A blast from the past: effects of early life stage experiences in a range shifting intertidal snail

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Introduction

M. lugubris
the dark unicorn snail

- Oceans are warming rapidly under climate change
- Species, like the whelk *Mexacanthina lugubris,* are shifting their ranges[1]
- Understanding thermal tolerance is important for predicting survival and persistence of organisms
- *M. lugubris* has several life stages (egg→larva→[hatch]→juvenile→adult)
- Life stage affects vulnerability of offspring to environmental conditions (younger = more vulnerable)[2,3]
- Previous experiences may affect current/future performance, known as carry over effects, which can impact vulnerability

Where do snails lay their eggs? Does it matter?

Objective: **Evaluate whether environmental conditions experienced by early life stages within egg capsules in the field induce detectable effects in larval thermal tolerances**

Results

Where do snails lay their eggs?

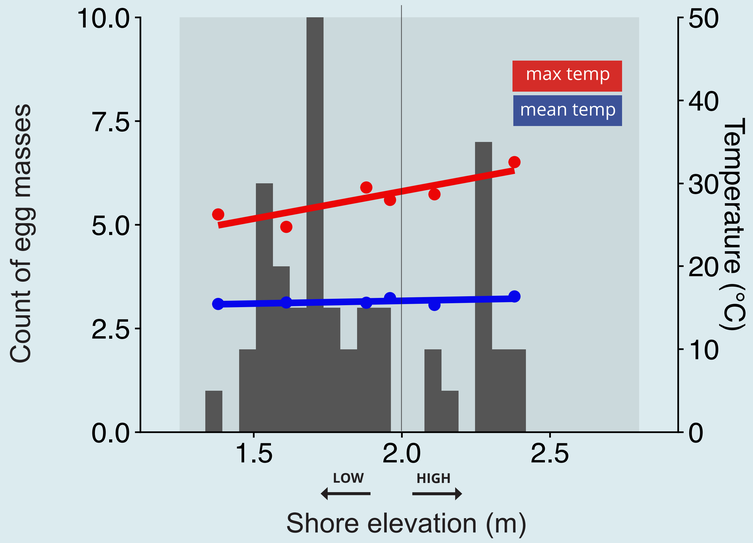


Fig 1. **Snails laid more egg masses at lower tidal elevations (<2m, N=38) at Thousand Steps Beach**. Masses were found between 0.81 m and 2.41 m across the intertidal zone (grey box = surveyable area). All capsules were found within the mussel bed except one found in a tide pool. Max temperature increased with increasing shore elevation.

How many eggs do snails lay?

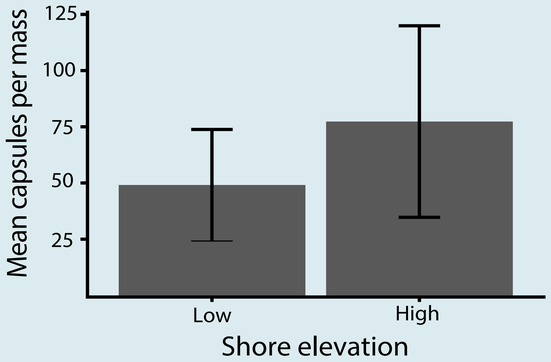
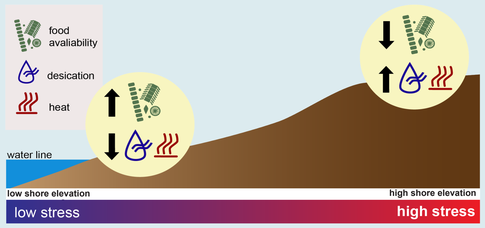


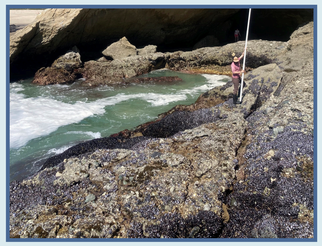
Fig 2. **There was a trend toward laying more capsules per mass in higher shore elevations** (GLM; p=0.07). Snails laid 15-126 eggs per mass (N=21). Masses were divided based on the distribution of masses (> 2 m, indicated by dashed line in Fig. 1).

Does where a snail lays eggs affect larval thermal tolerance?

Unlike with intertidal mussels, for which shore elevation was strongly associated with larval thermal tolerance[2], **we did not find an effect of shore elevation on larval thermal tolerance (N=14, GLM P>0.05).**

Approach

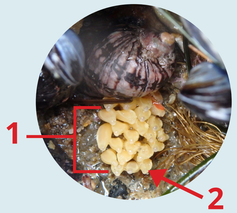




To test for effects of environmental conditions on thermal tolerance of snail larvae, we quantified field temperatures and measured larval thermal tolerances across a natural intertidal thermal gradient.

Site: Thousand Steps Beach, Laguna Beach, California

- Recorded temperature across shore elevational gradient using iButton data loggers
- Surveyed for egg cases across & recorded shore elevation, microhabitat & number of capsules per mass
- Collected subsample of capsules per egg mass for a larval LT_{50} (thermal tolerance) test



1. Egg mass: collection of egg capsules
2. Egg capsule: one case

Installed iButtons across gradient to record *in situ* temperature

Measured shore elevation egg masses using a laser level & rod

Discussion

- *M. lugubris* potentially lays more capsules per mass at high shore elevation as a bet hedging technique.
- Thermal tolerances of larvae could be buffered by adult behaviors such as laying location and microhabitats.
- This buffering effect might protect this whelk species from the effects of climate change.
- Future work: evaluate egg distribution of *M. lugubris* across shore elevation gradient & latitude in native & expanded ranges.

References

[1] Fenberg, Posbic, & Hellberg. 2014. doi.org/10.1002/ece3.1181 [2] Pandori & Sorte. 2019. doi.org/10.1111/oik.05886
[3] Waite & Sorte. 2022. *Ecology*. e03565 **tinyurl.com/Waitemussels**

Acknowledgements

UCI Undergraduate Research Opportunities Program
Natural Reserve System, University of California
Minority Postdoc
California State Parks

This work took place on the original homelands and unceded lands of the Tongva & Kizh indigenous groups.

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