2021 Australian Wildlife Society

University of Technology Sydney Wildlife Ecology Research Scholarship

A Molecular Deep Dive: An Omics-Based Assessment of Protein and Metabolite Changes in Freshwater Microalgae When Exposed to Sublethal Concentrations of Zinc

Gwilym Price

Australia's freshwater systems play a vital role in supporting Australia's significant aquatic and terrestrial biodiversity. However, wildlife decline in freshwater ecosystems is occurring at a fast pace. To protect and conserve these important ecosystems, there is a need to ensure that they are managed effectively and protected with the most robust and up-to-date science. Freshwaters are often contaminated by pollutants from residential, industrial, or agricultural sources. Zinc is one of the most used and widespread metal contaminants that enter freshwater systems worldwide, with Australia being no exception.

The management of contaminants entering these water systems is regulated with the use of the Australian and New Zealand Water Quality Guidelines. These guidelines are derived for contaminants using ecological toxicity data to determine at what concentration a contaminant will have a negative effect on endemic species within an ecosystem.

The toxicity of metal contaminants to aquatic life depends on the chemistry of the freshwater system, such as hydrogen (pH), hardness, and dissolved organic carbon. These factors significantly affect metal bioavailability, and thus

Top: Gwilym Price is a PhD candidate at the University of Technology Sydney and CSIRO Land and Water. Gwilym chose to study environmental chemistry and ecotoxicology as he has always had a strong passion for the environment and science more broadly. He finds working at the intersection where human development meets nature fascinating, as it is so often portrayed as two incompatible areas. Image: Sally Carney.

Preparing test media. Image: Gwilym Price.

toxicity to aquatic life. Our guidelines for Australia currently account for the effects of hardness, however the data used for assessing these effects are primarily based on North American fish species. Such data may not be appropriate for the conservation of Australian species or ecosystems.

Australia has a diverse range of freshwater ecosystems and a large range of water chemistry, from the soft waters of Kakadu to the acidic tannin-stained streams in Tasmania. Given the great variability of Australia's freshwater chemistry, there are conditions where our current guidelines for metals are not appropriately protecting the ecosystem. The influence of hardness on zinc toxicity is understudied for Australian freshwater conditions, and the influence of dissolved organic carbon on zinc toxicity is understudied more broadly.

Advances in omics technologies have allowed for the study of metal stress-induced changes to the biochemical composition of microalga. Metals can alter the biochemical composition of microalgae, resulting in changes in the abundance of certain metabolites and proteins. These biochemical changes can have significant food web consequences by altering the availability of different organic molecules to higher trophic levels. Changes in biochemical composition have also been shown to occur at sub-lethal metal concentrations, demonstrating that metal contamination can have negative ecological impacts at lower concentrations than typically detected when using traditional methods.

Harvesting microalgae. Image: Gwilym Price.

The project aims to investigate the influence of water chemistry on zinc toxicity to a freshwater microalga. Understanding these influences on freshwater biota is a key step in developing robust and protective water quality guidelines that are adaptable depending on the ecosystem water chemistry.

The project also aims to investigate the influence of zinc at sublethal concentrations to understand biochemical changes which may have important ramifications for whole freshwater ecosystem health. Microalgae, as primary producers, play a critical role in freshwater ecosystem health through the oxygenation of the water column and as the base of the aquatic food chain upon which all aquatic biota directly or indirectly depend.

The project will model the relationship between water chemistry and zinc toxicity, and the results will be used to develop bioavailability-based guidelines for Australian and New Zealand Water Quality Guidelines.

Funds provided by the Australian Wildlife Society will be used to access protein and amino acid analysis to gain important insights into how sublethal concentrations of zinc influence the biochemical composition of algae and greater insight into the mode of action of zinc contamination.

Gwilym Price in the field, taking samples from a freshwater system. Image: Doctor Darren Koppel.