Elevated CO_2 induces different molecular responses from selectively bred and wild type Sydney rock oysters

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Introduction

Changes to ocean chemistry from increasing anthropogenic CO_2 have been shown to significantly impact marine organisms. Estuarine species that form their shell from calcium carbonate are especially susceptible but the risk extends beyond impaired calcification to physiological and subcellular processes.

However, a study of the larvae of Sydney rock oysters selectively bred for disease resistance suggests they may be less affected by elevated CO_2 than non-selected wild type oysters.

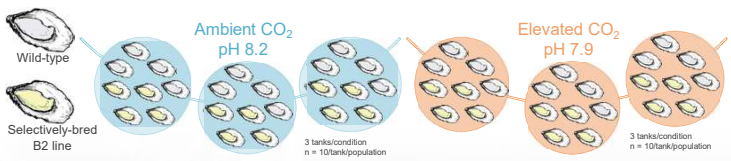
In the current study, we investigated the proteomic differences between adults in these two oyster populations in order to explain the molecular processes involved in any potential resilience of selectively bred Sydney rock oysters to ocean acidification.

Aims

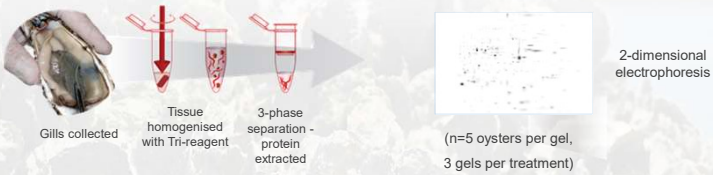
- To compare the proteomic response of selectively bred (B2 line) and wild-type oysters to elevated CO_2 to understand the molecular differences between the two populations.
- To identify if these molecular processes form the basis for observations seen in larvae.

Methods

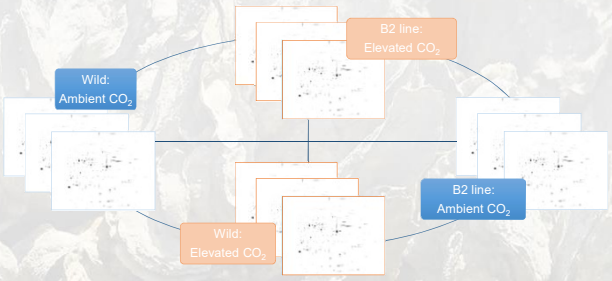
One month experimental CO_2 exposure



Protein extraction and analysis



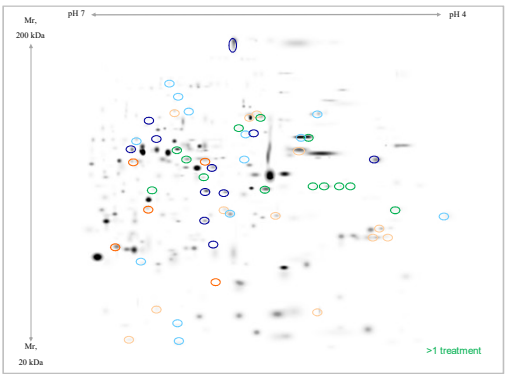
Differential spot detection



Mass spectrometry – LC-MS/MS

67 differentially expressed spots

Results

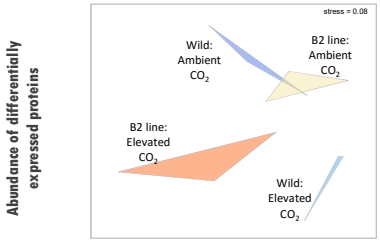


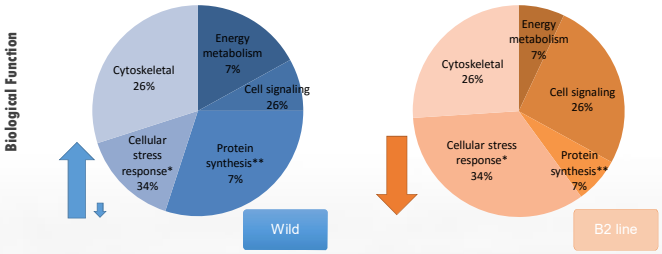
Wild: ambient to elevated CO_2 = 21 (95% increased in intensity after exposure)

B2 line: ambient to elevated CO_2 = 13 (100% decreased in intensity after exposure)

Wild / B2 line: ambient CO_2 = 7 (90% higher intensity in B2 line)

Wild / B2 line: elevated CO_2 = 26 (90% higher intensity in wild)





* Including molecular chaperones, anti-oxidant enzymes, oxidoreductases; **including mRNA metabolism and post translational processing

Conclusions

- Populations of wild and selectively bred Sydney rock oysters mount different proteomic responses to elevated CO_2 exposure.
- Wild Sydney rock oysters show an increased molecular response suggesting an inducible generic stress response. Stress leads to increased energy production with ROS produced as by products; molecular chaperones and anti-oxidant systems increased to prevent excessive ROS disrupting the cytoskeleton thus preventing apoptotic cell death.
- Selectively bred Sydney rock oysters show a decreased molecular response. Large decreases in the cellular stress response (inc anti-oxidant systems) may not be sufficient to compensate for small decreases in energy metabolism production and cell signaling activity resulting in uncontrolled oxidative damage, shutdown of cellular systems and cytoskeletal induced cell apoptisis.
- This study shows the adaptive capacity for enhanced mitochondrial energy production in selectively bred Sydney rock oysters may help protect larvae from elevated CO_2 whilst being deleterious to adults.

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