Co-culturing coral recruits and microherbivores to improve coral survival and growth

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Background

- Corals are r-selected animals: the **majority will die before reaching adulthood**
- Corals can reproduce asexually or sexually, but **sexual reproduction is preferred for aquaculture** as it does not destroy broodstock, maintains genetic diversity, allows for selective breeding and has a higher theoretical yield than asexual
- To meet the increasing demand for corals from reef restoration groups and the ornamental trade, we must increase our supply of aquacultured sexually propagated corals
- In *ex situ* environments **survival of young corals recruits is a significant bottleneck**, and one mechanism contributing to this is **competition or overgrowth by algae**, in particular crustose coralline algae (CCA)[1]
- **Co-culture of coral recruits with small, grazing herbivores** is one method to combat this problem, and has been shown to improve *Acropora* and *Pocillopora* survival, growth and health[2][3][4]
- Small gastropods and juvenile sea urchins, that feed on biofilms, filamentous algae, diatoms and CCA, have been tested and found to be effective grazers for use in co-culture with these corals[2][4]
- However, co-culture has not been tested against coral recruits of different morphologies, and the importance of controlling CCA in recruit grow-out has not been determined

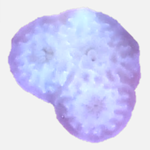
Aims

1. Compare the effectiveness of grazers with broader diets (gastropods *Calthalotia strigata* and *Turbo haynesi*) against a CCA only grazing species (juvenile *Acanthaster* cf. *solaris* (COTS)) at improving coral survival and growth
2. Determine the effectiveness of co-culture on corals recruits with previously untested mounding morphologies

Methodology

Coral recruit plugs per tank

Branching, 10 days old
Acropora millepora x10
Acropora tenuis x10
Acropora secale x10



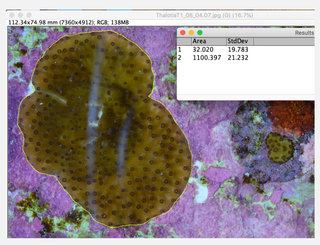
Mounding, 30 days old
Porites lobata x10
Platygyra daedalea x3

Grazing treatments, 4 replicate 50L tanks per treatment

Thalotia	Turbo	COTS	Mix	Control
30 *Calthalotia strigata*	30 *Turbo haynesi*	40 *Acanthaster* cf. *solaris*	20 + 10 each	No grazers

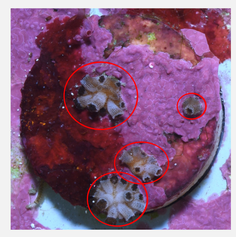
Data collection and analysis

Grow out corals and photograph fortnightly for **182 days**



Measure basal surface area at Day 0, 56 and 182

Compare treatments using Linear Mixed Effects Models



Count survival of individual recruits fortnightly

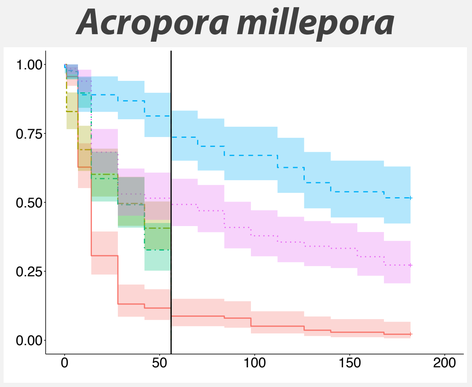
Compare treatments using Kaplan-Meier and Cox Mixed Effects Models

Results

Due to COTS switching to coral feeding at Day 56, analysis of Mix and COTS treatments was stopped after this point

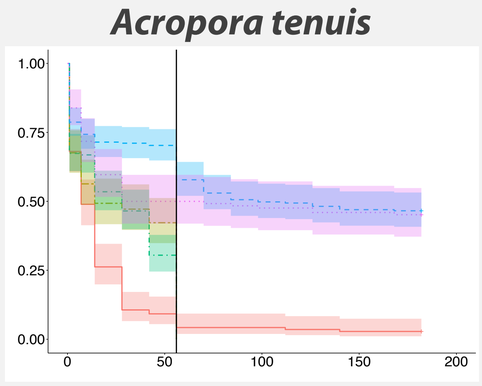
Survival (D0 → 182)

