MASTS Postdoctoral and Early Career Researcher Exchange (PECRE) Fellowship Final Report

Dr. Sophie McCoy

Host: Dr. Nicholas Kamenos, School of Geographical and Earth Sciences, University of Glasgow

Changes in the molecular-scale structure of coralline algae over 3 decades of 'natural' ocean acidification

Background

The goal of this exchange was to combine geochemical and imaging techniques with a unique ecological dataset to determine decadal-scale impacts of ocean acidification on coralline algal habitats. PECRE enabled Dr. McCoy to visit the lab of Dr. Kamenos at the University of Glasgow for two months to learn and perform these techniques.

Pseudolithophyllum muricatum is an encrusting, habitat-creating, intertidal coralline alga. *P. muricatum* collected in the 1980s, 1990s, and 2010s from Tatoosh Island, USA, provide us with the unique ability to assess the effects of recent ocean acidification on the calcium carbonate (high-Mg calcite) structure and mineral hardness of this coralline alga. pH decline has been measured directly at Tatoosh since 2000, with evidence that changes to local seawater carbon cycles have occurred within the last century isolated from other changes.

Ecology is tightly linked to skeletal traits in coralline algae, and direct links have been made between skeletal thickness and competitive ability as well as skeletal strength and resistance to grazing. *P. muricatum* is an ecologically dominant species, and increased susceptibility to grazing predation can thus lead to changes in ecosystem structure. Previous work indicates that overall thallus thickness has halved over the last 30 years but we do not understand if this makes the species more prone to grazing damage. We used Raman spectroscopy to investigate changes in the skeletal lattice structure of *P. muricatum* over the last three decades. This provides insights to the physiological trade-offs faced by *P. muricatum*, *e.g.* whether skeletal changes result from reduced investment in skeletal growth *vs.* reduced maintenance leading to dissolution. 3D SEM image analysis of grazing scars observed on the coralline algal surface was used to compare the physical effects of grazing between historical and modern samples to understand changes in direct grazing impacts with ocean acidification. To contextualize the ecological ability of modern *P. muricatum* compared with other species, these methods were repeated on a sister species, *P. whidbeyense*, and the related coralline *Lithophyllum impressum*. Together these data will enable us to determine the likely ecological impacts of future ocean acidification at realistic time scales of change.

Interaction with MASTS Community

During her visit to Scotland, Dr. McCoy interacted daily with members of the Department of Geographical and Earth Sciences (GES) at the University of Glasgow. This included weekly participation in the Kamenos lab meeting and reading groups as well as discussions

with other researchers using the Imaging Spectroscopy And Analysis Centre (ISAAC) facilities at the University of Glasgow. Dr. McCoy met several other early career researchers in GES, and received peer mentorship from others and served as a mentor for PhD students. Dr. McCoy also gave a seminar at the Scottish Association for Marine Science, hosted by Dr. Michael Burrows, and spent the day speaking with Dr. Burrows and several PhD students and postdocs about current and future research projects.

Completed and Expected Outputs

Knowledge exchange: Dr. McCoy learned analytical techniques at the ISAAC facility, including Raman spectroscopy, Scanning Electron Microscopy (SEM) and 3D SEM, and Electron Back Scatter Diffraction (EBSD), working closely with microanalyst Peter Chung and Dr. Kamenos on sample acquisition, processing, and ongoing data interpretation. Dr. McCoy also received preliminary training on field use of Pulse Amplitude Modification (PAM) fluorometry from Dr. Kamenos and advice on data analysis and interpretation from Dr. Kathryn Schoenrock, a research fellow in the Kamenos group.

Method development: Raman spectroscopy methods previously developed by Dr. Kamenos needed to be adapted for the different species studied here (*Pseudolithophyllum muricatum*, *Pseudolithophyllum whidbeyense*, and *Lithophyllum impressum*). This broadens our understanding of this technique across multiple coralline algal species. Data obtained from Raman and imaging analyses are anticipated to result in a publication.

Added value: Method development was faster than anticipated and no major complications arose. This permitted Dr. McCoy to take advantage of her visit to GES and the Kamenos lab to pursue additional activities.

- Dr. McCoy brought existing samples of the California mussel, *Mytilus californianus*, for exploration on Raman and SEM. The goal was to obtain preliminary mineralogical data to motivate future work and develop Raman methodology to analyze the mussels' inner calcitic layer. However, Dr. McCoy was able to fully complete data acquisition and a publication is now anticipated from this opportunistic project.
- Dr. McCoy joined members of GES on a 5-day field trip to the Isle of Arran, Scotland. While on Arran, Dr. McCoy conducted physiological fieldwork on articulated corallines (*Corallina* spp.) and gained a better understanding of local intertidal communities. The field trip early in Dr. McCoy's fellowship visit enabled her to meet many researchers in GES and get a first-hand feel for the regional intertidal ecology.

Future Plans Enabled by PECRE

It is hoped that collaboration between FSU and the University of Glasgow will continue, both between Dr. McCoy's and Dr. Kamenos' lab groups and additionally with others at both institutions through the networks developed during this fellowship visit. Two publications are already taking form from the data collected during the PECRE visit and results will be presented at an upcoming Gordon conference in July 2016; Dr. McCoy will highlight the coralline algal study in her keynote presentation at the meeting and Dr. Kamenos will include the mussel project in a poster presented at the meeting. It is thus anticipated that the results of this PECRE collaboration will generate a larger collaborative network for future work.