Tamara Green, University of St Andrews

Investigation into the carbon biogeochemistry of Caribbean mesophotic coral reefs

The aim of this study was to investigate the carbon and sulphur biogeochemistry of a mesophotic Caribbean tropical coral reef. Mesophotic reefs are defined as those reefs that occur at depths greater than 30m, often extending to depths well in excess of 100m. Because of recent advances in diving technology (the use of rebreathers, for example) there has been an increased focus on understanding these understudied habitats, but with very little focus on the biogeochemistry of these systems. Our investigation sought to constrain the carbon and sulphur biogeochemistry down a depth gradient at several different sites in the Caribbean, along the Mesoamerican Barrier Reef (the second longest barrier reef in the world after the Great Barrier Reef). Carbonate chemistry (total alkalinity and dissolved inorganic carbon) can act as an indicator of coral reef health, by giving us an estimation of coral calcification and seawater pH. Sulphur biogeochemistry, particularly dimethylsulphoniopropionate (DMSP) and dimethylsulphoxide (DMSO), have been known to act as indicators of coral stress at the organism level. They also play crucial roles in ecosystem health, acting as grazing deterrents, antioxidants and potential foraging cues for pathogenic bacteria (*Vibrio spp*). Since mesophotic reefs are a deeper continuation of shallow water reefs, and can act as potential rifugia for coral species, understanding the carbon and sulphur biogeochemistry of these habitats has potential significance for the management and understanding of reef health.

Our research was conducted in conjunction with Operation Wallacea and with the Thinking Deep team at the University of Oxford. We sampled 6 sites on the island of Utila, off the coast of Honduras, in the western Caribbean. Sites were sampled down a depth gradient from 0m to 80m, and water samples were taken for dissolved inorganic carbon (DIC), total alkalinity (TA), DMSP and DMSO (DMSP/O). We also sampled one species of coral down a depth gradient at one site for intracellular DMSP/O. Since water column sulphur can be affected by abiotic (light) as well as biotic (microbial) processes, intracellular concentrations tell us much more about the health of the organism, rather than the ecosystem.

Results so far and continuing work

We took samples for DIC and TA and noted a general increase in DIC with depth at all sites. Samples were also taken for water column and intracellular DMSP/O and we noted some interesting and significant relationships. We looked at intracellular DMSP as a function of depth at both sites and found no overall effect of depth on the dataset. This is because, interestingly, the patterns are opposite at LB and TMA. LB shows higher DMSP with increasing depth while at TMA it decreases - this is statistically significant $p = 0.035$.

We also noted that the type of benthic cover does have a significant effect on water column DMSP, in which there are clear significant linear relationships between sponges, macroalgae, soft and hard coral, and water column total DMSP with depth. This relationship with depth differs to what we saw intracellularly. It appears benthic cover is a much stronger driver of water column DMSP than intracellular concentrations.

Currently, there are plans to gather more data to test key hypotheses:

- Soft and hard coral, and macroalgal cover play a greater role in net water column DMSP than intracellular concentrations.
- We also hypothesise that sponges act to remove DMSP from seawater, by filtering large volumes of water in reef ecosystems.

To test these hypotheses, we went back to The Maze for one day in July 2016 and sampled:

- Water from over macroalgae, over hard coral, over soft coral, over bare sediment (to act as a control) and immediately above the osculum of a sponge and one a few feet away from the sponge
- We will analyse our samples for DIC, TA and DMSP/O.

We expect these results will provide a mechanistic/physiological/environmental insight as to what's driving sulphur and carbonate biogeochemistry in these systems, and build upon our work from July 2015.

The MASTS small grant enabled me to purchase fieldwork kit for sampling water, consumables for preparing and fixing samples, purchasing consumables for the analysis of samples and shipping samples back to the UK – both for July 2015 and 2016.