Energetics of the lecithotrophic larvae of *Laternula elliptica* under pH and temperature stress

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Introduction

*Laternula elliptica* is an infaunal bivalve found at a range of depths throughout the Southern Ocean. Experiments have shown elevated temperatures (+2°C) largely accelerate development in the larvae, potentially reducing time spent at vulnerable stages1,2. Reduced pH (pH 7.80 and 7.65) significantly impairs larval shell development and integrity (Figure 1)2). Responses in adult *L. elliptica* indicate there is an energetic and metabolic cost at low pH and elevated temperature2,3, however, such effects on the larvae are unstudied.

**Larval Energetics**

Larvae under reduced pH conditions may experience higher energetic costs as they maintain calcification and cellular gradients4,5. Additionally, altered patterns of development may place additional strain on these resources. *L. elliptica*, with non-feeding, lecithotrophic larvae, are fully reliant on maternally provided energetic reserves until metamorphosis. This study investigated the use of lipid and protein energy reserves and metabolic responses, during development and under stress.

**Results**

**Lipids**

- ~200 ng total lipid in newly fertilised larvae, eight classes
- Dominated by triacylglycerol (TAG) and phospholipids (PL); 64 and 30% of total lipids, respectively
- Significant reserves remained at D-larvae stage (151 ng; >75% of initial pool).
- At ambient temperature, less lipid use was observed under reduced pH (Figure 2a, p = 0.016); no other pH or temperature effect

**Protein**

- Protein content was variable at 24 h post-fertilisation (8.8 - 38.5 ng larvae-1)
- Significant increases in protein content at -0.5°C (p < 0.001; small initial reserve)

**Conclusions**

- *L. elliptica* larvae are well provisioned, with lipids the primary energetic source (specifically TAG and PL)
- Significant lipid reserves remain at the D-larvae stage, even under stress
- Protein is not a major energetic reserve for larval development in this species
- Lack of change in oxygen consumption rates with elevations in temperature above -0.5°C indicates larvae may be approaching temperature thresholds and thermal limitation
- No correlation between oxygen consumption and lipid use
- Rather than increasing the use of finite energy stores, larvae may be prioritising their energy use:
  - Diverting from less immediate functions, e.g. shell development, somatic growth, with potentially negative implications for larval condition and survival at settlement
- May account for previous observations of lower shell integrity at reduced pH2,5

**Future directions**

- Are responses similar in other species?
- Planktrotrophy vs. lecithotrophy – does feeding strategy influence response?
- Longer term exposure – will these metabolic responses deplete resources?

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References

2. Bylenga, et al. (in press)