Trade-offs between local acclimation and resilience in a rapidly changing ocean: Exploring the mechanisms behind the response of zooplankton to environmental stressors

Supervisors

Main supervisor: Doctor Helen Findlay (Plymouth Marine Laboratory)
Co-supervisor: Doctor Ceri Lewis (University of Exeter)
Co-supervisor: Dr Angus Atkinson (Plymouth Marine Laboratory)
Co-supervisor: Dr Geraint Tarling (British Antarctic Survey)

Project enquiries - Email: hefi@pml.ac.uk **Contact number:** +44 (0) 01752 633450

Host Institution: Plymouth Marine Laboratory

Project description

The Problem: In a rapidly changing environment, organisms have three potential options: to migrate elsewhere, to adapt, or to become locally extinct. Different species have differing adaptive and acclimation capacities, and it is widely assumed that species with the widest distributions also have the greatest environmental tolerances. However, this was recently questioned by a study which revealed that the globally distributed copepod, Oithona similis, was less tolerant to relatively small changes in CO_2 than endemic arctic copepods[1]. Two explanations were proposed for the paradoxical sensitivity: First, they had a more limited vertical distribution and so had less pre-exposure to different levels of CO_2. Second, they simply do not have adequate physiological mechanisms to cope with large changes in the environment. Currently the sub-lethal effects of stressors, the mechanisms associated with coping with change/stress, and thus the trade-off between local acclimation and overall sensitivity, are understudied and represent a large knowledge gap for zooplankton species. Detailed ecological, behavioural and physiological understanding is required to assess the mechanisms that control zooplankton responsesto changes in climate and ocean acidification (OA). This project will use Oithona as a model species to explore whether globally distributed zooplankton locally acclimate to a set of environmental conditions, what mechanisms they have to cope with stress, and how this impacts their ability to respond to environmental changes.

The Research: Station L4, part of the Western Channel Observatory (WCO) time-series (http://www.westernchannelobservatory.org.uk/), provides an opportunity to gather concomitant data about Oithona, and other zooplankton, biology and their associated environmental experience over a range of time-scales. The time-series will provide the multi-stress context essential for interpreting the effects of single stressors such as OA. For example it can provide indications of the resilience/sensitivity of a species to its natural range of temperature, CO_2, salinity, and quantity, quality and timing of food sources. A range of techniques will be used to determine the mechanisms of physiological response using laboratory mesocosm facilities. Oxygen consumption, feeding rate, performance/condition indices (e.g. female body mass and egg production rates) and state-of-the-art acid-base physiology techniques[2], will be taken in ship-collected zooplankton from L4 throughout the year as well as from targeted laboratory experiments. Additionally

opportunities of sampling from the Polar Regions may be available for making comparisons to the L4 temperate population.

References:

[1] Lewis CN, Brown KA, Edwards L, Cooper G, Findlay HS (2013) Sensitivity to ocean acidification parallels natural pCO2 gradients experienced by Arctic copepods under winter sea ice.Proceedings of the National Academy of Sciences of the United States of America, 110: E4960-E4967, doi:10.1073/pnas.1315162110.

[2] Venn AA, Tambutte E, Lotto S, Zoccola D, Allemand D, Tambutte S (2009) Imaging intracellular pH in a reef coral and symbiotic anemone. Proceedings of the National Academy of Sciences of the United States of America, 106, 16574-16579.