# Monitoring cadmium and zinc contamination in freshwater systems with the use of the freshwater river crab, *Potamonautes warreni*

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## Abstract

Zn (an essential element) and Cd (a non-essential element) levels were measured in water and sediment samples and in *Potamonautes warreni* individuals from Germiston Lake, an impacted site, and Potchefstroom Dam, a minimally impacted site. All samples for metal analysis were acid digested in triplicate at 200 to 250°C with 55% nitric and 70% perchloric acids in a ratio of 2:1 (v/v). The results revealed that the Cd levels in the water, sediment and biota were similar at the two sites, but that higher levels of sediment-bound Zn were detected at the impacted site. Cd levels in *P. warreni* were low and did not differ significantly between the two sites. Zn concentrations, were significantly higher in the organisms from the impacted site, a result which could be exacerbated by the softer water from that site. This might suggest that the levels of Zn were not well regulated by *P. warreni*. Gender-related differences were not observed for either metal at either site. While the size and mass of *P. warreni* did not affect Cd accumulation at either site, Zn levels were influenced by these parameters, but only from the more impacted site. This observation might suggest that size- and mass-related trends become evident only where high environmental Zn levels prevail. The results presented here imply that *P. warreni* could indeed prove to be a useful bioaccumulative indicator for Zn contamination. In this regard further investigations are essential before their use as bioindicators for Cd accumulation can be proven.

## Introduction

Zn is fairly abundant in nature and its ores are widely distributed (Kelly, 1988). Cd, on the other hand, is a comparatively rare element (Aylett, 1979) that is usually closely associated with Zn ores (Friberg et al., 1974). This tends to lead to the release of Cd into the environment whenever Zn is released (Hem, 1972). Although small amounts of these metals are released by leaching of rocks and other natural processes, the levels of these metals in inland waters are often greatly increased by anthropogenic activities, ranging from mining to industry (Birch et al., 1996). Zn and Cd compounds can enter the bodies of aquatic animals via the gills, the general body surface and the alimentary canal, following ingestion of contaminated food particles (Jennings and Rainbow, 1979). The bioavailability of these metals. is usually correlated with the $Zn^{2+}$ (Smies, 1983) and $Cd^{2+}$ ions (WHO, 1992). Their bioavailability is therefor influenced more by the chemical forms of the elements (Coombs, 1979) and their interactions with other substances in solution (Eisler, 1981) rather than by the total levels of the metals present in the water (Kersten and Förstner, 1987). For example, the bioavailability of Cd to benthic aquatic organisms is limited by its strong adsorption to environmental components such as sediment and organic matter (WHO, 1992).

While Zn is an essential metal that is an important constituent of cells and upon which several enzymes depend as a cofactor (Friberg et al., 1974), Cd is a non-essential metal that is toxic even when present in very low concentrations (Wong and Rainbow, 1986). The toxic effect of Cd is exacerbated by the fact that it has an extremely long biological half-life (Webb, 1975) and is therefore retained for long periods of time in organisms after bioaccumulation (WHO, 1992). Although Zn does not appear to be toxic to most freshwater invertebrates (Timmermans, 1993), it can become toxic at elevated levels such as found in Germiston Lake (Phillips, 1980).

Anthropogenic activity can result in greatly increased levels of Cd and Zn in the environment. These elevated metal levels can have detrimental effects on both the biota inhabiting the aquatic environment as well as people who utilise this environment for food, recreation and potable water. It is therefor essential that the contamination of freshwater systems by these metals be carefully monitored. The aim of this study was to determine the levels of these metals in the freshwater river crab, *Potamonautes warreni*, collected from two differentially impacted sites and to assess the potential use of these organisms as bioaccumulative indicators of the degree of Cd and Zn contamination in these aquatic systems.

## Materials and methods

Water, sediment and *P. warreni* individuals were collected from Germiston Lake and Potchefstroom Dam (Fig. 1) every second month between February 1995 and February 1996. A detailed description of these two sites is given in Sanders et al. (1997). Water samples of 200 mℓ used for the determination of dissolved metal content were filtered through a 0.45 µm pore size filter paper on site, and particulate metal content was calculated after analysis of the unaltered water samples. Surface sediment samples were collected with a stainless steel corer (5 cm diameter) fitted with a perspex lining. Only the top 5 cm of sediment was retained for analysis. All sediment samples were oven dried and sieved to allow separation into the following size categories: granules (2 000 to 4 000 µm); coarse sand (250 to 1 680 µm); fine sand (62.5 to 210 µm); and silt and clay (< 62.5 µm) (Folk and Ward, 1957). *Potamonautes warreni* was sampled with ten traps (1 m x 30 cm), baited with freshly killed fish and placed onto the

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