Intraspecific variability in the response of coral to increasing temperature and ocean acidification

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1. Introduction

- Calcification is an important process in corals and for the production of coral reef calcium carbonate framework.
- Organismal-scale studies show ccean acidification and warming can both impact calcification rates in reef-building corals[1,2]
- To understand the effects of ocean acidification on calcium carbonate production, we need to understand population-level impacts[3]
- Intraspecific variability is a critical factor determining how populations will respond to global change through natural selection[4]

2. Aims

As part of a research program evaluating the scale-dependence of coral calcification at high pCO_2, we are using a common garden approach to explore the potential for adaptation to modulate population responses to ocean acidification. In this experiment we aim to:

1. Determine if there is intraspecific variability in the calcification response of the scleractinian coral *Acropora pulchra* to high CO_2 and temperature over which natural selection could act.
2. Determine if intraspecific variability in calcification response is related to growth rate.

3. Methods

- Two experiments were performed in Moorea, French Polynesia, assessing the response of *A. pulchra* net calcification (G_n), as determined through buoyant weighing, to two temperature (~27 and 30 °C) and two pCO_2 levels (~400 and 1000 µatm).
- Experiment 1: *A. pulchra* colonies from 4 genotypes were grown in a common garden for 10 months to remove site-specific physiological effects. Nubbins were then taken from the genotypes for a 3 week experiment in which they were exposed to one of four treatments in a 2x2 factorial design.

