Metal concentrations in *Clarias gariepinus* and *Labeo umbratus* from the Olifants and Klein Olifants River, Mpumalanga, South Africa: Zinc, copper, manganese, lead, chromium, nickel, aluminium and iron

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Abstract

The upper catchment of the Olifants River, from its origin near Bethal to its confluence with the Wilge River, north of Witbank, and its tributaries are being subjected to increasing afforestation, mining, power generation, irrigation, domestic and industrial activities. These activities have a profound effect on the water quality. The major point sources of pollution in the study area include mines, industries and very importantly, combined sewage purification works that are located alongside the river. In addition to oxidizable material, these sources contain detergents, nutrients and metals. It was therefore necessary to determine the extent to which these activities affect the water quality of the system. The bioaccumulation of zinc (Zn), copper(Cu), manganese (Mn), lead (Pb), chromium (Cr), nickel (Ni), aluminium (Al) and iron (Fe) in the skin, muscle, liver and gill tissues of *Clarias gariepinus* and *Labeo umbratus* from the Upper Olifants River and Klein Olifants River was investigated over the period February 1994 to May 1995. The highest concentrations of these metals were found in the gill and liver tissues of both species, with lower concentrations in the skin and muscle tissues. Bioaccumulation patterns were found to vary according to the species of the fish, mainly according to their different feeding habits and the routes of metal uptake. It also varied as a function of the different localities. Accumulation was size specific, with higher concentrations of metals found in smaller fish.

Introduction

All metals are natural constituents of the environment and are found in varying levels in all ground and surface waters (Martin and Coughtrey, 1982). Some are essential, required for the normal metabolism of aquatic organisms, while others are non-essential and play no significant biological roles (Prosi, 1979; Rainbow and White 1989). In addition to their natural occurrence, metals may enter and contaminate the environment from five general sources namely geological weathering (the source of natural/background levels), industrial processing of metals and ores, the use of metals and their compounds, leaching of metals from municipal and solid waste dumps - especially mine dumps, and animal and human excretions (Förstner and Prosi, 1979; Witman, 1979). Metal pollution in South Africa and especially in the Upper Olifants River catchment area, is mainly attributed to water use for afforestation, mining and power generation, irrigation as well as domestic and industrial purposes (Coetzee, 1996).

Metals are persistent and tend to accumulate in the environment, especially in the sediments (Tessier and Campbell, 1990; Birch et al., 1996). The chemical characteristics of metals are responsible for the fact that all metals ultimately become toxic at some elevated concentration (Rainbow, 1985). Abnormally high concentrations can cause the inability of organisms to excrete, sequester or otherwise detoxify themselves, especially in the case of non-essential metals (Thorp et al., 1979). They can also become strongly enriched in the aquatic food chain, through a process referred to as biomagnification (Förstner and Müller, 1976).

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Organisms can accumulate metals to levels above those which are required for normal physiological functioning. The measurement of metal concentrations in these organisms provides the basis for the use of bioaccumulative indicators of the degree of metal pollution in various aquatic ecosystems. The objective of this study was to determine the extent of zinc (Zn), copper (Cu), manganese (Mn), lead (Pb), chromium (Cr), nickel (Ni), aluminium (Al) and iron (Fe) bioaccumulation in different tissues of the African Sharptooth Catfish, *Clarias gariepinus* and the Moggel, *Labeo umbratus* from the Upper Olifants River Catchment (Klein Olifants River - Locality KOR1 and the Olifants River -Locality OR1) (Fig. 1). These data were required to assess the possibility of elevated levels of these metals in fish due to point and diffuse sources of pollution in the Upper Catchment of the Olifants River. The dependence of bioaccumulation in different tissues on the species, size, gender and locality differences of these fish were specifically addressed.

Experimental method

Description of catchment and localities

The Olifants River originates in the Bethal-Trichardt area and flows in an easterly direction before crossing the Kruger National Park into Mozambique (Fig. 1). The Olifants River basin in the Transvaal drains a large area of over 54 575 km^2 (Theron et al., 1991). Although conditions are not ideal for afforestation due to low rainfall, approximately 17 680 ha of exotic afforestation occurs in the upper catchment, which is concentrated around Witbank and Middelburg in the catchments of the Olifants and Klein Olifants Rivers respectively. The upper catchment, with its tributaries, drains a portion of the Mpumalanga highveld where most of the