Enhanced development of early benthic juveniles of Crown of Thorns Starfish, *Acanthaster planci* at near future acidification and warming.

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Background

Population outbreaks of the coral eating **Crown of Thorns Starfish (COTS) contribute to global declines in coral reef** (De'ath *et al.*,2012; Baird *et al.*,2013).

WHAT WE KNOW AND DON'T KNOW:

- Coral reefs are in global decline from ocean acidification and warming (Hoegh-Guldberg *et al.*, 2007**;** Ban *et al.*, 2014).
- COTS are responsible for large declines in the Indo Pacific region, contributing 40% to a 50% decline in coral reef cover on the Great Barrier Reef from 1987-2012 (Baird *et al.*, 2013;De'ath *et al.*, 2012).
- What is not known is how this major predator of coral reefs will fare under future ocean change and how future ocean change will influence future populations of COTS that threaten coral reef systems.

Aim

Test the response of COTS to ocean acidification and warming at sensitive life history stages (Fig 1), with a particular focus on post settlement success that determine population success under changing ocean conditions.

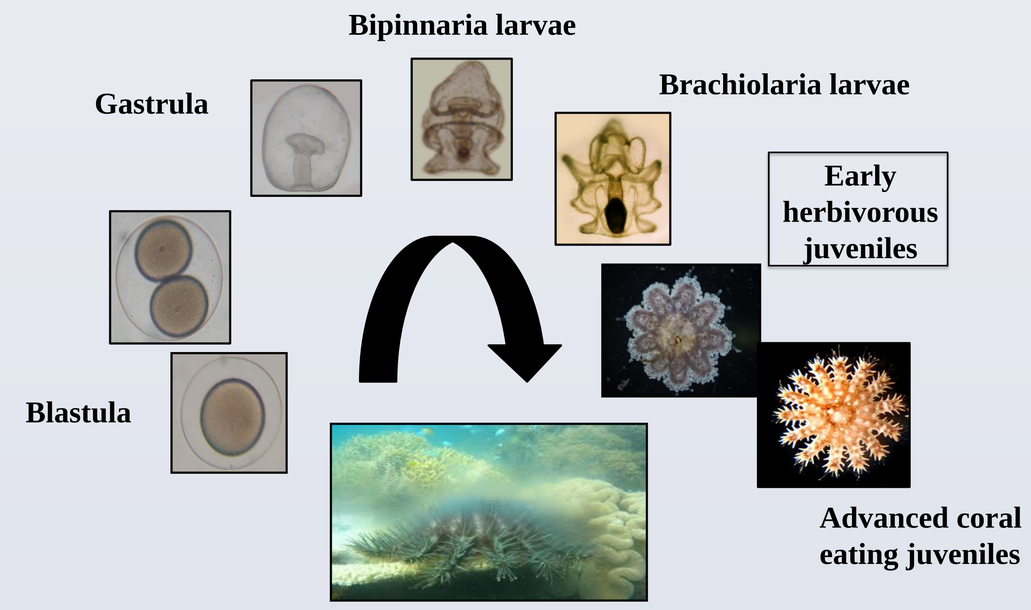

Fig 1 Life history of the Crown of Thorns starfish.

Methods

Gametes were removed from arms of adults (20-40 cm), by making insertions between arms. Embryos were fertilised and grown into larvae in 300 L rearing tanks.

Larvae were settled onto polycarbonate plates with **crustose coralline algae (CCA)** to induce metamorphosis into early juveniles that feed on CCA. Juveniles with 5-6 arms (5 mm) were used in experiments.

Juvenile were grown in a purpose built flow through climate change system that provides **three temperatures × three pH = nine treatments** in a **fully factorial design** in all possible combinations set to those expected by the turn of the century (IPCC, 2014).

Growth and feeding was measured through photographic analysis to determine specific **growth rates in area** (Fig 2a**)**, **arm number**, **spine number** in three longest arms (Fig 2b) and area of **feeding scars** (Fig 2c) at the end of 8 weeks in treatment.

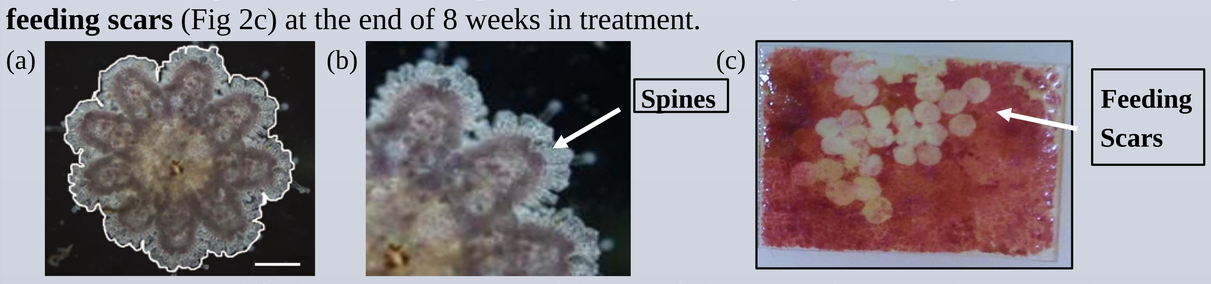

Fig 2 Growth and feeding measurements of Crown of Thorns starfish juvenile at 8 weeks, Scale bar = 100 µm.