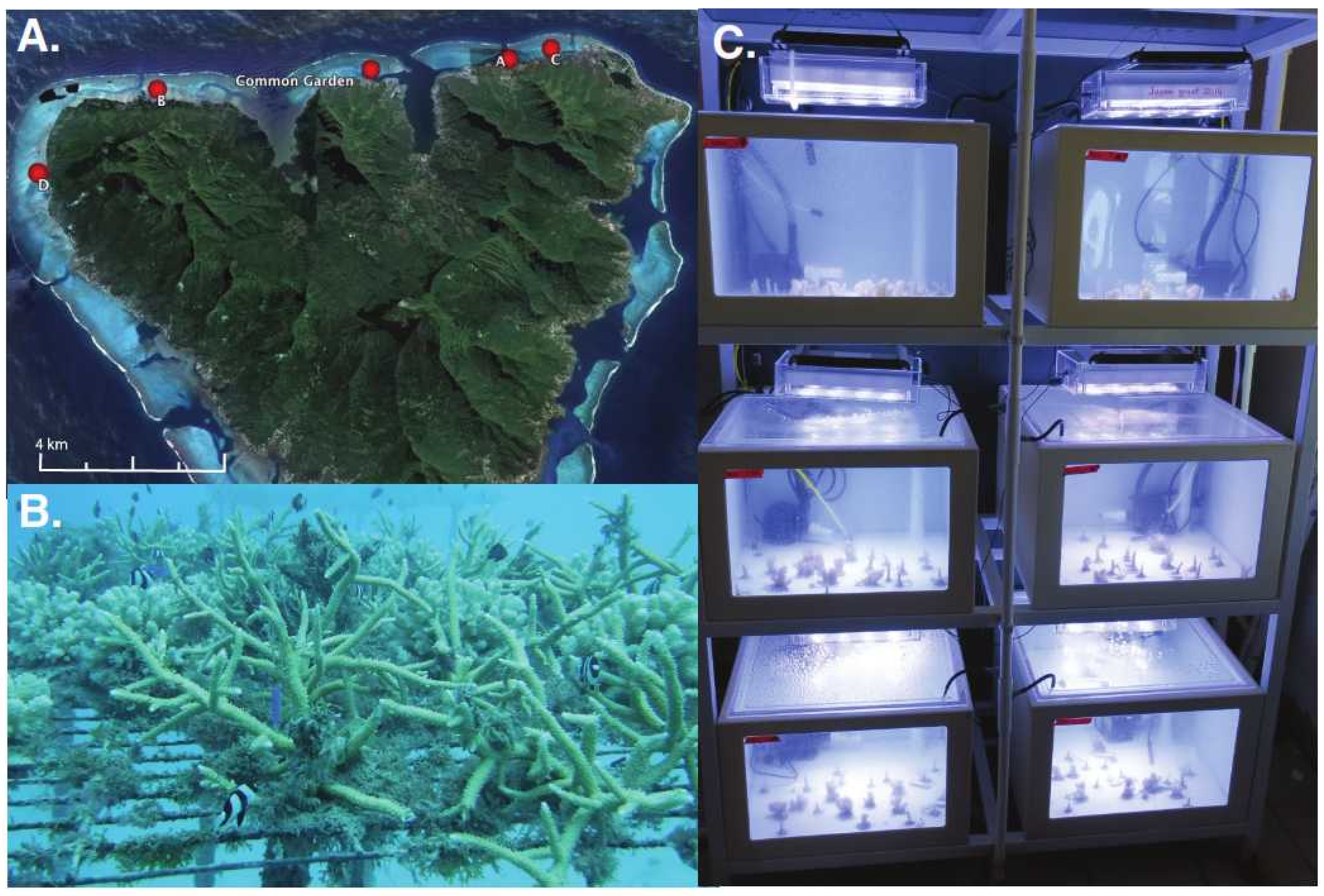

Fig 1. (A) Initial collection sites of the four genotypes of *A. pulchra* (genotypes A-D) and location of common garden in Moorea, French Polynesia. (B) Common garden. (C) Exposure of coral nubbins to temperature and CO_2 treatments.

- Experiment 2: Nubbins from 68 colonies were grown for 3 weeks in 27 °C/ambient pCO_2 then grown for 3 weeks in 30 °C/1000 µatm pCO_2. The change in G_n from ambient to treatment conditions was related to G_n under ambient conditions.

4. Results & Discussion

- Overall, with genotypes pooled together, there was a significant negative effect of both pCO_2 and temperature on G_n (ANOVA, $P < 0.05$). However, G_n was significantly affected by temperature in only one genotype (Genotype D) (Fig. 2), suggesting evolution may result in future prevelance of thermotolerant genotypes. G_n was significantly affected (ANOVA, $P < 0.05$) by pCO_2 in all genotypes (Fig. 2).

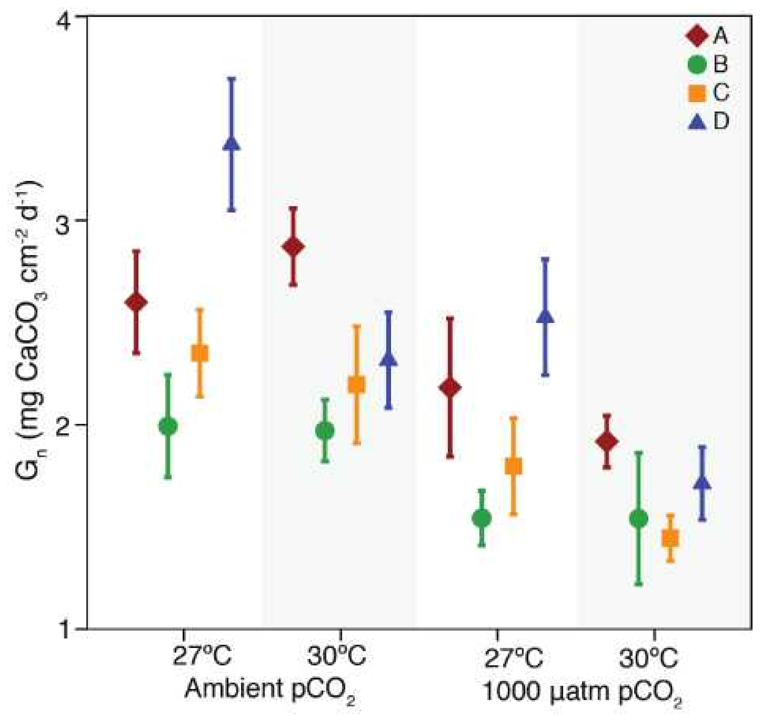

Fig 2. Mean (± standard error) of surface area normalized net calcification rates (G_n) of each genotype under the four pCO_2 x temperature treatments.

