UNIVERSITY OF TECHNOLOGY, SYDNEY

METAL ACCUMULATION IN TOADFISH, *TETRACTENOS GLABER*, AND THEIR PREY ITEMS

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CERTIFICATE OF AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. I certify that all information sources and literature used are indicated in the thesis.

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ABSTRACT

Estuaries support productive and diverse ecosystems, based on the abundant food and diverse habitats. However with increasing human pressures, many estuaries along the coastline of Australia have become degraded. The primary objective of this study was to investigate the effects of estuarine metal contaminants on the physiology, and the subsequent accumulation, in the smooth toadfish, *Tetractenos glaber,* and their prey items in estuaries in the Sydney region, south eastern Australia.

Toadfish and sediments were collected during three seasonal sampling periods (June 2002, September 2002 and January 2003) in four estuaries in the Sydney region (Port Hacking River, Cowan Creek, Parramatta River and Lake Macquarie). Sediment and toadfish tissue metal concentrations varied both spatially and temporally, with highest concentrations exhibited in the metal contaminated estuaries (Lake Macquarie and Parramatta River) during spring 2002 and summer 2003. Toadfish accumulated metals in different tissue, however field experiments were limited in determining the main pathways of accumulation.

Controlled laboratory kinetic experiments using radioisotopes of ^{109}Cd and ^{75}Se, indicated that differences in the relative contributions of water and food in the accumulation of these metals are generally governed by the physiology of the toadfish and the type of prey eaten. The distribution of metals in fish organs is important for better understanding metal kinetics and their subsequent toxicity. Toadfish exposed to ^{109}Cd in both water or food showed a shift in distribution from gut lining at the end of the uptake phase to the excretory organs, such as liver, by the end of the loss phase, suggesting that the main uptake pathway for water exposure was via the gut and not the gills, due to fish drinking large amounts of water to maintain osmoregulation. There was no appreciable shift in the distribution of ^{75}Se from the uptake or loss phases, being mostly associated with the excretory organs (gills, liver and kidneys). Further investigation into the accumulation of metals in toadfish prey items revealed that differences in uptake and loss of ^{109}Cd and ^{75}Se were influenced by their aqueous speciation, as well as differences in animal physiology, sequestration, storage and excitation mechanisms. The uptake rates and CFs of ^{109}Cd and ^{75}Se were highest, and the biological half-lives the longest, in pygmy mussels, ghost shrimps and polychaetes relative to the semaphore and soldier crabs.

Elevated metal concentrations in certain toadfish tissues from the four estuaries were linked to reduced lipid concentrations and increased protein concentrations, which may be detrimental for growth, reproductive output and survivorship of the fish. A closer investigation into the nutritional value and metal concentrations of toadfish prey items in a selected metal contaminated estuary (Parramatta River) revealed that toadfish from the more contaminated sites within the estuary may grow faster due to higher nutritional value of prey items on a local scale, however on a larger spatial scale, this was not evident. Further investigation is required to determine whether larger toadfish size can be attributed to physiological acclimation or genetic resistance through generations of continuous metal exposure.

Many studies have assessed metal concentrations in water, sediments and biota in the field, however few studies have combined both field and laboratory experiments to examine the effects of metals on fish physiology and reproduction, and metal transfer pathways in aquatic biota. This study has contributed to a better understanding of metal accumulation and its physiological effects in estuarine biota and highlights the high spatial and temporal variability in responses of organisms to environmental metal pollution.