Findings

- High growth rates at low pH 7.6 (ANOVA: $P < 0.001$; Post hoc: **8.1=7.8 < 7.6**).
- High growth rates at 28 and 30 °C warming (ANOVA: $P < 0.001$; Post hoc: **26 < 28 = 30 °C**).
- Juveniles had more arms at low pH 7.6 across all temperatures (ANOVA: $P = 0.026$; Post hoc: **8.1=7.8 < 7.6**).
- Production of spines as a proxy for calcification was not affected by warming and acidification.
- No breach in thermal tolerance levels or mortality at high temperatures.

GROWTH

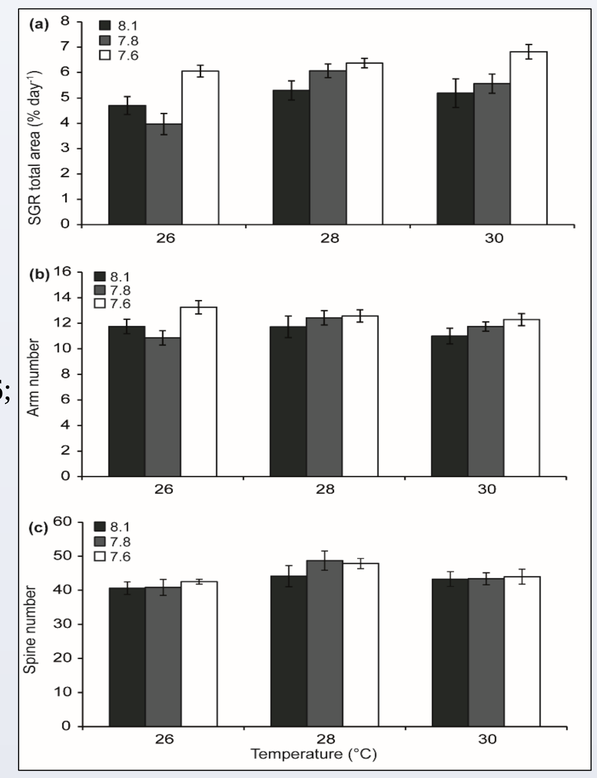

Fig 3 **Growth early of juvenile COTS** after 8 weeks in nine treatments (3 temperatures × 3 pH) measured as specific growth rate (SGR % day^{-1}) in total surface area (a) number of arms (b) and number of spines on three longest arms (c). Values are means ± SE; n = 7-8.

CONSUMPTION

- High feeding rates at low pH 7.6 across all temperatures (ANOVA: $P = 0.02$; Post hoc: **8.1 = 7.8 < 7.6**).
- High feeding rates/area at low pH 7.6 across all temperatures (ANOVA: $P = 0.003$; Post hoc: **8.1 = 7.8 < 7.6**).

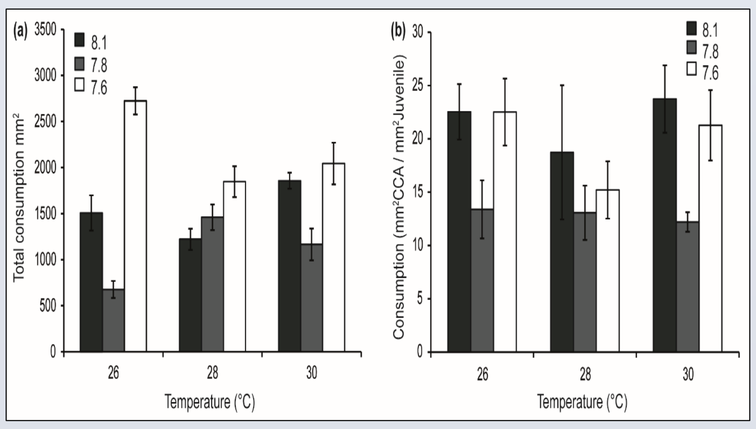

Fig 4 **Consumption of CCA by juvenile COTS** over 8 weeks in nine treatments (3 temperature x 3 pH): total area (mm^2) of coralline algae consumed (a) and area (mm^2) consumed per size, corrected by dividing by the area (mm^2) (b) of individual juveniles. Values are means ± SE, n = 7-8.

Conclusion

Future ocean acidification and warming promotes growth in highly sensitive juvenile stages of the Crown of Thorns starfish.

Increased growth was supported by high feeding rates on crustose coralline algae under future acidification.

Early juveniles are highly tolerant to 30 °C warming.

References

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