Acropora millepora



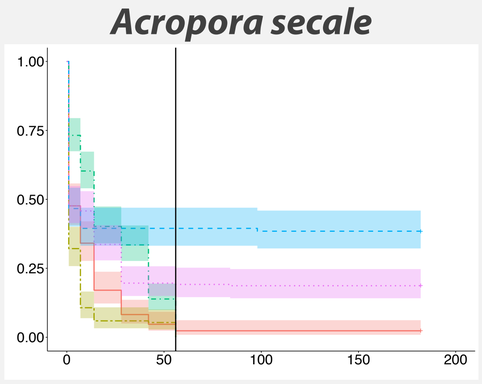
***Thalotia*: 51.6% ± 5.24%**

Acropora tenuis



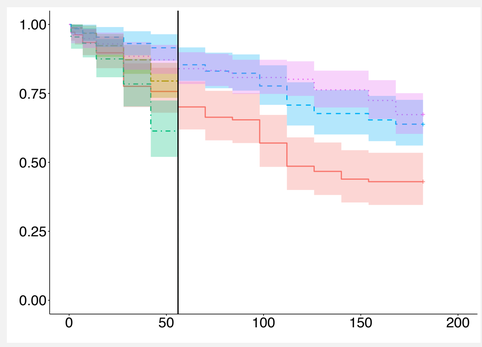
***Thalotia*: 46.6% ± 3.16%**
***Turbo*: 45.2% ± 4.47%**

Acropora secale



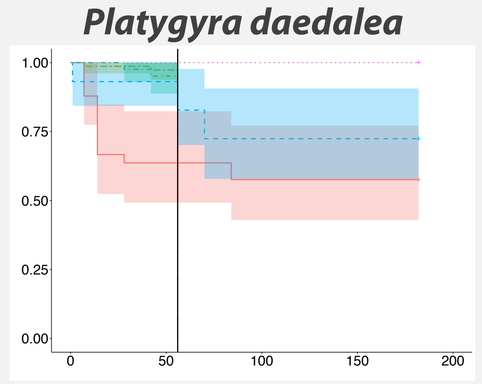
***Thalotia*: 38.5% ± 3.48%**

Porites lobata



***Turbo*: 67.3% ± 3.76%**
***Thalotia*: 63.8% ± 4.21%**

Platygyra daedalea



***Turbo*: 100% ± 0%**

Highest significant coral recruit survivals at Day 182 listed beneath each figure

Growth (D0 → 56)

	Control	*Thalotia*	*Turbo*	Mix	COTS
Acropora millepora	C	A	B	B	C
Acropora tenuis	B	A	B	B	B
Acropora secale	C	A	B	A	B
Porites lobata	A	A	A	A	B
Platygyra daedalea	A	A	B	A	B

Growth ranks based on statistical significance, mean growth and occurrence of outliers

Growth (D0 → 182)

	Control	*Thalotia*	*Turbo*
Acropora millepora	B	A	B
Acropora tenuis	B	A	A
Acropora secale	B	A	B
Porites lobata	A	B	B
Platygyra daedalea	A	B	B

Conclusions

1. *Calthalotia strigata* and *Turbo haynesi* did increase survival of all species of corals
2. CCA grazing by COTS did increase survival compared to the control, but not as significantly as the gastropods that targeted filamentous and other algae species
3. Younger corals' growth was significantly increased by *Calthalotia strigata*
4. The effects of grazing were less pronounced on mounding corals and older corals

References

[1] Ladd, M. C., & Shantz, A. A. (2020). Trophic interactions in coral reef restoration: A review. *Food Webs, 24*. doi:10.1016/j.fooweb.2020.e00149
[2]Craggs, J., Guest, J., Bulling, M., & Sweet, M. (2019). *Ex situ* co culturing of the sea urchin, *Mespilia globulus* and the coral *Acropora millepora* enhances early post-settlement survivorship. *Sci Rep, 9*(1), 12984. doi:10.1038/s41598-019-49447-9
[3] Toh, T. C., Ng, C. S. L., Guest, J., & Chou, L. M. (2013). Grazers improve health of coral juveniles in ex situ mariculture. *Aquaculture, 414-415*, 288-293. doi:10.1016/j.aquaculture.2013.08.025
[4] Henry, J. A., O'Neil, K. L., & Patterson, J. T. (2019). Native Herbivores Improve Sexual Propagation of Threatened Staghorn Coral *Acropora cervicornis*. *Frontiers in Marine Science, 6*. doi:10.3389/fmars.2019.00713

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