when the water pH was reduced to pH 7.6. Between the two students, they characterised an impressive array of traits in acidic conditions with Ceballos-Osuna looking at survival rates and cardiac performance, amongst others, and Carter focusing more on determining changes in metabolism and energetics.

Overall, the two lead researchers reached broadly the same conclusion, as Stillman remembers: 'different life stages did not, on average, respond to pH differently, so the effect of low pH on the embryos, larvae and juveniles was similar. On average, low pH tended to reduce their metabolic performance, they had lower heart rates and they had lower oxygen consumption rates.' In addition, larvae, whose habitat tends to have a stable ambient pH near 8, did not seem to be worse affected than the embryos or juveniles.

Unlike their initial theory, it seemed that in fact all life stages seemed to do worse when maintained in more acidic conditions. However, this wasn't the only unexpected result, as Stillman hints: 'So what we didn't set out to study in the beginning, but what turned out to be our most interesting finding I think, had to do with the way we did our experiments.' He goes on to explain that, although easier for handling purposes, the team did not mix broods from multiple mothers. This meant that broods originating from one mother were kept separate from other broods. When the team came to do their measurements they knew exactly which mother the embryos or larvae had come from. While overall measurements indicated that metabolic performance was decreased in acidic conditions, they found that in fact some broods weren't as affected and some even had higher metabolism under low pH. 'That finding was unexpected and is extremely important because it says that there is a lot of variation within a species in terms of how an organism will respond to future low pH', says Stillman. So, while on average embryos and juveniles might not be pre-adapted to living in a more acidified marine environment due to their life history, there is scope within the species as a whole for adaptation to acidified conditions, and some of these young crabs will have increased tolerance for low pH. So, there is still hope of finding these crabs in rock pools when exploring the shore in years to come.

References

Ceballos-Osuna, L., Carter, H. A., Miller, N. A. and Stillman, J. H. (2013). Effects of ocean acidification on early life-history stages of the intertidal porcelain crab *Petrolisthese cinctipes*. *J. Exp. Biol.* **216**, 1405-1411. »Abstract/Full Text

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