Predicting the response of ecologically and economically significant oysters to climate change

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Background

As a consequence of sequestration of increasing atmospheric CO_2 , it has been suggested that ocean acidification will occur, threatening the biodiversity and survival of marine organisms and ecosystems which may be unable to adapt to the rate of CO_2 absorption which exceeds that of any other time on the planet[1,2,5]. To date, studies have found a range of negative impacts of elevated CO_2 on oysters and other molluscs including:

- a reduction in calcification and growth[1,2,3]
- a reduction in reproductive capacity and population recruitment[4]
- disturbances in the energy metabolism and acid-base status of adults[1, 5,6]

The extent of these impacts being greater in the presence of elevated temperature[7,8] and yet differing, even between closely related species. Among Ostreids, Parker et al., (2010) examined the effects of elevated CO_2 and temperature on two ecologically and economically significant oyster species, the effect size being greater for the Sydney rock oyster, *Saccostrea glomerata* than for the more resilient and robust Pacific oyster, *Crassostrea gigas.*

Research Issue

The reasons for species-specific differences of *S.glomerata* and *C.gigas* and the robustness in response of *C.gigas* are not understood. Most recently it has been suggested that marine organisms with greater metabolic rate and feeding efficiency may be resilient to the impacts of climate change[9]. Previous studies have found that the metabolic efficiency and feeding rate of adult *C.gigas* was greater than *S.glomerata* under ambient conditions[10], but it is unknown how metabolic rate and feeding efficiency will be altered under elevated CO_2 and temperature.

Hypothesis: *If S.glomerata and C.gigas are exposed to elevated pCO_2 and temperature then there will be a difference in the metabolic efficiency and feeding rate of S.glomerata and C.gigas.*

Deciphering the underlying physiological mechanisms through which mollusc species will respond to climate change stress will enable "climate proofing" of our significant aquacultural industries world wide.

Methodology

Oysters were exposed to ambient and elevated CO_2 and temperature treatments, simulating current and predicted near-future[2] oceanic conditions (Figure 3; Photos 1 & 2).

Physiological parameters including clearance rate[10], absorption efficiency[10], oxygen consumption[7,10], excretion rate[11], oxygen: nitrogen ratio[10], haemolymph pH[7,10], condition index[10] and scope for growth[10] were compared between treatments and species using a 3-factor orthogonal analysis of variance.

Figure 1: Experimental design

Photos 2 and 3: Laboratory set-up

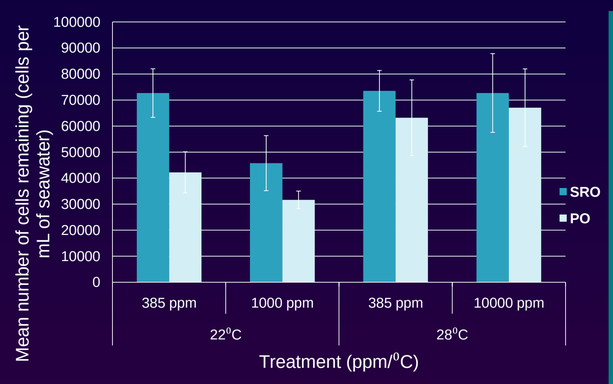

Figure 4: Mean number of cells remaining per treatment after 60 minutes of feeding

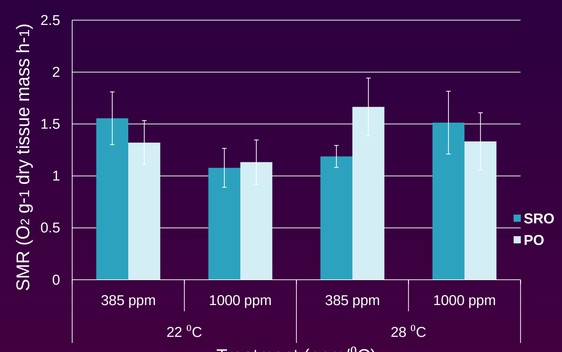

Figure 5: Standard Metabolic Rate

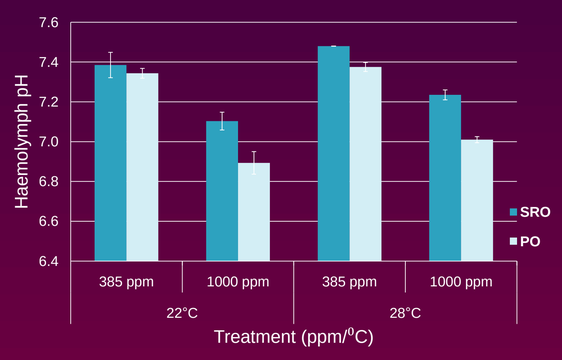

Figure 6: Haemolymph pH

Results

Clearance Rate

Interim results show a significant difference in the mean cells remaining after 60 minutes between temperature treatments (28°C > 22°C; $P < 0.05$). There was a trend for less clearance of cells at elevated temperature, and at 22°C *C.gigas* cleared more cells than *S. glomerata*. (Figure 4).

Standard Metabolic Rate

There was no significant difference between species (Figure 5).

Haemolymph pH

A species x CO_2 interaction was present. There was a significant difference between species at elevated CO_2 (385ppm > 1000ppm). *C.gigas* had a lower haemolymph pH than *S.glomerata* (Figure 6).

Absorption Efficiency

There was no significant effect of treatment on the absorption efficiency between species.

Scope for Growth

Scope for growth will be determined once the remaining physiological parameters are finalised.

Significance and Outcomes

1. A measure of the synergistic impact of elevated CO_2 and temperature on the metabolic efficiency and feeding rate of the Sydney rock and Pacific oysters will determine some of the mechanisms associated with the more resilient and robust response in *C.gigas*.

2. Recommendation to aquaculture industries on which species of oysters will be more resilient to climate change stressors.

3. Integration and communication of research findings to the aquaculture and fisheries industries for consideration into the NSW Oyster Industry Sustainable Aquaculture Strategy ("OISAS").

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