Effect of oxidative stress on the biochemistry of dimethylsulfoniopropionate (DMSP)-lyase enzymes in tropical reef organisms – to start October 2019

Christine Desty Scholarship, fully-funded (Home/EU fees £4630 plus stipend of £15,009) for an MSc by Dissertation (MSD) in the School of Biological Sciences, University of Essex

Background

Tropical coral reefs are a substantial source of the climate-cooling gas dimethyl sulfide (DMS). The major precursor of DMS is the secondary metabolite dimethylsulfoniopropionate (DMSP) that is biosynthesised to high concentrations in symbiotic dinoflagellates of the tropical genus *Symbiodinium* [1]. In the phytoplankton *Emiliania huxleyi*, the algal *Alma* DMSP-lyase enzymes are responsible for the production of DMS and *Symbiodinium* contains homologs of *Ehux-Alma1* [2]. Despite their global importance, the biochemical function of DMSP and DMS in corals is underexplored. Since both operate as antioxidants that scavenge harmful reactive oxygen species (ROS) in *E. huxleyi* [3], the cycling of DMSP and DMS may have profound implications for the susceptibility of corals to ROS-induced lethal coral bleaching and the following destruction of reef environments.

Approach

Supported with an ongoing PhD project and in collaboration with King Abdullah University of Science and Technology (KAUST), we recently started building understanding of the dynamics of DMSP and DMS in the *Aiptasia*-*Symbiodinum* model system under physiological stress. Importantly, we grow *Aiptasia*-*Symbiodinum* combinations that show different susceptibilities to ROS-induced bleaching making this model system a preferred choice to study the function of DMSP/DMS under oxidative stress. The studentship applied for here will align with our ongoing efforts by investigating the biochemical basis of DMSP-to-DMS conversion in *Symbiodinium* and *Aiptasia*. With guidance from the supervisors, the student will direct the project's research emphasis and develop scientific hypotheses to assess the function of DMSP and DMS in the *Aiptasia*-*Symbiodinum* model system. The initial objectives and associated time scale are:

1. Conduct a literature review and use *in-silico* searches to identify homologs of *Alma*-like genes in the publicly available genomes of *Symbiodinium* and *Aiptasia*. **[Months 1-2]**
2. Purchase synthetic genes, recombinantly express and purify *Alma*-like proteins in *Escherichia coli* cells. Confirm resulting DMSP-lyase activities using gas chromatographic enzyme assays. **[Months 2-6]**
3. Carry out biochemical analysis of *Alma*-like proteins and initiate crystallisation trials to pursue X-ray crystallography studies. **[Months 5-7]**
4. Grow clonal cultures of stress-resilient and stress-susceptible combinations of *Symbiodinium* and *Aiptasia*. **[Months 3-5]**
5. Synthesise **[Month 3]** and apply the specific *Alma* DMSP-lyase inhibitor 2-bromo-3-(dimethylsulfonio)-propionate (Br-DMSP) [4] to assess the biochemical functioning of DMSP-lyases in the stress physiology of *Aiptasia*, *Symbiodinium* and the *Aiptasia*-*Symbiodinum* holobiont. **[Months 5-12]**
6. Analyse data **[Months 2-12]** and prepare a thesis. **[Months 10-12]**

Feasibility and Training

This project uses methodologies that are well-established in our laboratories [e.g. 1] or published by others [2-4]. The student will receive specific training to address the objectives 1 and 3 (supported by Hough), 2 (Worrall and Hough), 4 and 5 (Steinke with synthesis supported by Dr Sinan Battah), 6 (all supervisors).

The student will work cross-disciplinarily with the Ecology and Environmental Microbiology and the Protein Structure and Mechanisms of Disease groups. Training and supervision will be supported by weekly meetings with the primary supervisor and at appropriate points with the additional supervisors. This project provides opportunity to gain skills sought after by industry and research employers, and presents excellent preparation to pursue PhD studies in biochemistry.

References

1. Steinke, M., et al. 2011. Concentrations of dimethylsulfoniopropionate and dimethyl sulfide are strain-specific in symbiotic dinoflagellates (*Symbiodinium* sp., Dinophyceae). *Journal of Phycology* **47**(4): 775-783.
2. Alcolombri, U., et al. 2015. Identification of the algal dimethyl sulfide–releasing enzyme: A missing link in the marine sulfur cycle. *Science* **348**(6242): 1466-1469.
3. Sunda, W., et al. 2002. An antioxidant function for DMSP and DMS in marine algae. *Nature* **418**(6895): 317-320.
4. Alcolombri, U., et al. 2017. Assigning the Algal Source of Dimethylsulfide Using a Selective Lyase Inhibitor. *ACS Chemical Biology* **12**(1): 41-46.

Entry requirements and application procedures

Highly motivated applicants with, or expecting, a good degree in the broad area of Life Sciences are encouraged to apply.

Applications should be submitted electronically by **24th April 2019** see here for details https://www.essex.ac.uk/pgapply/enter.aspx

You are encouraged to contact the supervisor before application: msteinke@essex.ac.uk, mahough@essex.ac.uk and jworrall@essex.ac.uk If you have any queries with the online application process, please contact ecrix@essex.ac.uk

For general information about the School of Biological Sciences at the University please visit our webpages http://www.essex.ac.uk/bs/.

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