Optimizing abalone settlement and metamorphosis: a red macroalgae candidate as an alternative to existing algal substrates

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Introduction

Key challenges in abalone farming are to improve the **settlement success** of larvae and provide them with **algae** able to cover their nutritional needs during the early stages. Both being crucial to obtain a high yield of juveniles.

Intensive nursery culture of abalone has been increasingly pursued due to growing demand.

Introduction

However, there is a need to explore alternative algal feeds for abalone nurseries to:

- Establish robust repeatable hatchery protocols
- Improve production reliability and reduce the inconsistency between batches.
- Improve survival and growth of the early stages
- Ensure a reliable production of juveniles

The objectives of this study are to test the effects of different algae treatments on the settlement survival and growth of *Haliotis tuberculata coccinea* post-larvae.

Applied to various species at large scale
Material and methods

Experiments performed testing the settlement induction capacity of red and green macro and microalgae at experimental scale.

Two Rhodophytes were selected:

- **Sahlingia subintegra** for
  - its growth characteristics
  - being widespread from polar to tropical areas
  - being reported as being grown as primary food for abalone (Hurtado-Ponce A. Q. and Umezaki. I. 1985)

- **Rhodosorus marinus** for
  - unicellular red algae predominantly found in warm and coastal waters worldwide (West and Calumpong, 1990; Fresnel and Billard, 1995)
  - High GABA content
Cultures were grown in batch in filtered natural seawater supplemented with F/2 medium under natural light conditions and at ambient temperature. Settlement plates colonised during 2 weeks.

Hatchery production processes that could be applied at larger scale
Material and methods

- **Ulvella leptochaete**
  - Test another species of *Ulvella*
  - Macroalgae have to be thoroughly investigated as a source of potential settlement cues

Cultures of *Ulvella leptochaete* performed according to production methods of *U. lens* (Courtois de viçose et al., 2012) in filtered natural seawater, supplemented with F/2 medium, using increase in water temperature, nutrients and light to trigger spores release. Cultures maintained under natural light conditions at ambient temperature.

- CCA
  - Control. Settlement plates remained in nursery tanks to be colonized by CCA until reaching coverage similar to Rhodophytes and *U. leptochaete*. 
Material and methods

• Triplicate, flow through, natural light and ambient temperature

• 2L Aquariums, fitted with 5x 5 cm plates colonized by algal substrate and a total of 200 larvae/l/ aquarium.

• Fed twice a week with 50 ml of a diatom mixture (Amphora sp. and Navicula incerta) at a density of $10^6$ cells/ml after settlement

• Settlement & metamorphosis monitored at 72h post introduction

• Post-larval survival and growth monitored during 5 weeks

• Live post-larvae counted on every settlement plate of each replicate ($n$ 12/treatment) under a dissecting microscope
Results & discussion

- Colonised substrates had a significant effect on the settlement rates.
- The number of settled larvae was significantly higher on *Sahlingia subintegra* germlings (58 ±12%) than on the other treatments and higher than the settlement observed on *U. lens* or *U. lens* + *U. rigida* in other studies (Courtois de Viçose et al., 2012; Daume et al., 2004).
Results & discussion

- Settlement rates on CCA (30 ± 6%) were lower than the ones observed for other species or in other studies with *H. tuberculata*. Could be linked to the maturity of the germlings, bacterial biofilm, larvae quality (Roberts et al. 2007).

- Low settlement rates induced by *Ulvella leptochaete* germlings (7±1%) indicate that not all Ulvella germlings have similar settlement induction capacity as *U. lens*. Green macroalgae germlings have different settlement induction capacities function of age, development stage, enrichment (Courtois de Viçose et al., 2012; Muñoz et al., 2012).

- GABA content of *Rhodosorus marinus* did not have a significant effect on settlement induction (6±1%), lower than the ones induced by other species of microalgae (Su&Sung 2011). GABA had no significant effect on *H. tuberculata coccinea* in previous studies (Courtois de Viçose et al., 2010).
Results & discussion

Post-larval survival during the five weeks after settlement was not significantly different (P>0.05) between the 2 algae treatments. Similar to the one observed with germlings of *Ulva* sp. or *U. lens* (Daume et al., 2004; Muñoz et al., 2012) and lower than the ones observed in previous studies *H. tuberculata coccinea* (Courtois de Viçose et al. 2010, 2012)
Results & discussion

- Shell length after 5 weeks was not significantly different between the 2 treatments and similar to the highest shell lengths reported in previous studies.

- Growth rates obtained for CCA and *Sahlingia subintegra* are within the range of those reported in previous *H. tuberculata coccinea* studies (25–44 µm /day)(Courtois de Viçose et al., 2012). Growth rates are also in line with the ones observed in studies on *U. lens* supplemented with diatoms (26–40 µm /day) (Daume et al., 2004) and post larvae feeding on diatoms (20-39 µm /day) (Kawamura and Takami, 1995; Gordon et al. 2006)
Conclusions & future

- Colonisation of substrates with *Sahlingia subintegra* demonstrated its interest for *H. tuberculata coccinea* settlement, growth and survival.
- The presence of this algae in multiple geographical locations could enable the evaluation of its suitability for other abalone species.
- *Sahlingia subintegra* growth in culture demonstrated its ability to rapidly colonise substrates.
- The settlement plates conditioning techniques developed at a small scale will have to be further tested at larger scale to estimate their suitability to be applied into the nursery and improve the reliability of abalone juveniles production.
- Establish potential food source of *Sahlingia subintegra* to cover juveniles’ nutritional needs once they pass the diatom’s dependency.
- Further studies to refine substrates conditioning techniques and evaluate the effect of the substrate age, enrichment and biochemical profile. To establish technical protocols for substrate preparation.
Thank you

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