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Heavy metal concentrations in mallards in New Zealand

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To my Grandfather, Gerald Gibb.

(Gibb and MacMahon, 1955)

I miss your late-night phone calls about the elusive iPad off button, your well-worn stories, your passion for learning, but most of all, I miss your endless enthusiasm and support for 'my ducks' and their lead.

I'm not sure who should apologise the most- you for leaving right before my original due date, or me for not writing fast enough.

I'm sorry you never got to see the full story.

Abstract

This study aimed to identify the exposure of two geographically separated populations of mallard ducks (*Anas platyrhynchos*) and a cross-section of native waterbirds to three heavy metals. The concentrations of cadmium (Cd), copper (Cu), and lead (Pb) were determined in the liver, blood, and eggshell of mallard ducks and in archived liver samples from 71 native waterbirds. By using mallards as a bioindicator to establish the bioavailability and contamination of the New Zealand waterfowl ecosystems to these three heavy metals, the pollution rate and possible dangers to both environment and human health can be established. Exposure to all three metals is widespread in mallards, with all livers and blood samples showing detectable levels of all metals. Eggshells concentrations were low for Cd (3.5%) and Pb (13.6%), and detectable levels of Cu were found in all eggshells, reflecting its status as a trace mineral.

Pb is a nonessential, highly toxic heavy metal that is of concern to waterfowl due to the use of Pb shot ammunition for hunting. Ingestion rates of Pb shot were examined through analyses of mallard gizzard contents, and while Pb ingestion was found, there was a significant decrease in both sites from rates recorded prior to Pb shot restrictions. Mallards from the Waikato site were found to have significantly higher concentrations of Pb, in both liver and blood, suggesting that the bioavailability within this region is higher than Southland. For native waterbirds, only two pāteke (*Anas chlorotis*) from Aotea (Great Barrier Island) had hepatic Pb concentrations consistent with toxic levels of exposure.

Cd is a toxic carcinogen known to adversely affect reproduction and survival. In mallards, while Cd blood concentrations were low, 32.4% of livers had elevated Cd above background levels and 16.1% of livers were above the maximum allowable threshold in offal for human consumption. Whio (*Hymenolaimus malacorhynchos*) from the West Coast of the South Island and pāteke from Aotea were found to have hepatic Cd concentrations that suggest high environmental exposure of Cd within these two regions.

Cu is an essential trace element, however in excess it can produce toxic effects. A high proportion (15.8%) of mallards were found to have hepatic Cu concentrations elevated above toxic thresholds. In contrast to the rural living mallards, native waterbirds all had only physiologically normal hepatic concentrations of Cu.

This study provides evidence for contamination of New Zealand waterfowl ecosystems with these three heavy metals, suggests that consumption of waterfowl livers may be contraindicated for human health, and that heavy metal exposure in mallards is at levels consistent with adverse effects on individual and population level health in these important game birds.

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P.S. This thesis began with a mudfish translocation, and if my grandfather hadn't stolen the show, this thesis would be dedicated to those mudfish who, tragically lost their home to the ever-straightening Northern Motorway. I'm sure this research will trickle back to you somehow.

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