- Although there was significant intraspecific variation, there was no genotype that maintained ambient G_n when exposed to high pCO_2 and temperature (Fig. 2).
- This suggests, on these time scales, that phenotypic buffering (i.e. maintenance of a functional phenotype under environmental stress) was not sufficient in any of the examined genotypes to maintain ambient G_n
- Similar to a previous study on Mediterranean corals[5], faster growing individuals under ambient conditions had the largest decline in G_n (Fig. 3), resulting in less variance in growth rates under projected future temperature and pCO_2 conditions representative of future scenarios.

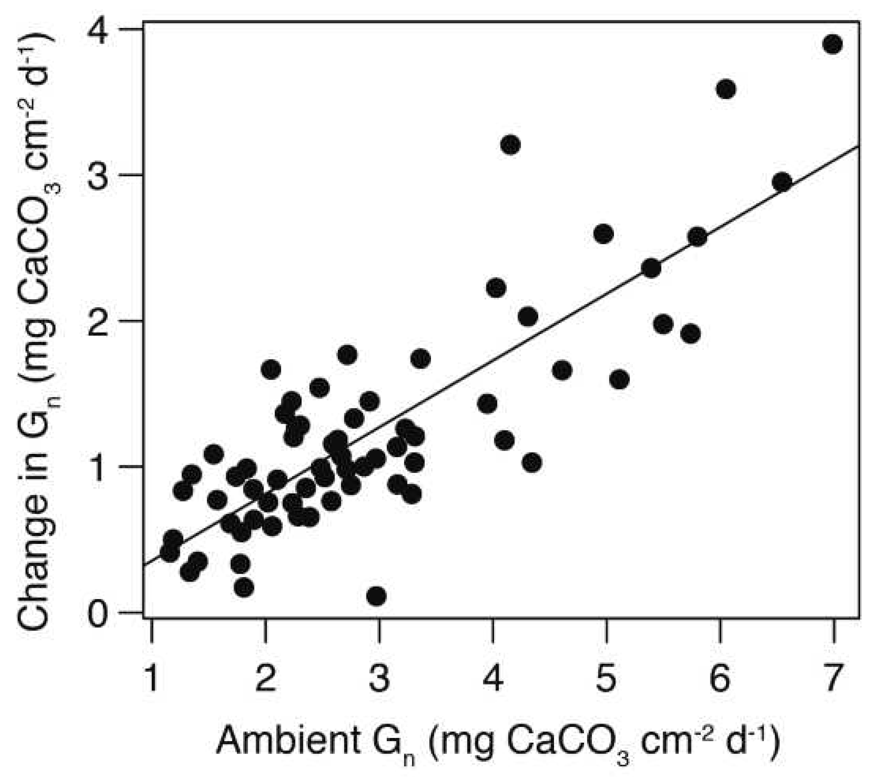

Fig 3. Relationship between the net calcification rate (G_n) of *A. pulchra* under ambient temperature and pCO_2 conditions and the change in G_n from ambient to high temperature and pCO_2.

5. Conclusions

- Corals display intraspecific variability in their response to increasing temperature and pCO_2, which will be important in determining future population dynamics and evolution in a high CO_2 ocean.
- Ocean acidification and warming may have greater effects on faster growing corals, which may have implications for both coral populations and reef calcium carbonate production.

6. References

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2. Comeau, et al. 2016. *Coral Reefs.*
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4. Parkinson & Baums. 2014. *Front. Microbiol. 5*
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