

**Life in the freezer: The role of  
dimethylsulfoniopropionate (DMSP) in the  
physiological and biochemical adaptations of  
Antarctic microalgae**

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This thesis is submitted in fulfilment of the requirements for the degree of Doctor  
of Philosophy in Science

## CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Cristin Sheehan declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy in Science, in the School of Life Sciences at the University of Technology Sydney. This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution. This research is supported by an Australian Government Research Training Program Scholarship.

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## ABSTRACT

Marine microalgae are the fuel of the Antarctic ecosystem and changes in primary production can impact the entire food web, as well as the nutritional value at the base of the food web which is dependant not only on biomass but also the macromolecular content of the individual species. Primary production by Antarctic microalgae is also of key importance in the biogeochemical cycling of carbon and sulfur. Antarctica has a unique and dynamic environment where microalgae are evolutionarily adapted to live in freezing temperatures under extreme and oscillating environmental gradients exposing them to solar, osmotic, oxidative and nutrient stress. This thesis investigated the physiological and biochemical adaptations of Antarctic microalgae, focusing on the role dimethylsulfoniopropionate (DMSP) plays in surviving in the harsh Antarctic environment. This thesis provides new knowledge into who are the DMSP producers in Antarctica, the spatial dynamics and role of DMSP in natural Antarctic microbial communities.

In a screening study, 16 species of Antarctic microalgae were characterised by their growth rates, physiological health, carbon content, DMSP production and DMSP lyase activity. We found that DMSP production and rates of lyase activity were species-specific, varying within taxa, and that diatom species can produce significant levels of DMSP, in the same magnitude as known DMSP producing haptophytes, *Phaeocystis spp.*

In a descriptive study, we take a geographical look at the DMSP content and lyase activity, macromolecular profiles and productivity of three different Antarctic microalgal communities from three unique Antarctic environments; the open ocean to the sea ice and a hypersaline lake. We reveal that species diversity is reduced with more challenging environmental conditions and the species with the greatest phenotypic plasticity dominate in harsher settings. This thesis found that macromolecular content of microalgae changes based on environment, whereby sea-ice microalgae were higher in caloric value due to heavy investment in lipids compared to pelagic species.

Using manipulative laboratory studies, we delivered new insight into the response of DMSP to environmental stress and future climate change scenarios as well as macromolecular responses at the species and community levels. Exposure to hypersaline conditions did not induce increased DMSP production, potentially due to the salinity shift being too rapid. In addition, there was no significant change in DMSP or macromolecular concentrations in response to ocean acidification at the species level, however there was a difference at the community level due to a shift in community composition.

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