Impacts of Ocean Acidification and Warming on Juveniles of Two Antarctic Heart Urchins, *Abatus ingens* and *Abatus shackletoni*

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INTRODUCTION

Global studies on the adverse effects of ocean acidification and warming on calcified organisms is well-documented. Antarctica is increasingly recognised as being extremely vulnerable to current and projected climate change. The response of *Abatus* sp. juveniles to near-future warming (+2˚C) and ocean acidification (-0.2 – 0.4 units) was investigated. The Antarctic heart urchins, *Abatus ingens and Abatus shackletoni*, undergo direct development from embryo to juvenile within the brood pouches of adult females.

METHODOLOGY

- 22 juveniles per species were used per treatment (n=22).
- Juveniles were photographed then exposed to combinations of 3 pH levels (pH 8.01 (Control), pH 7.83 and pH 7.63) and 2 temperatures (-1˚C (Control) and 1˚C).
- After 4 weeks, they were examined for survivorship, abnormality and re-photographed.
- 10 spines per juvenile were measured pre- and post-exposure.
- Data were analysed by two-way ANOVA.

Abatus ingens

Figure 1: Adult and juvenile *A. ingens.*

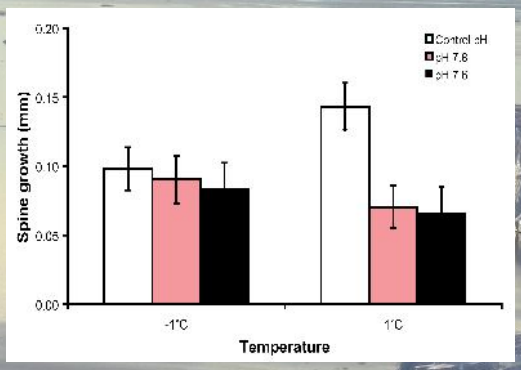

Figure 3: Mean spine growth (mm) after 4 weeks. There was a significant effect of pH but not temperature (ANOVA pH: $F_{2,131} = 4.241$; $p < 0.05$; temperature: $F_{1,131} = 0.029$, $p = 0.865$). N=22.

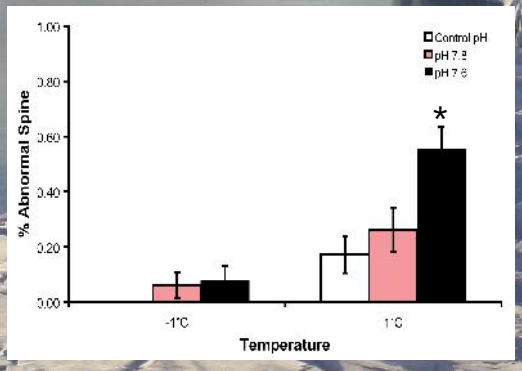

Figure 5: Mean percentage of abnormal spines after 4 weeks. There was a significant interaction between pH and temperature ($F_{2,131} = 3.118$; $p < 0.05$). N=22.

Abatus shackletoni

Figure 2: Adult and juvenile *A. shackletoni.*

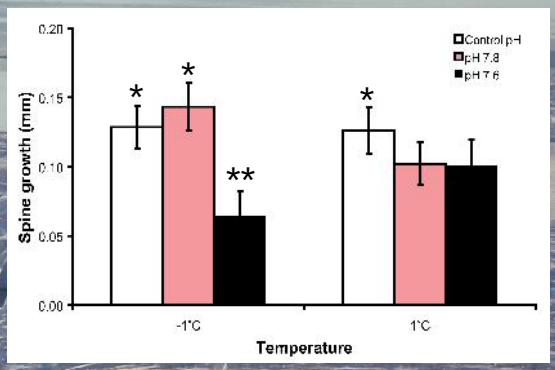

Figure 4: Mean spine growth (mm) after 4 weeks. There was a significant interaction between pH and temperature ($F_{2,131} = 3.323$; $p < 0.05$). N=22.

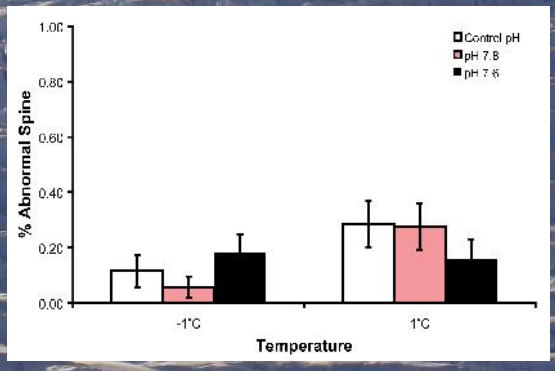

Figure 6: Mean percentage of abnormal spines after 4 weeks. There was a significant effect of temperature but not pH (ANOVA temperature: $F_{1,131} = 5.003$, $p < 0.05$; pH: F2,131 = 0.156, $p = 0.856$). N=22.

MAJOR FINDINGS AND CONCLUSIONS

Under experimental near-future warming and acidification scenarios, juvenile *A. ingens* and *A. shackletoni* maintained spine growth although the amount of growth decreased as pH levels decreased. As characteristic of marine invertebrate development, spine growth was greater at the higher temperature. This was strongly evident in *A. ingens*, and warming appears to have reduced the deleterious effects of pH as shown by *A. shackletoni*. However, as temperatures increased, greater percentages of abnormal spines in juveniles were observed. For *A. ingens*, this was further impounded by decreasing pH levels. In conclusion, the development of juveniles of *A. ingens* and *A. shackletoni* appear to be negatively impacted by ocean warming and acidification.